

ICC ARBITRATION CASE NO. 19784/AGF/RD

In the matter of an arbitration
under the Rules of Arbitration of the International Chamber of Commerce
in force as from 1 January 2012

between:

1. **SOUTHERN CALIFORNIA EDISON COMPANY;**
(UNITED STATES OF AMERICA)
2. **EDISON MATERIAL SUPPLY LLC;**
(UNITED STATES OF AMERICA)
3. **SAN DIEGO GAS & ELECTRIC COMPANY; AND**
(UNITED STATES OF AMERICA)
4. **CITY OF RIVERSIDE**
(UNITED STATES OF AMERICA)

The Claimants

and

1. **MITSUBISHI NUCLEAR ENERGY SYSTEMS, INC.**
(UNITED STATES OF AMERICA)
2. **MITSUBISHI HEAVY INDUSTRIES, LTD.**
(JAPAN)

The Respondents

FINAL AWARD

Arbitral Tribunal

Jonathan D. Schiller

John W. Hinchey

Professor Dr. Albert Jan van den Berg (President)

10 March 2017

Representing the Claimants:

Southern California Edison Company and
Edison Material and Supply LLC

Peter A. Wald
Melanie M. Blunski
LATHAM & WATKINS LLP
505 Montgomery Street, Suite 2000
San Francisco, CA 94111
U.S.A.

Thomas J. Heiden
LATHAM & WATKINS LLP
330 North Wabash Avenue, Suite 2800
Chicago, IL 60611
U.S.A.

Henry Weissmann
MUNGER, TOLLES & OLSON LLP
355 South Grand Avenue, 35th Floor
Los Angeles, CA 90071

San Diego Gas & Electric Company:

John A. Yacovelle
Neil A.F. Popović
Marisa B. Miller
SHEPPARD MULLIN RICHTER & HAMPTON LLP
12275 El Camino Real, Suite 200
San Diego, CA 92130
U.S.A.

City of Riverside:

Howard B. Golds
Scott W. Ditfurth
BEST, BEST & KRIEGER LLP
3390 University Avenue, 5th Floor
Riverside, CA 92501
U.S.A.

Representing the Respondents:

Barbara L. Croutch
Jack McKay
John R. Heisse
Thomas Allen
PILLSBURY WINTHROP SHAW PITTMAN LLP
725 South Figueroa Street, Suite 2800
Los Angeles, CA 90017
U.S.A.

Deborah S. Ballati
Mark D. Petersen
FARELLA BRAUN + MARTELL LLP
235 Montgomery Street, 17th Floor
San Francisco, CA 94104
U.S.A.

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LIST OF DEFINED TERMS

10 MW test	A test of FIT-III
AECL	Atomic Energy of Canada Limited
AIT	NRC Inspection Procedure 93800 ‘Augmented Inspection Team’
ANO-2	Unit 2 of Arkansas Nuclear One
Answer	The Respondents’ Answer and Counterclaims, filed on 27 December 2013
APWR Model test	A test of FIT-III
AREVA	A France based nuclear steam generator designer. Previously FRAMATONE
AREVA’s 6 June 2012 Presentation	AREVA’s Presentation on Unit 3 Repair options, dated 6 June 2012
AREVA Report	AREVA’s assessment of MHI’s Type 1 Repair proposal, dated 30 May 2013
ASLB	Atomic Safety and Licensing Board of the Nuclear Regulatory Commission
ASME	American Society of Mechanical Engineers
ATHOS	Analysis of the Thermal Hydraulics of Steam Generators
AVB	Anti-Vibration Bar
Award	This present arbitration Award in ICC Case 19784/AFG
Blasius Equation	An equation for calculating surface friction
B&W	Babcock & Wilcox and/or Babcock & Wilcox Canada
B&W 6 June 2012 Presentation	B&W’s presentation on Unit 3 repair options, dated 6 June 2012.
BAFO	Best and Final Offer
Bechtel	Bechtel Corporation
C-PHM	Claimants’ Post-Hearing Memorial, filed 14 July 2016

C-RPHM	Claimants' Reply Post-Hearing Memorial, filed 31 August 2016
CAL	Confirmatory Action Letter of the Nuclear Regulatory Commission, dated 27 March 2012
CDS	Conformed Design Specification
Civil Code	The California Civil Code
Claimants	Southern California Edison Company, Edison Material Supply LLC, San Diego Gas & Electric Company and City of Riverside
Clotaire test	A test of FIT-III
Commercial Code	The California Commercial Code
Consolidated Answer	The Respondents' Consolidated Answer to Joinder of Claims and Counterclaims of the Respondents, filed on 18 August 2014
Connors' Equation	The equation for calculating critical velocity
Costs	Legal fees and expenses and administrative and tribunal costs of the arbitration
Counter-Memorial	The Respondents' Counter-Memorial, filed on 11 May 2015
Counter-Memorial to SDG&E	The Respondents' Separate Counter-Memorial to SDG&E's Memorial, filed on 11 May 2015
CR	Circulation Ratio
C-PHM	The Claimants' Post-Hearing Memorial, filed on 14 July 2016
CPUC	California Public Utilities Commission
C-RPHM	The Claimants' Reply Post-Hearing Memorial, filed on 31 August 2016
Defect(s)	Section 1.2.12 of the RSG Contract
Design Improvements Presentation	Study of design improvements against tube flow vibration problem, dated 31 May 2012
\$	United States dollar
ECT	Eddy current testing

Edison	Southern California Edison Company and Edison Material Supply LLC
EIX	Edison International
EMS	Edison Material Supply LLC
EPRI	Electric Power Research Institute
Exponent	The Claimants' experts, Dr. Morse and Dr. Kytömaa.
F=ma	Force equals mass multiplied by acceleration
FEI	Fluid elastic instability
FEE	Fluid elastic excitation
FIT-III	Flow in Tube Bundle Three Dimensional Analysis
FIV	Flow-induced vibration
FIVATS	Flow-Induced Vibration Analysis of Tubular Structures
Freon test	A test of FIT-III
FSAR	Final Safety Analysis Report
Gap Velocity Error	The Respondents' admitted error of failing to convert gap velocities in the FIT-III post processor from tubes configured in a square array to a triangular pitch array
Hearing	Hearing held for these proceedings from 21 March 2016 through 29 April 2016 in San Francisco, USA
ICC	International Chamber of Commerce
ICC Court	International Court of Arbitration of the International Chamber of Commerce
ICC Rules	Arbitration Rules of the International Chamber of Commerce as in force as from 1 January 2012
Idelchik handbook	A textbook which includes means for calculating pressure loss
Incident	The 31 January 2012 leak in SONGS Unit 3 and the subsequent unplanned shutdown.
Initial Draft Report	Draft of MHI's Root Cause Evaluation Report, 30 March 2012

INMG	Internal Nuclear Management Group
IVHET	Impact Vibration of Heat Exchanger Tube with Gap Support Code
LAR	License Amendment Request
List of Issues	The list of issues the Parties requested that the Tribunal address in this Award, dated 26 April 2016
JSME	Japanese Society of Mechanical Engineers
K	Connors' Constant in Connors' Equation
k	Contraction Pressure Loss Coefficient in Idelchik handbook
Kg/cm²	Kilograms per square centimeter
Liability Cap	Cap on Mitsubishi's overall liability as agreed by Edison during contract negotiations
Majority	Presiding arbitrator Albert Jan van den Berg and arbitrator Mr. John Hinchey
Memorial	Memorial submitted by the Claimants, filed on 10 February 2015
Mitsubishi or MHI	Mitsubishi Heavy Industries, Ltd. and Mitsubishi Heavy Industries America, Inc (or Mitsubishi Nuclear Energy Systems, Inc)
MHI's Response to AREVA Report	Exh. JX-2190
MHIA	Mitsubishi Heavy Industries America, Inc.
MoU	Memorandum of Understanding between Mitsubishi and Edison regarding a payment of Edison's expenditures for the repair of SONGS, dated 20 December 2012, Exh. JX-1572
MNES	Mitsubishi Nuclear Energy Systems, Inc.
NEIL	Nuclear Energy Insurance Limited
Notice of Joinder	Notice of Joinder by City of Riverside in Claims Alleged in Request for Arbitration Filed by Southern California Edison Company and Edison Material Supply LLC of 17 July 2014
NRC	Nuclear Regulatory Commission

NRC Lessons Learned Report	NRC report on its response to the SONGS Incident, dated 15 March 2015
NRR	Nuclear Reactor Regulation
NSH	No significant hazards
OSGs	Original steam generators
PAR	Performance Analysis Report
Parties	The Claimants and the Respondents collectively
Party	The Claimants and the Respondents individually
PHM	The Post-Hearing Memorials of the Parties
PHTC	Pre-Hearing Telephone Conference held on 3 March 2016
φ	phi
Φ	Phi
PO 1	Procedural Order No. 1 of 8 December 2014
PO 2	Procedural Order No. 2 of 22 December 2014
PO 3	Procedural Order No. 3 of 4 June 2015
PO 4	Procedural Order No. 4 of 16 October 2015
PO 5	Procedural Order No. 5 of 5 December 2015
PO 6	Procedural Order No. 6 of 18 December 2015
PO 7	Procedural Order No. 7 of 24 December 2015
PO 8	Procedural Order No. 8 of 15 January 2016
PO 9	Procedural Order No. 9 of 3 February 2016
PO 10	Procedural Order No. 10 of 9 March 2016
PO 11	Procedural Order No. 11 of 12 July 2016
PSI	Pounds per Square Inch
Purchase Order	Revision 2-4 of the Purchase Order without regard to the dispute over whether Rev. 4 to the Purchase Order was ever agreed to by the Respondents
PWR	Pressurized Water Reactor
QA	Quality Assurance

RAI	Request for Additional Information by the NRC in response to a CAL submission
RAI3	SCE's response of 1 April 2013, to the NRC's RAI on items 68-70; Exh. JX-1724
RCA	Root Cause Analysis by MHI provided to the NRC, dated 25 February 2013
Rejoinder	The Respondents' Rejoinder to the Claimants' Reply, filed on 5 January 2016
Rejoinder to Counterclaims	The Claimants' Rejoinder to the Respondents' Reply to the Counterclaim, filed on 19 January 2016
Rejoinder to SDG&E	The Respondents' Rejoinder to SDG&E's Reply, filed 5 January 2016
Reply	The Claimants' Reply to the Respondents' Counter-Memorial, filed on 23 October 2015
Reply to Counterclaims	The Claimants' Reply to the Respondents' Counterclaims, filed on 17 February 2014
RfA	The Claimants' Request for Arbitration, filed on 16 October 2013
Request for Bifurcation	The Respondents' request for bifurcation, filed on 21 October 2014
Reply to Request for Bifurcation	The Parties' reply and/or further submissions on the Respondents' Request for Bifurcation, filed on 31 October 2014
Respondents	Mitsubishi Nuclear Energy Systems, Inc. and Mitsubishi Heavy Industries, Ltd.
Reynolds Number	A means of determining surface friction
RFI	Request for Information
RFP	Request for proposal to vendors to provide RSGs for SONGS Units 2 and 3, issued by Edison on 12 December 2003
Riverside	City of Riverside
Riverside Reply to Counterclaims	Reply to the Respondents' Counterclaims, filed by the City of Riverside on 16 September 2014
RRVHs	Replacement Reactor Vessel Heads

RRVH Contract	Purchase Order incorporating the Procurement Specification SO23-618-01 for Reactor Vessel Head Replacement for Unit 2 and Unit 3, San Onofre Nuclear Generating Station, issued on 1 December 2005 and last countersigned on 14 December 2005
RSG or RSGs	Replacement steam generators
RSG Contract	Conformed Specification for Design and Fabrication of the Replacement Steam Generators for Unit 2 and Unit 3, San Onofre Nuclear Generating Station (Specification SO23-617-01), Revision 4 between MHIA and EMS, dated 9 November 2010
R-PHM	The Respondents' Post-Hearing Memorial, filed on 14 July 2016
R-RPHM	The Respondents' Reply Post-Hearing Memorial, filed on 31 August 2016
SAFSTOR	A long term decommissioning option for a nuclear power plant that places the plant in a "safe storage" mode with decommissioning efforts deferred
SCE	Southern California Edison Company
SDG&E	San Diego Gas & Electric Company
SDG&E Joinder	San Diego Gas & Electric Company's Joinder in Southern California Edison Company and Edison Material Supply LLC's Answer to Respondents' Counterclaims, filed on 17 September 2014.
SDG&E Memorial	SDG&E's Memorial, filed on 10 February 2015
SDG&E Reply	SDG&E's Separate Reply to the Counter-Memorial of the Respondents, filed on 23 October 2015
SDG&E RfA	San Diego Gas & Electric Company's Joinder in Southern California Edison Company and Edison Material Supply LLC's Request for Arbitration and Alternative Claims filed on 18 July 2014
SDR	Supplier Deviation Requests
SGIR	Steam Generator Inspection and Repair
SGIR costs or SGIR Damages	Expenses incurred by SCE for SGIR.
SGRT	Steam Generator Replacement Team

SONGS	San Onofre Nuclear Generating Station
SONGS Owners	Southern California Edison Company, San Diego Gas & Electric Company and City of Riverside
SoRy	Statement of Reply, filed by the Claimants on 23 October 2016
SR	Stability Ratio
SSPC	Steam Generator Steady State Performance Calculation Code
St-Lucie 2	Reactor 2 of the St-Lucie nuclear steam generator in Florida
Suzuta Correlation	An interfacial velocity correlation
T/H	Thermal hydraulic
T/H Parametric Report	MHI's 2008 Thermal and Hydraulic Parametric Calculations Report, Exh. JX-822
Transcript	Transcripts of Hearing of 21 March 2016 through 29 April 2016
Tribunal	The Tribunal in ICC Case 19784/AFG comprised of Professor Dr. Albert Jan van den Berg, Jonathan Schiller and John Hinchey
TSP	Tube Support Plate
TTW	Tube-to-tube wear
Type 1 or Type 1 Repair	AVB repairs performed through the existing manways and deck hatches of the RSGs
Type 2 or Type 2 Repair	AVB repairs requiring removal of the steam dome at the top of the RSGs to provide greater access to the top of the tube bundle
Type 3 or Type 3 Repair	Replacement of the tube bundle portion of the RSGs through the existing equipment hatch of the containment dome
Type 4 or Type 4 Repair	Complete replacement of the RSGs (i.e., a second full replacement) requiring containment dome walls around the reactors to be re-opened

U-bend region	The curved, upper portion of the tubes in some steam generators, like the SONGS RSGs, which are fabricated in the shape of a large upside-down U
UCC	Uniform Commercial Code
UFSAR	Updated Final Safety Analysis Report
USFT	United States Field Team
Void fraction or VF	Fraction of air in a two-phase flow of steam
Warranty	Section 1.17 of the RSG Contract
Waterford 3	Reactor 3 of the Waterford nuclear steam generator in Louisiana
Westinghouse's 5 June 2012 Presentation	Westinghouse's Presentation on a SONGS Repair, dated 5 June 2012
10 CFR	Title 10 of the US Code of Federal Regulations

I. INTRODUCTION

1. On 31 January 2012, Unit 3 of the San Onofre Nuclear Generating Station (“SONGS”) was brought into an unplanned shutdown following the detection of a radioactive leak in a recently installed Replacement Steam Generator (“RSG” or “RSGs”) designed and manufactured by Mitsubishi Heavy Industries and its American subsidiary (jointly “MHI”). There had been a breach of the reactor’s primary-to-secondary containment, such that irradiated water in the primary heat transfer tubes was leaking into the secondary water supply, raising concerns of exposure to the environment (the “**Incident**”).
2. On account of the expert work of SONGS employees, Unit 3 was quickly shutdown. The actions of the SONGS professionals ensured that only a miniscule radiation leak occurred, 200 times less than the effect of having a smoke detector in a home for a year.¹
3. Following the Incident, personnel from MHI were dispatched to inspect the SONGS facilities.
4. As it happened, SONGS Unit 2 was also shutdown at that time due to a routine refueling outage. By consequence, following the unplanned shutdown, SONGS was not generating any electricity for the communities it served, including the City of Riverside and the San Diego Gas & Electric Company, claimants in this arbitration.
5. The consequences of the investigation into the SONGS Incident are set forth in the Facts of this Award, in Section VII below and considered by the Tribunal as described immediately below.

¹ Exh. JX-1045.

6. This arbitration is brought pursuant to a contract that is further described in Section VII.C below.
7. To facilitate the resolution of this dispute, the Tribunal requested that the Parties compile and address a List of Issues for determination by the Tribunal. The Tribunal's reasoning in this Award broadly follows these Issues.
8. Under Issue A, the Tribunal considers the burden of proof for the Issues under determination.
9. Prior to considering Issue B, the Tribunal undertakes an analysis of various design errors in the RSGs, as alleged by the Claimants.
10. Under Issue B, the Tribunal considers the Claimants' submission that the Respondents breached their contractual obligations. In particular, the Tribunal also considers whether the Claimants' numerous allegations of errors in the design and manufacture of SONGS are adequately supported by the evidence submitted.
11. Prior to considering Issue C, the Tribunal undertakes an analysis of repair and replacement efforts.
12. Under Issue C, the Tribunal considers whether the Incident triggered the Respondents' warranty obligations under the RSG Contract to repair or replace SONGS. In particular, the Tribunal also considers the evidence as to whether the Respondents would have been able to develop a repair or replacement for Unit 3, but for the post-ASLB shutdown decision.
13. Under Issue D, the Tribunal considers the Claimants' allegations that the RSG Contract was procured by fraud or misrepresentation such that the contractually agreed limitation of liability provisions of the RSG Contract should be waived.

14. Under Issue E, the Tribunal considers the remedies available to the Claimants for the Respondents' breach of the RSG Contract.
15. Under Issue F, the Tribunal considers whether by operation of the California Commercial Code the limitation of liability provision and waiver of consequential damages provision of the RSG Contract should be waived.
16. Under Issue G, the Tribunal considers whether the Claimants have grounds to rescind the RSG Contract under California law.
17. Under Issue H, the Tribunal considers what damages, if any, should be awarded to the Claimants.
18. Under Issue I, the Tribunal considers the Respondents' counterclaims.
19. Under Issue J, the Tribunal considers the specific claims of the San Diego Gas & Electric Company, a claimant in this arbitration.
20. Under Issue K, the Tribunal considers the apportionment of the costs of this arbitration.

II. **THE PARTIES**

The Claimants

21. The first claimant is Southern California Edison Company ("SCE"), a regulated public utility incorporated under the laws of the State of California. SCE is a 78.21% co-owner and operating agent of the San Onofre Nuclear Generating Station ("SONGS"). SCE's address is as follows:

SOUTHERN CALIFORNIA EDISON COMPANY
2244 Walnut Grove Avenue

Rosemead, CA 91770
U.S.A.

22. The second claimant is Edison Material Supply LLC (“**EMS**”), a Delaware limited liability company with its principal place of business in California. EMS is a subsidiary of SCE. EMS’ address is as follows:

EDISON MATERIAL SUPPLY LLC
2244 Walnut Grove Avenue
Rosemead, CA 91770
U.S.A.

23. SCE and EMS shall be jointly referred to as “**Edison.**”

24. The third claimant is San Diego Gas & Electric Co. (“**SDG&E**”), a regulated public utility incorporated under the laws of the State of California. SDG&E is engaged in the business of generating, transmitting and distributing electric energy to approximately 3.4 million people located in San Diego and Southern Orange county. SDG&E is a 20% co-owner of SONGS. SDG&E’s address is:

SAN DIEGO GAS & ELECTRIC COMPANY
8326 Century Park Court
San Diego, CA 92123
U.S.A.

25. The fourth claimant is the City of Riverside (“**Riverside**”), a California charter city and municipal corporation organized and existing under the laws of the State of California. Riverside, which through its public utilities department, owns and operates an electrical generating, transmitting and distribution system providing electricity and other services to the approximately 304,000 residents and other customers within Riverside. Riverside is a 1.79% co-owner of SONGS. Riverside’s address is as follows:

CITY OF RIVERSIDE
3900 Main Street
Riverside, CA 92522
U.S.A.

26. SCE, EMS, SDG&E and Riverside shall be jointly referred to as the “**Claimants.**”
27. The Claimants are represented in this arbitration by their duly authorized attorneys, mentioned at page 2 above.

The Respondents

28. The first respondent is Mitsubishi Nuclear Energy Systems, Inc. (“**MNES**”), a Delaware corporation organized and existing under the laws of the State of Delaware. MNES is the successor-in-interest to Mitsubishi Heavy Industries America, Inc. (“**MHIA**”). The address of MNES’ principal place of business is as follows:

MITSUBISHI NUCLEAR ENERGY SYSTEMS, INC.
13860 Ballantyne Corporate Place, Suite 250
Charlotte, North Carolina 28277
U.S.A.

29. The second respondent is Mitsubishi Heavy Industries, Ltd., a corporation organized under the laws of Japan. The address of its principal place of business is as follows:

MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5 Konan 2-chome
Minato-ku
Tokyo 108-8215
Japan

30. MNES and Mitsubishi Heavy Industries shall be jointly referred to as “**MHI,**” “**Mitsubishi,**” or the “**Respondents.**”
31. The Respondents are represented in this arbitration by their duly authorized attorneys, mentioned at page 2 above.

32. The Claimants and the Respondents are jointly referred to as “**Parties.**” The Claimants and the Respondents are individually referred to as “**Party.**”

III. THE ARBITRAL TRIBUNAL

33. In the present case, the Arbitral Tribunal is constituted as follows:

Jonathan D. Schiller, Co-Arbitrator (nominated jointly by the Claimants)
BOIES, SCHILLER & FLEXNER LLP
575 Lexington Avenue
New York, NY 10022
U.S.A.

John W. Hinchey, Co-Arbitrator (nominated jointly by the Respondents)
JAMS INTERNATIONAL
555 13th Street NW
Suite 400 West
Washington, DC 20004
U.S.A.

Professor Dr. Albert Jan van den Berg, President (nominated by the co-arbitrators)
HANOTIAU & VAN DEN BERG
IT Tower, 9th Floor
Avenue Louise 480 – Bte 9
1050 Brussels
Belgium

IV. PROCEDURE

34. The present case concerns the Conformed Specification for Design and Fabrication of the Replacement Steam Generators for Unit 2 and Unit 3, San Onofre Nuclear Generating Station (Specification SO23-617-01), revision 4 Contract, between MHIA and EMS dated 9 November 2010 (“**RSG Contract**”).
35. On 16 October 2013, SCE and EMS submitted their Request for Arbitration (“**RfA**”). In their RfA, SCE and EMS sought certain declarations for breach of the RSG Contract and related damages, in addition to immediate interim relief.
36. On 27 December 2013, the Respondents submitted their Answer and Counterclaims (“**Answer**”).
37. On 17 February 2014, the Claimants filed their Reply to the Respondents’ Counterclaims (“**Reply to Counterclaims**”).
38. On 27 June 2014, the Secretary General of the International Court of Arbitration of the International Chamber of Commerce (“**ICC Court**”), in accordance with Article 13(2) of the ICC Rules, confirmed Mr. Jonathan D. Schiller as co-arbitrator upon the Claimants’ joint nomination and Mr. John W. Hinchey as co-arbitrator upon the Respondents’ joint nomination.
39. On 17 July 2014, Riverside submitted its Notice of Joinder by City of Riverside in Claims Alleged in Request for Arbitration Filed by Southern California Edison Company and Edison Material Supply LLC (“**Notice of Joinder**”).
40. On 18 July 2014, SDG&E submitted San Diego Gas & Electric Company’s Joinder in Southern California Edison Company and Edison Material Supply LLC’s Request for Arbitration and Alternative Claims (“**SDG&E RfA**”).

41. On 18 August 2014, the Respondents served their Consolidated Answer to Joinder of Claims and Counterclaims of Respondents (“**Consolidated Answer**”).
42. On 12 September 2014, the Secretary General of the ICC Court, in accordance with Article 13(2) of the ICC Rules, confirmed Professor Dr. Albert Jan van den Berg as President of the Arbitral Tribunal upon the joint nomination of the co-arbitrators.
43. On 16 September 2014, Riverside submitted its Reply to the Respondents’ Counterclaims (“**Riverside Reply to Counterclaims**”). The City of Riverside has made no further separate written submissions in this arbitration.
44. On 17 September 2014, SDG&E submitted San Diego Gas & Electric Company’s Joinder in Southern California Edison Company and Edison Material Supply LLC’s Answer to Respondents’ Counterclaims (“**SDG&E Joinder**”).
45. On 23 September 2014, the Tribunal sent a draft Agenda for the Case Management Conference regarding the conduct of the arbitral proceedings to the Parties.
46. On 29 September 2014, the Tribunal sent a revised draft Agenda for the Case Management Conference to the Parties, which was annotated in the joint submissions of the Parties dated 15 and 21 October 2014.
47. On 21 October 2014, the Respondents requested the bifurcation of the arbitral proceedings (“**Request for Bifurcation**”), to which the Claimants objected on the same day.
48. Pursuant to the Tribunal’s invitation, the Parties submitted their replies to the Respondents’ Request for Bifurcation on 31 October 2014 (“**Reply to Request for Bifurcation**”).

49. Pursuant to the Case Management Conference held between the Tribunal and the Parties on 12 November 2014 in Washington, D.C., the Tribunal circulated a draft of Procedural Order No. 1 and a corresponding timetable on 17 November 2014.
50. On 21 November 2014, the Claimants jointly filed an Application for Interim Measures.
51. Following the Parties' joint comments to draft Procedural Order No. 1 on 2 December 2014, the Tribunal, by consent of the Parties, issued Procedural Order No. 1 ("**PO 1**") with a corresponding timetable on 8 December 2014.
52. On 10 December 2014, the Respondents jointly filed their Response to the Application for Interim Measures.
53. Pursuant to the telephone hearing held between the Tribunal and the Parties addressing the Application and Response for Interim Measures, the Tribunal issued Procedural Order No. 2 ("**PO 2**") on 22 December 2014, dismissing the Claimants' Application for Interim Measures dated 21 November 2014.
54. On 10 February 2015, the Claimants submitted their Memorial ("**Memorial**"). That same day, SDG&E submitted its separate Memorial ("**SDG&E Memorial**") on its particular damages. Both Riverside and SDG&E have adopted the submissions of Edison in this arbitration as their own.²
55. On 11 May 2015, the Respondents jointly submitted their Counter-Memorial and Counterclaims to the Claimants' Memorial ("**Counter-Memorial**"), including their submitted witness statements.

² Memorial, p. 1; SDG&E Memorial, ¶¶ 19, 24, 26, 28.

56. That same day, the Respondents jointly submitted their Counter-Memorial to the SDG&E Memorial (“**Counter-Memorial to SDG&E**”).
57. On 21 May 2015, the Parties filed their requests for document production, with the Claimants identifying certain of the Respondents’ source codes used in the design of the SONGS RSGs as relevant and material documents in this arbitration.
58. Per the Parties’ agreement and proposed Confidentiality Order, the Tribunal ordered in Procedure Order No. 3 dated 4 June 2015 (“**PO 3**”), that as of 1 October 2014 all evidence, testimony, submissions of the Parties, and orders of the Tribunal shall be kept confidential.
59. On 5 June 2015, the Parties submitted their responses to the requests for document production.
60. On 18 June 2015, the Parties submitted their replies to the responses to the requests for document production.
61. On 25 June 2015, the Tribunal issued its decision with regard to the Parties’ requests for document production.
62. On 27 July 2015, the Claimants submitted their expert evaluations of their damages, quantifying their claim at \$7,571,000,000.³
63. In a letter to the Tribunal dated 6 October 2015, the Claimants filed further requests with regard to the production and use of the Respondents’ source codes.
64. On 12 October 2015, the Respondents objected to the Claimants’ further requests with regard to the production and use of the Respondents’ source codes.

³ Expert Report of Mr. Graves, ¶ 20 (Figure 1).

65. That same day, the Tribunal and the Parties held a telephone conference with regard to the site visits at SONGS and MHI's facilities in Japan.
66. On 16 October 2015, the Tribunal issued Procedural Order No. 4 ("**PO 4**"), containing its decisions with regard to the Claimants' requests for the production and use of the Respondents' source codes.
67. On 23 October 2015, the Claimants submitted their joint Reply to the Respondents' Counter-Memorial and Counterclaims ("**Reply**"). The Reply was submitted on behalf of all of the Claimants.⁴
68. That same day, SDG&E submitted its separate Reply Memorial regarding its particular damages ("**SDG&E Reply**").
69. On 31 October 2015, the Respondents submitted presentation materials for the site visits to MHI's facilities in Japan.
70. On 2 November 2015, the Claimants submitted presentation materials for the site visit at SONGS.
71. The Tribunal and the Parties conducted site visits at SONGS on 6 November 2015 and at MHI's facilities in Kobe on 9 November 2015.
72. On 14 November 2015, the Tribunal circulated a draft of Procedural Order No. 5 for review and comments by the Parties.
73. In a letter to the Tribunal dated 1 December 2015, the Respondents requested the production of a number of un-redacted documents, which the Claimants opposed in a response dated 11 December 2015.

⁴ Reply, p. 1.

74. On 2 December 2015, the Parties jointly submitted their comments to the draft of Procedural Order No. 5.
75. On 5 December 2015, the Tribunal issued Procedural Order No. 5 (“**PO 5**”), (i) directing the Parties to produce an index of the items exhibited during the site visits; (ii) inviting the Parties to agree on several procedural matters; and (iii) determining outstanding issues in relation to the Hearing.
76. On 9 December 2015, the Parties submitted a chart indicating their respective positions for a deposition protocol.
77. In a letter to the Tribunal dated 14 December 2015, the Respondents maintained their request for the production of un-redacted documents.
78. In a letter to the Parties dated 15 December 2015, and pursuant to ¶ 16.1 of PO 1, the Tribunal proposed the appointment of Mr. Eric van Eyken as administrative secretary, to which the Parties agreed on 17 December 2015.
79. On 11, 14, 16 and 21 December 2015, the Parties submitted their respective positions on areas of disagreement regarding the deposition protocol referred to in ¶ 76 above.
80. On 18 December 2015, the Tribunal issued Procedural Order No. 6 (“**PO 6**”), denying the Respondents’ request for production of un-redacted documents.
81. On 24 December 2015, the Tribunal issued Procedural Order No. 7 (“**PO 7**”), deciding on the outstanding issues between the Parties in relation to the deposition protocol.
82. On 5 January 2016, the Respondents submitted their joint Rejoinder Memorial (“**Rejoinder**”), including their supplemental witness and initial expert statements.

83. On 5 January 2016, the Respondents submitted their joint Rejoinder Memorial to the Reply of SDG&E (“**Rejoinder to SDG&E**”).
84. On 15 January 2016, the Tribunal issued Procedural Order No. 8 (“**PO 8**”), determining that a video of the inside of a steam generator need not be produced on account of the prohibitive cost of obtaining same.
85. In a letter dated 14 January 2016, the Claimants requested the Tribunal issue a subpoena for the deposition of Mr. Paul Langford, a retired former consultant to MHI, to which the Respondents objected in their response of 19 January 2016.
86. On 19 January 2016, the Claimants jointly submitted their Rejoinder Memorial to Counterclaims (“**Rejoinder to Counterclaims**”). The Claimants also submitted their rebuttal witness statements and expert reports. The Claimants adjusted their claim of damages to \$6.918,000,000.⁵
87. In a letter dated 22 January 2016, the Claimants maintained their request to the Tribunal to issue a subpoena for the deposition of Mr. Paul Langford.
88. In a letter dated 26 January 2016, the Respondents affirmed their objection to the Claimants’ request to issue a subpoena for the deposition of Mr. Langford.
89. On 2 February 2016, the Respondents submitted their rebuttal expert reports.
90. On 3 February 2016, the Tribunal issued Procedural Order No. 9 (“**PO 9**”), granting the Claimants’ request to issue a subpoena for the deposition of Mr. Langford, subject to several conditions.

⁵ Rebuttal Expert Report of Mr. Graves, ¶ 9.

91. On 8 February 2016, in accordance with ¶ 7.5 of PO 1,⁶ the Parties communicated a list of their witnesses whose testimony was intended to be heard in this arbitration and a list of witnesses who would be requiring interpretation assistance. Depositions were held between 8 February and 14 March 2016.
92. On 2 March 2016, the Tribunal and the Parties held a Pre-Hearing Telephone Conference (“**PHTC**”), the minutes of which were circulated on 3 March 2016.
93. In a letter dated 4 March 2016, the Claimants requested to make use of deposition video evidence as part of their “case in chief,” which was opposed by the Respondents in their letter of 8 March 2016.
94. In a letter dated 4 March 2016, the Respondents requested the submission of a witness statement by Mr. Langford and the modification of PO 9, which was opposed by the Claimants in their letter of 8 March 2016.
95. On 7 March 2016, the Parties submitted their time estimates for the examination of witnesses and their preferred order of examination of fact and expert witnesses.
96. In emails dated 7 and 8 March 2016, the Claimants objected to (i) the Respondents’ proposed order of witnesses who had both submitted individual and joint statements/reports; and (ii) the length of direct examination of witnesses who had both submitted individual and joint statements/reports.
97. In an email dated 8 March 2016, the Respondents opposed the Claimants’ objections to (i) the order of witnesses who had both submitted individual and joint statements/reports proposed by the Respondents; and (ii) the length of direct

⁶ Section 1.22.2.5 of the RSG Contract requires that witnesses be identified at least 45 days prior to the Hearing. While 8 February 2016 is only 43 days prior to the start of the Hearing, all witness and experts in this arbitration submitted statements prior to this date in accordance with the agreed timetable of PO 1. The Parties have not raised any issues in this regard.

examination of witnesses who had both submitted individual and joint statements/reports.

98. On 9 March 2016, the Tribunal issued Procedural Order No. 10 (“**PO 10**”), deciding on outstanding issues with regard to (i) deposition evidence; (ii) the deposition of Mr. Langford; and (iii) joint expert witness statements/reports.
99. On 20 March 2016, the Claimants revised their damages to \$6,667,000,000.⁷
100. The Hearing was conducted over six weeks from 21 March through 29 April 2016.
101. During the Hearing, the Tribunal received oral testimony from 17 of the Claimants’ fact and expert witnesses and 20 of the Respondents’ fact and expert witnesses. In addition, the Tribunal heard from four of the Claimants’ experts on quantum, including from Mr. Michael King on the damages unique to SDG&E, and from three of the Respondents’ quantum witnesses. The Parties elected not to call a number of witnesses, including the fact witnesses of SDG&E, and proceeded instead to submit deposition transcripts for witnesses, with designations of key passages selected for review by the Tribunal. A complete list of witnesses and experts, along with a brief description of their roles, is included as **Annex A** to this Award.
102. Riverside and SDG&E were present throughout the Hearing.⁸ Both Riverside and SDG&E made opening statements on 21 March 2016.⁹ SDG&E and Riverside presented a daily opening statement on 22 April 2016 at the commencement of the quantum phase of the Hearing.¹⁰ Riverside examined Mr. Graves on 22 April 2016.¹¹

⁷ See Exh. JX-2279, i.e., Revised Summary of Damages by Mr. Graves.

⁸ See generally Transcript.

⁹ Transcript, pp. 41-44.

¹⁰ Transcript, pp. 5171-5180.

¹¹ Transcript, p. 5110.

SDG&E examined Mr. King, its quantum expert, on 26 April 2016.¹² SDG&E also examined Mr. Emmert, one of the Respondents' quantum experts on 27 April 2016.¹³

103. In addition to oral testimony, the Tribunal received oral opening statements of 45 minutes per side, closing statements of 95 minutes per side, and 15-minute daily opening statements on most days of the Hearing.
104. Prior to the closure of the oral Hearing, counsel for the Parties confirmed that the Tribunal has acted fairly and impartially and ensured that each Party had a reasonable opportunity to present its case, as required by Article 22(4) of the ICC Rules.¹⁴ The Parties were informed that failure to object could constitute a waiver of their rights to raise allegations of procedural unfairness under California law. Following the Parties' affirmations, the President declared the Hearing closed.
105. On 7 July 2016, the ICC Court extended the deadline for the issuance of the Award to 30 November 2016.
106. On 12 July 2016, the Tribunal issued Procedural Order No. 11 ("**PO 11**"), denying the Respondents' request to address recent factual developments in their post-hearing memorial.
107. Simultaneous Post-Hearing Memorials ("**C-PHM**" and "**R-PHM**" respectively) were received from the Parties on 14 July 2016. The Parties submitted Reply Post-hearing Memorials ("**C-RPHM**" and "**R-RPHM**" respectively) on 31 August 2016. As part of these post-hearing submissions, the Parties provided their positions on the issues the Tribunal is required to decide in this arbitration. The Parties were informed

¹² Transcript, pp. 6056-6137.

¹³ Transcript, pp. 6370-6372.

¹⁴ Transcript, pp. 6648-6649.

that these positions would be copied directly into this present Award as part of their submissions on each of the Issues under determination.

108. On 3 October 2016, the Parties filed their Submissions on the legal and other costs of the arbitration. On 2 November 2016, the Parties submitted their Replies to the respective Submissions on costs.
109. On 3 November 2016, the ICC Court extended the deadline for the issuance of the Award to 30 December 2016.
110. On 1 December 2016, the ICC Court extended the deadline for the issuance of the Award to 31 January 2017.
111. On 6 January 2017, the ICC Court extended the deadline for the issuance of the Award to 28 February 2017.
112. On 27 January 2017, the Tribunal submitted the draft award for scrutiny to the ICC Court.
113. On 2 February 2017, the ICC Court extended the deadline for the issuance of the Award to 31 March 2017.
114. On 27 February 2017, the Tribunal notified the Parties of the closure of the proceedings in accordance with Article 27 of the ICC Rules.

V. LIST OF ISSUES FOR DETERMINATION BY THE TRIBUNAL

115. Procedural Order No. 5, ¶ 7, required that the Parties submit a list of issues, agreed if possible, for determination in this arbitration by 26 February 2016. The Parties were unable to submit a list of issues for this date.

116. The list of issues to be decided in this arbitration was again raised during the PHTC of 2 March 2016. The Parties were requested to submit a list of issues by 4 March 2016.
117. The Claimants submitted their list of issues on 4 March 2016 and the Respondents submitted their list of issues on 7 March 2016.
118. On 8 March 2016, the Claimants invited directions from the Tribunal that the Parties submit a joint list of issues by 18 March 2016. The Tribunal ordered the Parties to produce a joint list of issues by 16 March 2016.
119. On 14 March 2016, the Tribunal provided the Parties with a proposed list of issues, based upon the Parties' previously submitted draft list of issues as well as the Parties' pleadings. The Parties were requested to provide their comments thereon by 17 March 2016. The Parties provided separate submissions, modifying the proposed list of issues.
120. On 18 March 2016, the Claimants provided further modifications to the list of issues. The Respondents provided their own further comments on 19 March 2016.
121. During the Hearing, the Tribunal invited the Parties to meet and further refine the list of issues for determination.¹⁵ Subsequently, various drafts of the list of issues were exchanged inter-party and with the Tribunal.
122. On 24 April 2016, the President, on behalf of the Tribunal, met with counsel from the Parties to reach an agreement on a final list of issues for determination in this arbitration. The final and agreed List of Issues was circulated on 26 April 2016 and is provided as **Annex B** to this Award.

¹⁵ Transcript, pp. 9-11.

123. This List of Issues and the Parties' positions, mentioned in ¶ 107 above, constitutes the structure of the Tribunal's analysis in this Award.

VI. ARBITRATION AGREEMENT AND APPLICABLE LAW

124. The Parties' dispute resolution procedure and agreement to arbitrate is set out in Sections 1.22.1 and 1.22.2 of the RSG Contract, which is headed "Arbitration of Dispute" and which provides:

1.22 DISPUTE RESOLUTION

1.22.1 Disputes

The Parties shall attempt in good faith to promptly resolve any Dispute by negotiations between the Director of Procurement and Material Management, or its designee, and an officer of the Supplier. Pending resolution of a Dispute, the Supplier shall continue to perform the Work as directed by the Edison Representative and EMS shall continue to make payments for the undisputed items. The disputing Party shall give the other Party written notice of the Dispute. Within thirty (30) days after receipt of such notice, the receiving Party shall submit a written response to the disputing Party. The notice and response shall include a statement of the relevant Party's position and a summary of the evidence and arguments supporting its position. The Director of Procurement and Material Management, or its designee, and the appropriate officer of the Supplier shall meet at a mutually acceptable time and place within thirty (30) days after the date of the disputing Party's notice and thereafter as often as they reasonably deem necessary to exchange relevant information and to attempt to resolve the Dispute.

1.22.2 Arbitration of Dispute

1.22.2.1 If the Dispute has not been resolved through negotiation within ninety (90) days after the date of the notice of Dispute received pursuant to Section 1.22.1, the Dispute shall be finally settled and resolved by arbitration in accordance with the ICC Rules, subject to such modifications of the ICC Rules as are set forth in this Section 1.22.2.

1.22.2.2 The number of arbitrators shall be three (3). One (1) arbitrator shall be appointed by Supplier and one (1) arbitrator shall be appointed by EMS or Edison, as applicable, in accordance with Article 8 of the ICC Rules, and the third arbitrator shall be selected by the two (2) party-appointed arbitrators or, failing agreement, by the ICC in accordance with the ICC Rules.

1.22.2.3 The arbitration proceeding shall be conducted in the City of San Francisco, California, United States of America in the English language; and all testimony or documentary evidence shall be submitted in English.

1.22.2.4 To facilitate the comprehensive resolution of related Disputes, and upon request by any Party to the arbitration proceeding, the arbitration panel may, at any time before the first oral hearing of evidence, consolidate the arbitration proceeding with any other arbitration proceeding between or among the Parties arising from or out of the Purchase Order.

1.22.2.5 At any hearing of oral evidence, each Party to the arbitration proceeding or its legal counsel shall have the right to present and examine its witnesses and to cross-examine the witnesses of the other Party. No evidence of any Party's witness shall be presented in written form unless the other Party shall have the opportunity to cross examine such witness, except as the parties to the arbitration proceeding otherwise agree in writing or except under extraordinary circumstances where the interest of justice requires a different procedure. Notwithstanding the ICC Rules, a party shall communicate to the arbitration panel and the opposing parties the names and business addresses of each witness whose written or spoken testimony it intends to present in the arbitration proceeding and the subject matters upon which they will testify at least forty-five (45) days prior to the date of the hearing at which such witness may testify. Furthermore, and without regard to the provisions of the ICC Rules, any Person named by a party to be a witness shall be made available for deposition by the opposing parties at least twenty (20) days prior to the hearing at which such witness may testify. The Parties shall reasonably cooperate with respect to the venue for depositions to be taken in the arbitration proceeding. The arbitrators shall be required to apply California substantive law in ruling upon any Dispute in accordance with the Parties' intent as expressed in Section 1.32 of the Purchase Order.

1.22.2.6 If the prevailing Party makes a claim during the arbitration proceeding, the arbitral award in favor of such Party shall include an award for pre-award (pre-judgment) interest and costs for legal representation and assistance.

1.22.2.7 Any decision or award of the arbitration panel shall be final and binding upon the Parties to the arbitration proceeding. The Parties hereby waive, to the extent permitted by any Applicable Law, and agree not to invoke or exercise, any and all rights to appeal, review or impugn such decision or award by any court or tribunal. The Parties agree that the arbitral decision or award may be enforced against the parties to the arbitration proceeding or their assets wherever they may be found, and that a judgment upon the arbitral decision or award may be entered in any court having jurisdiction thereof.

125. Additional provisions of the Parties' dispute resolution provisions are as follows:

1.22.3 Arbitral Decisions and Awards

If any Party to an arbitration proceeding fails or refuses to comply with any arbitral decision or award within twenty (20) days after the date on which it receives notice of the decision or award, the other Party, the arbitration panel or their attorneys-in-fact may immediately proceed to request the judicial approval necessary for the execution of such decision or award before a competent judge of the domicile of such refusing Party or before any other court of competent jurisdiction. Any award of monetary damages shall bear interest from and including the award date to but excluding the date of payment in full at the lesser of twenty-five percent (25%) per annum or the maximum contractual interest rate permissible under the applicable laws of the State of California. Further, if any prevailing Party is required to retain counsel to enforce the arbitral decision or award, the Party against which the decision or award is made shall reimburse the prevailing Party for all reasonable fees and expenses incurred and paid to said counsel for such service, together with interest thereon from and including the payment date to, but excluding, the date of reimbursement in full at the lesser of twenty-five percent (25%) per annum or the maximum contractual interest rate permissible under the applicable laws of the State of California.

1.22.4 Deadlines

All deadlines specified in this Section 1.22 may be extended by the written agreement of the Parties to the Dispute

1.22.5 Procedures

The procedures specified in this Section 1.22 shall be the sole, exclusive procedures for the resolution of Disputes; provided, however, that any Party may seek a preliminary injunction or other preliminary judicial relief if, in its reasonable, good-faith judgment, such action is necessary to avoid irreparable damage. Despite such action, the Parties shall continue to participate in good faith in the procedures specified in this Article. All applicable statutes of limitations shall be tolled while the procedures specified in this Section 1.22 are pending, and the Parties shall take any and all actions required to effectuate such tolling.

1.22.6 Effect

The Purchase Order and the Parties' rights and obligations under it shall remain in full force and effect pending the outcome of any Dispute resolution procedure invoked under this Section 1.22, except to the extent the Purchase Order is terminated but subject to Section 1.23.7. The Parties shall, therefore, continue to perform their obligations under the Purchase Order notwithstanding the pendency of any Dispute.

126. Pursuant to Section 1.22.2.5 of the RSG Contract, the Tribunal shall apply California substantive law to this dispute:

The arbitrators shall be required to apply California substantive law in ruling upon any Dispute in accordance with the Parties' intent as expressed in Section 1.32 of the Purchase Order.

VII. FACTS

A. BACKGROUND

(a) The San Onofre Nuclear Generating Station (SONGS)

127. SONGS is jointly owned by SCE (78.21%), SDG&E (20%) and Riverside (1.79%).¹⁶ This ownership structure is reflected in, amongst other agreements, an operating agreement dating to 1987.¹⁷ SCE was the plant's operating agent, on behalf of itself, SDG&E, and Riverside. EMS was SCE's procurement agent and originally signed the RSG Contract for the purchase of the RSGs.
128. SONGS provided baseload electricity in southern California to approximately 1.4 million homes.¹⁸ SONGS operated for nearly 45 years, from 1968 until 2013. Electricity at SONGS was generated by nuclear pressurized water reactors. It had three generating units: Unit 1, which operated between 1968 and 1993, and Units 2 and 3, which began operation in 1983 and 1984, respectively, until their retirement in June 2013.¹⁹ The electric generating capacity of Units 2 and 3 was 3390 MWt per Unit,²⁰ to be increased to 3458 MWt per Unit²¹ with the replacement steam generators. Each Unit had two steam generators.
129. Baseload generators, such as SONGS, are capable of providing stable capacity to the grid at fixed costs.

¹⁶ Exh. JX-67 (At some juncture following the signing of this contract, the City of Anaheim appears to have transferred its share interest to SCE).

¹⁷ Exh. JX-67.

¹⁸ Witness Statement of Craver, ¶ 18.

¹⁹ Memorial, ¶ 3; Witness Statement of Palmisano, ¶ 9.

²⁰ Exh. JX-162, p. 2-29; Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc., ¶ 19.

²¹ Exh. JX-219, p. 1.

130. SONGS is a regulated utility as opposed to a merchant utility. The effect of this is that the revenue stream for electricity generated at SONGS is dictated both by market conditions and by the rates set by the California Public Utilities Commission (“CPUC”).²² CPUC established rates take into account both SONGS (approved) capital expenditures and operating expenses.²³ The price of electricity generated by SONGS is set by the market rate through a competitive generating process. As a regulated utility, SONGS is guaranteed cost recovery of its approved capital expenditures and operating expenses from its rate payers.²⁴
131. As regards safety and efficiency, SONGS was below the median of nuclear plants in the US.²⁵ During 2009-2010, SONGS was operating with approximately 2250 employees and a similar number of contractors.²⁶ As part of a business transformation plan and a SONGS “return to excellence plan,” these staff numbers were to be reduced. That reduction was underway for 2012-2013.²⁷ This excellence plan would have reduced headcount to about 1500 employees and improved SONGS’ costs structure.²⁸ Even following these reductions, SONGS was projected to have the second highest operation and management costs in the industry.²⁹

(b) **How SONGS Worked**

132. SONGS generated electricity from steam that turns a turbine to create electrical power. The heat source are nuclear fuel rods in the reactor vessel in each unit (a Pressurized Water Reactor (“PWR”). Heat is transferred from a nuclear reactor

²² Witness Statement of Reed, ¶¶ 61-62.

²³ Witness Statement of Reed, ¶ 62.

²⁴ Rebuttal Witness Statement of Reed, ¶ 10.

²⁵ Transcript, p. 2310 (Mr. Craver).

²⁶ Exh. JX-2124.

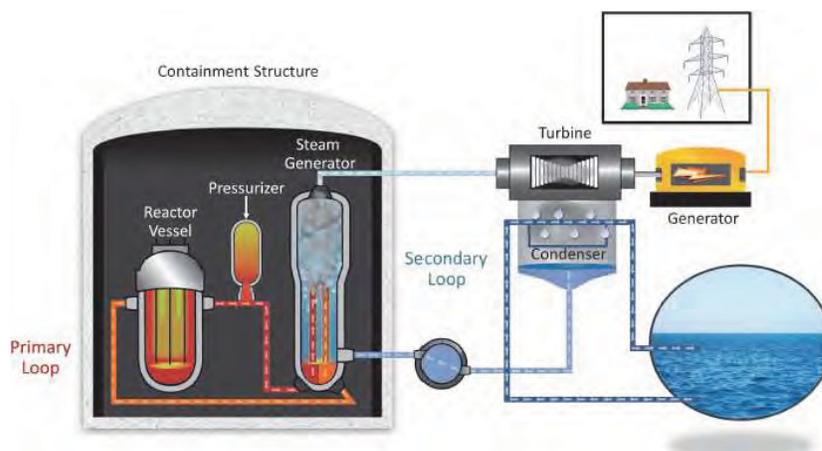
²⁷ Transcript, pp. 5549-5553 (Mr. Bauder); Exh JX-2051.

²⁸ Transcript, pp. 6224-6225 (Mr. Metcalfe).

²⁹ Transcript, pp. 6224-6225 (Mr. Metcalfe); Exh. JX-2313, p. 8.

vessel and then dissipated in the steam generator. The heat transfer is done through thousands of individual tubes, comprising a tube bundle, that carry the irradiated pressurized water from the reactor vessel into the steam generator where they vaporize water in the steam generator into steam that powers the turbines. It is these tubes that are at issue in this arbitration.

133. There are two “closed loops” of water. The tube bundles, carrying the irradiated water, are part of the “primary loop” system. A “secondary loop” contains water that is transformed into steam that powers the generator. This is illustrated by the following graphic:³⁰



134. In this graphic, the primary loop, in red, consists of the above described reactor vessel and tube bundle. The secondary loop, in blue, shows water being heated into steam, powering the turbine (and electric generator) and being condensed (i.e., cooled) back

³⁰ Respondents' Tutorial, p. 1; See also Witness Statement of Wharton, ¶ 9.

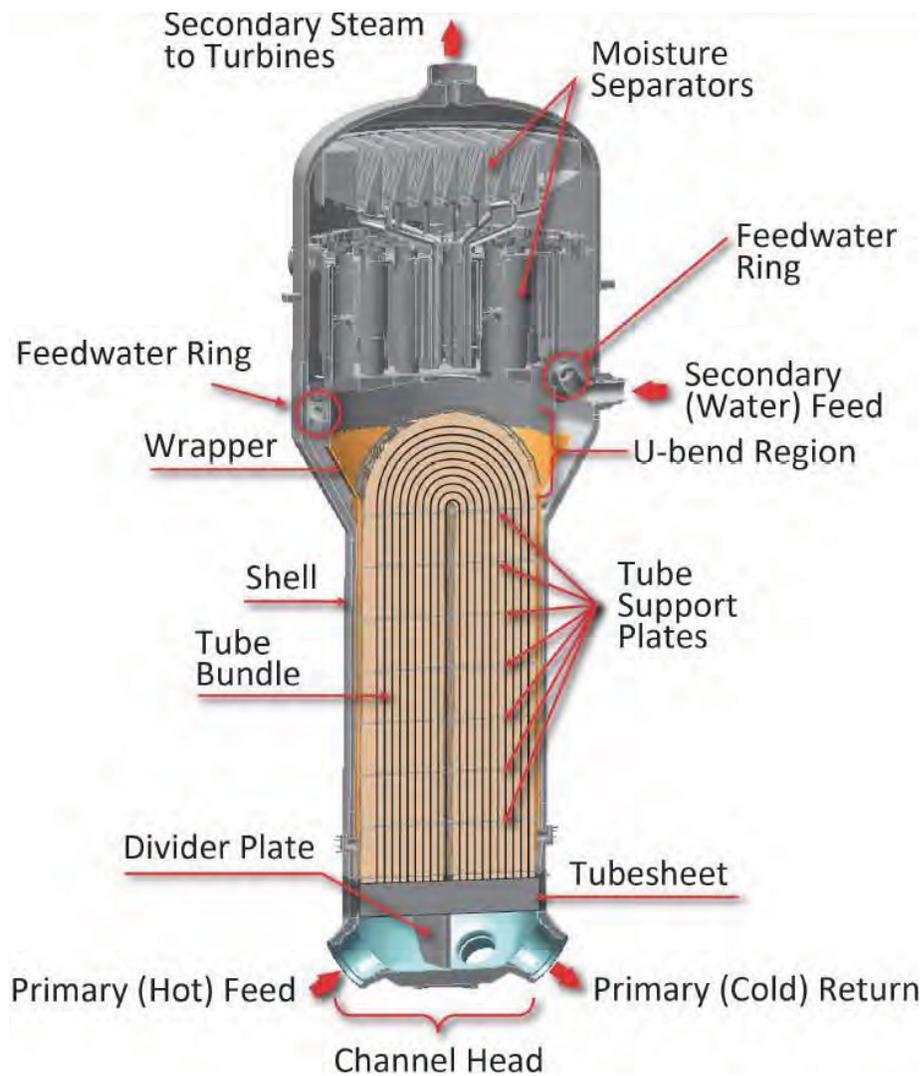
into water which can be recycled³¹ and re-used in the steam generator to be turned back into steam.

135. It is paramount to the safe operation of a steam generator that the primary and secondary systems remain do not mix as the primary system is radioactive.

(c) **Steam Generator**

136. The original steam generators (“**OSG**”) in Units 2 and 3 at SONGS differed in several respects from the replacement steam generators (“**RSG**”) which are at issue in this case. Where relevant, those differences will be mentioned in this Award. For the purposes of how SONGS worked, the RSG will be described briefly below.
137. The graphic below illustrates the primary components of the RSG:

³¹ The secondary loop does not appear to be an entirely closed system and an amount of water needs to be consistently added back in.



138. The tube bundle in a steam generator is comprised of thousands of tubes. Each of the four SONGS RSGs contains 9,727 tubes. The tubes have both a straight leg region and, as identified in the graphic, a U-bend region. In this arbitration, the area at issue is in the U-bend region, where each individual tube is bent in a “U” shape.
139. Water flows into the tubes from the primary hot feed, identified in the graphic, from the reactor vessel and pressurizer and then flows out from the tube into the primary

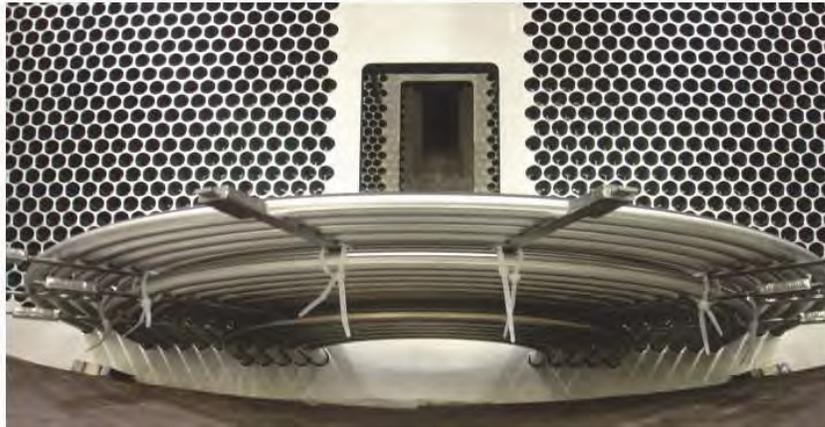
cold return. The individual tube then has a “hot leg” side (in the graphic on the left) and a “cold leg” side (in the graphic on the right) in addition to the U-bend region.

140. The thermal hydraulic (“T/H”) conditions of an operating steam generator, discussed in more detail below,³² may cause individual tubes to vibrate and interact with other tubes and components in the steam generator. To avoid or mitigate these interactions, steam generator design requires that the generators operate within acceptable T/H conditions and that these vibrations be restrained to prevent tube degradation.³³
141. Tube degradation refers to the effect of impacts on a tube narrowing and rubbing away at the tube’s sides. That may occur by contact of the tubes with the tube support plates (“TSP”) or with other tubes in the U-bend of the bundle, as will be further explained below. If that tube becomes sufficiently worn down (i.e., thin), it must be “plugged” to take it out of service by sealing the tube at both ends. Only a certain number of tubes, at SONGS 8%, can be plugged prior to that particular steam generator having to be taken out of service and resulting in the entire Unit having to be taken out of service.
142. The tube bundles at SONGS are contained within circular TSPs as illustrated in the below picture:³⁴

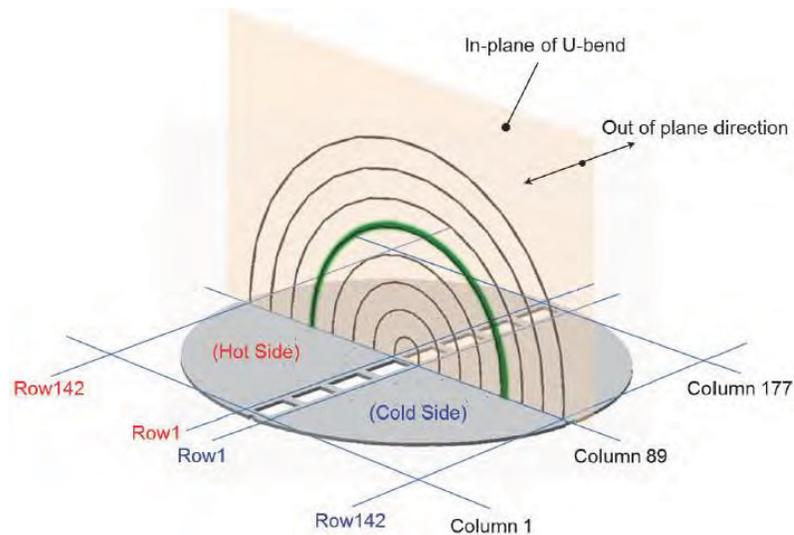
³² Section VII.A(d) below.

³³ The Claimants submit that the SONGS RSGs operated outside the envelope of acceptable T/H conditions and experienced excessively high wear in addition to unprecedented fluid elastic instability. See e.g. Transcript, pp. 19 and 1219 citing to Exh. JX-2000 (NRC Review of Lessons Learned From the San Onofre Steam Generator Tube Degradation Event).

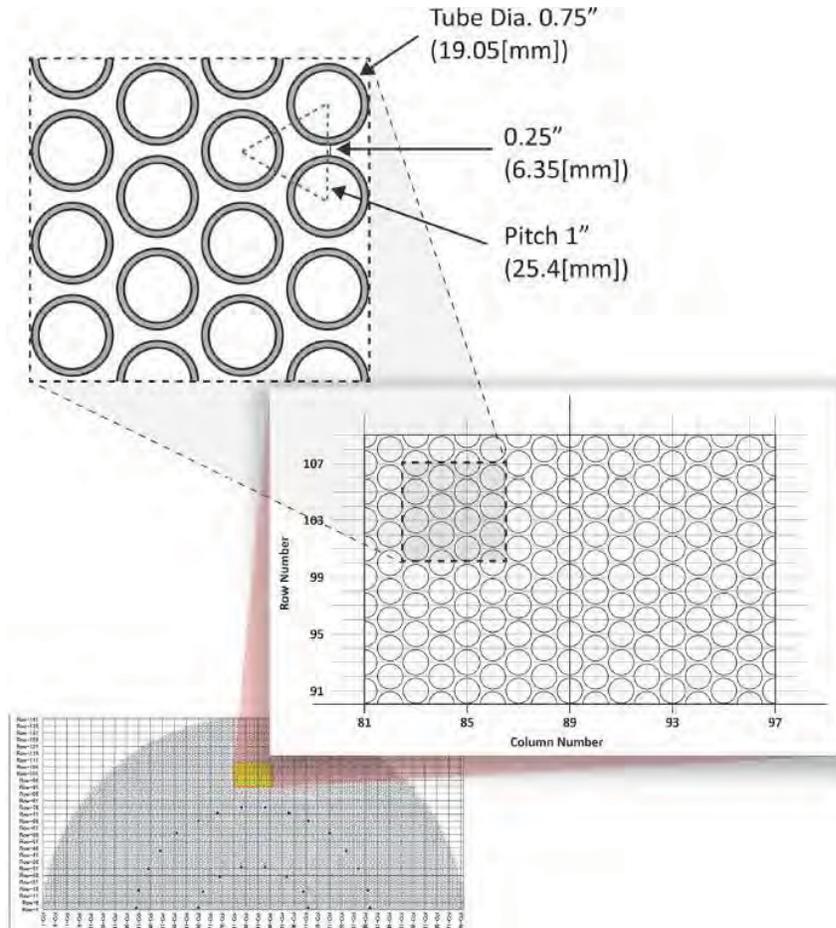
³⁴ Respondents’ Tutorial, p. 25.



143. The tubes are arranged in both rows and columns, as shown in the figure below. In each column, the smallest tube sits closest to the center of the circle of the bundle. Above this inside tube are a series of other tubes, each slightly taller, that surround the inner tube, and are placed until the edges of the circle are reached. Each tube has a specific identifier corresponding to its position in the TSP. The number is represented by a row number, for the SONGS RSGs 1-142, which is mirrored for the hot and cold side, and a column number, for the SONGS RSGs 1-177. For example, tube R142C89 corresponds to the tube that is in the outermost row (142) and in a central column (89).



144. The TSPs of the SONGS RSGs are of a triangular pitch design, as illustrated below.³⁵

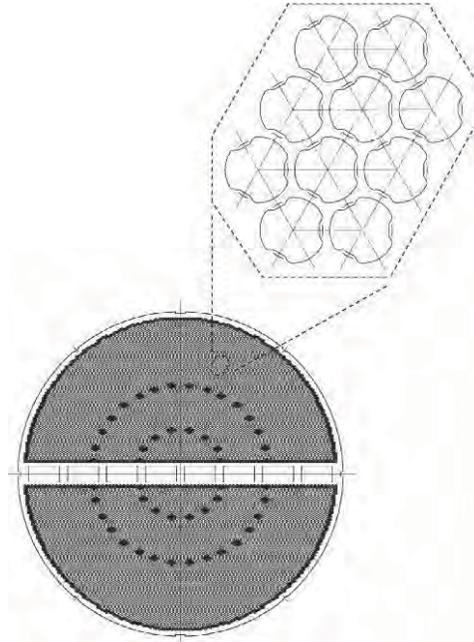


145. The triangular pitch in the SONGS RSGs is different from the OSGs of SONGS Units 2 and 3, which were designed with a square pitch design. A triangular pitch has more tubes in the same amount of space. As will be discussed later in this Award,³⁶ a triangular pitch TSP causes a higher steam velocity. These factors affect T/H conditions in the steam generator.

³⁵ Respondents' Tutorial, p. 6.

³⁶ See Section VII.D(c) below.

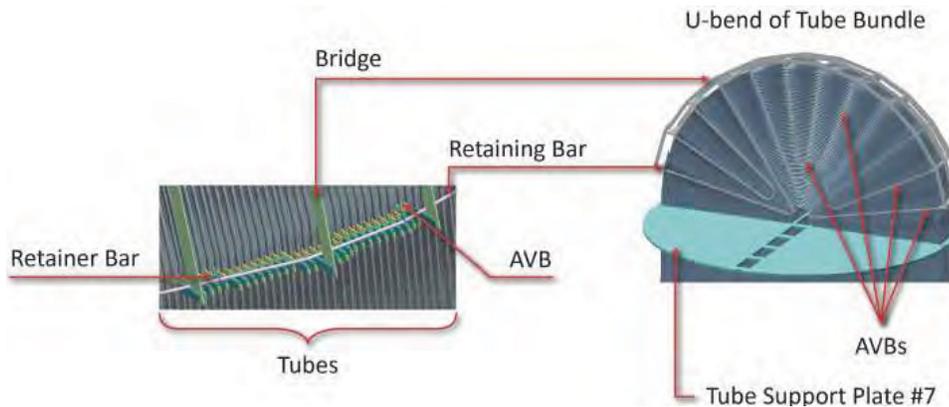
146. The TSPs are designed with broached holes in which the tubes pass through. These holes also allow the water and steam to pass through.³⁷



147. The U-bend region of the tube bundle in the RSGs has anti-vibration bars and retainer bars. Those are employed to minimize the vibrations in the RSGs. A graphic of the anti-vibration bars (“**AVB**”), retainer and retaining bars is provided below.³⁸

³⁷ Respondents’ Tutorial, p. 10.

³⁸ Respondents’ Tutorial, p. 22.



148. The following is a picture of an AVB:³⁹

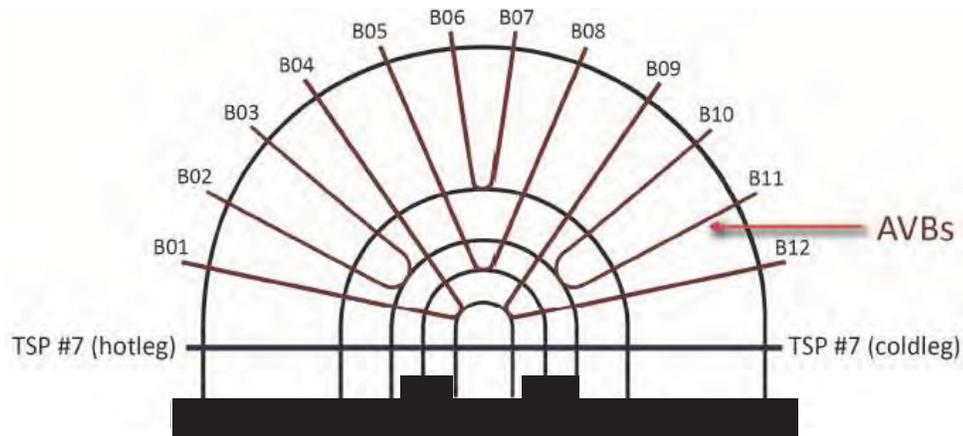


149. The AVBs are inserted between the columns of tubes to prevent the tubes from hitting those in other columns. This is also illustrated in the picture of the TSP at ¶ 142 above. In total, some [REDACTED] AVBs are employed to prevent the tubes from hitting tubes in other columns.⁴⁰ A cross-section of AVB placement is provided below:⁴¹

³⁹ Respondents' Tutorial, p. 15.

⁴⁰ Respondents' Tutorial, pp. 30-31.

⁴¹ Respondents' Tutorial, p. 11.



150. As can be seen, the lengths of an individual AVB vary.
151. On account of the T/H forces in an operating steam generator, the tubes are subject to vibration.
152. Vibration of tubes in the straight vertical section of the RSG is restrained by the TSPs, as described in ¶ 144 above and the subsequent graphic.
153. In the U-bend, tube movement can take place along two axis: out-of-plane and in-plane, as depicted in the graphic at ¶ 143 above.
- An out-of-plane movement consists of horizontal movement between the tubes in different columns, such that they may contact AVBs and/or tubes in adjacent columns.
 - An in-plane movement consists of vertical movement of tubes within the same columns, such that they may contact the tubes above or below them in the same columns.

154. The Respondents contend that severe in-plane movement on account of fluid elastic instability,⁴² as occurred at SONGS, was unknown, and in any event subsumed in the design against out-of-plane fluid elastic instability, until the Incident at SONGS.⁴³
155. While this Award references to a number of other components, those do not appear to be a central focus of this arbitration.

(d) **Steam Generator Design Basics**

156. In order to meet the contractually specified operating life for a steam generator, the designer is required to design and manufacture such as to prevent or minimize tube wear.
157. As regards the types of wear, those can be named for the components that are interacting. For example, tube-to-tube wear (“**TTW**”) is wear on account of the interaction of tubes, whereas tube-to-AVB wear is wear on account of the interaction between tubes and AVBs. Other types of wear interaction include tube-to-TSP, tube-to-retainer bar, and foreign object wear (from any loose foreign material in the steam generator).
158. As mentioned, tube wear is caused by vibration on account of T/H forces acting on the tubes, pushing them in various directions; both sideways (“out-of-plane”) or up and down (“in-plane”).
159. The excitation of a tube in an operating steam generator is aptly described in Respondents’ Tutorial:

[T]ubes in a steam generator are continually excited by the force of the steam-water mixture that flows upward through the tube bundle. More

⁴² As described in Section VII.A(d) below, fluid elastic instability represents the point at which a tube becomes unstable and vibrates excessively.

⁴³ The Nuclear Incident is reviewed at Section VII.F(a) below.

specifically, as the mixture rises through the tube bundle, it interacts with the tubes (and TSPs, AVBs and any other structural impediments). Because of these interactions, the mixture's direction of flow changes, and the flowing mixture imparts some of its energy on the tubes (and the other impediments to flow) which cause the mixture to change direction. This energy, having been transferred to the tubes, causes the tubes to vibrate with a certain frequency and amplitude (depending primarily on the length of the vibrating portion of the tube).⁴⁴

160. In the U-bends of U-bend steam generators, the steam-water mixture flowing through the U-bend may produce two mechanisms of tube vibration: turbulence induced excitation, also called "random vibration," and fluid-elastic excitation.⁴⁵
161. Tube vibration and wear on account of random vibration is generally minimal. Random vibration is expected in steam generators.⁴⁶
162. Fluid-elastic excitation operates as a two way street: forces applied by the fluid to tube and forces applied by the tube to the fluid.⁴⁷ This synergistic coupling becomes significant when the steam-water mixture velocity approaches the velocity at which a tube becomes unstable. This situation of a tube "going wild" is referred to as fluid-elastic instability ("FEI").⁴⁸ As it is comprehensively described in Respondents' Tutorial:

A tube that is experiencing fluid-elastic vibration can be either 'stable' or 'unstable.' As addressed above, a tube absorbs energy from the steam-water mixture flow moving past the tube. Further, a vibrating tube dissipates energy during the course of its vibration due to its movement through the steam-water mixture that surrounds the tube and due to friction as it interacts with the adjacent AVBs (and TSPs), in addition to other dissipation ("damping") mechanisms. Where the vibrating tube

⁴⁴ Respondents' Tutorial, pp. 32-33.

⁴⁵ Respondents' Tutorial, p. 33.

⁴⁶ Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc., ¶ 89.

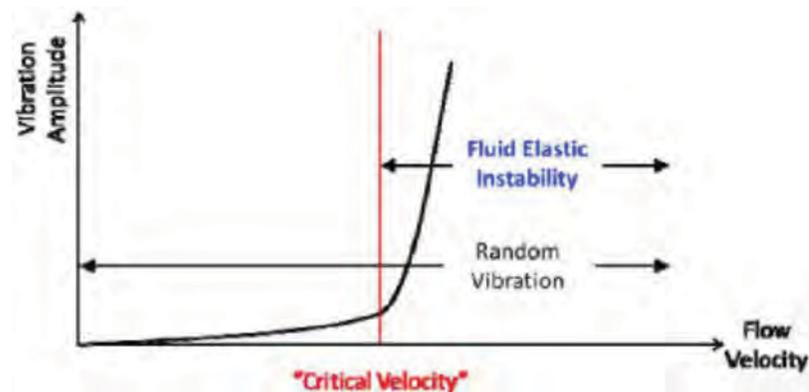
⁴⁷ Respondents' Tutorial, p. 34.

⁴⁸ Respondents' Tutorial, p. 35.

dissipates more energy than is imparted to it by the steam-water flow, the tube is stable. When the amount of energy imparted to the vibrating tube by the steam-water flow exceeds the dissipated energy, the tube becomes unstable.

Fluid-elastic excitation forces increase as the steam-water mixture flow velocity increases. When the energy imparted to the tube from fluid-elastic forces is equal to the energy dissipated by the tube motion, the tube is at the threshold of instability. The flow velocity at this threshold is defined as the “critical velocity.” At steam-water flow velocities greater than the critical velocity, the tube becomes unstable, and the amplitude of the tube’s vibration increases significantly. This phenomenon is referred to as fluid elastic instability (“FEI.”) Stability is an important consideration in the design and operation of a steam generator.

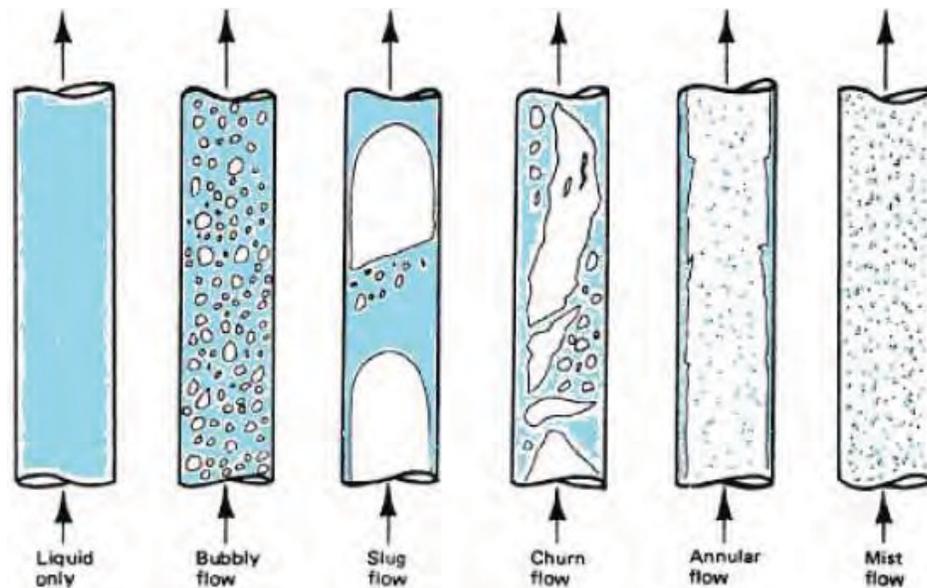
163. The foregoing can be depicted:



164. Thus, the T/H forces are basically the movement of the water or steam inside the operating steam generator. The forces can be measured in terms of velocity, known as flow velocity, and in terms of density, known as void fraction, which will be briefly described below.

165. *Flow velocity* is the speed of steam inside the steam generator. Flow velocity is measured for both liquid water or dry steam, known as a one-phase flow, and steam comprised of varying mixtures of water and air, known as two-phase flow. Measuring

the behavior of two-phase flow is complex. The two-phase steam can manifest in different patterns:⁴⁹



166. *Void fraction* (“VF”) represents the percentage of air in a steam mixture. VFs range from a low void fraction of 0% (or 0.0), representing water, to a high void fraction of 100% (or 1.0), representing dry steam absent water.
167. VF is relevant to a type of tube damage called dryout or tube cracking.⁵⁰ Overly dry steam associated with a high void fraction is therefore a concern with regard to damage on account of dryout.
168. One of the other factors affecting T/H conditions is the *circulation ratio* (“CR”). The circulation ratio represents the amount of water in the secondary loop that re-circulates in relation to the flow that leaves as steam:⁵¹

⁴⁹ Respondents’ T/H Tutorial, p. 7.

⁵⁰ As further discussed in ¶ 178 below, VF is also an important factor in tube damping.

⁵¹ Respondents’ Tutorial, p. 18.

$$\text{Circulation Ratio} = \frac{(\text{Recirculation Wet Steam} + \text{Steam to Turbines})}{\text{Steam to Turbines}}$$

169. The amount of water exiting the turbines equals the amount of water that is added to the steam generator from an outside source. For the SONGS RSGs, the value is designed to be 3.3, indicating that approximately a third of the water in the steam generator leaves as dry steam and is replaced by new water.⁵²
170. Whether or not a tube will suffer from fluid elastic instability is calculated using the *stability ratio* (“SR”). That equation is calculated by dividing the effective velocity of the steam over the critical velocity of the tube:

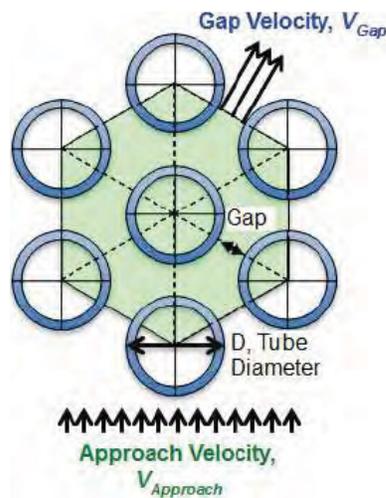
$$\text{Stability Ratio} = \frac{\text{effective velocity}}{\text{critical velocity}}$$

171. Where the effective velocity exceeds the critical velocity, i.e., the division results in a value greater than 1.0, that tube is unstable. Conversely, where the division results in a value less than 1.0, the tube is stable.
172. *Effective velocity* of the steam is generally a measure of the flow velocity of the steam surrounding a particular area of the tube at which the stability ratio calculation is being performed. Effective velocity is therefore dependent upon the operating conditions of the steam generator and the space available in the steam generator for the steam to travel. The space is limited by the number of tubes and the tube support structure, such as TSPs and AVBs. More tubes, more tightly packed tubes, more tube support plates, more anti-vibration bars, and more of any physical component in the RSG – all these factors increase the flow velocity and effective velocity of the steam (comparable with putting a thumb on a garden hose⁵³). Effective velocity is generally

⁵² Respondents’ Tutorial, p. 18.

⁵³ Transcript, pp. 228 (Dr. Kytömaa), 482 (Dr. Lahey).

dependent upon the velocity of the steam approaching a tube, the gap velocity, and the velocity leaving a tube:⁵⁴



173. *Critical velocity* is not a velocity but rather a measure of the ability of the tube to withstand the T/H force acting on the tube. Critical velocity is calculated using an equation called Connors' Equation, a simplified version of which is below:

$$V_c = (\text{natural frequency}) \times \sqrt{(\text{damping ratio}) \times (\text{other parameters})} \times \text{constant}(K)$$

174. For the purposes of this arbitration, the elements at issue of Connors' Equation are:
- i. Natural frequency of the tube;
 - ii. Damping; and
 - iii. Connors' Constant (K).

175. The *natural frequency* of the tube represents the innateness of the tube when exposed to force, such as T/H force. A U-shaped tube, such as those found in the RSGs, can

⁵⁴ Respondents' T/H Tutorial, pp. 8-9.

move sideways and up and down. The natural frequency of the tubes is such that force on the tube will cause it to vibrate first sideways, i.e., in an out-of-plane direction, rather than up and down, i.e., in an in-plane direction. The natural frequency of the tube is limited by tube span length.

176. Tube span length represents the distance between support points restraining the tubes. These support points are from TSPs or AVBs (see ¶¶ 141 - 149 above). The more support points, the more the tube is restrained from instability. However, as adding more support structures to the steam generator reduces the amount of space for the steam to flow, this also increases the flow velocity. More support structures also increase the number of potential contact points at which random wear can occur. However, these support points also facilitate damping.
177. *Damping* is a counterforce which mitigates (dissipates) tube vibration and therefore (i) makes FEI less likely; and (ii) minimizes the effect of random vibration.⁵⁵ Damping forces are either structural or from the water content in the steam. Structural damping, such as friction damping, is provided by resistance force on the tubes from the support structure, i.e., TSPs and AVBs. Damping from the water in the steam, generally “two-phase damping,” represents the ability of the water in the steam to absorb some of the force from the vibrating tube. Total damping is the sum of individual damping mechanisms, such as structural damping, two-phase damping, and other forms of T/H damping from the water content of the steam (i.e., squeeze-film and viscous).⁵⁶
178. VF, being a measure of the water content, therefore is correlated to two-phase damping. At higher void fractions, there is less water, and therefore less two-phase damping. Conversely, at lower void fractions, there is more water and more two-

⁵⁵ Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc., ¶ 68.

⁵⁶ Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc., ¶ 68.

phase damping. As will be discussed later in this Award, T/H conditions, such as VF, were part of the root cause of the wear and tube leak that occurred at SONGS.

179. Finally, *Connors' Constant* (“**K**”) is a variable selected by the designer, either based upon an industry recommendation or their own research. What exactly Connors’ Constant is, or how it is derived, is beyond the scope of this arbitration. For the purposes of this arbitration, Connors’ Constant is generally seen as a factor of conservatism in the calculation of stability ratios.

(e) **Regulatory**

180. The operation of nuclear power plants in the United States is undertaken pursuant to Title 10 of the US Code of Federal Regulations (“**10 CFR**”). The US Nuclear Regulatory Commission (“**NRC**”) is mandated with the enforcement of those regulations.
181. Under 10 CFR 50.59, only a “like for like” replacement of a nuclear steam generator or its components are permitted absent regulatory involvement. Otherwise, changes to a nuclear power plant may require NRC review, including the possibility of public hearings. Similar to other nuclear plant operators, SCE required that Units 2 and 3 be replaced under this “like for like” process to avoid regulatory delays. This “like for like” requirement was at issue both during the design phase of the RSGs and the repair or replacement efforts of the Parties.
182. Deviations from the “like for like” philosophy are possible without triggering a regulatory review. The NRC regulations and guidelines provide criteria to determine whether a change is possible without triggering an evaluation and/or public hearing. The Parties are disagreed as to whether a repair of Unit 3 could have been undertaken without triggering a NRC review and public hearing. The Parties are further disagreed as to whether approval of a repair could ever be obtained from that process.

183. NRC decisions in this regard can be challenged before administrative tribunals. The decision to restart Unit 2 following the Incident was found to be a violation of the 10 CFR 50.59 process by a panel of the NRC's Atomic Safety and Licensing Board ("ASLB"). That panel required that public hearings be held prior to a restart of SONGS Unit 2 for 5 months at 70% power.
184. In addition to the 10 CFR 50.59 process, the NRC was involved in other aspects of this dispute, including (i) requiring that SCE improve its safety culture; (ii) inspections of MHI's facilities and operations; (iii) investigating the SONGS Incident; (iv) preventing a restart of SONGS prior to SCE satisfying it as to the safety of doing so; (v) imposing requirements to ensure that SONGS could withstand a seismic incident similar to the Fukushima incident in Japan; and, but for the SONGS shutdown; (vi) the NRC would have been involved in reviewing SCE's license renewal application for the operation of SONGS beyond 2022.

B. THE DECISION TO UPGRADE

185. While SONGS Units 2 and 3 were licensed to operate until 2022, the existing steam generators had exhibited degradation and were predicted to reach the end of their operating life some years prior to that date.⁵⁷ In order to ensure continuous operations, SCE decided to procure RSGs prior to reaching the limit of the operating life of the OSGs. The procurement of the RSGs was undertaken by EMS, as supported by SCE.
186. SCE was not alone in its decision to upgrade its steam generators. Since 1989, some 65 nuclear power plants in the United States had upgraded their steam generators.⁵⁸ With the exception of the earliest plant upgrades, all those since were undertaken in a manner that limited regulatory oversight by restricting the upgrades such that they

⁵⁷ Exh. JX-1954, p. 7; Witness Statement of Wharton, ¶ 12.

⁵⁸ Exh. JX-1954, p. 5.

fell within the scope of the current generator’s operating license and specifications under 10 CFR 50.59, as discussed in Section VII.A(e) above.⁵⁹ The NRC had determined that an operator could install RSGs consistent with its existing operating license without triggering a regulatory review.⁶⁰

187. On 1 November 2001, SCE created an internal team, the Steam Generator Replacement Team (“SGRT”) to explore the purchase of four replacement steam generators for Units 2 and 3 of SONGS.

C. RSG CONTRACT

(a) Timeline of Negotiations and Contract Conclusion

188. The timelines of the negotiation and contract conclusion given by the Parties do not show major differences. A consolidated version, which, based on the available record, is slightly expanded, is the following:

- January 2002: MHI and Edison have initial contact regarding the RSG project at SONGS.⁶¹
- March 2002: Edison provides MHI with fundamental design parameters, a questionnaire detailing areas of particular concern, and an agenda for Edison’s upcoming April visit to Mitsubishi.⁶²
- April – May: SRGP Team conduct benchmarking visits to potential RSG suppliers (including Mitsubishi).⁶³

⁵⁹ Exh. JX-1954, pp. 5-6.

⁶⁰ Exh. JX-1954, p. 7.

⁶¹ Counter-Memorial, ¶ 31.

⁶² Counter-Memorial, ¶ 31.

⁶³ Counter-Memorial, ¶ 31.

- 3-8 April 2002: Edison personnel visit MHI's Kobe, Japan facility to discuss Edison's invitation to bid and the scope of the RSG project.⁶⁴
- February 2003: MHI and Edison meet to discuss plans for Edison's RSG Request for Proposal, including Edison's design requirements.⁶⁵
- April-May 2003: Edison requests detailed information on MHI's design philosophy; MHI provides responses (including MHI's response to Edison's Request for Information of 2 May 2003 ("RFI") and its response of 9 May 2003).⁶⁶
- 11 August 2003: Edison issues revision D of its Conformed Design Specification ("CDS"), which sets the fundamental design requirements for the SONGS RSGs.⁶⁷
- December 2003: Edison and MHI meet to discuss Edison's upcoming Request for Proposal and additional technical issues.⁶⁸
- 12 December 2003: Edison issues its Request for Proposal for RSGs (CDS revision 1) for the RSGs ("RFP") to a number of vendors; the RFP includes proposed commercial and technical terms.⁶⁹
- 27 February 2004: MHI submits its response to Edison's RFP, including a Commercial Proposal and a Technical Proposal.⁷⁰

⁶⁴ Counter-Memorial, ¶ 31.

⁶⁵ Counter-Memorial, ¶ 31.

⁶⁶ Exh. JX-267; Exh. JX-268.

⁶⁷ Exh. JX-271.

⁶⁸ Counter-Memorial, ¶ 31.

⁶⁹ Counter-Memorial, ¶ 31.

⁷⁰ Exh. JX-293.

- 27 February 2004: Edison files an application with the CPUC for the SONGS SGRP, which was expected to cost about US\$ 680 million.⁷¹
- March-July 2004: Edison evaluates bid proposals.⁷²
- June-August 2004: Edison and MHI meet to discuss MHI's Proposal.⁷³
- 3 August 2004: Edison requests Best and Final Offers (“**BAFO**”) from MHI and AREVA (formerly Framatome).⁷⁴
- 12 August 2004: MHI and AREVA each submit their BAFO.⁷⁵
- August-Early September 2004: Edison and Mitsubishi meet to discuss key commercial terms.⁷⁶
- Late September 2004: Edison and MHI meet for over two weeks to continue discussing key commercial terms and technical requirements for the SONGS RSGs.⁷⁷
- 28 September 2004: Edison issues the RSG Contract revision 2 to MHI reflecting the agreed upon commercial terms, conditions, and technical requirements, for a fixed price of US\$ 136,990,000. It comprises some 384 pages. It is formally executed by EMS issuing a Purchase Order and Revision

⁷¹ Counter-Memorial, ¶ 31.

⁷² Counter-Memorial, ¶ 31.

⁷³ Counter-Memorial, ¶ 31.

⁷⁴ Counter-Memorial, ¶ 31.

⁷⁵ Counter-Memorial, ¶ 31.

⁷⁶ Counter-Memorial, ¶ 31.

⁷⁷ Counter-Memorial, ¶ 31.

2 of the “Conformed Specification for Design and Fabrication of Replacement Steam Generators for Unit 2 and Unit 3.”⁷⁸

- 30 September 2004: MHI executes RSG Contract Revision 2.⁷⁹

189. On 30 September 2004, Edison and MHI executed an “end user agreement”. That end user agreement provides that SCE would “be bound by and also share in the benefits derived from” relevant sections of the RSG Contract.⁸⁰ Years later, in January and February 2007, Edison and SCE executed an assignment agreement under which MHIA’s rights and obligations were transferred to MNES.⁸¹

190. The RSG Contract was subjected to revisions. The fourth, and latest, version of the RSG Contract governs the Parties’ relationship at present.⁸² References in this Award to the RSG Contract are to this fourth version.⁸³ While there was some initial dispute between the Parties as to which version of the RSG Contract is operative,⁸⁴ the Parties have not further particularized any issues regarding the applicability of Revision 4 of the RSG Contract. The Respondents’ post-hearing submissions on the List of Issues clarifies that differences between Revisions 3 and 4 are not germane to the present arbitration.⁸⁵

191. Another document relevant to the dispute at issue is the Purchase Order. It provides that the RSG Contract attached thereto is incorporated by reference.⁸⁶ The RSG

⁷⁸ Exh. JX-316.

⁷⁹ Counter-Memorial, ¶ 31.

⁸⁰ Exh. JX-317.

⁸¹ Exh. JX-686.

⁸² RSG Contract.

⁸³ See also Section XIII.A(a) below.

⁸⁴ Respondents’ Answer, p. 4; Memorial, ¶ 38.

⁸⁵ Respondents’ Position Statement on the Revised List of Issues, ¶ 46.

⁸⁶ Exh. JX-321, p. 4.

Contract consists of three main sections, the relevant provisions of which will be reviewed below:

- Section 1: General Terms and Conditions;
- Section 2: Non-Technical Requirements;
- Section 3: Technical Requirements.

(b) General Terms and Conditions (Section 1 of the RSG Contract)

192. The General Terms and Conditions, as set forth in Section 1 of the RSG Contract open with introductory provisions in Section 1.1.1, which provides in relevant part:

In consideration of payments to be made and the obligations to be performed by EMS, the Supplier agrees to furnish the Apparatus, all Documentation and the Technical Services to EMS or Edison and all of its other obligations, all in accordance with the requirements of the Purchase Order. Supplier shall ensure that (i) the Work complies with Applicable Laws, Applicable Standards and the other terms, conditions and requirements of the Purchase Order; (ii) the Work shall be performed with Supplier's best skill and judgment, in a safe, expeditious, good and workmanlike manner in accordance with the preceding clause (i); and (iii) the Work shall be approved as to form, use and content by public and private entities authorized to administer or enforce any Applicable Law or Applicable Standard whose approval of the final design and fabrication of the Apparatus, or any portion thereof, is necessary for the installation and operation of the Apparatus (...)

193. Section 1.2 of the RSG Contract sets forth the definitions. A number of those definitions that will be referred to in this Award are the following.

194. Section 1.2.4 of the RSG Contract regarding "Apparatus":

RSG Units (as defined below) and any and all other equipment, machinery, material, supplies, special tools, accessories, purchased

components, computer hardware and firmware, to be furnished by the Supplier and purchased by EMS under the Purchase Order.

195. Section 1.2.5 of the RSG Contract regarding “Applicable Laws”:

Applicable Laws: To the extent related to the Purchase Order, all laws, treaties, ordinances, judgments, decrees, injunctions, writs, orders, rules, regulations, and interpretations of any Governmental Authority to the extent having jurisdiction over Supplier, the Apparatus, SONGS, the Jobsite, generation or transmission of electricity, performance of the Work or the Purchase Order, including, without limitation, the design, construction or operation of the Apparatus.

196. Section 1.2.13 of the RSG Contract regarding “Defect”:

Work that (i) does not conform to the requirements of the Purchase Order; (ii) is not new as of the date of delivery or of uniform good quality as required pursuant to the Purchase Order; (iii) is not free from defects or deficiencies in design, application, materials, manufacture or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order; or (iv) would adversely affect, contrary to the requirements of the Purchase Order; (a) the performance of the Apparatus under operating conditions consistent with those contemplated in the Purchase Order; (b) the continuous safe operation of the Apparatus during the Apparatus’s design life; or (c) the structural integrity of the Apparatus; and/or (v) are not suitable for the use as set forth in the Purchase Order.

197. Section 1.2.17 of the RSG Contract regarding “Documentation”:

Documentation: Drawings (including Certified Drawings), specifications, procedures, instructions, lists, reports, test results, calculations, manuals, schedules, software, and other data to be furnished by the Supplier, as stated in the Specification or elsewhere in the Purchase Order.

198. Section 1.2.40 of the RSG Contract regarding “Purchase Order”:

Purchase Order: The complete set of documents issued by EMS to the Supplier, as may be amended by Change Orders, which authorizes the Work, specifies the commercial terms, and incorporates by reference these General Terms and Conditions, the Specification and other referenced documents, all of which form the contract between the Parties.

199. Section 1.2.45 of the RSG Contract regarding “Specification”:

Specification: The documents consisting of Section 1 “General Terms and Conditions,” Section 2 “Non-technical Requirements,” and Section 3, “Technical Requirements.”

200. Section 1.2.59 of the RSG Contract regarding “Work”:

Work: The Apparatus, together with all engineering, analysis (including without limitation analysis of the impact of installation and use of the Apparatus on then-existing SONGS facilities), design, manufacturing, fabrication, assembly, inspection, testing, Documentation, Technical Services and all other obligations of the Supplier to be performed or furnished as required by the Purchase Order.

201. Section 1.3 of the RSG Contract specifies the scope of work:

Supplier acknowledges that issuance of the Purchase Order and acceptance by Supplier constitutes a fixed price obligation to complete the entire scope of the Work (other than as set forth in Section 1.9.2 for certain Technical Services). In light of the foregoing, Supplier has included within the Purchase Order Price the cost to complete the entire scope of Work, including any engineering, analysis, design, manufacturing, fabrication, assembly, inspection, testing, services, labor, materials and equipment that are indicated on the Purchase Order, required in order to comply with the intent of the Purchase Order or that are likely to be required in accordance with Applicable Law or Applicable Standards, or that are properly and customarily included within the general scope and magnitude of the work incorporated into equipment similar to the Apparatus and having similar technical requirements (including performance of the Apparatus in order to provide the functionality required for the Apparatus and to comply with the intent of the Purchase Order), [that are] considered as part of the Work. As a result, and notwithstanding Section 1.1 0, Supplier hereby

waives any and all claims for an increase in the Purchase Order Price or an extension of the Guaranteed Delivery Date or any date herein based, in whole or in part, upon an assertion that any certain engineering, analysis, design, manufacturing, fabrication, assembly, inspection, testing, service, labor, material or equipment is not includable in the Work when such engineering, analysis, design, manufacturing, fabrication, assembly, inspection, testing, service, labor, material or equipment is indicated on the Purchase Order, required in order to comply with the intent of the Purchase Order or is likely to be required in accordance with Applicable Law or Applicable Standards, or is properly and customarily included within the general scope and magnitude of the work incorporated into equipment similar to the Apparatus and having similar technical requirements (including performance of the Apparatus in order to provide the functionality required for the Apparatus and to comply with the intent of the Purchase Order).

202. In Section 1.11 of the RSG Contract (“Project Management”), Section 1.11.8 addresses Edison’s approvals:

Any review or approval required from EMS or the Edison Representative (such as review or approval of any drawings, reports or other submittals) shall not relieve the Supplier from its obligations under the Purchase Order, including its obligation to independently verify and assure that the Work complies with all of the requirements of the Purchase Order.

203. Section 1.17 of the RSG Contract contains the warranty provisions. It provides in relevant part:

1.17 WARRANTY

The Supplier warrants that the Apparatus shall meet all the requirements of the Specification, including the Applicable Standards.

1.17.1 Design, Workmanship and Material

1.17.1.1 The Supplier warrants that the Apparatus shall be free from Defects.

1.17.1.2 The warranty period for discovery of Defects in an RSG Unit (and associated portion of the Apparatus) (which, for purposes of this Section 1.17 shall be considered part of the RSG Unit) shall (subject to Section 1.16.4) commence upon Acceptance of the RSG Unit and continue for twenty (20) years unless this period is extended for an additional ten (10) year period by EMS's exercise if an option that is described in the Purchase Order (such period as extended, "Warranty Period"). If, during the Warranty Period, the RSG Unit is not available for use due to failure to meet the warranty requirements, such time of unavailability shall not be counted as part of the Warranty Period. The Warranty Period for such repaired or replaced Work, as well as those portions of the RSG Unit damaged by the applicable Defect, shall begin upon Acceptance of such repaired or replaced Work and shall continue for a duration equivalent to the remainder of the original warranty period specified in this Section 1.17.1.2, except that, where the remaining term of the Warranty Period is less than three (3) years, then the Warranty Period specified herein shall extend so the Warranty Period is three (3) years for such repair or replacement of Work that is subject to this provision. No warranty Work performed under this Section 1.17 shall be considered complete until the Edison Representative reviews and accepts such warranty Work.

1.17.1.3 Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner, by the Supplier at its sole expense with due diligence and dispatch by repairing or replacing (as appropriate) any defective part and other portion of the Work affected by such Defect. Supplier shall be responsible for all costs and expenses associated with such repair or replacement, including but not limited to (i) any necessary adjustments, modifications, change of design, removal, repair, replacement or installation of the Apparatus; and (ii) all parts, materials, tools, equipment, transportation charges and labor as may be necessary for such repair or replacement, except those specified in Section 1.17.7.4.

a) (...)

b) Should the Supplier fail to take action to correct any Defect within two (2) days after upon notification to the Supplier or fails to diligently continue performing such correction to completion thereafter, then the Edison Representative may perform or EMS or Edison may have

performed such necessary warranty work and backcharge the Supplier for such direct costs for repair or replacement and/or declare Supplier to be in default pursuant to Section 1.24. Such EMS or Edison performed warranty work shall not be construed as to void the warranty provisions and such warranty work shall be subject to Supplier's warranty obligations hereunder as if such warranty work had been performed by Supplier.

c) If Supplier is obligated to repair or replace the Apparatus or any part thereof under this Section 1.17, Supplier will undertake a technical analysis of the problem and correct the "root cause" unless Supplier can demonstrate to the Edison Representative's satisfaction that there is not a risk of the reoccurrence of such problem.

1.17.2 Performance

1.17.2.1 The Supplier warrants that the Apparatus shall meet the additional performance standards set forth in the following subsections of this Section 1.17.2.

1.17.2.2 Tubes Plugged Due To Degradation: Subject to Supplier's rights as expressly provided in Section 1.45, the tubes of each RSG shall be designed and fabricated such that they remain in service throughout the Warranty Period specified in Section 1.17.1.2. During the first ten (10) years of the Warranty Period, the Supplier shall be responsible for the cost of preventive maintenance or removal from service (by plugging and/or stabilization) of the tubes within each RSG as required by the SONGS Technical Specifications (or other governing document which describes Edison's commitment to the NRC with respect to tube preventive maintenance or removal from service). Thereafter, EMS shall bear the cost of the first ten (10) tubes per RSG that require plugging in the eleventh (11th) year of the Warranty Period and Supplier shall bear the cost of any tube thereafter that requires plugging that year. EMS shall bear the cost for the first tube per RSG that requires plugging in each subsequent year for the remainder of the Warranty Period and Supplier shall bear the cost of any tube thereafter in any subsequent year of the Warranty Period. If the number of tubes for which EMS is responsible for plugging in any year after the tenth (10th) year of the Warranty Period is greater than the number of tubes in such year that were actually plugged, then the excess number shall be added to and increase the number of tubes in the subsequent year of the Warranty Period for which

EMS shall bear the cost. If Supplier is required to bear the cost of plugging any tube in accordance with this Section, Supplier shall pay EMS the liquidated damages specified in Section 1.29.2 (ii) in lieu of such cost.

1.17.2.3 Primary-to-Secondary Leakage: There will be no primary-to-secondary leakage due to Defects in any of the RSG Units for the duration of the Warranty Period.

1.17.2.4 If at any time during the Warranty Period the Apparatus fails to satisfy the requirements of Section 1.17.2.3 above, the Supplier shall pay the liquidated damages specified in Section 1.29.2.1.

1.17.3 Documentation

The Supplier warrants that the Documentation shall be free from Defects, accurate and as specified in the Purchase Order. The Supplier shall, at its cost, correct any nonconforming Documentation discovered within five (5) years after its Acceptance, which shall be the warranty period for the Documentation.

204. The final provision of Section 1.17 of the RSG Contract, contained in Section 1.17.14, is a “Limitation of Warranties” provision, the text of which reads:

EMS’S SOLE REMEDY FOR BREACH OF SUPPLIER’S WARRANTY OBLIGATIONS SET FORTH IN THE PURCHASE ORDER SHALL BE AS SET FORTH OR PERMITTED HEREIN, AND THERE ARE NO OTHER REMEDIES FOR BREACH OF SUCH WARRANTY OBLIGATIONS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE, OTHER THAN AS PERMITTED IN THE PURCHASE ORDER. THE WARRANTIES SET FORTH IN THE PURCHASE ORDER ARE THE ONLY WARRANTIES MADE BY SUPPLIER WITH RESPECT TO THE WORK, AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, RELATING TO OR ARISING UNDER OR OUT OF THE WORK ARE HEREBY DISCLAIMED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.
(capitalization as in original text)

205. Section 1.21 of the RSG Contract provides for “Consequential Damages; Limitation of Liability” in the following wording:

1.21.1 Neither EMS nor Edison, on the one hand, nor the Supplier on the other hand (including its subcontractors and EMS's and Edison's subcontractors of any tier) shall be liable to the other Party for any special, indirect, incidental or consequential damages whatsoever, whether in contract, tort (including negligence) or strict liability including, but not limited to, loss of use of or under-utilization of labor or facilities, loss of revenue or anticipated profits, cost of replacement power or claims from customers, resulting from a Party's performance or nonperformance of its obligations under the Purchase Order, or in the event of suspension of the Work or termination of the Purchase Order.

1.21.2 Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that such limitation of liability shall not apply to: (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks.

(c) Non-Technical Requirements (Section 2 of the RSG Contract)

206. The Non-Technical Requirements, as set forth in Section 2 of the RSG Contract, include matters such as work location, delivery point, delivery dates, Edison representatives, project protocol, project management, quality assurance, document submittal requirements, and Supplier Deviation Requests (“SDR”).
207. As regards Engineering and Design, Section 2.6.4 (part of the “Project Protocol” in Section 2.6) of the RSG Contract provides:

All matters related to the design, licensing, or engineering in general, will be discussed directly between Supplier's and Edison's Engineering Representatives appointed for this Project and considered single points

of contact in said matters. The “single-point-of contact” philosophy shall be observed as much as possible, in order to avoid miscommunication.

All calculations, analyses, drawings, reports, procedures, and other engineering documents being sent by the Supplier for Edison’s review, or for information only, shall be addressed to Edison’s Engineering Representative. All such documents being returned to the Supplier following Edison’s review shall be addressed to Supplier’s Engineering Representative.

Edison’s and Supplier’s Engineering Representatives will establish mutually acceptable regular meeting schedule and format (face-to-face, teleconference, or videoconference) to discuss and deal with engineering issues. The teleconferences shall be held weekly and face-to-face meetings shall be held monthly during the engineering phase, at a location that is mutually acceptable. After this, an appropriate meeting frequency shall be mutually agreed to by the Parties.

208. Also relevant to the present case is the subsequent provision concerning Design Review, set forth in Section 2.6.5 of the RSG Contract:

The Supplier shall perform in-house design reviews of all drawings, calculations, analyses, and other documents in accordance with Supplier's QA Program prior to submitting them to Edison. Edison will participate in design reviews of the mutually agreed to critical design items/issues, and activities which represent “points of no return” (for definition of such activities see Section 3.9) prior to commencing their implementation (...)

(d) Technical Requirements (Section 3 of the RSG Contract)

209. The Technical Requirements, as set forth in Section 3 of the RSG Contract, include matters such as scope of the project, work by the Supplier (MHI), services furnished by Edison, technical definitions and acronyms, codes and standards, licensing requirements, servicing conditions, performance requirements, design requirements, quality assurance/quality control, acceptance criteria. A number of the provisions that are in dispute are quoted below.

210. The definition of “Margin” in the list of definitions set forth in Section 3.4.1 of the RSG Contract merits mention as it is at issue in relation the repair proposed by MHI:

The difference between the performance/design parameter value as included in the Specification or proposed by the Supplier and the minimum regulatory and/or design criteria value as of the date of the Purchase Order.

211. Section 3.5 of the RSG Contract concerns Codes and Standards. It incorporates American Society of Mechanical Engineers (“ASME”) standards regarding design and construction of nuclear steam generators. In this connection, it is to be mentioned that MHI is a licensed steam generator designer under the ASME and holds an ASME “N-Stamp.”⁸⁷
212. Section 3.6 of the RSG Contract relates to Licensing Requirements, stating that “Edison intends to replace the steam generators under the 10 CFR 50.59 rule” discussed in Section A(e) above on NRC regulations.⁸⁸ Section 3.6.1.1 then states: “Consequently, Edison requests that the RSGs be as close as possible to the existing steam generators in form, fit, and function (...)” The 10 CFR 50.59 reference is repeated in Section 3.9.1 quoted below.
213. Section 3.8 of the RSG Contract contains the Performance Requirements. Section 3.8.1 requires that “the RSGs be designed as large as possible within the dimensional and other limitations imposed in Sections 3.6.1 and 3.9.1, and Tables 3A-1 and 3A-3.” The limitations include the just mentioned 10 CFR 50.59 rule. Section 3.8.1 then specifies the requirements for Heat Transfer, Water Level Stability, Circulation

⁸⁷ An ASME N-Stamp holder is certified as a designer and manufacturer of nuclear boiler and pressure vessels in the nuclear industry. The manufacturer can then put a maker’s stamp on the manufactured vessel, i.e. the steam generator.

⁸⁸ See ¶ 180 above.

Ratio, Moisture Carryover, Steam Carryunder, Reactor Cooler Flow Rate, Primary-to-Secondary Leakage and Blowdown.

214. Section 3.8.2 of the RSG Contract provides for the “Performance Analysis Report (Thermal Hydraulics Report)” (“**PAR**”), a document whose significance is in dispute between the Parties. It states, in relevant part, the following:

The Supplier shall prepare and submit for Edison's approval a Performance Analysis Report documenting all thermal-hydraulic aspects of the RSG design. All necessary descriptions, analyses, calculations, graphs, and tables shall be included in the Performance Analysis Report, either directly, or as appendices, enclosures, or references. The Performance Analysis Report shall include all computer codes and modeling for the thermal-hydraulic performance of the RSGs. The design calculations shall assume 40-year design life of the RSGs and shall identify quantitatively available design Margins, where applicable.

The thermal-hydraulic design parameters for the RSGs are specified in Table 3A-1. The numerical values of these parameters are either imposed or shall be proposed by the Supplier. Based on the values of these parameters, the Supplier shall calculate the expected thermal-hydraulic performance of the RSGs. Where applicable, the calculations shall be performed for a power level range from 0 to 100% power. The report shall also include the mathematical model, analytical methods and data used to calculate the RSG performance. The calculations shall be performed for all applicable design transients identified in the SONGS UFSAR and addressed in the Licensing Topical Report. Heat transfer calculations for the purpose of sizing the tube bundle shall be performed for the nominal tube wall thickness, as specified by the Supplier, and shall address the ability of the RSGs to support natural circulation. Heat transfer calculations shall also be performed for the maximum allowable tube wall thickness as a "sensitivity case."

215. Section 3.9 of the RSG Contract addresses Design Requirements. The “Design Criteria” are provided for in Section 3.9.1, which states:

Edison desires that the RSGs dimensionally and functionally closely match the existing steam generators, in order to allow for their

installation under the 10 CFR 50.59 rule and with no or minimal modifications to the existing plant systems, structures, or components. Consequently, the following requirements and limitations are being imposed on the RSG design : (...)

These and other design parameters for the existing SONGS steam generators and the RSGs are specified in Supplement 3A, Tables 3A-1 and 3A-3. The tables in the “Original Design Data” column specify the values of the existing steam generators and in the “Replacement Design Data” column specify the values for the RSG, either imposed by Edison or proposed by the Supplier (...)

216. Supplement 3A, Tables 3A-1 and 3A-3, referred to in the above provisions as well as a number of other RSG Contract provisions,⁸⁹ contain steam generator data (notably T/H (thermal hydraulic) conditions), such as CR (Circulation Ratio) at 100% power for the OSG (CR of 3.2) and the RSG (CR of 3.3). It does not specify a number of T/H values, such as VF (void fraction) and velocity values,⁹⁰ with the result that it is in dispute whether the T/H values stated in the PAR, but not in the Tables in Supplement 3A, have a contractual value.⁹¹
217. The remainder of Section 3.9 is subdivided in the following categories:
- General Design Requirements (Section 3.9.2);
 - Detailed Design Requirements (Section 3.9.3, including notably provisions on tube supports in Section 3.9.3.7 which are relevant to disputes between the Parties⁹²);

⁸⁹ RSG Contract, Sections 3.1.3, 3.7.2.1, 3.8.1, 3.8.1.1, 3.8.2, 3.9.1, 3.9.3.23, 3.9.5.1, 3.9.6.2, 3.9.6.3, 3.9.6.4, 3.20.2.1.

⁹⁰ For T/H conditions, see Section VII.A(d) above.

⁹¹ For these terms, Section VII.A(d) above; Section XIII.A(c) below.

⁹² See Sections XIII.D(j) and XIII.F(d) below.

- Material Requirements (Section 3.9.4);
- Structural Requirements (Section 3.9.5, including the requirement that “the RSGs shall be designed such as to preclude their damage or malfunction due to corrosion or vibrations, including flow-, turbulence-, and environmentally-induced vibration”);
- Design Loading Requirements (Section 3.9.6);
- Certified Design Report (Section 3.9.7).

(e) **Design Basis**

218. During the Hearing, it became apparent that an issue in dispute with MHI’s proposed repair to the RSGs was whether the RSGs as designed were consistent with the “design basis” of the RSGs.
219. The Tribunal inquired with the Parties what is meant by the term “design basis.”⁹³ The term “design basis” appears to have both a technical regulatory meaning and a more colloquial meaning.
220. The Parties are agreed that the term “design basis” is a term of art of the NRC, as included under 10 CFR 50.2:

Design bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility that the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted ‘state of the art’ practices for achieving functional goals or (2) requirements derived from analysis based on calculations and/or experiments of the effects of a postulated

⁹³ Transcript, p. 3373.

accident for which a structure, system, or component must meet its functional goals.⁹⁴

221. References in the RSG Contract to “design basis” are limited to instances of earthquakes, main steam line break events, and to tube-to-tube sheet welds.⁹⁵
222. Other aspects of the RSG design, whether specified or not in the RSG Contract, or provided in the PAR may constitute design requirements, design inputs or outputs, and may be referred to colloquially as the “design basis” for the RSGs, absent any particular reference to such as a contractual or regulatory design basis in the RSG Contract or otherwise. For example, during a 13 July 2015 design meeting between MHI and SCE, ██████████ of MHI, used the term “design basis” in a colloquial matter, “explaining that the design basis [of the TSPs] build on the design decision from prior SG models.”⁹⁶

D. THE DESIGN OF SONGS RSGs

223. The factual aspects of designing the SONGS RSGs will be examined in this Section. First, the design experience of MHI will be addressed (Section D(a) below), followed by SCE’s involvement in the design process (Section D(b) below). Then, the design software used by MHI will be surveyed (Section D(c) below). Thereafter, the design process itself, which lasted several years, will be addressed (Section D(d) below). Those design processes that are at issue include determination of CR (Circulation Ratio), VF (void fraction), Velocity and the Gap Velocity Error, SR (Stability Ratio), and Tube-to-AVB gaps (Section D(e) below).

⁹⁴ Transcript, pp. 3386, 3396 (Daily Opening on behalf of the Respondents and the Claimants, 12 April 2016).

⁹⁵ RSG Contract, Sections 3.4.1, 3.6.2, 3.9.3.1, 3.9.3.13, 3.9.5.1, 3.10.3.4.

⁹⁶ Exh. JX-439, p. 8.

224. This Section concerns a selection of design issues in the present case from a factual perspective. It is apparent that MHI and SCE had significant numbers of interactions over the multiyear design process. It is beyond the scope of this arbitration to lay out the factual background behind every design decision, the vast majority of which do not appear to be at issue in this arbitration.

(a) **Mitsubishi's Design Experience**

225. MHI's early pressurized water reactor steam generators were based upon a license of Westinghouse technology in 1959.⁹⁷ MHI constructed nine reactors in Japan in the 1970s-1980s based upon this Westinghouse design.⁹⁸ Over the 1980s-1990s, MHI designed and constructed an additional 15 steam generators based upon two versions of its own steam generator design, which improved upon the 1950s Westinghouse model.⁹⁹ The licensing agreement between MHI and Westinghouse ended in or around the early 2000s, following which MHI designed and constructed steam generators based upon its own design.¹⁰⁰

226. Over some fifty years, MHI has designed and constructed RSGs and other nuclear steam generator components for plants in countries in Europe and Asia, and in the United States.¹⁰¹

227. While it is apparent that MHI has decades of experience in the nuclear steam generator industry, the SONGS RSG design and construction exceeded the scale of previous work undertaken by MHI. The 2000s designs by MHI were for RSGs that were of a generating capacity that was a third to a half of that of SONGS.¹⁰² Smaller

⁹⁷ Witness Statement of ██████ ¶ 2.

⁹⁸ Witness Statement of ██████ ¶ 2.

⁹⁹ Witness Statement of ██████ ¶ 3.

¹⁰⁰ Transcript, p. 650 (Dr. Elder).

¹⁰¹ Witness Statement of ██████ ¶ 6.

¹⁰² Transcript, pp. 650-651 (Dr. Elder).

steam generators do not have T/H conditions as extreme as larger steam generators.¹⁰³

228. SCE was aware of the challenges in moving to a larger steam generator design, and expressed the same to MHI in a November 2004 letter:

This will be one of the largest steam generators ever built for the United States and represents a significant increase in size from those that Mitsubishi Heavy Industries has built in the past. It will require Mitsubishi Heavy Industries to evolve a new design beyond that which they currently have available. Such design evolutions require a careful, well thought approach that fully evaluates the risks inherent in creating a new and significantly larger steam generator. Such design evolutions tend to challenge the capability of existing models and engineering tools used for proven steam generator designs. Success in developing a new and larger steam generator design requires a full understanding of the risks inherent in this process and putting in place measures to manage these risks. Understanding the difficulty in transitioning from the standard Mitsubishi Heavy Industries steam generator design to a new and larger two-loop design, San Onofre has made it a goal to partner with Mitsubishi Heavy Industries and maintain a close relationship with your engineering and fabrication organization to assist them in this design evolution.¹⁰⁴

(b) SCE's Involvement

229. As such, SCE specified that it would be involved in the design of the SONGS RSGs:

To this end we are performing detailed, intrusive evaluations of your design documentation and your approach to design evolution on this job.¹⁰⁵

¹⁰³ Transcript, p. 651 (Dr. Elder).

¹⁰⁴ Exh. JX-330.

¹⁰⁵ Exh. JX-330.

230. As part of this involvement, it assigned staff to Mitsubishi's facilities in Japan to provide oversight of "design, licensing, fabrication, delivery and acceptance activities."¹⁰⁶ SCE explained this supervision as follows:

Because these steam generators represent a significant increase in size and change in design from what MHI has produced in the past, they are considered (from SCE's standpoint to represent a first-of-a-kind design for MHI) and, consequently, an error-likely situation (this would also be true if any other supplier had been chosen).¹⁰⁷

231. SCE, however, made clear that its involvement was in no way to "relieve [Mitsubishi] of any responsibilities" for the design of the RSGs.¹⁰⁸ This is further specified in the RSG Contract.¹⁰⁹

(c) Design Software

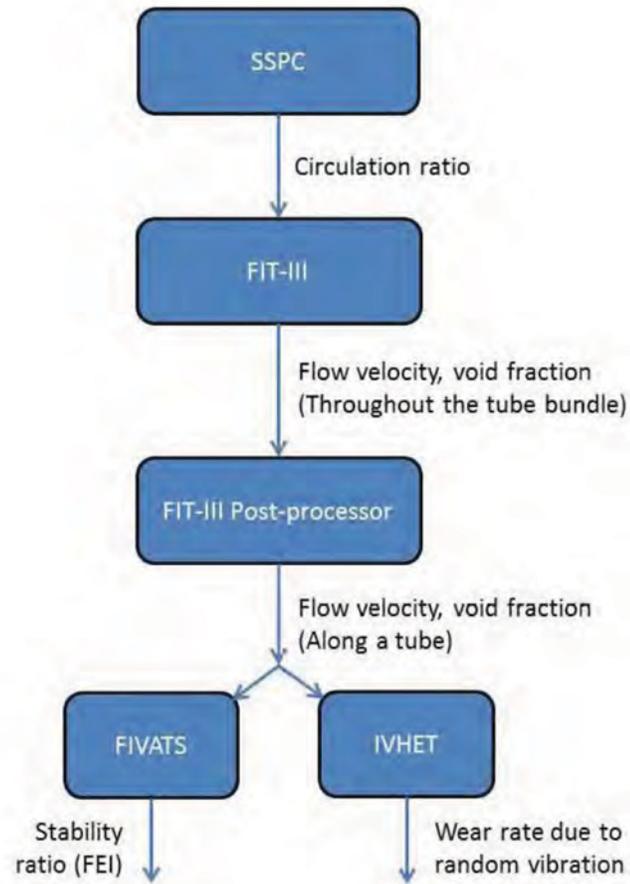
232. To design the RSGs, MHI utilized a number of software programs to calculate the T/H conditions expected in the RSGs. These T/H conditions are relevant to tube wear and the life of the steam generator. MHI predicted the T/H conditions in the RSGs in three sequential steps, as illustrated in the below diagram:

¹⁰⁶ Exh. JX-443, p. 5.

¹⁰⁷ Exh. JX-443, p. 5.

¹⁰⁸ Exh. JX-443, p. 5.

¹⁰⁹ RSG Contract, Section 3.2.1.



233. One of the errors identified in the Root Cause analysis into the Unit 3 Incident was a communications error using the Flow in Tube Bundle 3-Dimensional Analysis (“**FIT-III**”) output to the FIT-III post processor which led to the under-prediction of Effective Velocity by a factor of 2.3 on account of the failure to account for the triangular pitch in the RSGs, as opposed to a square pitch layout, of the SONGS tube

bundle.¹¹⁰ The effect of this error is that stability ratio (SR) was under-predicted in the design of SONGS.¹¹¹ This error is known as the “Gap Velocity Error.”¹¹²

234. In addition to this error, the Claimants have alleged various errors contained within these codes and the accuracy, validation and improper use of the codes themselves, which the Respondents dispute.
235. MHI’s various design software as depicted above are briefly described below.
236. First, MHI used its proprietary Steam Generator Steady State Performance Calculation Code (“SSPC”) to calculate the CR (Circulation Ratio) and other conditions in the RSGs. SSPC is an MHI proprietary code used to determine the overall T/H conditions in the steam generator, including circulation ratio.¹¹³ According to Exponent (the Claimants’ expert), the T/H conditions calculated include temperature, pressure, VF (void fraction) and flow velocity.¹¹⁴ According to the SSPC Code Validation and Qualification Report, SSPC calculates temperature (heat transfer), CR (Circulation Ratio), primary pressure loss, and secondary volume and mass.¹¹⁵ MHI does not appear to state that SSPC calculates VF, which appears to be done during the next step, by FIT-III. The results calculated by using SSPC are inputs for FIT-III.

¹¹⁰ Exh. JX-1447, p. 28; Transcript p. 265 (Respondents).

¹¹¹ See Counter-Memorial, ¶ 303.

¹¹² See ¶ 301 below.

¹¹³ Expert Report of Kytömaa and Morse, ¶¶ 61-62.

¹¹⁴ Expert Report of Kytömaa and Morse, ¶ 61.

¹¹⁵ Exh. JX-578.

237. SSPC was developed in 2004 and was first used by MHI in the design of the Fort Calhoun RSGs, which were completed in 2006.¹¹⁶ In addition to being used at SONGS, it was used in the design of RSGs in France and Belgium.¹¹⁷
238. MHI's SSPC was introduced to SCE in MHI's technical proposal for the SONGS RSGs.¹¹⁸
239. For the purposes of this arbitration, Exponent has recreated a version of SSPC based upon the formulas specified in the SSPC manual.¹¹⁹ Claimants have alleged that the Respondents' SSPC code contains errors.¹²⁰
240. Second, MHI used its proprietary FIT-III code to calculate the velocities and void fractions throughout the tube bundle.
241. FIT-III was verified using a number of tests, including the so-called "10 MW test of 1974-1980," the "APWR Model test of 1982-1986," the "Clotaire program of 1982-1987 and the 10 MW Freon test of 1994-1999."¹²¹
242. Unlike other codes, the Claimants' experts, Exponent, were not capable of reproducing the FIT-III code for the purposes of their expert analysis in this

¹¹⁶ Exh. JX-2172.

¹¹⁷ Exh. JX-2172.

¹¹⁸ Exh. JX-293, p. 212.

¹¹⁹ Design Review and Failure Analysis Expert Witness Statement of Dr. Harri Kytömaa And Dr. Timothy Morse, Exponent, Inc., ¶ 71.

¹²⁰ Design Review and Failure Analysis Expert Witness Statement of Dr. Harri Kytömaa And Dr. Timothy Morse, Exponent, Inc., ¶ 72.

¹²¹ Exh. JX-293, p. 203.

arbitration.¹²² The Claimants have submitted that there are also various errors in the FIT-III code.¹²³

243. Third, MHI converted the FIT-III outputs into velocity and void fraction along individual steam generator tubes using a set of post-processing procedures, referred to as the FIT-III “Post-Processor.”
244. MHI used its FIT-III Post-Processor results in two ways.
245. First, MHI inputted those results into its proprietary software (“**FIVATS**” - Flow-Induced Vibration Analysis of Tubular Structures) for calculating SR (stability ratio) and thus predicting the potential for out-of-plane FEI (fluid elastic instability). MHI did not specifically calculate for in-plane FEI as, in its view, such was unexpected in a U-bend steam generator as the natural frequency of the tubes was such that out-of-plane FEI would occur before in-plane FEI.
246. For the purposes of this arbitration, the Claimants’ expert, Exponent, developed its own version of FIVATS to replicate MHI’s FEI analysis and SR calculations.¹²⁴ Exponent verified that their recreation of FIVATS matched the results of data generated by MHI’s version of FIVATS.¹²⁵
247. Second, MHI inputted those results into its proprietary software (“**IVHET**” - Impact Vibration of Heat Exchanger Tube with Gap Support Code) for calculating tube wear due to random vibration.

¹²² Transcript, p. 450 (Dr. Kytömaa).

¹²³ Design Review and Failure Analysis Expert Witness Statement of Dr. Harri Kytömaa And Dr. Timothy Morse, Exponent, Inc., ¶¶ 107-108.

¹²⁴ Transcript, pp. 255, 947 (Dr. Kytömaa and Dr. Morse).

¹²⁵ Transcript, p. 1084 (Dr. Morse).

248. IVHET is used to make determinations regarding the structure of the U-bend, the two-phase steam water flow in a steam generator, and analysis vibrations in both the “in-plane and the out-of-plane direction.”¹²⁶
249. For the purposes of this arbitration, IVHET’s main feature is the calculation of wear depth through the computation of the work rate of tubes in the U-bend region. Work rate is defined as a function of contact force and sliding length over time.¹²⁷
250. Apart from MHI’s proprietary codes, an alternative code to FIT-III, i.e., **ATHOS** (Analysis of the Thermal Hydraulics of Steam Generators), is relevant to this arbitration on account of its use post-Incident and its use in the industry. ATHOS was developed by the Electric Power Research Institute, EPRI. Members of EPRI, including utilities, were granted access to ATHOS and its user manuals.¹²⁸ Similar to FIT-III, ATHOS is used to calculate void fractions and velocities in steam generators. There are various versions of ATHOS, including customized versions in used by other designers, such as Westinghouse. While ATHOS was not used by MHI in the design of the RSGs, it was used for the analysis following the Incident.
251. Also, another code, the ABAQUS code, was used by MHI in both the design of the RSGs and as part of its post-Incident repair efforts. ABAQUS is a commercial code used to calculate contact forces in steam generators.¹²⁹ ABAQUS as such can also be used to calculate gaps between tubes and the support structure.¹³⁰
252. Within the T/H conditions in the RSG depicted above, the velocities played an important role. It may be mentioned here that there is no dispute that MHI under-

¹²⁶ Exh. JX-721, p. 6.

¹²⁷ Exh. JX-721, p. 6.

¹²⁸ Transcript, p. 3682 (Dr. Blandford).

¹²⁹ Transcript, p. 399 (Dr. Kytömaa).

¹³⁰ Transcript, p. 3370 [REDACTED]

predicted velocities in the RSGs. This is evident from the facts on record, in particular the root cause analysis into the Unit 3 Incident.

(d) **The Design Process**

253. The contractual design process of the SONGS RSGs started in the Fall of 2004 and lasted several years. To properly understand that process, it is useful to consider the period prior to the execution of the RSG Contract in September 2004. The relevant design period of the SONGS RSGs, therefore, spans from SCE's early bid requests, such as the RFI issued in May 2003¹³¹ through the issuance of the PAR (Performance Analysis Report) on 28 October 2008.¹³²
254. During this period, the design process generally involved technical meetings, design review meetings, and executive oversight meetings, with such meetings held in both Kobe and California, and held both in person and by video/telephone conference. At such meetings various design and fabrication specifications and design parameters were reviewed.
255. In addition, SCE personnel and consultants generally provided SCE and MHI with comments on documents, action items were identified, and reports provided regarding issues raised.
256. From the design era, the Claimants have submitted a witness statement from Mr. Michael Wharton, the project manager for the steam generator replacement project and a deposition transcript from Mr. Paul Langford, one of the Respondents' contemporary consultants in the design of the RSGs. The Respondents have submitted witness and expert reports from [REDACTED] a lead project engineer for the SONGS RSGs, [REDACTED] MHI's Deputy Director for

¹³¹ Exh. JX-267.

¹³² Exh. JX-813.

Nuclear Component Design, [REDACTED] an MHI engineer responsible for the design of the AVB structure, [REDACTED] who was involved with RSG design efforts and FIT-III, [REDACTED] a marketing representative for MHI's nuclear business, and Mr. Robert ("Con") Wilson, a consultant contemporarily hired by MHI to assist with the design of the SONGS RSGs.

257. During the design process, some changes in design required that MHI issue SDRs (supplier deviation requests),¹³³ in which MHI sought permission for and justified its requests to deviate from contractual design specifications. Other design elements, such as changes to the calculation of void fraction and flow velocity, evolved absent such formal steps.
258. The RSGs were to be designed in accordance with specifications set forth in the RSG Contract, including Table 3A-1 and regulatory and technical guidelines.
259. As mentioned, the term "design basis" has both a technical NRC meaning and a colloquial meaning.¹³⁴ The design basis for the RSGs includes values specified in the RSG Contract and various parameters and calculations undertaken over the design period. These values are generally documented in various reports, drawings, meetings and other documentation.

(e) **Design Issues**

(i) *Determination of Circulation Ratio (CR)*

260. The first selected design issue concerns the CR as the Claimants have alleged various design errors in the calculation of the CR.

¹³³ See ¶ 206 above.

¹³⁴ See ¶¶ 218-222 above.

261. As mentioned above,¹³⁵ the CR represents the amount of water in the secondary loop that re-circulates in relation to the flow that leaves as steam. The water recirculates through the downcomer¹³⁶ after passing through the moisture separators situated above the U-bend and entering back into the steam generator through the secondary water feed. The relevance of CR is in regard to tube cracking on account of dryout and to VF (void fraction).
262. Over the design period, the CR in the RSGs was revisited on a number of occasions, and eventually set at 3.3.
263. The design chronology regarding the CR is the following.
264. The SONGS OSGs had a CR of 3.2.¹³⁷ The SONGS RFI of 2 May 2003 specified a requested CR of greater than 4.0.¹³⁸
265. The reason for this request is likely to be that the OSGs for Unit 2 and Unit 3 were facing an earlier than expected end of life due to their reaching of a tube plugging limit.¹³⁹ A cause of this shortened life was on account of tube dryout and corrosion.¹⁴⁰ The record appears to support a motivation behind SCE's push towards a higher CR as primarily a means of avoiding a reoccurrence with the RSGs of similar tube damage.¹⁴¹

¹³⁵ See ¶¶ 168-169 above.

¹³⁶ The downcomer is the region between the tube wrapper and the shell of the steam generator in which water recirculates back into the steam generator following condensation.

¹³⁷ Exh. JX-267.

¹³⁸ Exh. JX-267.

¹³⁹ Witness Statement of Mr. Wharton, ¶¶ 12-13.

¹⁴⁰ Witness Statement of Mr. Wharton, ¶ 11.

¹⁴¹ Witness Statement of Mr. Wharton, ¶ 105.

266. MHI's response of 9 May 2003 to SCE's Request for Information proposed a CR of approximately [REDACTED] as part of the design criteria for the RSGs,¹⁴² a figure that MHI considered "optimal for minimizing deposits and FIV."¹⁴³
267. On 23 May 2003, MHI answered a SCE question regarding the selection of CR by stating that "based on [its] experience, a CR between [REDACTED] and [REDACTED] is optimal for water level stability and FIV."¹⁴⁴ MHI further explained that a high CR "produces areas of high velocities that can increase the potential for Flow Induced Vibration (FIV¹⁴⁵)."¹⁴⁶ One aspect affecting the CR was the decision to adopt a "broached tube support plate," which "results in a slightly lower circulation ratio."¹⁴⁷
268. On 27 February 2004, MHI's technical proposal mentioned that the "MHI RSG design incorporated the following design requirements," namely a "high circulation ratio that prevents dryouts and minimizes corrosion."¹⁴⁸ Table 3A-1 ("Steam Generator Data") of MHI's technical proposal provided a proposal for a CR of [REDACTED] in the column "Replacement Design Data" as opposed to a ratio of 3.2 in the column "Original Design Data."¹⁴⁹ MHI stated:

The thermal-hydraulic design of the SG secondary side is important for reliable operation. Design objectives are to minimize corrosion and vibration. Circulation ratio (CR) is one of the main parameters in meeting this objective.

Too low a CR will produce low velocities or stagnant areas of high steam quality that will result in high levels of corrosion. Too high a CR

¹⁴² Exh. JX-268.

¹⁴³ Exh. JX-269.

¹⁴⁴ Exh. JX-269, p. 1.

¹⁴⁵ "FIV" means flow induced vibration.

¹⁴⁶ Exh. JX-269, p. 1.

¹⁴⁷ Exh. JX-269, p. 4.

¹⁴⁸ Exh. JX-293, p. 142.

¹⁴⁹ Exh. JX-293, p. 126.

produces areas of high velocity that increase tube vibration (FIV). MHI has developed an accurate thermal-hydraulic code (FIT III) for evaluating an optimum range of CR's that minimize both corrosion and vibration during operation.¹⁵⁰

269. SCE's bid evaluation of 28 July 2004 stated that the MHI proposal for a CR of [REDACTED] compared to a proposal by Framatome/AREVA for a CR of [REDACTED] and a ratio of [REDACTED] proposed by Doosan.¹⁵¹
270. The RSG Contract of 28-30 September 2004 included a Revision 2 of the RSG Design Specifications, dated 29 September 2004, which also stated that the CR specified in Table 3A-1 of the RSG specifications, had a CR of [REDACTED].¹⁵²
271. On 15 March 2005, MHI made a presentation to Edison regarding AVB design, in which it stated that calculating stability ratios assuming loss of one contact point is the "conservative industrial standard."¹⁵³
272. On 23 March 2005, MHI submitted a so-called "SDR" (supplier deviation request), to officially modify the contractual requirement of a CR of [REDACTED] to a value of [REDACTED].¹⁵⁴ This change was made on account of a change to the downcomer and to "increase the margin of RSG water level stability."¹⁵⁵ It was left unanswered until a later SDR was agreed to by SCE (see ¶ 277 below).
273. In a 16 August 2006 RSG Executive Oversight Meeting, a presentation by the members (which included SCE and Mitsubishi) shows that other steam generators had CRs ranging from 3.0 to 4.5. With respect to the steam generators that were

¹⁵⁰ Exh. JX-293, p. 423.

¹⁵¹ Exh. JX-311, p. 9.

¹⁵² Exh. JX-316, Supplement 3-A, p. 246.

¹⁵³ Exh. JX 380, p. 15.

¹⁵⁴ Exh. JX-384.

¹⁵⁵ Exh. JX-384.

discussed in the presentation, these steam generators with circulation ratios from 3.0 to 4.5 generally had void fractions in the 0.9-0.95 range. According to this 16 August 2006 presentation, a CR for SONGS of [REDACTED] correlated to a maximum expected void fraction of approximately [REDACTED].¹⁵⁶

274. In a 31 August 2005 video conference between SCE and MHI, MHI stated that further calculations led it to change the expected CR from [REDACTED] to [REDACTED].¹⁵⁷ SCE expressed its dissatisfaction with this design change and MHI observed that it would explore a reduction from seven TSPs (tube support plates) to six TSPs which would increase CR upward to [REDACTED].¹⁵⁸
275. In a 13 September 2005 internal MHI analysis, it was determined that a move from seven TSPs to six TSPs showed that an increase to CR “does not decrease the void fraction significantly based on FIT-III analysis results.”¹⁵⁹ A change from seven TSPs to six TSPs would increase the CR from [REDACTED] to [REDACTED] which would decrease void fraction from [REDACTED] to [REDACTED].¹⁶⁰ The results of this study were shared with SCE on 13 October 2005.¹⁶¹
276. A 6 October 2005 feasibility assessment by MHI shows that MHI and SCE agreed not to reduce the number of TSPs from seven to six on account of structural integrity concerns in the event of a main steam line break.¹⁶²

¹⁵⁶ Exh. JX-467, p. 59.

¹⁵⁷ Exh. JX-465.

¹⁵⁸ Exh. JX-472.

¹⁵⁹ Exh. JX-481, p. 1.

¹⁶⁰ Exh. JX-481, p. 1.

¹⁶¹ Exh. JX-499.

¹⁶² Exh. JX-494.

277. On 4 November 2005, another SDR was issued by MHI to SCE, officially requesting to change the CR from the contractual value of ■ to 3.3.¹⁶³ The change was undertaken on account of changes to the downcomer width and to optimize the design to “improve structural strength and decrease the potential for tube vibration.”¹⁶⁴ This change was determined not to have a significant detrimental effect on the possibility of tube dryout.¹⁶⁵ On 14 November 2005, the Supplier Deviation Request was signed off on by SCE.¹⁶⁶
278. In a 1 December 2005 RSG Executive Oversight meeting of SCE and MHI, ■ ■ ■ ■ ■ for MHI, confirmed that the final circulation ratio for the SGS “shall be 3.3.”¹⁶⁷
279. On 20 December 2005, MHI issued revision 1 to the Thermal and Hydraulic Parameters for SONGS, showing a CR of 3.3.¹⁶⁸ The CR of 3.3 was incorporated into revision 2 of the Design of Anti-Vibration Bar report of 19 January 2006.¹⁶⁹
280. Revision 3 of the Specification to the RSG Contract, dated 7 November 2006, shows that a CR of 3.3 was incorporated into Table 3A-1 of the RSG Contract.¹⁷⁰
281. On 28 October 2008, the PAR (Performance Analysis Report) was issued by MHI.¹⁷¹ The PAR states that “the circulation ratio is optimized to be 3.3 such that the design of down comer [*sic*] and tube support plate flow area to reduce the potential of tube

¹⁶³ Exh. JX-504.

¹⁶⁴ Exh. JX-504, p. 3.

¹⁶⁵ Exh. JX-504, p. 6.

¹⁶⁶ Exh. JX-512.

¹⁶⁷ Exh. JX-516.

¹⁶⁸ Exh. JX-527.

¹⁶⁹ Exh. JX-542.

¹⁷⁰ Exh. JX-647, p. 256.

¹⁷¹ Exh. JX-813.

vibration and water level instability as shown in Table 3.3-2” of the PAR.¹⁷² Table 3.3-2 shows that various design alternatives “for optimizing circulation ratio” would all have a negative effect on the stability ratio, generally decrease the damping factor, but could marginally improve void fraction by ██████ although one option would decrease void fraction by ██████¹⁷³

282. The final RSG Contract Revision 4 dated 28 July 2010 specifies that the RSG CR was to be 3.3, per Table 3A-1 of the RSG Contract.¹⁷⁴

(ii) *Determination of Void Fraction (VF)*

283. The second selected design issue concerns the VF (void fraction) as the Claimants have alleged the Respondents were required to provide a repair to the RSGs that would restore VFs to the value that was used in the PAR and other design basis documents as the basis for the design, which were within (but at the high end of) known operating experience. The Claimants also submit that there are errors in the Respondents’ calculation of VFs.¹⁷⁵
284. As mentioned,¹⁷⁶ VF represents the percentage of air in a steam mixture. VFs range from a low VF of 0% (or 0.0), representing water, to a high VF of 100% (or 1.0), representing dry steam absent water. MHI calculated VF using FIT-III.
285. VF varies for every tube in the RSG and along every portion of a tube. As such, references to VF are either to average VF, or, at issue in this arbitration, to maximum VF in the U-bend region, that is, the expected highest VF in the RSG.

¹⁷² Exh. JX-813, p. 23.

¹⁷³ Exh. JX-813, p. 25.

¹⁷⁴ RSG Contract, Supplement 3-A at p. 251.

¹⁷⁵ See e.g. Memorial, ¶ 100.

¹⁷⁶ See ¶ 166 above.

286. Unlike CR, whose value is specified in the RSG Contract and to which changes required issuance of SDRs (supplier deviation requests), VF appears an intermediate design variable. As such, there does not appear to be a specific targeted maximum VF that the RSG design is required to meet. Instead, it is a factor in considering overall design choices. However, during the design MHI specified that a maximum VF of █████% was the highest value calculated for the RSGs and this figure was incorporated into MHI's PAR of 28 October 2008. The contractual relevance of the PAR is disputed between the Parties.¹⁷⁷
287. The design chronology regarding the VF is the following.
288. Revision D of Edison's CDS (Contractual Design Specifications), dated 11 August 2003, which set the fundamental design requirements for the SONGS RSGs, specified that VF was to be minimized in the downcomer region of the RSGs.¹⁷⁸ On 12 December 2003, the same requirement is specified in revision 1 of the draft RSG Contract.¹⁷⁹ On 29 September 2004, the same requirement is specified in revision 2 of the executed RSG Contract.¹⁸⁰
289. At a 24-25 May 2005 Design Review Meeting between SCE and MHI in Kobe, discussions took place on the significance of the high VF in the U-Bend and MHI was tasked with undertaking a parametric FIT-III analysis and other appropriate analysis to optimize tube bundle design.¹⁸¹

¹⁷⁷ See Section XIII.A below.

¹⁷⁸ Exh. JX-271, p. 22.

¹⁷⁹ Exh. JX-276, Section 3.8.1.5.

¹⁸⁰ Exh. JX-316, Section 3.8.1.5.

¹⁸¹ Exh. JX-411, p. 9; Exh. JX-412.

290. A 16 June 2005 letter from SCE's Mr. Dwight Nunn to MHI's General Manager, [REDACTED] [REDACTED] illustrates SCE's concerns over VF:

In our joint technical meeting, we also learned more about certain thermal-hydraulic aspects (void fraction) of the RSG design. Void fraction is an important thermal-hydraulic parameter, related to the probability of dry out occurring during power operation (the higher the void fraction, the higher the probability of dry out). Tube dry out is an undesirable phenomenon as it may eventually result in tube cracking. The information presented to Edison in the most recent Technical Meeting indicated that for the SONGS RSG the expected void fraction is very high. Consequently, Edison requests that MHI launch a consolidated effort aimed at addressing high void fraction in the RSG.¹⁸²

291. A 28 June 2005 AVB design team meeting between SCE and MHI reviewed MHI's analysis showing that both type of AVB configurations under consideration had similar VF.¹⁸³
292. Technical discussions between SCE and MHI during the week of 11 July 2005 considered aspects of VF.¹⁸⁴ It appears that [REDACTED] of MHI, was tasked with confirming that a VF would not be a concern for tube dryout and corrosion and was to confirm the maximum VF of [REDACTED] under FIT-III and document such in a Performance Report.¹⁸⁵ MHI was also requested to investigate the "possibility of reducing the VF through changes to the RSG design (e.g. indexed U-bend region, TSP flow slow size adjustment, etc.)."¹⁸⁶

¹⁸² Exh. JX-424.

¹⁸³ Exh. JX-433.

¹⁸⁴ Exh. JX-439.

¹⁸⁵ Exh. JX-439, p. 4.

¹⁸⁶ Exh. JX-439, p. 4.

293. During a 15 July 2005 meeting between SCE and MHI, MHI presented comparable data for its plants at Tihange and Ft. Calhoun, indicating that those had VFs of █% and █% respectively.¹⁸⁷
294. In a 29 July 2005 email, Mr. Wilson followed up on comparable plant data and reported that:

The █ RSG and the █ RSG both have $\frac{3}{4}$ ' tubes. The █ tube pitch is 6% greater than that of █. Both of these tube bundles are approximately the same size and have similar circulation ratios. The █ average-to-maximum void fraction difference is 7.5% while the █ difference is 11%. This demonstrates that tighter tube packing causes the void fraction to be elevated. The larger SONGS RSG tube bundle has nearly twice as many tubes with the same tube spacing, yet the FIT-III average-to-maximum void fraction difference is almost the same (i.e. █). This suggests that the number of tubes or size of the U bend does not significantly influence the maximum void fraction (according to FIT-III results). Therefore, for tube bundles with the SONGS tube spacing (1.0" triangular pitch with 3A" tubes) the average-to-maximum FIT-III void fraction difference is █ (. . .).¹⁸⁸

295. In a 16 August 2005 RSG executive oversight meeting, SCE and MHI, in a presentation prepared jointly between MHI and SCE's SGRT (Steam Generator Replacement Team), conclude that the void fraction calculated by Mitsubishi using FIT-III was not a concern for dryout and that the "maximum value was not unusual."¹⁸⁹ The joint presentation concludes that as "dryout does not occur in SONGS RSGs (...) therefore, we do not need to investigate the possibility of reducing the maximum void fraction."¹⁹⁰ A chart that is included in the presentation

¹⁸⁷ Exh. JX-439, p. 13.

¹⁸⁸ Exh. JX-453; Exh. JX-455.

¹⁸⁹ Exh. JX-467, p. 57.

¹⁹⁰ Exh. JX-456, p.8.

from meeting displays that at a CR of [REDACTED] SONGS was predicted to have a void fraction in the [REDACTED] to [REDACTED] range, similar to other plants.¹⁹¹

296. In a 17-20 August 2005 design and technical meeting between MHI and SCE, MHI observed that while concerns with void fraction and dryout had been addressed, it still had to address issues of void fraction, damping and tube vibration.¹⁹² In particular, a presentation from around that meeting states that “although void fraction may be high due to the large bundle size, the maximum value is not unusual” and “dryout and tube corrosion in the SONGS RSG U-bend does not occur.”¹⁹³ That meeting also identified the need to identify that the maximum expected void fraction was [REDACTED]¹⁹⁴
297. Revisions 1 through 3 to the Design of AVBs report were issued on 25 November 2005, 19 January 2006, and 17 February 2006, respectively. They appear to maintain the same considerations with regard to VF as version 0.¹⁹⁵
298. In a 24 February 2006 email from MHI’s consultants Mr. Wilson to Mr. Langford and MHI, Mr. Wilson wrote that he has doubts regarding the accuracy of all VF codes (FIT-III, ATHOS, and PORTHOS¹⁹⁶), that comparing results across codes is misleading (but comparing results obtained by employing the same code would be of greater value), that he therefore recommended conducting an analysis using the same code, between the Arkansas Nuclear One RSGs and the SONGS RSGs, and that he recommends generally a conservative approach with regard to VF and

¹⁹¹ Exh. JX-467, p. 59.

¹⁹² Exh. JX-468, p. 6.

¹⁹³ Exh. JX-456, p. 4.

¹⁹⁴ Exh. JX-469, p. 76.

¹⁹⁵ Exh. JX-514; Exh. JX-542; Exh. JX-561.

¹⁹⁶ PORTHOS is another code developed by EPRI that is similar to ATHOS.

damping.¹⁹⁷ Mr. Wilson also indicated that, “if time permit[ed]” he would “like to see several comparisons made with different programs and different mesh configurations” as “such as battery of analyses would be very enlightening – and would prove useful in the future.”¹⁹⁸

299. Revisions 4 and 5 to the Design of AVBs report were issued on 21 March 2008 and 3 July 2008, respectively. It appears to maintain the same considerations with regard to VF as versions 0 through 3.¹⁹⁹
300. As mentioned above,²⁰⁰ on 28 October 2008, the PAR (Performance Analysis Report) was issued. The PAR identified that a CR of 3.3 results in maximum VF in the U-bend of [REDACTED] calculated by using FIT-III.²⁰¹

(iii) Determination of Velocity and Gap Velocity Error

301. A third selected design issue concerns the Gap Velocity Error. As mentioned above,²⁰² there is no dispute between the Parties that MHI under-predicted velocities in the RSGs by a factor of 2.3 due to a failure to account for the design of the SONGS RSGs using a triangular pitch as opposed to a square pitch tube array.²⁰³
302. Given this admission, there is no need for the Tribunal to provide a comprehensive factual history surrounding velocities in the design of SONGs. Rather, in light of the issues at stake in this arbitration, the Tribunal considers it pertinent to provide the chronological history of the Parties’ contemporaneous investigation, prepared by

¹⁹⁷ Exh. JX-567.

¹⁹⁸ Exh. JX-567.

¹⁹⁹ Exh. JX-760; Exh. JX-782.

²⁰⁰ See ¶ 281 above.

²⁰¹ Exh. JX-813, p. 25.

²⁰² See ¶ 233 above.

²⁰³ For gap velocity, see ¶ 172 above.

MHI, into Mr. Langford's concerns regarding FIT-III's calculation of velocities.²⁰⁴ Whether MHI ignored the advice and warnings of its consultants is at issue in this arbitration, as is whether MHI was aware of the Gap Velocity Error.

303. On 15 October 2005, Mr. Langford communicated to MHI that the "overall gap velocity distributions appear to be lower than my expectations" and speculated as to whether there was "any possibility that the plotted distributions represent bulk flows that should be multiplied by $p/p-d$ ²⁰⁵ to obtain gap velocity distribution."²⁰⁶
304. Mr. Langford proposed that "incremental progression of calculations showing how features of the SONGS design reduced velocities from levels characteristic of previous domestic designs" be undertaken.
305. MHI prepared a "Chronology of Resolution of Mr. Langford's Comments on FIT-III Gap Velocity," dated 24 March 2006.²⁰⁷ That chronology does not conclude that Mr. Langford's concerns were met, as indeed the RSGs were designed with this Gap Velocity Error, but does suggest that MHI, Mr. Langford, and Mr. Wilson (who had similar concerns), were eventually satisfied that the potential wear consequences of the concerns were addressed by comparing data for SONGS with that of another power plant, i.e., [REDACTED]
306. The chronology was exhibited in this arbitration by the Claimants as evidence of MHI's failure to adequately resolve the gap velocity concerns raised by Mr. Langford:

²⁰⁴ Exh. JX-577.

²⁰⁵ "p/p-d" represents pitch divided by pitch minus diameter. Pitch is indicative of the arrangement of the tubes while diameter is the diameter of the tube. The formula for calculating flow velocity (i.e. gap velocity) is to take approach velocity multiplied by $p/(p-d)$.

²⁰⁶ Exh. JX-500.

²⁰⁷ Exh JX-577.

October 15 2005

On October 15, 2005, in advance of the #6 Design Review Meeting (“DRM”), which was scheduled for October 17, 2005 between MHI and SCE, Mr. Langford provided comments regarding the draft version of the “Design Review of Anti-Vibration Bar” presentation to MHI. In these comments, Mr. Langford noted that “the overall gap velocity distributions appear to be lower than my expectations.” See Attachment 1 (showing Mr. Langford’s comments).

October 18 2005

On October 18, 2005, attendees at the #6 Design Review Meeting reviewed a slide that showed that the work rate²⁰⁸ from the domestic SG was [REDACTED] that of the SONGS RSGs potentially because the SONGS fluid velocity appeared much lower than the fluid velocity of the domestic plant.²⁰⁹ Consequently, MHI generated Action Item 31. See Attachment 2 (providing the origin and text of Action Item 31).

Action Item 31: “MHI to review the wear calculation and explain the reasons why the SONGS velocity and consequential wear calculations are so different than those for the domestic SG - 11/28/05.”

November 29 2005

On November 29, 2005, in advance of the Technical Discussion Meeting (“TDM”) which was scheduled for December 7, 2005, [REDACTED] sent a draft presentation to Mr. Langford and Mr. Wilson, among others. See Attachment 3 (showing this transmittal). Slide 31 of this draft presentation shows that MHI was at the time reperforming the SONGS wear calculation using the revised thermal hydraulic condition (FIT-III flow velocity distribution including the AVB peaking effect) in a more conservative condition (consecutive inactive supports and one-sided wear) in light of Langford’s comments. See Attachment 4. This draft presentation did not, however, provide findings or conclusions regarding

²⁰⁸ Work rate is defined as a function of contact force and sliding length over time (See Exh. JX-721, p. 6).

²⁰⁹ “Domestic plant” refers to another plant to which SONGS was compared.

the resolution of Action Item 31. See Attachment 5 (including the full draft presentation as sent to Mr. Langford for his review).

December 1 2005

On December 1, 2005, Mr. Langford provided comments regarding the draft presentation to [REDACTED] and Mr. Wilson, among others. Mr. Langford noted that the extent to which the substance of slide 31 responds to Action Item 31 was unclear. The material which Mr. Langford reviewed was a draft and did not include the revised wear calculation. Mr. Langford suggested that MHI undertake a parametric study to determine the parameter that was responsible for the difference between the work rate in the domestic SG²¹⁰ and the work rate in the SONGS RSGs. See Attachment 6 (providing Mr. Langford's comments regarding the draft presentation).

December 7 2005

Based on Mr. Langford's suggestion, MHI performed a wear calculation for both domestic SG and SONGS RSG and discussed the influential elements to the wear calculation by comparison. At the December 7, 2005 TDM, MHI presented the findings and conclusions of that study to SCE. MHI and SCE consequently agreed to close Action Item 31. See Attachment 7a (stating that MHI has reperfomed the wear calculation), 7b (comparing the key wear-related parameters for the domestic plant and for SONGS), 7c (comparing the flow characteristics for the domestic plant and for SONGS).

February 21 2006

On February 21 2006, Mr. Wilson responded to an email from [REDACTED] and suggested that MHI develop a comparison of the wear potential between SONGS RSGs and [REDACTED] RSGs, which were successful RSGs at 2006, in order to demonstrate that SONGS RSG was in acceptable range of wear potential. See Attachment 8 (showing Mr. Wilson's suggestion). MHI consequently developed that comparison.

²¹⁰ "Domestic SG" refers to a another nuclear steam generator to which SONGS was compared.

February 22 2006

On February 22, 2006, and in response to Mr. Wilson's suggestion, ██████ sent a comparison of vibration potential between ██████ and SONGS to Mr. Langford and Mr. Wilson, among others. See Attachment 9 (showing this transmittal) and Attachment 10 (showing a table that compares the vibration potential between ██████ and SONGS). ██████ noted that although MHI could perform wear depth analyses on the ██████ SGs, that doing so is not necessary as the principles of engineering approach shows conclusively that SONGS has a lower potential for wear than does ██████

February 24 2006

On February 24, 2006, Mr. Langford provided comments regarding the table that compares the vibration potential between ██████ and SONGS to ██████ and Mr. Wilson, among others. Mr. Langford noted that it would be beneficial to compare SONGS and ██████ using a single T/H code, i.e., either FIT-III or ATHOS, so as to allow a detailed comparison of wear potential among the SGs of those plants. See Attachment 11 (showing Mr. Langford's comments and outlining his revisions to the table as provided by ██████ and Attachment 12 (showing the table with Mr. Langford's revisions).

Later that day, Mr. Wilson responded to Mr. Langford's comments, and noted that although he has doubts regarding the accuracy of FIT-III, ATHOS, and PORTHOS, that he supports using those tools whenever possible. See Attachment 13.

February 28 2006

On February 28, 2006, and in advance of the TDM, which was scheduled for March 13, 2006 between MHI and SCE, Mr. Wilson provided comments on the table that compares the vibration potential between ██████ and SONGS as revised by Mr. Langford to ██████ and Mr. Wilson, among others. See Attachment 14.

March 4 2006

On March 4, 2006, Mr. Langford responded to Mr. Wilson's February 27, 2006 comments, noting that he would review them prior to attending MHI's internal meeting, which was scheduled for March 9 and 10, 2006. See Attachment 15.

March 9-10 2006

On March 9 and 10, 2006, MHI met with Mr. Langford and Mr. Wilson to discuss the content of the Technical Discussion Meeting, which was scheduled for March 13, 2006 between MHI and SCE. The attendees concluded that the comparison of vibration potential between ██████ and SONGS was acceptable and that MHI should not perform an additionally-detailed analysis for the reasons that ██████ provided on February 22 2006. They also concluded that MHI should focus its efforts on AVB fabrication and tube-bundle assembly.

March 13 2006

On March 13, 2006, MHI presented to SCE a comparison of the vibration potential of the SONGS RSGs to the ██████ SGs. This comparison concluded that the vibration potential of the SONGS RSGs is 60% that of the ██████ SGs. See Attachment 16a (providing a summary of the wear analysis evaluation), 16b (comparing the vibration potential between the SONGS RSGs and the ██████ SGs), and 16c (providing the resolution of Action Items 30 and 31). Mr. Langford stated that this comparison provided convincing evidence that the SONGS RSGs would perform better than the ██████ SGs. Mr. Wilson recommended that MHI's effort be focused on the control of manufacturing variables to produce small, uniform gaps - rather than to expend excessive effort in performing vibration and wear analysis. See Attachment 17.

Based on these consultants' comments, MHI concentrated its efforts on the precise tube-to-AVB gap control after this meeting.²¹¹

307. That the Gap Velocity Error was only discovered following the Incident is indicative that MHI never did resolve Mr. Langford's particular concerns regarding gap

²¹¹ Exh. JX-577.

velocity. It is apparent that Mr. Langford, Mr. Wilson, and MHI alternatively agreed on a means of minimizing any vibration consequences of that error through a focus on AVB fabrication and assembly, i.e. by “concentrated (...) efforts on the precise tube-to-AVB gap control.”²¹² SCE does not appear to have objected to this approach at the 13 March 2006 joint meeting, although it did raise concerns regarding the potential for tube cracking, as occurred in the OSGs.²¹³

(iv) Determination of Stability Ratio (SR)

308. A fourth selected design issue concerns the SR (stability ratio). As explained above,²¹⁴ SR is calculated by dividing effective velocity of the steam over the critical velocity of the tube. Effective velocity is generally a measure of the flow velocity of the steam surrounding a particular area of the tube. Critical velocity is not a velocity in the proper sense of the word, but rather a measure of the ability of the tube to withstand the T/H force acting on the tube. Critical velocity is calculated by using an equation called Connors’ Equation.²¹⁵
309. If SR is greater than 1.0, a tube becomes unstable and may experience FEI (fluid elastic instability). SR can be calculated for both the in-plane and out-of-plane directions, respectively. MHI calculated SR using FIVATS.²¹⁶
310. The process of selecting the target SR and the components of Connors’ Equation used in calculating the SR are examined below, as are MHI’s design considerations regarding AVBs and calculations of in-plane and out-of-plane SRs.

²¹² Exh. JX-577, p. 3.

²¹³ Exh. JX-575, p. 3.

²¹⁴ See ¶¶ 170-173 above.

²¹⁵ See ¶¶ 174-179 above.

²¹⁶ See ¶¶ 245-248 above.

(1) Selection of Stability Ratio Target

311. The question here is which factors MHI used when determining SR and whether the selection of the factors was sufficiently conservative. An example of conservatism is that calculations are made on the basis of the assumption that one AVB is ineffective (also referred to as “support location”). Other examples of conservatism include the choice of Connors’ Constant, damping, and the margin to instability of the SR.
312. MHI’s 25 May 2003 response to SCE’s RFI mentions that MHI evaluated SR in accordance with Section III of the ASME code and designed “so that SR is less than 1.0.”²¹⁷ MHI further provided that “usually [it] design[ed] AVBs with the margin against flow induced vibration as double (SR is less than ■■■)” using “the lowest values of experimental data such as critical coefficient²¹⁸ and damping factor shown in ASME Sec. III.”²¹⁹
313. MHI’s 27 February 2004 technical proposal also mentions a SR target of designing below 1.0 for each tube.²²⁰
314. In a 19 March 2004 response by MHI to SCE’s request for additional information, MHI provided that the “margin to instability is represented by 1-SR” and that the “outer most U-bend represents the worse-case for SR” and that therefore “this is why Row 143 was chosen for our proposal.”

²¹⁷ Exh. JX-269, p. 26.

²¹⁸ The critical coefficient is the same as Connors’ Constant K.

²¹⁹ Exh. JX-269, p. 26.

²²⁰ Exh. JX-293, p. 283.

315. The RSG Contract does not specify a target stability ratio or maximum acceptable stability ratio, but does specify that the PAR was to provide “margin(s) to flow instability,”²²¹
316. In a March 2005 design presentation to SCE, MHI stated that a “design criteria” for preventing tube failure from FEI is to assume “one inactive support at all locations and still have a tube SR of less than [REDACTED]”²²² According to this presentation, the “design basis” for SONGS was that with “conservative assumptions,” “less than [REDACTED] tubes” should be “plugged in 40 years for wear.”²²³ The presentation also provides that “fluid elastic vibration does not occur in case[s] that stability ratio is less than 1.”²²⁴
317. A 17 March 2005 presentation to SCE by MHI regarding AVB design provides that the number of AVB support points is determined by the need to prevent FEI assuming the loss of one contact point (i.e., one ineffective AVB) and that “this assumption is [a] conservative industrial standard.”²²⁵
318. A 23-24 May 2005 technical meeting discussion between SCE and MHI provided that a “design criteria” for preventing FEI is that FIV does not occur (“Stability ratio < 1”), even with one unsupported AVB. The joint presentation by SCE and MHI further provides that these are “conservative guidelines,” which “other fabricator[s]” do not apply.²²⁶

²²¹ RSG Contract, Section 3.8.2.

²²² Exh. JX-389, p. 4.

²²³ Exh. JX-389, p. 4.

²²⁴ Exh. JX-389, p. 10.

²²⁵ Exh. JX-380, p. 15.

²²⁶ Exh. JX-409, p. 19.

319. An 8 June 2005 Evaluation of Tube Vibration report of MHI stated that “the calculated maximum stability ratio is [REDACTED]” for Row 142.²²⁷ It is to be noted that Row 142 tubes include those with the highest expected SR.
320. A 29 June 2005 internal SCE email, sent by Mr. Russell, who at the time was a consultant for SCE and presently a witness for MHI, to other SCE personnel reflects his recommendation that “the stability ratio should be less than 0.75 per the specification with all support locations participating.”²²⁸ He further commented that MHI’s 8 June 2015 draft Evaluation of Tube Vibration report “appears to utilize a [REDACTED] standard for stability with one support location not participating” and recommended that this be discussed “in light of the uncertainty in calculation methods and adverse wear in U-bends with large steam generators.”²²⁹ Mr. Russell further provided that the industry standard is for a “SR less than 0.75.”²³⁰ During the Hearing, Mr. Russell affirmed his thinking of the time.²³¹
321. Minutes of a 16 September 2005 technical discussion meeting between SCE and MHI mention that SR is calculated assuming both all active supports and one inactive support.²³² This assumption was incorporated into the 30 September 2005 Revision 0 of MHI’s Design of Anti-Vibration Bars Report.²³³ Accordingly, Row 142 Column 88 would have a SR of [REDACTED] when all supports are active and a SR of [REDACTED] if one support is inactive.

²²⁷ Exh. JX-419, pp. 5, 26.

²²⁸ Exh. JX-435.

²²⁹ Exh. JX-435; See also Exh. JX-433, p. 9.

²³⁰ Exh. JX-435.

²³¹ Transcript, p. 4665.

²³² Exh. JX-465, p. 36-37.

²³³ Exh. JX-490, p. 6.

322. The 11 December 2007 Revision 3 to MHI's Evaluation of Tube Vibration report states that MHI again calculated SR for all tubes effective and with one ineffective support. The "Extreme Conservative Case," assuming a total damping ratio²³⁴ of █████²³⁵ and with one ineffective support mentions a predicted SR of █████ for Row 142 Column 88.²³⁶
323. The 28 October 2008 PAR (Performance Analysis Report) by MHI records that the maximum expected SR in the RSG straight leg is of █████ and the maximum SR were "less than 1.0 even if 1 support is inactive," with the calculations performed according to the ASME (American Society of Mechanical Engineers) standards.²³⁷ Under the RSG Contract, MHI was required to meet various ASME standards.
324. The PAR concludes that the SR of the RSGs were acceptable and met the requirements of Section 3.8.2 of the RSG Contract:
- Detailed calculations, by region, showing that cross-flow velocities within the tube bundle shall be such as to minimize tube wear at the tube-to-tube support interfaces. The calculations shall clearly identify the damping factor(s) used and margin(s) to flow instability for steam flow rates of up to 120% of the design flow rate.²³⁸
325. The PAR by MHI provides that this obligation was met, with the maximum SR being █████ for velocities of 120% the design flow rate, or █████ at 100%. The PAR also states that "for conservative evaluation, case studies also have been performed in Ref. 10 to confirm there is negligible possibility of fluid elastic vibration."²³⁹

²³⁴ Damping is provided by both the water content in steam, as represented by void fraction, and by structural factors, such as friction.

²³⁵ Being 0.20 from structural damping and █████ from two-phase damping.

²³⁶ Exh. JX-730, p. 93.

²³⁷ Exh. JX-813, p. 75.

²³⁸ Exh. JX-813, p. 75.

²³⁹ Exh. JX-813, p. 75.

326. “Ref. 10” mentioned in the PAR is the abovementioned version 3 of the MHI Evaluation of Tube Vibration Report, dated 11 December 2007. That document mentions that the “base case” calculation of stability ratios uses the ASME recommended values of 1.5% for damping²⁴⁰ and a Connors’ Constant,²⁴¹ K, of 2.4.²⁴²
327. The Evaluation of Tube Vibration Report also provided two alternate “actual case” evaluations and one scenario described as an “extreme conservative case” analysis. Greater conservatism was achieved through selecting a lower structural damping value in combination with the ASME recommended Connors Constant of 2.4.
328. These three alternative cases, rather than using an ASME recommended total damping value of 1.5% (for wet steam), include a structural damping of either 0.2% (minimum) or 1% (average) based upon MHI test results in combination with two-phase damping based upon VF, with the “extreme conservative case” using a structural damping of 0.2%.²⁴³ In this regard, the Tribunal notes the opinion of Mr. Langford, the Claimants’ witness, that “it will be difficult to know exactly where the currently used 1.5% damping ratio becomes non-conservative”²⁴⁴ as the “use of a constant 1.5% masks the actual tube behavior.”²⁴⁵ It follows that the use of actual two-phase damping variables based upon void fraction in combination with alternate structural damping values may address Mr. Langford’s concern with using the ASME recommended value of 1.5% combined damping.

²⁴⁰ As stated in ¶ 177 above, damping reduces the risk of instability. Damping is either from the water in the steam (represented by void fraction) or from structural forces, such as friction.

²⁴¹ As stated in ¶ 179, Connors’ Constant is a variable used in stability ratio calculations. What exactly Connors’ Constant represents is not germane to this arbitration.

²⁴² Exh. JX-730, p. 37.

²⁴³ Exh. JX-730, p. 52.

²⁴⁴ See ¶ 342 below.

²⁴⁵ Exh. JX-460, p. 3.

329. One alternative evaluation scenario adopted a K of ■■■²⁴⁶ based upon experimental data.²⁴⁷
330. The report provides that “for conservative evaluation stability ratios are analyzed in all cases when 1 point is removed,” i.e., one ineffective support, with that inactive support being the “most critical support.”²⁴⁸ The report concludes that for the U-bend region:
- All stability ratios in base case are less than 1.0 even if any support point is inactive. ... All the stability ratios of each tube and each condition are less than 1.0 and the validity of AVB design is confirmed by the code calculation.²⁴⁹
331. The three alternative cases also generally calculated SRs of below one, including with one inactive support, with the exception of Tube R142C88, which had a SR of ■■■ in an “extreme conservative case,” with a structural damping ratio of 0.2%, T/H damping according to void fraction, and one inactive support.²⁵⁰ MHI discounted the risk of FEI in tube R142C88, as “this case is too conservative and not realistic.”²⁵¹ The report also finds that under a “flow peaking effect” condition, SRs are also below one, even with one ineffective support.²⁵²

²⁴⁶ The Tribunal understands that a K of ■■■ is less conservative than a K of 2.4. See Exh. JX-730, p. 93.

²⁴⁷ Exh. JX-730, p. 55.

²⁴⁸ Exh. JX-730, p. 55.

²⁴⁹ Exh. JX-370, p. 65.

²⁵⁰ Exh. JX-730, p. 92.

²⁵¹ Exh. JX-730, p. 92.

²⁵² Exh. JX-730, p. 120.

(2) Selection of Connors' Constant

332. Connors' Constant, K, is one of the variables in Connors' Equation.²⁵³ Steam generators designers have two options in selecting the value for K. Either, they may adopt a value of 2.4 from Appendix N of Section III to the ASME Code or they may use a value based upon their experimentally derived data. A lower K value is a more conservative assumption in SR calculations.²⁵⁴
333. In the design of SONGS, MHI used a K of 2.4, while it used a K of [REDACTED] for one of its alternative SR case analysis. The use of a K of [REDACTED] was calculated based upon MHI's experimental data for the appropriate K in the U-bend region.²⁵⁵ According to MHI's Evaluation of Tube Vibration Report, a K of [REDACTED] was an appropriate critical factor for the U-bend portion of a tube in a triangular pitch array with SONGS' pitch to diameter ratio.²⁵⁶
334. MHI's 27 February 2004 technical proposal provides that a Connors' Constant of 2.4 was to be used.²⁵⁷ The use of a K of 2.4 was maintained in version 3 of the MHI Evaluation of Tube Vibration Report, dated 11 December 2007.²⁵⁸
335. It appears that other designers used different values for Connors' Constant. The Claimants' experts, Exponent, in a Rebuttal Expert report, mentioned that Westinghouse used a K of 5.0.²⁵⁹ During the Hearing, Dr. Au-Yang (the Respondents' expert) stated that he recalled that Babcock & Wilcox ("**B&W**")²⁶⁰

²⁵³ See ¶ 179 above.

²⁵⁴ Transcript, p. 3836 (Mr. Boyd).

²⁵⁵ Exh. JX-730, p. 55.

²⁵⁶ Exh. JX-730, p. 55.

²⁵⁷ Exh. JX-293, p. 284.

²⁵⁸ Exh. JX-730, p. 37-37.

²⁵⁹ Expert Report of Exponent, ¶ 110.

²⁶⁰ B&W is Babcock & Wilcox and/or Babcock & Wilcox Canada, competitors to MHI in the nuclear industry.

may have used a K of ■■■²⁶¹ Mr. Boyd (the Respondents' expert) similarly mentioned that B&W used a K of between ■■■ and ■■■ for designs in the 90s.²⁶²

(3) Selection of Damping Ratios

336. The damping ratio represents the sum of the various damping factors that mitigate tube vibration, such as structural damping, viscous damping, and two-phase damping.²⁶³ Two-phase damping is affected by the VF (void fraction) of the steam, with higher VF providing minimal damping.
337. The selection of a damping ratio can represent a means of obtaining conservatism in design.
338. In addressing SR, MHI's design recommendation was to focus not on the benefits of two-phase damping from VF, but rather on AVB configuration.²⁶⁴ MHI's base case calculations were undertaken using a damping ratio of 1.5, in accordance with Section III of the ASME code.
339. MHI's 27 February 2004 technical proposal provided that a damping value of 1.5% was used for wet steam.²⁶⁵
340. MHI's 25 February 2005 report on the Evaluation of Tube Vibration provides the damping values for various evaluation scenarios:²⁶⁶

²⁶¹ Transcript, p. 3130.

²⁶² Transcript, p. 3757.

²⁶³ Two-phase damping is damping from the water in steam.

²⁶⁴ Exh. JX-501, p. 157.

²⁶⁵ Exh. JX-293, p. 283.

²⁶⁶ Exh. JX-515 at 51.

	Damping ratio, h	Critical Factor, K
Base Case (Code Calculation)	1.5% According to ASME	2.4 According to ASME
Actual Case-1	Calculated based on void fraction when structural damping is 1.0%	2.4 According to ASME
Actual Case-2	Calculated based on void fraction when structural damping is 0.2%	■ According to experimental data
Extreme Conservative Case	Calculated based on void fraction when structural damping is 0.2%	2.4 According to ASME

341. In calculating stability ratios, MHI used various damping scenarios as set forth in the above table, including both the ASME recommendation of 1.5% and scenarios where T/H damping is based upon void fraction data and structural damping is either assumed to be 1% or 0.2%. The ASME recommended value for damping is either 1.5% for wet steam or 0.5% for dry steam, i.e., where there is no T/H damping.²⁶⁷ As explained during the Hearing by Exponent, the Claimants' expert, the ASME 0.5% value represents structural damping only, as T/H damping is zero at a void fraction of 1.0 (or 100%).²⁶⁸ As further explained by Exponent, where there is some T/H damping, at void fractions of 99% or 95%, then a minimal T/H damping value is added to the structural damping of 0.5%.²⁶⁹
342. In a 28 July 2005 email, MHI's consultant Mr. Langford expressed his view that as "it will be difficult to know exactly where the currently used 1.5% damping ratio becomes non-conservative²⁷⁰ for FIT-III"²⁷¹ and that the "use of a constant 1.5%

²⁶⁷ Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc., ¶ 86.

²⁶⁸ Transcript p. 1126.

²⁶⁹ Transcript p. 1127.

²⁷⁰ At high enough void fractions, the actual two-phase damping will be less than the recommended ASME value for wet steam.

²⁷¹ Exh. JX-445, p. 1.

masks the actual tube behavior.”²⁷² He recommended obtaining “as much margin as possible against reduced damping” and factor in damping differences in doing between-plant comparisons.²⁷³

343. A 13 October 2005 presentation on AVB design presented at a 18 October 2005 design meeting between SCE and MHI shows that stability ratios were below 1.0 if calculated using a structural damping ratio of 1% with one inactive support.
344. MHI emphasized SR calculations for the tube at Row 142 Column 88 (R1452C88), as one that is considered to be at the greatest risk of instability. Using a more conservative assumption of structural damping of 0.2%, a Critical Constant (K) of 2.4, and one inactive support, R142C88 would be unstable, with a SR of [REDACTED]²⁷⁴ Having calculated a SR above 1.0, MHI “confirmed that work rate is less than 40% wall loss for 40 operating years by tube wear analysis”, i.e., that despite instability under these conditions, tube R142C88 would not require plugging.²⁷⁵ This case study also illustrated that for MHI’s “base case” two-phase damping and other non-structural damping T/H damping is of only [REDACTED] for R142C88 with one inactive support.²⁷⁶ Similarly, based upon revision 2 to the Evaluation of Tube Vibration Report, two-phase and other non-structural damping appears to be [REDACTED] for R142C88.²⁷⁷
345. The design approach to damping does not appear to have evolved following October 2005.

²⁷² Exh. JX-460, p. 3.

²⁷³ Exh. JX-445; Exh. JX-454.

²⁷⁴ Exh. JX-498, p. 24; Exh. JX-501.

²⁷⁵ Exh. JX-498, p. 24.

²⁷⁶ Exh. JX-498, p. 24; Exh. JX-501; see also Transcript, p. 950.

²⁷⁷ Exh. JX-515, p. 93.



349. MHI’s design also proposed to address “fretting wear problems,” identified as “a major source of SG tube problems in many SG’s throughout the world” through a combination of (i) choosing a better alloy for the AVBs; (ii) increasing the number of support points; (iii) reducing the clearance between AVBs and tubes; and (iv) “improved installation and checking procedures which improve gap control and alignment.”²⁸² MHI proposed having “effectively zero” gap to address such wear.²⁸³
350. In a 28 March 2005 design presentation, MHI calculated SR for sample rows, indicating a highest SR of [REDACTED] for Row 142 using a [REDACTED] AVB configuration.²⁸⁴ This design is as follows:²⁸⁵

²⁸² Exh. JX-293, p. 172.

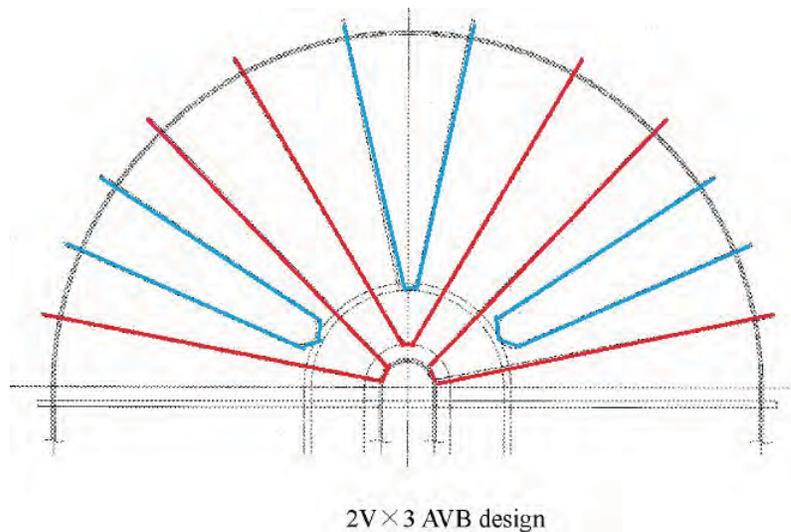
²⁸³ Exh. JX-293, p. 174.

²⁸⁴ Exh. JX-389, pp. 13-14.

²⁸⁵ Exh. JX-465, p. 9 (Colors added by the Tribunal for clarity).



351. A 30 April 2005 draft of MHI’s initial Design Plan for Anti-Vibration Bar report mentioned that, based upon T/H analysis, a 12 support point AVB design had been decided, “considering the case [of] any single point unsupported conservatively” and to adopt a 2Vx3 AVB design, with the details to be worked out through analysis and experimentation.²⁸⁶ The 2Vx3 AVB design is as follows:²⁸⁷



²⁸⁶ Exh. JX-392; Exh. JX-398; Exh. JX-399, p. 14.

²⁸⁷ Exh. JX-465, p. 9 (Colors added by the Tribunal for clarity).

352. Minutes of a 23-24 May 2005 technical meeting between SCE and MHI reflect discussions of alternative 3 AVB configurations in addition to its preferred 2Vx3 AVB design.²⁸⁸
353. Minutes of a 28 June 2005 AVB design team meeting mention that an alternative AVB design with ■ points of support was rejected as the calculated SR for Row 142 with one support point inactive was above 1.0.²⁸⁹ As previously specified, tube R142C88 was one of the tubes that MHI's evaluations calculated to have the highest SR.
354. A 29 June 2005 email from SCE's consultant Mr. Russell to SCE voiced his concerns regarding wear that had been found to occur in other large steam generators, such as Calvert Cliffs (Westinghouse) and St Lucie.²⁹⁰ He wrote that "the fact that wear is occurring at higher rates for large U-bend tubes (interior to the bundle) implies that something is occurring that is not yet fully understood" by the industry.²⁹¹ Mr. Russell observed that MHI agreed to review issues surrounding growth gap. Mr. Russell also gave his view that MHI's ■ AVB configuration may be preferred and should be studied further.²⁹²
355. A 28 July 2005 email from MHI's consultant Mr. Wilson to ■ at SCE states that in his review of wear at comparable plants, he concluded that the tube-to-AVB gaps at comparable plants was not as small as "advertised" and that "it will be difficult to get the SONGS wear below that of ANO-2 because the U-bend is larger

²⁸⁸ Exh. JX-409.

²⁸⁹ Exh. JX-433, p. 18.

²⁹⁰ Exh. JX-435 (Calvert Cliffs Nuclear Power Plant is a nuclear power plant located on the western shore of the Chesapeake Bay near Lusby, Calvert County, Maryland in the Mid-Atlantic United States. St. Lucie is a nuclear power plant located on Hutchinson Island, near Port St. Lucie, Florida).

²⁹¹ Exh. JX-435.

²⁹² Exh. JX-435.

and the tube spacing is tighter.”²⁹³ To recall, ANO-2 refers to Unit 2 of Arkansas Nuclear One. [REDACTED] Mr. Wilson recommended that MHI would have to control the AVB gaps precisely and move to a [REDACTED] or 2Vx3 AVB configuration.²⁹⁴

356. Minutes of a 16 September 2005 meeting between SCE and MHI reflect that the “stability ratio of a 2Vx3 AVB design has little difference from that of [REDACTED] staggered design and margin for FEV of both design[s] is almost [the] same.”²⁹⁵ MHI’s evaluation found that void fraction and velocities were nearly identical under either configuration while the 2Vx3 configuration had marginal benefits otherwise.²⁹⁶
357. The 30 September 2005 revision 0 to MHI’s Design of AVBs report states that by having average unsupported spans “of less than [REDACTED]” results in there being sufficient “margin to prevent fluid elastic vibration.”²⁹⁷ The acceptance criteria for the AVB design is that there is a SR of “less than 1.0 even with 1 inactive support.”²⁹⁸ MHI stated that SR for all tubes were less than 1.0 and that there was “no potential of fluid elastic vibration.”²⁹⁹
358. MHI’s Design of AVB Report was subject to 5 revisions, with the final version dated 3 July 2008.³⁰⁰ The 2Vx3 AVB configuration was adopted with tube span lengths averaging [REDACTED] to provide a “large margin against fluid elastic vibration.”³⁰¹ The PAR incorporates this final version.

²⁹³ Exh. JX-452.

²⁹⁴ Exh. JX-452.

²⁹⁵ Exh. JX-465, p. 10.

²⁹⁶ Exh. JX-465, p. 10.

²⁹⁷ Exh. JX-490, p. 22.

²⁹⁸ Ex. JX-490, p. 35.

²⁹⁹ Exh. JX-490.

³⁰⁰ Exh. JX-782.

³⁰¹ Exh. JHX-782, p. 23.

(5) In-Plane SR Calculations

359. In-plane SR calculations are undertaken to determine the likelihood of a tube suffering from in-plane FEI. In-plane movement is explained at ¶ 153 above.
360. The various versions of the “Evaluation of Tube Vibration” developed and presented by MHI to SCE between 25 February 2005³⁰² and 11 December 2007³⁰³ do not appear to show that in-plane SR calculations were performed. They only provided analysis on out-of-plane calculations.³⁰⁴

(6) Out-of-Plane SR Calculations

361. Out-of-plane movement is explained above.³⁰⁵
362. Out-of-plane SR calculations are undertaken to determine the likelihood of a tube suffering from out-of-plane FEI.
363. The initial draft of MHI’s Evaluation of Tube Vibration Report of 25 February 2005 does not provide calculated SR, but shows the methodology to be used.³⁰⁶ Version 1 of the Evaluation of Tube Vibration, dated 8 June 2005, also does not provide calculated SR.³⁰⁷
364. The 30 November 2005 version 2 of MHI’s Evaluation of Tube Vibration Report does calculate SR for nine tubes in the U-bend region.³⁰⁸

³⁰² Exh. JX-371.

³⁰³ Exh. JX-730.

³⁰⁴ Exh. JX-419; Exh. JX-515.

³⁰⁵ See ¶ 153 above.

³⁰⁶ Exh. JX-371, p. 13.

³⁰⁷ Exh. JX-419.

³⁰⁸ Exh. JX-515, p. 6-7.

365. The SR calculated in version 3 of MHI's Evaluation of Tube Vibration Report dated 11 December 2007 are identical to those of version 2 of the Report.³⁰⁹

366. The calculated SR equally match those of the PAR of 28 October 2008.³¹⁰ For the straight leg, the maximum SR was calculated as being [REDACTED] while the worst tube in the U-bend was calculated as being [REDACTED] with one inactive support point.³¹¹

367. In the PAR, MHI also stated that:

All these stability ratios are less than 1.0, therefore it is technically judged that RSG tube in straight region is stable for fluid elastic vibration.

For U-bend region, it has been confirmed that stability ratios are less than 1.0 even if 1 support is inactive.³¹²

368. MHI further stated that:

For conservative evaluation, case studies also have been performed in [MHI's Evaluation of Tube Vibration Report of 11 December 2007] to confirm there is negligible possibility of fluid elastic vibration.³¹³

369. Regarding tube wear, MHI declared in the PAR that:

The tubing wall loss is calculated to be less than [REDACTED] which is enough smaller than the plugging limit.³¹⁴

³⁰⁹ Exh. JX-730, p. 7-8.

³¹⁰ Exh. JX-813, p. 78-79.

³¹¹ Exh. JX-813, p. 75.

³¹² Exh. JX-813, p. 75.

³¹³ Exh. JX-813, p. 75.

³¹⁴ Exh. JX-813, p. 75 (According to Table 3.1-A of the RSG Contract, the plugging limit was 8%).

(v) Tube-to-AVB Gaps

370. The Parties are in dispute as to the situation surrounding tube-to-AVB gaps. According to the Claimants, large tube-to-AVB gaps that either existed at the time of manufacture or developed on account of the extreme T/H conditions in the RSGs allowed in-plane FEI to occur.³¹⁵ The Respondents dispute this.
371. Tube-to-AVB gaps can be a cause of tube wear. The size of the gap can also be an issue in how significant wear is on account of gap-limited³¹⁶ FEI.³¹⁷ The design paradigm at the time of the design of SONGS was for designing and manufacturing the tube and AVB structure such that there was the greatest uniformity in tubes and AVBs, small gaps, and a minimum AVB twist.³¹⁸ Uniformity refers to gap sizes being similar in size.³¹⁹ In other words, as Mitsubishi's Design of Anti-Vibration Bar Report stated, in accordance with the design paradigm, the RSGs were designed with an "effective zero gap" between the tube and the AVB that was designed to minimize contact force between the tube and the AVB.³²⁰ Accordingly, Section 3.10.3.5 of the RSG Contract required the statistical outermost tube-to-AVB gaps not to exceed 0.021 inches.
372. A chronology of the design is the following.
373. MHI's 27 February 2004 Technical Proposal Bid for the RSGs mentions that MHI's new RSG design had "improved installation and checking procedures which

³¹⁵ See e.g. Transcript, pp. 5386-7.

³¹⁶ Gap-limited FEI occurs where a tube suffers from FEI but the wear consequences are limited by the tube hitting an AVB rather than another tube. The wear may or may not result in that tube requiring plugging.

³¹⁷ See e.g. Transcript, p. 783.

³¹⁸ See e.g. Transcript, p. 4178.

³¹⁹ See e.g. Expert Statement of Dr. Begley, ¶ 79.

³²⁰ Exh. JX-782, p. 12.

improved gap control and alignment”³²¹ in order to address fretting wear.³²² This was achieved through a “statistical tube/AVB gap method whereby this gap is effectively zero.”³²³ MHI clarified that:

minute tube/AVB gaps exist based on the dimensional difference between the largest tube [outer diameter] and the rest of the tubes in each respective row of tubes. This gap is very small. Based on ECT³²⁴ data from operating SG’s manufactured by MHI using this concept of gap control, there are no indications of any fretting, indicating the tubes are effectively supported at all AVB locations. This concept will be applied to the San Onofre RSG’s.³²⁵

374. MHI further stated in the Bid Proposal that it has a “gap control process” for assembling the tube bundle.³²⁶
375. On 8 June 2004, MHI provided a response to SCE’s questions on its proposal stating that “the worst wear depth at the AVB” is of [REDACTED] being [REDACTED]% of tube wall thickness.³²⁷
376. The September 2004 contractual design specifications (CDS) provide the gap requirements that MHI was to meet:³²⁸

The supplier shall demonstrate (by analysis) that all specified clearances and tolerances are maintained after the RSG position is changed from horizontal to vertical The supplier shall develop and submit for Edison’s approval an Engineering and Fabrication Gap Control Methodology describing control of effective "zero" tube-to-fiat bar gap,

³²¹ “Alignment” refers to the tubes being centered and not pressed against a support.

³²² Exh. JX-293, p. 172.

³²³ Exh. JX-293, p. 174.

³²⁴ “ECT” stands for Eddy Current Testing. ECT is a method for testing for imperfections, such as tube wear.

³²⁵ Exh. JX-293, p. 174.

³²⁶ Exh. JX-293, p. 175.

³²⁷ Exh. JX-307, p. 1.

³²⁸ Exh. JX-316, Section 3.10.3.5.

gap uniformity and parallelism of the tube bundle in the out-of-plane direction prior to tube fabrication. The gap statistical size (mean+3s) shall not exceed 0.003,” and shall be validated by empirical data. Should this value be exceeded, an SDR shall be generated. The methodology shall specify the number of thickness measurement points for each flat bar type.

377. Notes from a 24 February 2005 meeting between SCE and MHI show that MHI believed that “larger interior gaps are acceptable” where there were more AVBs and shorter unsupported tube lengths.³²⁹ MHI’s consultant Mr. Wilson’s internal email to MHI following that meeting provided that he thought a contractual requirement of gaps less than 0.003 inches was not achievable.³³⁰ As such, Mr. Wilson considered that the CDS would have to be modified.
378. Minutes of a 28 March 2005 technical meeting between SCE and MHI record that two options to control gaps were under discussion, a conventional approach that allowed space for thermal expansion and an approach that minimized gaps but would have flowering³³¹ of the entire bundle due to thermal expansion.³³² The alternate approach would improve gap sizes as it would reduce tube-to-AVB gaps by [REDACTED]
[REDACTED]³³³
379. A 29 June 2005 email from SCE’s consultant Mr. Russell to SCE mentions his view that wear at St. Lucie (another nuclear power plant in the US) was causing larger gaps in the interior of the tube bundle such that tubes were not fully supported. He

³²⁹ Exh. JX-370, p. 4.

³³⁰ Exh. JX-370, p. 3.

³³¹ “Flowering” means a process by which T/H forces push tubes apart creating larger gaps in the center columns and smaller gaps in the outer columns.

³³² Exh. JX-387, p. 4.

³³³ Exh. JX-387, p. 4.

proposed conducting an analysis for the SONGS design as to the effect of changing gap sizes.³³⁴

380. A 23 July 2005 set of notes from a discussion between MHI's consultants Mr. Wilson and Mr. Langford record Mr. Langford's preference against large gaps.³³⁵

381. In a 28 July 2005 email from Mr. Wilson to MHI, Mr. Wilson wrote that gaps in the B&W plants are "not as small as advertised" and therefore recommended that "MHI's best craftsmen will be needed to control gaps precisely, and more support points are needed (i.e., [REDACTED] or 3 x 2Vs)."³³⁶ Mr. Langford's recommendations were for MHI to focus on both increasing the margin against instability through the use of additional support points and to limit the potential for wear by improvements in manufacturing.

382. Minutes of technical meetings between SCE and MHI held from 14-16 September 2005 report that Mr. Langford recommended having gaps of less than [REDACTED] in high VF zones and that therefore the AVB design team determined that the design basis should be for "the most uniform gaps achievable and as near zero" as possible. Also considered at that meeting were recommendations that variability in gaps be as small as achievable.³³⁷

383. On 30 September 2005, MHI's Revision 0 of the Design of Anti-Vibration Bars Report was completed, listing as design criteria the need to minimize tube-to-AVB gaps to avoid tube vibration and minimize wear potential.³³⁸ The report also

³³⁴ Exh. JX-435.

³³⁵ Exh. JX-441.

³³⁶ Exh. JX-452.

³³⁷ Exh. JX-483, pp. 13-14.

³³⁸ Exh. JX-490, p. 9.

identified a requirement for uniformity in AVB thickness and flatness to ensure uniform gaps.³³⁹

384. Minutes of a 17 October 2005 Design Review Meeting between SCE and MHI record that MHI committed to controlling AVB twist³⁴⁰ along the advice provided by Mr. Langford.³⁴¹
385. On 21 November 2005, MHI issued Revision 1 to its Design of AVB Report.³⁴²
386. In a 30 November 2005 email, MHI's consultant Mr. Langford expressed some concerns to MHI in regard to how gap measurements were treated for wear calculations.³⁴³
387. In a 5-9 December 2005 technical meeting, MHI and SCE discussed steps taken to control gaps and AVB twisting.³⁴⁴
388. On 16 January 2006, MHI issued Revision 2 to its Design of AVB Report.³⁴⁵
389. On 31 January 2006, MHI provided an answer and calculations regarding how gaps were calculated.³⁴⁶ In February/March 2006, Mr. Wilson and Mr. Langford expressed concerns regarding the adequacy of this explanation.³⁴⁷ In a 6 February 2006 response, [REDACTED] of MHI, proposed tube bundle rotations³⁴⁸ to assist

³³⁹ Exh. JX-490, p. 10.

³⁴⁰ "AVB twist" refers to the AVB becoming less flat, possibly on account of welding. A twisted AVB creates a sharper contact point for adjacent tubes as compared to a flat AVB.

³⁴¹ Exh. JX-501/502, p. 15.

³⁴² Exh. JX-514.

³⁴³ Exh. JX-518, p. 5.

³⁴⁴ Exh. JX-519.

³⁴⁵ Exh. JX-542.

³⁴⁶ Exh. JX-549.

³⁴⁷ Exh. JX-551; Exh. JX-552.

³⁴⁸ "Rotations" involve rotating the tube bundle.

in gap measurements³⁴⁹ and also expressed concern with the arbitrariness of the need to ensure gaps that are less than [REDACTED] while also indicating his commitment to meeting the SONGS specifications though good workmanship.³⁵⁰

390. On 17 February 2006, MHI issued Revision 3 to its Design of AVB Report.³⁵¹
391. In a 20 February 2006 email from MHI's [REDACTED] to MHI's consultants Mr. Langford and Mr. Wilson, he suggested that the contractual design specifications of gaps of 0.003 inches is an "impossible criterion" and that MHI would be submitting a SDR (supplier deviation request).³⁵²
392. In a 13-17 March 2006 Design Review and Technical Meeting between SCE and MHI, Mr. Wilson provided his recommendation that efforts be focused on controlling manufacturing to produce small, uniform gaps, and not focused on excessive vibration and wear analysis.³⁵³ On the other hand, SCE expressed concerns regarding the relaxation of the tube-to-AVB gap requirement, stating that "minimizing gaps during fabrication was the only way to obtain low tube wear."³⁵⁴
393. During a 2 June 2006 meeting between SCE and MHI, MHI expressed concerns with a SCE requirement that internal gaps be measured, stating that such would be time consuming and provide inaccurate results³⁵⁵ and that there was no way to estimate the gaps of the operating RSGs.³⁵⁶ A presentation by MHI from that meeting shows that all outermost gaps were measured at [REDACTED] while over [REDACTED] of side region

³⁴⁹ "Gap measurements" involve measuring the space between a tube and AVBs.

³⁵⁰ Exh. JX-555.

³⁵¹ Exh. JX-516.

³⁵² Exh. JX-564, p. 8.

³⁵³ Exh. JX-575, p. 3.

³⁵⁴ Exh. JX-575, p. 5.

³⁵⁵ Exh. JX-586.

³⁵⁶ Exh. JX-587, p. 36,

gaps exceeded the design specifications of ██████ but that this includes measurement deviation and that no gap exceeded ██████³⁵⁷ MHI suggested to SCE that it would be introducing a supplier deviation request regarding tube-to-AVB gaps.³⁵⁸

394. A 3 July 2006 MHI reply to a meeting action item provides that post-assembly inspection to tube-to-AVB gaps in a RSG had found some gaps that exceeded the design and that these would be fixed through re-welding.³⁵⁹
395. A 5 July 2006 email from MHI's consultant Mr. Langford to MHI shared his concerns with the welding of AVBs and gaps.³⁶⁰ A 28 July 2006 email from MHI's consultant Mr. Wilson to MHI provided his support for addressing Mr. Langford's concerns regarding welding procedures while also indicating his support for MHI requesting a SDR (supplier deviation request) as regards Section 3.10.3.5 of the RSG Contract as:

0.003" is impossible criteria and statistical size of inner gap cannot be evaluated (. . .) According to US standard, the requirement is requested to change to 95% of the outer-most gap size shall not exceed 0.005.³⁶¹

396. On 7 August 2006, MHI issued a SDR to SCE, requesting to deviate from a maximum gap requirement of 0.003 inches as it was impossible to accurately measure such gaps for internal tubes.³⁶² MHI further justified its proposed change by explaining that no measuring device allowed for measuring the internal gaps, as would be required under Section 3.10.3.5 of the then current contractual design specifications.

³⁵⁷ Exh. JX-587, p. 34.

³⁵⁸ Exh. JX-587, p. 39.

³⁵⁹ Exh. JX-595.

³⁶⁰ Exh. JX-596.

³⁶¹ Exh. JX-587, p. 37.

³⁶² Exh. JX-601.

397. On 8 August 2006, SCE requested that MHI provide further information regarding its supplier deviation request.³⁶³
398. On 18 August 2006, a technical meeting between SCE and MHI was held to discuss tube-to-AVB gaps and MHI's SDR.³⁶⁴ Following this meeting, on 22 August 2006, MHI submitted a Revision 1 to its supplier deviation request.³⁶⁵
399. On 26 August 2006, Mr. Wilson emailed MHI to suggest that further efforts be taken to address gaps on the tube bundle periphery in order to avoid wear as occurred in the RSGs of ANO-2, another nuclear power plant in the US, and suggested that MHI engineers develop a better gap measurement tool and a mockup to perfect welding techniques.³⁶⁶ It should be noted that ANO-2 is another large PWR.
400. Around 7 September 2006, Mr. Wilson informed MHI that Mr. Langford continued to have significant concerns regarding MHI's gap control processes that had to be addressed.³⁶⁷
401. Between 12-15 September 2006, a design review and technical meeting between SCE and MHI was held at which gap control was again discussed.³⁶⁸ MHI committed to extra training and better processes for the assembly of the tube bundle.³⁶⁹

³⁶³ Exh. JX-602.

³⁶⁴ Exh. JX-606.

³⁶⁵ Exh. JX-608.

³⁶⁶ Exh. JX-610.

³⁶⁷ Exh. JX-616.

³⁶⁸ Exh. JX-618.

³⁶⁹ Exh. JX-618.

402. On 29 September 2006, MHI submitted a “supplier commercial change request” and a SDR (supplier deviation request) to address AVB gap measurements.³⁷⁰ SCE replied on 5 October 2006 requesting further information.³⁷¹
403. A 6 October 2006 presentation by MHI highlighted the differences in MHI’s and SCE’s position, including MHI’s conclusion that accurately measuring tube-to-AVB gaps in the interior portion of the tube bundle was not feasible.³⁷²
404. On 8 November 2006, MHI informed SCE that the contractual design specifications (CDS) had to be changed as there was no technological way to gather “empirical” measurements accurately for the interior of the tube bundle area for tube-to-AVB gaps.³⁷³ This letter was in response to a letter from SCE dated 19 October 2006.
405. On 15 November 2006, SCE officially rejected MHI’s SDR regarding gap measurement specifications and informed MHI that it was in breach of the contractual specifications.³⁷⁴
406. On 19 January 2007, MHI issued a Non-Conformance Report in which it reported that gaps in Unit 2A (also known as 2E89) between AVBs and tubes were found to exceed the design requirements.³⁷⁵ An assessment of this was undertaken by MHI. MHI determined that the gaps were not a concern, although SCE and MHI agreed to undertake manufacturing improvements for the other RSGs to avoid re-occurrence.

³⁷⁰ Exh. JX-624; Exh. JX-625.

³⁷¹ Exh. JX-627.

³⁷² Exh. JX-629.

³⁷³ Exh. JX-648.

³⁷⁴ Exh. JX-650.

³⁷⁵ Exh. JX-675.

407. Appendix 1 to the Non-Conformance Report provides the diagnostics flowchart surrounding issues of large tube-to-AVB gaps and the role of SR in wear analysis.³⁷⁶ This evaluation matrix highlights that in the event (i) of large gaps, the process is to engage in measurement of those gaps, (ii) that gaps are too large, to evaluate the SR of those tubes, (iii) that the SR is found to be above 1.0, to evaluate the effect of the gaps over the 40 year life of the tube; and (iv) that wear limit is exceeded to either rework the tube by heat shrink or subject the tube to further consideration by engineers.³⁷⁷
408. MHI and SCE appeared to have reached agreement as to the causes of the gaps in the first RSG for SONGS (Unit 2A) and agreement on steps to address gaps in Unit 2B.³⁷⁸
409. A 8-9 February 2007 technical discussion meeting between SCE and MHI included discussions of the causes of the large gaps in Unit 2 and efforts at both measurement and avoiding such gaps in the remaining RSGs.³⁷⁹
410. The 21 March 2007 Revision 7 of MHI's post-assembly AVB inspection procedure showed that measurement of gaps was only being undertaken for the outer tubes, as access to the inner tubes was not possible for accurate measurement.³⁸⁰
411. Minutes of a 27-30 March 2007 design review and technical meeting between SCE and MHI reflect that MHI had taken measures for controlling gaps during assembly for Unit 2B.³⁸¹

³⁷⁶ Exh. JX-675, p. 104.

³⁷⁷ Exh. JX-676, p. 104.

³⁷⁸ Exh. JX-675, p. 24-29.

³⁷⁹ Exh. JX-683.

³⁸⁰ Exh. JX-692, p. 5.

³⁸¹ Exh. JX-693.

412. A 30 November 2007 Non-Conformance Report by MHI stated that some gaps in Unit 3A were “larger than the criterion,” but that MHI did not propose any corrective action.³⁸² The criterion was for gaps to be below [REDACTED]³⁸³ For gaps above this, an evaluation flow chart was to be followed to determine what actions were required.³⁸⁴ Following this chart, MHI stated that the SR for these tubes did not exceed 1.0 and therefore the gaps were “acceptable.”³⁸⁵
413. Meeting minutes of a 6 December RSG Executive Oversight Meeting mention that MHI had improved the gaps in Unit 2A through reworks.³⁸⁶
414. A 19 March 2008 Non-Conformance Report by MHI recorded that some gaps between the tubes and AVBs were larger than the criterion³⁸⁷ for Unit 3B.³⁸⁸ MHI did not propose any action, reasoning that no tubes had consecutive large tube to AVB gaps.³⁸⁹ According to MHI’s gap evaluation process flowchart, as the gaps were not in consecutive AVB locations, this meant that the gaps were acceptable.³⁹⁰
415. A 20 March 2008 SDR (supplier deviation request) mentions that MHI notified SCE about non-conforming gaps in Unit 3B.³⁹¹ SCE approved the non-conformity on 18 April 2008.³⁹²

³⁸² Exh. JX-726.

³⁸³ Exh. JX-726, p. 13.

³⁸⁴ Exh. JX-726, p. 15.

³⁸⁵ Exh. JX-726, p. 14.

³⁸⁶ Exh. JX-729.

³⁸⁷ The criterion was for gaps to be below [REDACTED]

³⁸⁸ Exh. JX-662, p. 7; Exh. JX-758.

³⁸⁹ Exh. JX-758, p. 3.

³⁹⁰ Exh. JX-758, p. 3.

³⁹¹ Exh. JX-759.

³⁹² Exh. JX-759.

416. The 21 March 2008 Revision 4 to the Design of AVB Report by MHI maintains the same objectives as Revisions 0 through 3.³⁹³ It also records that while outer tubes are controlled to have gaps less than [REDACTED] these requirements do not necessarily apply to inner tubes.³⁹⁴ The report specifies that for the purposes of wear evaluation, tube-to-AVB gaps for inactive support points are “conservatively” estimated to be [REDACTED] or [REDACTED].³⁹⁵
417. A 25 April 2008 SDR states that MHI notified SCE about non-conforming gaps in Unit 3A.³⁹⁶ SCE approved the non-conformity on 30 May 2008.³⁹⁷
418. Meeting minutes of a 4 June 2008 RSG Executive Oversight meeting record that MHI notified SCE that the gaps in Unit 3B were “controlled in good condition.”³⁹⁸
419. On 3 July 2008, MHI issued Revision 5 to its Design of AVB Report.³⁹⁹
420. A 7 July 2008 email from MHI’s consultant Mr. Langford to MHI suggests that he was “very troubled” regarding tube-to-AVB gaps and proposed steps to be taken in this regard.⁴⁰⁰

³⁹³ Exh. JX-760.

³⁹⁴ Exh. JX-760, p. 123.

³⁹⁵ Exh. JX-760, pp. 123-124.

³⁹⁶ Exh. JX-770.

³⁹⁷ Exh. JX-770.

³⁹⁸ Exh. JX-774.

³⁹⁹ Exh. JX-782.

⁴⁰⁰ Exh. JX-784.

421. A 16 August 2008 supplier deviation request reflects that MHI again sought to change the RSG Contract’s requirements regarding gaps sizes and measurement.⁴⁰¹ A similar supplier deviation request was submitted on 13 October 2008.⁴⁰²
422. The PAR (Performance Analysis Report) of 28 October 2008⁴⁰³ does not appear to provide any particularized information regarding gaps.
423. The 28 July 2010 Revision 4 to the RSG Contract records the following modifications to the Parties’ agreement, namely a modification from the allowable gap deviation:

3.10.3.5 Tube Supports/Tube Bundle

(...) The Supplier shall perform measurement of bundle outer-most tube-to-AVB gaps when tubes and AVBs are not deformed out-of-plane.

(...)

The Supplier shall develop and submit for Edison’s approval a Fabrication Procedure describing the methodology of controlling the outer-most tube-to-AVB gaps, gap uniformity and parallelism of the tube bundle in the out-of-plane direction. The statistical outer-most tube-to-AVB gaps shall not exceed 0.021.” The number of thickness measurement points for each AVB shall be specified in an Inspection Procedure.⁴⁰⁴

⁴⁰¹ Exh. JX-796.

⁴⁰² Exh. JX-811.

⁴⁰³ Exh. JX-813.

⁴⁰⁴ RSG Contract, pp. 185-186.

E. DELIVERY, INSTALLATION, AND ACCEPTANCE OF THE RSGS

424. The Unit 2 RSGs arrived at SONGS on 14 February 2009 and were installed by the Bechtel Corporation (“**Bechtel**”).⁴⁰⁵ Unit 2 installation outage began on 26 September 2009.
425. About one year later, the Unit 3 RSGs arrived on 4 October 2010.⁴⁰⁶ Its installation outage began on 10 October 2010 as Bechtel installed the two Unit 3 RSGs.
426. The cost of the installation by Bechtel was some US\$ 322 million, with an additional US\$ 125 million for the removal of the original Units 2 and 3 steam generators.⁴⁰⁷
427. As part of the contractual acceptance criteria under Section 1.16 of the RSG Contract, SCE conducted inspections of the RSGs. Following those inspections, SCE provided its formal acceptance of the Unit 2 RSGs on 21 September 2010,⁴⁰⁸ followed by its formal acceptance of the Unit 3 RSGs on 3 May 2011.⁴⁰⁹
428. The first operational cycle for Unit 2 ran for approximately 22 months, from 13 April 2010 through 1 January 2012.⁴¹⁰ Following a period of routine refueling and inspection, Unit 2 should have restarted during early March 2012.⁴¹¹ During this period, the inspection of Unit 2 tubes identified higher than expected retainer bar vibration, which resulted in tube plugging.⁴¹² The inspection also identified higher than expected tube-to-AVB and tube-to-TSP wear.

⁴⁰⁵ Witness Statement of Wharton, ¶ 122; Witness Statement of Palmisano, ¶ 11.

⁴⁰⁶ Witness Statement of Wharton, ¶ 122; Witness Statement of Palmisano, ¶ 11.

⁴⁰⁷ Witness Statement of Wharton, ¶¶ 122-123.

⁴⁰⁸ Exh. JX-924.

⁴⁰⁹ Witness Statement of Wharton, ¶ 126.

⁴¹⁰ Witness Statement of Palmisano, ¶ 12.

⁴¹¹ Witness Statement of Palmisano, ¶ 12.

⁴¹² Witness Statement of Palmisano, ¶ 22.

429. The Unit 3 RSGs commenced operation on February 2011.

F. THE NUCLEAR INCIDENT AND INVESTIGATION

(a) The Nuclear Incident

430. Approximately 11 months following the installation of the Unit 3 RSGs, on 31 January 2012, SONGS Unit 3 was brought into a voluntary unplanned shutdown following the leakage of approximately 82 gallons of irradiated water.⁴¹³ The leak developed to 75 gallons per day with a 30 gallons per hour rate of increase within an hour and 5 minutes of the leak starting.⁴¹⁴ Regulatory guidelines on primary-to-secondary leakage impose a limit of 150 gallons a day.⁴¹⁵
431. SCE immediately notified the NRC of the Incident, as required by 10 CFR 50.72(b)(2)(iv)(B).⁴¹⁶
432. The leak resulted in an exposure of 0.0000452 millirems to an exposed member of the public, below the annual regulatory limit of 100 millirems per year.⁴¹⁷ A 31 January 2012 press release by SONGS stated that “the potential leak poses no imminent danger to the public or plant workers” and that “there has been no release to the atmosphere.”⁴¹⁸ A 17 February 2012 SCE press release following the leak stated:

The radioactivity released to atmosphere during the steam generator tube leak was barely measurable – 4E-5 millirems or 0.00004 millirems -- which is 200 times less than you would receive by having a smoke

⁴¹³ Exh. JX-1007, p. 6.

⁴¹⁴ Exh. JX-1023, p. 1.

⁴¹⁵ See e.g. Exh JX-214, p. 17.

⁴¹⁶ Exh. JX-1023, p. 17.

⁴¹⁷ Exh. JX-1264, p. 11.

⁴¹⁸ Exh. JX-1019.

detector in your home for a year. This updates our initial estimate of 7E-7 millirems or 0.0000007 millirems that we provided to the NRC.⁴¹⁹

433. At the same time of the Unit 3 leak, SONGS Unit 2 was offline for a scheduled refueling.

(b) Investigation

434. On 1 February 2012, SCE informed MHI of the leak and “potential defect” in what is formally referred to as “Unit 3E088” and requested that MHI initiate corrective action within two days, as required by the RSG Contract.⁴²⁰
435. On 3 February 2012, MHI informed SCE that it was dispatching an inspection team for 7-8 February 2012, the first day that safe inspection of Unit 3 was possible.⁴²¹
436. A 5 February 2012 internal SCE email shows the results of the preliminary investigations. In Unit 2, three types of wear were identified: (i) “minor wear” at TSPs, which was characterized as a “routine issue and not a significant concern;” (ii) AVB wear at more than a 1000 locations in each RSG that is “more significant” and would result “in a handful of tubes being removed from service by plugging;” and (iii) retainer bar wear which could be resolved by removing tubes from service.⁴²² In addition, a foreign object was found in Unit 2 at the fourth TSP. Inspection for Unit 3 was planned, although initial causes were thought to be wear or a foreign object.
437. A 7 February 2012 MHI discussion paper examining the retainer bar wear in both Units provides a preliminary conclusion that the wear was caused by fluid elastic

⁴¹⁹ Exh. JX-1045.

⁴²⁰ Exh. JX-1025.

⁴²¹ Exh. JX-1030; Exh. JX-1032.

⁴²² Exh. JX-1033.

vibration, and not FEI (fluid elastic instability).⁴²³ The preliminary recommendations by MHI were to plug the affected tubes.

438. On 11 February 2012, the Unit 3 tube that leaked was identified as R106C78.⁴²⁴ No cause was identified, although foreign material wear was discounted from consideration.
439. Minutes of a 11 February 2012 joint SCE-MHI meeting state that an “in-situ” test was performed on Unit 2 and it successfully passed.⁴²⁵ SCE declared that it would be requesting an independent review into Unit 3. MHI expressed a preliminary belief that a repair could be undertaken through either stabilization or insertion of additional AVBs.⁴²⁶
440. A 13 February 2012 Revision 0 of MHI’s Retainer Bar Tube Wear report recommends that a portion of the retainer bars be removed and four tubes be plugged.⁴²⁷ MHI stated that the remaining 90 tubes in proximity to the retainer bars should last for the 40 years of the operating life of SONGS, although MHI declared they could be plugged if SCE so desired.⁴²⁸ MHI stated that FEI is not an applicable cause of the wear.⁴²⁹
441. A 16 February 2012 analysis plan by MHI was developed to determine the causes of the RSG failures for both Units.⁴³⁰ Amongst the possible causes and issues at study

⁴²³ Exh. JX-1035.

⁴²⁴ Exh. JX-1039; Exh. JX-1040.

⁴²⁵ Exh. JX-1041.

⁴²⁶ Exh. JX-1041.

⁴²⁷ Exh. JX-1042.

⁴²⁸ Exh. JX-1042, p. 17.

⁴²⁹ Exh. JX-1042, p. 12.

⁴³⁰ Exh. JX-1044.

was an investigation into FEI and into the possibility that large tube-to-AVB gaps emerged during fabrication, transportation, or on-site erection.⁴³¹

442. A SONGS NRC notification report for 17 February 2012 mentions that following the leak, eddy current testing (“ECT”) examinations⁴³² were performed on both Unit 3 RSGs. These ongoing inspections showed that “multiple tubes in each steam generator have wear degradation at support points (AVBs and TSPs) exceeding the tech. spec. plugging limit of 35% through wall depth.”⁴³³ At that time, the condition was thought to be limited to Unit 3.
443. On 18 February 2012, SCE formally informed MHI that it would be seeking independent assessments of the problems at SONGS and would be charging MHI, per the RSG Contract, for its efforts in investigating and repairing the RSGs.⁴³⁴ MHI replied on 21 February 2012, acknowledging that AREVA was engaging in an investigation.⁴³⁵
444. A 23 February 2012 presentation by MHI raised the concern that the “impact between tubes in in-plane vibration may be caused by in-flow fluid elastic instability,” i.e., FEI.⁴³⁶ MHI also questioned whether the damping friction forces between the tubes and AVBs was adequate.⁴³⁷
445. Notes exhibited by the Claimants from 24 February 2012 document the results of the ECT of the 9727 tubes in each Unit 3 RSG, showing significant amounts of low level

⁴³¹ Exh. JX-1044.

⁴³² ECT is an electromagnetic testing method which makes use of electromagnetic induction to detect surface flaws in conductive materials.

⁴³³ Exh. JX-1023, p. 2.

⁴³⁴ Exh. JX-1046.

⁴³⁵ Exh. JX-1048.

⁴³⁶ Exh. JX-1051, p. 11.

⁴³⁷ Exh. JX-1051, p. 11; for damping friction, see ¶ 177 above.

wear at AVB locations, minimal amounts of TSP wear, and wear above the amount of the tube plugging limit at both TSP points and wear in the U-bend freespan.⁴³⁸

Steam Generator 3E088

Through Wall Thickness Percentage, Number of Tubes						
	≥50%	35-49%	20-34%	10-19%	<10%	Total
U-Bend Freespan Wear	26	18	18	7	0	69
TSP Wear	48	25	14	55	11	153
AVB Wear	0	2	48	298	346	694
Totals	74	45	80	360	357	916

Steam Generator 3E089

Through Wall Thickness Percentage, Number of Tubes						
	≥50%	35-49%	20-34%	10-19%	<10%	Total
U-Bend Freespan Wear	16	29	13	9	0	67
TSP Wear	44	39	20	27	9	139
AVB Wear	0	0	14	243	423	680
Totals	60	68	47	279	432	886

446. A 27 February 2012 internal SCE note states that the wear at SONGs appears more severe than that experienced in the industry, although not incomparable.⁴³⁹ The note also states that the design for Units 2 and 3 are the same and that an investigation into fabrication differences was under way.
447. On 28 February 2012, SCE sent MHI a letter requesting that MHI approve the repairs performed on Unit 2 and confirm that no further repairs were required prior to a Unit 2 restart.⁴⁴⁰

⁴³⁸ Exh. JX-1052, p. 2.

⁴³⁹ Exh. JX-1054, p. 3.

⁴⁴⁰ Exh. JX-1056.

448. A 28 February 2012 AREVA report into the degradation at SONGS Unit 2 and 3 shows that the rates of future wear degradation for SONGS remained to be determined.⁴⁴¹ The report also summarized similar industry experience that had experienced first or early cycle wear.
449. An undated February 2012 report to the Board of Directors of Edison International (“EIX”), the parent company of SCE, by its president, Mr. Theodore Craver, states that the resolution of issues with Unit 2 would likely take several weeks and for Unit 3 several months. The initial solution to Unit 2 was a preventative plugging of 94 tubes adjacent to retainer bars as well as plugging four additional tubes. This plugging was described as “well within expected industry experience with steam generators,” “well within safety margins,” but also “well above industry experience for the first fuel cycle of new steam generators.”⁴⁴²
450. For Unit 3, it was concluded that it also suffered from the same retainer bar problems as Unit 2, for which preventative plugging was required. Mr. Craver also concluded that the Unit 3 RSGs had a “unique problem.” Mr. Craver stated that resolving this situation was not just a technical challenge, but also one of carefully managing public perceptions, especially with the upcoming anniversary of the Fukushima disaster.⁴⁴³
451. A SONGS regulatory notification report of 2 March 2012 mentions the causes of the tube leak were “tube to tube interaction in the tube bend area” and that investigations were ongoing.⁴⁴⁴
452. On 2 March 2012, MHI responded to SCE’s letter of 28 February 2012 and stated that it could not give its approval as to the adequacy of the repairs as the repairs to

⁴⁴¹ Exh. JX-1057.

⁴⁴² Exh. JX-1026, p. 3.

⁴⁴³ Exh. JX-1026, pp. 3-4.

⁴⁴⁴ Exh. JX-1023, p. 26.

Unit 2 differed from what MHI had recommended. MHI also stated that it had yet to carry out a root cause assessment, such that they could not rule out that the “conditions observed in the Unit 3 RSGs could potentially appear in the Unit 2 RSGs after re-start.”⁴⁴⁵

453. Notes of a 3 March 2012 meeting between senior SCE officials and ██████████ of MHI reflect that it was expected that repairs would take six months to a year, with one to two months to design a repair concept, six months to verify that repair concept, and a few months to implement the repair.⁴⁴⁶
454. On 6 March 2012, SCE released its root cause evaluation into Unit 2.⁴⁴⁷ That report stated that the inspection of Unit 2 had identified 10 tubes with wear depths of 28-90%.⁴⁴⁸ The cause of this wear was identified as a design defect in the retainer bar. In total, 94 tubes in each Unit 2 RSG adjacent to retainer bars were preventatively plugged and a dozen were stabilized.⁴⁴⁹ In addition, 2400 tubes in the two RSGs were found to have wear at AVB or TSP points and four tubes were plugged.⁴⁵⁰ SCE characterized this wear as higher than other plants after one cycle although not different in type.⁴⁵¹
455. With regard to Unit 3, SCE reported that “since the steam generators for both units are of the same design with very minor differences in fabrication and operation, it is likely that the root cause investigation for Unit 3 will result in additional requirements or repairs to prevent a similar result from occurring.”⁴⁵² The Unit 3

⁴⁴⁵ Exh. JX-1060.

⁴⁴⁶ Exh. JX-1061.

⁴⁴⁷ Exh. JX-1063.

⁴⁴⁸ Exh. JX-1063, p. 5.

⁴⁴⁹ Exh. JX-1063, p. 5.

⁴⁵⁰ Exh. JX-1063, p. 5.

⁴⁵¹ Exh. JX-1063, p. 21.

⁴⁵² Exh. JX-1063, p. 15.

initial wear assessment determined that Unit 3 suffered from in-plane FEI, with the probable cause being “AVB deflections that occurred during Unit 3 fabrication,” which caused reduced resistance from the AVBs.⁴⁵³ SCE’s Root Cause Evaluation Report notes that Unit 2 “has not experienced the same phenomena as Unit 3” despite having “twice the run-time.”⁴⁵⁴

456. A 10 March 2012 progress report by MHI on its root cause evaluation states that differences between Unit 3 and Unit 2 were insufficient contact force in Unit 3 and a high number of “continuous inactive supports.”⁴⁵⁵ The report also indicates that differences between both Units include the number of tube bundle rotations during construction and that Unit 3 had better dimensional control and more uniformity in tube to AVB gaps.
457. A 13 March 2012 MHI status report states that SCE’s proposed schedule at a 10 March 2012 meeting was for a June 2012 restart of both Units, operation for four-five months followed by an inspection, a further six-ten months of operation, and then long-term repairs on Unit 3 in April 2013 and Unit 2 in October 2013.⁴⁵⁶ Regarding the cause of the wear, MHI maintained that the issue was not a difference in gap sizes between Units 2 and 3 but rather the contact force between the AVBs and tubes.⁴⁵⁷ The report also states that “fluid-elastic vibration occurs within both unit 2 and unit 3” but that small gaps meant that wear was minimal.⁴⁵⁸ MHI’s repair concept was to add additional AVBs, which they planned on testing for both

⁴⁵³ Exh. JX-1063, p. 16.

⁴⁵⁴ Exh. JX-1063, p. 16.

⁴⁵⁵ Exh. JX-1066, p. 11.

⁴⁵⁶ Exh. JX-1070, p. 6.

⁴⁵⁷ Exh. JX-1070, p. 7.

⁴⁵⁸ Exh. JX-1070, p. 8.

effectiveness and implementation,⁴⁵⁹ and to propose to SCE for the end of March 2012.⁴⁶⁰

458. A 14 March 2012 SCE draft report into the causes of the Unit 3 leak identified flowering and ineffective tube-to-AVB gap control during assembly as highly probable causes for the wear and a number of other possible causes.⁴⁶¹ Various potential causes were eliminated from consideration.
459. On 16 March 2012, MHI issued revision 1 to its Retainer Bar Tube Wear Report, with a recommendation to remove 12 of 24 retainer bars in each RSG and plug four tubes.⁴⁶² MHI further identified that plugging of the 94 tubes adjacent to the retainer bars was an acceptable alternative.
460. On 23 March 2012, SCE informed the NRC of the steps it was taking with regard to Units 2 and 3 and the results of the assessments to date.⁴⁶³

(c) **NRC Confirmatory Action Letter (CAL)**

461. On 27 March 2012, the NRC issued a Confirmatory Action Letter (“CAL”).⁴⁶⁴ Such a letter sets the regulatory regime that SCE (and MHI) were required to meet to restart SONGS. The CAL in question concerned “Commitments to address Steam Generator Tube Degradation” in Units 2 and 3.
462. In the CAL, the NRC noted with respect to Unit 3:

⁴⁵⁹ See ¶ 525 below. MHI conducted two basic tests, Basic Test 1 and Basic Test 2. These were to determine (i) the contact force required to prevent FEI and (ii) test methods for inserting AVBs. As part of these tests, different AVB designs and thicknesses were evaluated.

⁴⁶⁰ Exh. JX-1070, p. 8.

⁴⁶¹ Exh. JX-1071.

⁴⁶² Exh. JX-1072.

⁴⁶³ Exh. JX-1079.

⁴⁶⁴ Exh. JX-1080.

On January 31, 2012, your staff at San Onofre Nuclear Generating Station (SONGS) Unit 3 performed a rapid shutdown because of indications of a steam generator tube leak on the 3E88 steam generator. Following extensive testing of 100 percent of the steam generator tubes in both Unit 3 steam generators, your staff identified unexpected wear caused by steam generator tubes rubbing against each other, as well as against retainer bars. Additional in-situ pressure testing of 129 steam generator tubes was performed for the tubes that exhibited the most wear. Your staff identified that eight steam generator tubes in the Unit 3 3E88 steam generator had failed the pressure test. Failure of the in-situ pressure test is an indication that, for certain design basis events, such as a main steam line break, these steam generator tubes may not be able to maintain design structural integrity. You are continuing to evaluate these results to develop corrective actions for the Unit 3 steam generators.⁴⁶⁵

463. The NRC noted with respect to Unit 2:

SONGS Unit 2 was shutdown at the time of this event for a regularly scheduled refuelling outage, and planned testing of 100 percent of the steam generator tubes was already in progress. Testing results on Unit 2 showed unexpected wear at retainer bars similar to the Unit 3 results, but did not show any wear from tubes rubbing against each other. Based on these results, your staff identified 6 tubes requiring plugging, and 186 additional tubes that were plugged as a precautionary measure. Evaluation for additional plugging or other corrective actions is continuing for Unit 2, based on ongoing evaluations of Unit 3 testing results.⁴⁶⁶

464. The NRC listed in the CAL the actions that SCE was required to complete prior to the return to service of Unit 2 or Unit 3.

For Unit 2, SCE was required to determine the causes of the Unit 3 wear and develop a plan for operation of Unit 2 that included inspections and operational limits and justification for a belief that it could be safely operated:

⁴⁶⁵ Exh. JX-1080, p. 1.

⁴⁶⁶ Exh. JX-1080, p. 1.

Actions for Unit 2

1. Southern California Edison Company (SCE) will determine the causes of the tube-to-tube interactions that resulted in steam generator tube wear in Unit 3, and will implement actions to prevent loss of integrity due to these causes in the Unit 2 steam generator tubes. SCE will establish a protocol of inspections and/or operational limits for Unit 2, including plans for a mid-cycle shutdown for further inspections.
2. Prior to entry of Unit 2 into Mode 2,⁴⁶⁷ SCE will submit to the NRC in writing the results of your assessment of Unit 2 steam generators, the protocol of inspections and/or operational limits, including schedule dates for a mid-cycle shutdown for further inspections, and the basis for SCE's conclusion that there is reasonable assurance, as required by NRC regulations, that the unit will operate safely.⁴⁶⁸

For Unit 3, SCE was required to (i) complete in-situ testing; (ii) plug tubes exceeding the wear limits; (iii) determine the cause of tube-to-tube wear; (iv) develop actions to prevent reoccurrence; (v) develop a wear inspection plan, and submit its inspection results into the Unit 3 wear; and (vi) provide reasonable assurances that the plant could operate safely:

Actions for Unit 3

3. SCE will complete in-situ pressure testing of tubes with potentially significant wear indications in accordance with the Electric Power Research Institute (EPRI) Steam Generator In-situ Pressure Test Guidelines and will plug tubes in accordance with those guidelines.
4. SCE will plug all tubes with wear indications in excess of your Steam Generator Program Requirements (SGPR) and EPRI guidelines as well as perform preventive plugging or take other corrective actions to address retainer bar-related tube wear in Unit 3.

⁴⁶⁷ Mode 2 refers to the plant being in start-up mode at a low power level.

⁴⁶⁸ Exh. JX-1080, p. 2, ¶¶ 1-2.

5. SCE will determine the causes of tube-to-tube interaction and implement actions to prevent recurrence of loss of integrity in the Unit 3 steam generator tubes while operating.

6. SCE will establish a protocol of inspections and/or operational limits for Unit 3, including plans for a mid-cycle shutdown for inspections. The protocol is intended to minimize the progression of tube wear, and ensure that tube wear will not progress to the point of degradation that could cause tubes not to meet leakage and structural strength test criteria.

7. Prior to entry of Unit 3 into Mode 4,⁴⁶⁹ SCE will submit to the NRC in writing the results of your assessment of Unit 3 steam generators, the protocol of inspections and/or operational limits, including schedule dates for a mid-cycle shutdown for further inspections, and the basis for SCE's conclusion that there is a reasonable assurance, as required by NRC regulations, that the unit will operate safely.⁴⁷⁰

(d) NRC Augmented Inspection Team (AIT)

465. The NRC used what is referred to as “NRC Inspection Procedure 93800 ‘Augmented Inspection Team’” (“AIT”). The AIT was to provide an independent assessment into probable causes and contributing factors concerning the SONGS Incident.⁴⁷¹
466. As mentioned in items 2 and 5 of the CAL, SCE was required to provide assurances that Unit 2 could be safely restarted and to identify the causes of the wear in Unit 3.
467. A 29 March 2012 comparison by MHI between SR calculated using ATHOS (EPRI’s code) and FIT-III (MHI’s code)⁴⁷² showed that SR using ATHOS were [REDACTED] times higher, i.e., closer to indicating tube instability.⁴⁷³

⁴⁶⁹ Mode 4 refers to operations just prior to shutdown of the reactor.

⁴⁷⁰ Exh. JX-1080, p. 1, ¶¶ 3-7.

⁴⁷¹ Exh. JX-1083.

⁴⁷² For ATHOS and FIT-III, see ¶¶ 240 and 250 above.

⁴⁷³ Exh. JX-1082.

468. Minutes of a 30 March 2012 NRC AIT debrief reflect that the NRC was examining a number of factors surrounding the Unit 3 leak and Unit 2 issues.⁴⁷⁴ The NRC AIT identified nine items which remained unresolved following its investigation, including concerns regarding manufacturing improvements for Unit 3 and a discrepancy in the results generated by FIT-III and ATHOS:

(...)

(3) Dimensional Design Control for the RSGs (AVBs and G value for the SG u-tubes)

The NRC noted the root cause evaluations currently in-progress by SCE and MHI have identified potential causal factors for the tube-to-tube wear associated with improvements in manufacturing and design control that were made throughout the RSG fabrication process. Specifically, improvements in tube fabrication and tube bundle /AVB assembly may have resulted in increased tube-to-AVB gap size, which may have allowed increased tube vibration and tube-to-tube wear. The NRC is interested in the results of the SCE and MHI cause evaluations as they relate to this item.

(...)

(9) ATHOS model differences

Mr. Werner⁴⁷⁵ stated NRC Research Engineer Carl Thurston performed an independent thermos-hydraulic analysis and obtained void fractions and fluid velocities significantly higher than the original MHI model. Mr. Werner noted Mr. Thurston's⁴⁷⁶ results were similar to MHI's current ATHOS modeling results, however Mr. Thurston's analysis resulted in maximum fluid velocities in the area of the tube bundle corresponding to the area of observed tube-to-tube wear. The current MHI ATHOS results do not identify peak fluid velocities in that region. Mr. Werner stated the

⁴⁷⁴ Exh. JX-1083.

⁴⁷⁵ Exh. JX-1083, p. 2 (Identified in the Minutes as NRC AIT's "Region IV, Division of Reactor Safety, Branch Chief (Team Lead)").

⁴⁷⁶ Exh. JX-1083, p. 2 (Identified in the Minutes as NRC AIT's "Research Engineer").

results are preliminary and Mr. Thurston will continue to perform his own analysis and to communicate with SCE and MHI regarding the ongoing thermo-hydraulic and fluid-elastic vibration analyses in the coming weeks.⁴⁷⁷

469. In addition, the NRC AIT made a number of observations, noting that both SCE and MHI had “very strong” quality assurance (“QA”) programs, but that MHI’s manufacturing procedures “appeared to lack detail and were difficult to follow,” and identified concerns regarding tube-to-tube gaps:

(1) SONGS & MHI QA Programs

Mr. Werner stated inspector Jonathan Ortega-Luciano reviewed the SCE and Mitsubishi Quality Assurance programs. He noted both programs were very strong.

(2) MHI Manufacturing Procedures

Mr. Werner noted the MHI manufacturing procedures reviewed by his inspection team appeared to lack detail and were difficult to follow. He added that no procedural inadequacies were identified, however, and this is only an Observation rather than an issue of concern. [After the Debrief, MHI stated they would like to follow-up with the NRC to address any misunderstanding of their work instructions. NRA will assist MHI in discussing this item further with the NRC.]

(3) Tube-to-Tube Gap Clearances

The inspectors noted there were several instances of tube-to-tube clearances in the U-bend region that were less than the limit during fabrication and were accepted as-is. Mr. Werner suggested these instances be re-evaluated to ensure they are still acceptable in light of what we now know.⁴⁷⁸

⁴⁷⁷ Exh. JX-1083, pp. 3-4.

⁴⁷⁸ Exh. JX-1083, p. 4.

(e) **Ongoing Investigations into Unit 2 and Unit 3**

470. The ongoing investigation into the Incident and the situation of Units 2 and 3 is of relevance in this arbitration in determining the Claimants' case.
471. A 30 March 2012 draft of MHI's Root Cause Evaluation Report ("**Initial Draft Report**") found as follows:⁴⁷⁹
- (i) That "the thermal-hydraulic conditions," "namely high void fraction" and "high flow velocity" are the main causes of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs. The high VF is on account of a "very large and tightly packed tube bundle" with "high heat flux,"⁴⁸⁰
 - (ii) That "by design, U-bend support in the in-plane direction was not provided for the SONGS SGs, consistent with the MHI experience and contemporary industry practice" and that the SONGS experience demonstrates that "flat bar AVBs" did not provide the "friction forces required to prevent tubes from vibrating in the in-plane direction and eventually being fluid elastic unstable."⁴⁸¹ Unit 3 had greater uniformity and better fabrication standards for tubes and AVBs, leading to this instability;⁴⁸²
 - (iii) The recommended solution was the plugging of all affected tubes;⁴⁸³
 - (iv) The "mechanistic cause analysis" found that "the causes of the tube excessive vibration are the thermal-hydraulic operating conditions of the SG Secondary

⁴⁷⁹ Exh. JX-1087.

⁴⁸⁰ Exh. JX-1087, p. 5.

⁴⁸¹ Exh. JX-1087, p. 6.

⁴⁸² Exh. JX-1087, p. 6.

⁴⁸³ Exh. JX-1087, p. 6.

side and lack of sufficient tube support for the tubes.” The investigation also found “a strong correlation between the void fraction (...) and the percentage of tubes with” tube-to-tube wear and AVB wear;⁴⁸⁴

- (v) VFs of above 0.992, calculated using ATHOS, were found correlated to high wear indications;⁴⁸⁵
- (vi) The differences between Unit 2 and Unit 3 was found to be on account of improvements in “AVB dimensional control” such that the average contact force in Unit 3 was less than Unit 2. In addition, the effect of more rotations of the tube bundle in Unit 3 was found to be “negligibly small;”⁴⁸⁶
- (vii) Tube-to-AVB wear was found to be on account of random vibration and the chance of out-of-plane FEI deemed to be “very unlikely.”⁴⁸⁷

472. The Initial Draft Report states that tube plugging in the RSGs had been performed, with 2.2% and 3.2% of Unit 2 tubes plugged and 4.0% and 4.4% of Unit 3 tubes plugged.⁴⁸⁸ MHI declared that tube plugging and operating at 70% power would allow for a temporary restart but that “modifications to the AVB support structure” appears to be a long-term solution.⁴⁸⁹

473. An Initial Draft Report appendix on tube wear in the straight leg concluded that tube-to-TSP wear was not caused by FEI.⁴⁹⁰

⁴⁸⁴ Exh. JX-1087, pp. 51-52.

⁴⁸⁵ Exh. JX-1087, pp. 54-56.

⁴⁸⁶ Exh. JX-1087, p. 59.

⁴⁸⁷ Exh. JX-1087, pp. 65-66.

⁴⁸⁸ Exh. JX-1087, p. 75.

⁴⁸⁹ Exh. JX-1087, pp. 74-76.

⁴⁹⁰ Exh. JX-1084, p. 2.

474. An Initial Draft Report appendix on tube-to-AVB gaps undertaken by eddy current testing (ECT) concludes that “Unit-3 SGs have slightly larger average tube-to-AVB gaps than the Unit-2 SGs, with the largest in SG-3A” with the effect that there is less contact force in Unit 3.⁴⁹¹ The report also found that “the largest gaps are found in the zone bounded by Columns 77 to 81 and Rows 104 to 122” and that “this zone corresponds to the region with the most severe wear in Unit-2 and Unit-3.”⁴⁹² The report further determined that there were areas with sequential gaps such that tubes were unsupported and “would exhibit unstable vibration characteristics under normal operating conditions.”⁴⁹³
475. An Initial Draft Report appendix regarding visual inspection of the RSGs found that there were no large gaps in either Unit 2 or Unit 3.⁴⁹⁴ The report also determined that Unit 3 showed signs of in-plane vibration while Unit 2 did not show signs of in-plane vibration.⁴⁹⁵
476. A 30 March 2012 SCE “deep dive” presentation regarding SONGS summarized the problem at Unit 2 as wear caused by inadequate retainer bars and at Unit 3 FEI related to “inadequate tube support, critical flow, [and] inadequate damping.”⁴⁹⁶ The presentation identified a potential June 2012 restart date for Unit 2 and recommendations that Unit 2 restart at reduced power and be subject to greater inspections to monitor wear. The report also states that a “contact force of [REDACTED] at each AVB location prevents tube in-plane vibration (and significant wear).”⁴⁹⁷ The presentation shows that gap size affected out-of-plane vibration but not in-plane

⁴⁹¹ Exh. JX-1085, p. 5.

⁴⁹² Exh. JX-1085, p. 51.

⁴⁹³ Exh. JX-1085, p. 52.

⁴⁹⁴ Exh. JX-1086, p. 3.

⁴⁹⁵ Exh. JX-1086, pp. 3-4.

⁴⁹⁶ Exh. JX-1088, p. 4.

⁴⁹⁷ Exh. JX-1088, p. 49.

vibration.⁴⁹⁸ The presentation identifies two potential causes of the lack of insufficient contact force, bundle flowering and more uniform manufacturing of AVBs.⁴⁹⁹

477. A 31 March 2012 report from Mr. Craver to the Board of Directors of EIX, SCE's parent company, provided an update on SONGS, identifying what was required to satisfy the CAL, indicating that a restart would likely be at a reduced power level, and raising strategic questions over the future of SONGS:

For the NRC to approve our restarting the units, it must determine [whether] we can provide "reasonable assurance" (within the meaning of nuclear safety regulations) that it is safe to do so. Reasonable assurance is gained by (a) knowing the causes of the tube wear, (b) developing robust engineering models based on that knowledge that can accurately predict the pace and type of additional tube wear after the units are restarted, (c) concluding the fixes to the worn and potentially susceptible tubes are complete and adequate (tube plugging and stabilization), and (d) developing an operating regimen that avoids creating the conditions that caused the excessive tube wear and that allows us to gain more information through testing and monitoring.

The engineering experts now believe they know the causes of the tube wear, and we are told that the models have been modified such that they have confidence in their ability to predict the kind of tube wear we have seen. The tube plugging and stabilization will be expanded in Unit 2 now that testing has determined there are two tubes there with early signs of the same in-plane tube-to-tube wear found in a number of tubes in Unit 3. When that is complete, the conclusion will likely be reached [that] the steam generators are "fixed." The final requirement will be to develop an operating plan that avoids recreating the conditions (Flow Induced Vibration) that causes the unusual tube wear phenomenon (Fluid Elastic Instability). That will likely mean reducing the plant output to reduce the velocity of the water and steam flow in the steam generators, thereby reducing the Flow Induced Vibration. Currently, we expect we will have to de-rate the plants to about 90% of capacity to accomplish this. It is

⁴⁹⁸ Exh. JX-1088, p. 50.

⁴⁹⁹ Exh. JX-1088, p. 51.

also likely that we will propose running the units for only a few months before bringing them down for another round of tube inspections, instead of the usual 22 month fuel cycle at least for some time before gaining reasonable assurance that instability is no longer occurring under the changed operating conditions. Bottom line: the operating parameters required to give us and the NRC "reasonable assurance" that the units are safe to restart will mean we likely generate less electricity than the units used to before the new steam generators were installed and less than they are designed to generate.

Assuming we can achieve reasonable assurance it is safe to restart the units, we will need to confront some difficult strategic questions. It seems as though the basic choices for the steam generators are (a) continue to operate them as planned after we fix them, (b) replace them with new ones that perform as designed, or (c) shut the plant.⁵⁰⁰

478. In addition, Mr. Craver identified that a restart of the plant in a condition where it “is not performing as designed” may lead to concerns from outside groups. Mr. Craver also raised concerns regarding cost recovery. Mr. Craver cautioned that a complete redesign of the plant would take several years, be quite expensive (significantly exceeding the cost of the replacement RSGs alone) and was not necessarily recoverable.⁵⁰¹
479. A 4 April 2012 SCE “deep dive” presentation⁵⁰² identified the same causes at issue as the prior presentation of 30 March 2012.⁵⁰³ Regarding differences between Unit 2 and Unit 3, the presentation discounted the effect of a higher number of Unit 3 tube bundle rotations as “negligible” but identified the greater precision in the manufacturing of Unit 3 AVBs.⁵⁰⁴ Amongst the presentation’s conclusions was that a “zero-gap” tube-to-AVB gap is insufficient to prevent in-plane FEI and that contact

⁵⁰⁰ Exh. JX-1097, pp. 4-5.

⁵⁰¹ Exh. JX-1097, p. 5.

⁵⁰² Exh. JX-1101.

⁵⁰³ Exh- JX-1088 (See ¶ 476 above).

⁵⁰⁴ Exh. JX-1101, p. 13.

force is required.⁵⁰⁵ Short term measures were identified as plugging and long terms measures included either inserting “additional thicker AVBs” or insertion of “additional wave shaped AVBs.”⁵⁰⁶

480. A 6 April 2012 MHI presentation on gaps and wear identifies that the effect of gap size on wear was small and that calculated wear was consistent with measured wear.⁵⁰⁷ The presentation also concluded that the effect of contact force on in-plane FEI was large and that a [REDACTED] contact force would prevent in-plane FEI.⁵⁰⁸
481. A 6 April 2012 AREVA report on the in-situ tests at Unit 3 explains that 8 tubes failed the in-situ test in Unit 3E88 and none of the remaining 121 tested tubes in either Unit 3 88 or 89 failed.⁵⁰⁹
482. A 6 April MHI presentation on tube wear shows that the lack of contact force in Unit 3 was on account of improved AVB manufacturing and flowering of the tube bundle.⁵¹⁰
483. On 11 April 2012, MHI released its version 0 of its Root Cause Evaluation Report, including appendices.⁵¹¹ The report concludes that the Unit 3 wear in the U-bend region was caused by low contact force and high VFs.⁵¹² MHI’s proposed repairs included a short term plugging and stabilization approach and a long-term approach of installing thicker AVBs or wave AVBs.⁵¹³ MHI also found that:

⁵⁰⁵ Exh. JX-1101, p. 32.

⁵⁰⁶ Exh. JX-1101, p. 36.

⁵⁰⁷ Exh. JX-1103, p. 8.

⁵⁰⁸ Exh. JX-1103, p. 9.

⁵⁰⁹ Exh. JX-1104, p. 4.

⁵¹⁰ Exh. JX-1105.

⁵¹¹ Exh. JX-1108.

⁵¹² Exh. JX-1108, p. 43.

⁵¹³ Exh. JX-1108, p. 42.

- (i) the wear in the U-bend region of Unit 3 was caused by “fluid elastic vibration;”⁵¹⁴
- (ii) the additional number of rotations of the Unit 3 tube bundle had a negligible effect;⁵¹⁵
- (iii) there was a greater uniformity in the Unit 3 tubes and AVBs;⁵¹⁶ that this uniformity resulted in less contact force between the tubes and AVBs;⁵¹⁷ and
- (iv) thermal expansion increased some gaps in the middle of the tube bundle by ■■■
■■■⁵¹⁸

484. In a 11 April 2012 “deep dive” presentation, SCE identified developments in the study of thermal dynamics since the design of SONGS and discussed the Unit 2 restart process.⁵¹⁹

485. Minutes of a 13 April 2012 meeting between MHI and SCE reflect a discussion over restarting Unit 2 at reduced power and concerns over both public and regulatory perception.⁵²⁰

486. Revision 2 to MHI’s Report on the Validity of FIT-III is dated 13 April 2012.⁵²¹ The report identifies the Gap Velocity Error in the SONGS design,⁵²² calculates that SRs

⁵¹⁴ Exh. JX-1108, p. 11.

⁵¹⁵ Exh. JX-1108, p. 13.

⁵¹⁶ Exh. JX-1108, p. 13.

⁵¹⁷ Exh. JX-1108, p. 23.

⁵¹⁸ Exh. JX-1108, p. 20.

⁵¹⁹ Exh. JX-1109.

⁵²⁰ Exh. JX-1112.

⁵²¹ Exh. JX-1114.

⁵²² For the Gap Velocity Error, see ¶ 233 above.

for the SONGS design are still below one⁵²³ (even with one ineffective support), and concludes that had higher VFs been calculated, or ATHOS been used, the likely course of action would have been a modified design of the AVB structure, which would nonetheless not have prevented in-plane FEI:

The flow velocity and void fraction predicted by ATHOS are greater than FIT-III. The causes of the lower flow velocity predicted by the modified FIT-III code for the triangular tube array SGs are due in part to the specific numerical values/correlations selected as well as the gap velocity transformation inconsistent with ASME Section III Appendix-N 1331.1 definition.

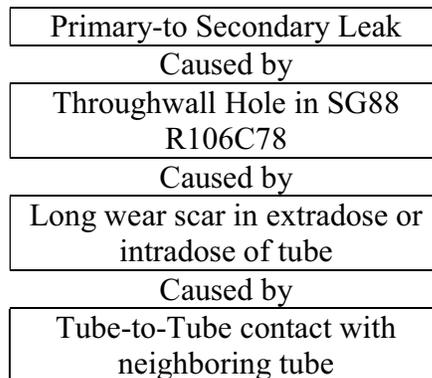
After the observation of tube to tube wear (TTW) in the SONGS RSGs, MHI conducted an evaluation of the SONGS RSG design based on ATHOS. MHI confirms that with all supports active the maximum stability ratio based [on] ATHOS outputs is less than 0.75 which is lower than the ASME Section III Appendix N-1330 required 1.0. MHI concludes that the AVB design is adequate to prevent the out-of-plane FEI. MHI also confirms that the stability ratios for tubes in the TTW region is less than 1.0 even assuming one inactive support.

If MHI had used a thermal-hydraulic code such as ATHOS, the predicted thermal-hydraulic conditions would have been more severe than those predicted by FIT-III. If MHI had determined that the predicted thermal-hydraulic conditions should have been addressed based on this more severe analysis, SONGS RSG design may have been modified. The likely design modification would have been the insertion of additional AVBs of flat bar type, but most of the tube wear indications due to the in-plane FEI and random vibration at AVB support points would not have been prevented, because flat bar type AVBs when used in the "zero contact force" design followed in the SONGS RSGs would not provide effective supports for in-plane FEI and random vibration at high void fraction (steam quality) conditions.⁵²⁴

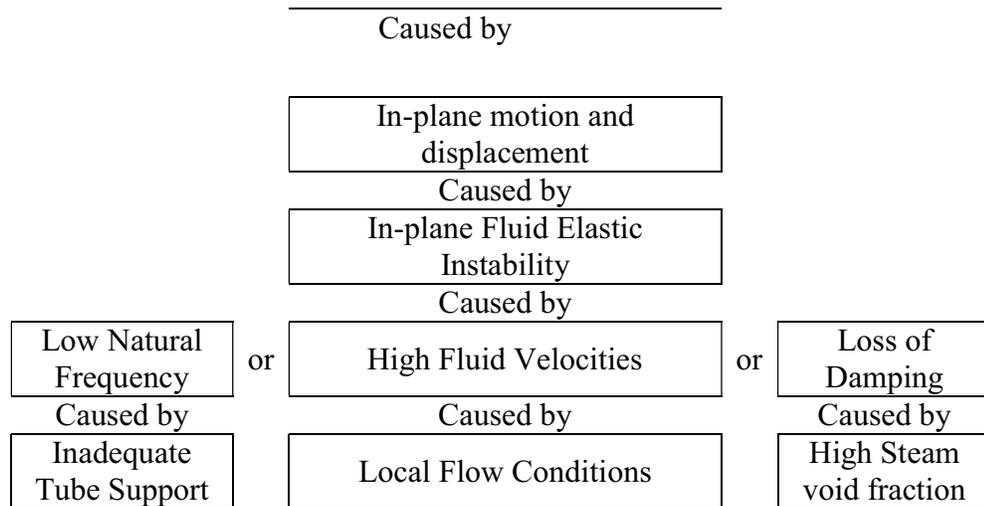
⁵²³ Exh. JX-1114, p. 22 (A SR of [REDACTED] is calculated for R120C78 which MHI declared representative of the area of high TTW).

⁵²⁴ Exh. JX-1114, p. 28.

487. A 17 April 2012 draft chart of comments identifies various comments by SCE and independent reviewers regarding MHI’s root cause evaluation.⁵²⁵
488. A 17 April 2012 presentation by MHI identifies the relationship between tube-to-tube wear and contact forces.⁵²⁶ MHI concluded that gap sizes are of minimal effect on in-plane FEI but that contact force is crucial in avoiding in-plane FEI, with a [REDACTED] contact force on the tubes required.⁵²⁷
489. A further presentation on tube-to-tube wear and contact forces by MHI on 18 April 2012 explains that imperfections in manufacturing of tubes and AVBs create contact forces that prevent in-plane FEI.⁵²⁸
490. On 20 April 2012, a meeting of experts in the field was convened at which various issues surrounding the SONGS T/H conditions and a reduced power restart were discussed.⁵²⁹ A presentation by SCE at that meeting demonstrated the “root cause staircase” under consideration.⁵³⁰



⁵²⁵ Exh. JX-1115.
⁵²⁶ Exh. JX-1118.
⁵²⁷ Exh. JX-1118, p. 34.
⁵²⁸ Exh. JX-1122, p. 3.
⁵²⁹ Exh. JX-1126.
⁵³⁰ Exh. JX-1127, p. 3.



491. In a 20 April 2012 email from MHI’s consultant Mr. Wilson to ██████████ at MHI in the context of revisions to MHI’s root cause analysis, he stated his assumptions that the “root cause is related to VFs higher than that of prior experience – and that future designs should establish a not-to exceed void fraction criterion” and that “this gets back to the observation that big bundles are beyond our experience.”⁵³¹
492. A 23 April 2012 draft report of an expert panel convened by SCE to review the SONGS Incident generally concluded that gaps sizes did not have a large effect on in-plane FEI but that contact force did have an effect.⁵³² The panel also recommended that a restart be at a lower power level, of 90% for Unit 2 and 80% for Unit 3, combined with additional preventative plugging. The panel declared that a long term solution had to be implemented as soon as possible.
493. In an internal MHI email of 23 April 2012, ██████████ wrote:

Based on informal discussions with various SCE people, it is clear that SCE intend to backcharge MNES for everything related to the repairs *up*

⁵³¹ Exh. JX-1128, p. 4.

⁵³² Exh, JX-1129.

to the LOL. SCE continue to avoid discussions or taking action regarding “mutual agreement” of the repair methodology and costs because the SCE PJ team plans to do whatever they want and then let the SCE/MNES commercial people work out the details (costs) LATER. ██████████ ██████████ and myself have warned the SCE PJ team about the lack of “mutual agreement” and each time the response is the same... “Please let us know what you need!” We have requested the information we need however SCE has only provided partial information. They are not responding to our requests.⁵³³

494. ██████████ concluded this email by stating that MHI needed to start documenting its commercial position in more project letters.⁵³⁴
495. SCE had assembled an Expert Panel for the restart of SONGS. A 24 April 2012 summary of its recommendations states that the “basis for restart must address all the key elements that drive FEI – fluid damping, fluid forces, and tube support conditions.”⁵³⁵ SCE’s Expert Panel further recommended that “SCE must demonstrate that each of the factors described (...) are moving toward a more stable state for the tubes.”⁵³⁶ Dr. Pettigrew, of the École Polytechnique of L’Université de Montréal, member of the Expert Panel,⁵³⁷ opined that, in particular, “squeeze film”⁵³⁸ damping was “critical for preventing FEI.”⁵³⁹ The Expert Panel also recommended

⁵³³ Exh. JX-1130, p. 4.

⁵³⁴ Exh. JX-1130, p. 4.

⁵³⁵ Exh. JX-1131, ¶ 1.2.

⁵³⁶ Exh. JX-1131, ¶ 1.3(2).

⁵³⁷ Exh. JX-1126.

⁵³⁸ Squeeze film damping is a type of thermal hydraulic damping. MHI considered this effect to be insignificant and did not account for it in design (Exh. JX-782 at 116-118). Post-Incident testing at Chalk River commissioned by AREVA to assist with the SONGS repair confirmed MHI’s approach by finding that squeeze film damping was indeed negligible for AVBs, overturning prior research from 1988 on TSPs (Exh. JX-1868 at 45).

⁵³⁹ Exh. JX-1131, ¶ 1.3.1.

that power levels be reduced and that MHI calculate stability levels, with sufficient margin, that would allow for safe operation.⁵⁴⁰

496. In a 25 April 2012 report, SCE's consultant Dr. Begley stated his contemporaneous view that "the tube to tube wear degradation in Unit 3 makes it the worst case degraded steam generator in the history of domestic nuclear power."⁵⁴¹ Dr. Begley reported that had three tubes in Unit 3 suffered an additional [REDACTED] of loss to their walls, they would have "burst at normal operating conditions."⁵⁴² He further reported that while the industry has operating experience for other large generators that suffered comparable amounts of wear, there were no data on wear progression for in-plane FEI as it is a new phenomenon.⁵⁴³ Amongst Dr. Begley's recommendations for moving forward were reduced power levels and shorter run periods.⁵⁴⁴
497. On 25 April 2012, SCE issued a "Request for Information" to the nuclear industry requesting "possible repair methods which can be implemented to ensure safe and reliable operation of the SONGS SGs until the end of the current plant operating license and beyond."⁵⁴⁵ The Request for Information identifies the causes of the tube wear issue as either or both of SR being incorrectly calculated or the as-built tube supports differing from those as designed.⁵⁴⁶ SCE stated that "to mitigate this, either the AVB structure has to be repaired such that the tube U-bend supports are active"

⁵⁴⁰ Exh. JX-1131, p. 7.

⁵⁴¹ Exh. JX-1132, p. 1.

⁵⁴² Exh. JX-1132, p. 1.

⁵⁴³ Exh. JX-1132, p. 1.

⁵⁴⁴ Exh. JX-1132, p. 4.

⁵⁴⁵ Exh. JX-1133, p. 1.

⁵⁴⁶ Exh. JX-1133, p. 2.

or “the AVB structure/tube bundle [has] to be redesigned to ensure that the tubes are not subject to FEI during plant operation.”⁵⁴⁷ SCE provided its repair objectives:

- Restore the 40 year service life of the SGs.
- Allow for plant operation without restrictions on reactor power.
- Be implementable under the 10 CFR 50.59 rule.⁵⁴⁸

SCE requested that repair submissions from potential bidders be submitted by the end of June 2012.

498. Meeting minutes of a 27 April 2012 internal MHI meeting mention that efforts were under way to construct a repair mockup and that MHI was to engage in testing to ensure that their repair would not have adverse effects.⁵⁴⁹
499. An internal MHI repair plan of 27 April 2012 shows that MHI was developing and testing a thicker AVB concept and was undertaking what it called “Basic Test One” to determine the insertability of various thicker AVBs in a mock bundle and measure the contact forces generated by these thicker AVBs. A timeline for the repairs showed that the repair would be implemented for the first quarter of 2013.⁵⁵⁰
500. On 30 April 2012, AREVA completed its technical summary for the evaluation of Unit 2 wear that was requested by SCE as the response to the CAL.⁵⁵¹ AREVA stated that two tubes were found to have suffered from tube-to-tube wear.⁵⁵²

⁵⁴⁷ Exh. JX-1133, p. 2.

⁵⁴⁸ Exh. JX-1133, p. 3; for the 10 CFR 50.59 rule, see ¶ 181.

⁵⁴⁹ Exh. JX-1137.

⁵⁵⁰ Exh. JX-1138.

⁵⁵¹ Exh. JX-1141.

⁵⁵² Exh. JX-1141, pp. 11-12.

501. On 7 May 2012, SCE’s revision 0 to its Root Cause Evaluation of Unit 3 was completed.⁵⁵³ SCE concluded that “the mechanistic cause of the tube-to-tube wear was identified as FEI, involving the combination of localized high steam/water velocity (tube vibration excitation forces), high steam void fraction (loss of ability to dampen vibration), and insufficient tube to AVB contact forces to overcome the excitation forces.”⁵⁵⁴ SCE identified “correction actions to prevent recurrence of FEI include lowering power operations to reduce tube excitation forces and improve the ability to dampen vibration.”⁵⁵⁵ Additional recommended actions included stabilization and plugin of tubes.
502. The 7 May 2012 Root Cause Evaluation Report further:
- (i) Contains a description of the in-situ test failures;⁵⁵⁶
 - (ii) Identifies that two tubes in Unit 2 also suffered from tube-to-tube wear;⁵⁵⁷
 - (iii) Describes the various wear conditions experienced by both Units;⁵⁵⁸
 - (iv) Finds that FEI is the cause of the in-plane tube-to-tube wear, as ordinary turbulence does not sufficiently explain such wear patterns;⁵⁵⁹

⁵⁵³ Exh. JX-1149.

⁵⁵⁴ Exh. JX-1149, p. 4.

⁵⁵⁵ Exh. JX-1149, pp. 4-5.

⁵⁵⁶ Exh. JX-1149, p. 13.

⁵⁵⁷ Exh. JX-1149, p. 28.

⁵⁵⁸ Exh. JX-1149, pp. 18-19.

⁵⁵⁹ Exh. JX-1149, p. 28.

- (v) Recognizes that both MHI and SCE concluded that FEI occurred at SONGS “and that the combination of T/H conditions and lack of effective tube AVB supports resulted in FEI;”⁵⁶⁰
- (vi) Concludes that “differences in manufacturing/fabrication could contribute to the mechanism of tube-to-tube wear seen in the Unit 3 SGs.” In particular, these differences include more precisely manufactured tubes in Unit 3 and slightly larger tube-to-AVB gaps in Unit 3.⁵⁶¹
503. On 7 May 2012, a meeting took place between MHI and SCE, in particular its CNO Mr. Dietrich. According to the minutes prepared by MHI, SCE was informed of MHI’s then current repair concepts, including additional AVBs, T/H improvements, testing and the repair mockups.⁵⁶² The minutes reflect that contemporaneous SCE thinking was that a replacement of AVBs was “imagined,” but that Mr. Dietrich may have been open to an additional AVB concept.⁵⁶³
504. MHI’s Revision 1 of its Technical Evaluation Report of tube wear at SONGS Unit 3 dates 9 May 2012.⁵⁶⁴ The report identified the wear experienced at SONGS in a Degraded Tubes Overview:⁵⁶⁵

⁵⁶⁰ Exh. JX-1149, p. 21.

⁵⁶¹ Exh. JX-1149, p. 22.

⁵⁶² Exh. JX-1150.

⁵⁶³ Exh. JX-1150, ¶ 2. “Questions were raised over why adding 2 units is good. Response to this was that it is sufficient to prevent plane vibration. [As for SCE, it seems that overall replacement of AVB was imagined and it seems that additional 2 units was alright. Going forward, discussions are required regarding its logic as well as effects towards out of plan [sic] vibration.”

⁵⁶⁴ Exh. JX-1152.

⁵⁶⁵ Exh. JX-1152, p. 11.

Unit	2A					2B				
Number of Tubes	861					732				
Wear Depth (%)	FSW / TTW	AVB	TSP with U-bend	TSP without U-bend	Retainer Bar	FSW / TTW	AVB	TSP with U-bend	TSP without U-bend	Retainer Bar
0 ~ 10	0	385	35	33	0	0	275	26	86	0
11 ~ 20	2	299	30	20	0	0	219	19	53	0
21 ~ 30	0	52	1	0	2	0	51	0	0	0
31 ~ 40	0	0	0	0	1	0	0	0	0	0
41 ~	0	0	0	0	1	0	0	0	0	2
Total	2	736	66	53	4	0	546	45	139	2

Unit	3A					3B				
Number of Tubes	895					921				
Wear Depth (%)	FSW / TTW	AVB	TSP with U-bend	TSP without U-bend	Retainer Bar	FSW / TTW	AVB	TSP with U-bend	TSP without U-bend	Retainer Bar
0 ~ 10	0	432	12	7	0	0	384	18	10	0
11 ~ 20	13	222	24	7	0	13	247	51	10	0
21 ~ 30	31	19	4	1	0	33	31	4	0	1
31 ~ 40	52	0	1	0	0	29	2	0	0	0
41 ~	69	0	0	0	1	86	0	0	0	2
Total	165	673	41	15	1	161	664	73	20	3

505. MHI's Technical Evaluation Report notes that given the differences between the wear experienced in Unit 2 and Unit 3, a manufacturing difference was the likely cause, with improvements in the manufacture of tubes and AVBs for Unit 3 the most likely explanation.⁵⁶⁶ MHI found that gaps in Unit 3 were slightly larger, indicating less contact force.⁵⁶⁷ MHI identified a relationship between high VFs and tube-to-tube wear, with tube-to-tube wear occurring at VFs of 0.990 at above. MHI concluded:

Additional countermeasures and repairs will be studied to determine potential mid-to-long term solutions to mitigate tube vibration and associated wear. FEI should be avoided, regardless of tube-to AVB contact force as it is not possible to control tube-to-AVB contact force during design, fabrication or operation.⁵⁶⁸

⁵⁶⁶ Exh. JX-1152, pp. 46-47.

⁵⁶⁷ Exh. JX-1152, p. 48.

⁵⁶⁸ Exh. JX-1152, p. 81.

506. On 10 May 2012, another meeting took place between MHI and Mr. Dietrich of SCE. The minutes prepared by MHI reflect that SCE informed MHI that the NRC had concerns with the FIT-III error that had to be addressed although SCE did not share those concerns.⁵⁶⁹

507. A 11 May 2012 internal presentation by SCE shows SCE's understanding that (i) results by ATHOS are more conservative than FIT-III;⁵⁷⁰ (ii) the "use of the FIT-III results during design is not considered a direct cause of the SONGS tube wear";⁵⁷¹ (iii) fabrication is an apparent cause of in-plane FEI in combination with T/H conditions;⁵⁷² and (iv):

The design of the SONGS steam generators did not account for in-plane FEI; industry operating experience and test data from research efforts indicated that if out-of-plane FEI is not a concern, in-plane FEI would not occur.⁵⁷³

508. The AIT of the NRC had raised questions regarding FIT-III. The Challenge Board⁵⁷⁴ considered those questions on the basis of presentations by MHI. A summary of a 11 May 2012 FIT-III Challenge Board meeting shows that:

- (i) the Challenge Board did not find that MHI had sufficiently demonstrated that the SR were adequate as MHI had not sufficiently justified the inputs to ATHOS and FIT-III;⁵⁷⁵

⁵⁶⁹ Exh. JX-1157; for the FIT-III error, see Section XI.C(a) below.

⁵⁷⁰ Exh. JX-1163, p. 1.

⁵⁷¹ Exh. JX-1163, p. 1.

⁵⁷² Exh. JX-1163, p. 2.

⁵⁷³ Exh. JX-1163, p. 3.

⁵⁷⁴ The FIT-III Challenge board consisting of representatives from SCE, MHI, EPRI, AREVA, B&W and others was set up to review FIT-III following the Incident (Exh. JX-1165).

⁵⁷⁵ Exh. JX-1165, p. 2.

- (ii) the FIT-III model was adequately validated using experimental correlation but whether FIT-III was being used outside its validated range was an open question;⁵⁷⁶
- (iii) it was not conclusively demonstrated that the FIT-III was not a contributing cause to the flow-induced vibration leading to tube-to-tube wear in SONGS RSGs;⁵⁷⁷
- (iv) “no generally accepted industry acceptance guidelines exist for thermal-hydraulic conditions” and as such it is unknown whether “higher void fractions and velocities predicted by ATHOS” would have led to a redesign of SONGs but a “standard design practice [was] not to treat the thermal-hydraulic model on its own merits;”⁵⁷⁸
- (v) MHI’s approach to design conservatism was a SR target of one missing support as it believed that this was more conservative than a 0.75 SR target with all supports working; and⁵⁷⁹
- (vi) the Challenge Board was looking to obtain directly comparable results from FIT-III and ATHOS.

509. As part of the May 2012 FIT-III Challenge Board process, MHI prepared a number of presentations, providing answers regarding the function and validation of FIT-III.⁵⁸⁰

⁵⁷⁶ Exh. JX-1165, p. 48.

⁵⁷⁷ Exh. JX-1165, p. 21.

⁵⁷⁸ Exh. JX-1164, p. 1.

⁵⁷⁹ Exh. JX-1164, p. 4.

⁵⁸⁰ See e.g. Exh. JX-1166; Exh. JX-1167; Exh. JX-1169; Exh. JX-1170; Exh. JX-1171. Exh. JX-1172.

510. Revision 2 of MHI's Technical Evaluation Report for the tube wear in Unit 3 is dated 21 May 2012.⁵⁸¹ The report maintains the general conclusion that the Unit 3 wear was caused by FEI on account of high T/H conditions and insufficient tube support. Revision 2 added an annex on fatigue evaluation of tubes on account of in-plane vibration and updated the wear analysis for both Units.
511. An internal SCE email of 21 May 2012 from SCE's Mr. Palmisano to SCE's Mr. Dietrich mentions Mr. Palmisano's views that the operational assessments for Unit 2 were well underway, that a restart of Unit 3 was more challenging, and that there was a need to discuss the option of installing additional AVBs as a long-term repair.⁵⁸²
512. A 24 May 2012 MHI presentation to SCE on in-plane FEI evaluation demonstrates that even if the RSGs operated at 50% power, if [REDACTED] AVB support points are inactive in the in-plane direction, then there would be in-plane instability.⁵⁸³ According to MHI's presentation, operating at 70% and [REDACTED] active supports would also lead to in-plane instability.⁵⁸⁴ The presentation concludes that at 100% power, SONGS required at least [REDACTED] to [REDACTED] active AVBs in the in-plane direction.
513. On 25 May 2012, MHI circulated its responses to the Challenge Board regarding questions over FIT-III.⁵⁸⁵
514. MHI prepared minutes of a 29 May 2012 meeting between SCE's Mr. Dietrich and MHI reflect the importance of addressing political, public and regulatory concerns. SCE stated that (i) California's Senator Barbara Boxer may be prepared to campaign against SONGS; (ii) that the public's attitudes to the need for SONGS would change

⁵⁸¹ Exh. JX-1181.

⁵⁸² Exh. JX-1184.

⁵⁸³ Exh. JX-1185, p. 21.

⁵⁸⁴ Exh. JX-1185, p. 22.

⁵⁸⁵ Exh. JX-1187.

if the outage lasted past September 2012; (iii) and that the NRC would be more convinced by the results of experiments than by analytical data.⁵⁸⁶ SCE also declared that it hoped to restart Unit 2 for August 2012. Mr. Dietrich also requested that MHI provide its Unit 3 repair plan ahead of schedule and stressed the importance of having a root cause analysis that is easily explainable.⁵⁸⁷

G. SONGS RESTART, REPAIR AND REPLACEMENT EFFORTS

515. Following the initial investigation period, SCE and MHI engaged in various efforts to find a repair for Unit 3. According to the Claimants, SCE never received an adequate⁵⁸⁸ repair option from MHI until late December 2012,⁵⁸⁹ when MHI eventually offered a replacement option. Immediately following this offer, SCE informed MHI that this placed them in breach of their obligations under the RSG Contract.
516. Nonetheless, MHI carried on with both a repair and a replacement option. MHI presented a repair plan for April 2013. SCE had this plan evaluated by AREVA.
517. Further efforts were however cut short following a decision of the ALSB that the restart of Unit 2 required a public hearing. Shortly after this decision, SCE took the decision to shutdown SONGS.

(a) The May 2012 Repair Presentations

518. On 31 May 2012, MHI formally presented its repair proposal concept to SCE in two slide presentations, the first titled “Study of Design Improvements Against Tube

⁵⁸⁶ Exh. JX-1190.

⁵⁸⁷ Exh. JX-1190, p. 2.

⁵⁸⁸ The Claimants submit that the replacement option itself is not adequate, given the lengthy timeline to develop a replacement.

⁵⁸⁹ Exh. JX-1571.

Flow Vibration Problem”⁵⁹⁰ (“**Design Improvements Presentation**”) and the second titled “Detailed Study for Insertion of Additional Thicker AVBs” (“**AVB Insertion Study**”).⁵⁹¹

519. The Design Improvements Presentation identifies the SR formula, as described above:⁵⁹²

$$SR = \frac{\textit{Effective Velocity}}{\textit{Critical Velocity}}$$

520. MHI explained that in order to decrease the SR, mathematically either the numerator, Effective Velocity (Ve), has to decrease or the denominator, Critical Velocity (Vc), has to be increased.⁵⁹³
521. MHI identified two options for decreasing Effective Velocity (Ve): (i) a redesign of the RSGs that modified the pitch/diameter ratio by re-arranging the tube bundle design; or (ii) the modification of the RSG internals around the downcomer or around the top TSP.⁵⁹⁴ MHI discounted the two modification options as not effective, with the downcomer modification likely to increase VF even higher and the TSP modification only having a beneficial effect on a small number of tubes.⁵⁹⁵
522. MHI identified eleven options for increasing the Critical Velocity (Vc) under two categories: (i) measures to increase AVB effectiveness in the in-plane direction; and (ii) measures to generally decrease the VF and improve damping.⁵⁹⁶ Of the six

⁵⁹⁰ Exh. JX-1191.

⁵⁹¹ Exh. JX-1192.

⁵⁹² See ¶ 170 above.

⁵⁹³ Exh. JX-1191, p. 2.

⁵⁹⁴ Exh. JX-1191, p. 3.

⁵⁹⁵ Exh. JX-1191, pp. 7-8.

⁵⁹⁶ Exh. JX-1191, pp. 4-5.

options to increase AVB effectiveness, MHI characterized two as not effective (stabilizers and additional AVBs), two as difficult to implement (wave AVBs and expandable AVBs), one as possibly effective (tube expansion), and one as effective (the insertion of thicker AVBs).⁵⁹⁷ Of the five options to reduce VF, one is described as impossible to undertake (change to the primary separators), two options to modify the feedwater injection are qualified as ineffective and difficult to perform, a fourth option to modify the feedwater ring is subject to uncertainty, and the fifth option (removal of portions of tubes) is considered a “huge effort.”⁵⁹⁸ MHI also presented another six options that were considered impossible, ineffective, or already implemented.⁵⁹⁹

523. MHI concluded that there were four effective and applicable repair methods: (i) additional thicker AVBs; (ii) tube expansion; (iii) modification of the feedwater injection system; and (iv) removal of a portion of the straight leg tubes.⁶⁰⁰
524. MHI recommended that SCE go forward with the installation of additional thicker AVBs and that further efforts be undertaken in this direction regarding scheduling, investigation and development, consideration of accessibility and workability, effectiveness and reliability, and calculation of radiation exposure to workers.⁶⁰¹ MHI provided an implementation schedule for May 2013.
525. MHI’s second presentation of 31 May 2012, the AVB Insertion Study, focused on the installation of thicker AVBs.⁶⁰² MHI presented that there were two insertion options, through the top of the U-bend bundle or from the side of the U-bend bundle,

⁵⁹⁷ Exh. JX-1191, pp. 7-15.

⁵⁹⁸ Exh. JX-1191, pp. 16-20.

⁵⁹⁹ Exh. JX-1191, pp. 21-27.

⁶⁰⁰ Exh. JX-1191, p. 28.

⁶⁰¹ Exh. JX-1191, p. 28.

⁶⁰² Exh. JX-1192.

or a combination of both options.⁶⁰³ MHI explained its two basic tests that supported this recommendation. It had previously presented “basic test one” on 7 May 2012 to test insertion force, contact force, change to gaps with existing AVBs, damage to existing tubes, and the effect on SR.⁶⁰⁴ “Basic test two” tested insertion force, the movement of tubes during insertion, and the effectiveness of the “alignment expansion tool” used in the insertion process through a seven column mockup of the actual SONGS RSGs.⁶⁰⁵ MHI stated that a future step was the construction of a full size mockup of the SONGS RSGs to verify the repair and engage in training for the installation.⁶⁰⁶ MHI also stated that further verification was required to get “final confirmation” of effectiveness and workability, perform a technical verification, and develop the procedures, tools and training to perform a repair.⁶⁰⁷

526. Following MHI’s presentation, one of the SCE attendees, Mr. John Brabec, reported to SCE’s Mr. Dietrich.⁶⁰⁸ Mr. Brabec reported that MHI would “have a full scale mockup complete at the end of July at which time the testing of the recommended repair strategy will begin, with completion mid-September” and that MHI believed it could implement the repair in spring/summer of 2013. Mr. Brabec shared his opinion that a steam dome removal was likely required to implement the repair and that he was skeptical that a less intrusive repair was “doable.” With regard to timing, he believed the repair could only be done for the Fall of 2013 and that while the proposed repair may address the current problem it may create other issues, but he

⁶⁰³ Exh. JX-1192, pp. 6-10.

⁶⁰⁴ Exh. JX-1192, p. 12.

⁶⁰⁵ Exh. JX-1192, p. 15.

⁶⁰⁶ Exh. JX-1192, p. 20.

⁶⁰⁷ Exh. JX-1192, p. 21.

⁶⁰⁸ Exh. JX-1193.

thought that “the mockup activities may answer this question with reasonable certainty.”⁶⁰⁹

527. As reflected in MHI drafted minutes from the 31 May 2012 meeting,⁶¹⁰ SCE inquired with MHI as to various matters, including further alternatives to reduce VF, and further investigations into the use of expandable AVBs.⁶¹¹
528. SCE declared that it would go to Kobe, Japan, to examine the full scale mockup at the end of August 2012. Regarding the thicker AVB repair, SCE (i) requested that MHI consider whether thicker AVBs could be applied to all high VF areas; (ii) inquired whether the repair would be performed in water or in air [REDACTED]; and (iii) asked whether the repair would last for 40 years. MHI was unable to immediately provide this latter confirmation and agreed to revert.⁶¹²
529. At the EIX board level, the parent company of SCE, its president, Mr. Craver, presented in the form of a “June 2012 Board Letter” the following update regarding SONGS and the repair efforts, reflecting the challenges of uncertainty regarding a repair timeline, license renewal, cost recovery, and political opposition:

Over the last six months, SONGS has steadily become more complicated and difficult, and less positive. As of now, it appears that neither of the two units will be back on-line this summer. Unit 2 may be operating by early fall, but only at partial power. Unit 3 probably cannot be restarted soon by running at partial power, and to operate at all will likely require costly repairs that will take many months at a minimum to complete. As the time line expands to complete the complex engineering work on the causes and remedies of the unusual tube wear, the political pressure grows from environmental and anti-nuclear groups to intervene in the

⁶⁰⁹ Exh. JX-1193.

⁶¹⁰ Exh. JX-1203; See ¶¶ 518-526 above.

⁶¹¹ Exh. JX-1203, pp. 3-4.

⁶¹² Exh. JX-1203, pp. 7-8.

NRC's plant restart decision process, and by some to shut the plant down permanently. The NRC, weakened by its own very public discord, is more susceptible to this political pressure. The CPUC has announced that it may issue an Order Instituting Investigation (OII) this month, focused to some extent on rate-making and financial issues, but really quite open-ended.

We have been steadfast about focusing on the nuclear safety issues above anything else, and that won't change. However, the potential for financial loss to the company is growing. There are four buckets of costs: (a) \$670 million for the new steam generators that has yet to be finally approved for inclusion into rate base, (b) the inspection and repair costs of the steam generators, (c) the costs of the more expensive replacement power required during the time the plant is down, and (d) the potential loss if the CPUC orders SONGS removed from rate base and no longer recoverable in rates, if the plant is down for an extended period. The key issue will be the costs that ratepayers bear, versus those borne by Edison shareholders. [Redacted]

The central objective of our engineering work is determining what constitutes a "fix" for the steam generator tube wear. Tube wear is expected and common in the industry, but typically occurs where tubes come in contact with the tube support structure (tube-to-support wear). The accepted "fix" is to remove the worn tubes from service by plugging and stabilizing them. Over the years, the industry has developed a program of wear modeling, inspection, and repair to safely manage this type of wear.

Our steam generators are experiencing Fluid Elastic Instability, an uncommon phenomenon which causes a more insidious tube-to-tube wear. We know that steam flow characteristics and loose tube supports are the cause of this unusual tube-to-tube wear. Therefore, the "fix" involves altering the steam flow or tightening the tube supports or both. In Unit 2, the steam generators ran twice as long as those in Unit 3 and only exhibited slight tube-to-tube wear in two of the 19,454 tubes. This suggests that we can focus on altering the steam flow characteristics to assure that Fluid Elastic Instability does not reoccur. To change steam flow, we will need to lower the power output to probably around 70%. In Unit 3, we experienced extensive tube-to-tube wear in 326 of the 19,454 tubes.

Although not yet conclusive, it seems increasingly likely that we will be able to operate Unit 2 safely by running at reduced power. However, to run Unit 2 at full power, and to run Unit 3 at all, will require "fixing" the tube support structure. This will require extensive and expensive work. As the technical challenge became clearer, Pete and his team several weeks ago started analyzing 4 generic options: 2 alternatives for strengthening the support structure of the existing tube bundles, and 2 alternatives for replacing the steam generators. The time and cost involved in any of these alternatives will challenge our relationship with MHI, our customers and the community, and will complicate the political and regulatory situation.

More broadly, the strategic alternatives we are evaluating are: (a) run one or both units at partial load for an extended period of time, (b) repair the existing steam generators so that we can run both at full power, (c) replace the steam generators with new ones from MHI or perhaps another vendor, and (d) shut down the plant. Safety will always be of paramount importance. Beyond that, the choice between the four alternatives will be primarily based on cost (NPV). A major factor stakeholders will weigh in evaluating the choices will be who bears the costs, [Redacted]. The final consideration will be reliability of the electric system, but that usually circles back to cost considerations. The license renewal decision will be an important consideration as well. It is more difficult to justify costly "fixes" with positive NPV's and investment paybacks with only 10 years remaining on the existing license at SONGS. The more costly options might make sense if we have a 30 year investment horizon with a 20 year license extension, but getting one under these conditions will be difficult.⁶¹³

(b) Repair Proposals from Westinghouse, AREVA, and B&W

530. SCE received repair proposals from Westinghouse (5 June 2012) ("**Westinghouse's 5 June 2012 Presentation**"), AREVA (6 June 2012) ("**AREVA's 6 June 2012 Presentation**"), and Babcock and Wilcox (6 June 2012) ("**B&W 6 June 2012 Presentation**") in response to its request for information of 25 April 2012, as described in ¶ 497 above.

⁶¹³ Exh. JX-1194, pp. 1-2.

(i) Westinghouse

531. Westinghouse's 5 June 2012 presentation overviewed the SONGS RSG situation. It identified various repair options aimed at improving T/H conditions and/or improving tube support.⁶¹⁴ Westinghouse's identified potential T/H improvements generally involved changes to the downcomer, TSPs, and the feedwater system.⁶¹⁵ Westinghouse's proposed stability improvement options included modifications to the U-bend assembly, AVB replacement, and AVB augmentation.⁶¹⁶ Westinghouse also provided an option to replace the entire tube bundle or lower shell of the RSGs.⁶¹⁷

532. Westinghouse concluded that:

Replacement AVBs or AVB augmentation could be the best long term solution for SONGS. However, additional engineering studies need to be performed to determine the feasibility of these options.

There appears to be various methods that will modify the secondary side flow to reduce the FIV potential. However, it's not possible to determine which is the best solution without further analysis.⁶¹⁸

533. Westinghouse recommended further study on AVB replacement, AVB augmentation, and T/H improvements.⁶¹⁹

⁶¹⁴ Exh. JX-1199.

⁶¹⁵ Exh. JX-1199, pp. 13-15.

⁶¹⁶ Exh. JX-1199, pp. 17-19.

⁶¹⁷ Exh. JX-1199, p. 20.

⁶¹⁸ Exh. JX-1199, p. 21.

⁶¹⁹ Exh. JX-1199, p. 21.

(ii) AREVA

534. AREVA’s 6 June 2012 presentation stated two apparent causes of instability: (i) “[l]ack of sufficient restraint in the in-plane direction – AVBs not active;” and (ii) “[h]igh secondary side void fraction in affected region leading to FEI.”⁶²⁰ It focused on two approaches: (i) “[i]ncrease the friction between the tubes and AVBs” [REDACTED] [REDACTED] [REDACTED] and (ii) “[m]ethods to reduce the void fraction and/or velocity in the affected area” [REDACTED] [REDACTED]⁶²¹

535. Of nineteen options considered, AREVA rejected 15 and considered four “worthy of further evaluation and/or testing.”⁶²² [REDACTED] [REDACTED] [REDACTED] [REDACTED]

536. AREVA’s preferred option was the first option: hydraulic expansion [REDACTED] [REDACTED] [REDACTED]

537. Regarding the second option, the installation of additional AVBs, which was a variation of MHI’s proposal, AREVA stated that it had experience with this option, [REDACTED]

⁶²⁰ Exh. JX-1200, p. 5.
⁶²¹ Exh. JX-1200, p. 6.
⁶²² Exh. JX-1200, p. 8.
⁶²³ Exh. JX-1200, p. 9.
⁶²⁴ Exh. JX-1200, p. 15.

[REDACTED]

[REDACTED]⁶²⁵

538. AREVA’s recommendation was to develop a detailed engineering design and mockup testing of the [REDACTED] process⁶²⁶ while in parallel to work with MHI on the design, engineering analysis and development of an installation process for inserting additional AVBs.⁶²⁷

539. Amongst the information, AREVA stated that it required from SCE or MHI to move forward with a repair was the target VF and gap velocity for the RSGs.⁶²⁸

540. AREVA also provided [REDACTED]
[REDACTED]⁶²⁹

(iii) Babcock & Wilcox

541. B&W’s 6 June 2012 presentation identified three general repair categories: (i) the addition of “additional flatbars down 30° lane” to add positive in-plane support; (ii) the increase of preload between tubes and existing AVBs to improve in-plane support; and (iii) the improvement of U-bend T/H conditions through changes to the existing AVBs, top TSP or the downcomer.⁶³⁰

⁶²⁵ Exh. JX-1200, p. 20.

⁶²⁶ [REDACTED]
[REDACTED]

⁶²⁷ Exh. JX-1200, p. 28.

⁶²⁸ Exh. JX-1200, p. 29.

⁶²⁹ Exh. JX-1200, p. 50.

⁶³⁰ Exh. JX-1202, p. 39.

(iv) Third-Party Review of Repair Options

542. On 8 June 2016, at the request of SCE, Mr. Ellis Merschoff, in his role as a consultant, produced a report “from a former regulator’s perspective” on the return to service of SONGS and the proposed repair options of Westinghouse, AREVA, and B&W, but not MHI.⁶³¹ Mr. Merschoff concluded that, from the regulator’s perspective, a proposed repair option should place positive force on the tubes and that, absent very convincing calculations and test results, adjustment to the T/H conditions was also required:

A. Considering the original steam generators were highly constrained against in-plane motion, the repair should include some positive restraint for in-plane movement. More and thicker AVBs would not be enough without some very convincing calculations and test results to show that friction is sufficient to suppress in-plane vibration. Options that provide positive restraint from in-plane motion are the B&W 30 degree tube lane comb insertion, the scalloped or dimpled AVBs suggested by AREVA, or hydraulic expansion that traps the AVB.

B. The thermal hydraulic conditions in the SONGS steam generator are more severe than other U-bend steam generators. These conditions will need to be mitigated to get SONGS closer to other successfully operating steam generators.

(...)⁶³²

⁶³¹ Exh. JX-1206.

⁶³² Exh. JX-1206, p. 10.

(v) SCE Review of Repair Options

543. On 11 June 2012, SCE's Mr. Olech circulated a table summarizing the proposed repair options of Westinghouse, AREVA and B&W and his views of the pros and cons of each.⁶³³
544. Regarding short term actions to address the T/H conditions, Mr. Olech identified that the "effect may not be sufficient to eliminate tube FEI."⁶³⁴
545. Regarding the installation of additional AVBs, such as thicker AVBs, Mr. Olech identified as pros that such "may provide positive tube in-plane support" and that the repair "can be implemented under 50.59 rule" but as negatives that the effect may not be sufficient; the effect is "difficult to predict analytically;" requires qualification; and "may result in shifting the problem to elsewhere in tube bundle."⁶³⁵
546. Mr. Olech identified the long term options of redesign and replacement of the steam generators as ones in which he had "high confidence" or very high confidence" in resolving the problem but cautioned that these have a "very long lead time."⁶³⁶
547. In a 13 June 2012 internal SCE "deep dive" presentation, SCE outlined the status of repair efforts and repair options.⁶³⁷ For Unit 2, SCE identified that it is difficult to demonstrate that in-plane FEI would not occur absent the introduction of "AVB support" and at reduced power.⁶³⁸ Based upon an Operational Assessment presentation by Intertek, consultants hired by SCE to assist with the Unit 2 restart, in order to move forward with a restart the NRC would require an operational

⁶³³ Exh. JX-1210.

⁶³⁴ Exh. JX-1210, p. 2.

⁶³⁵ Exh. JX-1210, pp. 2-3.

⁶³⁶ Exh. JX-1210, pp. 2-3.

⁶³⁷ Exh. JX-1212.

⁶³⁸ Exh. JX-1212, p. 7.

assessment that demonstrates a very high probability that there would be no tube leaks within the period of the next inspection cycle.⁶³⁹ An operational assessment presentation by Dr. Begley at AREVA identified that high confidence that in-plane FEI would not occur in Unit 2 could be achieved and demonstrated.⁶⁴⁰ Dr. Begley presented that there was an acceptably low risk that the two tubes in Unit 2 that suffered tube-to-tube wear did not have ■ inactive supports in the in-plane direction (the condition under which FEI would occur even at a reduced power level).⁶⁴¹ A 13 June 2012 Westinghouse OA presentation identified that there was an acceptably low risk of Unit 2 experiencing in-plane FEI as SR would be improved by lower operating power and that a shorter operating cycle would add additional protection against a tube leak.⁶⁴²

548. A 21 June 2012 presentation to the Board of Directors of EIX, the parent company of SCE, identifies the four strategic alternatives under consideration: (i) a restart of Unit 2 at 70% power and shutdown of Unit 3; (ii) a restart of Unit 2 at 70% followed by a repair of Unit 2 in January 2014 and of Unit 3 in April 2014; (iii) a restart of Unit 2 at 70% power followed by a replacement of Unit 2 in April 2016 and Unit 3 in October 2016; and (iv) a shutdown of both Units for January 2013.⁶⁴³ The most cost effective option was calculated as a restart of Unit 2 at 70% power and a repair of both Units in early 2014.
549. A 28 June 2012 internal SCE presentation on the repair options identified four types: Type 1 – an AVB repair option, Type 2 – an AVB repair option installed by cutting and removing the RSG dome, Type 3 – a replacement of the tube bundle and lower

⁶³⁹ Exh. JX-1212, pp. 12-27.

⁶⁴⁰ Exh. JX-1212.

⁶⁴¹ Exh. JX-1212, p. 49.

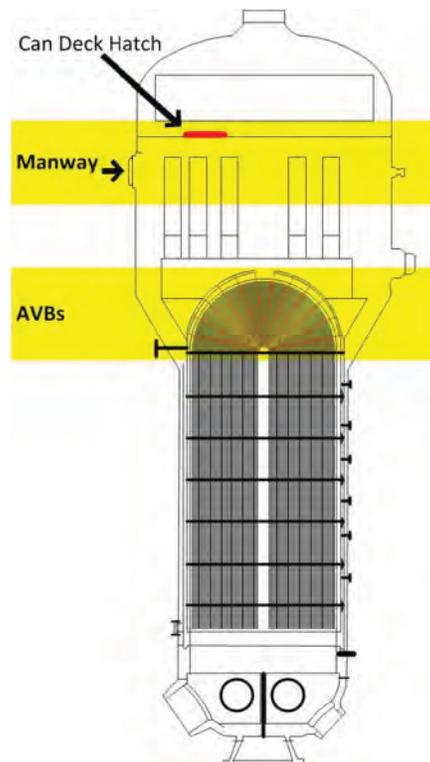
⁶⁴² Exh. JX-1212, p. 73.

⁶⁴³ Exh. JX-1227.

assembly, and Type 4 – a complete RSG replacement.⁶⁴⁴ A SCE pros and cons evaluation identified the Type 4 option as having the most pros and least cons.⁶⁴⁵

550. Accordingly, as of June 2012, the various theoretical repair options fell into four broad categories:⁶⁴⁶

- **Type 1** – AVB repairs performed through the existing manways and deck hatches of the RSGs.

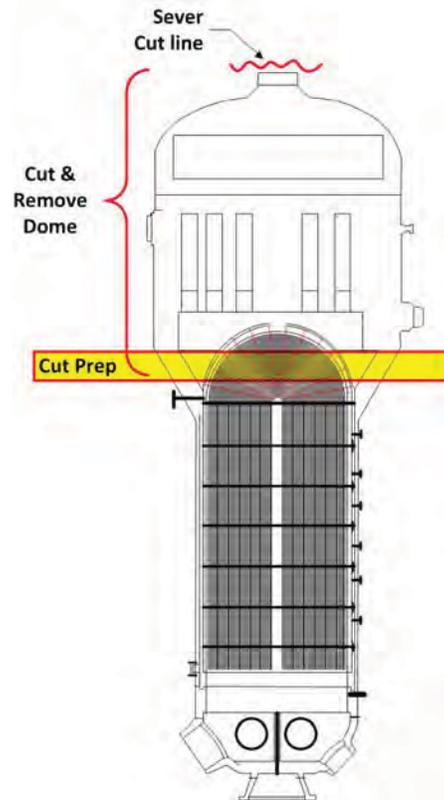


⁶⁴⁴ Exh. JX-1231.

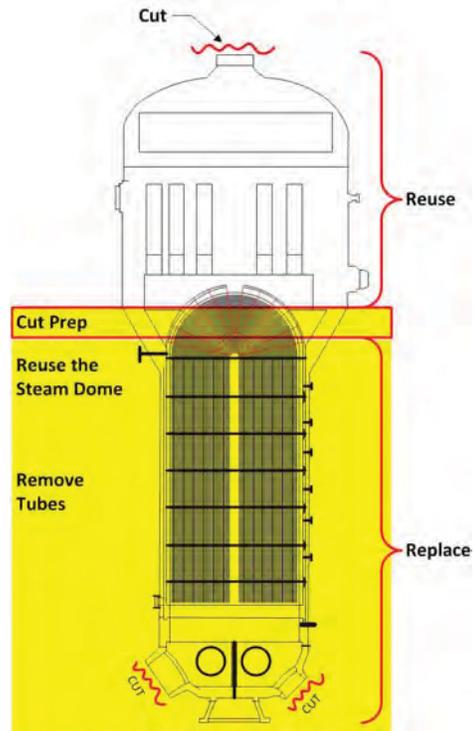
⁶⁴⁵ Exh. JX-1231, pp. 15-16.

⁶⁴⁶ Exh. JX-231, pp. 3, 6, 9, 12; Witness Statement of Mr. Avella, ¶ 20.

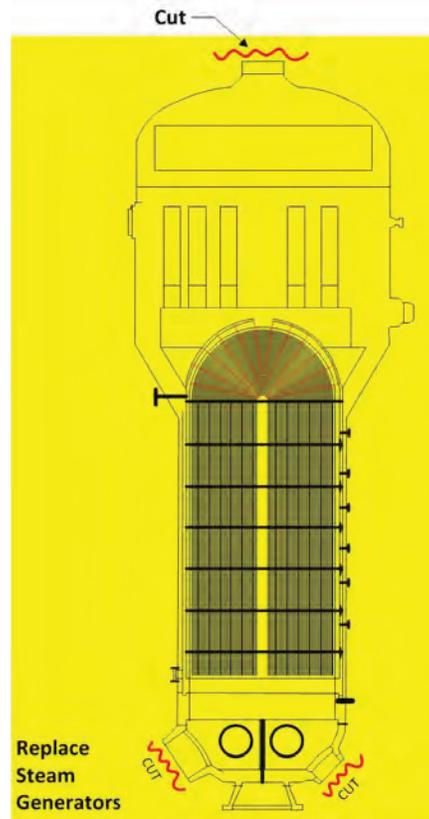
- **Type 2** – AVB repairs requiring removal of the steam dome at the top of the RSGs to provide greater access to the top of the tube bundle.



- **Type 3** – Replacement of the tube bundle portion of the RSGs through the existing equipment hatch of the containment dome.



- **Type 4** – Complete replacement of the RSGs (*i.e.*, a second full replacement), requiring the concrete containment dome walls around the reactors to be re-opened.



551. Of these options, the “**Type 1 Repair**” is of particular concern to the repair efforts and is at issue in this Arbitration.

(c) **The June 2012 Continuing Investigation into Incident**

552. On 15 June 2012, MHI released its Revision 2 to the Evaluation of Stability Ratio for Return to Service of Unit 2 Report, integrating prior SCE comments.⁶⁴⁷

553. On 18 June 2012, MHI released its Revision 5 to its Evaluation of Tube Vibration Report, incorporating prior SCE comments.⁶⁴⁸

⁶⁴⁷ Exh. JX-1216.

⁶⁴⁸ Exh. JX-1219.

554. On 22 June 2013, MHI completed an internal assessment into the FIT-III gap error, concluding that this error was not a “direct cause of the SONGS tube wear.”⁶⁴⁹ MHI’s justification of this conclusion was that even accounting for the Gap Velocity Error, SRs were below one, with all supports active.⁶⁵⁰
555. On 27 June 2012, MHI released Revision 3 to its Unit 3 Tube Wear Technical Evaluation Report, updating the document to incorporate comments from SCE and the expert review panel.⁶⁵¹
556. A 28 June 2012 Corrective and Preventive Request/Action Report by MHI identified that FIT-III, FIVATS, and IVHET had not received “commercial dedication” although mentioned that those codes had been verified and validated.⁶⁵² The “commercial dedication” or “commercial grade dedication” designation allows for approval of third-party components or tools by the NRC, certifying that commercially available products can be safely used in the nuclear field by the supplier as if they were developed by the N-Stamp holder.⁶⁵³

(i) AIT Hearing

557. On 18 June 2012, the NRC AIT⁶⁵⁴ held a public hearing into the SONGS Incident and restart efforts.⁶⁵⁵ In addition to NRC officials, Mr. Dietrich, Mr. Bauder, and Mr. Palmisano of SCE participated. The AIT team leader identified the root causes of the Incident as higher than expected flow velocities on account of an under-predicting of

⁶⁴⁹ Exh. JX-1228, p. 16.

⁶⁵⁰ Exh. JX-1228, pp. 11, 16.

⁶⁵¹ Exh. JX-1229.

⁶⁵² Exh. JX-1233.

⁶⁵³ Transcript, pp. 1306, 1342 (Mr. Merschoff).

⁶⁵⁴ For AIT, see ¶ 465 above.

⁶⁵⁵ Exh. JX-1221.

velocities.⁶⁵⁶ The AIT identified manufacturing differences between Unit 2 and Unit 3 and a lack of contact force in Unit 3 as the cause of the wear.⁶⁵⁷ The AIT generally identified that the investigation and efforts by SCE into resolving the Incident were excellent and that the NRC investigation would be ongoing.

558. In addition to statements from the AIT and SCE, the hearing received comments from various concerned citizens regarding cost and safety at SONGS.

(ii) Friends of the Earth

559. On 18 June 2012, Friends of the Earth, a NGO anti-nuclear activist group, filed a petition and request for a stay to prevent the restart of SONGS absent a public hearing.⁶⁵⁸ Friends of the Earth alleged that the RSG design did not comply with the 10 CFR 50.59 process and that a reduced power start posed unacceptable risks to the public.⁶⁵⁹

(iii) Reorganization of SCE's Repair Teams

560. On 20 June 2012, SCE reorganized its repair teams, and put Mr. Edward Avella in charge of the Unit 3 repairs, while leaving Mr. John Brabec responsible for the Unit 2 restart efforts.⁶⁶⁰

(d) The July 2012 Repair Proposal

561. During July 2012, MHI reported back regarding the status of investigations into repair options and T/H improvement possibilities under consideration.

⁶⁵⁶ Exh. JX-1221, p. 21.

⁶⁵⁷ Exh. JX-1221, pp. 22-23.

⁶⁵⁸ Exh. JX-1220; See also Exh. JX-1222.

⁶⁵⁹ Exh. JX-1220, pp. 41-47.

⁶⁶⁰ Exh. JX-1225.

(i) MHI's July 2012 Repair Proposal

562. On 2 July 2012, MHI delivered its further presentation regarding the SONGS repairs.⁶⁶¹ On T/H improvements, MHI identified that the various options under consideration would be either ineffective or only minimally effective in improving T/H conditions.⁶⁶² With regard to tube-to-AVB focused repair option, MHI provided a review of the hydraulic expansion option and a number of further issues to be resolved in that regard. MHI eliminated from consideration the option of repositioning AVBs, expandable AVBs and a full AVB replacement. MHI determined that further study of thicker AVB, scalloped (comb) AVB, and 30 degree AVB repair concepts were merited.⁶⁶³ MHI stated that evaluation of the remaining options would continue over the summer and fall of 2012 and that it expected to make a final repair recommendation for October 2012.⁶⁶⁴
563. During the 2 July 2012 presentation, SCE requested that MHI further review options to improve T/H conditions. SCE also requested further testing to verify tube wear and suggested testing using MHI's "shaker table" at Takasago.⁶⁶⁵ MHI minutes of the presentation reflect an understanding that improvements in T/H conditions were necessary on account of the conclusions of the root cause analysis.⁶⁶⁶
564. A 2-3 July 2012 SCE internal email chain from Mr. Brabec to Mr. Palmisano and then Mr. Dietrich and other SCE individuals shows SCE's understanding that all identified T/H improvements were found individually ineffective. SCE considered

⁶⁶¹ Exh. JX-1238.

⁶⁶² Exh. JX-1238, pp. 4-7.

⁶⁶³ Exh. JX-1238, pp. 39-41.

⁶⁶⁴ Exh. JX-1238, pp. 91-99.

⁶⁶⁵ Exh. JX-1239, p. 2.

⁶⁶⁶ Exh. JX-1240, p. 3 (The Root Cause Analysis identified that a combination of high T/H conditions and inadequate support caused in-plane FEI).

that a repair would take some 14 months, and requested at that 2 July 2012 meeting that MHI examine the effectiveness of some combination of T/H improvements as this was a requirement of the repair.⁶⁶⁷

(ii) *Ongoing Restart, Repair, and Investigation Efforts*

565. On 8 July 2012, Westinghouse issued its preliminary report on the wear occurring at Unit 2 in order to support a restart.⁶⁶⁸ Westinghouse concluded that:

Analysis has shown that the wear observed at the AVB locations in the SONGS Unit 2 steam generators were produced as a result of out-of-plane motion associated with fluid elastic instability. There were no indications of in-plane instability, even for the tubes found with tube-to-tube wear.⁶⁶⁹

566. Westinghouse concluded that Unit 2 could restart at 80% power, that fluid elastic instability would cause some wear, that this wear would be manageable and that wear on account of “marginally unstable tubes is not uncommon” so long as the wear that can occur during operations is small.⁶⁷⁰ Out of an abundance of caution, Westinghouse recommended that Unit 2 operate at 70% power for an initial six month period to “confirm that no unanticipated conditions occur in the SG that would adversely influence the wear model.”⁶⁷¹

567. On 11 July 2012, AREVA submitted a more detailed proposal for its repair options, including its hydraulic expansion approach.⁶⁷²

⁶⁶⁷ Exh. JX-1241.

⁶⁶⁸ Exh. JX-1251.

⁶⁶⁹ Exh. JX-1251, p. 10.

⁶⁷⁰ Exh. JX-1251, p. 11.

⁶⁷¹ Exh. JX-1251, p. 11.

⁶⁷² Exh. JX-1255.

568. On 13 July 2012, MHI produced Revision 4 to its Technical Evaluation Report of Unit 3 tube wear, incorporating a variety of edits.⁶⁷³
569. On 17 July 2012, MHI produced Revision 5 to its Technical Evaluation Report of Unit 3 tube wear, editing the executive summary.⁶⁷⁴
570. On 18 July 2012, the NRC provided the results of its AIT inspection into SONGS.⁶⁷⁵ The NRC concluded that the RSG “design and configuration did not provide the necessary margin to prevent” in-plane FEI.⁶⁷⁶ The NRC further concluded that as Unit 2 was of the same design, it was “also susceptible” to in-plane FEI. The NRC required that SCE submit a plan to prevent the reoccurrence of tube-to-tube wear before the resumption of power at either Unit 2 or 3. The AIT conclusions include:

(...)

(2) The combination of unpredicted, adverse thermal hydraulic conditions and insufficient contact forces in the upper tube bundle caused a phenomenon called “fluid-elastic instability” which was a significant contributor to the tube to tube wear resulting in the tube leak. The team concluded that the differences in severity of the tube-to-tube wear between Unit 2 and Unit 3 may be related to the changes to the manufacturing/fabrication of the tubes and other components which may have resulted in increased clearance between the anti-vibration bars and the tubes.

(3) Due to modeling errors, the SONGS replacement generators were not designed with adequate thermal hydraulic margin to preclude the onset of fluid-elastic instability. Unless changes are made to the operation or configuration of the steam generators, high fluid velocities and high void fractions in localized regions in the u-bend will continue

⁶⁷³ Exh, JX-1256.

⁶⁷⁴ Exh, JX-1262.

⁶⁷⁵ Exh. JX-1264; Exh. JX-1265.

⁶⁷⁶ Exh. JX-1264, p. 2.

to cause excessive tube wear and accelerated wear that could result in tube leakage and/or tube rupture.

(4) The thermal hydraulic phenomena contributing to the fluid-elastic instability is present in both Unit 2 and 3 steam generators.⁶⁷⁷

571. In an internal SCE email of 19 July 2012, Mr. Olech set forth his view that none of the vendors had presented adequate repair options which would meet the repair criteria of ensuring a 40 year life for the RSGs and were generally inadequate.⁶⁷⁸
572. On 21 July 2012, MHI produced Revision 4 of its evaluation of SR for the return to service of SONGS, which included a wear analysis at 70% power.⁶⁷⁹

(e) **August 2012**

573. On 2 August 2012, MHI asked that SCE provide it with any written notes regarding repair criteria that Mr. Avella, of SCE, had established for Unit 3.⁶⁸⁰ SCE responded by advising that Mr. Avella's criteria for satisfactory repairs consisted of operating at 100% power, with restored margin for both T/H and plugging capacity, and 40 year life cycle for RSGs.⁶⁸¹
574. On 3 August 2012, MHI presented the results of its investigations into improved T/H conditions.⁶⁸² MHI concluded that a combination of T/H conditions could improve VF from 0.996 to [REDACTED] but that any single approach to improving T/H conditions had a minimal effect.⁶⁸³ MHI also provided an update on the construction of its full-scale mockup, and investigation into other repair options, such as hydraulic

⁶⁷⁷ Exh. JX-1264, pp. 4-5.

⁶⁷⁸ Exh. JX-1457, p. 2.

⁶⁷⁹ Exh. JX-1271.

⁶⁸⁰ Exh. JX-1284.

⁶⁸¹ Exh. JX-1285.

⁶⁸² Exh. JX-1289; See also Exh. JX-1287.

⁶⁸³ Exh. JX-1289, p. 9.

expansion. MHI's presentations incorporated SCE's repair criteria as set forth by Mr. Avella.

575. The meeting notes by SCE of the 3 August 2012 Meeting, mentioned in ¶ 574 above, state the three criteria:

SCE SGR Team previously specified three success criteria for an acceptable restoration of the SONGS Unit 2 and Unit 3 Steam Generators:

- Must solve the Thermo-Hydraulic (T/H) problem to reliably operate;
- Must restore the plant to 100% Power for 40 Year life;
- Must restore tube plugging margin to original Design Specification.⁶⁸⁴

576. The notes further mention that none of the 27 modification options presented by MHI or other vendors would meet SCE's success criteria, and that MHI stated that the originally calculated VF "cannot be recovered with the existing tube bundle geometry." According to the notes, SCE believed that MHI could only "improve" but not "resolve" the T/H issues completely. SCE's identified take away was that "the only effective method to recover the design parameters (identified to date) is to reconfigure the tube bundle." In SCE's view, the only way to do so was by a "replacement of the bundle or entire steam generator."

⁶⁸⁴ Exh. JX-1289, p. 1; See also Exh. JX-1287, p. 1.

577. On 5 August 2012, B&W wrote to MHI to provide its answers regarding testing,⁶⁸⁵ that could be performed at the AECL Chalk River testing facilities in Canada.⁶⁸⁶ B&W mentioned that the full set of tests would be a multi-year endeavor and questioned whether such was necessary. B&W also stated that it did not consider a number of the proposed tests necessary to validate the repair. B&W proposed that an air-water test be performed to verify a proposed thicker AVB repair.⁶⁸⁷ On 9-10 August 2012, SCE, MHI, B&W and Professor Pettigrew, of the École Polytechnique of Université de Montréal, attended a meeting at the Chalk River testing facility to develop testing to verify repair approaches at SONGS.⁶⁸⁸
578. On 10 August 2012, MHI produced Revision 6 of its Technical Evaluation Report into tube wear at Unit 3.⁶⁸⁹
579. In a 15 August 2012 internal MHI email, MHI's [REDACTED] opined that Mr. Avella, of SCE, had made up his mind to pursue a replacement strategy, not repair strategy.⁶⁹⁰
580. During a 17 August 2012 Steam Generator Replacement Team meeting, it became apparent that MHI's preferred repair approach was a combination of thicker AVBs and a 30 degree AVB insertion.⁶⁹¹ This corresponds to the Type 1 Repair depicted above.⁶⁹² For that meeting, Mr. Avella, of SCE, prepared a set of decision maps for

⁶⁸⁵ The testing at Chalk River was to determine if MHI's proposed repair would work.

⁶⁸⁶ Exh. JX-1303, p. 11 (AECL is the Atomic Energy of Canada Limited, a federal Crown corporation, and is Canada's largest nuclear science and technology laboratory. AECL operates Chalk River, a nuclear research facility located in Deep River, Ontario, Canada).

⁶⁸⁷ Exh. JX-1303, p. 13.

⁶⁸⁸ Exh. JX-1303, pp. 2-7.

⁶⁸⁹ Exh. JX-1300.

⁶⁹⁰ Exh. JX-1305.

⁶⁹¹ Exh. JX-1309; Transcript, pp. 2795, 2809.

⁶⁹² See ¶ 550 above.

the repair process. Internal MHI emails following that meeting report the perspective that SCE was frustrated with the speed of the proposed repairs, the duration of the outage, and the concern over the 23 weeks needed to perform the AECL testing.⁶⁹³

581. On 22 August 2012, MHI produced Revision 6 to its report on Screening Criteria for Susceptibility to In-Plane Motion.⁶⁹⁴

582. On 22 August 2012, AREVA provided its operational assessment for the restart of Unit 2, concluding that it could be restarted safely at reduced power.⁶⁹⁵

583. On 23 August 2012, in an internal MHI email, ██████████ wrote that:

MHI has an obligation to provide a repair recommendation, a detailed repair plan including a validation, and a plan to implement the repair. It has been 23 weeks since both SONGS units have been shut down and we do not have a repair recommendation, repair plan, or an agreement with an American subcontractor to implement the repair. The repair plan, validation, implementation all require an American partner.⁶⁹⁶

584. During the Hearing, ██████████ of MHI, who was cc'd on this email, testified that ██████████ had copied this language from Mr. Avella,⁶⁹⁷ although admitted there was no indication that ██████████ disagreed with it.⁶⁹⁸ In a prior internal email of 21 August 2012, ██████████ provided the same above statement while prefacing it with “here is latest SCE position.”⁶⁹⁹ In this email, ██████████ also expressed his view that SCE’s focus on replacement was not to be taken seriously and should be only

⁶⁹³ Exh. JX-1312.

⁶⁹⁴ Exh. JX-1314.

⁶⁹⁵ Exh. JX-1315.

⁶⁹⁶ Exh. JX-1319, p. 1.

⁶⁹⁷ Transcript, p. 2489.

⁶⁹⁸ Transcript, p. 2550.

⁶⁹⁹ Exh. JX-1320.

considered as back-up in case the repair efforts failed and that MHI would never agree to pay for the replacement of the RSGs.⁷⁰⁰

585. On 28 August 2012, Westinghouse, at the request of SCE, completed its report on FIV (flow induced vibration) and tube wear analysis of the RSGs and another on a potential restart of Unit 2.⁷⁰¹ Westinghouse concluded that the tubes were stable, in both in-plane and out-of-plane directions, if all supports were active.⁷⁰² Westinghouse further found that a single tube had a SR equal to 1.0 with one inactive support but there was no indication of instability in either the in-plane or out-of-plane direction.⁷⁰³ Westinghouse reported that out-of-plane instability would occur only with two missing supports and, in in-plane instability, with four missing supports.
586. Westinghouse concluded that two tubes with tube-to-tube wear in Unit 2 did not experience in-plane FEI and that its analysis found that “significant tube-to-tube wear would not be projected to occur during the next cycle of operation of Unit 2” at a reduced 70% power.⁷⁰⁴ Westinghouse further provided that “the potential for in-plane instability to develop over the next cycle of operation is not considered credible for several reasons” and that “the potential for any wear to begin to develop at currently effective AVBs is considered to be negligible.”⁷⁰⁵
587. Regarding the causes of the wear, Westinghouse concluded that “tube/AVB wear that could approach plugging margins within one operation cycle is caused by

⁷⁰⁰ Exh. JX-1320.

⁷⁰¹ Exh. JX-1322.

⁷⁰² Exh. JX-1322, p. 115.

⁷⁰³ Exh. JX-1322, p. 115.

⁷⁰⁴ Exh. JX-1322, p. 136.

⁷⁰⁵ Exh. JX-1322, p. 380.

amplitude limited fluid elastic tube excitation within larger than expected clearances.”⁷⁰⁶

588. Mr. Langford, one of the authors of the two Westinghouse reports, testified during the Hearing that the analysis into Unit 3 found AVB symmetry variations,⁷⁰⁷ and that there were tubes with up to 12 unsupported⁷⁰⁸ AVBs in the in-plane direction (compared to five to eight in the Unit 2 RSGs).⁷⁰⁹
589. During a 29 August 2012 meeting of the SGRT, MHI confirmed that NRC will be in Kobe in September and October 2012 to review AVB insertion techniques. MHI noted that SCE had not reviewed nor approved any facet of the proposed mockup, which is an initiative of MHI, and that MHI will inform NRC about this. MHI also noted that SCE would not formally review a mockup procedure without a full plan.⁷¹⁰
590. On 29 August 2012, MHI wrote to Mr. Avella, of SCE, regarding the SGR Decision Maps:⁷¹¹

Further to our Weekly Status Meeting on August 24, 2012 this is to confirm that MNES is agreeable to using the SGR Decision Maps as a basis for technical and project planning purposes in connection with the development of a mutually acceptable steam generator repair plan. We understand that neither party has committed to a repair plan at this point. We also understand the SGR Decision Maps do not constitute a binding obligation and shall not be construed to amend or modify either party’s

⁷⁰⁶ Exh. JX-1322, p. 384.

⁷⁰⁷ Exh. JX-1322, p. 428

⁷⁰⁸ The more consecutive inactive supports along a tube the greater that tubes’ chances of suffering from in-plane FEI. It appears that more that six-eight unsupported points are required for in-plane FEI to occur.

⁷⁰⁹ Transcript, p. 1742.

⁷¹⁰ Exh. JX-1330 ; See also Exh. JX-1328.

⁷¹¹ Decision maps are a project management tool to assist in evaluating the possibilities and outcomes of the project. MHI appears to have been concerned regarding agreeing to decision maps that only addressed technical concerns rather than technical concerns in combination with other concerns, such as timeframes.

obligations under the SONGS Replacement Steam Generator Purchase Order.⁷¹²

591. On 30 August 2012, MHI released Revision 7 of its Technical Evaluation Report on the tube wear of Unit 3.⁷¹³

(f) September 2012

592. In his September 2012 report to the Board of Directors of EIX, the parent company of SCE, Mr. Craver, the president of EIX, reported that a decision would soon be reached as to whether they should restart Unit 2.⁷¹⁴ Mr. Craver also reported that a decision on Unit 3 remained pending.

593. A 6 September 2012 Board presentation on the Unit 2 restart efforts identified that the three operational assessments had concluded that a restart at 70% power was safe, that independent challenges of these assessments also concluded that a restart was safe, and that while experts believed that there were physical differences between both Units, those experts had been unable to conclude those differences caused the greater wear in Unit 3.⁷¹⁵

594. In preparation of the 7 September 2012 SGRT meeting, MHI presented its findings regarding the wear mechanisms in Unit 2 and Unit 3.⁷¹⁶ MHI reported that tube-to-tube wear developed at VFs greater than 0.992⁷¹⁷ and that tube-to-AVB wear occurred at VFs greater than [REDACTED]⁷¹⁸ MHI identified that tube-to-AVB contact force

⁷¹² Exh. JX-1329.

⁷¹³ Exh. JX-1334.

⁷¹⁴ Exh. JX-1344.

⁷¹⁵ Exh. JX-1349.

⁷¹⁶ Exh. JX-1350.

⁷¹⁷ Exh. JX-1350, p. 23.

⁷¹⁸ Exh. JX-1350, p. 25.

“is approximately 4 times” greater in Unit 2 than Unit 3.⁷¹⁹ Regarding tube-to-AVB wear, MHI observed that this wear was on account of random vibration, and not out-of-plane FEI based upon visual inspection of the gaps, consistency with St. Lucie⁷²⁰ wear, and the consistency of the wear found with calculations of expected random wear.⁷²¹

595. MHI also found that the FEI wear in Unit 3 was there since the start of operations, rather than a phenomenon which had grown on account of loss of AVB support due to random vibration based upon the wear patterns of the RSGs.⁷²²
596. Another report presented to the SGRT compared the T/H conditions, using ATHOS, from the OSGs to the RSGs, finding that the OSGs had a VF of [REDACTED] compared to 0.996 for the RSGs, while steam quality differed more significantly.⁷²³
597. In an internal MHI email of 7 July 2012, one of MHI’s senior engineers in the repair efforts wrote to [REDACTED] of MHI, providing his opinion on “the list of ideas related to SONGS repairs” that “if the T/H and velocity are not 100% improved, then no matter how much is done to the AVB, it would simply be treating the symptoms.”⁷²⁴ The engineer also opined that it was not possible to drastically improve T/H conditions as those are set by the overall design of the RSGs. Regarding next steps, he opined that the only way to achieve 100% power output for the RSGs would be a replacement option.⁷²⁵

⁷¹⁹ Exh. JX-1350, p. 28.

⁷²⁰ St. Lucie is a nuclear power plant located on Hutchinson Island, near Port St. Lucie, Florida.

⁷²¹ Exh. JX-1350, p. 33.

⁷²² Exh. JX-1350, p. 40.

⁷²³ Exh. JX-1350, p. 45 (For ATHOS, see ¶ 250 above).

⁷²⁴ Exh. JX-1351, p. 6.

⁷²⁵ Exh. JX-1351, p. 6.

598. On 10 September 2012, MHI commenced a mockup test for the insertion of thicker AVBs and measuring of contact forces in Kobe. The test was to be completed for 19 October 2012.⁷²⁶
599. On 14 September 2012, MHI produced Revision 8 of its Technical Evaluation Report on tube wear in Unit 3.⁷²⁷
600. Also on 14 September, MHI produced Revision 1 to its “Evaluation of the stability ratio of out-of-plane fluid elastic instability” report.⁷²⁸
601. Additionally, on 14 September, MHI completed on that date Revision 2 of a report titled “Analytical Evaluations for Operational Assessment.”⁷²⁹
602. During a 19 September 2012 SGRT meeting, MHI notified SCE that they were pushing back their proposed repair recommendation from 31 October to 30 November to allow for an assessment of the mockup and final calculations.⁷³⁰
603. In an internal MHI email of 20 September 2012, ██████████ of MHI, expressed his view that SCE was no longer interested in a repair effort and preferred a replacement effort for various reasons, including the license renewal process and public opposition.⁷³¹ ██████████ also opined that SCE, however, was not trying to influence or pressure MHI into a replacement.⁷³²
604. During a 21 September 2012 meeting of the SGRT, MHI reported that it was further reducing the number of possible repair options and looking to provide a single repair

⁷²⁶ Exh. JX-1360, p. 11.

⁷²⁷ Exh. JX-1366.

⁷²⁸ Exh. JX-1367.

⁷²⁹ Exh. JX-1368.

⁷³⁰ Exh. JX-1376; See also Exh. JX-1378.

⁷³¹ Exh. JX-1381.

⁷³² Exh. JX-1381.

recommendation for the end of November 2012. SCE and MHI also discussed what the “acceptance criteria” of a repair were, with SCE’s position that it was SCE’s role to identify the performance criteria (being “resolve T/H, Restore Tube plugging margin, return to post SGR 100% power, be able to operate for 40 years, and be able to obtain NRC approval”) and that it was MHI’s role to develop the recommendation to meet these criteria.⁷³³ MHI’s notes from that meeting reflect a discussion regarding a need to provide a basis for MHI’s recommendations and further testing.⁷³⁴ MHI’s notes also reflect a discussion about the verification of MHI’s software codes, SSPC, IVHET, FIVATS, and ABAQUS.⁷³⁵

605. On 24-25 September 2012, the NRC visited MHI shipyard in Kobe and R&D center in Takasago.⁷³⁶ MHI presented its proposed repair options: (i) thicker AVB insertion; (ii) 30 degree AVB insertion; or (iii) comb type AVB insertion.⁷³⁷ MHI also demonstrated the technique of inserting a thicker AVB at the mockup.
606. On 24 September 2012, Mr. Avella and Mr. Moran of SCE met with [REDACTED] and [REDACTED] of MHI and discussed the modalities for reaching an agreement on a type 3 replacement option.⁷³⁸
607. On 25 September 2012, Intertek⁷³⁹ and AREVA⁷⁴⁰ completed their operational assessment reports, concluding that Unit 2 could be safely restarted at reduced power.

⁷³³ Exh. JX-1382.

⁷³⁴ Exh. JX-1387; See also Transcript, pp. 2665-2666.

⁷³⁵ Exh. JX-1387, p. 3 (For those codes, see Section VII.D(c) above).

⁷³⁶ See Exh. JX-1389.

⁷³⁷ The comb AVB option was later abandoned by MHI (See ¶ 627 below).

⁷³⁸ Exh. JX-1390 (For type 3 repair, see ¶ 550 above).

⁷³⁹ Exh. JX-1342 (Intertek were consultants hired by SCE to assist with the Unit 2 restart).

⁷⁴⁰ Exh. JX-1393.

608. On 26 September 2012, MHI presented its answers to a number of SCE questions concerning its conclusions regarding the wear mechanisms in Unit 2 and Unit 3.⁷⁴¹
609. On 27 September 2012, MHI issued Revision 3 of its report on the validity of the use of FIT-III results during the design of the SONGS RSGs.⁷⁴² MHI also issued Revision 9 to its Technical Evaluation Report on tube wear in Unit 3.⁷⁴³
610. During a 28 September 2012 meeting, MHI presented to SCE on various technical options for a replacement RSG.⁷⁴⁴

(g) October 2012

611. On 2 October 2012, Westinghouse completed Revision 4 of its Operational Assessment for the restart of Unit 2.⁷⁴⁵ It concluded that the steam generator performance criteria⁷⁴⁶ will be satisfied during the planned operating period of five months at 70% power.
612. On 3 October 2012, SCE submitted its CAL (Confirmatory Action Letter) response to the NRC.⁷⁴⁷ SCE's restart plan and justification of its safe operations consisted of over 1100 pages:
- CAL Action Item 1 called for SCE to identify the cause of the wear in Unit 3. SCE's response identified the cause as "tube-to-tube interaction" that occurred in both Unit 3 RSGs and occurred "in a single pair of tubes" in one of the Unit

⁷⁴¹ Exh. JX-1395.

⁷⁴² Exh. JX-1398.

⁷⁴³ Exh. JX-1408.

⁷⁴⁴ Exh. JX-1399.

⁷⁴⁵ Exh. JX-1407.

⁷⁴⁶ These criteria are established in the Steam Generator Program Guidelines (See Exh. JX-947, pp. 7, 8).

⁷⁴⁷ Exh. JX-1420 (For the CAL, see ¶ 461 above).

2 RSGs.⁷⁴⁸ SCE identified “the cause of the tube-to-tube wear in Unit 3 SGs [as] fluid elastic instability (FEI), resulting from the combination of localized high steam velocity, high steam VF, and insufficient contact force between the tubes and the anti-vibration bars.”⁷⁴⁹

- CAL Action Item 2 called for SCE to provide the result of its assessment of Unit 2 and the basis for its conclusions that Unit 2 could be operated safely. In response, SCE identified that the wear of the two tubes in Unit 2 with tube-to-tube wear was less pronounced than in Unit 3 and that the lower level of tube-to-tube wear in Unit 2 was attributed to “manufacturing differences that result in greater contact between the tubes and AVBs in Unit 2, providing greater tube support.”⁷⁵⁰ To prove the safety of a Unit 2 restart, SCE undertook to operate Unit 2 at 70% power, for a period of no more than 150 days, plugged the two tubes in Unit 2 suffering from tube-to-tube wear, and preventatively plugged tubes in the at risk area for in-plane FEI.⁷⁵¹ Justifying this approach, SCE submitted three independent operational assessments, from Intertek/APTECH, AREVA, and Westinghouse.

613. In a 5 October 2012 internal MHI email, Mr. Chris Kudla, a consultant for MHI, expressed his dissatisfaction with regard to a perceived lack of focus by MHI on replacement efforts, which appeared to be SCE’s preference.⁷⁵² During the Hearing, counsel for SCE inquired with MHI’s [REDACTED] about apparent internal

⁷⁴⁸ Exh. JX-1420, p. 2.

⁷⁴⁹ Exh. JX-1420, p. 2.

⁷⁵⁰ Exh. JX-1420, p. 3.

⁷⁵¹ Exh. JX-1420, pp. 3-4.

⁷⁵² Exh. JX-1410.

disagreements at MHI regarding the repair process.⁷⁵³ As raised during the Hearing, Mr. Kudla's engagement with MHI was terminated for 31 October 2012.⁷⁵⁴

614. During a 11 October 2012 meeting, MHI presented the then current high-level status of its repair efforts.⁷⁵⁵ MHI's notes of that meeting identify that SCE raised concerns over political, regulatory and public objections to SONGS.⁷⁵⁶ In particular, SCE raised the possibility that the NRC would require a license amendment request for the Unit 2 restart, that the CPUC would require that SCE pursue cost recovery litigation against MHI, and that the license extension application period⁷⁵⁷ was approaching. SCE emphasized that a repair solution must be one which "will never cause a problem" and that it was important to have high level CEO meetings regarding steps forward.⁷⁵⁸
615. During the period 9-17 October 2012, the NRC conducted another site visit inspection to MHI's facilities in Kobe. While SCE did not actively participate in the inspection, they did send observers.
616. On 16 October 2012, the SCE Internal Nuclear Management Group ("INMG") met.⁷⁵⁹ They evaluated the options available for Unit 2 following the initial run cycle, which appears to be the four repair/replacement options under consideration for Unit 3 as identified at ¶ 550 above.⁷⁶⁰ The INMG also reviewed a ranking of the four

⁷⁵³ Transcript, p. 2717 [REDACTED]

⁷⁵⁴ Exh. JX-1485; See Transcript, pp. 2672-2680; 2702-2715 [REDACTED] While the Respondents suggest this termination was on account of Mr. Kudla's services not being required, the Claimants' questioning, during the Hearing, suggested that Mr. Kudla may have been terminated for questioning the adequacy of MHI's repair.

⁷⁵⁵ Exh. JX-1438; See also Transcript, p. 2143 (Mr. Dietrich).

⁷⁵⁶ Exh. JX-1442.

⁷⁵⁷ It would take a number of years to obtain a license renewal for SONGS.

⁷⁵⁸ Exh. JX-1442, p. 2.

⁷⁵⁹ Exh. JX-1453.

⁷⁶⁰ Exh. JX-1453, pp. 6-11.

repair/replacement options, which identified the replacement options as preferable to the repair options according to SCE’s four evaluation criteria:⁷⁶¹

POTENTIAL IMPROVEMENT BASED ON TYPE					
TYPE	Description	FEI*	POWER*	LIFE*	PLUGGING*
1	AVB repairs performed in existing SG with entry through the existing manways and steam deck hatches	3	1	0	0
2	AVB repair performed by sever of Main Steam line, steam dome cut and removal for access	3	1	0	0
3	Replace lower portion of the Steam Generator with exception of steam dome. Steam Domes may require rework	5	5	5	5
4	Replace SG’s similar project scope as the SGR project 2009-2011	5	5	5	5

*Note: Ranking of the potential success of each of the Modification “Type’s” for resolution of the four major success criteria is based on a scale of 1 (lowest potential to resolve) to 5 (highest potential to resolve)

617. The INMG also identified that of the four options, the Type 1 Repair could be completed the quickest, for 2013-2014 at an estimated cost of \$110 million while the other options would take longer and be more expensive, with the Type 4 repair taking until 2017 at a cost of \$410 million.⁷⁶²

618. Also on 16 October 2012, the INMG considered the strategic and financial side of the options available.⁷⁶³ The INMG reviewed the various regulatory risks, costs, and

⁷⁶¹ Exh. JX-1453, pp. 10-11.

⁷⁶² Exh. JX-1453, p. 6.

⁷⁶³ Exh. JX-1456.

uncertainties associated with various restart, replacement and shutdown options for both Units.

619. Around 17 October 2012, the NRC completed its site inspection of MHI's facilities and the repair mockup in Kobe.⁷⁶⁴ In addition to MHI's admitted Gap Velocity Error,⁷⁶⁵ the NRC identified two apparent findings, (i) a potential non-conformance in the contractual design specifications and the requirements of 10 CFR 50 and (ii) a potential non-compliance with Appendix B of 10 CFR 50 in the use of parts from a supplier that had not met the commercial grade dedication requirements.⁷⁶⁶
620. For the 22 October 2012 SGRT meeting, MHI presented an overview of its proposed analytical methods for evaluating the repairs to SONGS.⁷⁶⁷
621. A 22 October 2012 INMG meeting further reviewed the strategic considerations of the options at SONGS, noting that the financial benefits of a Unit 2 restart at 70% power were minimal, and that the costs for Unit 3 were significant, absent a compensation payment for Unit 3.⁷⁶⁸ The INMG considered that a Unit 2 restart at 70%, with the option of moving to 100%, and a shutdown of Unit 3 as one of the least worse options available.⁷⁶⁹
622. A 25 October 2012 presentation to the Board of Directors of EIX lists the strategic options and constraints facing SONGS, including approximately \$100 million a

⁷⁶⁴ Exh. JX-1460.

⁷⁶⁵ For the Gap Velocity Error, see ¶ 233 *et seq.* above

⁷⁶⁶ Exh. JX-1460, p. 1.

⁷⁶⁷ Exh. JX-1468.

⁷⁶⁸ Exh. JX-1470.

⁷⁶⁹ Exh. JX-1470, p. 31.

month in costs, including replacement power and the importance of receiving NRC authorization to restart Unit 2.⁷⁷⁰

(h) November 2012

623. An SGRT meeting was held on 1 November 2012.⁷⁷¹ MHI's internal reports following this meeting identified that SCE required adjustments to the T/H conditions to bring the plant within industry experience and as a means of controlling wear.⁷⁷² MHI's internal reports also reflected concern over whether a thicker AVB repair could last for the required 40-year life cycle of the RSG.⁷⁷³
624. During the SGRT meeting of 6 November 2012, MHI presented a video of its mockup efforts, which, according to the minutes, showed some challenges in insertion, and specified that it would be making a repair recommendation for the end of November 2012.⁷⁷⁴ MHI's internal notes reflect concerns expressed by Mr. Avella that MHI was not sufficiently focused on the replacement options.⁷⁷⁵
625. On 8 November 2012, Mr. Avella formally provided MHI with SCE's repair criteria, which had been informally provided in several meetings since 27 July 2012:
1. Resolution of thermal hydraulic conditions such that SONGS can operate at all power levels without undue tube vibration or unacceptable wear,
 2. Restoration of the design to ensure thermal capacity of each steam generator of at least 1729 MWt,
 3. Restoration of the full life of the steam generator components to forty years,

⁷⁷⁰ Exh. JX-1478; Exh. JX-1479.

⁷⁷¹ Exh. JX-1486.

⁷⁷² Exh. JX-1487.

⁷⁷³ Exh. JX-1489.

⁷⁷⁴ Exh. JX-1496.

⁷⁷⁵ Exh. JX-1497.

4. Restoration of the tube plugging margin to less than 8% at End of Life.⁷⁷⁶

626. Also on 8 November 2012, in a Memorandum and Order, the NRC rejected the 18 June 2012 request, mentioned in ¶ 559 above, by Friends of the Earth for a stay of a SONGS restart and a hearing request. However, the NRC also referred the question of whether the CAL process constituted a *de facto* license amendment for determination by the ASLB (Atomic Safety and Licensing Board)⁷⁷⁷ and questions regarding the SONGS replacement under 10 CFR 50.59 to the NRC executive director for operations for further consideration.⁷⁷⁸
627. During the 9 November 2012 SGRT meeting, MHI informed SCE that it had abandoned the comb AVB option due to insertion problems, that all mockup testing was complete, and that it was focused on the analysis of the tests.⁷⁷⁹
628. On 13 November 2012, Mr. Avella of SCE wrote to MHI stating that “SCE has requested a final proposal for a permanent repair by November 30, 2012.”⁷⁸⁰ In the same letter, SCE provided MHI with SCE’s repair evaluation criteria (detailed in the attachment to the letter), being: effectiveness in meeting warranty conditions, validation, implementation, and operational impacts. SCE stated that a number of criteria would be evaluated as “go/no go” criteria, with a no go assessment ruling out the repair as a permanent repair option, although indicating it may be re-assessed as a temporary repair.⁷⁸¹ Internal MHI correspondence upon receiving Mr. Avella’s conditions noted concerns with the evaluation matrix, including that some aspects

⁷⁷⁶ Exh. JX-1500.

⁷⁷⁷ For the ASLB, see ¶ 183 above.

⁷⁷⁸ Exh. JX-1501.

⁷⁷⁹ Exh. JX-1502.

⁷⁸⁰ Exh. JX-1504.

⁷⁸¹ Exh. JX-1504, p. 1.

related to replacement were not yet known and that cost and timing did not appear to be relevant criteria for an evaluation of options.⁷⁸²

629. A 14 November 2012 SONGS Strategic Review presentation again identified the regulatory and financial considerations at issue in deciding on restart, replacement and shutdown scenarios.⁷⁸³
630. During a 16 November 2012 SGRT meeting, MHI updated SCE regarding its testing of AVB repair options and stated that the thicker AVB insertion option remained its preferred option, having discounted a 30 degree option and the comb AVB option.⁷⁸⁴ SCE expressed concerns regarding insertion forces and damage to the tube bundle, and uncertainty in radiation dosage to workers. SCE also emphasized the fact that a repair implementation had not been practiced under the restrained conditions of an enclosed mockup.⁷⁸⁵
631. During a 19 November 2012 SGRT meeting, SCE reinforced its requirement that MHI present a “final option” to SCE by 30 November 2012 and that “repair means long term replacement for [SGRT]” and emphasized that this requirement had “not changed over the past three months.”⁷⁸⁶
632. During a 27 November 2012 SGRT meeting, MHI informed SCE that it had removed the “Type 2” repair option from consideration.⁷⁸⁷
633. On 28 November 2012, Mr. Dietrich (SCE) wrote to MHI indicating that the duration of the shutdown at SONGS had or was soon to reach the point that the California

⁷⁸² Exh. JX-1503.

⁷⁸³ Exh. JX-1509.

⁷⁸⁴ Exh. JX-1516.

⁷⁸⁵ Exh. JX-1516.

⁷⁸⁶ Exh. JX-1518.

⁷⁸⁷ Exh. JX-1527 (For Type 2 repair, see ¶ 550 above).

regulators would have to investigate the plant and that SCE would no longer be receiving payments from rate payers.⁷⁸⁸ SCE also expressed its view that:

Time of course has been and remains of the essence. We believe that the current absence of repairs is inconsistent with the contractual requirement to repair with dispatch.⁷⁸⁹

634. Mr. Dietrich requested that MHI provide a repair or replacement plan by 28 December 2012 that addressed SCE’s repair criteria.⁷⁹⁰
635. Prior to the 30 November 2012 SGRT meeting, MHI postponed the presentation of its final repair option pending SCE’s consent to a confidentiality agreement.⁷⁹¹
636. On 30 November 2012, the NRC provided MHI with an official Notice of Non-Conformance based upon its inspection in Kobe in October 2012, finding that MHI had failed to ensure conformity of a number of components and had failed to ensure commercial grade dedication⁷⁹² of a third-party supplier.⁷⁹³
637. Also on 30 November 2012, the NRC held public hearings, with SCE, regarding SONGS.⁷⁹⁴ At that meeting, Mr. Dietrich emphasized SCE’s prioritization of a “safety first” culture and conclusion that Unit 2 could be safely restarted.⁷⁹⁵ Additionally, Mr. Palmisano, of SCE, presented his view that while there was more wear than expected in Unit 2, that wear was manageable.⁷⁹⁶

⁷⁸⁸ Exh. JX-1531.

⁷⁸⁹ Exh. JX-1531, p. 2.

⁷⁹⁰ Exh. JX-1531, p. 2.

⁷⁹¹ Exh. JX-1537.

⁷⁹² For an explanation of commercial grade dedication, see ¶ 556 above.

⁷⁹³ Exh. JX-1536.

⁷⁹⁴ Exh. JX-1539.

⁷⁹⁵ Exh. JX-1539, p. 4.

⁷⁹⁶ Exh. JX-1539, p. 15; Transcript p. 1045.

(i) December 2012

638. On 4 December 2012, MHI produced Revision 9 of its report on the “Mockup Test Plan for the Verification of Repair Measures for Tube Vibration Issue.”⁷⁹⁷
639. During the 7 December 2012 SGRT meeting, MHI reported that it had completed its calculations on contact force and wear analysis.⁷⁹⁸
640. At the 13 December 2012 EIX Board of Directors meeting, the “SONGS Strategic Review” showed “Key Takeaways.”⁷⁹⁹ The first one provides:
- Current path is partial power operation of Unit 2 and shutdown of Unit 3. Resolves short term reliability issues, but highest cost to ratepayers
 - Repair not feasible. Given long lead times, replacement of steam generators is only a viable option if Mitsubishi Heavy Industries covers cost, license renewal is assured and partial operation occurs during fabrication.
641. On 14 December 2012, MHI provided SCE with a formal letter stating that both a thicker AVB in combination with changed operating parameters to address T/H conditions and steam generator replacement were viable repair options.⁸⁰⁰ MHI reported that implementing an AVB repair would take a year, not including any required regulatory review, and that a replacement SG would take five and a half years.⁸⁰¹ In addition, MHI provided a presentation with an evaluation of the proposed

⁷⁹⁷ Exh. JX-1546.

⁷⁹⁸ Exh. JX-1552.

⁷⁹⁹ Exh. JX-1557, p. 9.

⁸⁰⁰ Exh. JX-1559, p. 2; Exh. JX-1560, p. 3.

⁸⁰¹ Exh. JX-1559, p. 2; Exh. JX-1560, p. 3.

repair methods and a completed repair evaluation matrix,⁸⁰² as sent by SCE on 13 November 2012.⁸⁰³

642. During a 14 December 2012 SGRT meeting, at which the above submission of MHI was presented and discussed, SCE expressed its view that a “Type 1 Repair is not viable and adequate.”⁸⁰⁴ Based upon the screening criteria, SCE deemed the Type 1 Repair not adequate due to the “information provided” in that meeting, i.e., the risk of loose part generation and the need for special tools and techniques to implement the repair.⁸⁰⁵ SCE’s minutes also provide that “the complete screening has not been completed by SCE,” suggesting that it is possible that SCE may or may not have had additional concerns that were not raised at the meeting.⁸⁰⁶ SCE also requested that MHI revise its time estimates for a replacement to be closer to three years, which was, in its view, consistent with industry standards.⁸⁰⁷ Internal emails following this meeting reflect that SCE was dissatisfied in having received two repair options rather than a single repair option.⁸⁰⁸
643. On 19 December 2012, SCE’s Mr. Avella wrote to MHI to convey his dissatisfaction with the multiple repair options and requesting a final recommendation by 23 December 2012.⁸⁰⁹
644. Also on 19 December 2012, Mr. Dietrich wrote to MHI to advise of his dissatisfaction and his view that the lack of a repair plan was in violation of the RSG

⁸⁰² Exh. JX-1560, p. 76.

⁸⁰³ See ¶ 628 above.

⁸⁰⁴ Exh. JX-1561 (For Type 1 repair, see ¶ 550 above).

⁸⁰⁵ Exh. JX-1561, pp. 1-2.

⁸⁰⁶ Exh. JX-1561, pp. 1-2.

⁸⁰⁷ Exh. JX-1561, p. 2.

⁸⁰⁸ Exh. JX-1564.

⁸⁰⁹ Exh. JX-1565.

Contract's requirement for a repair "with due diligence and dispatch" and that the lack of specificity in a repair option did not meet MHI's contractual requirements.⁸¹⁰

645. On 20 December 2012, MHI responded to Mr. Avella's letter of 19 December, stating that while it believed its thicker AVB repair option was technically viable, as MHI had rejected that repair, given the need for a mutually agreed repair option, it was recommending a replacement option, subject to the negotiation of mutually acceptable terms and conditions.⁸¹¹
646. Also on 20 December 2012, MHI and SCE entered into a MOU in which MHI agreed to make a payment of \$45,361,816.94 by 26 December 2012 to cover SCE's expenses in the repair efforts, subject to both parties reservations of rights in this regard.⁸¹²
647. On 21 December 2012, MHI wrote to Mr. Avella, expressing the view that MHI was not required to submit a single repair option under the RSG Contract. MHI acknowledged that SCE was requesting a final single repair option, and was therefore proposing a Type 3 Replacement, subject to further negotiation of the terms and conditions thereof.⁸¹³
648. On 25 December 2012, MHI provided the NRC with a response to the Notice of Non-Conformance of 30 November 2012.⁸¹⁴
649. On 26 December 2012, the NRC issued a "Request for Additional Information" ("RAI") to SCE regarding its response to the CAL of 3 October 2012.⁸¹⁵

⁸¹⁰ Exh. JX-1566.

⁸¹¹ Exh. JX-1571.

⁸¹² Exh. JX-1572; Exh. JX-1574.

⁸¹³ Exh. JX-1579.

⁸¹⁴ Exh. JX-1584; Exh. JX-1588 (For the Notice of Non-Conformance, see ¶ 634 above).

⁸¹⁵ Exh. JX-1585 (For SCE's response, see ¶ 612 above).

650. Also on 26 December 2016, MHI produced Revision 10 to its Technical Evaluation Report of Unit 3 tube wear.⁸¹⁶
651. On 27 December 2016, MHI responded to Mr. Dietrich's letter of 28 November 2012,⁸¹⁷ agreeing that time was of the essence and stating that MHI was available for discussions to reach a formal agreement on the technical and commercial aspects of a Type 3 replacement option.⁸¹⁸ MHI annexed to its letter a description of its repair efforts.⁸¹⁹
652. On 28 December 2012, MHI produced Revision 11 of its Technical Evaluation Report of Unit 3 tube wear.⁸²⁰

(j) January 2013

653. During a 3 January 2013 SGRT meeting, MHI and SCE discussed preliminary aspects of a replacement, including the desire to have the design specifications developed by July 2013 in order to expedite the schedule.⁸²¹
654. On 8 January 2013, SCE's Mr. Dietrich wrote to MHI advising that the Type 3 repair option does not constitute a repair with "dispatch:"

An outage spanning at least seven years does not constitute a repair or replacement with "dispatch" and far exceeds any reasonable repair period that was contemplated in the contract. For these and other reasons, we believe it [is] clear that any contractual limitations on liability are no

⁸¹⁶ Exh. JX-1586.

⁸¹⁷ See ¶ 633 above.

⁸¹⁸ Exh. JX-1590.

⁸¹⁹ Exh. JX-1590, pp. 3-5.

⁸²⁰ Exh. JX-1591.

⁸²¹ Exh. JX-1608.

longer applicable. We will therefore be looking to Mitsubishi to make SCE and its customers whole for all resulting damages.⁸²²

655. Mr. Dietrich further stated that SCE was willing to move forward but that MHI must bear all costs associated with a replacement.⁸²³
656. On 8 January 2013, SCE provided the NRC with an answer to item 1 of the NRC's RAI of 26 December 2012.⁸²⁴ A day later, SCE provided answers to items 15 and 30 of the NRC's RAI.⁸²⁵ Subsequently, on 10 January 2013, SCE provided an answer to item 16 of the NRC's RAI.⁸²⁶
657. Also 10 January 2013, SCE wrote MHI to exercise what it claimed was a contractual right under Section 1.9.6 of the RSG Contract to inspect MHI's files with regard to the design of the RSGs.⁸²⁷
658. On 16 January 2013, SCE provided the NRC with an answer to RAI item 19⁸²⁸ and on 17 January 2013 to RAI items 10 and 17.⁸²⁹ On 18 January 2013, SCE provided an answer to RAI items 12 and 13.⁸³⁰
659. On 18 January 2013, MHI wrote to Mr. Avella of SCE to request technical dimensions required as part of the Type 3 replacement option.⁸³¹ Mr. Avella provided

⁸²² Exh. JX-1610, pp. 1-2; Exh. JX-1612, pp. 1-2.

⁸²³ Exh. JX-1610, p. 2; Exh. JX-1612, p. 2.

⁸²⁴ Exh. JX-1611.

⁸²⁵ Exh. JX-1613; Exh. JX-1614.

⁸²⁶ Exh. JX-1616.

⁸²⁷ Exh. JX-1617.

⁸²⁸ Exh. JX-1619.

⁸²⁹ Exh. JX-1621.

⁸³⁰ Exh. JX-1623; Exh. JX-1624.

⁸³¹ Exh. JX-1622.

a partial response on 21 January 2012, stating that further information was being requested from AREVA.⁸³²

660. On 21 January 2013, SCE provided the NRC answers to RAI items 11 and 28.⁸³³
661. On 22 January 2013, MHI responded to Mr. Dietrich's letter of 8 January 2013 (see ¶ 654 above), expressing its view that it was under no contractual requirement to provide a single repair option.⁸³⁴ According to MHI, SCE's Mr. Avella had rejected the repair option as one that had "not been field-proven" and was only "supported by calculations."⁸³⁵ It laid out its repair efforts, stating:

Accordingly, we were extremely surprised to receive your January 8 letter which criticizes our selection of a tube bundle replacement option as not being consistent with our obligation to act with dispatch. As described above, Mitsubishi and SCE had numerous meetings to discuss repair or replacement options as a remedy and at no time did SCE inform us that replacement does not constitute an acceptable remedy due to "lack of dispatch." In fact, during these meetings the SCE representatives clearly indicated a strong technical preference for replacement over repair as the basis for mutually agreeable remedy, recognizing that replacement would need much more time to implement than the repair option (on the order of 4 to 5 years).⁸³⁶

662. On 24-25 January 2013, SCE provided the NRC with answers to RAI item 5, 7, 9, 18 and 27.⁸³⁷

⁸³² Exh. JX-1627; Exh. JX-1628.

⁸³³ Exh. JX-1629; Exh. JX-1630.

⁸³⁴ Exh. JX-1632.

⁸³⁵ Exh. JX-1632, p. 1.

⁸³⁶ Exh. JX-1632, p. 3.

⁸³⁷ Exh. JX-1633; Exh. JX-1634; Exh. JX-1654.

663. On 25 January 2013, MHI responded to SCE's letter of 10 January 2013,⁸³⁸ in which SCE requested to audit MHI's documents, objecting that the documents so sought were not those contemplated by Section 1.9.6 of the RSG Contract, which, in its view, applied to accounting records only.⁸³⁹
664. On 29 January 2013, SCE provided an answer to item 14 of the NRC's RAI.⁸⁴⁰
665. On 30 January 2013, SCE submitted pleadings to the ASLB in regard to the NRC's referral of the Friends of the Earth petition alleging that a CAL constituted a *de facto* license amendment.⁸⁴¹ SCE's position was that a CAL did not constitute a *de facto* license amendment.⁸⁴²
666. On 31 January 2013, SCE provided the NRC an answer to RAI item 29.⁸⁴³
667. Also on 31 January 2013, MHI wrote to SCE, requesting that additional supporting documentation be provided to facilitate MHI's determination as to whether expenses incurred by SCE in regard to the repair efforts were properly chargeable to MHI.⁸⁴⁴ MHI challenged over \$5 million as not chargeable to its account and alleged that the remaining \$39 million of expenses had insufficient justification.⁸⁴⁵

(k) February 2013

668. In his February 2013 report to the Board of directors of EIX, the parent company of SCE, EIX's president Mr. Craver outlined the regulatory and strategic challenges

⁸³⁸ See ¶ 657 above.

⁸³⁹ Exh. JX-1635.

⁸⁴⁰ Exh. JX-1636.

⁸⁴¹ Exh. JX-1637; Exh JX-1639.

⁸⁴² Exh. JX-1637, pp. 15-52.

⁸⁴³ Exh. JX-1645.

⁸⁴⁴ Exh. JX-1649.

⁸⁴⁵ Exh. JX-1649, p. 2.

facing SONGS.⁸⁴⁶ Mr. Craver reported that the NRC was facing political pressure over the restart and that anti-nuclear groups were working to slow down the approval process. SCE's strategy was to get their CAL approved quickly through a confirmatory order or a no-significant hazards determination. SCE also faced uncertainty in its dealing with CPUC and getting a determination on the cost recovery framework.

669. On 4 February 2013, SCE provided the NRC answers to RAI items 6 and 8⁸⁴⁷ and on 6 February 2013 to RAI items 20, 21, 22, 23, 24, 26 and 31.⁸⁴⁸ A day later, SCE provided the NRC an answer to RAI item 25.⁸⁴⁹
670. In a 7 February 2013 presentation by SCE's Mr. Dietrich to the NRC, he explained that the Unit 3 FEI was on account of a combination of high velocities, high dryness and loose support and that Unit 2 did not suffer from in-plane FEI as it had better supports:⁸⁵⁰

⁸⁴⁶ Exh. JX-1650.

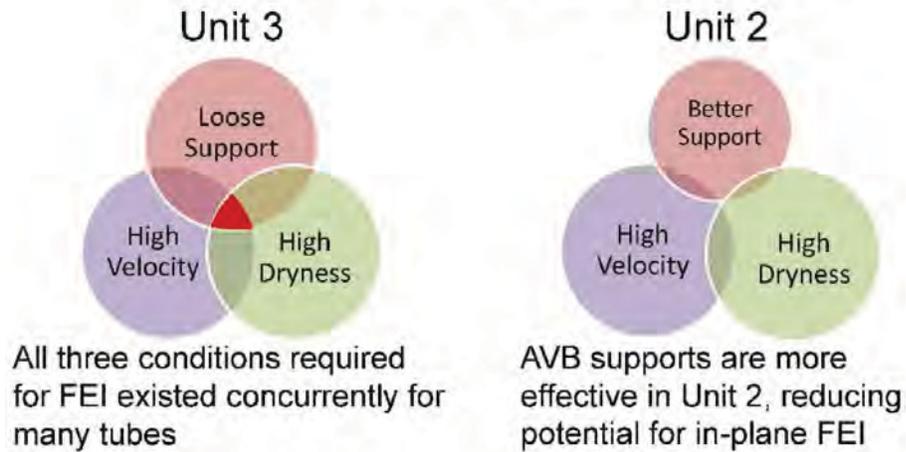
⁸⁴⁷ Exh. JX-1652; Exh. JX-1653.

⁸⁴⁸ Exh. JX-1655.

⁸⁴⁹ Exh. JX-1656.

⁸⁵⁰ Exh. JX-1657, p. 4; Transcript p. 2118 (Mr. Dietrich).

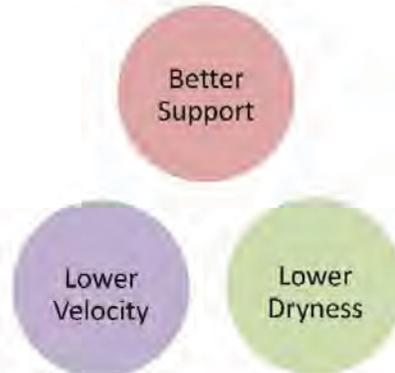
Contributors to In-plane Fluid Elastic Instability (FEI)



671. Mr. Dietrich's presentation also identified that a combination of better support, lower velocity, and lower dryness can preclude in-plane FEI.⁸⁵¹

⁸⁵¹ Exh. JX-1657, p. 8; Transcript p. 2172 (Mr. Dietrich).

In-plane FEI can be Precluded



Eliminating the concurrent combination of high velocities, high dryness and inadequate support can preclude FEI

672. During that NRC presentation, the NRC and the public also heard from NRC staff, representatives from EPRI, MHI, AREVA and Westinghouse as well as Professor Pettigrew, from the École Polytechnique of Université de Montréal, and an interest group opposed to the restart of SONGS.⁸⁵² AREVA's presentation identified that the wear in Unit 2 was manageable and that the Unit could be safely restarted at 70% power.⁸⁵³
673. On 11 February 2013, SCE's Mr. Dietrich responded to MHI's letter of 22 January 2013 and stated that SCE had never rejected MHI's Type 1 Repair option but, rather, that repair option failed to meet the repair criteria.⁸⁵⁴ Mr. Dietrich further stated that SCE was happy to again consider the Type 1 Repair option if that was what MHI

⁸⁵² Exh. JX-1659; Exh. JX-1662; Exh. JX-1664; Exh. JX-1665.

⁸⁵³ Exh. JX-1664, pp. 16-17.

⁸⁵⁴ Exh. JX-1666.

was recommending. Additionally, Mr. Dietrich invited MHI to reconsider its stance regarding SCE's contractual right to inspect documents.

674. On 21 February 2013, MHI responded to Mr. Dietrich's 11 February letter,⁸⁵⁵ expressing its view that the Type 1 Repair option was a technically viable repair, and that the replacement was recommended on account of SCE's insistence on a single repair option and on "numerous considerations beyond technical viability."⁸⁵⁶ MHI also emphasized the applicability of the parties' risk allocation bargain in the RSG Contract. It also stated that the document inspection rights claimed by SCE were not applicable.
675. Also on 21 February 2013, the NRC issued a further RAI.
676. On 25 February 2013, MHI formally provided the NRC with its Root Cause Analysis ("RCA") and its Supplemental Technical Evaluation Reports.⁸⁵⁷
677. Also on 25 February, SCE provided the NRC answers to RAI2 items 2, 3, 4 and 32.⁸⁵⁸ On 27 February, SCE submitted a complete answer to all of the NRC's RAI.⁸⁵⁹ This completed SCE's answers to all of the NRC's initial questions regarding the operational assessments supporting the restart of Unit 2 at 70% power.⁸⁶⁰

⁸⁵⁵ See ¶ 673 above.

⁸⁵⁶ Exh. JX-1672.

⁸⁵⁷ Exh. JX-1676 (MHI's Final Root Cause Analysis is dated 12 October 2012 (Exh. JX-1447)).

⁸⁵⁸ Exh. JX-1677; Exh. JX-1678.

⁸⁵⁹ Exh. JX-1681.

⁸⁶⁰ Exh. JX-1679.

(I) March 2013

678. On 5 March 2013, SCE's INMG (Internal Nuclear Management Group) met to discuss the financial situation of SONGS, including revenue and cost projections under various scenarios.⁸⁶¹
679. On 11 March 2013, MHI submitted to Mr. Avella of SCE a draft of its design for the Type 3 replacement option and stated that the final report was to be prepared for early May 2013.⁸⁶²
680. Also on 11 March 2013, MHI issued Revision 4 to its "Analytical Evaluations for Operational Assessment," incorporating changes suggested by SCE.⁸⁶³
681. On 14 March 2013, SCE submitted to the NRC an amendment to the operational assessment prepared by Intertek, consultants hired by SCE to assist with the Unit 2 restart.⁸⁶⁴
682. On 15 March 2013, SCE provided the NRC answers to RAI2 items 42 and 54.⁸⁶⁵
683. Also on 15 March 2013, SCE applied to the CPUC to have the costs of the steam generator replacements permanently included in its rate base.⁸⁶⁶

⁸⁶¹ Exh. JX-1694.

⁸⁶² Exh. JX-1697.

⁸⁶³ Exh. JX-1698.

⁸⁶⁴ Exh. JX-1703.

⁸⁶⁵ Exh. JX-1706; Exh. JX-1707.

⁸⁶⁶ Exh. JX-1708.

684. On 20 March 2013, SCE provided answers to RAI2 items 33-40, 41, 43, 44, 55-61 and 63-67.⁸⁶⁷ On 22 March 2013, SCE provided an updated answer to RAI item 18 and answers to RAI2 items 46-52.⁸⁶⁸
685. On 25 March 2013, SCE provided MHI with further supporting documentation and comment regarding its repair expenses.⁸⁶⁹
686. On 29 March 2013, SCE provided the NRC an answer to RAI2 item 62.⁸⁷⁰

(m) **April 2013**

687. On 1 April 2013, SCE provided the NRC answers to items 68-70 of the NRC's RAI ("RAI3").⁸⁷¹ On 2 April, SCE provided revised answers to items 11 and 13 of the NRC's Original RAI.⁸⁷²
688. On 4 April 2013, MHI issued Revision 0 of its "U-bend Repair Report," documenting its proposal for a Type 1 thicker AVB repair option.⁸⁷³ MHI communicated its report to SCE on 5 April 2013, advising its preference for arranging a presentation on its content.⁸⁷⁴
689. On 5 April 2013, SCE submitted a License Amendment Request ("LAR") to the NRC, proposing to add two footnotes to its operating license to restrict operation of

⁸⁶⁷ Exh. JX-1711; Exh. JX-1712; Exh. JX-1713; and Exh. JX-1714.

⁸⁶⁸ Exh. JX-1716; Exh. JX-1717; Exh. JX-1718.

⁸⁶⁹ Exh. JX-1719.

⁸⁷⁰ Exh. JX-1724.

⁸⁷¹ Exh. JX-1724.

⁸⁷² Exh. JX-1731; Exh. JX-1732.

⁸⁷³ Exh. JX-1734.

⁸⁷⁴ Exh. JX-1735.

Unit 2 to no more than 70% power,⁸⁷⁵ which it further supplemented on 9 April 2013.⁸⁷⁶

690. Also on 9 April 2013, Senator Barbara Boxer of California, Chairman of the Senate Committee on Environment and Public Works, and Mr. Edward Markey, ranking member of the House Natural Resources Committee, formally wrote to the Chairman of the NRC, demanding that the NRC not take any action that could lead to a restart at SONGS “before the [NRC] completes its comprehensive investigation and provides a full opportunity for public participation.”⁸⁷⁷
691. On 10 April 2013, SCE provided the NRC answers to RAI3 items 53 and 72.⁸⁷⁸ On 15 April 2013, SCE provided the NRC an answer to RAI2 item 45.⁸⁷⁹ On 16 April 2013, SCE provided the NRC an answer to RAI2 item 71.⁸⁸⁰
692. In his April 2013 report to the Board of EIX, the parent company of SCE, EIX’s president Mr. Craver reported that SCE had submitted to the NRC the LAR (License Amendment Request) for a restart of Unit 2.⁸⁸¹ The earliest date for a potential decision was late May 2013, which would permit a June 2013 restart. Mr. Craver noted that in order to get approval, SCE would need to ensure that all open RAIs had been addressed. Mr. Craver further reported that all the issues identified by the NRC to date had been non-substantive, although a recent substantive issue had been raised regarding circulation ratio calculations, which he hoped would be resolved shortly.⁸⁸² Mr. Craver expected that the NRC would close its CAL inspection in May 2013, at

⁸⁷⁵ Exh. JX-1736.

⁸⁷⁶ Exh. JX-1740.

⁸⁷⁷ Exh. JX-1739.

⁸⁷⁸ Exh. JX-1742.

⁸⁷⁹ Exh. JX-1745.

⁸⁸⁰ Exh. JX-1746.

⁸⁸¹ Exh. JX-1729, p. 3.

⁸⁸² Exh. JX-1729, p. 3.

which point he expected a “white finding” by the NRC, indicative of “low to moderate safety significance and an acceptable level of performance by the licensee, but outside the nominal risk range.”⁸⁸³ Mr. Craver also reported on significant headcount reductions at SONGS, with over 2,500 positions reduced.

693. On 25 April 2013, SCE provided MHI with its comments regarding the draft design report for the Type 3 repair option for Unit 3.⁸⁸⁴
694. On 26 April 2013, SCE wrote to MHI to narrow the list of documents it was requesting regarding the design of SONGS.⁸⁸⁵
695. On 26 April 2013, SCE informed the NRC that it would be submitting its report on seismic evaluation and potential modifications required to SONGS in the light of the Fukushima disaster by 31 January 2016.⁸⁸⁶
696. On 30 April 2013, the INMG met to discuss various cost and revenue forecasts for the various restart and shutdown options available at SONGS.⁸⁸⁷
697. On 30 April 2013, FTI Consulting, hired by MHI to review SCE’s repair costs submitted to MHI for reimbursement, completed its review of AREVA related expenses for the repair of SONGS, and identified various purported document deficiencies.⁸⁸⁸

⁸⁸³ Exh. JX-1729, p. 4.

⁸⁸⁴ Exh. JX-1748.

⁸⁸⁵ Exh. JX-1750.

⁸⁸⁶ Exh. JX-1751.

⁸⁸⁷ Exh. JX-1755.

⁸⁸⁸ Exh. JX-1757.

(n) May 2013

698. On 3 May 2013, MHI produced Revision 12 of its Technical Evaluation Report on tube wear in Unit 3.⁸⁸⁹
699. Also on 3 May 2013, AREVA, commissioned by SCE, presented its response to MHI's thicker AVB repair method, indicating its belief that MHI's proposed repair could be installed faster than MHI estimated, and raising a number of questions.⁸⁹⁰
700. On 6 May 2013, MHI responded to Mr. Dietrich's letter of 26 April 2013,⁸⁹¹ stating that the narrowed list of requested documents by MHI allegedly pursuant to the RSG Contract still fell outside of what was covered by the RSG Contract.⁸⁹²
701. On 7 May 2013, AECL (Atomic Energy of Canada Limited)⁸⁹³ produced the results of its research into damping and anti-vibration supports.⁸⁹⁴ While preliminary results had been shared with SCE during the research, the final report confirmed the finding that "there is little evidence of squeeze film damping" in regard to AVB support in the out-of-plane direction and "no discernable evidence" of squeeze film damping⁸⁹⁵ in the in-plane direction.⁸⁹⁶ AECL also reported that prior research into this area was not a priority given the expectation that in-plane FEI would not occur and an industry belief that the "primary damage mechanism was thought to be wear due to out-of-

⁸⁸⁹ Exh. JX-1759; Exh. JX-1760.

⁸⁹⁰ Exh. JX-1761.

⁸⁹¹ See ¶ 694 above.

⁸⁹² Exh. JX-1762.

⁸⁹³ For AECL, see n. 686 above.

⁸⁹⁴ Exh. JX-1766; Exh. JX-1767; Exh. JX-1768; Exh. JX-1769.

⁸⁹⁵ For "squeeze film damping," see ¶ 495 above.

⁸⁹⁶ Exh. JX-1766, p. 46.

plane FEI” and that “it was assumed that most of the supports would be effective in both directions.”⁸⁹⁷

702. On 8 May 2013, SCE provided MHI further support and explanation for its costs incurred in the repair efforts.⁸⁹⁸

703. On 13 May 2013, Mr. Dietrich of SCE responded to MHI’s 21 February 2013 letter,⁸⁹⁹ stating that MHI “has not provided sufficient documentation to SCE to establish that any of its proposed repair options [are] safe, effective, and would be approved by the [NRC] in a reasonable time as required by Section 1.17.1.3(c)” of the RSG Contract.⁹⁰⁰ Mr. Dietrich identified that the thicker AVB repair was insufficiently detailed and that MHI had not provided assurances that it could be implemented under 10 CFR 50.59. Mr. Dietrich further stated that “it is critically important to SCE that any proposed repair or replacement address the actual, expected thermal hydraulic conditions present in the RSGs when operating at full power.”⁹⁰¹

(i) *ASLB Panel Decision*

704. On 13 May 2013, by a Memorandum and Order, the NRC ASLB [i.e., Atomic Safety and Licensing Board]⁹⁰² Panel released a decision in response to the Friends of the Earth petition, which found that a Unit 2 restart at reduced power constituted an experiment and a *de facto* license amendment.⁹⁰³

⁸⁹⁷ Exh. JX-1766, p. 1-3.

⁸⁹⁸ Exh. JX-1770.

⁸⁹⁹ See ¶ 674 above.

⁹⁰⁰ Exh. JX-1776 (Section 1.17.1.3(c) is quoted at ¶ 203 above).

⁹⁰¹ Exh. JX-1776, p. 2.

⁹⁰² For the ASLB, see ¶ 183 above.

⁹⁰³ Exh. JX-1777.

705. The ASLB Panel ruling granted Friends of the Earth a hearing opportunity, by finding that the CAL process, although not the CAL itself, constituted a *de facto* licensed amendment for the following three independent reasons:
- (1) The restart of Unit 2 would grant SCE authority to operate without the ability to comply with all applicable technical specifications;
 - (2) The restart of Unit 2 would allow SCE to operate beyond the scope of its existing license; and
 - (3) SCE's Unit 2 Return to Service Plan includes a test or experiment that meets the criteria in 10 C.F.R. § 50.59 that require a license amendment.⁹⁰⁴
706. The ASLB Panel found that as the SONGS license allowed operation at 100% power, restricting operations to 70% power is a "deviation from a technical specification" that required a license amendment, "converting this CAL process to a *de facto* license amendment proceeding."⁹⁰⁵
707. Second, the ASLB Panel found that as "in-plane vibrations due to fluid elastic instability" was a new degradation mechanism not contemplated in the "Final Safety Analysis Report" ("FSAR") for the original SONGS steam generators, a restart would constitute a *de facto* license amendment.⁹⁰⁶
708. Third, the ASLB Panel reasoned that as in-plane FEI is a new degradation mechanism, there is no industry data on it, it would also be such that a restart constitutes a "test or experiment." The ASLB Panel therefore concluded that restart

⁹⁰⁴ Exh. JX-1777, p. 25.

⁹⁰⁵ Exh. JX-1777, p. 29.

⁹⁰⁶ Exh. JX-1777, pp. 32-33.

is “inconsistent with the analyses or descriptions” in the SONGS FSAR and it constitutes a *de facto* license amendment.⁹⁰⁷

709. Further, with respect to Unit 3, the ASLB Panel stated that “[t]he unprecedented extent of tube wear and failures that SCE experienced in the SONGS Unit 3 replacement steam generators reveal that these steam generators have serious design and operational issues [...] placing them beyond the envelope of experience with U-Tube steam generators.”⁹⁰⁸ With respect to Unit 2, the Panel stated that “after less than two years of operation (i.e., 20.6 months), tube integrity for Unit 2 steam generators can be guaranteed only for another eleven months of operation at 100% power.”⁹⁰⁹
710. The Panel concluded “that until the tube degradation mechanism is fully understood, until reasonable assurance of safe operation of the replacement steam generators is demonstrated, and until there has been a rigorous NRC staff review appropriate for a licensing action, the operation of Unit 2 would be outside the scope of its operating license because the replacement steam generator design must be considered to be inconsistent with the steam generator design specifications assumed in the FSAR and supporting analysis.”⁹¹⁰
711. In a footnote to its decision, the ASLB Panel states that as the tube-to-tube wear in Unit 3 “is far more extensive and severe than in Unit 2,” its conclusions “would per force apply to Unit 3 if SCE sought to restart it without a license amendment.”⁹¹¹

⁹⁰⁷ Exh. KX-1777, pp. 34-36.

⁹⁰⁸ Exh. JX-1777, p. 25.

⁹⁰⁹ Exh. JX-1777, p. 28.

⁹¹⁰ Exh. JX-1777, p. 32.

⁹¹¹ Exh. JX-1777, n. 29, p. 10.

712. In an internal SCE email from SCE’s consultant Mr. Merschhoff to Mr. Dietrich, Mr. Merschhoff characterized the decision as “surprising” and “hard to believe.”⁹¹²
713. The ASLB granted the requested relief sought, “the opportunity for an adjudicatory hearing incident to the license amendment proceedings for the restart of Units 2 and 3” for Friends of the Earth to comment open the restart of Unit 2.⁹¹³

(ii) Ongoing Design and Replacement Efforts

714. On 16 May 2013, MHI produced Revision 0 of its “Design Description Report of Tube Bundle Replacement for SONGS Unit 2 & 3.”⁹¹⁴
715. On 23 May 2013, MHI produced Revision 0 of its “U-bend Tube Damping Test for Comparison with AECL Test” Report.⁹¹⁵
716. Also on 23 May 2013, MHI produced Revision 0 of its “Evaluation of Stability Ratios Based on Alternative Methodology for Return to Service” Report.⁹¹⁶
717. On 24 May 2013, MHI produced Revision 7 of its “Evaluation of Stability Ratio for Return to Service” Report.⁹¹⁷

(iii) AREVA Report

718. On 24 May 2013, AREVA completed its independent review of MHI’s U-Bend Repair Report, as requested by SCE, which it undertook between 13 and 24 May

⁹¹² Exh. JX-1775.

⁹¹³ Exh. JX-1777, p. 38.

⁹¹⁴ Exh. JX-1783.

⁹¹⁵ Exh. JX-1787; Exh. JX-1788.

⁹¹⁶ Exh. JX-1790.

⁹¹⁷ Exh. JX-1793.

2013⁹¹⁸ (the “AREVA Report”). It submitted its Report to SCE, having added a footer to its Report, indicating its confidentiality, on 30 May 2013.⁹¹⁹

719. The lead report preparer of the AREVA Report is Mr. Donald Stewart, who is also an expert for MHI in this arbitration.

720. The Report’s summary states that:

The [U-Bend Repair] report displays strong evidence of intensive design, analysis and testing efforts by MHI. The Independent Review however concludes the subject thick-AVB repair requires further substantiation in several discipline areas before it can be installed and operated with confidence, and as such is not sufficient as a repair plan to implement as presented. The primary concerns are about long term operability.⁹²⁰

721. In particular, AREVA reported concern regarding “secondary effects which are deemed not sufficiently analyzed” [REDACTED]

722. AREVA concluded that “it is feasible to implement the thick AVB repair design concept” presented by MHI. AREVA also noted that “the proposed hardware concept, prototype tooling, and installation method outline describe a technically sound method” although “qualification tests” were required.⁹²²

723. Regarding licensing, AREVA concluded that the proposed repair did not “fit well in 10 CFR 50.59” and would therefore require a LAR and a “no significant hazards

⁹¹⁸ Exh. JX-1792.

⁹¹⁹ Exh. JX-1797.

⁹²⁰ Exh. JX-1797, p. 4.

⁹²¹ Exh. JX-1797, p. 4.

⁹²² Exh. JX-1797, p. 5.

analysis.”⁹²³ To do so, AREVA recommended installing instrumentation to verify tube movement during operation and/or an operation at 70% power but also noted that there was “potentially” a risk of a unanalyzed failure, [REDACTED]

[REDACTED].”⁹²⁴

724. In total, AREVA identified approximately 100 items, of varying degrees of concern, that it thought required answering including addressing both aspects of technological viability and implementation feasibility.
725. On 4 June 2013, AREVA provided a budget proposal to MHI in order to undertake the necessary work to further develop the thicker AVB repair effort.⁹²⁵

(o) The June 2013 Shutdown Decision

726. On 7 June 2013, SCE issued a press release announcing its decision to permanently retire SONGS.⁹²⁶ It gave as reasons “the continuing uncertainty about when or if SONGS might return to service.” It noted that the “recent ruling by an adjudicatory arm of the NRC, the [ASLB], creates further uncertainty regarding when a final decision might be made on restarting Unit 2,” and that “[a]dditional administrative processes and appeals could result in delay of more than a year.”⁹²⁷ It finally noted that “SCE intends to pursue recovery of damages from Mitsubishi Heavy Industries, the supplier of the replacement steam generators, as well as recovery of amounts under applicable insurance policies.”⁹²⁸

⁹²³ Exh. JX-1797, p. 6.

⁹²⁴ Exh. JX-1797, pp. 6-7.

⁹²⁵ Exh. JX-1809.

⁹²⁶ Exh. JX-1815.

⁹²⁷ Exh. JX-1815, p. 2.

⁹²⁸ Exh. JX-1815, p. 3.

727. In Mr. Craver's June 2013 report to the Board of EIX, the parent company of SCE, he reported on the decision to shut down SONGS. He also mentioned that SCE would be pursuing a rapid decommissioning strategy and that the decommissioning fund was 90% funded.⁹²⁹

728. Mr. Craver's justification for his decision to recommend a closure of SONGS was evidenced in his witness statements and examination at the Hearing. In his witness statement, Mr. Craver testified that:

By the beginning of June 2013 – after 16 months of being unable to operate SONGS due to Mitsubishi's defective RSGs – we could no longer spend more than \$2 million a day in hopes of someday being able to run SONGS again. We ultimately determined that we had to permanently retire SONGS for a number of reasons, including (a) the diminishing likelihood of being able to restore Unit 2 to partial service within a definite and reasonable period of time while awaiting a permanent repair or replacement, (b) the lack of definitive plans and analyses for a permanent repair or replacement of the defective RSGs, (c) economic analysis of how long the Units could be out of operation before foreclosing any economic benefit for the SONGS Owners and their customers; and (d) our need to focus on grid reliability for our customers.⁹³⁰

729. Mr. Craver's opinion was re-affirmed at the hearing, where he highlighted his decision to shut down was motivated by the significant daily cost of maintaining SONGS and the considerable uncertainty as to whether a restart was achievable.⁹³¹

730. In the same light, SCE's Mr. Dietrich's explanation of the reasons behind the decision to shut down, in his witness statement, was that after spending "countless hours discussing possible paths forward in hopes that (...) the continually mounting

⁹²⁹ Exh. JX-1804.

⁹³⁰ Witness Statement of Mr. Craver, ¶ 80.

⁹³¹ Transcript, pp. 2299-2300 (Mr. Craver).

technical, regulatory, economic, political challenges facing SONGS”⁹³² would be overcome:

By June 2013, we could no longer foresee when or if either Unit of SONGS would return to service at any power level or for any time duration. The ASLB decision had compounded the uncertainty (and likely length) of the timeline for NRC consideration of restart, and technical questions surrounding the AREVA OA in support of the CAL Response persisted. As a result, we could not predict with confidence when we would receive a final answer on whether we could restart Unit 2 at partial power on an interim basis.⁹³³

Furthermore, 16 months had passed since the leak, but Mitsubishi still had not presented a viable repair proposal (...) ⁹³⁴

Meanwhile, time was running out on the SONGS operating license, which was set to expire in 2022. In order to continuously operate SONGS past 2022, we would have needed to apply for a license renewal by 2017 and start preparing our license renewal application years earlier. If the RSG tube bundles or entire RSGs needed to be completely redesigned and replaced, the best case for having SONGS up and running again was 2018.⁹³⁵

731. Mr. Dietrich mentioned that it was in these circumstances that the management agreed that it was no longer prudent to spend tens of millions of dollars per month in the diminishing hope that SONGS would be able to restart.⁹³⁶ In the Hearing, he reaffirmed that for these reasons, shutting down the SONGS “right business decision,”⁹³⁷ which, he characterized in his Rebuttal Witness Statement, as a “difficult but necessary” decision.⁹³⁸

⁹³² Witness Statement of Mr. Dietrich, ¶ 72.

⁹³³ Witness Statement of Mr. Dietrich, ¶ 73.

⁹³⁴ Witness Statement of Mr. Dietrich, ¶ 74.

⁹³⁵ Witness Statement of Mr. Dietrich, ¶ 75.

⁹³⁶ Witness Statement of Mr. Dietrich, ¶ 78.

⁹³⁷ Transcript, pp. 2166-2167 (Mr. Dietrich).

⁹³⁸ Rebuttal Witness Statement of Mr. Dietrich, ¶ V.

732. In this regard, highlighting how difficult but necessary the decision to shut down SONGS apparently was, Mr. Ratcliffe, in his Expert Opinion on behalf of the Claimants, observed that there was “a concerted, thorough effort to achieve a path forward for the continued operation of SONGS.”⁹³⁹ However, he stated that the decision to shut down SONGS was warranted, since:

[I]t was not justifiable for Edison to continue spending the sums on SONGS (both incurred and forecast) given the increasingly remote prospects of either Unit providing safe and reliable power in the future. In deciding whether to retire the Units, Mr. Craver properly considered:

- the diminishing likelihood of being able to restore Unit 2 to partial service within a definite and reasonable period of time while awaiting an effective repair or re-replacement;
- the lack of definitive plans and analyses for an effective repair or re-replacement of the defective RSGs;
- the increasing uncertainty associated of restoring even some portion of SONGS to service;
- the absence of any Mitsubishi plan to correct the design defects that caused the failures, to restore the Units to the contract-standards of safe and reliable operation and to demonstrate that the failures would not reoccur;
- economic analysis of alternatives; and
- SONGS’ need to focus on its responsibility to provide safe and reliable, predictable baseload power for its customers.⁹⁴⁰

733. Mr. Ratcliffe reaffirmed his position during the hearings,⁹⁴¹ and also agreed with Mr. Craver’s approach towards the decision to shut down SONGS, stating that “certainly

⁹³⁹ Rebuttal Expert Opinion Statement of Mr. Ratcliffe, ¶ 8.

⁹⁴⁰ Expert Opinion Statement of Mr. Ratcliffe, ¶ 31.

⁹⁴¹ Transcript, pp. 2205-2208 (Mr. Ratcliffe).

I would have done exactly what Mr. Craver did with regard to the INMG internally.”⁹⁴²

734. In line with Mr. Dietrich and Mr. Ratcliffe, Mr. Morris also testified, as an Expert on behalf of the Claimants, that “[t]he economic analysis prepared for the INMG in June 2013 demonstrated that even if Unit 3 was shut down immediately there would be no benefit to restarting Unit 2 if restart was delayed until November 2014. If Unit 3 was not permanently retired, there would be no benefit to restarting Unit 2 if it could not be restarted by March 2014.”⁹⁴³ In this connection, he expresses his “doubt that Unit 2 could be restarted, even at partial power for a shortened cycle of operation, for at least a year”; and even if it could the economic benefits would be “slim-to-no[ne] (...) in the absence of a long-term repair.”⁹⁴⁴ Further, in the hearings, he reaffirmed his position,⁹⁴⁵ and like Mr. Ratcliffe, also confirmed that Mr. Craver’s decision to shut down, stating that “Mr. Craver went through the same process that I would have gone through.”⁹⁴⁶
735. The economic viability of the Claimants’ decision to shut down SONGS was admitted by the Respondents’ expert, Mr. Robert Denton, as well. Particularly, he stated:

Edison’s decision to shut down and decommission the San Onofre Nuclear Generation Station (“SONGS”) made economic sense for many reasons completely unrelated to the Mitsubishi replacement steam generators (“RSGs”). SONGS’s operating and maintenance costs were greater than the market price for replacement capacity and power; SONGS’s status as [a] poor performing plant with a very large staff did not portend improvement in economics; and Edison faced uncertain but significant capital outlays to

⁹⁴² Transcript, p. 2206 (Mr. Ratcliffe).

⁹⁴³ Expert Statement of Mr. Morris, ¶ 35.

⁹⁴⁴ Expert Statement of Mr. Morris, ¶ 36.

⁹⁴⁵ Transcript, pp. 2256-2257 (Mr. Morris).

⁹⁴⁶ Transcript, p. 2257 (Mr. Morris).

address post-Fukushima seismic and flooding issues a[s] well as other state and federal regulatory requirements ...⁹⁴⁷

Based on my review of the documents provided to me by Mitsubishi's counsel (including the Navigant and Concentric reports as well as Edison's Metcalfe and Graves reports), a strong case existed in June of 2013 for Edison to consider permanently closing SONGS for reasons unrelated to the Unit 3 tube leak.⁹⁴⁸

736. Mr. Denton enumerated a number of other reasons that made the shutdown an economically sensible decision, such as the very large staff employed at SONGS,⁹⁴⁹ expensive regulatory requirements of gathering and reviewing of seismic data,⁹⁵⁰ conducting seismic and flooding risk studies,⁹⁵¹ and using best available technology to reduce impacts to coastal and marine life that could have required adding expensive cooling towers.⁹⁵² He reaffirmed his position during the hearings; specifically, by stating that he did not have any "basis to disagree with the economic rationale for Ted Craver's decision to shut down San Onofre on June 7, 2013."⁹⁵³

(p) Post-Shutdown Events

737. During the late May and June 2013 shutdown decision timeframe and in the months following, SCE and MHI continued to exchange various letters regarding (i) the adequacy of SCE's justification of repair expenses; (ii) whether the RSG Contract permitted SCE to review various design documents; and (iii) purporting to assign blame for the failure to develop an appropriate repair option.⁹⁵⁴

⁹⁴⁷ Expert Report of Mr. Denton, ¶ 8(b).

⁹⁴⁸ Expert Report of Mr. Denton, ¶ 16.

⁹⁴⁹ Expert Report of Mr. Denton, ¶ 17(a).

⁹⁵⁰ Expert Report of Mr. Denton, ¶ 17(c).

⁹⁵¹ Expert Report of Mr. Denton, ¶ 17(d).

⁹⁵² Expert Report of Mr. Denton, ¶ 17(e).

⁹⁵³ Transcript, pp. 2961, 2965 (Mr. Denton).

⁹⁵⁴ See Exh. JX-1780; Exh. JX-1807; Exh. JX-1813; Exh. JX-1814; Exh. JX-1820; Exh. JX-1821; Exh. JX-1824; Exh. JX-1835; Exh. JX-1842, etc.

738. On 20 September 2013, the NRC terminated its CAL process on account of the decision to retire SONGS.⁹⁵⁵ The NRC issued a “green finding”⁹⁵⁶ for Unit 2 and a “white finding”⁹⁵⁷ for Unit 3 in regard to its inspection. The NRC further noted that MHI’s FIT-III code was improperly used, resulting in the Gap Velocity Error. The NRC declared that this was an error, which was questioned during the design phase by consultants⁹⁵⁸ and SCE, and that, therefore it could have been avoided. The NRC found that this design error resulted in the severe degradation experienced at SONGS.
739. Also on 20 September 2013, the NRC provided a similar notification to MHI, requesting an answer to its finding within 30 days.⁹⁵⁹
740. On 16 October 2013, SCE submitted its notice of arbitration. The procedural history following the commencement of these proceedings is set forth in Section 0 above.
741. During the Hearing, the Tribunal inquired with the Parties whether SCE ever formally terminated the RSG Contract in 2013 or any point thereafter. The Tribunal was informed that SCE did not terminate the RSG Contract nor did it submit an official notice of default pursuant to Section 1.24 of the RSG Contract.⁹⁶⁰
742. On 17 October 2013, MHI responded to the NRC’s 20 September 2013 letter, stating that it did not contest the non-conformance finding related to the Gap Velocity Error, which it itself reported and identified as a failure of the FIT-III manual to specify the gap formation.⁹⁶¹ MHI identified that SR calculations carried out with the error

⁹⁵⁵ Exh. JX-1868.

⁹⁵⁶ A green finding is a finding of “very low safety or security significance” (See Expert Statement of Johnson, ¶ 48).

⁹⁵⁷ A white finding represents a “low to moderate safety significance” (See Expert Statement of Johnson, ¶ 48).

⁹⁵⁸ The NRC is presumably referring to Mr. Langford and Mr. Wilson.

⁹⁵⁹ Exh. JX-1867.

⁹⁶⁰ Transcript, pp. 4456, 4685-4687 (Counsel).

⁹⁶¹ Exh. JX-1879.

corrected showed that the SONGS RSG tubes were stable. MHI further specified that it had corrected its manuals to avoid any future error. MHI also committed to using ATHOS for future design work in the US nuclear industry.⁹⁶²

743. On 21 October 2013, SCE responded to the NRC’s “white finding” regarding the Unit 3 tube leak and asserted that it acted reasonably in delegating design responsibilities for the RSGs to MHI, an N-stamp holder, while accepting that it was, of course, responsible under NRC regulations for the safety of SONGS.⁹⁶³
744. On 23 December 2013, the NRC responded to SCE’s letter of 21 October 2013, affirming its conclusion of a “white finding” in regard to the tube leak in Unit 3.⁹⁶⁴
745. On 20 March 2014, the NRC commissioned a report on the “lessons learned” from the SONGS Incident and investigation.⁹⁶⁵ It was noted, *inter alia that*:
- (i) The tube degradation at SONGS “was not significant from a safety perspective;”⁹⁶⁶ and
 - (ii) “Despite the lack of actual public health consequences of the steam generator degradation and the white finding issued to the licensee for their performance deficiency, the event resulted in significant licensing and oversight activities and significant communication opportunities and challenges with both external stakeholders and the Commission.”⁹⁶⁷

⁹⁶² Exh. JX-1879, ¶ 4(2).

⁹⁶³ Exh. JX-1881.

⁹⁶⁴ Exh. JX-1891.

⁹⁶⁵ Exh. JX-1920.

⁹⁶⁶ Exh. JX-1920, p. 1.

⁹⁶⁷ Exh. JX-1920, p. 2.

746. The NRC released its further Lessons Learned Report on 6 March 2015 (“**NRC Lessons Learned Report**”).⁹⁶⁸ The Parties have highlighted a number of aspects of this Report:

Therefore, the staff focused on the development of guidance for degradation mechanisms that cannot be adequately managed through the current Steam Generator Program, and which could prove to be a substantial safety hazard. Based on these considerations, the staff evaluated the need to change the regulatory guidance related to tube vibration that can lead to tube damage from wear or high cycle fatigue in a manner that is not manageable by the Steam Generator Program, such as the in-plane fluid-elastic instability that occurred at San Onofre.⁹⁶⁹

(...)

Despite the limitations of existing analysis methods and design tools for predicting the onset of U-bend in-plane fluid-elastic instability, no steam generators had experienced this condition until it occurred at San Onofre. A comparison between the San Onofre replacement steam generators and the replacement steam generators at other nuclear power plants, using the limited dataset of available evidence, suggests that the secondary side thermal hydraulic conditions of the San Onofre replacement steam generators were beyond the envelope of successful industry experience.⁹⁷⁰

(...)

Certain degradation mechanisms cannot be effectively managed through the normal in service inspection process, so efforts are made to eliminate the potential for these mechanisms during the design of steam generators. Fluid-elastic instability is a phenomenon that can result in tube damage through degradation mechanisms such as wear or high-cycle fatigue, with the interval between flaw initiation and tube failure ranging from a few days to a few months. This timeframe is too short and too unpredictable to be effectively managed by the Steam Generator

⁹⁶⁸ Exh- JX-1999, p. 33.

⁹⁶⁹ Exh. JX-1999, p. 30.

⁹⁷⁰ Exh. JX-1999, p. 31.

Program. Therefore, such phenomena should be addressed through steam generator design and reviewed by the staff, as necessary, using the proposed guidance described above.⁹⁷¹

(...)

During its review of the Mitsubishi technical evaluation reports and root cause report, as part of the follow up to the Augmented Inspection Team (AIT) inspection, the NRC inspection team found that industry design practice for commercial reactors in both the United States and Japan (as well as other countries using nuclear technology), at the time the San Onofre replacement steam generators were designed, did not specifically address in-plane fluid-elastic instability of the U-bends. Rather, industry's practice relied on actively controlling out-of-plane fluid-elastic instability of the U-bends, which is a more likely form of instability. The assumption at the time was that measures taken to control out-of-plane fluid-elastic instability would be sufficient to control in-plane fluid-elastic instability.⁹⁷²

(q) SCE's Cost Recovery

747. A number of events leading up to the shutdown decision and following the shutdown concerning SCE's cost recovery are described below.

(i) Secret Meeting with the CPUC

748. In March 2013, Mr. Steven Pickett, SCE's Executive Vice-President responsible for external affairs, met in a Warsaw hotel with Mr. Michael Peevey, the President of the CPUC.⁹⁷³ Mr. Peevey took notes at this meeting regarding the shutdown decision of SONGs.⁹⁷⁴ In particular, Mr. Pickett and Mr. Peevey discussed the recovery of pre-RSG investments, recovery of RSG and post-RSG investments, the costs of

⁹⁷¹ Exh. JX-1999, p. 32.

⁹⁷² Exh. JX-1999, p. 33

⁹⁷³ Transcript, p. 2342 (Mr. Craver).

⁹⁷⁴ Exh. JX-1721.

replacement power, the allocation of insurance proceeds, allocation of proceeds from any arbitration against the Respondents, decommissioning costs, operational and management cost recover, and an environmental offset donation.⁹⁷⁵ This meeting was apparently unlawful. SCE was fined \$16 million for failing to report that this meeting had occurred.⁹⁷⁶

(ii) Recovery from Insurers

749. Following the shutdown of SONGS, SCE received an insurance payout of \$400 million.⁹⁷⁷ Of that, 95% was provided directly to SCE's customers.⁹⁷⁸

(iii) Department of Energy Litigation

750. In 2016, SCE was scheduled to commence litigation against the US Department of Energy for its alleged failure to provide fuel storage services.⁹⁷⁹

751. On 6 July 2016, the Respondents sought leave to submit into evidence the status of these proceedings. In Procedural Order No. 11, the Tribunal declined to allow the submission of post-Hearing evidence in this regard.

(iv) CPUC Agreement

752. On 20 November 2014, an agreement⁹⁸⁰ was approved for recovery by SCE and SDG&E of costs related to SONGS RSG project and post-Incident costs.⁹⁸¹ Under this agreement, ratepayers were to "pay approximately \$3.3 billion on costs over ten

⁹⁷⁵ Exh. JX-1721.

⁹⁷⁶ Transcript, p. 2351 (Mr. Craver).

⁹⁷⁷ Transcript, p. 2386 (Mr. Craver).

⁹⁷⁸ Transcript, p. 2386 (Mr. Craver).

⁹⁷⁹ See Expert Report of Mr. Kenrich, ¶ 89.

⁹⁸⁰ It appears that on account of the secret meeting between Mr. Picket and Mr. Peevey that prior agreements were challenged and invalidated.

⁹⁸¹ Exh. JX-1968.

years (2012-2022), including costs of power the Utilities purchased after the outage, and recovery of the undepreciated net investments in SONGS assets (e.g., Base Plant), excluding the failed SGRP.”⁹⁸²

753. This agreement also provided for a distribution of any proceeds that SCE recovered in arbitration in which ratepayers would obtain “50% of the net recoveries from Mitsubishi.”⁹⁸³ Net recovery is calculated subsequent to deductions for the costs of the litigation.⁹⁸⁴

(r) Decommissioning

754. Following the permanent retirement of SONGS, the Claimants immediately took steps towards decommissioning SONGS. The Claimants’ position, expounded by Mr. Kenneth Metcalfe, in his Expert Report, is that they “were forced to begin decommissioning without having had sufficient time to completely plan for winding down and restructuring plant operations.”⁹⁸⁵
755. Similarly, the Claimants’ witness, Mr. Thomas Palmisano, who has “been overseeing efforts to decommission SONGS in compliance with all applicable laws and regulations,”⁹⁸⁶ has testified in his witness statement that “the sudden outage and subsequent retirement of SONGS left SCE unable to adequately prepare for the unexpected need to decommission the plant.”⁹⁸⁷
756. Notwithstanding the Claimants’ preparedness for the decommissioning of SONGS, it is essential to bear in mind that the Claimants had three different options, insofar

⁹⁸² Exh. JX-1968, p. 5.

⁹⁸³ Exh. JX-1968, ¶ 7.3.6, p. 129.

⁹⁸⁴ Exh. JX-1968, p. 160.

⁹⁸⁵ Expert Report of Mr. Metcalfe, ¶ 76.

⁹⁸⁶ Fact Witness Statement of Mr. Palmisano, ¶ 104.

⁹⁸⁷ Fact Witness Statement of Mr. Palmisano, ¶ 106.

as the preferred approach to decommissioning is concerned. These three alternatives are explained for the Claimants by Mr. Metcalfe in his Expert Report (supplemented by a corroboration during the hearings⁹⁸⁸) in the following terms:

NRC regulations provide for three alternative approaches to decommissioning: SAFSTOR, ENTOMB, and DECON. Under SAFSTOR, the nuclear facility is placed in a long-term, safe-storage configuration for future decommissioning. The ENTOMB approach is similar, but no NRC-licensed commercial nuclear plant has ever ultimately chosen to decommission under the ENTOMB approach. Under the DECON approach, decommissioning commences promptly following the permanent closure of the facility – for this reason, DECON is sometimes referred to as “Prompt DECON.”⁹⁸⁹

757. The existence of these three options is also acknowledged by the Respondents’ expert, Mr. John Reed, in his Expert Report.⁹⁹⁰
758. Notably, the NRC regulations mandate decommissioning within a period of 60 years. Thus, even for SAFSTOR while “the plant [is] in a safe condition for an extended period of time to be dismantled at a later point in time (...), you still have to complete decommissioning within 60 years under NRC rules.”⁹⁹¹
759. That being said, the Claimants opted to initiate prompt decommissioning immediately after the shutdown of SONGS, as opposed to deferring the same to a later period of time under the SAFSTOR method. Explaining why the Claimants preferred this approach of immediate decommissioning, Mr. Craver, for the Claimants, testified during the hearing:

We made a decision that it was going to be really in the best interests of the ratepayers, it would end up ultimately being lowest cost but also,

⁹⁸⁸ Transcript, pp. 6173-6174 (Mr. Metcalfe).

⁹⁸⁹ Expert Report of Mr. Metcalfe, ¶ 78.

⁹⁹⁰ Expert Report of Mr. Reed, ¶ 268.

⁹⁹¹ Transcript, pp. 124-125 (Mr. Palmisano).

more importantly, the community has been very concerned -- really going all the way back to Fukushima -- about having the plant on the coast and having the potential for nuclear material somehow getting into the communities. We have hundreds of thousands of people living relatively close to the plant, so our view was the sooner that we could get the spent fuel out of the spent fuel pools, which was where a lot of the community angst was -- again, kind of recalling what happened in Fukushima -- that was the issue. We needed to get the spent fuel out of the spent fuel pools into a more stable containment dry cask storage.⁹⁹²

760. Mr. Craver's testimony has been supplemented by Mr. Metcalfe's expert opinion, according to which the decision to opt for prompt decommissioning was reasonable. In his view, one of the chief reasons for this was that the:

[P]rimary difference at SONGS for us, from my experience in other plants, is that there was a Navy lease of that plant. It is leased from the U.S. Navy. And SONGS has always been concerned that the U.S. Navy wanted that land back when the plant stopped operating, and so that was one of the drivers of their public benefit reason for an immediate prompt DECON.⁹⁹³

761. During the Hearing, Mr. Thomas Palmisano, for the Claimants, also confirmed that the land on which SONGS was established was on leased land or an easement from the U.S. Navy,⁹⁹⁴ and that the U.S. Navy was informed of the "NRC decommissioning requirements and the possible options for decommissioning."⁹⁹⁵ Mr. Palmisano further stated that after explaining the decommissioning options to the Navy, the Claimants "thought it was appropriate to go into a prompt decommissioning because we had the funds available."⁹⁹⁶

⁹⁹² Transcript, p. 2352 (Mr. Craver).

⁹⁹³ Transcript, p. 6176 (Mr. Metcalfe).

⁹⁹⁴ Transcript, p. 124 (Mr. Palmisano).

⁹⁹⁵ Transcript, p. 124 (Mr. Palmisano).

⁹⁹⁶ Transcript, p. 125 (Mr. Palmisano).

762. On the other hand, Mr. John Reed, in his Expert Report on behalf of the Respondents and during the Hearing, opined that at the time SONGS was shutdown, SAFSTOR “was a reasonable alternative that was available”,⁹⁹⁷ and the reasons provided by the Claimants provide “no basis for disregarding the SAFSTOR approach in Claimants’ calculation of damages.”⁹⁹⁸ Further, he suggested that “[a]ll other things being equal (...), pushing off decommissioning to 2042 or later would have reduced damages under his model.”⁹⁹⁹
763. The damages predicted by the Claimants’ expert Mr. Frank Graves are presented in a tabulated chart in his Expert Report,¹⁰⁰⁰ as are Mr. Metcalfe’s calculations of Past and Future Decommissioning Damages. In making his calculations, Mr. Metcalfe took into account “[t]he impacts of losing important time and having to accelerate decommissioning work by almost three decades.”¹⁰⁰¹
764. On the other hand, on behalf of the Respondents, Mr. Reed contested the costs related to the impact of decommissioning SONGS sooner than planned, primarily on the grounds that the “Claimants’ assumption that SONGS would have operated to 2042 in the SONGS-In World is entirely speculative, unreasonably optimistic and unsupportable,”¹⁰⁰² and that the Claimants’ “damages are a product of their decision to commence decommissioning immediately after SONGS’ retirement when the widely-utilized option to defer the incurrence of decommissioning-related costs

⁹⁹⁷ Transcript, p. 6480 (Mr. Reed).

⁹⁹⁸ Expert Report of Mr. Reed, ¶ 279.

⁹⁹⁹ Transcript, p. 6455 (Mr. Reed).

¹⁰⁰⁰ Expert Report of Mr. Graves, ¶ 20.

¹⁰⁰¹ Expert Report of Mr. Metcalfe, ¶ 74.

¹⁰⁰² Expert Report of Mr. Reed, ¶ 254.

(known as “SAFSTOR”) was available to Claimants for purposes of their damages calculation.”¹⁰⁰³

765. In this connection, the time frame required to execute the Claimants’ chosen decommissioning plan that is currently in operation, was explained during the Hearing by Mr. Thomas Palmisano, as follows:

The initial decommissioning and the initial termination reduction of the NRC license will be done in approximately 2033. That will reduce the licensed area of the site and make land potentially available for the Navy at that point. There will be the remaining piece of land that we will continue under the NRC license for the independent spent fuel storage installation that will be there until the DOE removes fuel from the site. Then we will decommission that piece of the facility.

(...)

I currently expect the DOE to remove fuel from the site by 2049, and I will then decommission the rest of the facility by 2052.¹⁰⁰⁴

(s) **Grid Reconfigurations**

766. The decommissioning of a project of the magnitude of SONGS understandably had an impact on the Californian power grid, such that the power grid required reconfigurations. Explaining the reason behind such an impact, and the need for such reconfigurations to be undertaken by the Claimant SDG&E, [REDACTED], in his witness statement, testified:

SDG&E used the power generated at SONGS to supply electricity to SDG&E’s ratepayers. During its operating life, SONGS was SDG&E’s most critical energy source and a mainstay of SDG&E’s power supply portfolio. SONGS provided “baseload” power generation, meaning that it generated power consistently to meet demand, regardless of the time

¹⁰⁰³ Expert Report of Mr. Reed, ¶ 267.

¹⁰⁰⁴ Transcript, pp. 125-126 (Mr. Palmisano).

of day or the weather. The power grid in Southern California was specifically constructed to optimize transmission from baseload sources like SONGS because they are reliable sources of consistent power generation. SDG&E relied on SONGS Units 2 and 3 for consistent performance for almost 30 years, and was expected to operate for another 30 years thereafter if the license was extended by the NRC. And because of that consistent performance, SDG&E did not pursue other sources of energy.

If interruption to the power supply generated by a baseload plant like SONGS occurs, there can be significant effects on the cost of power and reliability of the transmission system, even if the overall energy deficit is covered by other sources. The effects are exponentially magnified when a complete shutdown of a baseload plant occurs. Among other things, SONGS provided important support to the power grid, enabling California to import more power from regions outside of California when necessary.¹⁰⁰⁵

767. In the same light, [REDACTED], in his witness statement on behalf of SDG&E, stated that “[a]s a result of the SONGS Shutdown, SDG&E was forced to modify the transmission grid to ensure a reliable supply of electricity to meet its customers’ demands.”¹⁰⁰⁶ Regarding the costs and timing of these modifications, [REDACTED] testified:

I obtained this information from the SDG&E transmission planning organizations (“SDG&E Transmission”). SDG&E Transmission informed me that SDG&E’s grid modifications included the construction of 230 kV capacitors at Penasquitos at a cost of \$7 million and the conversion of the generation units to synchronous condensers at Huntington Beach at a cost of \$16.1 million, delaying the Huntington Beach facility’s full retirement. SDG&E Transmission also informed me that the 230 kV capacitors at Penasquitos likely would have been needed when SONGS ultimately retired, whether SONGS stopped operating in 2012 or at the end of its license. SDG&E Transmission stated that the Huntington Beach synchronous condensers, on the other hand, would not

¹⁰⁰⁵ Corrected Fact Witness Statement of [REDACTED], ¶¶ 8-9.

¹⁰⁰⁶ Fact Witness Statement of [REDACTED], ¶ 3.

have been required, had SONGS continued to operate through the end of its license.

(...)

In addition to the 230 kV capacitors at Penasquitos and the synchronous condensers at Huntington Beach, SDG&E Transmission informed me that SDG&E incurred costs on six other transmission projects as a result, in part, of the SONGS Shutdown. Those projects include the (i) 230 kV line from Sycamore to Penasquitos; (ii) SONGS Switchyard – 1-225 MVar synchronous condenser; (iii) Talega Substation synchronous condenser; (iv) San Luis Rey – 2-225MVar synchronous condenser; (v) Miguel 500 kV Voltage Support; and (vi) the phase shifting transformer at Imperial Valley.

(...)

SDG&E has local capacity requirements (“LCRs”) to ensure that sufficient power generation is present to meet local electricity demands and provide reliable service. I discussed this issue with Mr. King, and he asked me to obtain information from SDG&E regarding its LCRs. SDG&E Transmission informed me that had SONGS not been taken offline permanently, the LCR would have been 1,893 MW in 2015 and 1,861 MW in 2019. Because of the small change in LCR between 2015 and 2019, I have been informed that it would be reasonable to assume that the LCR remained constant at the 2019 level thereafter.¹⁰⁰⁷

768. Further, Mr. Michael King, in his Expert Report on behalf of the Claimants, presents a tabulated exposition of the costs incurred by SDG&E towards grid reconfiguration,¹⁰⁰⁸ which rested on the premise that “[a]bsent SONGS, there is a need for modifications to the transmission grid to allow the transmission system to reliably deliver power. SDG&E has worked with the California Independent System Operator (CAISO) to identify projects necessary to replace what was lost due to the

¹⁰⁰⁷ Fact Witness Statement of ██████████, ¶¶ 3, 4, 6.

¹⁰⁰⁸ Expert Report of Mr. King, ¶¶ 85-87.

outage and retirement of SONGS.”¹⁰⁰⁹ He corroborated his position during the Hearing, by stating that these transmission upgrades are “related to [the] issue of SONGS being really necessary to reliably deliver electricity into San Diego.”¹⁰¹⁰

769. On the same note, explaining the costs incurred by SCE towards grid reconfiguration under the heads of “Huntington Beach Restoration and Conversion; Del Amo-Ellis Loop-In; Coastal and Southern Orange County Under Voltage Load Shedding; Johanna, Santiago, And Viejo Capacitor Banks; Barre-Ellis Transmission Line Decoupling; Beachball Substation & Static VAR Compensator; [and] Santiago Synchronous Condenser,”¹⁰¹¹ Mr. Kenneth Metcalfe in his Expert Report on behalf of the Claimants testified:

[T]he ultimately permanent loss of SONGS’s generation, starting in January 2012, had a significant impact on the grid, and required that Edison, working with the California Independent System Operator (or “CAISO”), identify alternatives to ensure continued reliable electric service to customers. In addition to securing new sources of electricity to replace that which was previously provided by SONGS, Edison and the CAISO also had to develop or accelerate a number of modifications to the electrical grid to ensure reliability.

(...)

After the SONGS tube leak, and once it became apparent that the plant would not timely be returning to service, the CAISO worked with Edison and other utilities (including SDG&E) to identify required modifications to the electrical grid and other projects to ensure continued grid stability and reliability. Those projects included reconfiguring certain transmission lines and substations, executing agreements that would

¹⁰⁰⁹ Expert Report of Mr. King, ¶ 54.

¹⁰¹⁰ Transcript, p. 6061 (Mr. King).

¹⁰¹¹ Expert Report of Mr. Metcalfe, ¶ 100.

allow Edison to “shed” load during times of peak demand, and developing new transmission voltage support resources.¹⁰¹²

770. During the Hearing, Mr. Metcalfe further testified on these grid reconfiguration measures, stating that they constitute “stop-gap measures that were implemented by SCE to replace the capacity and keep the grid stable.”¹⁰¹³
771. In sum, in the submission of the Claimants, “[t]he outage that followed the tube leak put pressure on the grid, threatened to throw it into imbalance. The Claimants were required to undertake grid modification projects to relieve that pressure and ensure the balancing of the grid. The main dispute between the parties on this category is whether these grid modification projects and the costs associated with them were caused by the SONGS outage or by other factors.”¹⁰¹⁴

VIII. SUMMARY OF THE PARTIES’ POSITIONS AND RELIEF SOUGHT

A. SUMMARY OF THE CLAIMANTS’ POSITION

772. The Claimants’ case is summarized in their post-hearing memorial as follows:

1. There is no credible dispute that Mitsubishi grossly failed to provide RSGs that complied with the RSG Contract—RSGs that would have extended, not ended, the useful life of SONGS. By any measure, the harm Mitsubishi caused Claimants is immense. Had Edison not awarded Mitsubishi the RSG Contract, the original SONGS steam generators would have lasted until at least 2012, and Claimants would have avoided the costs of replacement and the consequences of a radioactive leak. Had Mitsubishi performed the RSG Contract as promised, Claimants and their customers would have enjoyed the benefits of reliable, carbon-free nuclear power through 2042 with the license extension that functional RSGs would have ensured. Instead, Claimants were saddled with what Mitsubishi’s own expert called “the worst case [of] degraded steam

¹⁰¹² Expert Report of Mr. Metcalfe, ¶¶ 101-104.

¹⁰¹³ Transcript, p. 6148 (Mr. Metcalfe).

¹⁰¹⁴ Transcript, p. 5157 (Counsel).

generator[s] in the history of domestic nuclear power.” The embedded defects were so serious that Mitsubishi was never able to offer—much less implement, as required under the RSG Contract—a viable, tested, and proven repair solution. After 16 months of effort, enormous expenses that Mitsubishi still refuses to reimburse, and no real prospect that Mitsubishi could repair the damaged RSGs, Edison was left with no reasonable choice but to retire SONGS.

2. Mitsubishi’s conduct is especially troubling in the context of the nuclear power industry, where safety is paramount, and the principal goal must be not merely to protect the multibillion-dollar assets involved but to prevent grievous harm to public health and welfare. None of the excuses Mitsubishi makes for its failures is remotely sufficient to avoid liability. As the N-stamp holder and supplier of the RSGs, Mitsubishi cannot shift blame to its customer with its baseless assertions that Edison was somehow its risk partner in the design of the RSGs or that Edison’s draft specification somehow made unprecedented tube wear and a radioactive steam leak unavoidable. Edison had neither the experience nor the information necessary to detect Mitsubishi’s errors. Indeed, the evidence establishes that Mitsubishi concealed material facts from Edison, including the inaccuracy of Mitsubishi’s thermal-hydraulic codes, the inexperience of the engineers that Mitsubishi assigned to the project, and warnings from Mitsubishi’s own consultants, Robert “Con” Wilson and Paul Langford, about the thermal-hydraulic conditions that would exist in the RSGs.

3. As Claimants’ experts testified, many of the flaws in Mitsubishi’s RSG design were not matters of judgment but black-and-white violations of industry standards and the laws of physics. Although Mitsubishi downplays or denies most of the errors that Claimants’ experts uncovered in analyzing the RSGs’ failures, Mitsubishi admits that it incorrectly calculated gap velocities. Correcting this error alone would have revealed that Mitsubishi had designed out-of-plane instability into the RSGs and thus had no basis to assume that in-plane instability would not occur. Mitsubishi’s semantic argument that the tube wear and tube leak were caused by fluidelastic “excitation” rather than fluidelastic “instability” is, at best, a distinction without a difference. These terms are synonymous, but even if they were not, the RSG Contract required Mitsubishi to preclude all types of damaging flow-induced vibration.

4. Nor can Mitsubishi claim that repair was somehow thwarted because Edison “wasn’t interested.” As CEO Ted Craver, past and present Chief Nuclear Officers Pete Dietrich and Tom Palmisano, and others confirmed, Edison was very interested in repair. Restoring SONGS to service with dispatch was in the best interest of Claimants, their employees, and their customers. That is why Edison spent more than \$200 million investigating the cause of the tube wear and leak, trying to gain NRC approval of a partial restart plan, and supporting Mitsubishi’s repair efforts—even as Mitsubishi was refusing to fulfill its contractual obligation to reimburse Edison for those expenses. But given the magnitude of Mitsubishi’s engineering failures and the NRC’s intense scrutiny, Edison could not be cavalier about repair. Edison needed, and Mitsubishi was required to provide, a viable and tested solution that the NRC would approve. What Mitsubishi offered instead was a nuclear experiment. Not only was the Type 1 proposal to add thicker AVBs using positive pinning force a breathtaking departure from existing industry standards (and, at best, only a conceptual proposal), it did not address the extraordinary thermal-hydraulic conditions in the RSGs—and was not tested under those conditions, despite Edison’s repeated requests that Mitsubishi do so. Mitsubishi internally acknowledged at the time that “[i]f the thermal-hydraulic[s] and velocity are not 100 percent improved, no matter how much fiddling is done to the AVBs, it would simply be treating the symptoms.” Indeed, Mitsubishi admitted at the Hearing that the proposed “repair” would not eliminate out-of-plane instability.

5. On this record, Claimants must be permitted to recover the full measure of damage that Mitsubishi caused. If Mitsubishi’s failures are not sufficient to justify expunging the contractual limitations on liability or rescinding the contract under California law, it is difficult to imagine any case that could meet those standards. Under California Commercial Code section 2719(2), as repeatedly interpreted by the Ninth Circuit Court of Appeals, the total and fundamental failure of the repair-or-replace limited remedy entitles Claimants to recover the benefit of their bargain under the RSG Contract (i.e., \$1.277 billion incurred through 2015, plus \$5.392 billion to be incurred 2016-42)—and “unconscionability is irrelevant.” Mitsubishi’s strained interpretation of the legal standard for future damages is likewise flawed. California law does not allow a breaching party to escape liability simply because a non-breaching party cannot calculate the dollar value of the breach with perfect foresight and precision. Where the fact of future damage is proven, Claimants need only provide a “reasonable” basis for the

quantum, and Claimants have more than met this requirement through robust expert analysis and modeling.

6. Alternatively, under California Civil Code section 1689, a “failure of consideration” or fraud in the inducement of the contract entitle Claimants to rescind the RSG Contract (including limitations of liability) and recover damages sufficient to restore them to the position they would have been in had the RSG Contract never been executed (i.e., \$3.581 billion in NPV dollars). Notably, Mitsubishi agrees that, if rescission applies, three categories of Claimants’ rescission damages (totaling \$1.546 billion) are proper, and Mitsubishi has not offered any principled reason to treat the other categories differently. Rather, Mitsubishi focuses on narrow, technical arguments about whether this is a “rescission case.” These arguments fail as a matter of law and, more fundamentally, ignore the flexible, equitable nature of the rescission remedy. Under California law, the Tribunal has broad discretion to fashion an award that remedies Mitsubishi’s egregious wrongs.¹⁰¹⁵

B. SUMMARY OF THE RESPONDENTS’ POSITION

773. The Respondents’ case is summarized in their post-hearing memorial as follows:

1. This arbitration reflects Claimants’ calculated attempt to escape the carefully negotiated risk allocation they agreed to now that one of the very risks the Parties contemplated during contract negotiations in 2004 – the need to “repair or replace” the “Apparatus” – has come to pass. To do so, they argue essentially two things: first, that the record in this case supports a finding of breach on the part of Mitsubishi; and second, that there exists a legal basis for permitting Claimants to escape from the comprehensive risk allocation they previously agreed to. They have proven neither.

2. Undeterred by the evidence, which confirms that Mitsubishi at all times performed with resolute good faith in accordance with the industry standard of care and its contractual obligations, Claimants nonetheless strain to argue that this case fits into one of their various and evolving legal or contractual theories: that the warranty remedy in the Contract (“Warranty”) failed of its essential purpose under the California

¹⁰¹⁵ Claimants’ PHM, ¶¶ 1-6.

Commercial Code; that the limitation on Mitsubishi's liability ("Liability Cap") must fall as a result of gross negligence and/or fraudulent or willful misconduct; that the mutual waiver of consequential damages ("Mutual Waiver") should be ignored; or, alternatively, that the entire RSG Contract should be rescinded. Respondents respectfully submit that the evidence in this case admits of only one conclusion: that what happened, while regrettable, does not stem from, or amount to, a breach of the RSG Contract, nor does it legally or equitably justify voiding the heavily negotiated, industry-standard contractual limitations on liability. Both the Liability Cap and Mutual Waiver remain enforceable.

3. The evidence shows that Edison entered into the SONGS steam generator replacement project with eyes-wide-open about potential risks, proposed its own standard Mutual Waiver, conducted "intrusive" oversight over every aspect of the Contract's implementation and, when the units experienced a problem, unreasonably imposed limitations upon the solution, rendering a successful repair unattainable under Edison's own detailed specification. After a year and a half of misguided strategy, Edison made the business decision to close SONGS despite the fact that the solution for restoring the units to full power had long been put before them by Mitsubishi and suggested by three other leading nuclear component vendors. The solution was also similar to many prior repairs that had been successfully installed in numerous nuclear power plants around the world.

4. The vast majority of Claimants' alleged damages were voluntarily incurred as a result of Edison's unilateral decision to abandon efforts to restart the plant and to permanently close SONGS. The decision to close SONGS was either a rush to judgment after a failed restart strategy, or a strategic exit from the nuclear industry due to economic and market conditions unrelated to any conduct or failures of Mitsubishi. The closure of SONGS was not the result of Mitsubishi's actions. This fact alone forecloses the majority of Claimants' damages claims.

5. Claimants' efforts to prove errors by Mitsubishi in the design process, while vigorous and extensive, failed to show either that all but one of the alleged "errors" actually occurred, or that any of the alleged errors, even if they had been proven to have occurred, caused the tube-to-tube wear that was indisputably the cause of the leak in January 2012. And the characterization of any conduct by Mitsubishi as "gross negligence" or "fraud" is premised not on the nature of Mitsubishi's conduct, but

exclusively on Claimants' desire to have the Tribunal unwind the risk allocation agreed to by the Parties at contract initiation. That desired result is not legally, factually or equitably justified.

6. The failure to establish liability or a basis to escape the contractual Liability Cap is only part of Claimants' failure of proof. Claimants likewise have proved no damages:

- Two-thirds of Claimants' \$6.6 billion in damages are projected to be incurred in the 2022-2042 relicensing period without proof that relicensing would occur;
- The claim for \$2.3 billion in decommissioning damages results from Claimants' decision to decommission immediately and ignores the fact that decommissioning of SONGS was fully funded;
- All damages are based on assumptions about SONGS' future costs, which are inconsistent with its past and rely on market projections that Mr. Graves correctly said could be called a "fantasy";
- All damages numbers contain an unsupported 40% markup for presumed taxes that was never mentioned by Claimants in this arbitration, and were also derived using an unrealistic discount rate that inflates damages even further;
- Offsets of billions of dollars are required as a result of payments received by Claimants from their ratepayers and insurers;
- Claimants may recover only direct damages, and any direct damages disappear when unsupported amounts are deducted and Mitsubishi's \$45 million interim payment is considered.

7. Further, the magnitude of the difference between the Liability Cap and any actual damages suffered by Claimants (which Mitsubishi does not concede has been shown) is irrelevant to enforcement of the Liability Cap. The representatives who negotiated the RSG Contract clearly discussed and understood before entering into the Contract that the Liability Cap was intended to apply to "all risks," regardless of quantum.

8. As outlined in Respondents' Position Statement on the Revised List of Issues (hereafter "Response to the Issues List"), Claimants have failed to meet their burden of proof on any of their claims. Mitsubishi requests that Claimants' claims for relief be denied in their entirety and that Mitsubishi be provided a refund on the \$45 million it paid Edison in 2013 for amounts Edison has failed to substantiate as properly incurred warranty-related costs, plus amounts due under a related contract for replacement reactor vessel heads. In this post-hearing brief, Mitsubishi will not repeat each of the deficiencies in Claimants' proof that are outlined in the Response to the Issues List. Instead, this brief will focus on several issues that by themselves are dispositive of (1) any claims for damages in excess of the limitations of liability the Parties agreed to under the RSG Contract; (2) any claims for damages flowing from Edison's decision to close SONGS; and (3) any claims that Mitsubishi failed to discharge its obligations under the warranty provisions of the Contract.¹⁰¹⁶

C. SUMMARY OF SDG&E'S POSITION

774. Claimants SDG&E's case is summarized in their post-hearing memorial as follows:

1. (...) SDG&E incorporates by reference the arguments and evidence set forth in its Separate Memorial and Reply, as well as the arguments and evidence set forth in Claimants' Memorial, Reply, and Post-Hearing Memorial with respect to causes of action asserted on behalf of all Claimants.

(...)

3. The focus of Mitsubishi's opposition to SDG&E's claims has not been on their substance. Mitsubishi did not spend one minute of the hearing disputing any of SDG&E's liability claims or cross-examining any of SDG&E's fact witnesses (nor did Mitsubishi depose them). During the hearing, Mitsubishi only addressed SDG&E's damages claims. Yet even Mitsubishi's damages experts (John Reed and Michael Emmert) failed to review, let alone dispute, the statements of SDG&E's fact witnesses. Moreover, to the extent that Mitsubishi's damages experts had any quarrel with the initial expert report of SDG&E's damages expert

¹⁰¹⁶ Respondents PHM, ¶¶ 1-8.

Michael King, Mr. King addressed those issues in his rebuttal report and in his hearing testimony. Mssrs. Reed and Emmert asserted no further objection in their later reports or in their testimony at the arbitration.

4. Instead, Mitsubishi has chosen to focus on meritless procedural and technical arguments attacking SDG&E's standing to bring its claims. For example, Mitsubishi argues that SDG&E is not entitled to seek rescission as a remedy for Mitsubishi's misconduct because SDG&E is not a party to the RSG Contract. Mitsubishi is wrong. SDG&E has submitted undisputed evidence that EMS, the signatory to the RSG Contract, was SCE's agent at the time the RSG Contract was executed and that SCE was the agent of SDG&E by virtue of the SONGS Operating Agreement. Mitsubishi does not dispute the latter principal-agent relationship between SCE and SDG&E, but rather, challenges the relationship between EMS and SCE. The uncontested record evidence belies Mitsubishi's position. This evidence shows that the agent-principal relationship between EMS and SCE was not only the intent of the SONGS co-owners at the time that EMS was formed, but it is also strongly supported by the course of conduct among the parties during both the negotiation and performance of the RSG Contract. Through this agency relationship, SDG&E and the other SONGS co-owners are parties to the RSG Contract, and have standing to assert the remedy of rescission against Mitsubishi.

5. Mitsubishi has likewise disputed SDG&E's right to assert fraud, contending that Mitsubishi did not communicate with or make any disclosures to SDG&E. Mitsubishi's position ignores the agency relationship between SCE and SDG&E, which under California law, allows SDG&E to bring a claim for fraud against Mitsubishi. This law holds that fraud upon an agent is fraud upon the principal. Mitsubishi did not address this issue at the hearing and has never addressed this point of law in its papers. Nor has Mitsubishi addressed well-settled California law that even absent an agency relationship, SDG&E is entitled to assert fraud against Mitsubishi on the basis that Mitsubishi intended that SDG&E, as a SONGS co-owner, rely on Mitsubishi's misrepresentations and concealments. These misrepresentations and concealments include those that Mitsubishi made to procure the RSG Contract and those made during the performance of the RSG Contract, as described in detail herein and in Claimants' Post-Hearing Memorial.

6. As a result of Mitsubishi's misconduct, SDG&E incurred \$1.967 billion in benefit of the bargain damages (with \$694 million in damages from 2012 through 2022 and \$1.273 billion from 2023 through 2042) or, in the alternative, \$718 million in rescission damages. While Mitsubishi's damages experts raised a handful of challenges to SDG&E's damages in their initial reports, SDG&E's damages expert, Michael King, responded to and addressed those challenges in his rebuttal report dated January 19, 2016. Mr. King further addressed Mitsubishi's challenges during his hearing testimony. In Mitsubishi's rebuttal and supplemental reports that have been filed since Mr. King's rebuttal report and in the arbitration testimony, Mitsubishi did not raise any further objection to SDG&E's damages claims.

7. For these reasons and as set forth in more detail below, each and every one of SDG&E's claims is meritorious, and SDG&E is entitled to the relief it has requested.¹⁰¹⁷

D. SUMMARY OF THE RESPONDENTS' POSITION REGARDING SDG&E

775. The Respondents' case with regard to the claims by SDG&E is summarized in their post-hearing memorial as follows:

186. SDG&E's contribution during the hearing consisted entirely of the testimony of its damages expert, Michael King; SDG&E offered no factual evidence to support the merits of any of its claims for relief and those claims necessarily rise or fall with those of Edison. But separately, the deficiencies in SDG&E's damages case, which purports to quantify monies allegedly due to SDG&E on both benefit of the bargain and rescission theories, are many.

187. Insofar as SDG&E's damages claim relies upon the application of a 20% multiplier to the figures Mr. Metcalfe and Mr. Graves put forth for both benefit of the bargain and rescission damages, SDG&E's damages are flawed for the reasons stated above and in the Response to the Issues List at section H (Damages). This approach applied to SDG&E's damages for the following categories of benefit of the bargain damages: (1) Steam Generator Inspection and Repair; (2) certain Legal and Regulatory Costs; (3) SONGS License Renewal Costs; (4)

¹⁰¹⁷ SDG&E PHM, ¶¶ 3-7.

Decommissioning Costs; (5) Nuclear Fuel Costs; and (6) Plant Costs (O&M, CapEx).

188. Likewise, most of SDG&E's rescission damages reflect nothing more than a 20% multiplier applied to Edison's rescission damages amounts, plus an additional \$2 million for SDG&E's unique legal and regulatory costs; those damages therefore fail for the reasons set forth above and in section H.2 of the Response to the Issues List. Insofar as SDG&E's damages purport to reflect damages unique to SDG&E, the figures that Mr. King calculated independently for SDG&E, including Replacement Energy, Replacement Capacity from Market, Replacement Capacity from New Resources, Transmission Upgrades, Increased Local Capacity Requirements, and SDG&E's Unique Legal Fees, fail for three additional reasons.

189 *First*, certain of these damages (namely damages related to SDG&E's Replacement Energy and Replacement Capacity Costs, which comprise the vast majority of SDG&E's independent benefit of the bargain damages), are not recoverable because they are predicated on Mr. King's unsupported assumption that SONGS would have continued to operate until 2042. Mr. King offered no independent analysis justifying this assumption, which is flawed for all the reasons stated above and in the Response to the Issues List. During the hearing, Mr. King admitted that he had not done any projections assuming a 2022 shut down date, and confirmed that none of his 2042-based calculations are amenable to determining what SDG&E's damages would have been in the event of a 2022 shut down. Accordingly, not only are SDG&E's benefit of the bargain damages too speculative and uncertain to be recoverable, they also are not amenable to any principled reduction to account for a 2022 shut down date.

190 *Second*, as explained by Mr. Emmert, Mr. King failed to use SDG&E's actual costs, reported to the CPUC in connection with its OII proceeding, in calculating certain Replacement Capacity Costs. The CPUC required that SDG&E report costs incurred relative to the SONGS shutdown, including replacement capacity costs. Mr. King admitted at the hearing that he did not use SDG&E's self-reported OII report numbers for certain of his replacement capacity calculations. Indeed, the amounts that SDG&E actually reported to the CPUC in connection with this obligation were less than what Mr. King now opines are recoverable replacement capacity damages.

191 *Third*, Mr. King's benefit of the bargain damages calculation is further inflated to the extent it includes approximately \$800,000 in legal fees that SDG&E incurred in its NEIL insurance claim litigation, but fails to account for any offset for the NEIL settlement it obtained.¹⁰¹⁸

E. SUMMARY OF THE RESPONDENTS' POSITION ON COUNTERCLAIM

776. The Respondents' case with regard to their counterclaims is summarized in their post-hearing memorial as follows:

178. The remaining amount available under the Liability Cap is \$57,222,902, after accounting for Mitsubishi's prior payments and warranty work. While the initial purchase price was \$137,453,131, the Liability Cap must be reduced by \$7,459,765 of liquidated damages Mitsubishi paid for late delivery and ding signals; then by the \$45,361,817 Mitsubishi paid against Edison's invoices for SGRT expenses (which the parties agreed would be credited against the Liability Cap); and by the \$27,408,647 Mitsubishi expended in its own repair efforts. Therefore, if the Liability Cap is enforced, and the Tribunal finds that Claimants have met their burden of proving causation and have proven damages that are awardable under the contract with reasonable certainty, Claimants can recover, at most, up to \$57,222,902.

179. In addition, Mitsubishi is entitled to an award of \$47,333,464 on its counterclaims. Depending on the Tribunal's conclusions regarding the Liability Cap, the Mutual Waiver, and the availability of other damages, this amount should either be added to any damages awarded to Mitsubishi under the RSG Contract, or applied to reduce any damages awarded to Claimants.

180. Even if the Tribunal refuses to enforce the Liability Cap, if it enforces the Mutual Waiver, thereby excluding consequential damages from its award, then the only direct, justified costs Claimants have established under the Contract were \$46,847,654 from [Steam Generator Inspection and Repair ("SGIR")] costs, and legal/regulatory expenses. However, Mitsubishi has already paid Claimants \$45,361,817 for SGIR

¹⁰¹⁸ Respondents' PHM, ¶¶ 186-191.

costs. When the RRVH contract balance amount of \$1,971,647 is added, Mitsubishi is entitled to a return of \$485,810.

181. Regardless, under any damages calculus, all proven and permissible damages have already been compensated by insurance payments and the ratepayers (which together paid \$6 billion to Claimants as a result of the SONGS closure). This effectively reduces net damages to zero.¹⁰¹⁹

F. SUMMARY OF THE CLAIMANTS' POSITION ON COUNTERCLAIM

777. The Claimants' case with regard to the Respondents' counterclaims is summarized in their post-hearing memorial as follows:

(a) Respondents Are Not Entitled To Any Offset Or Refund

502. As discussed in section VII. A. 1. above, Mitsubishi paid Edison approximately \$45 million for expenses Edison incurred in attempting to return the RSGs to service. That amount represents only a fraction of what Edison spent in that endeavor, and what Mitsubishi owes under the RSG Contract. Nevertheless, Mitsubishi now asserts that only approximately \$30 million of that initial payment was properly chargeable, and counterclaims for the remaining \$15 million to be refunded or credited against any damages awarded to Claimants in excess of \$30 million. This counterclaim is baseless, and should be rejected for the same reasons that Claimants are entitled to recover the full amount of their SGIR damages.

503. Mitsubishi argues that the \$15 million it seeks in its counterclaim are part of the SGIR costs that fall outside the scope of the warranty provisions and are "not properly chargeable." As previously discussed, Mitsubishi has submitted only scant evidence in support of this claim. Mr. Ficca admitted that "it is likely that SCE incurred" these costs. Mr. Wade, who was the only one of Mitsubishi's witnesses to attempt to address the relationship between the SGIR costs and the RSG repair efforts, identified only \$57.6 thousand (out of \$181 million) in costs that, in his view, were not caused by the tube leak. Mitsubishi has not submitted any evidence to support a counterclaim for more than that amount. In stark contrast, Claimants supported the amounts invoiced to

¹⁰¹⁹ Respondents' PHM, ¶¶ 178-181.

Mitsubishi with more than 10,000 pages of supporting documentation and the testimony of Michael Wharton, who, along with his team of experienced nuclear engineers, verified that all of the invoiced costs were incurred solely due to the failure of the RSGs. Although Mr. Wharton was a key resource for Mr. Metcalfe's analysis of the SGIR costs—which Mitsubishi knew—Mitsubishi failed to ask him a single question on this subject in either his deposition or at the Hearing.

(b) Respondents Are Not Entitled To Further Payments For Useless Replacement Reactor Vessel Heads

504. Mitsubishi also counterclaims for an additional \$2 million representing the final milestone payment under a separate purchase order for the Replacement Reactor Vessel Heads ("RRVHs") that it supplied to Claimants. Mitsubishi did not make any argument in support of this claim either in its Rejoinder Memorial or during the Hearing. As set forth in prior Memorials, the conditions necessary to trigger the final milestone payment never occurred, and in any event the frustration of purpose doctrine relieves Claimants of any further obligations under the RRVH Contract.

505. The RRVH Contract provides that Respondents are not entitled to the final milestone payment until the RRVHs "have been installed;" "initial start-up . . . has been achieved;" and the RRVHs "have been in operation for sixty (60) days." It is undisputed that these conditions were not met: neither RRVH had been completely installed when the Unit 3 tube leak occurred, let alone started up or operated for 60 days. Under California law, a party is discharged of its obligations when a condition precedent did not and cannot occur. The irreparable failures of Mitsubishi's RSGs made it impossible for the RRVHs to be installed or operated, so Claimants have no obligation to make the final milestone payment.

506. Even if the RRVH Contract could somehow be interpreted in Mitsubishi's favor, California law excuses Claimants from making any further payment. When "the reason the parties entered the agreement has been frustrated . . . such that the value of performance . . . is substantially destroyed, the doctrine of commercial frustration applies to excuse performance." Both Mitsubishi's and Claimants' witnesses agree that the value of the RRVHs was "substantially destroyed" once the RSGs failed and could not be returned to service. ██████████ admitted that replacing

the reactor vessel heads is not necessary if a plant is not operating. Mr. Bauder explained during the Hearing that Claimants and Mitsubishi never would have entered into the RRVH Contract had they known that the RSGs were defective and would cause SONGS to shut down by 2013. The RSG failures are a textbook example of an unanticipated supervening circumstance that eliminated all of the value of the RRVH contract for Claimants. Mitsubishi is not entitled to any additional payments under the RRVH Contract.¹⁰²⁰

778. Claimant SDG&E “incorporate[d] the evidence and arguments set forth in Claimants’ Post-Hearing Memorial regarding the lack of support for MHI’s counterclaims” as its own submission.¹⁰²¹
779. Claimants Riverside’s opposition to the counterclaims was submitted in its Riverside Reply to Counterclaims submission of 16 September 2014.

G. THE CLAIMANTS’ RELIEF SOUGHT

780. The Claimants’ Request for Arbitration sought the following relief:

144. Claimants seek a declaration that Mitsubishi breached both the Contract and the warranties contained therein such that Claimants are entitled to damages in an amount not less than \$4 billion, to be proven at arbitration.

145. Claimants seek a further declaration that the limited remedies set forth in the Contract failed of their essential purpose and are unenforceable in these circumstances under section 2719 of the California Commercial Code. Claimants specifically seek a declaration that Mitsubishi’s failures were so total and fundamental that any waiver of consequential or other damages is unenforceable.

146. Claimants seek a further declaration that Claimants are entitled to be defended, indemnified, and held harmless from and against any and all liability, damages, losses, claims, demands, actions, causes of action,

¹⁰²⁰ Claimants PHM, ¶¶ 502-506.

¹⁰²¹ SDG&E PHM, ¶ 112.

and/or costs (including attorney's fees and expenses), arising from Mitsubishi's defective RSGs. An actual controversy exists between Claimants and Mitsubishi regarding the scope of Mitsubishi's liability under the Contract. Such a declaration is necessary and proper at this time to administer final and complete relief, and to liquidate any chance of subsequent litigation between Claimants and any other individuals or entities.

147. Claimants seek the full measure of direct, indirect, consequential, incidental, and special damages to which they may be entitled under the California Commercial Code. As a result of Mitsubishi's breaches of contract and warranty, Claimants have suffered or are reasonably certain to suffer all of the following losses:

- a. costs of the purchase and installation of the faulty RSGs;
- b. costs incurred in reliance on the RSGs operating in accordance with the Contract, including capital additions to SONGS and unused nuclear fuel;
 - a.[ii]¹⁰²² costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work;
 - b.[ii]¹⁰²³ increased operation, maintenance, and security costs, as well as generation portfolio effects attributable to the SONGS RSG outages;
- c. costs of purchasing power to serve the SONGS Owners' customers who otherwise would have been served by SONGS;
- d. lost revenue and/or profits;

¹⁰²² The Claimants' RfA has duplicate numbering. The Tribunal describes the second ¶ 147(a) as "¶ 147(a)[ii]."

¹⁰²³ The Claimants' RfA has duplicate numbering, containing two paragraphs numbered ¶ 147(b). The Tribunal describes the second ¶ 147(b) as "¶ 147(b)[ii]."

- e. costs of capacity and transmission upgrades, including efforts to support grid reliability, made necessary by the SONGS outages;
- f. the lost value of SONGS;
- g. costs related to NRC and CPUC proceedings triggered by the SONGS outage;
- h. pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;
- i. all costs of legal representation and assistance related to the enforcement of the Contract; and
- j. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the arbitration Tribunal deems just.

148. Claimants seek damages for all injuries proximately caused by Mitsubishi's negligent and/or fraudulent misrepresentations, including:

- c. [*sic*]¹⁰²⁴ costs of the purchase and installation of the faulty RSGs;
- d. costs incurred in reliance on the RSGs operating in accordance with the Contract, including capital additions to SONGS and unused nuclear fuel;
- e. costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work;
- f. increased operation, maintenance, and security costs, as well as generation portfolio effects attributable to the SONGS RSG outages;

¹⁰²⁴ The Claimants' RfA contains incorrect numbering, starting at ¶ 148(c).

- g. costs of purchasing power to serve the SONGS Owners' customers who otherwise would have been served by SONGS;
- h. lost revenue and/or profits;
- i. costs of capacity and transmission upgrades, including efforts to support grid reliability, made necessary by the SONGS outages;
- k. the lost value of SONGS;
- j. costs related to NRC and CPUC proceedings triggered by the SONGS outage;
- k. pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;
- l. all costs of legal representation and assistance related to the enforcement of the Contract; and
- m. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the Tribunal deems just.

149. In the alternative to the relief set forth in Paragraphs 147-48, Claimants seek rescission of the Contract and restitution, including:

- a. costs of the purchase and installation of the faulty RSGs;
- b. costs incurred in reliance on the RSGs operating in accordance with the Contract, including capital additions to SONGS and unused nuclear fuel;
- c. costs associated with the investigation of the damage to the RSGs and the causes of that damage, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work;

- d. increased operation, maintenance, and security costs and portfolio effects attributable to the SONGS outages;
- e. costs related to NRC and CPUC proceedings triggered by the SONGS outage;
- f. pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;
- g. all costs of legal representation and assistance related to the enforcement of the Contract; and
- h. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the arbitration Tribunal deems just.¹⁰²⁵

781. In their Memorial, the Claimants' request:

an award enforcing their rights regarding Mitsubishi's failure to design and fabricate RSGs that were free of defects and Mitsubishi's failure to repair or replace the RSGs once the embedded defects were discovered and requiring Mitsubishi to compensate Claimants for the full measure of the harm Mitsubishi caused them.¹⁰²⁶

782. In their Reply Memorial, the Claimants' request:

an award requiring Mitsubishi to compensate Claimants for the full measure of the harm Mitsubishi caused and denying all of Mitsubishi's counterclaims.¹⁰²⁷

¹⁰²⁵ RfA, ¶¶ 144-149.

¹⁰²⁶ Memorial, ¶ 443.

¹⁰²⁷ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 544.

783. In total, the Claimants are seeking \$6,667 billion in damages.¹⁰²⁸ In their closing submission at the arbitration, the Claimants Edison identified their damages as totaling \$4,906 billion.
784. The City of Riverside's damages are 1.79% of the total damages sought by the Claimants.¹⁰²⁹
785. The Claimants' alternative claim for rescission of the contract seeks total damages of 3,579 billion dollars.¹⁰³⁰ SDG&E's expert Mr. King places this figure at 3,581 billion dollars.¹⁰³¹

H. SDG&E'S RELIEF SOUGHT

786. SDG&E's Joinder in Request for Arbitration:

55. On information and belief, SDG&E joins in Edison's requests for relief asserted in paragraphs 144 through 149 of Edison's RFA: (1) as a party to the Contract or a third-party beneficiary of the Contract, SDG&E is entitled to all rights and relief under the Contract, and (2) as a party to the End User RSG Contract, attached as Exhibit B to Edison's RF A, in which EMS, SCE and MHI agreed that SCE, acting on behalf of itself and as Operating Agent for SONGS, would "be bound by and also share in the benefits derived from" relevant sections of the Contract, including but not limited to section 1.12 (Quality Control), section 1.17 (Warranty), and section 1.19 (Indemnity).

56. On information and belief, SDG&E joins in Edison's request for a further declaration that it is entitled to be defended, indemnified, and held harmless from and against any and all liability, damages, losses, claims, demands, actions, causes of action, and/or costs (including attorney's fees and expenses), arising from Mitsubishi's defective RSGs. An actual controversy exists between SDG&E and Mitsubishi regarding the scope

¹⁰²⁸ Claimants' Closing Presentation, slide 149; See also Exh. JX-2279, p. 4.

¹⁰²⁹ Transcript, p. 43.

¹⁰³⁰ Claimants' Closing Presentation, slide 219; See also Exh. JX-2229, p. 78.

¹⁰³¹ Exh. JX-2258, Table 11, p. 19.

of Mitsubishi' s liability under the Contract. Such a declaration is necessary and proper at this time to administer final and complete relief, and to liquidate any chance of subsequent litigation between SDG&E and any other individuals or entities. In addition, SDG&E requests all damages arising from Mitsubishi's failure to provide express indemnity, or in the alternative, SDG&E requests damages pursuant to the theory of equitable indemnity.

57. SDG&E joins in Edison's request for the full measure of direct, indirect, consequential, incidental, and special damages to which SDG&E may be entitled under California law. As a result of Mitsubishi's breaches of contract and the warranties contained therein, SDG&E has suffered or is reasonably certain to suffer all of the following losses:

- a. its share of the costs of the purchase and installation of the faulty RSGs;
- b. its share of the costs incurred in reliance on the RSGs operating in accordance with the Contract, including capital additions to SONGS and unused nuclear fuel;
- c. its share of the costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work;
- d. increased operation, maintenance, and security costs, as well as generation portfolio effects attributable to the SONGS RSG outages;
- e. costs of purchasing power to serve the SONGS Owners' customers who otherwise would have been served by SONGS;
- f. lost revenue and/or profits;
- g. costs of capacity and transmission upgrades, including efforts to support grid reliability, made necessary by the SONGS outages;
- h. its share of the lost value of SONGS;

1. costs related to NRC and CPUC proceedings triggered by the SONGS outage;

J. its share of the pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;

k. all costs of legal representation and assistance related to the enforcement of the Contract; and

l. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the arbitration Tribunal deems just.

58. SDG&E seeks damages for all injuries proximately caused by Mitsubishi's negligence and negligent interference with prospective economic advantage, including:

a. its share of the costs of the purchase and installation of the faulty RSGs;

b. its share of the costs incurred in reliance on the RSGs operating in accordance with the Contract, including capital additions to SONGS and unused nuclear fuel;

c. its share of the costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work;

d. increased operation, maintenance, and security costs, as well as generation portfolio effects attributable to the SONGS RSG outages;

e. costs of purchasing power to serve the SONGS Owners' customers who otherwise would have been served by SONGS;

f. lost revenue and/or profits;

g. costs of capacity and transmission upgrades, including efforts to support grid reliability, made necessary by the SONGS outages;

h. its share of the lost value of SONGS;

1. costs related to NRC and CPUC proceedings triggered by the SONGS outage;

J. its share of the pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;

k. all costs of legal representation and assistance related to the enforcement of the Contract; and

1. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the arbitration Tribunal deems just.¹⁰³²

787. The Memorial and Reply Memorial of SDG&E affirmed their request for relief.

788. In their closing submission at the arbitration, the Claimant SDG&E identified their damages as totaling 1,761 billion dollars.¹⁰³³

789. In its alternative claim for rescission, Claimant SDG&E seeks its share of the rescission damages claimed by the Claimants, 718 million dollars.¹⁰³⁴

I. THE RESPONDENTS' RELIEF SOUGHT

790. The Respondents' Answer to the Request for Arbitration provides:

49. For the foregoing reasons, Mitsubishi requests that the Arbitral Panel dismiss Edison's claims against Mitsubishi and enter an award in Mitsubishi's favour providing for: (1) payment for Mitsubishi's costs in pursuing tube bundle replacement in an amount to be proved, (2) payment of Mitsubishi's costs for extra-contractual services rendered to Edison to support the SONGS return to service effort in an amount to be

¹⁰³² SDG&E's RfA, ¶¶ 55-58.

¹⁰³³ Claimants' Closing Presentation, slide 149; See also Exh. JX-2279, p. 4.

¹⁰³⁴ SDG&E's Post-Hearing Memorial, ¶ 110.

proved, (3) recovery of any overpayment of the \$45 million provisional payment Mitsubishi made to Edison in an amount to be proved, (4) recovery of the \$1,971,647 final milestone payment due under the RRVH Contract, (5) interest on the above amounts, (6) Mitsubishi's reasonable attorney's fees in pursuing its claims and defences herein, and (7) such further relief as the Arbitral Panel deems appropriate.¹⁰³⁵

791. With regard to the separate claims of Riverside and SDG&E, in their Consolidated Answer to Joinder of Claim and Counterclaim, the Respondents:

Requests that the Arbitral Tribunal enter an award in Mitsubishi's favour against Riverside and SDG&E providing for: (1) payment for Mitsubishi's costs in pursuing tube bundle replacement in an amount to be proved, (2) payment of Mitsubishi's costs for extra-contractual services rendered to Edison to support the SONGS return to service effort in an amount to be proved, (3) recovery of any overpayment of the \$45 million provisional payment Mitsubishi made to Edison in an amount to be proved, (4) recovery of the \$1,971,647 final milestone payment due under the RRHV contract, (5) interest on the above amounts, (6) Mitsubishi's reasonable attorney's fees in pursuing its claims and defences herein, and (7) such further relief as the Arbitral Tribunal deems appropriate.¹⁰³⁶

792. In their Post-Hearing Memorial, the Respondents qualify their relief sought as follows:

192. Respondents respectfully request that Claimants' claims for relief be denied in full, that Mitsubishi's Counter-Claims be granted and Claimants fully compensate Respondents for all their party costs and expenses connected with the present arbitral proceedings, including its attorneys' fees and such other costs as Respondents/Counter-Claimants will specify in due course.¹⁰³⁷

¹⁰³⁵ Respondents' Answer, p. 49.

¹⁰³⁶ Respondents' Consolidated Answer, pp. 9-10.

¹⁰³⁷ Respondents' R-PHM, ¶ 192.

IX. INTRODUCTION TO TRIBUNAL'S CONSIDERATIONS**A. GENERAL OVERVIEW**

793. This arbitration has raised a significant number of technical and legal issues. The Tribunal's considerations focus on answering the Issues¹⁰³⁸ as put by the Parties and agreed to at the Hearing.
794. In addition, to facilitate the resolution of a number of these Issues, on which certain technical or factual determinations were required, the Tribunal has also provided its conclusions on certain additional factual aspects. For example, prior to addressing Issue B, generally regarding alleged breaches of contract on account of various design errors which the Claimants have alleged, the Tribunal first addresses these design errors. In doing so, the Tribunal is particularly guided by the expert evidence the Parties have submitted.

B. LIST OF ISSUES

795. As indicated in Section V above, the Parties' summary of their respective positions on the Issues for determination by this Tribunal are provided in this Award under sections titled "Claimants' Position" and "Respondents' Position." These submissions are taken from the Parties' PHM and RPHM submissions.
796. The Claimants' RPHM tracked the List of Issues and as such those submissions are included in this Award. The Respondents' RPHM address the matters in dispute in this arbitration, although does not track the List of Issues submission. Accordingly, the Respondents' RPHM is not included in this present Award. The Respondents' RPHM submissions are nonetheless considered by the Tribunal in rendering this present Award.

¹⁰³⁸ Issues, as specified in the List of Issues (See Annex B to the Award).

797. The Tribunal's consideration of the List of Issues submissions is not limited to the reasoning as summarized by the Parties in this Award, but rather includes all submissions and evidence put before it.

C. THE CONCURRING AND DISSENTING OPINION

798. In this Award, references to the Tribunal include the views of the concurring and dissenting arbitrator, except as otherwise specified in his separate opinion.

799. The Majority has had the opportunity to consider the Concurring and Dissenting Opinion of Mr. Schiller and its considerations of that Opinion are incorporated in this present Award.

X. BURDEN OF PROOF (ISSUE A)

800. In the Parties' submissions below, they have raised introductory questions of law surrounding the other Issues in dispute between the Parties.

801. The Tribunal's reasoning on the various sub-Issues in Issue A is briefly provided. The Tribunal considers that in general, the Party bringing the allegation has the burden of proof on that particular Issue. The Tribunal generally addresses the sub-Issues below in its analysis of the other Issues in dispute.

A. HAVE THE CLAIMANTS CARRIED THEIR BURDEN OF PROOF ON THE FOLLOWING ISSUES (ISSUE A.1)

802. The Claimants bear the burden of proof on the factual issues in dispute in this arbitration. A summary of the Claimants' case as set forth in the List of Issues is set forth below.

(a) Claimants' breach of contract claim (Issue A.1(a))

803. The Claimants have alleged various breaches of the RSG Contract. A number of these relate to the various alleged design errors as put forth by the Claimants. Other

contractual breaches are distinct issues, including the allegations of breach of contract for unpaid invoices and failure to allow access to documents.

(i) The Claimants' Position

804. In their Responses to Joint List of Issues, the Claimants submit that they “have established by a preponderance of the evidence (i.e., that it is more likely than not) that Respondents failed to perform certain duties and to meet certain standards of performance beyond those contained in the warranty, and that Respondents’ failures caused Claimants to suffer damages. In doing so, Claimants carried their burden of proving that Respondents breached the RSG Contract.”¹⁰³⁹
805. In addition, in their C-RPHM, the Claimants contend that “[t]here is no dispute between Claimants and Respondents regarding the elements of a claim for breach of contract.”¹⁰⁴⁰ Further, in response to the Respondents’ submissions, the Claimants contend the following:

Respondents disagree, asserting that Claimants “have shown no breach of any contract design obligation nor, importantly, established that the alleged breaches caused their damages.” This claim is incongruous in light of the evidence. As detailed *infra* at Section B, Claimants have met their burden of proof for breach of contract.

Respondents further allege that “Claimants may not maintain separate breach claims under the RSG Contract apart from their claim for breach of warranty.” Under California law, breach of contract and breach of warranty are separate causes of action. That the RSG Contract’s Warranty provides remedies for a breach of the RSG Contract’s Warranty (RSG Contract Section 1.17.14) does not limit the remedies available for a breach of contract action.¹⁰⁴¹

¹⁰³⁹ Claimants’ Responses to Joint List of Issues, ¶ A.1(a).

¹⁰⁴⁰ Claimants’ RPHM, ¶ 29.

¹⁰⁴¹ Claimants’ RPHM, ¶¶ 29-30.

(ii) The Respondents' Position

806. In their Position Statement on the Revised List of Issues, Respondents contend the following:

Claimants have raised a number of design-related breach claims as well as a breach of warranty claim under the RSG Contract, discussed separately below. Claimants have the burden of proving each of the required elements of a claim for breach of contract: (1) the existence of a binding contract, (2) performance of any applicable obligations by the parties seeking redress, (3) proof of breach, and (4) damages. Claimants have not met this burden.

(...)

[E]ven if Claimants were to establish all of the elements of breach of contract, Claimants must separately establish that a design-related breach is not subsumed in their breach of warranty claims. It is Mitsubishi's position that Claimants may not maintain separate breach claims under the RSG Contract apart from their claim for breach of warranty. The warranty provision contained in section 1.17 of the RSG Contract establishes the exclusive remedial scheme for addressing a "Defect" under the RSG Contract. Design-related breach claims are subsumed in Mitsubishi's warranty obligations and Claimants may not state separate claims for breach independent of the warranty and remedy provisions.

Even if Claimants were entitled to bring breach of contract claims independent of the remedial warranty provisions in the RSG Contract, as discussed in detail in section B below, Claimants have not established the required elements to prevail on any of their breach claims. They have shown no breach of any contract design obligation nor, importantly, established that the alleged breaches caused their damages.¹⁰⁴²

(iii) Tribunal's Determination

807. The Parties are agreed in their Post-Hearing Memorials and their respective positions on the List of Issues that the test for the Claimants' breach of contract claim is as set forth under *Spinks*.¹⁰⁴³ Under *Spinks* "a cause of action for breach of contract requires

¹⁰⁴² Respondents' Position Statement on the Revised List of Issues, ¶¶ 8-10.

¹⁰⁴³ Exhibit CL-237 (*Spinks v. Equity Residential Briarwood Apartments*, 171 Cal. App. 4th 1004, 1031 (2009)) [*"Spinks"*].

pleading of a contract, plaintiff's performance or excuse for failure to perform, defendant's breach and damage to plaintiff resulting therefrom."¹⁰⁴⁴

808. Whether the Respondents breached the RSG Contract is determined in Section XIII below, regarding Issue B, the Claimants' breach of contract claims.
809. The Respondents further submit that the Claimants bear the burden of establishing a causal link between any alleged breach and the alleged damages suffered by the Claimants. The Claimants do not dispute this requirement from *Spinks*. The Tribunal's determination on this is set forth in Section XX below, addressing Issue H, damages.
810. In addition, the Respondents submit that the Claimants bear the burden of demonstrating that the warranty provision in Section 1.17 of the RSG Contract is not the Claimants' exclusive remedy for breach. The Tribunal's determination is set forth in Section XVII below, Issue E, regarding remedies.
811. For the reasons set forth in the above referenced sections, the Tribunal concludes that the Claimants have not met their burden in relation to their breach of contract claim, except as in regards to Issue B.7, regarding the Claimants' unpaid expenses, and as to non-material claims.

(b) Claimants' breach of warranty claim (Issue A.1(b))

812. The Parties disagree as to whether the Claimants' alleged breach of contract claims constitute breaches of the contract or trigger the warranty provisions under Section 1.17 of the RSG Contract. The Parties further disagree as to whether the Respondents

¹⁰⁴⁴ *Spinks*, 1031.

met their obligations under the warranty provisions, and if not, whether that failure is on account of the Claimants' own actions.

(i) The Claimants' Position

813. In their Responses to Joint List of Issues, the Claimants submit that they “have established by a preponderance of the evidence (i.e., that it is more likely than not) that Respondents provided an express warranty that the RSGs would be “free from Defects” for 20 years and that any Defects would be repaired or replaced with due diligence and dispatch and that Respondents failed to meet these promises, thereby breaching the warranty and causing Claimants to suffer damages.”¹⁰⁴⁵
814. In addition, in their C-RPHM, the Claimants contend that “[t]here is no dispute between Claimants and Respondents regarding the elements of a claim for breach of warranty.”¹⁰⁴⁶

(ii) The Respondents' Position

815. In their Position Statement on the Revised List of Issues, the Respondents contend that “Claimants (...) have the burden of proving that MHI breached any warranty obligation under the RSG Contract. To prevail on a breach of warranty claim, Claimants must show (1) the existence of a binding contract for the sale of goods, (2) the presence of an express or implied warranty within that contract, (3) breach, (4) damages, and (5) timely notice. As discussed in detail in Section C below, Claimants have not established the required elements to prevail on their claim for breach of warranty. MHI satisfied its warranty obligations, except as excused by Edison's objectively unreasonable actions preventing MHI from implementing its repair.”¹⁰⁴⁷

¹⁰⁴⁵ Claimants' Responses to Joint List of Issues, ¶ A.1(b).

¹⁰⁴⁶ Claimants' RPHM, ¶ 31.

¹⁰⁴⁷ Respondents' Position Statement on the Revised List of Issues, ¶ 11.

(iii) Tribunal's Determination

816. As set forth in their Post Hearing Memorials and their respective positions on the List of Issues, the Parties are in agreement that the test for breach of warranty is as set forth in *Scott*.¹⁰⁴⁸ Under *Scott*, the elements of a breach of warranty claim under California law are (i) the existence of a binding contract for the sale of goods; (ii) the presence of an express or implied warranty within that contract; (iii) breach, (iv) damages; and (v) timely notice.¹⁰⁴⁹
817. There is also no disagreement between the Parties that the RSG Contract contains a clear warranty clause at Section 1.17.1 under which the Respondents warranted to provide RSGs that would be free from defects for 20 years and that any defects would be repaired or replaced with due diligence and dispatch.
818. There is no disagreement between the Parties that the RSGs were not repaired.
819. Whether the Claimants have carried their burden of proof in regarding to their warranty claims is determined in Section XV below, which addresses Issue C.

(c) That the RSG Contract's warranty remedy failed of its essential purpose (Issue A.1(c))

820. The Claimants submit that the RSG's warranty provisions were ineffective under California law and should be set aside under the failure of essential purpose doctrine, allowing for vacating of the limitation of liability clause.

(i) The Claimants' Position

821. In their Responses to Joint List of Issues, the Claimants submit that they "established by a preponderance of the evidence (i.e., that it is more likely than not) that

¹⁰⁴⁸ *Scott v. Metabolife Int'l, In.*, 115 Cal. App. 4th 404 (2004) [*Scott*].

¹⁰⁴⁹ *Scott*, 414-415.

Mitsubishi was unwilling or unable to repair or replace the RSGs with due diligence and dispatch, as required to fulfill the warranty remedy's essential purpose.”¹⁰⁵⁰

822. Further, they submit the following:

Respondents promised to provide Defect-free steam generators and further promised to repair or replace any Defects that arose for 20 years from the date of acceptance with due diligence and dispatch (the “Defect Warranty”). In exchange, Claimants agreed to limit Mitsubishi's overall liability by capping damages at 100% of the purchase price and waiving consequential damages.

Section 2719 of the California Commercial Code provides that when a limited remedy, such as the “repair or replace” warranty here, fails of its essential purpose, any contractual limitations of liability must give way to the Code's general damages provisions. The warranty and limitation of liability here are part of a “unitary package of risk allocation”—the provisions work together to protect the interests of both buyer and seller. The Ninth Circuit has clearly distilled the applicable law into a two-pronged test. First, did the limited remedy—repair or replacement—fail its essential purpose? If so, then the cap on damages is unenforceable and must give way to the general remedy provision of the Commercial Code. Second, is the failure of the limited remedy total and fundamental (i.e., has the waiver of consequential damages become oppressive by change of circumstances)? If so, the waiver of consequential damages must be expunged from the contract.

The RSG Contract provides that the repair-or-replacement warranty is Claimants' “sole remedy,” and that remedy failed of its essential purpose. The other alleged remedies in the RSG Contract are intended to augment the repair-or-replace warranty, not to supplant it. Claimants were not required to accept other lesser remedies in lieu of repair or replacement. Respondents' proposed Type 1 Repair would not have resolved the Defects in Mitsubishi's design and, in any case, the repair was still far from being implemented (or implementable) when Claimants were forced to shutter SONGS some 16 months after the RSG failures. Respondents admitted that they never sincerely offered to replace the RSGs. Accordingly, the liability cap and mutual waiver of consequential damages should be invalidated.¹⁰⁵¹

¹⁰⁵⁰ Claimants' Responses to Joint List of Issues, ¶ A.1(c).

¹⁰⁵¹ Claimants' Responses to Joint List of Issues, ¶ A.1(c).

823. In addition, in their C-RPHM, in response to the Respondents' submissions, the Claimants contend the following:

Respondents argue that Claimants must first “prove that the Commercial Code, and specifically Section 2719 of the Commercial Code, applies to this case.” Claimants have established that Commercial Code Section 2719 governs this matter. Section 2719 provides that when a limited remedy, such as the “repair or replace” remedy here, fails of its essential purpose, any contractual limitations of liability must give way to the Code’s general damages provisions. The RSG Contract’s warranty and limitations of liability are part of a “unitary package of risk allocation”—the provisions work together to protect the interests of both buyer and seller.

The Ninth Circuit has clearly and repeatedly distilled the applicable law into a two-pronged test.

First, did the limited remedy—repair or replacement—fail its essential purpose? If so, then the cap on damages is unenforceable and must give way to the general remedy provision of the Commercial Code.

Second, is the failure of the limited remedy total and fundamental (i.e., has the waiver of consequential damages become oppressive by change of circumstances)? If so, the waiver of consequential damages must be expunged from the contract.

The facts of this case establish that the limited remedy—repair or replacement—failed its essential purpose and that the failure was total and fundamental.

Respondents further argue that Claimants never attempted to pursue the default or backcharge options within RSG Contract Section 1.17.1.3(b), and because of this, Claimants were not deprived of the Warranty remedies in Section 1.17.1.3; “they simply chose not to avail themselves of them.” This is not correct under the Contract’s plain language. Repair or replacement is Claimants’ “sole remedy” for breach of the warranty. The default and backcharge options augment the repair-or-replace remedy; they do not supplant it, nor could they under the Contract’s terms. Claimants were not required to

accept these or any other lesser remedies in lieu of Respondents' promise to "repair or replace."¹⁰⁵²

(ii) *The Respondents' Position*

824. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants cannot meet the burden required to show the Warranty failed of its essential purpose. As one theory for setting aside the contractual limitations on liability in the RSG Contract, Claimants argue that under the California Commercial Code ("Commercial Code") the Warranty remedy failed of its essential purpose, thus permitting Claimants to pursue other remedies under the Commercial Code and to recover damages in excess of the Liability Cap, including consequential damages.

There are several steps associated with Claimants' burden on this issue. First, Claimants must prove that the Commercial Code, and specifically section 2719 of the Commercial Code, applies to this case. Claimants have not met this burden as addressed in Issues A.3(a) and F.1 below.

Second, Claimants must prove that the Warranty provision (RSG Contract section 1.17), with its multiple component parts, failed of its essential purpose. To do so, Claimants must prove Claimants were "deprived of [their] contractual remedy" and that "enforcement of the limited remedy would essentially leave plaintiff with no remedy at all." Claimants cannot meet this burden either. RSG Contract section 1.17.1.3 provides Edison with Mitsubishi's commitment to act with due diligence and dispatch to repair or replace problems associated with Defects. It also gives Edison the option to 1) independently work with third parties to "perform[] such necessary warranty work and backcharge the Supplier ... and/or 2) declare Supplier to be in default pursuant to section 1.24." Claimants' rights under the default option included terminating the Purchase Order and seeking a refund of up to the Liability Cap. As a matter of law, even if the repair option was not viable as Claimants contend, for example, the refund up to the amount of the Liability Cap (which was the Purchase Price) was a "minimum adequate remedy."

As addressed repeatedly in witness statements and hearing testimony, Mitsubishi acted with due diligence and dispatch in pursuing repair and replacement options for SONGS until Claimants decided to close the plant for

¹⁰⁵² Claimants' RPHM, ¶¶ 32-35.

business reasons. Mitsubishi proposed a viable thicker-AVB repair method that Claimants unreasonably ignored and rejected. Claimants instead pushed Mitsubishi toward replacement, yet when Mitsubishi then recommended replacement (another viable, but more expensive and time-consuming, option), Claimants declared Mitsubishi in breach.

Meanwhile, it is undisputed that Claimants never attempted to pursue the default or backcharge options within RSG Contract section 1.17.1.3(b). Under these circumstances, Claimants were not deprived of the Warranty remedies in section 1.17.1.3; they simply chose not to avail themselves of them.

(...)

Claimants cannot prove that the Warranty failed of its essential purpose under these circumstances.¹⁰⁵³

(iii) Tribunal's Determination

825. The Parties are in agreement that if the California Commercial Code applies to this dispute, Issue A.1(c), is governed by Section 2719 of the California Commercial Code.
826. Whether the California Commercial Code applies and whether the Claimants have carried their burden of proof is determined, to the extent required, in Section XVIII.A below.

(d) That the RSG Contract's liability cap should be invalidated (Issue A.1(d))

827. The Claimants submit that under the California Commercial Code and applicable authorities, the RSG Contract's limitation of liability clause should be set aside. The Respondents challenge the applicability of the California Commercial Code and seek to distinguish the applicability of the Claimants' submitted legal authorities on the facts of this present case.

¹⁰⁵³ Respondents' Position Statement on the Revised List of Issues, ¶¶ 12-17.

(i) The Claimants' Position

828. In their Responses to Joint List of Issues, the Claimants submit that “[w]here, as here, a limited remedy fails of its essential purpose, a breaching seller’s liability is no longer limited to that remedy. A repair or replace remedy fails of its essential purpose within the meaning of Section 2719 if the breaching manufacturer or seller is unwilling or unable to provide goods conforming to the contract within a reasonable time. Respondents concede this is the standard. Here, the evidence shows that Mitsubishi was “either unwilling or unable to provide a system that work[ed] as represented.” After 16 months, and substantial support from Edison (which was not required under the RSG Contract), Mitsubishi was unwilling or unable to offer a viable repair proposal, let alone complete an actual repair. Even now, after three plus years of working on its repair proposal, Mitsubishi still cannot demonstrate that its Type 1 Repair would fix the root causes and not cause harmful secondary effects. [Accordingly], the Defect Warranty failed of its essential purpose.”¹⁰⁵⁴

(ii) The Respondents' Position

829. In their Position Statement on the Revised List of Issues, the Respondents contend that “[e]ven if the Tribunal finds that the Commercial Code applies and the limited Warranty failed of its essential purpose, both threshold issues which are disputed, Claimants still bear the burden to prove the failure of the Warranty should result in striking down the Liability Cap as well. Claimants do not and cannot meet this burden.”¹⁰⁵⁵

830. In addition, the Respondents submit:

Depending on which analytical approach the Tribunal adopts, Claimants’ burden to invalidate the Liability Cap is to prove that either (1) under an independent analysis, the Liability Cap failed of its essential purpose (to

¹⁰⁵⁴ Claimants’ Responses to Joint List of Issues, ¶ A.1(d).

¹⁰⁵⁵ Respondents’ Position Statement on the Revised List of Issues, ¶ 18.

allocate risk between the parties), or (2) given the totality of the circumstances, including the sophistication of the parties and the efforts made by Mitsubishi, that the Liability Cap should be invalidated. As set forth in detail below in sections F.2(a) and F.2(b)(iii), the Liability Cap should be enforced regardless of which approach is adopted because the case law uniformly upholds limitations of liability provisions – even if faced with a repair remedy that failed of its essential purpose – where the buyer has other remedies available, including the ability to recover up to the Purchase Price which as a matter of law constitutes a “minimum adequate remedy,” where the risk allocation provisions were heavily negotiated by sophisticated parties, where a complex piece of equipment was involved, and where the seller did not ignore its warranty obligations but rather performed in good faith.

Separately, in order to invalidate the Liability Cap based on specific contractual exceptions, Claimants not only have the burden of proving an actionable breach of contract or breach of warranty, they hold the additional burden of proving gross negligence, fraud, or intentional or unlawful conduct. Claimants have not met this burden.

Finally, Claimants have also failed to meet their burden to prove that the Liability Cap should be invalidated under California Civil Code section 1668. As discussed in section F.3 below, section 1668 does not apply to provisions that do not provide a complete exemption, but rather only limit liability for economic harm. Even if section 1668 might otherwise apply, California case law demonstrates that in this case, more specific provisions in Commercial Code section 2719(3) would govern instead.¹⁰⁵⁶

(iii) Tribunal’s Determination

831. The Parties are in agreement that this Issue is governed by Section 2719 of the California Commercial Code.
832. Whether Section 2719 is applicable and if so whether the Claimants have carried their burden of proof that the RSG’s liability cap should be invalidated is determined, to the extent required, in Section XVIII.A below, addressing Issue F.

¹⁰⁵⁶ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 19-21.

(e) **That the RSG Contract’s mutual waiver of consequential damages should be invalidated (Issue A.1(e))**

833. The Claimants submit that on account of the scope of the Respondents’ failure not only does the limitation of liability fail, but also the consequential damages waiver. The Respondents dispute this and further disagree as to the relevant provisions of the California Commercial Code governing consequential damages.

(i) *The Claimants’ Position*

834. In their Responses to Joint List of Issues, the Claimants submit the following:

Where, as here, a limited remedy fails of its essential purpose, and the failure is total and fundamental *or* enforcement of a waiver of consequential damages has become oppressive by a change of circumstances, the consequential damages waiver must be invalidated. Four Ninth Circuit cases provide the standard for determining whether a failure of a limited remedy is “total and fundamental”—such that a waiver of consequential damages must be expunged. In *RRX, Milgard*, and *Fiorito Bros.*, the Ninth Circuit held that where there was no repair at all within a reasonable time, the failure of the limited remedy was total and fundamental. By contrast, the Ninth Circuit’s decision in *S.M. Wilson* illustrates when the waiver of consequential damages remains enforceable—*i.e.*, when the seller’s default is not total and fundamental. There, the Ninth Circuit’s reasoning relied on several factors—most significantly, that the goods in questions remained operable, albeit at a slower pace than anticipated. None of the facts relied upon by the Ninth Circuit in *S.M. Wilson* are present here.

The record is clear that the failure of the limited remedy in this case was total and fundamental. The RSG Contract repeatedly establishes that time is of the essence, and the Warranty clearly articulates the importance of prompt repairs, minimizing any steam generator downtime. The Warranty requires Mitsubishi to repair “with due diligence and dispatch,” to begin repairs “within two days,” to continue performing repairs diligently, and to perform Warranty repairs “at the Jobsite to minimize the down time of the Apparatus.” There was no fix for the RSGs that could be completed—*i.e.*, get the RSGs back up and running—within a reasonable time period, let alone with “dispatch.” Even if Mitsubishi’s Type 1 Repair proposal could have been presented to the NRC in June 2013—which it certainly could not have—and even if the Type 1 Repair would have been approved—which, again, it would not have—the repair still would have taken another 65 months (at a minimum) to implement. Thus, any repair or

replacement of the RSGs would have taken five to seven years to complete. As Mitsubishi admitted in 2012, a repair or replacement requiring that amount of time was “beyond the scope of [the parties’] agreement.” Further, Mitsubishi’s Type 3 replacement concept could not be completed with “due diligence and dispatch.”

It would be wholly inequitable and inconsistent with California law to require Edison to continue spending millions of dollars a day for years, while it waited for Mitsubishi to develop, test, and present a viable, comprehensive, supported and licensable repair plan—to say nothing of the additional years required to secure regulatory approval and implement such plans, in the poisoned regulatory environment created by Mitsubishi’s conduct. And it would be beyond folly to force Edison to wait past the point where the potential benefits of any such repair were outweighed by the real costs of keeping SONGS operable.

In addition to the total and fundamental failure of Mitsubishi’s default on its warranty obligations, the contractual waiver of consequential damages became “oppressive by change of circumstances.” As both parties agree, no one contemplated a scenario where all four RSGs were so fundamentally defective that they would all have to be taken offline at the same time, and that Mitsubishi would be unwilling or unable to repair or replace them with dispatch. Certainly Edison never contracted for the delivery of RSGs that were so riddled with deeply-embedded errors that they would exhibit thermal-hydraulic conditions never before experienced by the industry and suffer extreme and unprecedented wear leading to the permanent shutdown of SONGS. Mitsubishi’s RSGs were supposed to have a 40-year operating life, yet they failed after 11 months (for Unit 3) and 22 months (for Unit 2), respectively. As a consequence, Claimants suffered damages some 50 times more than the \$138 million limitation of liability. By any measure or reasonable consideration, enforcing the waiver of consequential damages in these circumstances would be oppressive.¹⁰⁵⁷

835. In addition, in their C-RPHM, the Claimants contend that “[t]he evidence shows that Respondents were either unwilling or unable to repair the RSGs within a reasonable time period, let alone with dispatch.”¹⁰⁵⁸ Moreover:

Because Respondents totally and fundamentally defaulted on their Warranty obligations, enforcement of the contractual waiver of consequential damages

¹⁰⁵⁷ Claimants’ Responses to Joint List of Issues, ¶ A.1(e).

¹⁰⁵⁸ Claimants’ RPHM, ¶ 38.

has become “oppressive by change of circumstances.” As Claimants and Respondents agree, no one contemplated a scenario in which all four RSGs were so fundamentally defective that they would all have to be taken offline at the same time, and that it would take at least another 5-7 years of re-design, re-engineering, and re-manufacturing to give Claimants the Defect-free steam generators for which they had contracted. Certainly, Edison never contracted for the delivery of RSGs that were so riddled with errors that they would exhibit thermal-hydraulic conditions never before experienced in the industry, and suffer extreme and unprecedented wear leading to SONGS’s permanent shutdown. Respondents’ RSGs were supposed to have a 40-year operating life, yet they failed after 11 months (for Unit 3) and 22 months (for Unit 2), respectively. By any measure or reasonable consideration, enforcing the waiver of consequential damages in these circumstances would be oppressive.¹⁰⁵⁹

(ii) *The Respondents’ Position*

836. In their Position Statement on the Revised List of Issues, the Respondents, while making reference to their submissions on Issue F, below, contend:

Claimants failed to meet their burden of proving that the mutual waiver of consequential damages (“Mutual Waiver”) should be invalidated. As explained in sections F.2(a)(iv), F.2(b), and F.2(b)(iv) below, the Commercial Code and applicable case law provides that even if the Warranty remedy failed of its essential purpose and the Liability Cap was invalidated, the Mutual Waiver must stand unless it is both procedurally and substantively unconscionable. Claimants do not attempt to prove, nor could they, that the Mutual Waiver is unconscionable where the RSG Contract was heavily negotiated by sophisticated parties, and where Claimants themselves introduced the Mutual Waiver provision which contained reciprocal benefits.

As discussed in section F.3 below, section 1668 does not apply to provisions such as the Mutual Waiver that do not provide a complete exemption, but rather only limit liability for economic harm. And even if it could apply, section 1668 is trumped by the more specific provisions in Commercial Code section 2719(3), which expressly states that a waiver of consequential damages is valid unless unconscionable.

Finally, the contractual exceptions that the parties negotiated for the Liability Cap (gross negligence, fraud, willful misconduct or illegal or unlawful acts) do not, by their terms, apply to the Mutual Waiver. Under the Mutual Waiver the

¹⁰⁵⁹ Claimants’ RPHM, ¶ 39.

parties each agreed the other would not be liable for consequential damages, without exception.¹⁰⁶⁰

(iii) Tribunal's Determination

837. The Parties are in disagreement with regard to the applicable test on this question, with the Claimants submitting the test is one of whether the failure of a limited remedy is “total and fundamental” and the Respondents submitting that the test is of “unconscionability” under Section 2719(3) of the California Commercial Code.
838. Whether the Claimants have carried their burden on this Issue is determined in Section XVIII.B below, regarding Issue F on limitation of liability. In particular, in Section XVIII.B(e)(iii), addressing Issue F.2(a)(iv), the Tribunal sets forth its considerations on the Parties’ contentions on the applicable test, which the Tribunal considers is that as put forth by the Respondents.

(f) Claimants’ negligent misrepresentation claim (Issue A.1(f))

839. The RSG Contract provides that the limitation of liability provision can be overcome on account of the Respondents’ fraud. The Claimants have submitted that the Respondents’ actions amounts to fraud, of which they submit, negligent misrepresentation is a subset.

(i) The Claimants’ Position

840. In their Responses to Joint List of Issues, the Claimants submit that “[i]n holding itself out as an expert on steam generator design, the representations that Mitsubishi made to Edison during the bid process became “actionable expressions of professional opinion rather than nonactionable predictions regarding future events.” Negligent misrepresentation requires proof of “(1) the misrepresentation of a past or existing material fact, (2) without reasonable ground for believing it to be true, (3)

¹⁰⁶⁰ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 22-24.

with intent to induce another’s reliance on the fact misrepresented, (4) justifiable reliance on the misrepresentation, and (5) resulting damage.” Importantly, in cases involving *expert professionals*—or those who hold themselves out as such—“expressions of professional opinion are treated as representations of fact” and “deliberate affirmations of fact based on special knowledge or expertise.” Claimants have established by a preponderance of the evidence (*i.e.*, it is more likely than not) that Respondents procured the RSG Contract by making unwarranted misrepresentations of fact upon which Edison justifiably relied to Claimants’ detriment.”¹⁰⁶¹

841. In addition, in their C-RPHM, the Claimants supplement the aforesaid submissions, by contending that “[t]here is no dispute regarding the elements of a claim for negligent misrepresentation. In holding themselves out as experts on steam generator design, Respondents made representations to Edison during the bid process that became “actionable expressions of professional opinion rather than nonactionable predictions regarding future events.””¹⁰⁶²

(ii) The Respondents’ Position

842. In their Position Statement on the Revised List of Issues, the Respondents contend that the “Claimants have not met their burden of proving negligent misrepresentation. To do so, Claimants must show “(1) a misrepresentation of a past or existing material fact, (2) without reasonable ground for believing it to be true, (3) with intent to induce another’s reliance on the fact misrepresented, (4) ignorance of the truth or justifiable reliance thereon by the party on whom the misrepresentation was directed, and (5) damages. As discussed in detail in Section D.2, Claimants have not done so. In fact, Claimants support this claim with only a single witness, and that witness admitted

¹⁰⁶¹ Claimants’ Responses to Joint List of Issues, ¶ A.1(f).

¹⁰⁶² Claimants’ RPHM, ¶ 40.

that he was unaware of any specific statements that Edison may have relied upon in entering into the RSG Contract. In addition, the Contract contains an integration clause in Section 1.37 that expressly supersedes any representations made by either party prior to the execution of the Contract.”¹⁰⁶³

(iii) Tribunal’s Determination

843. The Parties are agreed in the applicable test for the Claimants’ negligent misrepresentation claim, as expressed in both *CalPERS*¹⁰⁶⁴ and *Fox*.¹⁰⁶⁵
844. Whether the Claimants have carried their burden on this Issue is set forth in Section XVI below, addressing Issue D regarding the Claimants’ fraud and misrepresentation claims.

(g) Claimants’ intentional fraud claim (Issue A.1(g))

845. The RSG Contract provides that the limitation of liability provision can be overcome on account of the Respondents’ fraud. The Claimants have submitted that the Respondents’ actions amounts to fraud.

(i) The Claimants’ Position

846. In their Responses to Joint List of Issues, the Claimants submit that “[t]he procurement of a contract through an untrue or unwarranted assertion constitutes “[a]ctual fraud,” regardless of whether the party making the false statements believes them to be true. As long as it is stated “in a manner not warranted by the information of the person making it,” and reasonably relied upon by the party to which it is directed, even a negligently made statement is actionable as fraud. Indeed, California law makes clear that “negligent misrepresentation is a form of fraud” and constitutes

¹⁰⁶³ Respondents’ Position Statement on the Revised List of Issues, ¶ 25.

¹⁰⁶⁴ *CalPERS v. Moody’s Investors Serv., Inc.*, 226 Cal. App. 4th 643 (2014), CL-64, [*CalPers*].

¹⁰⁶⁵ *Fox v. Pollack*, 181 Cal. App. 3d 954 (1986), RL-122, [*Fox*].

“deceit.” Claimants have established by a preponderance of the evidence (i.e., it is more likely than not) that Respondents committed intentional fraud by procuring the contract through false representations that were not warranted by the information Respondents had and upon which Edison reasonably relied in awarding the RSG Contract. Claimants have also established that Respondents committed fraud by making material misrepresentations and omissions after obtaining the RSG Contract, upon which Claimants justifiably relied to their detriment.”¹⁰⁶⁶

847. In addition, in their C-RPHM, Claimants’ contend the following:

There is no dispute regarding the elements of a claim for intentional fraud.

(...)

Respondents allege that “[t]o establish a claim of fraudulent inducement, one must show that the defendant did not intend to honor its contractual promises when they were made.” As discussed in Section D.1(b)(ii), there is no such requirement in a claim for fraudulent inducement.¹⁰⁶⁷

(ii) The Respondents’ Position

848. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have not met their burden of proving intentional fraud. The elements of a fraud claim in California are “(a) misrepresentation (false representation, concealment, or nondisclosure); (b) knowledge of falsity (or ‘scienter’); (c) intent to defraud, i.e., to induce reliance; (d) justifiable reliance; and (e) resulting damage.” Intentional misrepresentation (fraud) carries a higher burden than negligent misrepresentation. As discussed in detail in section D.1 below, Claimants failed to meet that higher burden.

Furthermore, “[t]o establish a claim of fraudulent inducement, one must show that the defendant did not intend to honor its contractual promises when they were made.” And to recover damages for fraud, Claimants must have sustained

¹⁰⁶⁶ Claimants’ Responses to Joint List of Issues, ¶ A.1(g).

¹⁰⁶⁷ Claimants’ RPHM, ¶¶ 41-42.

damages proximately caused by the misrepresentation. As discussed in detail in section D.3 below, Claimants have not established these elements either. Again, Claimants rely upon a single witness who was unable to establish any of the above elements.¹⁰⁶⁸

(iii) Tribunal's Determination

849. The Parties are in disagreement with regard to the applicable test for whether the Respondents engaged in fraudulent misrepresentation, with the Claimants submitting the facts of this case elevate negligent misrepresentation to fraudulent misrepresentation and the Respondents submitting that the test for fraudulent misrepresentation is distinct from that of negligent misrepresentation and which the facts do not support having occurred.
850. Whether the Claimants have met their burden of proof on this Issue is set forth in Section XVI below, addressing Issue D regarding the Claimants' fraud and misrepresentation claims. In particular, in Section XVI.A(b)(iii), addressing Issues D.1(b), including Issues D.1(b)(i) and D.1(b)(ii), the Tribunal determines that the facts of this case are insufficient to meet the test as submitted by either of the Parties.

(h) Claimants' rescission claim (Issue A.1(h))

851. The Claimants alternative submission in this case is that on account of the total failure of consideration of in the provision of RSGs that the RSG Contract should be rescinded.

(i) The Claimants' Position

852. In their Responses to Joint List of Issues, the Claimants, placing reliance on Californian case law, make the following submissions:

“California law provides that a party may unilaterally rescind a contract if there is a material breach by the other party.” Claimants have demonstrated that

¹⁰⁶⁸ Respondents' Position Statement on the Revised List of Issues, ¶¶ 26-27.

Mitsubishi failed to supply RSGs “free from Defects,” and to repair the RSGs “at its sole expense with due diligence and dispatch.” These failures permit Claimants to rescind the RSG Contract: “if there was a breach of warranty, that is, if in any respect the machine was not what it was warranted to be,” a party has “the right ... to rescind the sale.” The reason for this rule is that a warranty is “an essential part” of the “inducement for the payment” such that an agreement “would not have been executed” without it. The evidence shows that the parties in this case viewed the repair warranty as just such an essential inducement.

Mitsubishi’s misrepresentations provide an alternative, independent basis for the rescission of the RSG Contract. Claimants have shown that Mitsubishi procured the RSG Contract by misrepresenting its ability to model thermal-hydraulic conditions and vibrational phenomena within the RSGs. Under California law, the effect of these misrepresentations is to grant Claimants a right to rescind the RSG Contract.¹⁰⁶⁹

853. In addition, in their C-RPHM, the Claimants clarify that the “Respondents’ argument that Claimants lack “standing” to pursue rescission fails for the myriad reasons provided (...) in Section G(4).”¹⁰⁷⁰

(ii) *The Respondents’ Position*

854. In their Position Statement on the Revised List of Issues, the Respondents contend that the “Claimants have failed to meet their burden to show that they are entitled to rescission (...) First, Claimants refuse to acknowledge that as third party beneficiaries to the Contract, Edison, SDG&E and Riverside lack standing to pursue this claim. Moreover, even if this fundamental defect is ignored, Claimants have failed to prove either of their claimed statutory bases for rescission: fraud in the inducement, or failure of consideration. Additionally, Claimants have failed to acknowledge their statutory and equitable obligation under rescission to restore to Mitsubishi the value of its services rendered in reliance on the Contract (i.e., return Mitsubishi to the *status quo ante*). Finally, Claimants have failed to show that

¹⁰⁶⁹ Claimants’ Responses to Joint List of Issues, ¶ A.1(h).

¹⁰⁷⁰ Claimants’ RPHM, ¶ 43.

rescission would be equitable in this case, or to provide any citation to legal precedent permitting rescission in a case even remotely similar to this case. Granting rescission in such a complex transaction involving sophisticated parties as is the case here would be truly unprecedented.”¹⁰⁷¹

(iii) Tribunal’s Determination

855. The Parties are in agreement that the test for rescission is whether MHI procured the contract under a fraudulent inducement, by fraudulent misrepresentation or on account of material failure of consideration.
856. There is disagreement as to whether any of the Claimants apart from Edison Material Supply may claim a rescission remedy and further disagreement as to whether rescission is an available remedy on the facts of this case given the inability of the Claimants to restore to MHI the value of the services rendered, let alone return the RSGs.
857. Whether the Claimants have carried their burden of proof to establish their claim of rescission is set forth in Section XIX below, addressing Issue G regarding the Claimants’ rescission claim.

(i) Claimants’ damages (Issue A.1(i))

858. The Claimants have quantified their alleged damages under both their material breach of contract claim and under their rescission claim.

(i) The Claimants’ Position

859. In their Responses to Joint List of Issues, the Claimants submit that they “met their burden of establishing by a preponderance of the evidence (*i.e.*, it is more likely than not) that they incurred damages. Where Claimants have met their burden with respect

¹⁰⁷¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 28.

to the fact of damages, the amount of damages need not be calculated with absolute certainty. The law requires only that some reasonable basis of computation of damages be used, and the damages may be computed even if the result reached is an approximation. Claimants have demonstrated a reasonable basis for their benefit-of-the-bargain damages.”¹⁰⁷²

860. Further, the Claimants submit that:

Mitsubishi’s breaches of contract and warranty entitle Claimants to recover the benefit of their bargain, which is all “loss resulting in the ordinary course of events” from Mitsubishi’s failures, including consequential damages for foreseeable losses. The exhaustive analysis of Claimants’ expert witnesses demonstrates that Mitsubishi has caused billions of dollars in harm, and the evidence is more than sufficient for the Tribunal to award the complete measure of Claimants’ benefit of the bargain damages (which is also the proper damages measure for Mitsubishi’s misrepresentations). *See infra* at section H: Damages.

Claimants have also met their burden of establishing their rescissory damages by a preponderance of the evidence. As the California Supreme Court has explained, rescission “puts the rescinding party in the *status quo ante*, returning him to his economic position before he entered the contract.” The law recognizes that “[i]t is usually impossible, after the lapse of a considerable time, to place a person *exactly* in the position he was in at the time he made the contract,” but “the fact that the *status quo* cannot be exactly reproduced *will not preclude* the plaintiff from equitable relief.” If the parties had never entered into a commercial relationship, Claimants would have avoided \$3.581 billion in present value terms (and more than \$2.4 billion in nominal dollars). These costs are Claimants’ reliance interest, which rescission justly restores to Claimants “for the purpose of undoing the harm which his reliance on the defendant’s promise has caused him.”¹⁰⁷³

¹⁰⁷² Claimants’ Responses to Joint List of Issues, ¶ A.1(i).

¹⁰⁷³ Claimants’ Responses to Joint List of Issues, ¶ A.1(i).

(ii) The Respondents' Position

861. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have failed to meet their burden of proof on both benefit of the bargain and rescission damages.

To prove benefit of the bargain damages, Claimants must show (1) damages were caused by conduct for which Mitsubishi was found liable; (2) damages were reasonably certain to occur; (3) the extent and amount of damages is reasonably certain; and (4) damages were foreseeable or naturally flowed from any conduct for which Mitsubishi was found liable. Claimants must also show that their damages are not barred by the RSG Contract's Mutual Waiver of Consequential Damages. Claimants have failed to meet their burden of proof on benefit of the bargain damages as discussed in section H below.

Claimants have also failed to meet their burden to prove they are entitled to rescission damages, as discussed more fully in section H.2 below. Claimants improperly seek many damages categories that are wholly inappropriate under a rescission remedy, and overstate and fail to support the arguably permissible damages they do seek. Moreover, Claimants' rescission damages calculations are inflated due to their refusal to acknowledge, much less account for, the value of services Mitsubishi conferred upon Claimants in reliance upon the Contract.¹⁰⁷⁴

(iii) Tribunal's Determination

862. Whether the Claimants have carried their burden of proof on damages is set forth in Section XX below, which concerns Issue H, damages.

863. On this Issue, as set forth in its reasoning in Section XX below, the Tribunal accepts the Claimants' position that damages must be proven by the preponderance of the evidence, that the amount of damages need not be calculated with absolute certainty, and that the Claimants need only demonstrate, with reasonable certainty, the nature and origin of the damages.

¹⁰⁷⁴ Respondents' Position Statement on the Revised List of Issues, ¶¶ 29-31.

B. HAVE THE RESPONDENTS CARRIED THEIR BURDEN OF PROOF ON THE FOLLOWING ISSUES (ISSUE A.2)

864. The Respondents have submitted a number of affirmative defenses and case theories in addition to counterclaims.

(a) That the Respondents were excused from further performance of the RSG Contract because of Claimants' conduct (Issue A.2(a))

865. Under the Respondents' theory of the case, the RSGs were not repaired but could have been repaired had the Claimants operated according to standard practice in the nuclear industry by engaging in an iterative process to approve a repair option. Further, the Respondents submit that the Claimants were not genuinely interested in a repair option.

(i) The Claimants' Position

866. In their Responses to Joint List of Issues, the Claimants submit that the "Respondents have failed to prove that Edison acted unreasonably or not in good faith at any point during the period of contractual negotiations, design, manufacture, installation, or in seeking to restore the RSGs to service after they failed due to Mitsubishi's flawed design."¹⁰⁷⁵

867. Further, with respect to the reasonableness and the rationality of their conduct, the Claimants contend:

Claimants' request that Mitsubishi resolve the extreme thermal-hydraulic conditions in the RSGs was both reasonable and absolutely necessary in light of the failures of the RSGs, the recommendations of its consultants, and the actions and statements of Mitsubishi. Respondents have not—and cannot—prove that Edison unreasonably or in bad faith withheld support for the flawed Type 1 Repair Concept. To the contrary, Edison demonstrated its support of the repair efforts by establishing the Steam Generator Repair Team and

¹⁰⁷⁵ Claimants' Responses to Joint List of Issues, ¶ A.2(a).

fronting \$181 million (nominal) toward recovery efforts out of its own pockets, the bulk of which Mitsubishi has yet to repay. Finally, Mitsubishi conceded that Edison's decision to shut down SONGS was a "rational business decision," and the record is replete with evidence fully explaining the economic bases for that decision.¹⁰⁷⁶

(ii) *The Respondents' Position*

868. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Respondents have met their burden to show that they were excused from further performance of the RSG Contract because of Claimants' unreasonable conduct. section 1.17.1.3 of the RSG Contract required Edison to mutually agree with Mitsubishi's proposed remedy before it could be implemented at SONGS. Under California law, the standard as to whether Mitsubishi was excused is whether Edison acted in an objectively reasonable manner in not allowing Mitsubishi to move forward with its proposed thicker-AVB repair or replacement concepts. Edison was bound by the covenant of good faith and fair dealing implied in every contract to act reasonably in agreeing to the repair. "The covenant of good faith finds particular application in situations where one party is invested with a discretionary power affecting the rights of another." The California Supreme Court has recognized that the covenant of good faith and fair dealing requires a party to act in a manner that is both subjectively *and* objectively reasonable. An analogy can also be appropriately made to satisfaction clauses under California law. In such cases, where the satisfaction clause concerns "commercial value or quality, operative fitness, or mechanical utility, dissatisfaction cannot be claimed arbitrarily, unreasonably, or capriciously," and the standard is that "of a reasonable person."

Here, Edison acted unreasonably in many different ways (...) As one prominent example, it insisted on improvements to thermal-hydraulic conditions when such improvements were unnecessary and disqualified Mitsubishi's thicker-AVB repair, a repair that would have corrected the root cause of the tube-to-tube wear pursuant to Mitsubishi's obligations in section 1.17.1.3(c) of the RSG Contract. Edison also acted unreasonably in evaluating Mitsubishi's proposed repair by failing to follow its own past practices for evaluating potential repairs, ignoring past industry experience, and ignoring the recommendations of other vendors that endorsed the viability of repairs similar

¹⁰⁷⁶ Claimants' Responses to Joint List of Issues, ¶ A.2(a).

to Mitsubishi's thicker-AVB repair. Edison further acted unreasonably in evaluating Mitsubishi's proposed replacement by requiring Mitsubishi to pay amounts above the contractually agreed Liability Cap before agreeing to proceed.¹⁰⁷⁷

(iii) Tribunal's Determination

869. The Parties disagree as to whether the Claimants' repair criteria, and in particular the requirement to restore T/H conditions, were good faith requirements or a strategy by the Claimants to force the Respondents into a replacement recommendation. On the specific question of who bears the burden of proof on this Issue, the Respondents admit¹⁰⁷⁸ that it is their burden, which the Tribunal considers must be proven on a balance of probabilities standard.

870. Whether the Respondents have carried their burden of proof on this Issue is set forth in Section XV.E below.

(b) That the Claimants failed to mitigate their damages (Issue A.2(b))

871. The Respondents submit that the Claimants failed to adopt alternative remedies, such as availing themselves of another supplier to repair the RSGs. The Respondents also submit that the Claimants adopted a more expensive decommissioning process than was required.

(i) The Claimants' Position

872. In their Responses to Joint List of Issues, the Claimants submit the following:

The affirmative defense of mitigation requires proof of "(1) what reasonable actions [Claimants] ought to have taken, (2) that those actions would have reduced the damages, and (3) the amount by which the damages would have

¹⁰⁷⁷ Respondents' Position Statement on the Revised List of Issues, ¶¶ 32-33.

¹⁰⁷⁸ Respondents' Position Statement on the Revised List of Issues, ¶ 32.

been reduced.” Mitsubishi cannot meet this burden for either of its two mitigation arguments.

First, Claimants’ decision to retire SONGS did not “cause” Claimants’ damages. By June 2013 there was no viable repair plan and the plant was incurring millions of dollars in both repair costs and standby O&M costs on a daily basis. Mitsubishi’s expert Mr. Robert Denton admitted that he has no “basis to disagree with the economic rationale for Mr. Craver’s decision” to retire SONGS. Mitsubishi cannot meet its burden to prove that Edison’s shutdown decision—which Mitsubishi’s own lawyers called “a perfectly rational business decision”—was unreasonable.

Mitsubishi also failed to meet its burden with respect to Claimants’ use of the DECON method of decommissioning instead of the SAFSTOR approach. Mitsubishi asserts that Claimants “opted for a more costly approach to decommissioning,” but completely fails to establish that Claimants had a less costly option available to them. The only support Mitsubishi offers for the proposition that Claimants could have used the SAFSTOR approach is that “[t]he NRC allows for [it].” But, as explained in the Metcalfe Reports, SONGS’s lease would not have permitted SAFSTOR, and the DECON method permitted Claimants to decommission the plant at a cost certain.¹⁰⁷⁹

(ii) The Respondents’ Position

873. In their Position Statement on the Revised List of Issues, the Respondents contend that they “have met their burden to show that Claimants failed to mitigate their damages. Respondents needed to show that Claimants did not “do everything reasonably possible to negate [their] own loss.” Respondents met their burden with evidence and testimony showing multiple, reasonable actions Claimants could have taken that would have reduced damages, both before the shutdown decision and after. Respondents showed that the majority of Claimants’ damages “could have been avoided by reasonable effort and expense.””¹⁰⁸⁰

¹⁰⁷⁹ Claimants’ Responses to Joint List of Issues, ¶ A.2(b).

¹⁰⁸⁰ Respondents’ Position Statement on the Revised List of Issues, ¶ 34.

(iii) Tribunal's Determination

874. The Parties are disagreed as to whether the Claimants could have mitigated their damages by measures prior to and after shutdown, such as using an alternate supplier and pursuing an alternate decommissioning strategy. On the specific question of who bears the burden of proof on this Issue, the Respondents admit¹⁰⁸¹ that it is their burden, which the Tribunal considers must be proven on a balance of probabilities standard.
875. Whether the Respondents have carried their burden of proof on this Issue is set forth, to the extent required, in Section XX below.

(c) The Respondents' entitlements to offsets to Claimants' damages, if any (Issue A.2(c))

876. The Respondents submit that the Claimants have obtained recovery already for damages claimed in this arbitration, notably through their insurer, from the US Department of Energy, and from California ratepayers such that to avoid double recovery, the Claimants damages should be discounted accordingly.

(i) The Claimants' Position

877. In their Responses to the Joint List of Issues, the Claimants submit that the "Respondents have (...) failed to prove that they are entitled to any offsets to Claimants damages for spent nuclear fuel settlements, compliance with once-through cooling or seismic regulations, proceeds from Claimants' insurer, or proceeds from the OII settlement."¹⁰⁸²
878. Further, in their C-RPHM, the Claimants, while making a reference to their submissions on Issued H.1.(d) and H.1.(e), submit the following:

¹⁰⁸¹ Respondents' Position Statement on the Revised List of Issues, ¶ 34.

¹⁰⁸² Claimants' Responses to Joint List of Issues, ¶ A.2(c).

Issues H.1.(d) and H.1.(e) below address Respondents' claims for offsets based on the settlement of (i) an insurance dispute and (ii) the OII (CPUC) proceeding. Apart from those issues, Respondents assert their entitlement to offsets based on the potential recovery of spent nuclear fuel-related damages in lawsuits against the U.S. Department of Energy, a proposed tax deduction (which they raise for the first time in their post-Hearing submissions), and potential additional expenditures associated with "once-through cooling" and seismic compliance regulations. For each of these arguments, Respondents bear the burden of proof—which they have failed to carry.

Respondents argue that Claimants' incremental spent fuel management damages—which are incurred exclusively in Period IV—should be offset by amounts that Claimants may receive from the DOE as damages or settlements resulting from the DOE's breach of its obligation to remove spent fuel from SONGS. Such an offset would be unduly speculative and inappropriate under California law, because Respondents have not articulated "the amount by which . . . damages [should be] reduced[.]" Respondents do not even offer—let alone establish through evidence—an alternative date for when the DOE will begin removing spent fuel from SONGS, which is a key driver of spent-fuel-management costs.

Nevertheless, Mr. Metcalfe conducted a sensitivity analysis to model the effect of adopting Mr. Reed's flawed spent fuel management assumptions on Claimants' decommissioning damages. Claimants' spent fuel-related damages would decrease by approximately \$117 million if one assumes that DOE would take the unrealistic and unprecedented action of reimbursing Edison in full and in real time as costs are incurred. And while Claimants' projection that the DOE will begin removing spent fuel by 2024 is reasonable, Mr. Metcalfe determined that Claimants' damages would only be reduced by approximately \$206 million even if the DOE never removed any spent fuel from SONGS.

Separate from their claimed spent fuel offset, Respondents assert that they are entitled to an offset of \$2.71 billion based on the misleading contention that "Mr. Graves . . . increased damages for taxes." In their memorials, expert reports, and presentations at the Hearing, Respondents never made this argument before, and the Tribunal should not condone Respondents' sandbagging by considering it now. Indeed, in an email dated June 27, 2016 (shortly before the parties' post-Hearing submissions were due), Respondents' counsel acknowledged that this argument falls outside the scope of the parties' mutually agreed List of Issues.

In an effort to justify their inexcusable delay in raising this issue, Respondents assert that the so-called "tax gross up" was "hidden," "deeply buried in the

Graves analysis,” and “nowhere stated in any of [Mr. Graves’] reports.” Respondents’ contention is patently false. Mr. Graves’ opening report (filed July 27, 2015) describes his calculation of the appropriate discount rate—the ATWACC, or after-tax weighted average cost of capital—at length, and includes the following point:

“There is one consequence of ratemaking that is not captured by just discounting the cash outlays at the ATWACC, which is the supplemental allowance for income taxes needed in rates in order for the utilities to achieve the desired return on equity: In order for utility equity investors to recover their allowed after tax return on equity (RoE), they must have a pre-tax income that includes enough to pay taxes and still have the target after-tax amount leftover as net income. This is accomplished in ratemaking by “grossing up” (dividing) the RoE component by $(1 - \text{tax rate})$ I have made this adjustment throughout my SONGS-In and SONGS-Out projections. Note that since the SONGS-In world is more capital intensive, it incurs this tax markup cost more extensively than the SONGS-Out world, reducing damages.”

Simply put, Respondents’ assertion that Mr. Graves secretly “increased damages” to “account[] for taxes on any award” is demonstrably false. While the use of an after-tax WACC is “mathematically identical” to “captur[ing] the taxes that will be due on any damage award,” Mr. Graves did not use the after-tax WACC for that reason; he used it because it is an integral and standard part of ratemaking in the electric utility industry.

Critically, Respondents’ only expert on this issue agrees that it is necessary to use an after-tax discount rate. As Mr. Reed stated in his opening report: “In my opinion, an after-tax discount rate of between 10% and 15% is more appropriate than Mr. Graves’ assumed 6.13%.” Mr. Reed thus never challenged Claimants’ use of after-tax discounting; in fact, he endorsed it. Nor did Respondents ever challenge the use of after-tax discounting until the Hearing had concluded, in an apparent attempt to preclude Claimants’ experts from being able to rebut this falsehood.

The prejudice caused by Respondents’ failure to raise this issue earlier is highlighted by their legal argument, which relies on cases in which certain tax arguments (which are distinct from the issue presented here) were found inadmissible at trial for being “too speculative.” Respondents’ cases, dealing with admissibility, reflect the well-established legal rule that “[t]o obtain reversal based on the erroneous admission of evidence, the record must show a timely objection Lack of such objection deprives the proponent of the evidence an opportunity to establish a better record or some alternative basis

for admission.” This basic rule of fairness has already been given effect in this proceeding, to Respondents’ benefit. When Claimants’ expert, Mr. Graves, timely noted several deficiencies in Respondents’ damages modeling, Respondents were allowed to add a new witness to this case in order to address those issues—and continued addressing them through unauthorized filings submitted nearly a month after the Hearing began. By contrast, Respondents have strategically chosen to withhold their attack until after expert testimony and the close of the Hearing. The Tribunal should give Respondents’ “tax gross up” argument the same consideration that Respondents gave it before and during the Hearing—none.¹⁰⁸³

879. In response to the Respondents’ submissions, and particularly the cases relied on by the Respondents in their submissions concerning Issue H.1(b), the Claimants contend the following:

In any event, Respondents’ argument fails on the merits. Respondents construct their legal theory around *DeSantis v. Oakmont LLC*, an unpublished decision of the California Court of Appeal. As Claimants have repeatedly reminded Respondents, unpublished decisions of the California courts are “not to be cited as authority.” *DeSantis* itself is irrelevant: the case does not address the taxability of damages awards, but the recoverability of a supposed “lost tax advantage.” Claimants do not seek to recover any lost tax advantage in this proceeding, and *DeSantis* has no relevance to this case.

Mitsubishi’s reliance on a concurring opinion in *Canavin v. Pacific Southwest Airlines* is similarly misplaced. A concurrence “has no precedential value” and is “no authority,” and in any event, Respondents stretch the *Canavin* concurrence beyond its reach. The *Canavin* concurrence concluded that a defendant should not be allowed to reduce damages by calculating future earnings on an after-tax basis: “[T]o allow the defendant to reduce the award by the estimated amount of income tax would create a windfall for the defendant.” This was the same principle that was upheld in the later and unanimous decision of *DePalma v. Westland Software House*, where the court recognized that “[i]n California, there is no statutory or common law precedent in a breach of contract action to give defendants collateral source credit for [a plaintiff’s] income tax benefits.” Respondents ask the Tribunal to disregard and turn this principle on its head—by creating an unprecedented offset for Claimants’ anticipated income tax liability.

¹⁰⁸³ Claimants’ RPHM, ¶¶ 53-59.

Lacking any California authority for their argument, Respondents rest their hopes on cases from the U.S. Court of Appeals for the Federal Circuit—which has consistently upheld the appropriateness of “a tax ‘gross up’ procedure.” As a trial court within the Federal Circuit noted (in an opinion that was later affirmed), the failure to account for the taxability of a damages award “would be unjust:”

It is only a possibility, and not a high one in our view, that the award will not be taxed. We cannot ignore the fact that, as a general proposition, amounts received as damages in litigation are taxable as income. In addition, if the matter is contested, plaintiff would have the burden of proving an exemption. We hold therefore that the award should be adjusted to account for subsequent taxation.

The facts of this case demand the same result—with even greater force, in light of the universal practice of after-tax discounting in the regulated utility industry.

As Mr. Graves testified, “the purpose of a gross-up is to make sure that, after taxes, the injured party receives the full value of damages for the harm that was incurred.” Such an approach is necessary here to avoid “a windfall for the defendant,” because courts “assume[] a judgment ... is [taxable] gross income unless [a party] can point to the I.R.C. or Treasury Regulations to demonstrate otherwise.” Respondents have made no attempt to show that amounts awarded in this proceeding would fall outside the Internal Revenue Code’s broad definition of taxable gross income, which is “all income from whatever source derived.” As noted above, Mitsubishi’s own damages expert believes that an after-tax discount rate is “appropriate,” implicitly acknowledging that a “tax gross up” (which is mathematically equivalent to after-tax discounting) is proper on the facts of this case.

Unable to show that after-tax discounting is inappropriate, Respondents direct their final challenge at the tax rate incorporated into Claimants’ damages analysis. Respondents falsely assert that “Claimants offered no evidence of the tax rate,” ignoring that the workpapers of Mr. Metcalfe (filed July 27, 2015) provide exactly such evidence, with a citation to SCE’s “Director of Regulatory Finance, Economics, and Risk Operations.” Respondents’ assertion that Mr. Graves “did not even look at the tax rate paid by either utility” is at best the result of their failure to review the record, and at worst a misrepresentation. The evidence in support of the tax rate has been in Mr. Metcalfe’s workpapers (and in the record) for more than a year, but Respondents failed to ask him a single question about it at the Hearing, even though Mr. Metcalfe made clear in his opening report that he—not Mr. Graves—is responsible for “adjust[ing]

past damages” (and rescission damages) “forward to 2016” using “the after-tax weighted average cost of capital for each of SONGS’s owners.” The tax rate Mr. Metcalfe used for that analysis is supported by the sources cited in his workpapers, and Mr. Graves adopted an identical tax rate in his forward-looking ATWACC. Mr. King referenced this tax rate in his workpapers, as well.

Respondents have never challenged Claimants’ tax rate, nor offered an alternative (either through their expert witness or otherwise), and therefore cannot meet their burden to prove an offset. Indeed, the only basis for Respondents’ conjecture that Claimants might have a lower effective tax rate than the one Claimants used is a potential “abandonment” deduction for the loss of SONGS, which Edison referenced in a public filing. In contrast to this potential deduction, the quantum of which is highly uncertain, it is beyond reasonable dispute that any award rendered against Respondents in this proceeding will be fully subject to a tax deduction. Federal law prevents Respondents from offsetting any of Claimants’ damages on this basis, because a taxpayer cannot take a deduction for a loss when there is “reimbursement” or a “reasonable prospect of recovery” from the party that caused the loss (i.e., Mitsubishi).

Accordingly, it is impossible for Claimants both to recover from Respondents and make a beneficial tax deduction based on that recovery. Respondents’ proposed offset would shift responsibility for their failures away from Respondents and onto the shoulders of Claimants, the federal government, and American taxpayers, in violation of the Internal Revenue Code. Respondents offer no justification for this outcome, beyond the desire to avoid the consequences of their own misconduct. The Tribunal should reject Respondents’ invitation to reallocate tax proceeds, and leave that matter to tax authorities who have primary jurisdiction over such questions.

Respondents also failed to prove that Claimants’ damages should be offset by an uncertain and unstated amount for expenditures SONGS may have had to incur to comply with California’s “Once-Through Cooling” (“OTC”) Policy. It is undisputed that the OTC Policy does not affect Claimants’ damages in Periods 1 through 3. Nor, in Claimants’ submission, would complying with the OTC policy have a major effect on Period 4 damages. Respondents disagree, arguing that complying with the OTC policy could have required Claimants to “build cooling towers or supply other protection for marine life that could cost hundreds of millions of dollars.” But Respondents’ once-through cooling expert conceded that California’s policy does not necessarily require cooling towers, and admitted that “a range of technologies, with varying costs” could

have satisfied the policy. That statement is insufficient to meet Respondents' burden of "specifically point[ing] out and prov[ing]" the amount of an offset.

Respondents neglect to mention that for nuclear plants like SONGS, there are specific carve-outs from the only provision of the OTC Policy that may actually require the construction of expensive cooling towers. Specifically, the California OTC Policy exempts nuclear plants from the cooling tower provision if compliance would be "wholly unreasonable" in consideration of "factors including, but not limited to, engineering constraints, space constraints, permitting constraints, and public safety considerations." If the Water Board concludes that compliance with the cooling tower provision "is wholly unreasonable based on the factors [listed above], then the . . . Board shall establish alternate requirements for that [plant.]"

It is clear that installing cooling towers at SONGS would have been "wholly unreasonable," as three studies conducted on the issue unanimously concluded. According to a study conducted by the Enercon engineering firm, "[r]etrofitting SONGS with a closed-loop cooling system [i.e., cooling towers] would be challenged with insuperable permitting obstacles, unparalleled—'one of a kind'—engineering challenges, adverse environmental impacts likely greater than those imposed by once-through cooling, and initial costs exceeding \$3.0 billion." Similarly, a report by Tetra Tech, an environmental and engineering consultancy, recognized potentially significant public safety risks, permitting challenges, and negative environmental effects that would need to be addressed before cooling towers could be installed at SONGS. Mr. Baggett had no basis to disagree with those reports, and admitted that installing cooling towers at the Diablo Canyon nuclear plant would have required leveling a mountain and moving more earth than was required to dig the Panama Canal. Mr. Baggett also said that installing cooling towers at SONGS would have been even more difficult than doing so at Diablo Canyon.

Respondents' claim for an offset based on OTC compliance costs is further undermined by the fact that the Policy is avoidable. Multiple plants have sued the California Water Board over the OTC Policy, but the Water Board has settled those cases by deferring or reducing the plants' compliance obligations. For three of those plants, the Water Board's settlements included permission to continue operating without cooling towers. These were conventionally powered, carbon-emitting plants, so it stands to reason that the Board would be even less likely to enforce the Policy against a nuclear plant—given the Policy's carve-outs for a nuclear plant with special engineering, permitting, and public safety constraints, and the ability of nuclear plants to deliver carbon-free energy.

Finally, Respondents fail to recognize that Claimants' damages analysis already allows for OTC compliance costs. SONGS had already spent approximately \$400 million on marine mitigation and other efforts to comply with OTC regulations. Mr. Metcalfe's estimates for future SONGS costs include additional marine mitigation expenditures, as well as margin for unplanned expenses. Respondents have never specifically identified what additional expenditures would be required—instead, they have just vaguely asserted that such expenditures would total hundreds of millions of dollars. This is patently insufficient to meet their legal burden.

Respondents' claim for an offset of \$166-175 million for costs related to seismic regulations is—if possible—even less compelling. Respondents' seismic expert, Dr. Lettis, had no opinion on whether seismic costs were already included in SONGS' budget or Mr. Metcalfe's damages analysis. Metcalfe's Rebuttal Report plainly shows that SONGS' budget included ample margin for necessary seismic analysis and remediation. Respondents never submitted any evidence to the contrary. Accordingly, Respondents have failed to meet their burden of showing that damages for Period 4 should be offset by additional costs for seismic compliance.

Respondents also suggest that OTC and seismic compliance issues could constitute a barrier to relicensure in addition to offsetting Claimants' damages, but offer no evidence in support of this claim. Mr. Baggett admitted that he did not “offer[] any opinion in this matter on whether the Board's Once-Through Cooling Policy requirements would have any impact on SONGS' ability to renew its operating license.” Similarly, Dr. Lettis admitted that he did not “have an opinion one way or the other” as to whether seismic concerns would have precluded license renewal. As the un rebutted testimony of Leeds & Strosnider explains, the ASLB denied a petition that would have expanded the scope of license renewal to include ongoing seismic compliance issues, which “eliminates this issue for consideration for SONGS.” And Respondents' NRC witnesses never addressed the impact of complying with the OTC Policy or seismic regulations on SONGS' relicensure. To the extent Respondents are suggesting that Claimants would have abandoned relicensure because these regulations would have made it too costly, such argument should be rejected. Neither of Respondents' experts could offer a firm estimate of expected compliance costs—Mr. Baggett could not even come up with a ballpark figure—and neither accounted for the fact that Claimants' damages estimates already budgeted for such costs.¹⁰⁸⁴

¹⁰⁸⁴ Claimants' RPHM, ¶¶ 60-73.

(ii) The Respondents' Position

880. In their Position Statement on the Revised List of Issues, the Respondents contend that they “have met their burden of proving entitlement to an offset to Claimants’ damages. California law requires that damages in a contract case be reduced by any collateral sources of recovery, such as insurance payments. As a matter of law, Claimants may not recover more in this action than they would have received under the contract. The record shows Claimants have recovered nearly \$6 billion from collateral sources, including Nuclear Energy Insurance Limited (“NEIL”) insurance payments and a settlement approved through the California Public Utilities Commission (“CPUC”). Any damages award must be offset by recoveries Claimants have already received from these other sources, in order to prevent an impermissible double recovery that provides Claimants with a windfall. While Claimants contend that they are recovering on behalf of the ratepayers, even if correct that argument would have no bearing because Section 1.21.1 of the Contract precludes recovery of “claims from customers.””¹⁰⁸⁵

(iii) Tribunal's Determination

881. The Parties disagree as to whether Claimants’ recovery in this arbitration should be offset by alternate recovery they have received from the Claimants’ insurer, ratepayers, the US Department of Energy and/or any other sources. The Parties are further disagreed as to whether the Claimants are, and if so it is appropriate, to have included a “tax gross up” in their alleged damages.

882. Whether the Respondents have carried their burden of proof on this Issue is set forth in ¶ XX below.

¹⁰⁸⁵ Respondents’ Position Statement on the Revised List of Issues, ¶ 35.

(d) **The Respondents' breach of contract counterclaim (Issue A.2(d))**

883. The Respondents submit that their maximum liability under the limitation of liability provision should be reduced on account of the actual purchase price paid for the RSGs, some \$45 million already paid by the Respondents, and the Respondents' own costs to repair the RSGs. The Respondents also seek payment for an unpaid invoice.

(i) *The Claimants' Position*

884. In their Responses to Joint List of Issues, the Claimants submit the following:

Respondents have failed to meet their burden of proof with respect to either of their counterclaims. Mitsubishi seeks refund or offset of \$15 million it paid to Edison for costs Edison incurred in support of its attempts to restore the RSGs to service (the "SGIR" damages). Mitsubishi admits that Claimants incurred these costs and that they are direct damages under California law. Respondents' only witness to examine the bases for the costs concluded that less than \$58 thousand (out of \$181 million in nominal dollars) in charges were not caused by the tube leak. In stark contrast, Claimants supported the amounts invoiced to Mitsubishi with more than 10,000 pages of supporting documentation.

Mitsubishi failed to support its other counterclaim for an additional \$2 million representing the final milestone payment under a separate purchase order for the Replacement Reactor Vessel Heads ("RRVHs") that it supplied to Edison. Mitsubishi did not make any argument in support of this claim either in its Rejoinder Memorial or during the Hearing. As set forth in prior Memorials, the conditions necessary to trigger the final milestone payment never occurred, and in any event the frustration of purpose doctrine relieves Edison of any further obligations under the RRVH Contract.¹⁰⁸⁶

(ii) *The Respondents' Position*

885. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Respondents have met their burden of proving that Edison could not substantiate the basis for Mitsubishi's \$45 million provisional payment for

¹⁰⁸⁶ Claimants' Responses to Joint List of Issues, ¶ A.2(d).

steam generator repair and inspection costs, and therefore some of that provisional payment should be refunded to Mitsubishi. Specifically, the evidence shows that Claimants have only justified \$32.8 million of those costs. Mitsubishi is entitled to a refund of that \$45 million payment to the extent that Claimants have failed to prove they are entitled to damages, as described below. As demonstrated in section I.2 below, Claimants failed to adequately substantiate the chargeability of the vast majority of their claimed steam generator inspection and repair costs.

Respondents have also met their burden of proving that Claimants breached the separate replacement reactor vessel head Contract (“RRVH Contract”). Claimants assert that their liability to Respondents for this \$1.97 million payment was excused by the doctrine of commercial frustration—that Respondents denied Claimants of the value of the RRVH Contract “by providing defective and unrepairable RSGs.” However the RSGs were not “unrepairable,” and Claimants’ unilateral commercial decision to decommission neither nullifies nor discharges Edison’s obligations under the RRVH Contract. Claimants have never identified an event of default under the RRVH Contract which might have excused this payment under section 1.16.5 of the RRVH Contract. As a result, Respondents are entitled to payment of the \$1.97 million, or a corresponding credit against any damages awarded to Claimants.¹⁰⁸⁷

(iii) Tribunal’s Determination

886. The Parties disagree as to whether the Claimants have adequately justified expenses for which the Respondents reimbursed them approximately \$45 million. On the specific question of who bears the burden of proof on this Issue, the Respondents admit¹⁰⁸⁸ that it is their burden, which the Tribunal considers must be proven on a balance of probabilities standard.
887. Whether the Respondents have carried their burden of proof on this Issue is set forth in Section XX and Section XIII.G below.

¹⁰⁸⁷ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 36-37.

¹⁰⁸⁸ Respondents’ Position Statement on the Revised List of Issues, ¶ 36.

C. WHO BEARS THE BURDEN TO PROVE (ISSUE A.3)

888. The Parties are disagreed on two threshold questions of law.

(a) Whether or not the California Commercial Code applies (Issue A.3(a))

889. The Claimants submit that the limitation of liability provision should be invalidated by operation of the California Commercial Code. The Respondents both dispute the applicability of this code to the RSGs and the substance of the law.

(i) The Claimants' Position

890. In their Responses to Joint List of Issues, the Claimants submit that “[n]either party bears the burden to prove whether the California Commercial Code (adapted from the Uniform Commercial Code (“UCC”) applies. Legal questions are not subject to burdens of proof. See *Rogers v. Home Shopping Network, Inc.*, 57 F. Supp. 2d 973, 983 (C.D. Cal. 1999) (“it is incorrect to speak in terms of ‘burdens’ when dealing with legal issues rather than matters of evidence... Burdens are relevant when evidence is ambiguous or evenly balanced. The result of a question of law cannot be ‘ambiguous’ or ‘evenly balanced.’ While some questions are more difficult than others, eventually the judge must answer the question to the best of his or her ability. Thus, burdens of proof have no place in Rule 12(b)(6) motions or other questions of law.”)¹⁰⁸⁹

(ii) The Respondents' Position

891. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

As the party seeking the benefit of the Commercial Code to invalidate limitation of liability provisions in the RSG Contract, Claimants bear the burden to prove that the Commercial Code applies to this dispute by

¹⁰⁸⁹ Claimants' Responses to Joint List of Issues, ¶ 3(a).

“establishing that the predominant thrust of the transaction was for goods and only incidentally for services.”

Claimants also bear the burden of proving facts sufficient to show that the California Commercial Code applies to this case. Under California Evidence Code section 500, “Except as otherwise provided by law, a party has the burden of proof as to each fact the existence or nonexistence of which is essential to the claim for relief or defense that he is asserting.”

Claimants failed to present evidence to prove that the essence of the RSG Contract, or its “predominant thrust,” was for the sale of goods; absent this proof, the Commercial Code does not apply to this case. Claimants’ assertion of failures and breaches by Mitsubishi are all – or at least predominantly – focused on the design and engineering analyses and services Mitsubishi contracted to provide under the RSG Contract. As such, Claimants have failed to meet their burden to prove that the Commercial Code applies.¹⁰⁹⁰

(iii) Tribunal’s Determination

892. The Parties are disagreed as to whether any Party, and if so which Party, bears the burden of proving that the California Commercial Code (“**Commercial Code**”) applies to this case.
893. While the Tribunal acknowledges, for the present purposes, that legal questions are not subject to the burden of proof, as submitted by the Claimants, the factual questions underlying a legal issue are subject to a burden of proof.
894. The Respondents submit that for the Commercial Code to be applicable, the Claimants must prove that (i) the RSGs are goods; and/or (ii) if the RSG Contract is a mixed contract for goods and services that either the goods portion dominates or alternatively the aspects in dispute in this arbitration relate to goods and not services calling for a hybrid application of the Commercial Code.

¹⁰⁹⁰ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 38-40.

895. The determination of the applicability of the Commercial Code is a mixed question of law and fact. What factually constitutes a good is born by the party asserting the applicability of the Commercial Code, while what legally constitutes a good is not subject to a burden of proof.
896. The Tribunal considers that, under Section 500 of the California Evidence Code, it falls on the Claimants to prove that the Commercial Code is applicable by proving that either the RSGs are goods, that the goods portion of the RSG Contract dominates, or that the issues in dispute relate to the goods portion of the RSG Contract over the services portion, if the RSG Contract is a hybrid agreement.
897. Accordingly, while the question of the applicability of the Commercial Code is one of law, the Claimants bear the burden of proving the underlying facts on which the applicability is to be determined.
898. However, as it is explained in ¶ 2548 below, the Tribunal proceeds with its analysis under the Commercial Code assuming its applicability, which includes the assumption that Claimants have met their burden of proof regarding the underlying facts.
- (b) **Whether or not the economic loss rule bars Claimants' claims for negligent misrepresentation and intentional fraud (Issue A.3(b))**
899. The Parties disagree as to whether the Claimants may alternatively present a case in tort in addition to their case in contract.

(i) The Claimants' Position

900. In their Responses to Joint List of Issues and their C-RPHM, the Claimants make a reference to their submissions made in response to Issue A.3(a), above, i.e., “[l]egal questions are not subject to burdens of proof. See *Rogers*, 57 F. Supp. 2d at 983.”¹⁰⁹¹

(ii) The Respondents' Position

901. In their Position Statement on the Revised List of Issues, the Respondents contend that the “Claimants have the burden of proving that the economic loss rule does not apply. Even if Claimants could recover on their tort claims, which they cannot, they have failed to show that recovery of tort damages is not barred by the economic loss rule. Claimants’ tort claims are all derivative of Claimants’ breach of contract claims and California law is clear that a party may not sue in tort for alleged breaches of contract provisions.”¹⁰⁹²

(iii) Tribunal's Determination

902. The Parties disagree as to who bears the burden of proof on whether or not the economic loss rule bars the Claimants claims regarding misrepresentation and intentional fraud.

903. The Tribunal considers that the Claimants’ submission, with respect to Issu A.3(b), that questions of law are not subject to a burden of proof, pursuant to *Rogers*,¹⁰⁹³ is correct. As the Claimants cite, *Rogers* provides that “it is incorrect to speak in terms of ‘burdens’ when dealing with legal issues rather than matters of evidence.”

¹⁰⁹¹ Claimants’ Responses to Joint List of Issues, ¶ A.3(b); Claimants’ RPHM, ¶ 77.

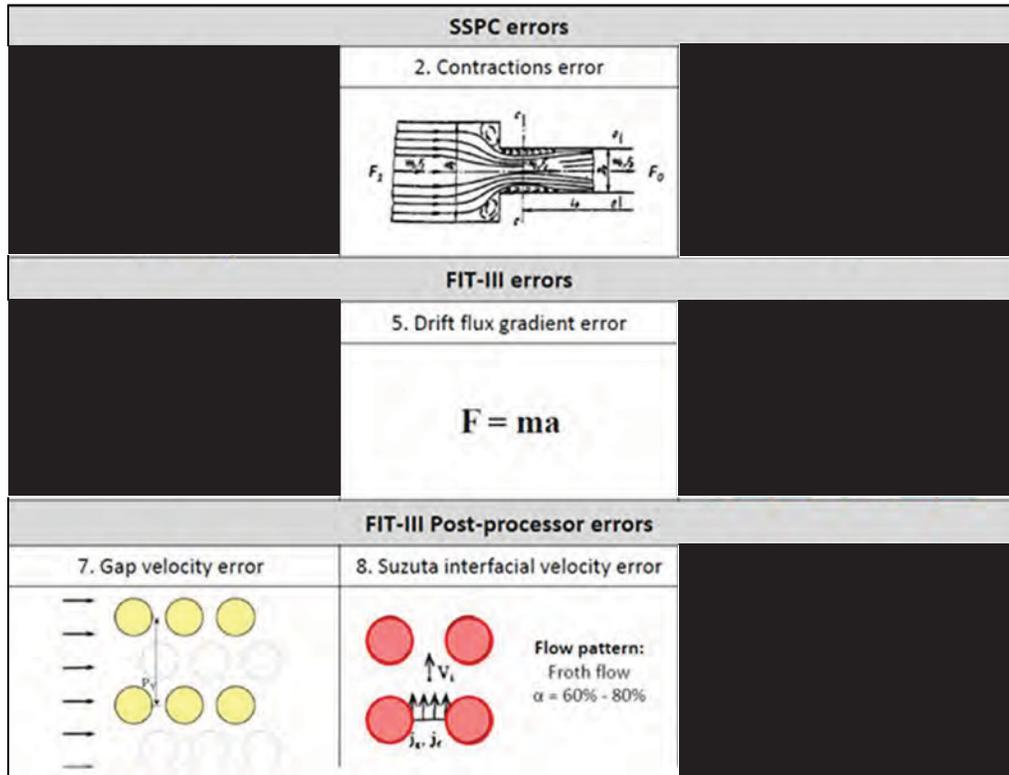
¹⁰⁹² Respondents’ Position Statement on the Revised List of Issues, ¶ 41.

¹⁰⁹³ Exhibit RL-261 (*Rogers v. Home Shopping Network, Inc.*, 57 F. Supp. 2d 973, 983) [“*Rogers*”].

XI. ALLEGED DESIGN ERRORS

904. The Claimants, through their experts, have identified various alleged errors in the design of the SONGS RSGs, which affect the calculation of the secondary side thermal hydraulics.
905. In particular, the Claimants have alleged that the Respondents' design of the SONGS RSG suffered from nine design errors in their software codes, as identified by the Claimants' experts at Exponent, Drs. Kytömaa and Morse, and as supported by other experts, such as Dr. Lahey.
906. A number of the Issues and Sub-Issues in the List of Issues subsume the question of whether the Respondents made these nine design errors. To facilitate the Tribunal's reasoning with regard to Issue B, and to a lesser extent Issues C, D, and F, the Tribunal first addresses these nine alleged design errors.
907. The alleged nine design errors were summarized in the following demonstrative exhibited, submitted by the Claimants at the Hearing on 18 March 2016, with the examination of the Claimants' expert Dr. Kytömaa at Exponent:¹⁰⁹⁴

¹⁰⁹⁴ C-Demo



908. The Tribunal considers these nine errors to be the most significant errors as contended by the Claimants, given their impact on the Issues under determination by the Tribunal in these proceedings.

909. In Appendix B of their Rejoinder, the Respondents have enumerated approximately 30 alleged design errors, as identified by the Claimants’ experts. These errors include the nine most significant errors referenced in ¶ 907 above as well as various other alleged errors, of varying effect. A number of those errors are addressed in Section XII below and/or addressed directly in the Tribunal’s determination of Issue B.

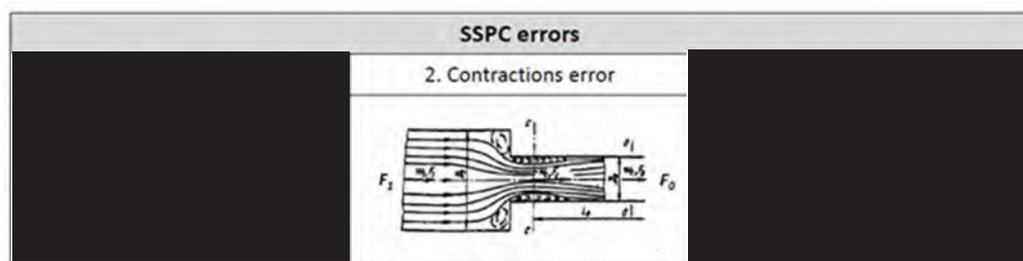
910. To the extent that this Award does not address a particular additional alleged error, the Tribunal considers that the evidence in support of that error is insufficient or immaterial and the Claimants' submissions in that regard are rejected.

A. ALLEGED SSPC ERRORS

911. As previously introduced, MHI's Steam Generator Steady State Performance Calculation Code (SSPC) is a proprietary code for the calculation of circulation ratios.¹⁰⁹⁵ All three of the Claimants' alleged errors result in a circulation ratio that is lower than MHI calculated and as incorporated into the RSG Contract. The Claimants' expert Exponent opines that the alleged errors also have the effect of increasing void fraction.¹⁰⁹⁶

912. The Claimants have alleged that SSPC contained multiple errors and have focused on the most significant three.¹⁰⁹⁷ The Claimants' allegations are based upon the expert evidence of Exponent, which the Tribunal understands the Claimants have adopted.

913. Exponent has identified three alleged errors in SSPC. These errors are identified as a "friction error," a "contractions error," and a "downcomer turn error:"



¹⁰⁹⁵ See ¶ 236 above.

¹⁰⁹⁶ Design Review and Failure Analysis Expert Witness Statement of Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc. ["Exponent Design Review"], ¶ 97.

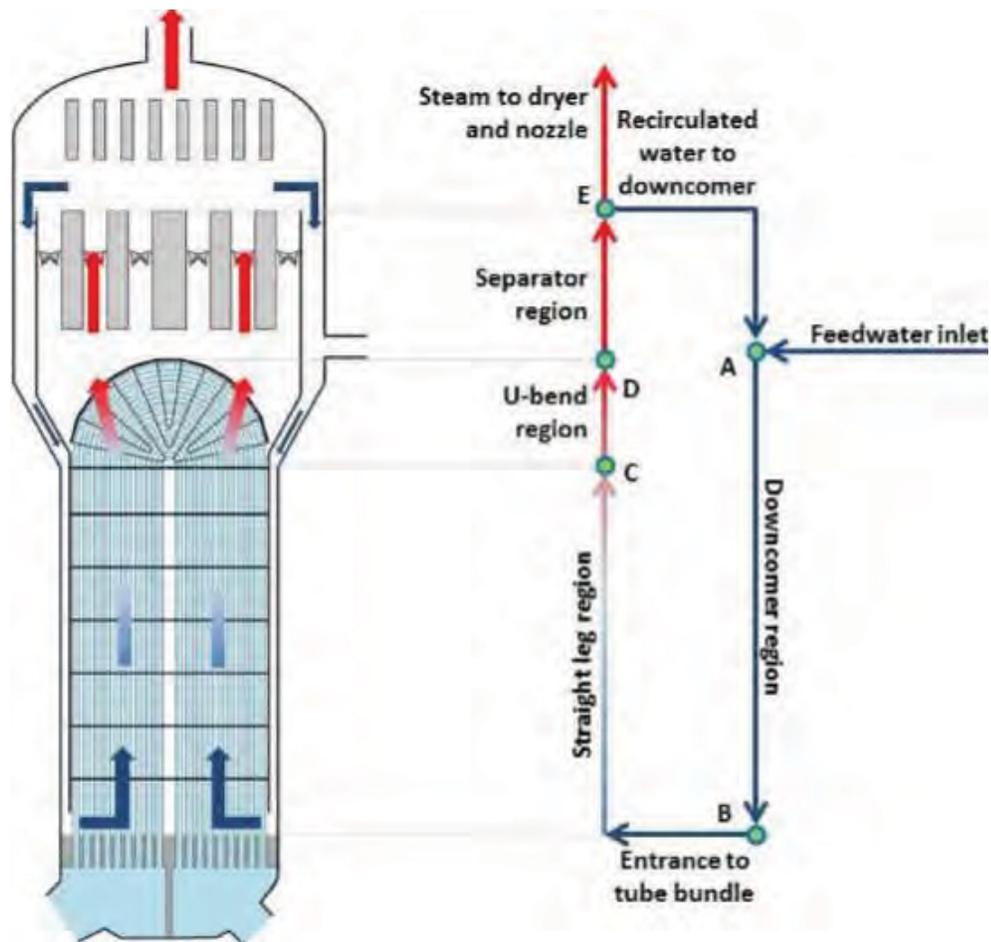
¹⁰⁹⁷ Claimants' Reply to Counter-Memorial and Counterclaims, ¶¶ 98-100.

914. The Respondents reject the Claimants' allegations.¹⁰⁹⁸ The Respondents submit that "a detailed rebuttal to Exponent's specific claims regarding SSPC is included in Dr. Hibiki's expert report."¹⁰⁹⁹
915. All three errors relate to the downcomer, which is the area of the RSG between the wrapper and the outside wall of the RSG in which water recirculates back into the steam generator after being condensed back into liquid form.
916. In the graphic below,¹¹⁰⁰ the area adjacent to the tube bundle with blue arrows pointing downwards is the downcomer, demonstrating the recirculation of water:

¹⁰⁹⁸ Respondents' Rejoinder, ¶¶ 88-91.

¹⁰⁹⁹ Respondents' Rejoinder, ¶ 91.

¹¹⁰⁰ Background and Tutorial Dr. Harri Kytömaa and Dr. Timothy Morse, Exponent, Inc. ["Exponent Tutorial"], ¶ 47, Figure 16.



917. After the steam has powered the turbines, it is condensed and water recirculates down through the downcomer back into the wrapper area of the RSG, where it is boiled by the tube bundle, once again becoming steam. The thermal hydraulics of the water exiting the downcomer, such as the velocity, are the inputs into calculating the thermal hydraulics in the tube bundle area.
918. All three SSPC errors relate to pressure loss. Pressure loss refers to a change in the water pressure on account of the physical environment. The physical environment may entail the surface smoothness of the area the water flows in, obstructions in the flow, or changes in the direction of the flow. Some of the alleged errors in FIT-III relate to the pressure loss on account of two-phase flow dynamics.

919. The summary of the Parties' positions and analysis below is largely based upon the evidence as presented by Exponent, the Claimants' expert, and Dr. Hibiki, the Respondents' expert, including their testimony at the Hearing.

(a) **Alleged Friction Error**

920. The alleged friction wall error relates to the Claimants' objection to MHI's calculation of the smoothness of the steel surface in the downcomer of the RSGs. According to the Claimants, MHI calculated a steel smoothness that was smoother than it should be. Smoother steel has less friction and, therefore, allows a liquid to flow more easily, thereby minimizing pressure loss.

921. In addition to calculation and modeling aspects, the Parties also disagree as to the actual smoothness of the steel of the downcomer.

(i) *The Parties' Positions*

922. The Claimants submit, supported by their expert Exponent, that "Mitsubishi used the wrong correlation to calculate pressure losses due to wall friction" and that "this error caused Mitsubishi to calculate a circulation ratio that was erroneously high and thus a void fraction that was erroneously low."¹¹⁰¹

923. Specifically, according to the Claimants' expert Exponent, MHI, rather than using a "Reynolds number¹¹⁰²" (that is determined using a "Moody Chart"¹¹⁰³) for

¹¹⁰¹ Exponent Design Review, ¶ 73.

¹¹⁰² As provided by Exponent, the Reynolds number characterizes the level of turbulence in the flow. (Exponent Design Review, n. 14). It was developed in the 19th Century by Professor Osborne Reynolds, a thermal hydraulics specialist.

¹¹⁰³ As provided by Exponent, the "Moody Chart is a graph that relates the friction factor in a flow passage to the Reynolds number and wall roughness. It is widely used in many fluid mechanics applications." (Exponent Design Review, n. 15). It was developed in 1944 by Professor Lewis Ferry Moody, a thermal hydraulics specialist.

identifying the friction from the wall in the downcomer, applied the [REDACTED]¹¹⁰⁴
[REDACTED]¹¹⁰⁵ In Exponent's view, while the results provided by the use of a Moody
Chart and the [REDACTED] are at first proximate, the results diverge at higher
Reynolds numbers.¹¹⁰⁶

924. In the Claimants' expert's view, MHI used an overly smooth value for wall friction,
which was physically impossible for a wall made of steel and as such underestimated
the "friction factor in the downcomer by more than a factor of [REDACTED]"¹¹⁰⁷
925. The Claimants' refer, in this respect, to their expert Exponent's illustration of this
alleged error on a Moody Chart as follows:

¹¹⁰⁴ The [REDACTED] was proposed in 1913 by Professor [REDACTED] a fluid dynamics
specialist, to evaluate friction.

¹¹⁰⁵ Exponent Design Review, ¶¶ 76-79.

¹¹⁰⁶ Exponent Design Review, ¶ 79.

¹¹⁰⁷ Exponent Design Review, ¶ 80.



926. Further, according to the Claimants' expert Exponent, the [REDACTED] (in blue in the graphic above) used by MHI generally corresponds with the actual friction of steel (in red in the graphic above) up to a particular Reynolds number (on the X-axis in the graphic above). The [REDACTED] and the actual friction eventually diverge and are in fact diverged for the Reynolds number in use at SONGS, which is representative of the actual smoothness of the steel in the downcomer.
927. The Respondents rely on their expert Dr. Hibiki.
928. Dr. Hibiki in part agrees with the Claimants' expert Exponent, while he disagrees as to the magnitude of the alleged friction error.

929. Thus, the Respondents' expert Dr. Hibiki agrees with Exponent that MHI does indeed make use of the [REDACTED] and not the Moody Chart, as, in Dr. Hibiki's opinion, it is easier to use the [REDACTED] in a computer code calculation than the Moody Chart.¹¹⁰⁸
930. However, the Respondents disagree with the Claimants' estimation of the smoothness of the downcomer wall. In this connection, the Respondents refer to their expert, Dr. Hibiki, who opines that "the downcomer surface is much smoother than what Exponent claims and the circulation ratio calculation in the Exponent Report is based on the incorrect downcomer surface roughness [REDACTED] times larger than the actual downcomer surface roughness."¹¹⁰⁹ According to Dr. Hibiki, the downcomer surface is [REDACTED] [REDACTED] to render it smooth.¹¹¹⁰
931. The Respondents also refer to Dr. Hibiki's agreement with the Claimants' expert Exponent that the [REDACTED] becomes less accurate than the Moody Chart and places the inaccuracy at "about [REDACTED] of the Reynolds number associated with downcomer water."¹¹¹¹
932. Also, the Respondents' expert Dr. Hibiki opines that had the Moody Chart been used, a circulation ratio of [REDACTED] would have been calculated, rather than [REDACTED] as calculated by SSPC.¹¹¹²
933. In rebuttal, the Claimants refer to their expert Exponent's rebuttal opinion, in which it objects to Dr. Hibiki's characterization of the Moody Chart as being difficult to

¹¹⁰⁸ Expert Report of Dr. Hibiki, ¶ 76.

¹¹⁰⁹ Expert Report of Dr. Hibiki, ¶ 77.

¹¹¹⁰ Expert Report of Dr. Hibiki, ¶ 77.

¹¹¹¹ Expert Report of Dr. Hibiki, ¶ 78.

¹¹¹² Expert Report of Dr. Hibiki, ¶ 79(3).

use. Exponent is of the view that there are equations available that do replicate the Moody Chart and that MHI uses those equations in FIT-III.¹¹¹³

934. In support of their position, the Claimants also refer to their expert's rebuttal opinion to the extent that it disagrees with Dr. Hibiki's description of the smoothness of the downcomer and identifies that MHI's own calculation actually used a much rougher surface.¹¹¹⁴
935. In addition, the Claimants' expert Exponent further critiques a design approach used by MHI that assumed a "perfectly smooth" surface, as being one that "defies physical reality."¹¹¹⁵
936. In general, the Respondents contend that SSPC is similar to other codes used in the industry, such as ATHOS.
937. Furthermore, the Respondents refer to their expert, Dr. Hibiki, who opines that the uses of the [REDACTED] is an acceptable engineering judgment, that results in a discrepancy, with the Moody Chart, of only [REDACTED] for the downcomer.¹¹¹⁶
938. Addressing the actual surface smoothness of the downcomer, Dr. Hibiki notes that the "actual surface roughness in the downcomers of the RSGs is [REDACTED]¹¹¹⁷ which is smaller than the 70 μm used in Exponent's version of SSPC."¹¹¹⁸

¹¹¹³ Rebuttal Expert Witness Statement of Dr. Harri Kytömaa And Dr. Timothy Morse, Exponent, Inc. ["Exponent Rebuttal"], ¶¶ 23-25.

¹¹¹⁴ Exponent Rebuttal, ¶ 26.

¹¹¹⁵ Exponent Rebuttal, ¶¶ 27-28.

¹¹¹⁶ Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 9.

¹¹¹⁷ μm are micrometers, a thousandth of a millimeter.

¹¹¹⁸ Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 8.

(ii) The Tribunal's Determination

939. Dr. Hibiki, in providing the Respondents' main evidence on this question, agrees with the Claimants' expert, Exponent, that the use of the ██████████ by MHI does create a discrepancy from the use of a Moody Chart.¹¹¹⁹ Dr. Hibiki opines that SSPC could have calculated a circulation ratio of ██████ rather than ██████ had a Moody Chart been used by MHI, as recommended by Exponent.
940. However, there is disagreement between the Parties and their experts as to three factors: (i) what the actual wall smoothness of the downcomer is (i.e., how smooth was the steel in reality); (ii) whether one should design assuming some fouling¹¹²⁰ of wall smoothness from operation; and (iii) the use of design assumptions.
941. In relation to the factors in the preceding paragraph, Dr. Hibiki criticizes Exponent in that it did not provide any reference for its use of a surface roughness of 70µm. In any event, the Tribunal considers this aspect to be ancillary to the primary question in this Issue and therefore considers that they do not require any particular determinations. That is, the Tribunal considers the question of the Respondents' design methodology to be of greater relevance than the actual surface roughness of the downcomer.
942. The Tribunal considers that the Claimants have shown that the Respondents' design choices led to a degree of under-prediction of the circulation ratio. Such under-prediction is thus to be considered an error in the calculation of the downcomer's surface friction. However, the Claimants have not particularized the effect of the friction error on the circulation ratio. Rather, the Claimants' expert Exponent particularizes the effect of all three alleged errors in SSPC, that is, the combined

¹¹¹⁹ Expert Report of Dr. Hibiki, ¶¶ 78-79. See also ¶ 931 above.

¹¹²⁰ Fouling represents the effect of residue left on a wall from water sediment.

effect of the alleged friction error, pressure losses in contractions error, and downcomer turn error.

943. However, the absence of a particularization of the effect of the friction error on the circulation ratio is not determinative as to whether there was a design error. That is so because the circulation ratio appears not to be as specified in the RSG Contract. This is evidenced by the Respondents' expert Dr. Hibiki's calculation that by using the Moody Chart, the circulation ratio would be the lower value of [REDACTED] rather than the higher of [REDACTED] specified in the RSG Contract.¹¹²¹
944. Therefore, the Tribunal considers that the Claimants have proven a design error in the calculation of the pressure loss from the surface friction of the downcomer.

(b) Alleged Pressure Losses in Contractions Error

945. The alleged pressure losses in contractions error concerns the following. As the water flows down the downcomer, its passage is interrupted on account of obstructions in the downcomer. These obstructions are known as contractions, where the space available is contracted, i.e., it is smaller than it was previously. These obstructions affect the pressure of the water flowing through the downcomer, causing pressure loss.
946. There are eight contractions in the downcomer, one obstruction at each of the seven tube support plates (TSPs) and a further contraction in the downcomer transition area of the RSG.
947. The narrowing in the downcomer towards the contraction may be sudden or gradual. This narrowing leads to pressure loss.

¹¹²¹ RSG Contract, Table 3A.

948. In case of a sudden contraction, the water flows from a larger area into a smaller area after passing through a sudden contraction. In contrast, a gradual contraction would see a narrowing from the larger area into the smaller area, rather than an abrupt sudden contraction.

(i) *The Parties' Positions*

949. In relation to the alleged pressure with losses contraction, the Claimants refer to their expert Exponent, who opines that “Mitsubishi used an incorrect equation to calculate the pressure losses in contractions” and that this resulted in an erroneously high circulation ratio and erroneously low void fraction.¹¹²²

950. The Claimants rely on Exponent when submitting that there are two methods used to calculate pressure losses coefficients in contractions, Idelchik method 1 and Idelchik method 2.¹¹²³

951. According to the Claimants' expert Exponent, MHI incorrectly combined elements of these two methods for the calculation of the pressure loss coefficient (k).¹¹²⁴

952. The Claimants' expert Exponent sets out that Idelchik method 1, used for sudden contractions, is:

$$k = \frac{1}{2} \left(1 - \frac{F_0}{F_1} \right)$$

953. Idelchik method 2, as set out by Exponent, used for gradual contractions, is:

¹¹²² Exponent Design Review, ¶ 84.

¹¹²³ Professor Isaak E. Idelchik produced a textbook on Hydraulic Resistance, titled the Handbook on Hydraulic Resistance (Exh. JX-263).

¹¹²⁴ Exponent Design Review, ¶ 86.

$$k = \zeta' \left(1 - \frac{F_0}{F_1} \right)^{0.75}$$

954. According to the Claimants’ expert Exponent, MHI’s combined method is:



955. According to the Claimants, in MHI’s combined method, the [REDACTED]
[REDACTED]
[REDACTED]

956. The Claimants contend that this combined method is found in MHI’s pressure loss formula, which incorporates, according to the Claimants’ expert, both a “contraction pressure loss correction coefficient” [emphasis added] with the “contraction pressure loss coefficient,” along with other variables required for calculating pressure loss.¹¹²⁶ The formula for the pressure loss of the downcomer transition is provided below:¹¹²⁷



957. The Claimants refer to their expert and submit that MHI’s 2008 Thermal and Hydraulic Parametric Calculations Report,¹¹²⁸ (the “T/H Parametric Report”) uses a



¹¹²⁶ Such as the Downcomer water specific volume (V_{DC}), Water mass flow rate in downcomer (W_{DC}), gravity acceleration (g), Downcomer flow area at lower shell part (A_{DLS}), and for downcomer obstructions the expansion pressure loss coefficient (CK_{DCSE}) (See nomenclature in Exh. JX-822, pp. 204-216). For downcomer obstructions, the pressure loss is calculated for each obstruction.

¹¹²⁷ Exh. JX-263, p. 263 (The pressure loss formula for the downcomer obstructions is similar but adds the pressure loss for expansion pressure loss following obstructions (Exh. JX-822, p. 264)).

¹¹²⁸ Exh. JX-822.

different nomenclature than their own expert Exponent as well as Idelchik. In the above formula, CD is the contraction pressure correction loss coefficient as used in Idelchik method 2 (i.e., zeta (ζ) or (ζ) depending on the script used). Also in the above formula, CK is the contraction pressure loss coefficient (k) obtained from Idelchik method 1.

958. In sum, the Claimants position is that [REDACTED]
[REDACTED]
[REDACTED]
959. The Respondents do not dispute that MHI used a modified Idelchik method 1 in calculating pressure loss. According to the Respondents' expert, however, MHI's use of a modified Idelchik method 1 is fully appropriate given that the contractions in the downcomer are gradual contractions, rather than sudden contractions.¹¹²⁹
960. Further, the Respondents rely on their expert Dr. Hibiki when agreeing with the Claimants' expert Exponent that only a sudden contraction uses Idelchik method 1 as put forth by Exponent.¹¹³⁰
961. The Claimants' expert Exponent's rebuttal re-affirms the opinion that for a gradual contraction area MHI should have used Idelchik method 2, as prescribed by Idelchik's handbook, rather than an improper combination of both methods.¹¹³¹
962. In addition, the Claimants refer to their expert Exponent, who provides calculated results setting forth that the MHI method under-predicted pressure loss coefficient (k), by up to 361%, for the downcomer transition and seven obstructions.¹¹³²

¹¹²⁹ Expert Report of Dr. Hibiki, ¶ 81.

¹¹³⁰ Expert Report of Dr. Hibiki, ¶ 81.

¹¹³¹ Exponent Rebuttal, ¶¶ 32-33.

¹¹³² Exponent Rebuttal, ¶¶ 33-34.

Location	Mitsubishi's Incorrect Method	Idelchik Method 2	Difference
Downcomer Transition	██████	0.3498	██████
Downcomer Obstruction 1	██████	0.0855	██████
Downcomer Obstruction 2	██████	0.0479	██████
Downcomer Obstruction 3	██████	0.0469	██████
Downcomer Obstruction 4	██████	0.0456	██████
Downcomer Obstruction 5	██████	0.0469	██████
Downcomer Obstruction 6	██████	0.0163	██████
Downcomer Obstruction 7	██████	0.0817	██████

963. The Respondents put forward their expert Dr. Hibiki in rebuttal. They object to the Claimants' expert's calculation of pressure loss coefficients. According to their expert Dr. Hibiki, the Claimants' expert Exponent incorrectly used MHI's equation in calculating pressure loss coefficients such that Exponent's table of calculations (as set forth in ¶ 962 above), purporting to quantify the extent of MHI's error, is wrong.¹¹³³
964. In particular, the Respondents support their position by Dr. Hibiki's opinion that it is incorrect to use MHI's contraction pressure loss correction coefficient values ██████

¹¹³³ Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 12.

[REDACTED]

[REDACTED]

965. At the Hearing, Dr. Hibiki testified that he reviewed MHI's pressure loss calculations and found MHI's calculations to be correct.¹¹³⁴ To confirm the accuracy of MHI's calculations, Dr. Hibiki verified the angle of the gradual obstructions. This angle geometry provides the correction coefficient (ζ) using either a chart or a formula for ζ in the Idelchik Handbook.¹¹³⁵

(ii) *The Tribunal's Determination*

966. As stated by the Claimants' expert, Exponent, the formula used in MHI's 2008 T/H Parametric Calculations Report for the calculation of the contraction pressure loss coefficient is based upon what Exponent calls the Idelchik method 1, as set out in the Idelchik handbook.¹¹³⁶

967. The Respondents have convincingly shown that where the Claimants' fault MHI, is in [REDACTED]

[REDACTED]

[REDACTED]

968. That MHI adopted this modified Idelchik method 1 is not disputed between the Parties.¹¹³⁷

¹¹³⁴ Transcript, p. 3539 (Dr. Hibiki).

¹¹³⁵ Exh. JX-739, p. 3.

¹¹³⁶ Exh. JX-822, p. 263 (See item 6: Contraction pressure loss coefficient CK_{DCT}); Exh. JX-822, p. 264 (See item 3: Contraction pressure loss coefficient $CK_{DCSC(i)}$); JX-739 at 4; Transcript, p. 3539.

¹¹³⁶ Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 12.

¹¹³⁷ Exh. JX-822, pp. 263-264 (See equation 7 for the downcomer transition and equation 5 for the downcomer obstructions).

969. MHI's 2008 T/H Parametric Report lists a [REDACTED] and [REDACTED] for the downcomer transition and the downcomer TSP obstructions, respectively, adopted from Idelchik's handbook, when using a [REDACTED] graduation.¹¹³⁸
970. The record shows that the Parties agree that MHI [REDACTED] [REDACTED]¹¹³⁹ According to the Respondents, however, this was proper engineering judgment.
971. In addition, the Respondents disagree with the Claimants' calculation of Idelchik method 2 using MHI's [REDACTED] from the MHI 2008 T/H Parametric Report. In particular, the Respondents' expert appears to suggest that the Claimants' expert should have used a different [REDACTED]
972. The Claimants' expert Exponent's methodology is not entirely clear, as they have not specified what [REDACTED] they used in Idelchik method 2.¹¹⁴⁰ Neither is the Respondents' expert's criticism of Exponent's methodology, who have also not identified what [REDACTED] should be used. As became evident during the cross-examination of Dr. Morse, further discussed below in ¶ 977 below, Exponent did not have access to the geometric information required for determining [REDACTED]
973. Given this absence of clarity, the Tribunal has verified the calculations performed by the Claimants' expert Exponent. This verification confirms the Respondents' assertion that Claimants' calculations use the [REDACTED] of [REDACTED] and [REDACTED] and Idelchik method 2. The Claimants, however, through their expert

¹¹³⁸ Exh. JX-822, pp. 263-264; Exh. JX-739, p. 3.

¹¹³⁹ Exh. JX-822, p. 263 (See [REDACTED]).

¹¹⁴⁰ See ¶ 977 below where Dr. Morse, the Claimants' expert, admits that he lacked geometric information required for this calculation.

Exponent do not use different¹¹⁴¹ [REDACTED] that would be obtained from reviewing the downcomer geometry.

974. As suggested by the Respondents' expert Dr. Hibiki, the Claimants' expert Exponent calculated the Idelchik method 2 results by using the [REDACTED] from MHI's 2008 T/H Parametric Report in order to calculate the [REDACTED] [REDACTED] provided in the table at ¶ 962 above.
975. According to the Idelchik handbook, the [REDACTED] used by MHI appears to correspond to a gradual contraction of [REDACTED]. The Respondents have not specified what gradual contraction value MHI should have used while employing Idelchik method 2. They have merely indicated that the Claimants' expert Exponent could not use MHI's values (apparently for [REDACTED]).
976. In this connection, the Respondents have affirmed, through their expert Dr. Hibiki, that they verified the calculations and the "geometrical data" from the "steam generator drawing."¹¹⁴² This geometric data presumably would provide the angle of the downcomer TSP obstructions and of the downcomer transition.¹¹⁴³
977. During the cross-examination of Dr. Morse, who testified on behalf of the Claimants' expert, Exponent, on this Issue, he acknowledged that he was lacking geometric information required for this calculation, in particular the geometry of the downcomer obstructions.¹¹⁴⁴ In their closing submissions, the Respondents

¹¹⁴¹ Assuming the geometry is different.

¹¹⁴² Transcript, p. 3539 (Dr. Hibiki).

¹¹⁴³ Or so the Respondents submit.

¹¹⁴⁴ Transcript, p. 1072 (Dr. Morse).

referenced a steam generator technical drawing, exhibited by the Claimants, allegedly identifying where such information could be obtained.¹¹⁴⁵

978. It is unclear whether the technical drawing referenced by the Respondents contains the required information for the Claimants' expert Exponent to have identified the gradual contraction value that could be used with Idelchik's method 2. The document referenced by the Respondents is of small scale engineering diagrams and difficult to read, let alone interpret:



979. Taking the above into consideration, as framed by the Parties' respective experts, a first question appears to be whether the Respondents exercised proper engineering judgment in using a [REDACTED] in combination with Idelchik method 1. A second question is whether MHI's decision to do so resulted in an under-prediction of the pressure loss at the downcomer obstructions. A third question is whether this under-prediction amounts to a design error.
980. With respect to the first question of whether the Respondents exercised proper engineering judgment, it is evident that MHI's method of calculating pressure loss deviates from the Idelchik textbook approach. It would appear that MHI's deviation results in a lower pressure loss than would otherwise be calculated.
981. While it is open to MHI to develop its own methods of calculation based upon experimentation, the use of a [REDACTED] in combination with

¹¹⁴⁵ Respondents' Closing Statement, slide 27; See also Transcript, p. 6199; Exh. JX-352, p. 15.

Idelchik method 1 appears inappropriate when considering the [REDACTED] of the Idelchik Handbook, as referenced by MHI's 2008 T/H Parametric Report. That table provides that for a contraction of [REDACTED] i.e., a sudden contraction, a value of [REDACTED] is to be used (as per Idelchik method 1). MHI appears to have combined this [REDACTED] value as used in method 1 with the [REDACTED] values for a [REDACTED] gradual contraction as used in method 2.¹¹⁴⁶

982. MHI has not shared any valid engineering reason for this decision.
983. Accordingly, answering the first question, MHI's decision to combine both of Idelchik's methods constitutes a mistake or at the very least a failure to adequately document deviations from its stated source of a formula, the Idelchik handbook.
984. With respect to the second question of whether MHI's decision to use a [REDACTED] [REDACTED] resulted in an under-prediction of the pressure loss at the downcomer obstructions, the Claimants have convincingly shown that in using a [REDACTED] [REDACTED] in combination with Idelchik method 1, results in a decrease in calculated pressure loss. This is a mere matter of arithmetic.
985. With respect to the third question of whether the under-prediction amounts to a design error, the Tribunal is not convinced that this mistake had any substantial effect on the design of the RSGs.
986. The Claimants' expert Exponent has calculated that on account of MHI's use of the modified Idelchik method 1, the pressure loss coefficients are under-predicted by 102%-361%.¹¹⁴⁷ While this appears substantive when presented as a percentage, the variations are far less apparent in absolute terms for the following reason.

¹¹⁴⁶ Exh. JX-739, p. 3.

¹¹⁴⁷ Exponent Rebuttal, ¶¶ 33-34.

987. For example, the Claimants' expert Exponent calculated the pressure loss coefficient at downcomer obstruction 6 as being 0.0163 compared [REDACTED] for MHI's calculation.¹¹⁴⁸ While 0.0163 is [REDACTED] larger than [REDACTED] the magnitude of this effect appears minimal when considering that the calculated pressure drop at contraction 6 is [REDACTED].¹¹⁴⁹
988. As demonstrated by the pressure loss formula provided at ¶¶ 956-957 above, the pressure loss coefficient is just one of the variables that make up the pressure loss formula.
989. Further, during the hearing, the Claimants' expert Exponent admitted that it was unable to quantify the particular effect of this mistake on circulation ratio as they lacked the geometry information required to make such calculations.¹¹⁵⁰
990. Given this lack of evidence as well as the relative weight of the downcomer pressure loss in the circulation ratio calculations, as submitted by the Respondents' expert Dr. Hibiki, the Tribunal does not consider the effect of the mistake in calculating the downcomer pressure loss coefficient significant.¹¹⁵¹
991. This does not change, however, the Tribunal finding that the Claimants have proven a design error in the SSPC calculations.

¹¹⁴⁸ Exponent Rebuttal, ¶¶ 33-34.

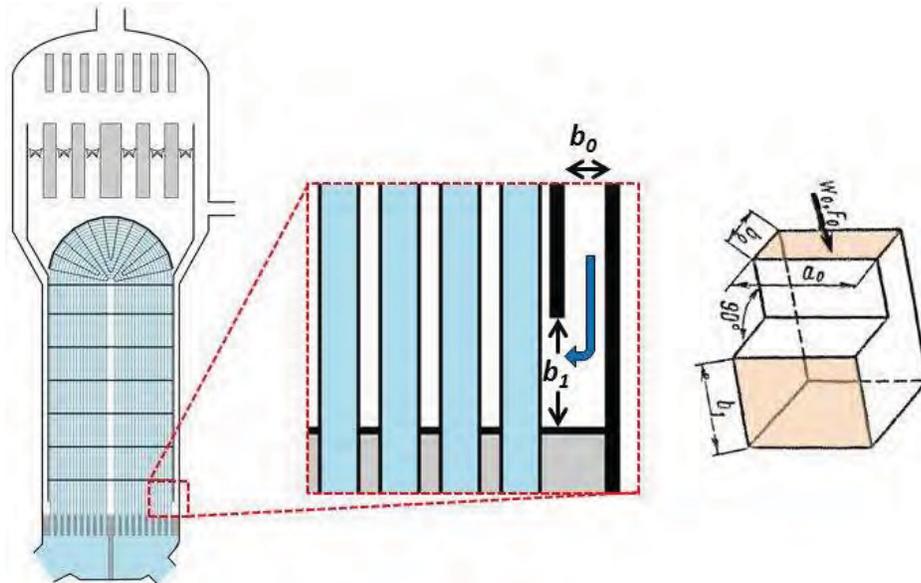
¹¹⁴⁹ Exh. JX-822, pp. 320-321.

¹¹⁵⁰ Transcript, p. 1072 (Dr. Morse).

¹¹⁵¹ Respondents' Closing Statement, slide 30.

(c) Alleged Downcomer Turn Error

992. The alleged downcomer turn error relates to the section at the bottom of the downcomer, where water exits the downcomer and turns into the tube bundle area of the RSGs, as depicted in the graphic below:¹¹⁵²



993. This turn creates a change in the pressure of the water flowing into the RSGs.
994. The amount of the pressure drop is affected by a pressure loss coefficient, which is calculated by a ratio of the width of the downcomer (b_0 in the graphic in ¶ 992 above) and the width of the opening leading to the tube bundle area (b_1 in the graphic in ¶ 992 above).

(i) *The Parties' Positions*

995. The Claimants contend that “Mitsubishi did not use a correct pressure loss coefficient when calculating the pressure drop at the bottom of the downcomer” and as a result

¹¹⁵² Exponent Design Review, ¶ 90.

“calculated a circulation ratio that was erroneously high and a void fraction that was erroneously low.”¹¹⁵³

996. According to their expert Exponent, the water exiting the downcomer turns at a 90° angle, resulting in pressure loss.¹¹⁵⁴ The pressure loss coefficient depends upon the width ratio between the inlet cross-section in the downcomer and the cross-section of the downcomer outlet.¹¹⁵⁵ MHI’s 2008 T/H Parametric Report identifies that they used a coefficient based upon Idelchik’s handbook.¹¹⁵⁶ Exponent suggests that it has identified that the Idelchik handbook only has empirical data for a width ratio of 2.0 while the RSG had a width ratio of [REDACTED].¹¹⁵⁷ The Claimants’ expert states that given this lack of empirical data, MHI had to extrapolate a pressure loss coefficient, which it did, adopting a value of [REDACTED].¹¹⁵⁸
997. The Claimants disagree with the extrapolation by MHI. They find support in their expert Exponent, according to whom with higher width ratios, the trend line is for a pressure loss coefficient that trends towards 1, rather than towards [REDACTED] the latter of which is the trend that Exponent opines MHI adopted.¹¹⁵⁹
998. Further, the Claimants’ expert Exponent modeled its own correlation in this regard, validated it against Idelchik’s reference data, and extrapolated the curve to find a pressure loss coefficient of 0.67, greater than MHI’s coefficient of [REDACTED].

¹¹⁵³ Exponent Design Review, ¶ 88.

¹¹⁵⁴ Exponent Design Review, ¶ 89.

¹¹⁵⁵ Exponent Design Review, ¶ 89.

¹¹⁵⁶ Exh. JX-822, p. 265; Exh. JX-733, p. 4.

¹¹⁵⁷ Exponent Design Review, ¶ 90.

¹¹⁵⁸ Exponent Design Review, ¶ 92.

¹¹⁵⁹ Exponent Design Review, ¶ 93.

999. The two methods are provided below:¹¹⁶⁰



1000. In contrast, the Respondents refer to their expert Dr. Hibiki who opines that the Claimants' expert Exponent's conclusion is "not necessarily correct."¹¹⁶¹

1001. Dr. Hibiki states that he cannot confirm Exponent's model as he lacks information on the inputs used.¹¹⁶² According to the Respondents' expert Dr. Hibiki, given the lack of data, both MHI and Exponent are engaging in an extrapolation from Idelchik's data and both extrapolations are broadly reasonable. Dr. Hibiki suggests that the effect of any such differences are "not significant."¹¹⁶³

¹¹⁶⁰ Exponent Design Review, ¶ 95.

¹¹⁶¹ Expert Report of Dr. Hibiki, ¶ 83.

¹¹⁶² Expert Report of Dr. Hibiki, ¶ 85.

¹¹⁶³ Expert Report of Dr. Hibiki, ¶ 86.

1002. In rebuttal, the Claimants, supported by their expert Exponent, dispute Dr. Hibiki's opinion that both its model and MHI's judgment are equally valid.¹¹⁶⁴
1003. The Claimants endorse their expert Exponent's model as a good fit to Idelchik's data and given that larger width ratios eventually lead to a pressure loss coefficient of 1, and not ■ as in MHI's extrapolation, its model is preferable to MHI's (incorrect) assumptions.

(ii) The Tribunal's Determination

1004. The Tribunal considers that MHI's selection of a downcomer pressure loss coefficient is a mistake in the design of the RSGs.
1005. As explained in the subsequent paragraph, the Claimants have persuasively established that the direction of the extrapolation of pressure loss coefficients calculated by MHI appears unreasonable.
1006. Moreover, the Respondents have not adequately contested the Claimants' submissions in this regard. In particular, the Claimants' evidence presented by their expert Exponent provides for a reasonable explanation that wider opening (b₁) corresponds to a discharge into an open space. Therefore, a trend line towards 1 (i.e., corresponding to a discharge into an open space) appears more reasonable than towards ■ (i.e., corresponding to a discharge into a confined space). As illustrated in Exponent's graphic above,¹¹⁶⁵ the water exiting the downcomer enters into the tube bundle area, which is, generally, an open space.¹¹⁶⁶

¹¹⁶⁴ Exponent Rebuttal, ¶¶ 35-39.

¹¹⁶⁵ See ¶ 992.

¹¹⁶⁶ That is of course filled with the tube bundle.

1007. Accordingly, the Claimants have demonstrated a design error by the Respondents in the SSPC calculations.

(d) **Effect of Alleged SSPC Design Errors**

1008. In light of the above findings that the Claimants have proven that the SSPC calculations contained the three alleged design errors, the Tribunal has to consider the effect of the SSPC design errors.

(i) *The Parties' Positions*

1009. In this respect, the Claimants rely on their expert Exponent, who states that the effect of these three errors is that the calculated circulation ratio of the RSGs is too high and the void fraction is too low.

1010. In particular, the Claimants take on their expert Exponent's calculation that after adjusting for these three errors, the circulation ratio would be 2.9 rather than MHI's calculated ██████¹¹⁶⁷ Exponent also calculates that void fraction using FIT-III would be 96.1% rather than MHI's calculated ██████¹¹⁶⁸ In its rebuttal statement, Exponent re-affirmed its calculations.¹¹⁶⁹

1011. The Respondents, in contrast, rely on their expert Dr. Hibiki who calculates that accepting the effect of Exponent's alleged errors regarding friction and the downcomer turn, would result in the corrected circulation ratio to be 3.13.¹¹⁷⁰

1012. The Respondents also refer to Dr. Hibiki's opinion that SSPC is a code that has been validated and that provides results approximate to measured data of operating

¹¹⁶⁷ Exponent Design Review, ¶ 104.

¹¹⁶⁸ Exponent Design Review, ¶ 104.

¹¹⁶⁹ Exponent Rebuttal, ¶ 43.

¹¹⁷⁰ Expert Report of Dr. Hibiki, ¶ 90.

plants.¹¹⁷¹ Dr. Hibiki notes that adopting the changes proposed by the Claimants' expert Exponent would improve the accuracy of SSPC in some regards and weaken the accuracy in other regards. The apparent conclusion being that SSPC may not be perfect, but it is adequate and comparable to other codes, such as ATHOS.

1013. The Claimants accept the Respondents' position that their expert's proposed changes would improve SSPC accuracy in some circumstances. They submit, however, that given this, MHI should have been using a better code; i.e., one that did not contain the errors that the Claimants' expert Exponent had identified.

(ii) The Tribunal's Determination

1014. The Respondents have challenged the significance of the Claimants' alleged errors.
1015. To this end, the Respondents cross-examined the Claimants' expert Exponent regarding the so-called "downcomer flow resistance." Dr. Kytömaa, of Exponent, testified that "most of the resistance actually comes from the downcomer (...) not all of it, but most of it."¹¹⁷² Dr. Kytömaa's statement was put to the Respondents' expert Dr. Hibiki during his examination by the Respondents. Dr. Hibiki disagreed, testifying that "actually, the downcomer pressure drop is about [REDACTED] so majority of the resistance comes from the wrapper¹¹⁷³ region."¹¹⁷⁴
1016. During the Respondents' closing statement, they returned to this and referenced MHI's 2008 T/H Parametric Report, indicating that the total pressure drop in the downcomer amounted to only [REDACTED] of the pressure drop in the steam generator loop, the remaining pressure drop occurring in the wrapper, i.e., the tube bundle area.¹¹⁷⁵

¹¹⁷¹ Expert Report of Dr. Hibiki, ¶ 91.

¹¹⁷² Transcript, p. 357 (Dr. Kytömaa).

¹¹⁷³ The wrapper region is broadly representative of the tube bundle area.

¹¹⁷⁴ Transcript, p. 3541 (Dr. Hibiki).

¹¹⁷⁵ Respondents' Closing Statement, slide 30; See also Transcript, p. 6601; Exh. JX-822, p. 321.

The SSPC errors are not at issue in the wrapper area. This is illustrated in the following table:¹¹⁷⁶

Pressure drop	Kg/cm ²	%	Issue (Exponent)
<i>Pressure drop of downcomer (SUM)</i>	██████	██████	Includes SSPC Errors
<i>Pressure drop in wrapper (SUM)</i>	██████	██████	Not at Issue
Total Pressure drop in loop (SUM) ████████████████████	██████	100%	

1017. The pressure drop in the downcomer area (amounting to ██████ of the pressure drop that occurs in the RSGs) is comprised of the sum of the pressure drop from the downcomer obstructions and transition, the friction in the downcomer, the downcomer turn and wrapper opening and other aspects:¹¹⁷⁷

Pressure drop	Kg/cm ²	%	Issue (Exponent)
Downcomer obstructions (SUM)	██████	██████	Contractions
Turn + wrapper opening	██████	██████	Downcomer turn error
Frictional drop of downcomer	██████	██████	Friction
[Other Aspects]	[...]	██████	-
Total Pressure drop of downcomer (SUM)	██████	██████	

¹¹⁷⁶ Respondents' Closing Statement, slide 30; See also Transcript, p. 6601; Exh. JX-822, pp. 320-321.

¹¹⁷⁷ Respondents' Closing Statement, slide 30; See also Transcript, p. 6601; Exh. JX-822, pp. 320-321.

1018. On account of the Respondents' mistakes, the pressure drop in the downcomer is higher than as calculated by the Respondents. As such, adopting the errors, would result in increasing the percentage of the pressure drop that occurs in the downcomer.
1019. The effect of these SSPC errors is primarily in the calculation of the circulation ratio (CR).¹¹⁷⁸ It should be reminded that MHI calculated a CR of [REDACTED]. According to the Claimants' expert Exponent, CR should be 2.9 (specifically 2.88) while the Respondents' expert Dr. Hibiki calculates the effect of MHI's errors, as alleged, resulting in a CR of 3.13.¹¹⁷⁹
1020. The Tribunal prefers Dr. Hibiki's estimate that the effect of these mistakes was a reduction in the CR to 3.13, rather than the 2.88 calculated by Exponent.¹¹⁸⁰ As Exponent admits, it was unable to perform all the calculations required given for example, the lack of data on the downcomer geometry.
1021. The Tribunal considers that a circulation ratio of 3.13 is still lower than as calculated by MHI during the design of SONGS. MHI would have been required to submit a supplier deviation request to SCE to have this lower circulation ratio approved. While SCE approved other reductions in the calculated circulation ratio, the record suggests that this was done reluctantly.
1022. As set out in the record, the circulation ratio of the OSGs was 3.2.¹¹⁸¹ The Tribunal considers that SCE would have presumably been concerned with the potential for dryout from an even lower circulation ratio.

¹¹⁷⁸ See ¶¶ 236-239 above (Section VII.D(c) above).

¹¹⁷⁹ Expert Report of Dr. Hibiki, ¶ 88.

¹¹⁸⁰ Expert Report of Dr. Hibiki, ¶ 88.

¹¹⁸¹ Exh. JX-267.

1023. The Tribunal also takes into account that the Claimants' expert Exponent has calculated that the lower circulation ratio marginally improves the stability ratio (SR).¹¹⁸² While Exponent calculates an increased void fraction [REDACTED] to 96.1% on account of SSPC errors alone), assuming one ineffective support, Exponent calculates a marginally improved maximum SR of 0.56 as compared to [REDACTED].¹¹⁸³ As Respondents submit in their Reply Post-Hearing Memorial, this does not result in a detriment to the RSGs.
1024. In light of the above, the record shows that in relation to the Claimants' alleged errors in SSPC, the RSGs are actually more stable than calculated by MHI.
1025. Accordingly, while the Tribunal considers that the Claimants have demonstrated three SSPC design errors that resulted in an under-prediction of circulation ratios and an under-prediction of void fraction, the Tribunal is not convinced that there was a material connection between these three SSPC errors and the SONGS Incident.

B. ALLEGED FIT-III ERRORS

1026. With respect to the Claimants' alleged FIT-III errors, the Tribunal recalls that MHI's Flow in Tube Bundle Three Dimensional Analysis, or the Flow in Three Dimensions (FIT-III) is a proprietary code for the calculation of thermal-hydraulic parameters, such as void fraction and velocity.¹¹⁸⁴
1027. The Claimants allege that the Respondents made three errors in FIT-III and have referenced the experts' reports of Exponent and Dr. Lahey as supporting evidence.¹¹⁸⁵

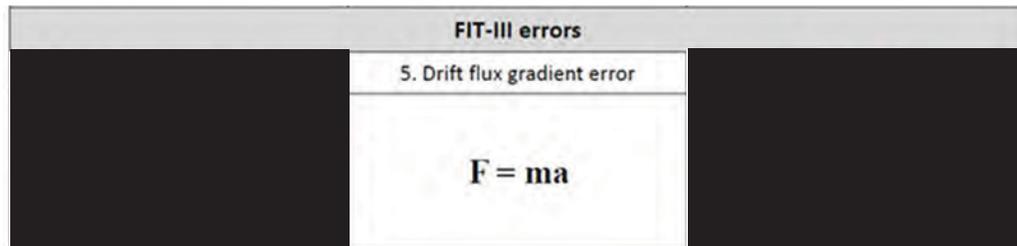
¹¹⁸² Exponent Design Review, ¶ 277, Table 22.

¹¹⁸³ Exponent Design Review, ¶ 277, Table 22.

¹¹⁸⁴ For use of FIT-III, see ¶¶ 240-249 above (Section VII.D(c) above).

¹¹⁸⁵ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 107.

1028. According to the Claimants, their experts Exponent and Dr. Lahey have identified three alleged errors in FIT-III, a “two-phase pressure drop error,” a “drift flux gradient error,” and a “porosity error:”

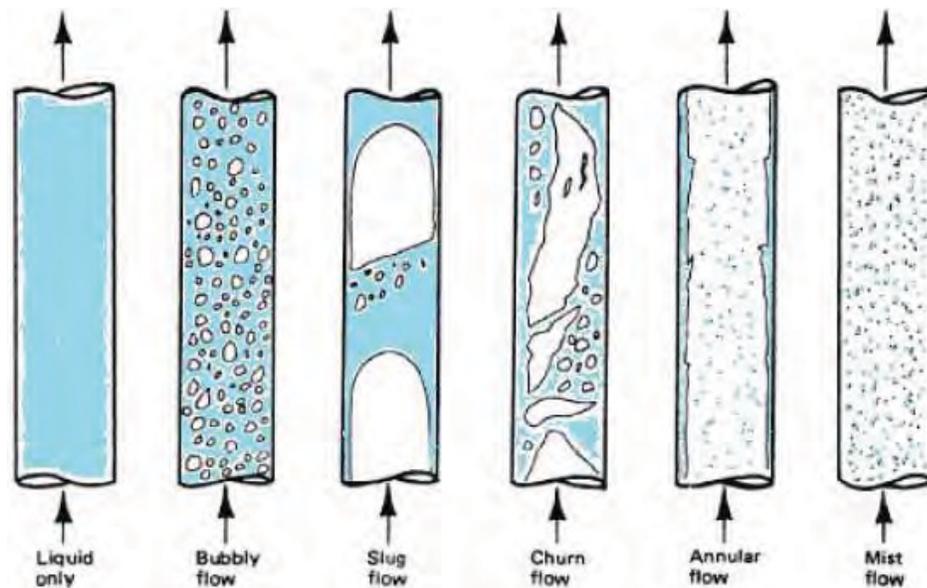


1029. The Respondents’ reject Exponent’s three alleged FIT-III errors in Appendix B to their Rejoinder Memorial. The Respondents submit that a detailed response to the alleged two-phase pressure drop error and the drift flux gradient error is provided by their expert Dr. Hibiki and a response to the alleged porosity error is provided by the Respondents’ expert [REDACTED]
1030. The summary of the Parties’ positions and analysis below is in consequence largely based upon the evidence, including Hearing testimony, as presented by Exponent and Dr. Lahey for the Claimants and Dr. Hibiki and [REDACTED] for the Respondents.

(a) **Alleged Two-Phase Pressure Drop Error**

1031. A two-phase flow is a mixture constituting of both water and air. The behavior of the two-phase flow is illustrated below and described in the introductory Section of this Award:¹¹⁸⁶

¹¹⁸⁶ See ¶ 165 above (Section VII.A(d) above).



1032. The pressure drop of a flow is correlated to the density of that flow. As water is denser than air, water creates more flow resistance than a two-phase mixture.
1033. The Claimants allege that the Respondents incorrectly modeled the pressure loss in the flow on account of a double counting of a variable while modeling this pressure loss.
1034. The Respondents submit that both Exponent and Dr. Lahey used the wrong equation from the FIT-III Manual and misread whether a particular Greek letter, Phi, was uppercase or lowercase such that Claimants found an error where there was none.

(i) The Parties' Positions

1035. As supported by their experts Exponent and Dr. Lahey, the Claimants submit that MHI “incorrectly calculated the two-phase pressure loss in FIT-III” and that “this error caused FIT-III to predict incorrect thermal-hydraulic conditions.”¹¹⁸⁷ This

¹¹⁸⁷ Exponent Design Review, ¶ 109.

conclusion by Exponent and Dr. Lahey is based upon constitutive¹¹⁸⁸ equations provided in the FIT-III Manual.¹¹⁸⁹ The Claimants rely on the explanations provided by their experts Exponent and Dr. Lahey. According to them, these equations contain an extra two-phase multiplier, the effect of which, according to Dr. Lahey, would be an under-prediction of gap velocities by “a factor of 3.39 for a void fraction of”  and “a factor of 4.84 for a void fraction of” 99.6%.¹¹⁹⁰

1036. In contrast, the Respondents refer to their expert Dr. Hibiki, who opines that Exponent and Dr. Lahey incorrectly assumed that other equations provided in Section 5.2 of Appendix 1 of the FIT-III Manual were used rather than the actual two-phase pressure loss equation found in Section 8 of Appendix 1 of the FIT-III Manual.¹¹⁹¹

1037. The Section 5.2 equations read as follows:



1038. The Section 8 equation reads as follows:



¹¹⁸⁸ Constitutive equations, as described by Dr. Hibiki are a means of implementing physics theory into engineering practice. (Transcript, pp. 5324-5325).

¹¹⁸⁹ Transcript, p. 616 (Dr. Lahey); Exh. JX-511, p. 98.

¹¹⁹⁰ Expert Witness Statement of Dr. Lahey, ¶ 33.

¹¹⁹¹ Expert Statement of Dr. Hibiki, ¶¶ 95-96; Exh. JX-511, pp. 98, 106.

(ii) The Tribunal's Determination

1039. According to the FIT-III Manual, the Section 5.2 equations are for “pressure loss due to tube bundles or other structures” in the x, y, and z directions while the Section 8 equation is for two-phase pressure loss.¹¹⁹²
1040. None of the Claimants’ expert reports identified what equations in the FIT-III Manual were being critiqued. Dr. Hibiki, on behalf of the Respondents, opined in his report that the equations that the Claimants’ experts Exponent and Dr. Lahey referenced were those in Section 5.2. However, according to Dr. Hibiki, the two-phase pressure loss equation is that from Section 8.¹¹⁹³
1041. At the Hearing, the Claimants’ expert Exponent (Kytömaa) confirmed that they critique Section 5.2 equations.¹¹⁹⁴ However, both Dr. Lahey¹¹⁹⁵ and Exponent¹¹⁹⁶ agree that the Section 8 equation is the correct equation for calculating two-phase pressure loss.
1042. This is confirmed by Dr. Hibiki’s oral testimony that the equation for calculating the FIT-III two-phase pressure loss should be the one found in Section 8 of Appendix 1 and not the one found in Section 5.2 of Appendix 1, as suggested by the Claimants’ experts Dr. Lahey and Exponent.
1043. Whether FIT-III contains an error therefore is determined by whether FIT-III used the Section 8 equation that the experts are agreed is correct.
1044. Prior to turning to that question, the Tribunal briefly addresses the apparent basis of this alleged error. The pressure loss equations provided in Section 5.2 of Appendix

¹¹⁹² Exh. JX-511, p. 91.

¹¹⁹³ Expert Statement of Dr. Hibiki, ¶¶ 95-96; Exh. JX-511, pp. 98, 106.

¹¹⁹⁴ See Transcript, p. 424 (Dr. Kytömaa).

¹¹⁹⁵ Transcript, p. 621 (Dr. Lahey).

¹¹⁹⁶ Transcript, p. 386 (Dr. Kytömaa).

I use a lower case Phi symbol “ ϕ .” As explained by Dr. Kytömaa, the only difference between the capital Phi and a lower-case Phi is that “the vertical bar will have horizontal lines through it.”¹¹⁹⁷ It would appear that when Dr. Lahey read the lower case Phi (“ ϕ^2 ”), he assumed this was a two-phase multiplier coefficient, used in two-phase pressure loss calculations.¹¹⁹⁸

1045. The nomenclature Section of the FIT-III Manual provides the following definition for the upper case Phi² (“ Φ^2 ”):

Φ^2 : Two-phase multiplier coefficient

1046. The lower case Phi² (“ ϕ^2 ”) is not a defined term in the FIT-III Manual.
1047. The FIT-III Manual does not define what the lower case Phi “ ϕ ” used in the Section 5.2 of Appendix 1 equations constitutes. During cross examination, Dr. Lahey testified that this would amount to a serious quality assurance (QA) failure.¹¹⁹⁹ In its rebuttal report, Exponent states that it “can think of no basis for why a code manual would include incorrect equations.”¹²⁰⁰
1048. With respect to the question of whether the FIT-III code used the Section 8 equation, which the experts are agreed is correct, the Claimants have submitted that to answer this question, the best evidence would be for the Respondents to exhibit the FIT-III source code.

¹¹⁹⁷ Transcript, p. 381 (Dr. Kytömaa).

¹¹⁹⁸ Transcript, p. 620. (Dr. Lahey).

¹¹⁹⁹ Transcript, p. 620. (Dr. Lahey).

¹²⁰⁰ Exponent Rebuttal, ¶ 50.

1049. The Respondents have not chosen to do so, claiming that it is highly confidential and proprietary. However, the Claimants bear the burden of proving the errors they alleged.
1050. Reversing the burden of proof, to provide an affirmative answer to this question, of whether the FIT-III code used the Section 8 equation, the Respondents submitted evidence that FIT-III does accurately calculate two-phase pressure loss by comparing the results of the FIT-III pressure loss calculation to (i) the results of pressure loss calculations from SSPC; and (ii) calculations performed by hand.
1051. In effect, the Respondents submit that both FIT-III and SSPC calculate two-phase pressure loss using the same Section 8 equation. Further, the FIT-III Challenge Board also verified what the two-phase pressure loss should be, by performing its own calculations. The Tribunal considers that if SSPC and the hand calculations provide a similar result to FIT-III, that would demonstrate that FIT-III does use the correct Section 8 equation.
1052. The FIT-III calculated pressure loss was calculated at [REDACTED]¹²⁰¹
1053. During cross-examination, the Claimants' expert Exponent agreed that SSPC correctly calculates pressure loss using the correct two-phase multiplier in the pressure loss model.¹²⁰² Exponent further agreed that SSPC calculated pressure loss could be compared to those of FIT-III.¹²⁰³ As submitted in the Respondents' closing statement, pressure loss using SSPC was calculated at [REDACTED]¹²⁰⁴

¹²⁰¹ Exh. JX-1283, p. 8; Respondents' Closing Statement, slide 37.

¹²⁰² Transcript, p. 387 (Dr. Kytömaa).

¹²⁰³ Transcript, p. 388 (Dr. Kytömaa).

¹²⁰⁴ Respondents' Closing Statement, slide 36; See also Exh. JX-822, p. 321.

1054. As part of the FIT-III challenge board process,¹²⁰⁵ the FIT-III results were compared to hand calculations¹²⁰⁶ of ██████████¹²⁰⁷
1055. During cross-examination, these results were put to the Claimants' expert Dr. Lahey, who agreed that the difference of █████ between FIT-III ██████████ and hand calculations ██████████ represented a close fit.¹²⁰⁸
1056. Given the close results between the two-phase pressure loss as calculated by FIT-III, SSPC and by hand, the evidence shows that FIT-III did use a correct pressure loss formula, as provided in Section 8.
1057. Based on the above, the Tribunal considers that the Claimants have not proven that there is an error in FIT-III's calculation of two-phase pressure drop.

(b) Alleged Drift Flux Gradient Error

1058. With respect to the Claimants' alleged drift flux gradient error, the Tribunal recalls that Newton's second law is force equals mass times acceleration ("**F=ma**").
1059. In a two-phase flow, the force of that flow ("**F**") is equal to the mass ("**m**") of the components of that flow (water and air) multiplied by the acceleration ("**a**") of that flow (i.e., the change in velocities of the water and air over time).
1060. Modeling the two-phase flow requires maintaining this equation in balance. There must be a conservation of the variables of mass, momentum and energy to maintain

¹²⁰⁵ The FIT-III challenge board, consisting of various experts, reviewed FIT-III following the Incident.

¹²⁰⁶ Hand calculations refer to calculations undertaken manually rather than by a software program.

¹²⁰⁷ Exh. JX-1283, p. 8; Respondents' Closing Statement, slide 37.

¹²⁰⁸ Transcript, p. 637 (Dr. Lahey).

the equilibrium. A “drift flux” approach is a means of calculating different velocities in a two-phase flow.¹²⁰⁹

1061. As explained by the Claimants’ expert Exponent, “the drift-flux gradient is a term in the momentum conservation equation needed to account for the different velocities of the two phases and depends on the local conditions (e.g. void fraction, density, pressure.)”¹²¹⁰ The Respondents have provided a similar definition.¹²¹¹ Both the Claimants’ expert Exponent and the Respondents have submitted that a more complete definition is beyond the scope of this arbitration.¹²¹²
1062. The Tribunal also takes into account the Respondents’ expert Dr. Hibiki’s explanation during the Hearing that while in physics $F=ma$, in thermal hydraulic engineering, $F \approx ma$ i.e., force only approximately equals mass multiplied by acceleration.¹²¹³ That is because engineers must develop equations to capture and approximate (as best as possible) the behavior of a two-phase flow. Doing so requires the use of constitutive equations.

(i) The Parties’ Positions

1063. The Claimants allege an error in the Respondents’ modeling of the conservation of energy, mass, and momentum in a two-phase flow, which would violate Newton’s second law, $F=ma$.

¹²⁰⁹ Transcript, p. 285 (Dr. Kytömaa).

¹²¹⁰ Exponent Design Review, ¶ 118.

¹²¹¹ Transcript, p. 285 (Dr. Kytömaa).

¹²¹² Exponent Design Review, ¶ 118; Transcript, p. 285 (Dr. Kytömaa) (Exponent has stated that a more complex definition is available in Dr. Lahey’s textbook and the ATHOS manual).

¹²¹³ Transcript, pp. 3609-3611 (Dr. Hibiki).

1064. In particular, according to the Claimants' expert Exponent and Dr. Lahey, FIT-III is deficient in that it does not include a "drift flux" gradient.¹²¹⁴ In this connection, the Claimants refer to the explanation provided by their experts that a drift flux term is required in order to conserve momentum.¹²¹⁵ According to the Claimants, lacking a drift flux term, FIT-III appears to violate Newton's second law, that force equals mass times acceleration (i.e., $F=ma$).
1065. In addition, the Claimants submit, supported by their expert Dr. Lahey, that FIT-III lacks a "Reynolds¹²¹⁶ stress term," which also results in a failure to conserve momentum.¹²¹⁷
1066. The Respondents appear to agree with the Claimants that FIT-III does not include either the allegedly missing drift-flux gradient or the Reynolds stress term.
1067. Moreover, the Respondents refer to their expert Dr. Hibiki, who agrees with the Claimants' Dr. Lahey that FIT-III does not contain the Reynolds stress term, submitting that this is intentional as the Reynolds stress term effect is "negligibly small" and "not important in full-scale steam generators."¹²¹⁸ Dr. Hibiki further references a paper by Dr. Lahey in which Dr. Lahey wrote "the Reynolds stress tensor is difficult to constitute and is thus often neglected."¹²¹⁹
1068. With regard to the allegedly missing drift-flux stress term, the Respondents appear to agree that this term is not present in FIT-III, and rely on the expert opinion of Dr.

¹²¹⁴ Exponent Design Review, ¶ 117; Expert Witness Statement of Dr. Lahey, ¶ 8(f).

¹²¹⁵ Exponent Design Review, ¶¶ 118-119; Expert Witness Statement of Dr. Lahey, ¶ 8(f).

¹²¹⁶ The Reynolds stress term appears to be further work from Professor Osborne Reynolds. The Reynolds Stress term accounts for a sort of T/H behavior.

¹²¹⁷ Expert Witness Statement of Dr. Lahey, ¶ 8(f).

¹²¹⁸ Expert Report of Dr. Hibiki, ¶ 110.

¹²¹⁹ Expert Report of Dr. Hibiki, ¶ 109.

Hibiki who opines that it is equally not present in other codes as well, such as CAFCA,¹²²⁰ an AREVA code.¹²²¹

(ii) *The Tribunal's Determination*

1069. The Respondents' closing submission admitted that the drift-flux term is not in FIT-III.¹²²² Also, the Respondents' closing submission identifies that Dr. Lahey, during cross-examination, agreed that he thought it was acceptable to not include the Reynolds stress term, stating that it "isn't the big thing I have a problem with" and that "if you have conditions where you don't think it's important, fair enough, you leave it out."¹²²³
1070. Accordingly, the Tribunal considers that the non-inclusion of the Reynolds stress term is not an error but a matter of engineering judgment.
1071. The Respondents have submitted that the drift-flux term was not included in FIT-III, nor in CAFCA, nor PORTHOS, an EPRI code.¹²²⁴ The Respondents submitted that only ATHOS, an "algebraic" code uses the drift-flux gradient, while "homogenous" codes such as FIT-III and CAFCA do not.¹²²⁵ The Respondents further content that FIT-III, CAFCA and PORTHOS address the conservation of mass in a different manner.¹²²⁶
1072. In effect, the Respondents' case is that FIT-III does not have a drift flux gradient component as it used a different constitutive equation to achieve the same result.

¹²²⁰ See Section VII.D(c) on design software.

¹²²¹ Expert Report of Dr. Hibiki, ¶¶ 107-108.

¹²²² Transcript, p. 6609 (Counsel).

¹²²³ Transcript, pp. 624-625 (Dr. Lahey).

¹²²⁴ Transcript, pp. 6610-6611 (For design software generally, see Section VII.D(c) above).

¹²²⁵ Transcript, pp. 6609-6611 (Counsel).

¹²²⁶ Transcript, pp. 6609-6611 (Counsel).

1073. The Claimants have convincingly shown that FIT-III included neither a drift-flux term nor a Reynolds stress term. The Tribunal, however, considers that these omissions are intentional and acceptable.
1074. Accordingly, the Respondents did not make an error in this regard.

(c) **Alleged Porosity Error**

1075. In relation to the Claimants' alleged porosity error, the Tribunal notes that the water and steam in the RSGs flow in the gaps left between the tubes, TSPs, AVBs, and other components. These gaps can be modeled in FIT-III. The space is either open, i.e., porous, or closed to the flow.

(i) *The Parties' Positions*

1076. According to the Claimants, FIT-III modeled porosity in a way that allocated more open space to a particular area than that area contained. This would be akin to saying a 1 gallon jug contains 1.2 gallons of milk, which, according to the Claimants would, of course, defy physics.¹²²⁷
1077. In particular, the Claimants contend in reliance on their expert Exponent that "Mitsubishi used a porosity greater than 1.0" in FIT-III, "which is physically impossible and therefore incorrect."¹²²⁸
1078. The Claimants' expert Exponent explains that porosity in FIT-III represents the percentage of a given area in the steam generator that is either occupied or free of obstructions (i.e., tubes, AVBs, etc.).¹²²⁹

¹²²⁷ Exponent Design Review, ¶¶ 123-125.

¹²²⁸ Exponent Design Review, ¶ 121.

¹²²⁹ Exponent Design Review, ¶ 122.

1079. A porosity of 0 signals a completely obstructed space while a porosity of 1 signals no obstructions. The Claimants maintain that, as explained by their expert Exponent, a porosity greater than 1 is impossible, as it would indicate that there was more free space in a completely free area than there is space available there.¹²³⁰

1080. In contrast, the Respondents contend that they took an intentional engineering choice to account for something called ██████████¹²³¹ that the FIT-III code could not otherwise calculate. According to the Respondents, the alleged porosity error is not an error, but a workaround.

1081. More specifically, the Respondents, referring to their expert ██████████ submit that “MHI intentionally adopted a special modeling treatment in its FIT-III calculation for the steam generator design to account for indexing in the tube bundle.”¹²³²

1082. ██████████ further explained that a ██████████
██████████¹²³³

(ii) The Tribunal’s Determination

1083. The Claimants have convincingly shown that FIT-III used a porosity ██████████ as admitted by the Respondents’ expert ██████████

1084. The Tribunal also considers ██████████ explanation that the Respondents had a valid reason to make this adjustment to FIT-III to account for ██████████ to be persuasive.

1085. While the evidence provided by the Claimants in the form of their expert Exponent is correct, that making this modification to FIT-III defies physics, the Tribunal

¹²³⁰ Exponent Design Review, ¶¶ 121-122.

¹²³¹ ██████████

¹²³² Expert Witness Statement of ██████████ ¶ 4.

¹²³³ Expert Witness Statement of ██████████ ¶¶ 4-5.

considers ██████████ explanation that this is a mere workaround reasonable. Exponent may not have programed FIT-III in this manner, but during cross-examination it did not prove that the Respondents' indexing calculations were unreasonable.¹²³⁴

1086. Accordingly, the Claimants have not proven that the alleged porosity error to be a design error.

(d) Conclusion Regarding Alleged FIT-III Errors

1087. In light of the above, the Tribunal does not consider any of the three alleged FIT-III design errors to have been a material cause of the SONGS Incident. To the extent that the Claimants have alleged inconsistencies and issues in the FIT-III code, the Respondents' explanations of these allegations are reasonable.

C. ALLEGED FIT-III POST-PROCESSOR ERRORS

1088. As part of their post-Incident investigations, the Respondents have admitted that there was an error in how information from FIT-III was processed by the FIT-III post-processor. In particular, there was a failure to correctly account for the fact that the SONGS RSGs had a triangular pitch tube bundle and, therefore, more tightly packed tubes than in a square array tube bundle. This resulted in what the Parties have called a "Gap Velocity Error", in which flow velocities were under-predicted and out-of-plane stability ratio calculations are incorrect by a factor of 2.3.

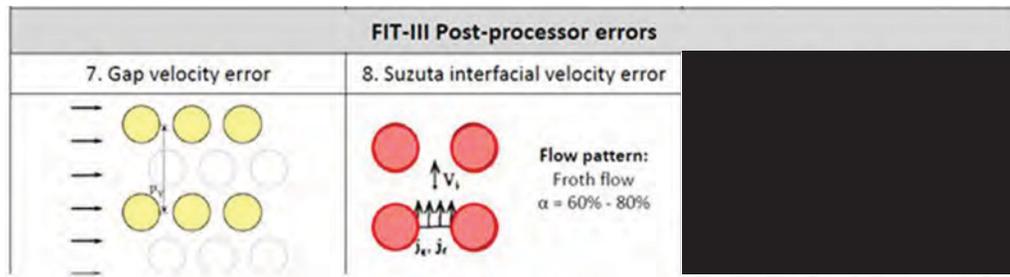
1089. This Gap Velocity Error was not new to FIT-III. Rather, it appears that MHI designed steam generators had incorporated this error for a number of years. Other plants by MHI, such as ██████████
██████████ also apparently contain this Gap Velocity Error.¹²³⁵ There is no

¹²³⁴ Transcript, pp. 252-255 (Dr. Kytömaa).

¹²³⁵ Transcript, p. 1211 (Mr. Merschoff).

convincing evidence suggesting that the Gap Velocity Error was an issue in these other steam generators.

1090. The Claimants have alleged two other errors, known as the “Suzuta¹²³⁶ interfacial velocity error” and the “velocity direction error”:



1091. The Suzuta¹²³⁷ correlation is a means of modelling two-phase flow. Regarding the Suzuta correlation, the Claimants allege that the Suzuta correlation is only valid for void fractions of up to 80%.¹²³⁸ As such, in designing a steam generator with a void fraction of [REDACTED] MHI used the correlation outside of its validated range.¹²³⁹ The Claimants’ evidence in this regard is based upon the opinions of Exponent and Dr. Lahey.

1092. The Respondents have addressed the Claimants’ allegations regarding the Suzuta correlation in Dr. Hibiki’s expert statement.

1093. Regarding the velocity direction (or directional) error, the Claimants, relying upon Exponent’s expertise, allege that the Respondents failed to adequately model flow

¹²³⁶ [REDACTED]

¹²³⁷ The Suzuta correlation is a means of modeling T/H behavior.

¹²³⁸ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 138.

¹²³⁹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 138.

velocities in three dimensions. The Respondents dispute this allegation as a matter of fact.

(a) **Gap Velocity Error**

1094. The Respondents have admitted to what is known as the Gap Velocity Error both in this arbitration and in the post-Incident investigation.
1095. The tube bundle at SONGS was arranged in a triangular pitch configuration. In such a configuration, the tubes are more tightly packed, reducing the space for the two-phase flow and therefore increasing flow velocities.
1096. In other designs, tube bundles can be arranged in a square array, with more space between the tubes, corresponding to slower velocities.
1097. Over a period of some 20 years, MHI failed to convert data for a square array to that of triangular arrays, resulting in the under-prediction of velocities not just at SONGS but in other designs.
1098. At SONGS, it is admitted that on account of this error, gap velocities were incorrect by a factor of 2.3. Similarly, stability ratios were also low by a factor of 2.3.
1099. In this arbitration, the primary effect of this error is on the calculation of tube stability ratios.
1100. The Respondents have characterized this error as a “miscommunication” between two of its units, the design group in Kobe and the R&D Laboratory in Takasago.¹²⁴⁰ The Claimants have provided evidence that this communication error is more than

¹²⁴⁰ Transcript, p. 257 (Dr. Kytömaa).

just poor communication, but represents an organizational failure and violation of NRC QA requirements.¹²⁴¹

1101. Regardless of what the error is called, the Tribunal considers the Gap Velocity Error a serious error which, as admitted, under-predicted stability ratios by a factor of 2.3. The effect of this error is considered by the Tribunal in its answers to the List of Issues, in Section XIII.D(c) below.

(b) **Alleged Suzuta Interfacial Velocity Error**

1102. With respect to the Claimants' alleged Suzuta interfacial velocity error, it should be noted that the speed of both the water and air bubbles in a two-phase flow can be measured empirically. Measurement tools, however, have their limitations and at sufficiently high void fractions (i.e., where the flow is mostly dry steam) these tools cannot measure the flow rates of the two-phases.
1103. There are different models used in correlating measured empirical data with calculated data from a code, such as the FIT-III post-processor.

(i) *The Parties' Positions*

1104. The Claimants allege that the Respondents misused one such correlation, i.e., the Suzuta correlation, in the measuring of the two-phase flow. The Respondents deny that they used the Suzuta correlation in FIT-III.
1105. More specifically, the Claimants, supported by their experts Dr. Lahey and Exponent, contend that MHI incorrectly modeled interfacial velocity.¹²⁴² Interfacial velocity is the velocity of an air bubble in a two-phase flow.¹²⁴³ In particular, Dr. Lahey and

¹²⁴¹ Transcript, p. 1348 (Mr. Merschoff).

¹²⁴² Expert Witness Statement of Dr. Lahey, ¶ 3; Exponent Design Review, ¶ 150.

¹²⁴³ Transcript, p. 304; Expert Witness Statement of Dr. Lahey, ¶ 11.

Exponent state that MHI used the “Suzuta correlation” to convert the mixture velocity¹²⁴⁴ as calculated by FIT-III to an interfacial velocity.¹²⁴⁵ They also opine that this is improper as the Suzuta correlation is only valid for void fractions of 60-80%, while the SONGS RSGs were calculated to have a maximum void fraction of ██████████¹²⁴⁶

1106. Objecting to the Claimants’ submissions, the Respondents contend, by reference to their expert Dr. Hibiki, that “MHI utilized the interfacial velocity correlation (or Suzuta correlation) for a SG design with square pitch (...) but has never used the interfacial velocity correlation for a SG design with a triangular pitch such as SONGS design.”¹²⁴⁷
1107. In rebuttal, the Claimants’ expert Dr. Lahey notes that Dr. Hibiki have not provided proof that the Suzuta correlation for interfacial velocity was not used in the FIT-III or FIT-III post-processor code.¹²⁴⁸ Dr. Lahey further states that the interfacial velocity was used in both the Freon-123¹²⁴⁹ experiment and discussed in the JSME¹²⁵⁰ code, such that it would be “odd” for “Mitsubishi to have used a different velocity.”¹²⁵¹
1108. In turn, in his rebuttal opinion, Dr. Hibiki reaffirmed his view that the interfacial velocity was not used in the design of the SONGS RSGs. As proof, he provides a flow velocity graph from MHI’s design of Anti-Vibration Bars report demonstrating

¹²⁴⁴ Mixture Velocity is the velocity of the two-phase flow.

¹²⁴⁵ Expert Witness Statement of Dr. Lahey, ¶ 35.

¹²⁴⁶ Expert Witness Statement of Dr. Lahey, ¶ 35.

¹²⁴⁷ Expert Report of Dr. Hibiki, ¶ 97.

¹²⁴⁸ Expert Witness Rebuttal Report of Dr. Lahey, ¶ 14.

¹²⁴⁹ The Freon-123 experiment was an experiment to test various T/H codes, including FIT-III.

¹²⁵⁰ The JSME code is the code of the Japanese Society of Mechanical Engineers, equivalent to the ASME.

¹²⁵¹ Expert Witness Rebuttal Report of Dr. Lahey, ¶ 14.

that “mixture velocity” was used, instead of “interfacial velocity [as shown in the graph below]:”¹²⁵²



1109. The Y-axis of this velocity graph reads U_m , the relevance of which is explained in the Tribunal’s reasoning below.

(ii) Tribunal’s Determination

1110. The determination of this Issue depends upon whether calculations in the FIT-III post-processor were done in accordance with annexes of the FIT-III Manual. The Respondents suggest that this not the case and reference MHI’s design of Anti-Vibration Bars (AVB) report.

1111. That AVB report, as commented by Dr. Hibiki, contains graphs of velocity where the Y-axis is measured with the term U_m .

1112. As explained during the Hearing by Dr. Kytömaa, the term U_m on the Y-axis represents mixture velocity, not interfacial velocity.¹²⁵³ Dr. Lahey has also testified

¹²⁵² Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 34; Exh. JX-782, p. 68.

¹²⁵³ Transcript, pp. 329 (Dr. Kytömaa), 6214 (Counsel).

during the Hearing that the term U_m on the Y-axis represents mixture velocity, not interfacial velocity.¹²⁵⁴

1113. Dr. Lahey's report specifies that "interfacial velocity" is expressed as V_i .¹²⁵⁵
1114. During cross-examination, Dr. Lahey stated that he would not be concerned with this error if MHI was indeed using mixture velocity and not interfacial velocity.¹²⁵⁶
1115. The confusion on this Issue appears to arise as graphs in annexes of the FIT-III Manual show that interfacial velocity, V_i , was used in the validation experiments of FIT-III.
1116. The Tribunal considers that, as submitted by the Claimants, the FIT-III Manual does suggest that FIT-III was validated in tests where interfacial velocity was used. The Respondents do not appear to dispute this.
1117. However, the results as calculated in MHI's Anti-Vibration Bar report are better evidence of the calculations actually performed in the design of the SONGS RSGs. As both Exponent and Dr. Lahey agree, that report reflects that mixture velocity was used, not interfacial velocity.
1118. The evidence suggests that the Respondents calculated velocities using mixture velocities.
1119. Accordingly, the Claimants have not proven that the Respondents made an error with regard to the calculation of interfacial velocity.

¹²⁵⁴ Transcript, p. 593 (Dr. Lahey).

¹²⁵⁵ Expert Witness Statement of Dr. Lahey, ¶ 35.

¹²⁵⁶ Transcript, pp. 564 (Dr. Lahey), 6615 (Counsel).

(c) **Alleged Velocity Directional Error**

1120. In relation to the Claimants' alleged velocity directional error, it should be taken into account that the two-phase flow moves in three dimensions in the steam generator.
1121. The Claimants allege that MHI incorrectly modeled this three dimensional movement. The Respondents counter that the basis for the Claimants' case is a poorly drafted sentence in the FIT-III Manual.

(i) *The Parties' Positions*

1122. The Claimants submit that MHI failed to properly calculate three dimensional flow velocities in the steam generator. In this respect, they rely on their expert Exponent.¹²⁵⁷
1123. The basis of Exponent's conclusion is that in MHI's Evaluation of Tube Vibration report, MHI defines velocity along the x-axis (U(x)) as the "flow velocity distribution orthogonal to the tube axis in tube axis direction."¹²⁵⁸ In a footnote, Exponent explains that:

Exponent interprets the phrase "*in the tube axis direction*" to mean "*in the plane of the tube.*" If Mitsubishi meant that it used velocity orthogonal (i.e, perpendicular) to the tube axis including both the in-plane and out-of-plane component, there would be no need to add the phrase: "*in the plane of tube.*"¹²⁵⁹ (emphasis in original)

1124. According to the Claimants' expert Exponent, this error is also found in MHI's Technical Evaluation Report of 2013.¹²⁶⁰ Exponent reports that this error is a

¹²⁵⁷ Exponent Design Review, ¶ 154.

¹²⁵⁸ Exponent Design Review, ¶ 159; Exh. JX-730 at 9.

¹²⁵⁹ Exponent Design Review, ¶ 159, n. 67.

¹²⁶⁰ Exponent Design Review, ¶ 160; Exh. JX-1759; Exh. JX-1760 (See ¶ 698 above).

violation of the recommendations of the ASME code.¹²⁶¹ The error allegedly resulted in an underestimation of stability ratios.¹²⁶²

1125. The Respondents have not provided expert opinion in response to the Claimants' expert's opinion.

1126. The Respondents submit that "MHI used all three directional components in its original design analysis."¹²⁶³ In support of this submission, the Respondents reference a witness statement of [REDACTED]

Ultimately, Mitsubishi performed eight stability ratio calculations, using total crossflow output from FIT-III.¹²⁶⁴

1127. Rebutting [REDACTED] statement, the Claimants submit that his statement is inadequate and unsupported.

1128. As further support for its conclusions, the Claimants rely on their expert Exponent, who references a table of stability ratios in [REDACTED] expert witness statement, for the Respondents, which Exponent opines match those of MHI's technical evaluation report.¹²⁶⁵ Exponent explains that the only way for those stability ratios to match would be if the same methodology was used, implicating an error in the use of velocity.

¹²⁶¹ Exponent Design Review, ¶ 160.

¹²⁶² Exponent Design Review, ¶ 160.

¹²⁶³ Respondents' T/H Tutorial, Appendix B.

¹²⁶⁴ Supplemental Fact Witness Statement of [REDACTED] ¶ 17.

¹²⁶⁵ Exponent Rebuttal, ¶ 58, n. 63 (See also Expert Witness Statement of [REDACTED] ¶ 50, Table 7; Exh. JX-1759, p. 206).

1129. In conclusion, the Claimants contend that either MHI made an error in the incorrect use of velocity directional or MHI's documentation is faulty. Also in this respect, the Claimants rely on their expert Exponent.¹²⁶⁶

(ii) *The Tribunal's Determination*

1130. At the Hearing, the Respondents submitted that their documentation was faulty. The Respondents summarize Exponent's evidence as follows:

The velocity directional error. The entire basis for this claim of this error is Exponent's interpretation of one line in a document, the Tube Vibration Report, written by Japanese engineers in English, and what Exponent thinks means they only use in-plane cross-flow velocity. That's the line there. Flow velocity distribution orthogonal to the tube axis in the tube axis direction. Orthogonal means perpendicular. **This sentence would be completely inconsistent and nonsensical if it means both perpendicular and in only the in-plane direction.**¹²⁶⁷ (emphasis added)

1131. The Respondents also acknowledge that the Claimants are correct regarding the comparison between the stability ratios in [REDACTED] statement and those of the Tube Wear Report.¹²⁶⁸ The Respondents explain that this was done to have comparable results between ATHOS and FIT-III:

It's true that in 2012, when Mitsubishi ran analyses with ATHOS after the tube leak, that initially it used only in-plane cross-flow velocity. Partly that's because ATHOS and FIT-III have different coordinate systems for how they create the meshes for the analysis of the thermal-hydraulic conditions in a steam generator.¹²⁶⁹

¹²⁶⁶ Exponent Rebuttal, ¶ 60.

¹²⁶⁷ Transcript, pp. 6615-6616 (Counsel).

¹²⁶⁸ Transcript, p. 6616 (Counsel).

¹²⁶⁹ Transcript, p. 6616 (Counsel).

1132. While the Respondents' explanation in this regard is not entirely convincing, it is not Issue determinative.
1133. The Tribunal also heard testimony from [REDACTED] expert on behalf of the Respondents, that FIT-III outputs "the three components, X, Y, and Z, as well as a total cross flow which synthesizes those three together."¹²⁷⁰
1134. The Respondents have explained this Issue comprehensibly.
1135. Consequently, the Tribunal considers that the inconsistencies between the Parties regarding the three dimensional flow velocities is a result of poor documentation of FIT-III, as opposed to being an actual error in the code.
1136. While inadequate documentation is problematic, the Claimants have not proven this to be a design error.

D. THE TRIBUNAL'S DETERMINATION ON THE ALLEGED NINE DESIGN ERRORS

1137. To summarize, the Tribunal's determination regarding the alleged nine design errors are as follows:
- i. SSPC Friction Error: The Claimants have proven this alleged design error;
 - ii. SSPC Contractions Error: The Claimants have proven this alleged design error;
 - iii. SSPC Downcomer Turn Error: The Claimants have proven this alleged design error;

¹²⁷⁰ Transcript, p. 3428 [REDACTED]

- iv. FIT-III Two-Phase Pressure Drop Error: The Claimants have not proven this alleged design error;
- v. FIT-III Drift Flux Gradient Error: The Claimants have not proven this alleged design error;
- vi. FIT-III Porosity Error: The Claimants have not proven this alleged design error;
- vii. FIT-III Post-Processor Gap Velocity Error: The Respondents have admitted to this design error;
- viii. FIT-III Post-Processor Interfacial Velocity Error: The Claimants have not proven this alleged design error;
- ix. FIT-III Post-Processor Velocity Directional Error: The Claimants have not proven this alleged design error.

1138. In sum, of the nine alleged design errors, the Tribunal concludes that the Claimants have proven the three SSPC errors and accepts the Respondents' admission as to the Gap Velocity Error.
1139. The Claimants have not proven the remaining five alleged errors in FIT-III and the FIT-III post-processor.
1140. Regarding the SSPC design errors, while the consequence of those errors was a lower than calculated circulation ratio and a higher than calculated void fraction, it is not proven that, but for these errors, material aspects of the design of the RSGs would have been changed.
1141. In particular, there is little evidence of any particular connection between these SSPC errors and any harm suffered by the Claimants.

1142. A main effect of a lower circulation ratio and higher void fraction would have been on the risk of tube corrosion. However, the choice of tubes made from Inconel 690 mitigated these concerns.¹²⁷¹ Given the already minimal benefit of two-phase damping at very high void fraction,¹²⁷² the effect of the minimally higher void fraction on damping is likely insignificant. As Mr. Langford, the Claimants' witness, testified "[damping] decreases dramatically once you get above 95, really after 97, and certainly after 99%, there's hardly any damping left."¹²⁷³ Therefore high void fraction is unlikely to have led to design changes to improve stability ratios. Further, the Claimants' expert Exponent itself calculates that adjusting for these errors in SSPC marginally improves stability ratios.¹²⁷⁴ That is, on account of the Respondents SSPC errors, MHI was overly conservative in its calculation of stability ratios. Accordingly, the Tribunal concludes the SSPC errors would not have led to other design changes as there were no detrimental design errors in this respect.
1143. Accordingly, the Tribunal considers that in relation to the SSPC errors, the Respondents were overly conservative in their calculation of stability ratios and slightly over-predicted the margin of instability.

XII. OTHER ALLEGED DESIGN AND MANUFACTURING ISSUES

1144. In addition to the nine alleged design errors, as set forth in Section XI above, a number of additional alleged design and manufacturing errors or issues have been raised by the Claimants. The Tribunal's determination on those are set forth in this present Section XII.

¹²⁷¹ See Transcript, p. 680 (Dr. Elder).

¹²⁷² See Confidential Videotaped Deposition of Mr. Langford, p. 54.

¹²⁷³ See Confidential Videotaped Deposition of Mr. Langford, p. 60.

¹²⁷⁴ Exponent Design Review, ¶ 277, Table 22.

A. USE OF FIT-III OUTSIDE VALIDATED RANGE

1145. The Claimants allege that the Respondents improperly used FIT-III outside of its validated range in the design of SONGS. According to the Claimants, there was no empirical basis for the T/H data calculated by FIT-III at high operating conditions.¹²⁷⁵
1146. The validated range of FIT-III is based upon experimentally-obtained data during tests, such as the so-called “10 MW Freon” test.¹²⁷⁶ The 10 MW Freon test was a test in which a 10 MW reactor is run using Freon gas (as opposed to air/water).
1147. Empirical data in these tests is obtained using a bi-optical probe. A bi-optical probe is a measuring device that has two fine tipped measuring points spaced slightly apart, which can measure the velocity of a two-phase flow under certain T/H flow patterns.

(a) The Parties’ Positions

1148. A basis for the Claimants’ allegations is MHI’s identification of the use of FIT-III outside of its validated range in a draft root cause evaluation document prepared by MHI dated 10 July 2012, stating the following:

Contributing Cause 2: Insufficient programmatic requirement to provide guidance for use of FIT-III when estimated beyond range of experimentally validated data.¹²⁷⁷

1149. MHI’s proposed corrective actions to address this cause were to revise the FIT-III manual to “provide guidance for use of FIT-III beyond range of experimentally

¹²⁷⁵ See Memorial ¶¶ 133, 144, 374; Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 120; Claimants’ PHM, ¶ 449.

¹²⁷⁶ Transcript, p. 598 (Dr. Lahey).

¹²⁷⁷ Exh. JX-1249, p. 6.

validated data” and to provide appropriate training in consequence of this manual revision.¹²⁷⁸

1150. According to the Respondents, MHI’s 12 October 2012 Final Root Cause analysis did not adopt the draft consideration as relied upon by the Claimants.¹²⁷⁹

1151. The Respondents claim that “FIT-III actually is valid for estimating void fractions up to and above the [REDACTED] void fraction that it estimated for SONGS.”¹²⁸⁰ The Respondents’ expert, [REDACTED] opines that FIT-III is validated using experimental data up to [REDACTED] void fraction.¹²⁸¹ [REDACTED] further opines that as the flow patterns¹²⁸² of steam are the same between [REDACTED] the calculations by FIT-III in this range are also valid.¹²⁸³

(b) The Tribunal’s Determination

1152. With respect to the alleged use of FIT-III outside its validated range in the design of the SONGS RSGs, the Tribunal notes that following the Incident, the FIT-III manual was updated to incorporate that FIT-III is valid for estimating void fraction up to and above [REDACTED]¹²⁸⁴

1153. The Claimants’ concern in relation to the use of FIT-III outside its range is put aptly by their expert Dr. Lahey:

[MHI] extrapolated the prediction of FIT-III to void fractions which were higher than they had validated against experimental data.

¹²⁷⁸ Exh. JX-1249, p. 6.

¹²⁷⁹ Counter-Memorial, ¶ 348 (citing to Exh. JX-1447, pp. 25-26).

¹²⁸⁰ Counter-Memorial, ¶ 325.

¹²⁸¹ Expert Witness Statement of [REDACTED], ¶¶ 25-26.

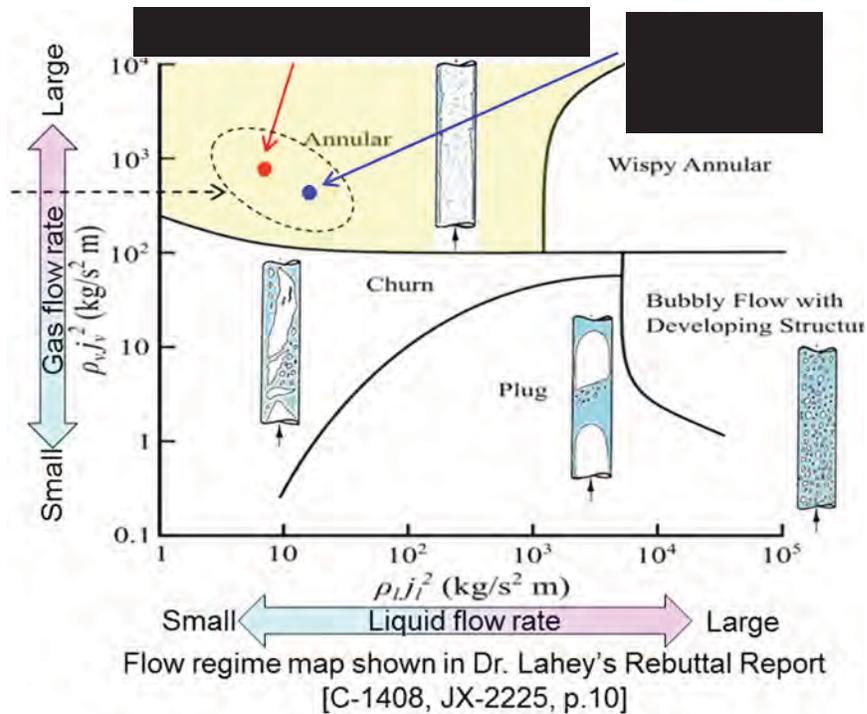
¹²⁸² For graphic of flow patterns, see ¶ 165 above.

¹²⁸³ Expert Witness Statement of [REDACTED] ¶¶ 25-26.

¹²⁸⁴ Exh. JX-1667, p. 16.

My concerns is I view FIT-III with its mistakes not as a physical based code – it’s not based on physics, because they’re wrong in there – but it’s like a digital correlation. So as long as you tune it, you can get [sic] interpolate it. You can get good results within the range where you have data against which you tune it. But if you extrapolate it, all bets are off because it’s not based on physics. So that was my concern with using it outside its range of validity.¹²⁸⁵

1154. During the Hearing, the Respondents provided the following demonstrative exhibit, illustrating the issues surrounding the use of FIT-III:¹²⁸⁶



Pictures of flow regimes with color are shown in Dr. Blandford's Report. [R-471, JX-2205, p.9]

¹²⁸⁵ Transcript, pp. 586-587 (Dr. Lahey).

¹²⁸⁶ Exh. JX-2299 (The demonstrative is based upon a chart from Dr. Lahey, the Claimants' expert, with color and the diagrams of flow patterns added by the Respondents).

1155. As explained by the Respondents' expert ██████████ the demonstrative plots the velocities of both the liquid and gas in steam.¹²⁸⁷ Also provided are the characteristics of the steam for different velocity combinations (churn, plug, bubbly, and annular flow). ██████████ testified that as a ██████████ and ██████████ void fraction have the same annular flows, the so-called ██████████ which is validated at a void fraction of ██████████ can also be used at ██████████¹²⁸⁸ The ██████████ is one of a number of equations used to calculate void fraction in FIT-III.¹²⁸⁹
1156. During the cross-examination of ██████████ the Claimants demonstrated that the use of FIT-III at sufficiently high void fractions lacked an empirical foundation during the design period.¹²⁹⁰
1157. In particular, it appears that it was only in 2011 that a paper by researchers at Oklahoma State University demonstrated, based upon a survey of prior research conducted during the 1970s-1980s,¹²⁹¹ that the ██████████ was found applicable for void fractions up to 98.6%.¹²⁹² However, ██████████ testified that even prior to the publication of the Oklahoma State University paper, it was his opinion that given the similarity in flow patterns, he had confidence in using the ██████████ ██████████ for void fractions up to ██████████¹²⁹³

(. . .) if the flow regime is the same, then it will exhibit essentially the same characteristics.¹²⁹⁴

¹²⁸⁷ Transcript, p. 3421 ██████████

¹²⁸⁸ Transcript, p. 3422 ██████████

¹²⁸⁹ Transcript, pp. 342-343 (Dr. Kytömaa).

¹²⁹⁰ Transcript, pp. 3480-3482 ██████████

¹²⁹¹ Transcript, pp. 3723-3724 (Dr. Blandford).

¹²⁹² Transcript, p. 3420 ██████████

¹²⁹³ Transcript, p. 3492 ██████████

¹²⁹⁴ Transcript, p. 3480 ██████████

1158. As explained by Dr. Lahey, for the Claimants, the use of a T/H code, such as FIT-III, outside its validated range is permitted under 10 CFR 50 Part B Section 3.¹²⁹⁵ The NRC, however, requires that extrapolations be based upon good data and a proper technique.¹²⁹⁶
1159. The Claimants have raised concerns regarding the data upon which FIT-III was validated. Their expert Exponent has raised concerns regarding the sufficiency of the number of tests validating FIT-III. Dr. Lahey and Exponent also have concerns with the collection of the empirical data as they opine bi-optical probes cannot be used at void fractions above a certain value, either 80% or 85%.¹²⁹⁷
1160. The Respondents' expert ██████ however, opined that bi-optical probes were accurate for void fractions up to 87%.¹²⁹⁸
1161. The discrepancy with the Claimants' experts is apparently on account of ██████ familiarity with more advanced bi-optical probe usage.¹²⁹⁹
1162. Furthermore, the Respondents' witness Mr. Wilson testified that it did not make sense to him that FIT-III was only validated for a void fraction of ██████ given that void fractions go up to 100%.¹³⁰⁰
1163. It is not evident to the Tribunal what consequences emerge from the use of FIT-III above its validated range.

¹²⁹⁵ Transcript, pp. 598-599 (Dr. Lahey).

¹²⁹⁶ Transcript, pp. 598-599 (Dr. Lahey).

¹²⁹⁷ Transcript, p. 308 (Dr. Kytömaa).

¹²⁹⁸ Exh. JX-2299, p. 3.

¹²⁹⁹ Transcript, pp. 3424-3425 ██████

¹³⁰⁰ Transcript, p. 3998 (Mr. Wilson).

1164. Under the Claimants' case, void fraction was under-predicted at SONGS. As set forth in Section VII.A(d) above, the consequence was that two-phase damping was under-predicted.
1165. However, MHI did not primarily use two-phase damping values in its stability ratio calculations and rather adopted the ASME recommended value of 1.5%.¹³⁰¹ Void fraction was only used for MHI's alternative case calculations. Further, there is some evidence that MHI already assumed [REDACTED] at void fractions at [REDACTED].¹³⁰²
1166. Further, to the extent that MHI did use actual void fraction data in its alternative case evaluations for stability ratios, it is recalled that the CLOTAIRE test demonstrates that FIT-III over-predicted void fraction as measured.¹³⁰³ As such, MHI was by consequence overly conservative in its calculations of void fraction.
1167. In light of the evidence presented by the Claimants, the Tribunal considers that to the extent the void fraction at SONGS exceeded either the experimentally validated range or the correlated range using the [REDACTED] MHI would indeed have used FIT-III outside its validated range.
1168. However, to the extent the void fraction at SONGS exceeded either the experimentally validated range or the correlated range using the [REDACTED] this would be the case no matter whether void fraction was [REDACTED] as provided in the PAR using FIT-III, or 99.6%, as calculated using ATHOS post-Incident.¹³⁰⁴

¹³⁰¹ See ¶¶ 336-345 above.

¹³⁰² See Transcript, p. 410 (Mr. Wilson).

¹³⁰³ See Exh. JX-98, pp. 124-125.

¹³⁰⁴ See Respondents' RPHM, Appendix 1, ¶ 11.

1169. As further discussed in the issues surrounding the Claimants' misrepresentations and fraud allegations, the Claimants allege that they were not aware of FIT-III's validation. This is despite the validation history of FIT-III and MHI's other codes having been provided to the Claimants as part of MHI's Technical Proposal bid to design the RSGs.¹³⁰⁵
1170. The Claimants have not been successful in convincing the Tribunal of any harm from the use of FIT-III outside its experimentally validated range. The NRC regulations, as mentioned, permit correlations calculations based upon good empirical data with proper techniques, which is the case in this instance.
1171. Further, the use of the [REDACTED] during the design era appears reasonable to the Tribunal. While the Claimants are correct that it is irregular to use a 2011 paper of the Oklahoma State University to justify past decision-making, it certainly does not appear extraordinary for MHI to have previously considered the use of FIT-III at higher void fractions to be reasonable. This is also valid to the extent that the Oklahoma State University paper is based upon 139 prior data sets dating to the 1970s and 1980s.¹³⁰⁶
1172. Further, while the Claimants' expert Exponent identified various tests under which ATHOS was verified,¹³⁰⁷ the Claimants' expert Dr. Lahey opined that there was nothing wrong with using extrapolation to go beyond the ATHOS available experimental data.¹³⁰⁸ Indeed, ATHOS was also benchmarked in the CLOTAIRE test.¹³⁰⁹

¹³⁰⁵ Exh. JX-293 at 292ff; See also Transcript, p. 166 (Mr. Wharton).

¹³⁰⁶ Transcript, p. 3724 (Dr. Blandford).

¹³⁰⁷ Exponent Rebuttal, ¶ 70, Table 2.

¹³⁰⁸ Transcript, p. 587 (Dr. Lahey).

¹³⁰⁹ Exh. JX-99.

1173. Considering the challenges of measuring high void fractions, it is not evident to the Tribunal that ATHOS was validated at a higher void fraction than FIT-III.
1174. Therefore, the Tribunal does not consider that the use of FIT-III in the design of RSGs with a high void fraction above experimental data is improper.
1175. The Tribunal also considers an additional aspect concerning the use of FIT-III as relevant in this connection, i.e., its accuracy.
1176. In relation to the accuracy of FIT-III, the Claimants' place emphasis on an email from the Respondents' consultant, Mr. Wilson, dated 9 September 2005, in which he states:

If you read the CLOTAIRE report comparing test data with FIT-III and all the other CFD codes used for SG tube bundles you will see (1) that the results vary significantly in some cases, and (2) that where the answers were easy, all codes got them right, but where the answers were complicated – like in the U-bend, FIT-III was very far away from the data and most other codes came closer.¹³¹⁰

1177. In that email, Mr. Wilson continued:

The real issue is not how accurate FIT-III is, the issue is how you use the FIT-III results. MHI needs to show that they add some “margin” to the FIT-III results in whatever direction is needed for the phenomena being evaluated. If it is void fraction and fluid damping – assume FIT-III under-predicts it – forget void fraction and assume zero damping and make design choices accordingly. For tube vibration, assume FIT-III under-predicts the velocity and the fluid density – increase the velocity and density by ~20% and make design choices accordingly. This way, inaccuracies of FIT-III (if there are any) are no longer an issue.¹³¹¹

¹³¹⁰ Exh. JX-480.

¹³¹¹ Exh. JX-480.

1178. During the Hearing, Mr. Wilson testified that MHI did assume [REDACTED] [REDACTED]¹³¹² Mr. Wilson also testified that every code was getting different results for T/H values in the U-bend.¹³¹³
1179. The Respondents' expert Dr. Hibiki testified that differences in velocities in the CLOTAIRE test between FIT-III and other codes were based upon MHI using a different definition of velocity than the one used in other codes.¹³¹⁴ Dr. Hibiki opined that this is why Mr. Wilson found the results to differ.
1180. Further, to the extent that Mr. Wilson was referring to void fraction (and not velocities), the CLOTAIRE data demonstrates that FIT-III over-predicted void fraction compared to empirical data, such that this is not a concern.¹³¹⁵
1181. The Tribunal is convinced that the issues raised by Mr. Wilson in the email mentioned in ¶¶ 1176-1177 above were adequately addressed by MHI for the following reasons.
1182. MHI adopted a design with a high number of tube support points in the form of 7 TSPs and 12 AVBs. The configuration of those AVBs was studied and discussed between SCE and MHI. The use of the ASME recommended value of 1.5% for all forms of damping, including structural damping, appears a conservative design choice.
1183. Further, a 20% margin in stability ratio calculations was a contractual requirement for calculations in the PAR:

¹³¹² Transcript, p. 4147.

¹³¹³ Transcript, pp. 4149-4150.

¹³¹⁴ Transcript, p. 3661.

¹³¹⁵ Exh. JX-99.

The Performance Analysis Report shall contain, as a minimum, the following information.

(...)

Detailed calculations, by region, showing that cross-flow velocities within the tube bundle shall be such as to minimize tube wear at the tube-to-tube support interfaces. The calculations shall clearly identify the damping factor(s) used and margin(s) to flow instability for steam flow rates of up to 120% of the design flow rate.¹³¹⁶

1184. The PAR provided exactly this, demonstrating that a 20% margin in flow velocities was accounted for:

As required by CDS Section 3.8.2, when the steam flow rate is up to 120% of design flow rate, the stability ratios do not exceed 1.0 because the flow rate is proportional to flow velocity and stability ratio as shown in equation (9) of in Section 7.1(2) and the maximum stability ratio will be [REDACTED]. For conservative evaluation, case studies also have been performed in Ref. 10 to confirm there is negligible possibility of fluid elastic vibration.¹³¹⁷

1185. Accordingly, the Tribunal concludes that the concerns raised by Mr. Wilson were addressed in the overall design of the RSGs. As set forth in ¶ 340 above, MHI undertook assessments of stability ratios using alternative scenarios assuming both structural damping (i.e. 0.2%) below the ASME recommended value (i.e., 0.5%) and with T/H damping based upon void fraction. As set for the in ¶ 1183 above, MHI undertook calculations adding a 20% margin to velocities.

¹³¹⁶ RSG Contract, Section 3.8.2.

¹³¹⁷ Exh. JX-813, p. 75.

B. HIGH VELOCITIES

1186. In addition to the adjustment to flow velocities on account of the FIT-III Gap Velocity Error, the Claimants have submitted that there are additional errors in FIT-III's calculation of velocities.

(a) The Parties' Positions

1187. The basis of these alleged errors dates to a May 2012 presentation by MHI, in response to question 197 from the NRC's AIT (Augmented Inspection Team).¹³¹⁸ To recall, the NRC inquired as to "why FIT-III velocities are significantly less than those produced by ATHOS."¹³¹⁹ At the time, ██████████ for MHI, responded that "the primary causes of the low flow velocity produced by FIT-III are considered to result from the following factors (...) [the] pressure loss coefficient for tube bundle [and the] two phase mixture density" in addition to "surface permeability" (i.e., the Gap Velocity Error¹³²⁰).¹³²¹ MHI provided the following chart to explain its answer:¹³²²

¹³¹⁸ For AIT, see Section VII.F(d) above.

¹³¹⁹ Exh. JX-1142, p. 14.

¹³²⁰ For the surface permeability being the same as the Gap Velocity Error, see Transcript, pp. 485, 3652-3653.

¹³²¹ Exh. JX-1142, p. 14; See also Exh. JX-1165, p. 40.

¹³²² Exh. JX-1142, p. 15.



1188. MHI's explanation is also provided in its Root Cause Analysis report.¹³²³ Similarly, MHI's "Report on the Validity of Use of the FIT-III Results during Design" provides:

Since the cross flow resistance in straight tube bundle of ATHOS is larger than that of FIT-III in contradiction to be U-bend region, ATHOS has less mixing between the hot side leg and the cold side of tube bundle than FIT-III. This leads to high quality and void fraction in the hot leg side as computed by ATHOS. Besides, the void fraction of ATHOS is larger than that of FIT-III under same quality condition because of the difference between slip model of FIT-III and the drift-flux model of ATHOS. Consequently, FIT-III gives relatively smaller void fraction than ATHOS due to the above two effects.

Because FIT-III predicts a lower void fraction and consequently a higher density, the predicted velocity is lower in order to maintain global mass balance.¹³²⁴

¹³²³ Exh. JX-1007, p. 21.

¹³²⁴ Exh. JX-1114, pp. 10; See also Exh. JX-1114, pp. 66, 67, 68.

1189. MHI's explanation was reviewed by the FIT-III challenge board,¹³²⁵ which did not appear to have any particular comments on the mixture density issue.¹³²⁶
1190. On 11 May 2012, MHI presented a 33 slide response to the NRC's AIT question number 197.¹³²⁷
1191. The NRC's Confirmatory Action Letter Response of 20 September 2013 also addressed this issue.¹³²⁸ A report annexed to the NRC Response by Dr. Dhir, consulted by the NRC, provides that:

The two phase mixture density depends on the system pressure and temperature and on the void fraction. Thus depending on the type of correlation that is used in obtaining void fraction for given liquid and vapor velocity (unless measured), the calculated critical velocities could differ. This is especially important at very high void fractions where two phase damping decrease very rapidly to near zero as void fraction reaches unity.¹³²⁹

(b) The Tribunal's Determination

1192. In relation to the NRC's Confirmatory Action Letter Response, mentioned in ¶ 1191 above, Dr. Lahey, for the Claimants, opined that he does not find MHI's explanation adequate. In particular, Dr. Lahey was not convinced by MHI's explanation on the differences of mixture densities.¹³³⁰

¹³²⁵ For FIT-III Challenge Board, see ¶ 508 above.

¹³²⁶ Exh. JX-1165, pp. 5-7.

¹³²⁷ Exh. JX-1170.

¹³²⁸ Exh. JX-1868.

¹³²⁹ Exh. JX-1868, p. 77.

¹³³⁰ Transcript, pp 581-583.

1193. The Claimants' expert Dr. Lahey did, however, find MHI's explanation regarding the effect of the pressure loss coefficient on account of different modeling of friction reasonable.¹³³¹

1194. Specifically, on mixture density, Dr. Lahey explained that:

Mixture density is just the weight of a mixture of vapor and liquid per unit volumes and it varies for void fraction.¹³³²

1195. He further explained MHI's process as follows:

What [MHI] did is said let's assume that the mass flux – the flow per unit area we call G – is the same. The prediction of mass flux would be the same in both FIT-III and ATHOS. If that were the case, you'd have the mixture density times mixture velocity. That's where the mass flux is. Because these densities are different by about a factor of 2, if you then corrected it, you would increase the velocity by a factor of 2.¹³³³

1196. Dr. Lahey, however, disagreed with MHI's process, opining that:

[I]t would be a very incredible event to have [the mass flux] be the same. There's no reason they should be the same. In any event, what this is trying to show is the problem is with the void quality correlations that were used in the two different codes, that one is too high in void fraction versus the other.¹³³⁴

1197. Dr. Lahey concluded that while the difference in the void quality calculations between ATHOS and FIT-III should differ, it should not differ by as much as calculated by MHI.¹³³⁵

¹³³¹ Transcript, p. 584.

¹³³² Transcript, p. 486.

¹³³³ Transcript, p. 487.

¹³³⁴ Transcript, pp. 487-488.

¹³³⁵ Transcript, p. 488.

1198. For Respondents, Dr. Hibiki has explained that the difference in mixture velocity calculations between FIT-III and ATHOS is on account of the following:

Velocity U_M is given by the ratio of mass velocity G to mixture density, ρM . This means U_m is equal to G divided by ρM . So this effect of difference of mixture density come from ρM part. Then this mixture density difference comes from the difference of void fraction prediction.¹³³⁶

1199. This explanation matches the explanation provided by Dr. Lahey.¹³³⁷ Nonetheless, Dr. Lahey opines that he “disagrees with [it] completely because there no real reason why the mass fluxes should be the same.”¹³³⁸

1200. Dr. Hibiki further explained that when the void fractions are very large, such as a difference between █████ using FIT-III and 99.6% using ATHOS, the effect is “over magnified in velocity.”¹³³⁹

1201. During their closing statement, the Respondents submitted as follows:

There’s a difference in mixture density, and that’s the result of the fact that ATHOS tends to predict higher void fractions than does FIT-III. Higher void fractions mean lower densities, and that difference in density accounts for some of the difference in predicted velocity.¹³⁴⁰

1202. The conclusion from the above is that differences in the ATHOS and FIT-III methodology on the calculation of mixture density account for at least some differences in velocity calculations. That is, the fact that ATHOS calculates a higher

¹³³⁶ Transcript, p. 3646.

¹³³⁷ Transcript, p. 581.

¹³³⁸ Transcript, p. 581.

¹³³⁹ Transcript, p. 3669.

¹³⁴⁰ Transcript, pp. 6606-6607.

void fraction than FIT-III at least partially explains why ATHOS also calculates higher velocities than FIT-III.

1203. The Tribunal need not resolve the expert's disputes as to the magnitude of the difference between the calculations of velocity in FIT-III and ATHOS.
1204. The Claimants' experts Dr. Lahey and Exponent opined that FIT-III had an extra two-phase multiplier, which accounted for higher velocities in FIT-III. As determined by the Tribunal in Section XI.B(a) above regarding the alleged two-phase pressure drop error, the Tribunal is not convinced by the Claimants' evidence put forward.
1205. Thus, while the Claimants find the Respondents' explanation inadequate, the Respondents' explanation was reviewed both by the FIT-III Challenge Board and the NRC.
1206. The Claimants themselves were aware of MHI's response to the NRC on this issue. Having such knowledge, during the repair era, the Claimants nonetheless were of the view that Unit 2 could be safely restarted despite this issue – albeit at an initially lower power level with corresponding lower velocities.
1207. Even assuming the Claimants are correct, in that there is another error in FIT-III, whether that error is material or not would be apparent in stability ratio calculations. That is, an alleged error in flow velocities is of concern if the effective velocity exceeds the critical velocity such that there is instability.
1208. However, as determined by the Tribunal in Section XIII.D(c) below, there is little to no evidence of the RSGs suffering from classic out-of-plane FEI. Nor do stability ratio calculations, assuming all supports effective, predict out-of-plane FEI.

1209. Accordingly, the Tribunal does not consider that the Claimants have demonstrated a design error in FIT-III's calculation of velocities.

C. ADDITIONAL ALLEGED DESIGN ERRORS

1210. The Claimants have made allegations regarding a number of additional design errors or issues with the Respondents' design of the RSGs. While less emphasis has been placed on these errors than on the nine alleged design errors described in Section XI above and as emphasized by the Claimants through their expert Exponent, the Tribunal considers it necessary and appropriate to review the Claimants' allegations in this regard.

1211. The Tribunal's evaluation of these issues is structured according to the compilation of these issues as presented in the Respondents' Appendix B to their Rejoinder Memorial. However, not all of the alleged errors in the Respondents' Appendix are addressed immediately below. A number of them are addressed in the Tribunal's determination of the List of Issues.¹³⁴¹

(a) Selection of Stability Ratio Criteria

1212. The Claimants' submit that the Respondents used improper values in the calculation of Connors' Equation, which provides the critical velocity used in stability ratio calculations. The Tribunal set forth the background on these calculations in Section VII.D(e)(iv) above.

¹³⁴¹ See Sections XIII (Breach of Contract) and XV (Breach of Warranty)

(i) *The Parties' Positions*

1213. In particular, the Claimants, voiced by their expert Exponent, are critical of MHI's election to use different values for Connors Constant, K, in their alternative case evaluations.¹³⁴²

1214. To recall, MHI used a K of [REDACTED] rather than 2.4, the ASME recommended value, in their alternative case calculation,¹³⁴³ despite allegedly not having empirical data to justify this choice in a triangular pitch steam generator.¹³⁴⁴ MHI does not appear to dispute Exponent's conclusion that they lacked empirical data from a triangular array (rather than a square array) in using a K of [REDACTED]. Rather, the K of [REDACTED] is "derived by proportional calculation based upon experimental data."¹³⁴⁵ MHI calculated a K of [REDACTED] through a proportional calculation of a K of [REDACTED] as found in the U-bend region of a square pitch array:¹³⁴⁶

Tube condition	Straight tube	U-bend tube
Squared array [REDACTED]	[REDACTED] (Ref 31)	[REDACTED] (Ref 32)
Triangular array [REDACTED]	[REDACTED] According to MHI internal experimental data	[REDACTED] Derived from experimental data: [REDACTED]

The Claimants' experts, Exponent, have criticized MHI's approach in this regard, opining that MHI had no basis to arrive at a K of [REDACTED] through cross-multiplication and opining that even if they had, they should have used a K of [REDACTED] not [REDACTED] as the K

¹³⁴² Exponent Design Review, ¶¶ 173-174.

¹³⁴³ See ¶¶ 332-335 above.

¹³⁴⁴ Exponent Design Review, ¶ 174.

¹³⁴⁵ Exh. JX-730, p. 55.

¹³⁴⁶ Exh. JX-730, p. 55. References 31 and 31 are papers by [REDACTED] a researcher at MHI exhibited as Exh. JX-200 and Exh. JX-225.

in square array U-bend tube area.¹³⁴⁷ During the Hearing, ██████████ the Respondents' witness, testified that this approach was arrived at in consultation with various consultants, including Mr. Langford, the Claimants' witness.¹³⁴⁸

(ii) *The Tribunal's Determination*

1215. The Respondents have admitted that the selection of a larger K is a less conservative design choice.¹³⁴⁹
1216. Nonetheless, the Tribunal finds nothing improper in the Respondents' design in this regard for the following reasons.
1217. As a preliminary point, the Tribunal notes that this was an alternative calculation for evaluation purposes. Moreover, MHI's calculations were in fact based upon empirical data. Further, other steam generator designers used higher Connors Constants and the decreased conservatism in MHI's use of a higher K in an alternative model was balanced by the increased conservatism of lower structural damping assumptions. Accordingly, the Tribunal does not find a design error in MHI having selected a K of ██████ in an alternative evaluation scenario.
1218. The Claimants further submit that MHI should have used a damping value of 0.5% rather than 1.5% in Connors' Equation to reflect that at high void fractions, steam is mostly dry and accordingly provides less damping.¹³⁵⁰ A damping value of 1.5% is an ASME recommended value for wet steam.¹³⁵¹

¹³⁴⁷ Exponent Design Report, ¶¶ 170-175; Transcript p. 1190 (Dr. Morse).

¹³⁴⁸ Transcript, pp. 3343-3344 ██████████

¹³⁴⁹ See Expert Witness Statement of Dr. Au-Yang, ¶ 24.

¹³⁵⁰ Exponent Design Review, ¶ 177.

¹³⁵¹ Exponent Design Review, ¶ 177.

1219. In MHI's evaluations, however, they did perform calculations using lower damping values. For example, during a design review meeting in October 2005, MHI presented calculations using damping based upon void fraction with two-phase damping as low as [REDACTED] for Tube R142C88¹³⁵² in addition to its calculations using the ASME recommended value of 1.5%.¹³⁵³ This is consistent with MHI's consultant Mr. Langford's advice during the design era to MHI to design with conservatism and assume near zero T/H damping at high void fractions.¹³⁵⁴ In sum, MHI considered a number of alternative damping scenarios in its design calculations. The Tribunal finds no fault in MHI's design choices regarding damping ratios.
1220. Also, the Claimants, through their expert Exponent, contend that MHI's selection of a structural damping criteria was insufficiently conservative.¹³⁵⁵ The Claimants' expert Exponent approves of MHI's alternative case evaluation using a structural damping of 0.2%, but not the evaluation using 1%. The Tribunal considers that MHI evaluated a number of different scenarios using different damping values and acted reasonably in doing so. The Tribunal recalls that the ASME recommended minimum structural damping is of 0.5%¹³⁵⁶ and notes that a value of 0.2%, as modeled by MHI, is smaller, i.e., more conservative, than the ASME recommended value.
1221. Moreover, the Claimants submit that MHI could have also evaluated stability ratio calculations assuming two ineffective supports for greater conservatism. In support of this submission, the Claimants refer to the evidence provided by their expert Exponent.¹³⁵⁷

¹³⁵² Exh. JX-501, p. 92.

¹³⁵³ Exh. JX-501, p. 90.

¹³⁵⁴ Exh. JX-460.

¹³⁵⁵ Exponent Design Review, ¶¶ 180-182.

¹³⁵⁶ See ¶ 341 above.

¹³⁵⁷ Exponent Design Review, ¶ 187.

1222. The Tribunal sees no pertinence to this conclusion. The determination of conservatism depends on the totality of various design choices and MHI's selections were expressly put before SCE. The Tribunal considers that with further and further conservative design choices, eventually, any SR calculation may identify instability. While a designer should be conservative, extreme conservatism is not a useful tool for design if it departs from realistic assumptions.
1223. The Claimants' expert Exponent has provided calculations, modifying MHI's assumptions of values in Connors' equation.¹³⁵⁸ Using more conservative assumptions leads to high stability ratios and eventually calculations of instability.
1224. The Tribunal is not convinced by the evidence submitted by Claimants in this regard. That MHI's design choices were effective in preventing out-of-plane FEI has been established as classical out-of-plane FEI did not occur, as determined by the Tribunal in Section XIII.D(c)(ii) below.
1225. Further, the Tribunal finds Dr. Au-Yang's explanation, for the Respondents, convincing:

In addition, if you have so many tubes with stability ratio bigger than 1 up to 4, after 11 months – you have the model of the steam generator here – after 11 months you open up the steam generator, all you see would be a pile of metal filings at the bottom. There won't be any tubes left on the top because they would be [*sic*] self-destruct.¹³⁵⁹

1226. When the RSGs in Unit 2 and 3 were opened up, inspections found significant wear, but nothing as severe as described by Dr. Au-Yang. The Claimants' expert

¹³⁵⁸ Exponent Design Review, ¶¶ 188-194.

¹³⁵⁹ Transcript, p. 3076.

Exponent’s recommendations for more conservatism appear overly conservative given the actual evidence of wear.

1227. The Claimants further criticize MHI’s selection of tubes to analyze for FEI. They rely on their expert Exponent, who opines that MHI “should have predicted that hundreds of tubes in the RSGs could potentially experience out-of-plane FEI and, as a result should have rejected its RSG design.”¹³⁶⁰ However, the inspections of the RSGs did not identify that hundreds of tubes suffered from classic out-of-plane FEI. At most, the inspection of the RSGs found two tubes that suffered TTW (tube-to-tube wear).¹³⁶¹
1228. In light of the above, the Tribunal is not convinced that MHI’s design choices in the selection of the variables for Connors’ Equation were insufficiently conservative or otherwise improper.
1229. The Tribunal’s determination of the Respondents’ design choices is also provided in answer to Issue B.4 below.¹³⁶²

(b) Assumption that Out-of-Plane FEI Bounds In-Plane FEI

1230. With respect to the Claimants’ submission that MHI’s assumption that out-of-plane FEI bound in-plane FEI, the Claimants refer to their expert Exponent. He opines that MHI’s assumption to not evaluate for in-plane FEI was improper.¹³⁶³ The Tribunal considers this assumption in Issue B.4(d) below.¹³⁶⁴

¹³⁶⁰ Exponent Design Review, ¶ 198.

¹³⁶¹ See ¶ 586 above. The Tribunal is not convinced that the TTW wear on these two tubes is on account of classic out-of-plane FEI. The TTW wear may be on account of these two tubes not meeting manufacturing specifications and being closer together.

¹³⁶² See Section XIII.D below.

¹³⁶³ Exponent Design Review, ¶¶ 208-225.

¹³⁶⁴ See Section XIII.D(d) below.

(c) Exponent's Corrected Stability Ratio Calculations

1231. The Claimants' expert Exponent has offered its own calculations of stability ratios at SONGS in using the various components of Connors' Equation as discussed in Section XII.C(a) above.

(i) The Parties' Positions

1232. The Claimants submit that MHI should have predicted that 34% of the tubes could become unstable and that 45% of the tubes did not meet MHI's own acceptance criteria for FEI calculations. In particular, the Claimants refer to their expert Exponent:

With Mitsubishi's errors corrected, the maximum stability ratio is 3.72. Of the 9727 tubes, 3,347 have a stability ratio greater than 1.0 and 4,410 (45%) have a stability ratio greater than [REDACTED]. In other words, Mitsubishi should have predicted that 34% of tubes could become unstable, resulting in out-of-plane FEI, and that 45% of the tubes did not meet Mitsubishi's own acceptance criteria for FEI calculations stability ratio below [REDACTED].¹³⁶⁵

1233. The Respondents, supported by Dr. Au-Yang, submit that Exponent's calculations are overly conservative so as to be unrealistic.¹³⁶⁶

(ii) The Tribunal's Determination

1234. In Section XI.D above, the Tribunal determined that the Claimants have not demonstrated the design errors as alleged, apart from the SSPC errors and the Gap Velocity Error.

¹³⁶⁵ Exponent Design Review, ¶ 283.

¹³⁶⁶ Respondents' Rejoinder, ¶ 68; Expert Witness Statement of Dr. Au-Yang, ¶ 23.

1235. Further, as reviewed in Section XII.C(a) above, the Tribunal does not consider that MHI's design choices in the selection of the inputs to Connors' Equation are inappropriate.
1236. The Claimants' contention that a third of tubes would suffer from out-of-plane FEI in the as designed RSGs is not supported by the facts. As mentioned, at worst only two tubes in the RSGs experienced TTW.¹³⁶⁷
1237. However, the Tribunal considers it pertinent to briefly address what the corrected stability ratios may be in the SONGS RSGs.
1238. The Claimants, through their experts Exponent, submit that MHI's "extreme conservative case" is "the closest case to a correct design analysis of the four cases Mitsubishi analyzed."¹³⁶⁸ As admitted by the Respondents however, on account of the Gap Velocity Error, SR are to be multiplied by 2.3 to provide accurate results. This is also a recommended multiplication by Exponent for correcting Mitsubishi's Extreme Conservative Case."¹³⁶⁹ Exponent undertook such a multiplication for tube R142C88.¹³⁷⁰ The Tribunal considers it useful to set forth the corrected stability ratios for the nine tubes MHI studied.
1239. While Exponent has undertaken calculations correcting for all their alleged design errors, as set forth in Section XI above, apart from the SSPC errors and the admitted gap velocity error, the Tribunal is not convinced as to the remaining five alleged design errors. As determined, the effect of the SSPC errors was an minor

¹³⁶⁷ See ¶ 586 above.

¹³⁶⁸ Exponent Design Review, ¶ 192.

¹³⁶⁹ Exponent Design Review, ¶ 194.

¹³⁷⁰ Exponent Design Review, ¶ 286 (Table 24).

improvement in SR, which the Tribunal does not include in its corrected calculations below.

1240. The calculated and corrected stability ratios, assuming all effective supports, in MHI’s “Extreme Conservative Case” are set forth below:¹³⁷¹

	Extreme Conservative Case (K = 2.4 / Hs = █████)		Gap-Velocity Correction (i.e. x 2.3)
	Damping ratio	Stability ratio	Stability ratio
R142C88	████	████	████
R47C89	████	████	████
R47C7	████	████	████
R26C88	████	████	████
R26C4	████	████	████
R14C88	████	████	████
R14C2	████	████	████
R1C89	████	████	████
R1C1	████	████	████

1241. All tubes are calculated to be stable, with SR below 1.0. Further, the tube with the highest SR, R14C2 is stable even if its values are multiplied by a further 20% █████ █████ as appears to be required under the RSG Contract to provide additional safety margin.¹³⁷²

1242. An alternative evaluation is possible, in which SR is calculated assuming one of the AVBs is ineffective or missing. In such a hypothetical situation, SR for some tubes exceeds 1.0, indicating instability (as highlighted in yellow below). Other tubes have SR that approaches 1.0 (as highlighted in orange below).

¹³⁷¹ Exh. JX-515, p. 93. Corrected calculations performed by the Tribunal through a multiplication of the calculated stability ratio by 2.3.

¹³⁷² RSG Contract, Section 3.8.2.

	Extreme Conservative Case (K = 2.4 / Hs = █████)		Gap-Velocity Correction (i.e. x 2.3)	
	Damping ratio	Stability ratio	Stability ratio	
R142C88	████	████	████	████
R47C89	████	████	████	████
R47C7	████	████	████	████
R26C88	████	████	████	████
R26C4	████	████	████	████
R14C88	████	████	████	████
R14C2	████	████	████	████
R1C89	████	████	████	████
R1C1	████	████	████	████

1243. Stability ratio calculations are a design tool to predict whether a tube would be unstable. Once the RSGs are constructed, whether a tube is unstable need not be determined by calculations and estimation but can be measured and determined by an assessment of wear at that tube. In this regard, there is no¹³⁷³ evidence of out-of-plane TTW on account of FEI. Further, as submitted by the Respondents, once the RSGs are constructed, the AVBs are there – physically present – such that an assumption of one missing AVB is obviously incorrect.¹³⁷⁴ Nonetheless, it may however be the case that the configuration of a AVB to a tube is such that there is gap-limited FEI or wear issues that require further design consideration or physical repair.¹³⁷⁵ The significance of such considerations is set forth in the following section.¹³⁷⁶

¹³⁷³ The two tubes in the RSGs with TTW do not appear to be on account of FEI, but rather a manufacturing discrepancy.

¹³⁷⁴ Transcript, p. 2537 █████

¹³⁷⁵ See ¶¶1442 - 1445 below.

¹³⁷⁶ See e.g. ¶ 1250.

(d) **Significance of the Difference in Void Fractions Calculated Using ATHOS and FIT-III**

1244. The Claimants allege an additional design error on the side of the Respondents concerning the significance of the difference in void fractions calculated using ATHOS and FIT-III.

(i) *The Parties' Positions*

1245. The Claimants contend that by using FIT-III, the Respondents under-predicted void fraction in comparison to results from ATHOS. In this respect, the Claimants rely on their expert Exponent, who expresses the following opinion:

At the design stage, Mitsubishi used FIT-III and calculated a maximum void fraction of ██████. After the failure, Mitsubishi used ATHOS and calculated a maximum void fraction of 99.6%. The difference between ██████ and 99.6% is significant. At ██████ of the flow is liquid that can dissipate tube vibration. At 99.6%, only 0.4% of the flow is liquid. In other words, the liquid fraction that can serve to damp vibration is lower by a factor of ██████¹³⁷⁷

1246. The Respondents rebut that it is unknown whether FIT-III or ATHOS is more accurate¹³⁷⁸ and that FIT-III already assumed limited T/H damping at high void fractions.

(ii) *The Tribunal's Determination*

1247. The Claimants' evidence is not convincing.

1248. In particular, the Claimants' expert Exponent's analysis on this issue does not persuade. Void fractions calculated by FIT-III and ATHOS are not comparable.¹³⁷⁹

¹³⁷⁷ Exponent Design Review, ¶ 22.

¹³⁷⁸ See Transcript, p. 161.

¹³⁷⁹ Exh. JX-567.

The Claimants appear to compensate for this in their Post-Hearing Memorial, where they submit that comparing the void fractions of comparable plants to SONGS, calculated using ATHOS, had “three times more liquid water than SONGS”¹³⁸⁰ and not 13 times more as submitted by the Claimants’ expert.

1249. The Tribunal is not convinced by these submissions for the following reasons.
1250. While the void fraction at SONGS does exceed that of other comparable plants, it does so by less than 1%.¹³⁸¹ It is not evident to the Tribunal that, had a higher void fraction been calculated during the design era, this would have led to a difference in design. The Tribunal finds the Respondents’ evidence that they may have adopted an additional set of AVBs convincing, but that such an approach is unlikely to have prevented the in-plane FEI that occurred in Unit 3 or random wear in both Units:

If MHI had used a thermal-hydraulic code such as ATHOS, the predicted thermal-hydraulic conditions would have been more severe than those predicted by FIT-III. If MHI had determined that the predicted thermal-hydraulic conditions should have been addressed based on this more severe analysis, SONGS RSG design may have been modified. The likely design modification would have been the insertion of additional AVBs of flat bar type, but most of the tube wear indications due to the in-plane FEI and random vibration at AVB support points would not have been prevented, because flat bar type AVBs when used in the “zero contact force” designed followed in the SONGS RSGs would not provide effective support for in-plane FEI and random vibration at high void fraction (steam quality) conditions.¹³⁸²

¹³⁸⁰ Claimants’ RPHM, ¶ 167.

¹³⁸¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 147.

¹³⁸² Exh. JX-1114, p. 28.

1251. Whether, nonetheless, the T/H conditions in general, including void fraction, constitutes a Defect under the RSG Contract is addressed by the Tribunal in Issue B.4(i) below.¹³⁸³

(e) **Validation of FIVATS**

1252. Mitsubishi's FIVATS code is discussed by the Tribunal in Section VII.D(c) above. FIVATS, Flow-Induced Vibration Analysis of Tubular Structures, is MHI's software for calculating FEI using the outputs of FIT-III.

(i) *The Parties' Positions*

1253. The Claimants contend that MHI failed to sufficiently validate FIVATS. In this respect, the Claimants rely on their expert Exponent.¹³⁸⁴

1254. More specifically, the Claimants' expert is critical that FIVATS (i) was not validated for sufficient modes of natural frequency; (ii) on average, calculated overly low stability ratios; and (iii) was only validated in an "in air" test and not in an air-water test.¹³⁸⁵

1255. For the Respondents, Dr. Begley submits evidence, opining that (i) FIVATS calculated stability ratios are within █████ of measured test values, "within the uncertainty typically associated with this type of comparison;" (ii) FIVATS was validated for the first five modes of natural frequency, being those most likely to result in high stability ratios; and (iii) validation in an air test is adequate given the greater calibration that can be undertaken in such a test.¹³⁸⁶

¹³⁸³ See ¶ 1563 below.

¹³⁸⁴ Exponent Design Review, ¶¶ 332-335.

¹³⁸⁵ Exponent Design Review, ¶¶ 333-335.

¹³⁸⁶ Expert Witness Statement of Dr. Begley, ¶¶ 138-139.

(ii) The Tribunal's Determination

1256. While the Claimants' evidence was further affirmed by their expert Exponent at the Hearing that all of MHI's codes were insufficiently validated, no significant particularizations were added regarding the validation of FIVATS.¹³⁸⁷
1257. For the following reasons, the Tribunal is not convinced that FIVATS was insufficiently validated. The validation of FIVATS demonstrated a match to within ■ of measured data.¹³⁸⁸ In this connection, the Tribunal accepts Dr. Begley's position that this is within the normal uncertainty range for a code validation. It also appears to be accurate enough for a designer to identify if a tube is at risk for FEI and can be accounted for through means of design conservative, such as a target stability ratio maximum of 0.75 or a one ineffective support design assumption.
1258. Accordingly, the Claimants have not established an additional design error in relation to the validation of FIVATS.

(f) Validation of IVHET

1259. As described in Section VII.D(c) above, MHI's IVHET code (Impact Vibration of Heat Exchanger Tube with Gap Support code) is used to estimate tube wear.

(i) The Parties' Positions

1260. According to the Claimants, IVHET was insufficiently validated. In particular, in reliance on their expert Exponent, the Claimants submit that the wear IVHET calculated was only compared to a single tube from an operating generator.

¹³⁸⁷ Transcript, p. 398.

¹³⁸⁸ Expert Witness Statement of Dr. Begley, ¶¶ 138-139.

Claimants also put forward evidence that IVHET over-predicted the wear in that single tube by some ██████¹³⁸⁹

1261. For the Respondents, Dr. Begley opines that IVHET’s accuracy of within ██████ “is within the range of what can best be expected for wear calculations.”¹³⁹⁰
1262. According to the Respondents, MHI’s acceptance criteria for the validation of IVHET was for the deviation of the wear rate calculation to be within ██████ of the measurement of wear.¹³⁹¹

(ii) The Tribunal’s Determination

1263. The Claimants have provided no comparison point for the Tribunal’s determination as to whether or not the validation of IVHET’s is within industry norms. The Claimants submit a ██████ deviation is notable while the Respondents submit this is within the acceptance criteria for a wear calculation code.
1264. The Claimants have also raised concerns with different versions of IVHET.¹³⁹²
1265. The Tribunal finds no particular issue with this. The development of a second version of software does not imply that the prior version of a software was defective. As submitted at the Hearing by the Respondents, “the only difference between versions 1 and version 2 of the IVHET code is an improvement in the convergence of that code” i.e., “how many steps the code takes to compute a result” and that “the equations in version 1 and 2 of IVHET are identical.”¹³⁹³

¹³⁸⁹ Exponent Design Review, ¶ 336.

¹³⁹⁰ Expert Witness Statement of Dr. Begley, ¶ 135.

¹³⁹¹ Exh. JX-721, p. 22.

¹³⁹² See e.g. Transcript p. 2619.

¹³⁹³ Transcript, p. 2766.

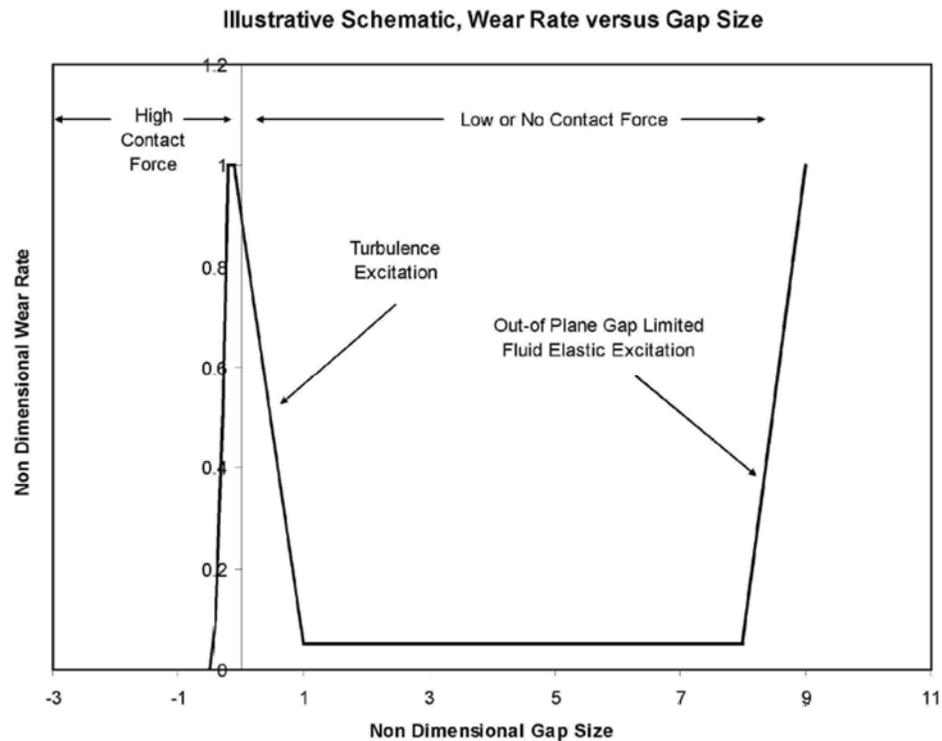
1266. In light of the above, the Tribunal finds that the Claimants have not established that the Respondents carried out an additional design error in relation to the validation of the IVHET.

D. TUBE GAPS AND MANUFACTURING ERRORS

1267. The Tribunal has addressed some of the factual issues surrounding tube gaps in Section VII.D(e)(v) above.

1268. The Parties disagree as to whether out-of-plane wear experienced at SONGS is on account of large gaps leading to out-of-plane gap limited FEI or whether very small gaps achieved in Unit 3 led to wear on account of turbulence excitation. This is illustrated in a schematic from an AREVA Operational Assessment developed to support the Unit 2 restart.¹³⁹⁴

¹³⁹⁴ Exh. JX-1393, p. 94.



1269. This illustrative schematic demonstrates two approaches to conceptualizing the relationship between wear and gap size.

1270. The vertical spike on the right in the illustration above (labeled “Out-of-Plane Gap Limited Fluid Elastic Excitation”) demonstrates what AREVA has described as the Westinghouse approach, in which evidence supports the conclusion that as gap size increases, eventually this leads to a sufficiently large gap that out-of-plane FEI occurs.¹³⁹⁵ In contrast, the left hand spike in the illustration above (labeled “Turbulence Excitation”) is what AREVA describes as the “nil gap hypothesis.”¹³⁹⁶

1271. AREVA’s explanation of these two models of wear is quoted in full below:

¹³⁹⁵ Exh. JX-1393, p. 62.

¹³⁹⁶ Exh. JX-1393, p. 62.

Before proceeding to a discussion of Unit 3 gap results a consideration of the implication of gap sizes relative to expected wear rates at AVB locations is worthwhile. Figure 6-31 presents a synthesis of viewpoints relative to the relationship between wear rates and tube to support gap sizes. Both seek to explain high wear rates at support locations. One is termed the nil gap hypothesis. The other exclusively favors out-of-plane, gap limited, fluid-elastic excitation. Both have been applied successfully. The nil gap hypothesis maintains that a zero gap condition, perhaps maintained by a small bias force, results in continuously high wear rates from turbulence excitation. For large gaps, out-of plane fluid-elastic excitation is admitted as a consideration but not expressly used. The nil gap hypothesis has been successfully applied and correctly predicts that many individual wear sites will exhibit constant wear rates over multiple cycles of operation. Westinghouse has demonstrated success with tire out-of-plane, gap limited, fluid-elastic excitation approach. Figure 6-31 shows high wear rates from turbulence excitation at a nil gap condition and high wear rates at larger gap sizes. Negative gaps imply high contact forces. Conceptually, there is some contact force that hinders motion to the extent that wear effectively ceases. A tube can experience a contact force on one side with a larger gap on the other side. If the contact force is sufficient, out-of-plane gap limited fluid-elastic excitation will not be an important consideration. Hence, a tube with a large one sided gap may or may not exhibit a high wear rate. The support may still be an effective support. Conversely, a tube with a small gap on each side will not exhibit a high wear rate. For small gaps, it will be an effective support.¹³⁹⁷

1272. The Parties fall on either side of this divide.

(a) **The Parties' Positions**

1273. The Claimants have generally adopted the Westinghouse approach and submitted that large gaps at SONGS on account of poor manufacturing have led to gap-limited out-of-plane FEI that caused considerable wear at SONGS. The Claimants' position is supported by Exponent and Mr. Langford.

¹³⁹⁷ Exh. JX-1393, p. 62.

1274. The Respondents have generally adopted the AREVA approach and submitted that SONGS was manufactured with small gaps, that it is the small gaps and uniformity of tubes that allowed in-plane FEI to occur, and that small gaps resulted in TTW on account of turbulence excitation.
1275. The Claimants' theory supports their breach of contract claim. That is, despite the RSG manufacturing standards requiring small uniform gaps, MHI lacked sufficient manufacturing experience, negligently fabricated RSGs with large gaps, and this resulted in excess wear. Under Mr. Langford's further theory, submitted as evidence by the Claimants, gap limited out-of-plane FEI caused wear resulted in the tube gaps growing, eventually creating the conditions for in-plane FEI in Unit 3.
1276. The Respondents' theory is that compliance with SCE's demanding manufacturing standards for a zero-gap RSG and high tube uniformity resulted in this nil gap hypothesis situation, a relatively new phenomena, where small uniform gaps results in wear on account of turbulence excitation. This approach is supported by the Respondents' experts Dr. Begley and Mr. Wilson (who is also a fact witness).

(b) The Tribunal's Determination

1277. In determining the tube gaps and manufacturing errors alleged by the Claimants, the Tribunal makes three observations:
- i. That the Tribunal is convinced that both Units at SONGS experienced out-of-plane gap limited FEI, as opined by various experts,¹³⁹⁸

¹³⁹⁸ See Section XIII.D(c)(iii) below.

- ii. That the design history demonstrates the impossibility or significant challenge of obtaining gap measurements from the central tubes in the bundle;¹³⁹⁹
 - iii. That as wear affects gap sizes, the gap sizes measured after the operation of the SONGS Units are not determinative as to the size of gaps at the time of delivery.¹⁴⁰⁰
1278. As submitted at the Hearing, the Claimants appear to accept that the nil gap hypothesis occurs in operating steam generators, stating that this is what was experienced at St. Lucie 2, but not at SONGS.¹⁴⁰¹
1279. The Respondents have submitted that the relationship between gap sizes and out-of-plane FEI is a “chicken and egg thing.”¹⁴⁰² That is, gap limited out-of-plane FEI causes gaps to grow and large gaps cause out-of-plane FEI.
1280. The Tribunal recalls that the issue is not simply whether a type of wear occurs, but what is the effect of that wear. Wear is of concern if it limits the life of the steam generator on account of tube plugging.
1281. The Tribunal also highlights AREVA’s statement that “a large one sided gap may or may not exhibit a high wear rate” as positive contact force from the other support may prevent tube wear from turbulence excitation.¹⁴⁰³

¹³⁹⁹ See Section VII.D(e)(v) above.

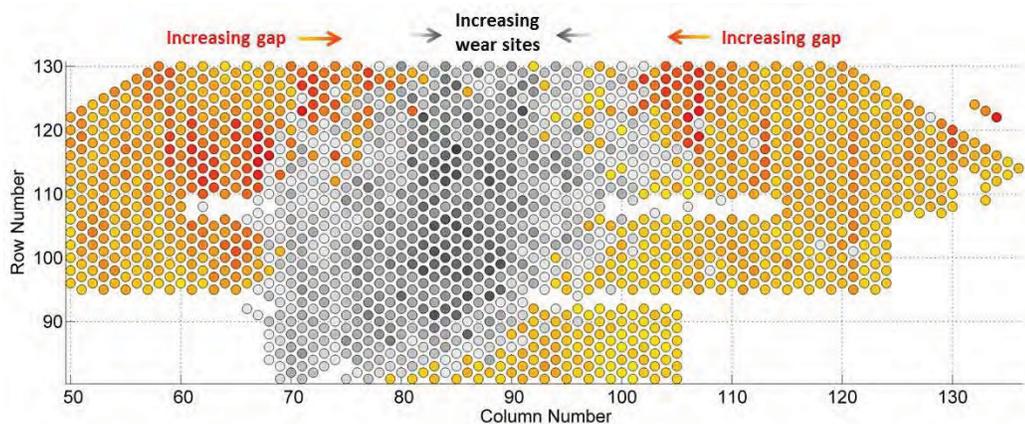
¹⁴⁰⁰ Respondents’ Closing Statement, slide 124.

¹⁴⁰¹ Transcript, pp. 5134-5135.

¹⁴⁰² Transcript, p. 5136.

¹⁴⁰³ Exh. JX-1393, p. 94.

1282. The Tribunal proceeds to consider the Claimants’ case on this issue, as supported by their expert Exponent.
1283. The Claimants’ expert Exponent states that “the actual tube-to AVB gaps for the tubes that did experience wear are unknown” as “they were never measured either before the failure or after the failure.”¹⁴⁰⁴ Despite this lack of evidence, Exponent hypothesizes that as measured gap sizes for tubes that did not experience wear increased closer to the tubes that experienced wear, a reasonable conclusion to draw is that the tubes that experienced wear had large gap sizes.¹⁴⁰⁵ This is illustrated in the illustration as follows with the red dots representing larger gaps and the grey dots being tubes that experience wear but for which gap measurements are not available:



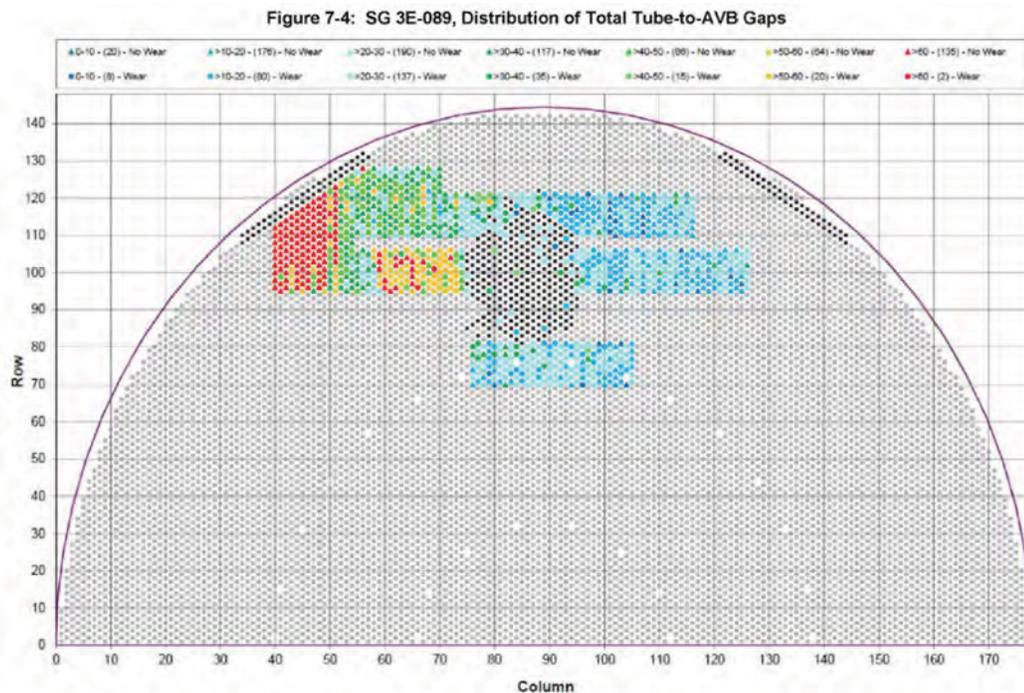
1284. In their closing submissions, the Respondents challenge Exponent’s methodology, stating that “Exponent chooses data to show only the largest gap, not the average gap or total gap, but the largest gap at one point on the tube. Also Exponent does not distinguish between one-sided gaps and two-sided gap.”¹⁴⁰⁶

¹⁴⁰⁴ Exponent Design Review, ¶ 365.

¹⁴⁰⁵ Exponent Design Review, ¶ 365.

¹⁴⁰⁶ Respondents’ Closing Statement, slide 118.

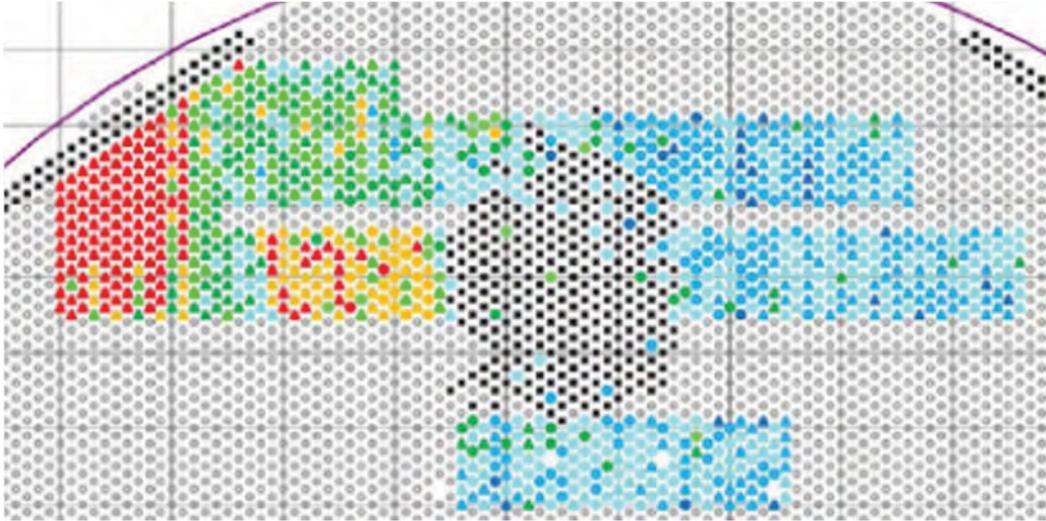
1285. The Respondents reference a different chart from AREVA. That chart demonstrates that the areas with the largest gaps (in red) (which generally did not suffer wear) and the areas with the smallest gaps, in blue, which did suffer wear are the opposite than the theory advanced by the Claimants through Exponent.¹⁴⁰⁷ Some areas with larger gaps, in green, generally did not suffer wear, while areas in yellow, with larger gaps either did or did not experience wear.¹⁴⁰⁸ AREVA's wear map is as follows:



1286. An expanded view to show the key sections is provided:

¹⁴⁰⁷ Exh. JX-934, pp. 31-36.

¹⁴⁰⁸ Exh. JX-934, pp. 31-36.



1287. As such, while Exponent interprets AREVA's data to suggest that the largest gaps are in the wear challenged area of the RSGs, the Respondents represent AREVA's data as demonstrating the contrary, that the smallest gaps are in the wear challenged area.¹⁴⁰⁹
1288. The Tribunal has reviewed the remainder of the Parties' evidence and submissions on this issue.
1289. The Tribunal does not consider it necessary to reach a conclusion as to how exactly the wear at SONGS was caused, whether through small or large gaps.
1290. In its review of Issue B.4(c) below, the Tribunal finds that the Claimants' have convincingly established that gap-limited out-of-plane FEI occurred at SONGS.¹⁴¹⁰ In its review of Issue B.6(e) below, the Tribunal concludes further that the Claimants have established inadequate tube support at SONGS.¹⁴¹¹

¹⁴⁰⁹ Respondents' Closing Statement, slide 120.

¹⁴¹⁰ See XIII.D(c)(iii) below.

¹⁴¹¹ See XIII.F(f)(iii) below.

1291. In the Tribunal's determination, inadequate tube support triggered the Respondents' warranty obligations under Section 1.17 of the RSG Contract, which reads in relevant parts as follows:

Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner Supplier at its sole expense with due diligence and dispatch by repairing or replacing (as appropriate) any defective part and other portion of the Work affected by such Defect. (....)

1292. Accordingly, the Tribunal does not consider it necessary to resolve the question of whether or not the as shipped RSGs had large gaps during manufacture in order to address the Claimants' Issue B claims.

1293. The Tribunal will revert to this question when considering the Claimants' claim as to whether the Respondents were grossly negligent in the manufacture of the RSGs under Issue F.4(i).¹⁴¹²

XIII. BREACH OF CONTRACT (ISSUE B)

1294. At issue are the following three questions: (i) what documents constitute the contractual agreement between Edison and MHI and in particular whether the Performance Analysis Report of 28 October 2008 prepared by MHI is a contractual document; (ii) whether the Respondents have breached contractual obligations in the design, manufacture or assembly of the RSGs; and (iii) whether the Respondents have breached other obligations of the RSG Contract, such as an alleged failure to provide access to documents and an alleged failure to pay for the Claimants costs relating to a repair of SONGS.

¹⁴¹² See Sections XVIII.D(a)-XVIII.D(c) below.

1295. The Respondents have generally adopted the position that the alleged breaches of the contract relating to the alleged defects trigger the warranty obligations of the contract and do not constitute contractual breaches in and of themselves.

A. WHAT DOCUMENTS CONSTITUTE THE RSG CONTRACT (ISSUE B.1)

1296. This Issue B.1 concerns the question of what documents constitute the RSG Contract. In this connection, the Parties dispute whether the PAR (Performance Analysis Report) dated 28 October 2008,¹⁴¹³ that MHI was required to prepare and submit to SCE in accordance with Section 3.8.2 of the RSG Contract, constitutes a contractual document setting forth design criteria for the RSGs.

1297. In the Claimants' submission, the PAR is a contractual document pursuant to Section 1.2.40 of the RSG Contract such that, for example, a void fraction of █████ identified in the PAR constitutes a contractual design criteria and MHI's failure to deliver RSGs with such a void fraction amounts to a breach of contract.

1298. In the Respondents' submission, the PAR is not a contractual document such that, for example, the calculated void fraction of █████ is not a contractual design specification.

1299. For the reasons provided below (see Issue B.1 below),¹⁴¹⁴ the Tribunal concludes that the PAR is not a contractual document under Section 1.2.40 of the RSG Contract. Rather, as described below (Issue B.1(c) below),¹⁴¹⁵ the Tribunal considers that failure to meet criteria set forth in the PAR could have triggered the Respondents' obligation to repair or replace the RSGs with due diligence and dispatch at the time of acceptance of the RSGs under Sections 1.16.2 and 1.16.3 of the RSG Contract.

¹⁴¹³ Exh. JX-813.

¹⁴¹⁴ See ¶¶ 1317, 1357 below.

¹⁴¹⁵ See ¶¶ 1348-1352 below.

1300. The Tribunal’s determination of Issue B.1 renders moot any determination on sub-Issue B.1(c)(i), which is nonetheless included in this Award for purposes of completeness and greater certainty.

(i) The Claimants’ Position

1301. In their Responses to Joint List of Issues, the Claimants submit that “Section 1.2.40 of the RSG Contract defines the Purchase Order as, “[t]he complete set of documents issued by EMS to the Supplier, as may be amended by Change Orders, which authorizes the Work, specifies the commercial terms, and incorporates by reference these General Terms and Conditions, the Specification and other referenced documents, all of which form the contract between the Parties.” In this way, Claimants and Respondents specifically agreed that the RSG Contract would evolve during the design and manufacture of the RSGs.”¹⁴¹⁶

1302. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that “[t]he “other referenced documents” include those that Respondents were specifically required to create and submit for Edison’s approval, including the various Design Reports, including the Licensing Topical Report, Performance Analysis Report (Thermal Hydraulics Report), Certified Design Report, and Code Data Report. By requiring the creation of these “other referenced documents,” Claimants and Respondents agreed that the RSG Contract would become more detailed and specific when the design of the RSGs was complete.”¹⁴¹⁷

(ii) The Respondents’ Position

1303. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

¹⁴¹⁶ Claimants’ Responses to Joint List of Issues, ¶ B.1.

¹⁴¹⁷ Claimants’ RPHM, ¶ 78.

The documents that make up the RSG Contract are the following documents issued by EMS to Mitsubishi: (1) the September 2004 Purchase Order (JX-321) and documents referenced therein; (2) the Specification (which includes the General Terms and Conditions) as amended by Change Order; and (3) any Change Orders that have been issued since the most recent Revision of the RSG Contract.

The identification of this universe of contract documents stems from the definition of Purchase Order at section 1.2.40 of the CDS, which states: “The complete set of documents issued by EMS to the Supplier, as may be amended by Change Orders, which authorizes the Work, specifies the commercial terms, and incorporates by reference these General Terms and Conditions, the Specification and other referenced documents, all of which form the contract between the Parties.” The terms “Specification,” “General Terms and Conditions,” and “Change Order” are also defined in the CDS; the term “Specification” is defined to include the General Terms and Conditions as well as Technical and Non-Technical Requirements, and a Change Order is a “document issued by EMS which, when accepted by the Supplier, amends the Purchase Order.” Notably, all documents that make up the RSG Contract were provided by EMS to Mitsubishi.

The phrase “other referenced documents” in the definition of Purchase Order applies to documents that existed at the time of execution of the Purchase Order. Section 3.5 of the Specification, for example, lists numerous design codes and standards as “referenced documents,” including codes from organizations such as the American Society of Mechanical Engineers (ASME) and the American Society for Testing and Materials (ASTM). Mitsubishi was required to comply with the requirements of those referenced documents because they were incorporated by reference into the Specification. There is nothing in the Purchase Order to suggest that the parties intended any document created after execution of the Purchase Order to become part of the Purchase Order and modify Mitsubishi’s obligations unless that document is incorporated into the Purchase Order by a change order. Indeed, where section 3.5 identified specific dated versions of design codes, Mitsubishi was required to comply with that exact version; ignoring any updates to the codes absent a modification of the Specification by Edison:

The user shall refer to this section whenever a document is referenced to assure that the proper revision is being used. A later version of some of the dated documents may become mandatory under regulations that have jurisdiction. If this takes place, the later version of each document shall be identified by means of a revision

to the Specification. Later versions shall not be adopted unless approved by Edison and incorporated into this Specification.

Thus, where the Contract used the term “referenced documents,” it limited those to specified documents in existence when the Purchase Order was signed, absent a Change Order adopting a later version.¹⁴¹⁸

(iii) *The Tribunal’s Determination*

1304. The Parties are in agreement that the set of documents which constitutes the RSG Contract is set forth in Section 1.2.40:

Purchase Order: The complete set of documents issued by EMS to the Supplier, as may be amended by Change Orders, which authorizes the Work, specifies the commercial terms, and incorporates by reference these General Terms and Conditions, the Specification and other referenced documents, all of which form the contract between the Parties.

1305. There is no dispute that the contract consists of:

- (i) *The original September 2004 Purchase Order¹⁴¹⁹ and documents referenced therein;*
- (ii) *The Contractual Design Specifications,¹⁴²⁰ identified in this Award as the RSG Contract, which include the “General Terms and Conditions,” “Non-Technical Requirements,” and “Technical Requirements;”*
- (iii) *Contractual Change Orders;*
- (iv) *Updated versions of the Purchase Order and the contractual design specifications (except as to non-relevant issues regarding version four of the RSG Contract).*

¹⁴¹⁸ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 42-44.

¹⁴¹⁹ Exh. JX-321.

¹⁴²⁰ RSG Contract and the prior versions thereof.

1306. Where the Parties are in disagreement is as to (i) whether the Parties agreed that the RSG Contract would evolve during the design and manufacture of the RSG; and (ii) with regard to the meaning of the words “and other referenced documents” in Section 1.2.40. Under the Claimants submission, “other referenced documents” includes the PAR along with other referenced reports.¹⁴²¹
1307. The Tribunal considers that the question as to whether the RSG Contract would evolve need not to be determined to resolve the question of what is meant by “other referenced documents.” Indeed, the Parties did agree that the RSG Contract could and would evolve by the issuance of Change Orders, including approved Supplier Deviation Requests. However, the evolution of the RSG Contract by Change Orders and approved Supplier Deviation Requests still requires the Tribunal to address the question whether the PAR is covered by the meaning of “other referenced documents.” Thus, assuming that the Parties agreed that the RSG Contract would evolve during the design and manufacture of the RSG, such evolution would need to be included in “other referenced documents.” In turn, if the Parties did not agree that the RSG Contract would evolve during the design and manufacture of the RSG, the Tribunal would still be required to address the question whether the PAR is covered by the meaning of “other referenced documents.”
1308. With respect to the question under (ii) in ¶ 1306 above, the PAR and the other referenced reports, which include the Design Reports required under Section 3.21.2 of the RSG Contract, are referenced in the Specifications. These types of “other

¹⁴²¹ Claimants’ PHM, Appendix A, pp. 269-270 (According to the Claimants, the list of other referenced documents includes: monthly Project Status Reports, Supplier Deviation Reports and Nonconformance Reports, Supplier Subcontracting Reports, Material Selection Report and Certified Material Test Reports, Tube Expansion Report, Post-Weld Heat Treatment, Final Cleanliness Inspection Report, Inspection/Nondestructive Examination Reports, Commercial Grade Item Dedication Reports, Nitrogen Plenum/Accelerometer Data Report, and at least four Design Reports: Licensing Topical Report, Performance Analysis Report (Thermal Hydraulics Report), Certified Design Report, and the Code Data Report).

documents” are part of the “Documentation” as defined in the RSG Contract at Section 1.2.17.

1309. Under the Respondents’ submission, the “other referenced” documents are documents, which existed at the time of the execution of the Purchase Order as set forth in Section 3.5 of the Specifications, and include the various technical codes and regulations to which the design and fabrication of the RSGs must conform, such as ASME codes, NRC regulations, and similar. These types of “other documents” are part of the “Applicable Standards” as defined in the RSG Contract at Section 1.2.6.
1310. Under Section 1.2.40 of the RSG Contract, contractual documents are those which (i) are “issued by EMS to the Supplier;” and (ii) “authorizes the Work.”
1311. Regarding (i), the PAR and various reports referenced within the PAR are not documents “issued by EMS to the Supplier,” but rather are documents prepared by MHI and delivered to Edison.
1312. Regarding (ii), the “Work” is defined in Section 1.2.59 of the RSG Contract to include not only the “Apparatus” (i.e., the RSGs) but also all design and fabrication services, including Documentation:

Work: The Apparatus, together with all engineering, analysis (including without limitation analysis of the impact of installation and use of the Apparatus on then-existing SONGS facilities), design, manufacturing, fabrication, assembly, inspection, testing, Documentation, Technical Services and all other obligations of the Supplier to be performed or furnished as required by the Purchase Order

1313. Accordingly, part of the Work, i.e., deliverables, to be carried out by MHI was the creation and submission of “Documentation” of the design of the RSGs, where Documentation is defined in Section 1.2.17 as:

Documentation: Drawings (including Certified Drawings), specifications, procedures, instructions, lists, reports, test results, calculations, manuals, schedules, software, and other data to be furnished by the Supplier, as stated in the Specification or elsewhere in the Purchase Order.

1314. The various reports, tests, and calculations which MHI was required to develop are therefore deliverables, which were required by MHI to be performed as part of the Work required under the RSG Contract. Producing these reports was a contractual obligation on MHI, but that does not imply that the content of those reports consists of or become contractual obligations.
1315. The Documentation is, therefore, not part of the approval process of the Work under terms specified by EMS per Section 1.2.40 but rather part of the Work that MHI was to perform under the Contract. This interpretation is further supported by other provisions of the RSG Contract:
- i. Under Section 1.5.1 “time is of the essence for delivery of the Apparatus and the Documentation,” further indicating that the Documentation is part of the deliverables to be performed by MHI;
 - ii. Under Section, 1.17.3, “the Supplier warrants that the Documentation shall be free from Defects, accurate and as specified in the Purchase Order. The Supplier shall, at its cost, correct any nonconforming Documentation discovered within five (5) years after its Acceptance, which shall be the warranty period for the Documentation.
1316. Furthermore, Table 3-1 of the RSG Contract provides a list of the Documentation that MHI is to provide as part of the Work, including the “Performance Analysis Report,” which is to be provided at least “12 months prior to delivery of the RSGs.”

1317. Accordingly, addressing the primary aspect of Issue B.1, whether the PAR is a contractual document, the Tribunal concludes that the PAR is not a document that creates obligations under the RSG Contract. The PAR is rather a required report on the status of the RSG design at the time of issuance and, therefore, a deliverable under the RSG Contract.

(a) **At the Time of Execution of the RSG Contract and its Revisions (Issue B.1(a))**

1318. This Issue B.1(a) concerns the question of what documents constitute the RSG Contract, specifically at the time of execution of the RSG Contract and its revisions.

(i) *The Claimants' Position*

1319. In their Responses to Joint List of Issues, the Claimants submit the following:

On September 28, 2004, EMS issued the RSG Contract, which included the Purchase Order, General Terms and Conditions, and Revision 2 of the Specification. MHIA executed the RSG Contract on September 30, 2004. Revision 2 of the Specification, Section 1.2.40, includes the same definition of Purchase Order cited above¹⁴²², and incorporates by reference all other referenced documents, although many had yet to be created. The Performance Analysis Report is specifically referenced in Revision 2.

The parties agree that Revision 3 of the RSG Contract was issued on October 12, 2006. Revision 3 incorporated various addenda, Supplier Deviation Requests, Referenced Documents and select commercial terms contained in prior Change Orders. Revision 3 was incorporated by Change Order 14 (Purchase Order Number 6C294014), which was issued to Mitsubishi on November 18, 2006. At the time Revision 3 became effective, dozens of Supplier Deviation Requests had been submitted (some of which were approved and became part of the RSG Contract), and numerous referenced documents existed, including Code Validation Reports.

On July 28, 2010, Edison approved Revision 4 of the Specification, likewise incorporating various addenda, Supplier Deviation Requests, Referenced Documents, and commercial terms contained in prior Change Orders. Revision

¹⁴²² See ¶ 1301 above.

4 was incorporated by Change Order No. 9 and was issued to Mitsubishi on November 9, 2010. Respondents initially argued that Revision 4 was not the operative version of the Specification, but appear to have dropped this objection. In any case, Claimants have established by a preponderance of the evidence that Revision 4 is operative. There are at least 26 of Mitsubishi's Supplier Deviation Requests, in addition to various addenda and technical and editorial changes agreed to by the parties, that are reflected only in Revision 4. Moreover, Revision 4 was referenced on all subsequent Change Orders signed by Respondents.

By the time of Revision 4, numerous "Referenced Documents" required by the RSG Contract had been drafted and approved, including the PAR, which is dated October 28, 2008. This document (and its supporting documents describing the methods of analysis and validating the conclusions in the PAR) became a part of the RSG Contract when Edison accepted the document on October 30, 2008.¹⁴²³

(ii) The Respondents' Position

1320. In their Position Statement on the Revised List of Issues, the Respondents contend that "[t]he RSG Contract was initially executed at the end of September 2004. At the time of execution, the documents that made up the RSG Contract were the following documents issued by EMS to Mitsubishi: (1) the September 2004 Purchase Order and documents referenced therein; and (2) Revision 2 of the Specification (which included the General Terms and Conditions)."¹⁴²⁴

(iii) The Tribunal's Determination

1321. Version 1 of the RSG Contract dates to 28 September 2004. The Parties are generally agreed as to the content of the RSG Contract at that date and as of the various revisions thereto.

¹⁴²³ Claimants' Responses to Joint List of Issues, ¶ B.1(a).

¹⁴²⁴ Respondents' Position Statement on the Revised List of Issues, ¶ 45.

1322. Where the Parties are in disagreement is as to whether the 30 October 2008 acceptance by SCE of the PAR integrated that report into the RSG Contract as an “other referenced document,” as referred to in Section 1.2.40 of the RSG Contract.
1323. The Tribunal does not consider that the issuance of Revision 4 of the RSG Contract, in and of itself, on a date following the creation of the PAR transforms the PAR, into a referenced contractual document. The Parties wanted to be very clear as to what documents created contractual obligation; thus, the determination of whether the PAR is a contractual document is based upon the words and context of the RSG Contract, as set forth in Issue B.1 above.¹⁴²⁵ Revisions thereto that resulted in the issuance of a new version did not change the Parties’ obligations under an agreement except as specifically identified. For greater certainty, none of the revisions to the RSG Contract appear to have changed the definition of the Purchase Order provided in Section 1.2.40 of the RSG Contract.
1324. The Tribunal’s determinations on this Issue are set forth in Issue B.1 in Section (iii)(iii) above and Issue B.1(c) in Section XIII.A(c)(iii) below.

(b) Subsequent to the Execution of the RSG Contract and its Revisions (Issue B.1(b))

1325. Having addressed the Issue of what constitutes the RSG Contract at the time of execution of the RSG Contract and its revisions, the Tribunal now turns to Issue B.1(b), which concerns the question of what constitutes the RSG Contract subsequent to the execution of the RSG Contract and its revisions.

(i) The Claimants’ Position

1326. In their Responses to Joint List of Issues, the Claimants submit that “[t]he “Referenced Documents” were, by definition, part of the RSG Contract from the time

¹⁴²⁵ See Section XIII.A above.

Revision 2 became effective, although the documents themselves had not yet been drafted. The content of the “Referenced Documents” became terms of the RSG Contract after approval by both parties (typically, the date of Edison’s acceptance of the document).”¹⁴²⁶

1327. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents assert in conclusory fashion that if Claimants’ reading of the term “other referenced documents” is correct, then all the documents listed in the “Document Submittal Schedule” at Table 3-1 of the RSG Contract must be part of the parties’ contract by virtue of being mentioned in the RSG Contract. Respondents misconstrue Claimants’ argument. Claimants do not assert that every document mentioned in the RSG Contract is part of the agreement. Rather, it is only those specifically enumerated reports that Mitsubishi was required to create and Edison to approve that became a part of the RSG Contract upon their completion. Therefore, some documents on the Document Submittal List, such as the Performance Analysis Report, are indeed “other referenced documents” included in the definition of Purchase Order. Others, such as Mitsubishi’s Project Organization Chart, were to be submitted for informational purposes only and thus were not required to be created by Respondents for Claimants’ approval. Thus, these were not part of the RSG Contract. A fair reading of the RSG Contract suggests that only those documents that were required to be created and approved are the “other referenced documents” that are part of the RSG Contract.

Respondents argue that the term “other referenced documents” means specifically the 71 third party codes and standards cited at Section 3.5 of the RSG Contract. If Respondents’ position were correct, the parties would surely have said as much. That is, if the “other referenced documents” to be incorporated into the RSG Contract were so easily limited to a single category of documents collected in a single section of the RSG Contract, the definition of Purchase Order could have been drafted more simply and clearly by unambiguously stating that it encompassed “the standards and codes set forth in Section 3.5.” The parties did not so draft the definition and chose instead the broader term “other referenced documents.” Logic dictates that the term includes those additional documents Respondents were required to create after

¹⁴²⁶ Claimants’ Responses to Joint List of Issues, ¶ B.1(b).

the design of the RSGs was complete and which were subject to approval by Claimants.¹⁴²⁷

(ii) The Respondents' Position

1328. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Subsequent to the initial execution of the RSG Contract, Revisions 3 and 4 to the Specification were issued by EMS to Mitsubishi, in November, 2006 and July, 2010, respectively. Mitsubishi disputes that it agreed to Revision 4 to the Specification; however, the changes between Revisions 3 and 4 are unlikely to have a material outcome on the issues that are in dispute. Those documents, as well as any Change Orders and supplier deviation requests that were bilaterally executed over time, became part of the RSG Contract.

The Parties had an established method of incorporating additional obligations and changes into the RSG Contract. Mitsubishi could issue Supplier Deviation Requests (“SDRs”) to Edison; once approved, these SDRs would be incorporated into the RSG Contract by Change Order.¹⁴²⁸

(iii) The Tribunal's Determination

1329. The Tribunal's consideration in relation to this Issue B.1(b) have to be read in conjunction with the Tribunal's considerations under Issues B.1 and B.1(a) above.¹⁴²⁹ Indeed, while the Tribunal had determined above that the PAR is not to be considered a contractual document under the RSG Contract and was not to be meant to be a contractual document at the time of the execution of the RSG Contract and its revisions, the question here is nuanced as to the timing, whether subsequent to the execution of the RSG Contract and its revisions the PAR may have become a contractual document.

¹⁴²⁷ Claimants' RPHM, ¶¶ 84-85.

¹⁴²⁸ Respondents' Position Statement on the Revised List of Issues, ¶¶ 46-47.

¹⁴²⁹ Sections XIII.A(iii) and XIII.A(a)(iii) above.

1330. As the Parties' submissions in this regard center around the question of the meaning of "other referenced documents" which the Tribunal had already addressed in relation to Issues B.1 and B.1(a) above, the Tribunal refers to its findings in this respect above.¹⁴³⁰
1331. Suffices to say that the Respondents initially raised an issue regarding whether Revision 4 of the RSG Contract was the operative version. The Parties are now agreed, for the purposes of this arbitration, that Revision 4 of the RSG Contract is the operative version.¹⁴³¹ As the Respondents submit that none of the changes between Revisions 3 and 4 are material to this present dispute, the Tribunal is not required to make a determination as to whether Revision 4 of the RSG Contract is in force or effect.
1332. As mentioned, the Claimants have raised the Issue as to whether "other referenced documents" that were created following the original RSG Contract include the PAR.¹⁴³²
1333. The Claimants discount the Respondents' submission that "other referenced documents" are limited to some 71 codes and standards set forth in Section 3.5 of the RSG Contract,¹⁴³³ submitting that if this was the case, the RSG Contract would have used more precise language rather than the term "other referenced documents."¹⁴³⁴

¹⁴³⁰ Section XIII.A(iii) ((¶¶ 1307-1317) above and Section XIII.A(a)(iii) (¶¶ 1322-1323) above.

¹⁴³¹ See ¶ 1328 above.

¹⁴³² Claimants' RPHM, ¶¶ 83-85.

¹⁴³³ Respondents' Position Statement on the Revised List of Issues, ¶ 44.

¹⁴³⁴ Claimants' RPHM, ¶¶ 85.

1334. As implicit in ¶¶ 1304 through 1317 above, the term “other referenced documents” is not defined in the RSG Contract. Whether the RSG Contract may have been drafted with greater precision in this regard is not determinative.
1335. For the reasons set out above,¹⁴³⁵ the Tribunal concluded that the PAR is not part of the RSG Contract. The Claimants have not established that subsequent to the execution of the RSG Contract and its revision the PAR became a contractual document. In particular, the Claimants’ submission that due to the alleged lack of ambiguity in Section 3.8.2 of the RSG Contract the PAR has subsequently become a contractual document is not convincing as the RSG Contract could just as equally have been drafted to specify that “other referenced documents” refers to the PAR under Section 3.8.2 of the RSG Contract as well as to other designated reports.
1336. Accordingly, answering Issue B.1(b), the Tribunal concludes that the PAR did not become a contractual document subsequent to the execution of the RSG Contract and Revision 2 of the RSG Contract.

(c) **Has the Performance Analysis Report Become Part of the RSG Contract Such that the Design Parameters Stated in the PAR have Become Binding Contractual Obligations (Issue B.1(c))**

1337. This Issue B.1(c) concerns the question of what documents constitute the RSG Contract and, in particular, whether the PAR has become part of the RSG Contract so that the design parameters stated in the PAR have become binding contractual obligations.
1338. As in relation to Issue B.1(b), this Issue, too, is conjoined with Issues B.1 and B.1(a).

¹⁴³⁵ Sections XIII.A(iii) and XIII.A(a)(iii) above.

(i) The Claimants' Position

1339. In their Responses to Joint List of Issues, the Claimants submit the following:

The PAR is a “Referenced Document” required by the RSG Contract, and as such forms part of the between the parties. The PAR became part of the RSG Contract on October 30, 2008, when Edison accepted the document. To the extent that the PAR incorporates additional documents by reference in lieu of setting forth the contractually-required information (Purpose; Results, Conclusions, and Recommendations; Assumptions; Design Inputs; Methodology; References; Nomenclature; and Computations), these documents also form part of the RSG Contract.

As part of the RSG Contract, the information, analyses, and conclusions set forth in the PAR are binding promises made by Respondents to Claimants regarding the performance of the RSGs. These promises included specific thermal-hydraulic parameters like void fraction and circulation ratio. These promises also included the analytical criteria used to assess the SR in the U-bend and the claimed conservatisms built into the design (i.e., SRs of less than 1.0 with one ineffective support).

Claimants relied on Respondents’ assertions that the alleged conservatisms provided a sufficient margin of safety in the RSGs. Because these representations are part of the RSG Contract, Respondents’ failure to meet the promised parameters resulted in nonconforming goods and, thus, a breach of the contract. See Claimants’ Post-Hearing Memorial at Appendix A.¹⁴³⁶

1340. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that the “Respondents’ position—that they were required to create the PAR but that its content need not accurately reflect the conditions in the RSGs and was not binding—is untenable. It ignores Respondents’ obligation to “document[] all thermal-hydraulic aspects of the RSG design” and renders the RSG Contract’s four-page description of the PAR’s required content a superfluity.”¹⁴³⁷

¹⁴³⁶ Claimants’ Responses to Joint List of Issues, ¶ B.1(c).

¹⁴³⁷ Claimants’ RPHM, ¶ 89.

(ii) The Respondents' Position

1341. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

[T]he Performance Analysis Report (“PAR”) document did not become part of the RSG Contract.

On April 12, 2016, day 16 of the hearing, Claimants, for the first time, asserted that the PAR was an “other referenced document” per section 1.2.40 and therefore became a contract document upon approval. Claimants’ counsel then asserted that Mitsubishi’s alleged failure to achieve certain values for various T/H parameters identified in the PAR is grounds for a breach of contract claim. This argument must fail for several reasons.

First, nothing in the RSG Contract supports this argument. The PAR is not identified as a contract document, nor is it a referenced document in the Purchase Order, or, for that matter, in section 3.5 of the Specification. And, it was not supplied by EMS to Mitsubishi; rather, it was provided by Mitsubishi to Edison.

Second, the section of the Specification that defines the PAR clearly states that “the thermal-hydraulic design parameters for the RSGs are specified in Table 3A-1,” which is part of the Specification. Any design parameters or values included in the PAR that are not specified in Table 3A-1 are not binding requirements under the RSG Contract.

Third, the plain meaning of the term “referenced documents” relates to documents which are referred to or consulted, not documents created as part of a design process.

Fourth, the PAR is one of 71 documents listed on the “Document Submittal Schedule.” If the PAR is a contract document, so must all of the other 70 lists, reports, plans, drawings, schedules, procedures and logs, such as any Root Cause Evaluation Reports (item 55), and the Vendor Manual (item 63). If EMS had intended for this to be the case, certainly it would have identified the documents as such.

Fifth, there is no mention in any of Claimants’ Memorials of the PAR creating contractual obligations, nor did a single witness testify, either in pre-filed or live testimony, that the Parties intended for the PAR to create such obligations.

Sixth, if the parties had intended to bind Mitsubishi to the values calculated in the PAR, there presumably would have been a Supplier Deviation Request and subsequent Change Order when those values changed during the design process. For example, the record shows that Mitsubishi's predicted void fraction levels changed from █████ in July 2005 to █████ in October 2005 to █████ in March 2008. If predicted void fraction levels were contract requirements, one would expect to see a Supplier Deviation Request requesting approval for those changes. Additionally, those changes would have been incorporated into Table 3A-1. By contrast, the parties did utilize the SDR [Supplier Deviation Request] process for changes to circulation ratio, which is a value reflected on Table 3A-1. In addition to the language of the Contract itself, the Parties' course of performance accordingly supports the view that values in the PAR but not reflected in Table 3A-1 were not considered contractual obligations.

While it is true that section 3.8.2 of the Specification required Mitsubishi to separately prepare the PAR, just as it had to prepare the other 70 documents listed on the submittal schedule, the requirement was only to prepare these documents and submit them for approval; it was not to create a contractual obligation to achieve each parameter value mentioned in the PAR.

Finally, at the hearing Claimants argued that *USM Corp. v. Arthur D. Little Systems*, a case from Massachusetts, supported its position that the parameters in the Performance Analysis Report were part of the RSG Contract. But as Respondents explained at the hearing, the Performance Analysis Report at issue in *USM Corp.* predated the contract and its results were expressly incorporated into the contract itself as an attachment. That is very different from the facts here, where the Performance Analysis Report was created after the Contract was executed. Therefore, *USM Corp.* supports Mitsubishi's position that, absent a Change Order, the Contract requirements must be defined at the time the Contract is signed.¹⁴³⁸

(iii) *The Tribunal's Determination*

1342. As determined in relation to Issues B.1 through B.1(b) above, the Tribunal does not consider the PAR to be a contractual document.¹⁴³⁹

¹⁴³⁸ Respondents' Position Statement on the Revised List of Issues, ¶¶ 48-57.

¹⁴³⁹ See ¶¶ 1317, 1323 and 1336 above.

1343. The Tribunal's determination is further supported by the difference in treatment between T/H values referenced in the PAR in comparison to those in the RSG Contract.
1344. The significance in this Arbitration of whether the PAR constitutes a contractual document is in regard to whether any T/H conditions set forth within the PAR are contractual requirements, which the design of the RSGs must conform to, and in particular, whether void fraction values specified therein were contractual requirements.
1345. The Tribunal is not convinced that a void fraction specified in the PAR constitutes a contractual obligation to which the design of the RSGs must conform. In this regard, the Tribunal is persuaded by the different treatment afforded to the T/H conditions specified in Table 3A-1 of the RSG Contract and to void fraction. As submitted by the Respondents, whereas design changes to the circulation ratio,¹⁴⁴⁰ a value specified in Table 3A-1, required contractual change orders under the RSG Contract, revisions to the calculation of void fraction required no such formality.
1346. While not contractual requirements, the specifications in the PAR are important to the approval of the RSGs. Section 1.16.1.3 of the RSG Contract requires that for the acceptance of delivery of the RSGs, the RSGs be in operation "for a sufficient period of time to demonstrate that they are capable of being operated safely, normally, and continuously in accordance with ... the Documentation."
1347. "Documentation" is defined in Section 1.2.17 of the RSG Contract as "drawings (including Certified Drawings), specifications, procedures, instructions, lists, reports, test results, calculations, manuals, schedules, software, and other data to be

¹⁴⁴⁰ For circulation ratio, see ¶ 168 above.

furnished by the Supplier, as stated in the Specification or elsewhere in the Purchase Order. As determined above in Issue B.1, Documentation thus includes the PAR.¹⁴⁴¹

1348. According to Sections 1.16.2 and 1.16.3 of the RSG Contract, failure to demonstrate that the RSGs could be operated “safely, normally, and continuously” in accordance with the requirements of the Documentation could have led SCE to find the RSGs as delivered contained “Defects” or otherwise did not meet the acceptance criteria. Further, SCE could also impose Liquidated Damages as defined in the RSG Contract or require that a repair be performed “with due diligence or dispatch” at MHI’s expense.
1349. The role of the PAR in providing acceptance criteria for the RSGs is such that the Claimants’ position that absent contractual force the PAR is superfluous is rejected.
1350. On 21 September 2010, SCE notified MHI that the Unit 2 RSGs met the Acceptance criteria.¹⁴⁴² A similar notification of Acceptance was provided for Unit 3 on 3 May 2011.¹⁴⁴³ According to Mr. Wharton, of SCE, Acceptance of the RSGs did not include a verification that would “discover latent defects in design or fabrication” nor “reveal operational problems such as wear.”¹⁴⁴⁴
1351. Be that as it may, the RSG Contract is clear that the relevance of requirements set forth in Documentation is at the time of acceptance of the RSGs. The remedy at the time of Acceptance is one of repair of the “Defects” or deficiencies identified or Liquidated Damages as defined in the RSG Contract.

¹⁴⁴¹ See ¶¶ 1316-1317 above.

¹⁴⁴² Exh. JX-924.

¹⁴⁴³ Witness Statement of Mr. Wharton, ¶ 126.

¹⁴⁴⁴ Witness Statement of Mr. Wharton, ¶ 125.

1352. The consequence of a failure of the RSGs to conform to the Documentation prior to the Acceptance of the RSGs is for MHI to repair the deficiencies with “due diligence and dispatch.” However, the time of Acceptance has passed and that passage should not grant SCE more rights than they had under the RSG Contract than existed at the time of Acceptance. The passage of time does not elevate a failure to conform with the Documentation into a contractual breach that bypasses the framework of Section 1.17 of the RSG Contract regarding warranties, as determined in Issue C.¹⁴⁴⁵
1353. For the above reasons on Issue B.1(c), as well as for the reasons set forth in relation to Issues B.1 through B.1(b) above, the Tribunal does not consider the PAR to be a contractual document.¹⁴⁴⁶
1354. Accordingly, the Claimants have not established that the PAR has become part of the RSG Contract so that the design parameters stated therein have become binding contractual obligations.

(d) Have the Documents Referenced at Page 80 of the PAR Become Binding Contractual Obligations (Issue B.1(c)(i))

1355. This Issue B.1(c)(i) concerns the follow-up question if the PAR has become part of the RSG Contract so that the design parameters stated in the PAR have become binding contractual obligations, have the documents referenced as page 80 of the PAR also become binding contractual obligations.
1356. As determined above,¹⁴⁴⁷ the PAR has not become a contractual document. Consequently, the Tribunal’s determination of the question under this Issue B.1(c)(i) has become moot.

¹⁴⁴⁵ Section XV below.

¹⁴⁴⁶ Sections XIII.A(iii), XIII.A(a)(iii) and XIII.A(b)(iii) above.

¹⁴⁴⁷ See ¶¶ 1317, 1323 and 1336 above.

(1) Interim Conclusion

1357. The Tribunal determines Issue B.1 in favor of the Respondents, finding that the PAR is not a contractual document as the proper interpretation of Section 1.2.40 of the RSG Contract limits the contractual documents to the Purchase Order, the Specifications, contractual Change Orders, including approved Supplier Deviation Requests and Applicable Standards identified in Section 3.5 of the RSG Contract.

B. ARE THE BREACHES OF CONTRACT ALLEGED BY CLAIMANTS AUBSUMED IN, AND GOVERNED BY, THE RSG CONTRACT'S WARRANTIES AND REMEDIES, AS IS CONTENTED BY RESPONDENTS? IF SO, WHAT IS THE CONSEQUENCE, IF ANY? (ISSUE B.2)

1358. This Issue B.2 concerns the question of whether the breaches of contract alleged by the Claimants are subsumed in, and governed by, the RSG Contract's warranties and remedies, as submitted by the Respondents.

(i) The Claimants' Position

1359. In their Responses to Joint List of Issues, the Claimants submit the following:

Under California law, breach of contract and breach of warranty are separate and distinct causes of action. Claimants' breach of contract claims are not subsumed in or governed by the RSG Contract's warranties and remedies. That the RSG Contract's Warranty provides sole limited remedies for a breach of Warranty (RSG Contract section 1.17.14) does not limit the remedies available for a breach of contract action. Section 1.17.14 provides the "sole remedy for breach of [Mitsubishi's] Warranty obligations"—not the other contractual obligations. Respondents' claim that the breach of contract claims are subsumed in the breach of Warranty claim is an attempt to evade the extensive contractual promises it made to Edison.

Ultimately, both the breach of the enumerated contractual provisions outside the Warranty and the breach of Warranty are subject to the provisions of Commercial Code and yield benefit-of-the-bargain damages. Claimants are

entitled to recover if the Tribunal concludes that *either* the contract or the warranty was breached (or both).¹⁴⁴⁸

(ii) *The Respondents' Position*

1360. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

The breaches of contract alleged by Claimants are subsumed in, and governed by, the RSG Contract's warranties and remedies. Section 1.17 of the RSG Contract (governing warranty obligations), and section 1.29 of the RSG Contract (governing liquidated damages) provide the available remedies under the RSG Contract. More specifically, section 1.17.14 provides, in pertinent part, as follows:

EMS'S SOLE REMEDY FOR BREACH OF SUPPLIER'S WARRANTY OBLIGATIONS SET FORTH IN THE PURCHASE ORDER SHALL BE AS SET FORTH OR PERMITTED HEREIN, AND THERE ARE NO OTHER REMEDIES FOR BREACH OF SUCH WARRANTY OBLIGATIONS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE, OTHER THAN AS PERMITTED IN THE PURCHASE ORDER.

(Caps in original.) Permitting Claimants to bring separate breach claims would render these specific remedial provisions and their limitations meaningless. California law governing contract interpretation does not allow this result, and Claimants have not advanced any legal principles or raised any factual issues that would cause the Tribunal to reach a different conclusion. The consequence of this is that Claimants cannot bring separate breach claims under the RSG Contract apart from their claim for breach of warranty.¹⁴⁴⁹

(iii) *The Tribunal's Determination*

1361. The Parties are in disagreement as to whether Section 1.17.14 of the RSG Contract limits the Claimants' claims to those of breach of Warranty.

¹⁴⁴⁸ Claimants' Responses to Joint List of Issues, ¶ B.2.

¹⁴⁴⁹ Respondents' Position Statement on the Revised List of Issues, ¶ 59.

1362. Section 1.17.14 of the RSG Contract, quoted by the Respondents in ¶ 1360 above, provides in unambiguous terms that the limitations therein solely apply to a breach of a warranty claim.
1363. Accordingly, the Claimants may pursue a breach of contract claim against the Respondents in addition to any breach of warranty claims, to the extent any such distinct claims may exist, as will be considered in Issue B.2(a) below.

(a) **Or, are there covenants in the RSG Contract that are separate and independent of Respondents' warranty obligations, as Claimants contend? If so, what is the consequence, if any? (Issue B.2(a))**

1364. As a follow-up to Issue B.2 above, this Issue B.2(a) concerns the question whether there are covenants in the RSG Contract that are separate and independent of the Respondents warranty obligations, as submitted by the Claimants.

(i) *The Claimants' Position*

1365. In their Responses to Joint List of Issues, the Claimants submit that the “Respondents breached numerous express covenants in the RSG Contract that are separate and independent of Respondents' warranty obligations. Each failure to perform a required duty constitutes a breach of the RSG Contract, which is a separate and distinct cause of action from Claimants' breach of warranty claim.”¹⁴⁵⁰
1366. In addition, in their C-RPHM, the Claimants contend that they “are entitled to recover benefit-of-the-bargain damages if the Tribunal concludes that Respondents breached either the contract or the warranty, or both.”¹⁴⁵¹

¹⁴⁵⁰ Claimants' Responses to Joint List of Issues, ¶ B.2(a).

¹⁴⁵¹ Claimants' RPHM, ¶ 93.

(ii) The Respondents' Position

1367. In their Position Statement on the Revised List of Issues, the Respondents, while making reference to their submissions concerning Issues B.2, A.1(a) and B.3-B.9, contend that “[t]here are not covenants in the RSG Contract that are separate and independent of Respondents’ warranty obligations (...) However, even if the Tribunal found there were covenants in the RSG Contract that are separate and independent of Respondents’ warranty obligations, Claimants would still be required to prove all the elements of breach of contract, which they have not done.”¹⁴⁵²

(iii) Tribunal's Determination

1368. The facts alleged by the Claimants in this case are pleaded in the alternative as breaches of contract, warranty, or both. The Claimants provide examples of the alleged contractual breaches. Those breaches are particularized as violations of Sections 1.9.4, 1.9.6 1.12.2, 1.17.1.3, 1.17.2.3, 1.17.6, 3.5, 3.7.1.1, 3.7.1.2 and 3.9.3.7 of the RSG Contract.¹⁴⁵³

1369. In this connection, Section 1.17 of the RSG Contract states that “the Supplier warrants that the Apparatus shall meet all the requirements of the Specification, including the Applicable standards.” Specification is defined to include the entirety of the RSG Contract.¹⁴⁵⁴ The Apparatus is defined to include the RSG Units and associated equipment and supplies furnished by MHI. The Applicable standards are defined to include the various codes, practices, and methods set forth in the Specifications, namely those identified in Section 3.5 of the RSG Contract.

1370. Thus, the warranty provisions cover the near entirety of the contractual obligations in dispute as set forth in the RSG Contract. The Tribunal considers that the Warranty

¹⁴⁵² Respondents’ Position Statement on the Revised List of Issues, ¶ 60.

¹⁴⁵³ Memorial, ¶ 323.

¹⁴⁵⁴ RSG Contract, Section 1.2.45.

provisions, however, would not cover contractual claims for matters that are, on their face, evidently not addressed by a warranty claim, such as, for example, pre-Acceptance¹⁴⁵⁵ defaults and non-technical matters.

1371. In this arbitration, such claims are limited to SCE's claim that MHI has failed to properly pay its repair invoices under Section 1.9.4 (and other Sections) of the RSG Contract and that MHI "refused to allow Claimants access to documents to which they have a right under" Section 1.9.6 of the RSG Contract.
1372. The remainder of the Claimants' particularized claims, i.e., post-Acceptance technical matters, are subsumed under Section 1.17.4 of the RSG Contract, which limits the Claimants' recovery to a breach of warranty claim.
1373. Accordingly, the Claimants' allegations of contractual breach relating to post-Acceptance technical matters are subsumed into the Warranty provisions of Section 1.17 of the RSG Contract while pre-Acceptance non-technical matters, such as non-payment of invoices and access to documents, are not subsumed.

C. WHICH PARTY OR PARTIES HAD DESIGN RESPONSIBILITY UNDER THE RSG CONTRACT? (ISSUE B.3)

1374. Issue B.3 concerns the question of which Party or Parties had the design responsibility under the RSG Contract.
1375. The Claimants submit that the Respondents had the design responsibility for SONGS, while the Respondents submit that the Claimants were heavily involved in the design process and established the main design variables.

¹⁴⁵⁵ The warranty period for discovery of Defects in the RSG Units commences upon Acceptance; Section 1.17.1.2.

(i) The Claimants' Position

1376. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi alone had design responsibility under the RSG Contract. The RSG Contract squarely allocates responsibility for “[e]ngineering and design” to Mitsubishi. Mitsubishi understood and accepted this responsibility, telling Edison weeks after Mitsubishi submitted its bid that “MHI is responsible for 100% of the RSG design.” Numerous Mitsubishi witnesses, including the President and CEO of MNES, as well as Mitsubishi’s engineers and consultants also recognized Mitsubishi’s contractual responsibility for the RSG design. Mitsubishi’s responsibility for the RSG design is consistent with Mitsubishi’s obligations as the N-Stamp Holder.”¹⁴⁵⁶
1377. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

The parties agree that Respondents alone had design responsibility under the RSG Contract and its applicable Codes (...) The evidence demonstrates that Respondents understood and accepted this responsibility.

Despite this clear contractual and ASME responsibility, Respondents have argued that Edison’s design specification limited their available design choices. This argument is belied by both the ASME Code and the RSG Contract. *First*, the ASME Code specifies that it is the role of the Owner (Edison) to furnish the N-Stamp Holder/designer (Mitsubishi) with “Design Specifications” that “contain sufficient detail to provide a complete basis for Division 1 construction or Division 2 design” Mitsubishi, as the N-Stamp Holder, was to “us[e] the Design Specification as a basis of design,” while also ensuring the “structural integrity” of its RSG design. Indeed, the ASME Code provides that the “requirement” of a “Design Specification” “shall not result in construction which fails to conform with the rules of this Section.” In other words, Mitsubishi cannot use the design specification to abdicate its responsibility as the designer.

Second, the RSG Contract provides that if Respondents (as the designer) determined that anything in the design specification could not be achieved or

¹⁴⁵⁶ Claimants’ Responses to Joint List of Issues, ¶ B.3.

risked introducing defects into the RSGs, Respondents were obligated to inform Edison and to request deviations from the RSG Contract. Respondents were well aware of their ability—and responsibility—to use the supplier deviation request procedure: “There were a fairly large number of deviations. I think we received maybe 100 supplier deviation requests.” ██████ testified that Respondents used supplier deviation requests to alter, among other things, the RSGs’ specified circulation ratio (a vital thermal-hydraulic parameter) as well as the various manufacturing tolerances. Respondents never suggested that complying with the specification or RSG Contract would create safety concerns or otherwise compromise the operation of the RSGs.

Respondents have also sought to shift design responsibility to Edison by noting Edison’s “intrusive involvement in the design process.” First, Edison’s involvement in the design process was consistent with its responsibility as the utility. Even if intrusive, the involvement of a customer (regardless of how many questions are asked or reassurances requested) cannot displace the ASME mandate that the designer (Mitsubishi) ensure the “structural integrity” of its design. Put simply, Edison’s “oversight did not relieve Mitsubishi of any responsibility for the design.” The RSG Contract, the ASME Code, and the parties’ course of conduct confirm that Respondents were “responsible for 100% of the RSG design.”¹⁴⁵⁷

(ii) *The Respondents’ Position*

1378. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Respondents do not dispute that under the RSG Contract Mitsubishi is the designer of record. However, as discussed in section B.4(a) below, the Edison design specifications set many of the basic parameters and design requirements.

Additionally, Respondents have raised the issue of Edison’s significant and intrusive involvement in the design process (in particular, the anti-vibration bar design) in order to demonstrate the fundamental conflict between Claimants’ current allegations of a careless design process undertaken by Mitsubishi and the undisputed record that Edison was actively and intrusively involved in that process at the time. In fact, Edison previously concurred in some of the very design choices that they now claim to be errors of Mitsubishi. The record in this matter unequivocally shows that Edison was satisfied, based on an active

¹⁴⁵⁷ Claimants’ RPHM, ¶¶ 94-97.

involvement and detailed review of design documentation, that Mitsubishi adequately discharged their responsibilities under the RSG Contract in accordance with applicable standards.

Mitsubishi also contends that the onset of in-plane FEI was the direct result of Mitsubishi achieving the tube-to-AVB gap and uniformity requirements specified by Edison and consistent with the then existing industry belief that a “zero” tube-to-AVB gap with no or small contact force was an effective means of mitigating tube-to-AVB wear.¹⁴⁵⁸

(iii) The Tribunal’s Determination

1379. There is no significant dispute between the Parties that the Respondents had the responsibility for the design of the RSGs under the RSG Contract and as a holder of an ASME N-Stamp.
1380. There is also no dispute that a number of the specifications for the design of the RSGs were established by SCE nor that SCE was involved in the design process.
1381. Moreover, both the ASME code and the RSG Contract assign design responsibility to MHI. Further, as an N-Stamp holder,¹⁴⁵⁹ MHI holds design responsibility. The Claimants cite to Section 3540 of the ASME Code regarding N-Stamp holders, which provides:

The N Certificate Holder has the responsibility for the structural integrity using the Design Specification as a basis of design, complying with this Section, and furnishing a Design report if required.¹⁴⁶⁰

1382. The RSG Contract also provides that “engineering and design” are responsibilities assigned to the supplier, i.e., MHI.¹⁴⁶¹

¹⁴⁵⁸ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 61-63.

¹⁴⁵⁹ An N-Stamp holder has a license to design and manufacture nuclear steam generators.

¹⁴⁶⁰ Exh. JX-872, p. 14.

¹⁴⁶¹ RSG Contract, Section 3.2.1.

1383. Accordingly, the Tribunal’s determination on Issue B.3 is that the Respondents had design responsibility under the RSG Contract.

1384. For greater clarity, the Tribunal notes however that the determination of this Issue B.3 is taken while noting that the Claimants nonetheless had an active role in the development of RSG specifications and in design choices, as further considered in Issue D below.¹⁴⁶²

D. IF AND TO THE EXTENT THAT MITSUBISHI WAS RESPONSIBLE FOR THE DESIGN, DID IT COMMIT DESIGN ERRORS AS ALLEGED BY CLAIMANTS? (ISSUE B.4)

1385. This Issue B.4 concerns the Parties’ disagreement as to whether the Respondents committed various design errors, as alleged by the Claimants.

(i) The Claimants’ Position

1386. In their Responses to Joint List of Issues, the Claimants, making reference to their submissions in their C-PHM, submit the following:

Mitsubishi’s design for the SONGS RSGs resulted in “secondary side thermal-hydraulic conditions” that “were beyond the envelope of successful industry experience,” as was cited by the NRC in its Lessons Learned Report. The parties agree that both Units 2 and 3 experienced in-plane and out-of-plane FEI.

Mitsubishi’s design errors stemmed from a several factors, including:

- Errors in its thermal-hydraulic codes (and Mitsubishi’s failure to realize and correct those errors).
- Lack of margin in the RSG design.
- Failure to identify and correct the Gap Velocity Error.

¹⁴⁶² Section XVI below.

- Errors in its analysis of random vibration.¹⁴⁶³

1387. In addition, in their C-RPHM, the Claimants contend that “[t]he material facts are undisputed. After a tube in Unit 3 leaked radioactive coolant, eight tubes failed in-situ pressure testing—an unprecedented occurrence in the U.S. nuclear industry—and all four RSGs were taken out of service. More than 3,400 tubes showed indications of severe wear after operating for just one cycle (or in the case of Unit 3, less than one cycle). The RSGs experienced four separate types of tube wear—including tube-to-tube wear in both Units. Such excessive wear, in such a short period of time, rendered the SONGS RSGs “the worst case degraded steam generator[s] in the history of domestic nuclear power.” Although Respondents’ manufacturing decisions played a role in the catastrophic failures of the RSGs, the principal cause, as discussed below, was the breadth and depth of the design errors committed by Respondents. Claimants note, however, that the existence of design errors is a condition sufficient to prove their claims for breach of contract and warranty, but not a necessary condition. To prevail on those claims, Claimants need only prove by a preponderance of the evidence that the RSGs did not conform to the RSG Contract.”¹⁴⁶⁴

(ii) *The Respondents’ Position*

1388. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

The “Issues” included in sections 4(a) through 4(f) have been acknowledged by Claimants to be “factual questions...intended to guide the Tribunal in determining whether Claimants have established breach of any or all of the numerous contractual provisions outlined in the memorials.” They should not accordingly be taken as specific allegations of breach of contract. Sections 6(a) through 6(e) represent the entirety of the specific contractual provisions

¹⁴⁶³ Claimants’ Responses to Joint List of Issues, ¶ B.4.

¹⁴⁶⁴ Claimants’ RPHM, ¶ 98.

Claimants contend to have been breached. Claimants are therefore limited to the specific contractual provisions they have pled. To the extent the issues in sections 4(a) through 4(f) form the factual basis of any element of Claimants' specific breach claims outlined in sections 6(a) through 6(e), it is Claimants' burden to demonstrate the appropriate nexus between Mitsubishi's conduct and the specific contractual provisions alleged to have been violated. Claimants have not done this.

In fact, Claimants have not attempted to establish the contractual basis for the issues in sections 4(a) through 4(f) at any point in these proceedings. So, even if the factual determinations in sections 4(a) through 4(f) are answered affirmatively, Claimants have failed to meet their burden to show that any or all of these purported design errors results in a breach of contract. As outlined below, Claimants have also failed to prove their alleged design errors as a factual matter.¹⁴⁶⁵

(iii) The Tribunal's Determination

1389. The Tribunal's determination as to whether the Respondents committed the various design errors that the Claimants allege is set forth in Sections XI and XII above.
1390. As held, the Claimants convincingly established that the Gap Velocity Error constitutes a material design error.¹⁴⁶⁶
1391. While the Tribunal determined¹⁴⁶⁷ that the circulation ratio as calculated by MHI is erroneous, the Tribunal does not consider that this miscalculation, to the extent that it may be considered a design error, resulted in any negative consequences on the design of the RSGs in general and in particular on tube stability ratios and the potential for FEI.
1392. To the extent that alleged further design errors are to be considered, the Tribunal's review is incorporated as needed into its analysis of the List of Issues.

¹⁴⁶⁵ Respondents' Position Statement on the Revised List of Issues, ¶¶ 64-65.

¹⁴⁶⁶ See Section XI.C(a) above.

¹⁴⁶⁷ See Section XI.A and see especially Section XI.A(d) above.

(a) **Did Mitsubishi fail properly to analyse the key design features of its RSG design? (Issue B.4(a))**

1393. This Issue B.4(a) concerns the question whether Mitsubishi failed to properly analyse the key design features of its RSG design, as alleged by the Claimants.

(i) *The Claimants' Position*

1394. In their Responses to Joint List of Issues, the Claimants submit the following:

Mitsubishi failed to appropriately and cumulatively analyze the following design choices it made when designing the SONGS RSGs:

- larger, more flexible tubes;
- greater number of more closely packed tubes;
- very little indexing;
- Fully tubed central region;
- greater resistance to flow in the tube support plate and downcomer design;
- more flexible U-bend with thinner, more flexible AVBs.

Each of the above parameters had the effect of increasing the thermal-hydraulic conditions and/or increasing the tubes' susceptibility to flow-induced vibration, which any competent (and experienced) designer would have known.¹⁴⁶⁸

1395. In addition, in their C-RPHM, the Claimants supplement the aforesaid submissions, in the following manner:

Beyond the various individual design errors (...), Respondents failed to appropriately and cumulatively analyze the design features it incorporated into

¹⁴⁶⁸ Claimants' Responses to Joint List of Issues, ¶ B.4(a).

the RSG design. Respondents made a series of non-conservative design choices that differed from the SONGS original steam generator (“OSG”) design and other large steam generators in the industry. Cumulatively, these decisions drove the unprecedented, never before seen thermal-hydraulic conditions exhibited by the SONGS RSGs. Specifically, the RSG design utilized:

- larger, more flexible tubes than the OSGs, which had “square bend” tubes. Square-bend tubes are stiffer than similar sized U-tubes, like those Mitsubishi chose for the RSGs. This change made the RSG tubes more susceptible to FIV.
- a greater number of more closely packed tubes than the OSGs. Respondents added 377 tubes to the RSG design. “The more tubes you have, the more thermal power you’re putting out, the more heat transfer, you will have higher void fractions in the U-bend.” “Mitsubishi’s RSG design had among the lowest P/D ratios (1.33) in the industry,” meaning the tubes were “pack[ed] . . . very close together.” The increased number and closeness of the RSG tubes led to increased velocities, increased void fractions, and greater risk of FIV.
- very little indexing. There was “significantly greater indexing in” comparable steam generators than in the RSGs, i.e., less “room for the fluid to get past the tubes in the U-bend in” the SONGS RSGs. “[T]he two effects [of this reduced indexing] are it increases velocity, it increases void fraction which increases the susceptibility to tube vibration and wear,” compared to the OSGs and other large replacement steam generators.
- a fully tubed central region. “The original Combustion Engineering-designed steam generators were supported on the bottom by a stay cylinder. . . . As a result there was a large area in the middle of the generator, a large circular area, which was untubed. And the effect of this was there was a large column of relatively cool water that did not pass through the bundle but went direct to the U-bend, and so you got an influx of cool water in the U-bend which acted to decrease velocities and particularly decrease void fraction in the U-bends. Most of the replacement generators designed for CE plants did not fully tube this central region;” Respondents did.
- greater resistance to flow in the tube support plate and downcomer design. The RSGs had smaller openings in the tube support plates than those in the OSGs and comparable designs. The RSGs “also had a very

narrow downcomer and higher flow resistance in the downcomer. These things promote low circulation ratio and high void fraction.”

- a more flexible U-bend with thinner, more flexible AVBs. The OSG tubes were supported in both the in-plane and out-of-plane directions by egg-crate supports, horizontal strips, vertical strips, and batwings,” while the RSGs used AVBs that “were the thinnest of any used in a steam generator.” The RSG support structure led to larger gaps, which in turn led to greater vibration and wear.

According to Dr. Gary Elder, Westinghouse’s former Chief Engineer, each of the above design choices had the effect of increasing the thermal-hydraulic conditions and/or increasing the tubes’ susceptibility to flow-induced vibration.

Respondents do not dispute that the SONGS RSG design incorporated these features, nor do they dispute the effects of these features. Instead, they argue that the above features “were well-proven modifications of a [Combustion Engineering] design.” Respondents point to the bids submitted by other vendors for the SONGS RSGs to substantiate this argument, but the bid documents are an inapt comparison. Bids are not designs ready for manufacture. They have not been fully analyzed, developed and vetted. Respondents, for example, point to the fully tubed central region in bids by Framatome and Dossan for SONGS but ignore that when replacing large Combustion Engineering steam generators, other designers—Babcock & Wilcox and Westinghouse—included non-tubed central regions in the final design. As Dr. Elder noted: “Had the other vendors fully developed their designs, they could have reached the same conclusion that Westinghouse did in designing the Waterford Unit 3 replacement steam generators and not fully tubed the central stay cylinder region.”

Taking another design feature, Claimants have shown that SONGS had the lowest indexing in the industry, which created small tube-to-tube gaps and drove up the crucial gap velocities at SONGS. SONGS indexing was half that of ANO-2 at the outermost rows and even greater towards the interior of the tube bundle. The effect of the lack of indexing compounds the other design choices made by Respondents such as the fully tubed central region (discussed above) as well as the greater number of more closely packed tubes, more flexible U-bend with thinner, more flexible AVBs, and others. At almost every turn, Respondents chose design features that would increase the flow velocities and decrease the amount of vibration-damping liquid water in the U-bend region of the RSGs.

As a result, Dr. Elder “would [have] expect[ed] the highest void fraction in the U-bend, the lowest circulation ratio, the highest velocities around the tube, and the greatest potential for tube vibration particularly in the U-bend.” When Respondents’ “results of the code . . . were the opposite,” Dr. Elder would “start questioning the adequacy of the code or how they were used. Something is wrong.” Dr. Asadi agreed: Mitsubishi’s design choices, as compared to the OSGs,

engineeringly show that you are making a hotter machine, you are making a machine, a steam generator, which is more powerful Compared to the [OSG,] . . . engineering judgment says that somebody should ask this question that, if the original design has a void fraction of ■ percent, now we are calculating a void fraction of ■ percent, what’s going wrong? What are we missing here?

In short, the evidence demonstrates that any competent (and experienced) steam generator designer would have understood that the design features Respondents incorporated into the SONGS design would lead to extremely high thermal-hydraulic conditions and resulting wear.

Respondents’ failure to properly analyze the key design features of the RSGs is perhaps not surprising in light of the fact that they gave the “responsibil[ity] for the design of the AVB assembly structure for SONGS” to ■■■■■ a novice engineer who had a complete lack of relevant experience. At the Hearing, ■■■■■ candidly admitted that prior to SONGS, he was not “involved in designing supports such as AVBs.” He had never “been consulted regarding what input values to use in the FIVATS [(stability ratio)] analysis,” never “evaluat[ed AVB] lay-out” options, “never done work related to the designing of the end cap, the retaining bar, the bridge or the retainer bar,” never worked on “controlling the gap between the AVB and the tubes,” and never “evaluat[ed] or analyz[ed] tube vibration problems as part of a design of a steam generator.” This is the individual Respondents put in charge of designing the support system for the largest steam generator it had ever designed and manufactured.

Respondents’ decision to task ■■■■■ with what it knew was a crucial aspect of the RSG design reflected their attitude that their previous “successful” designs could simply be “upsized” to fit SONGS. The only projects ■■■■■ had worked on had “approximately 3,000 tubes” per steam generator, as compared to 9,727 tubes in each of the SONGS RSGs. Indeed, after the failures, Respondents admitted that its “design process did not require . . . the comprehensive evaluation of the effects of individual changes and the cumulative effect of all changes” This lack of a design process

requirement, coupled with the inexperience of the engineer in charge of the AVB design and Claimants' expert testimony, provides conclusive proof that Respondents failed properly to analyze the key design features for the SONGS RSGs.¹⁴⁶⁹

(ii) *The Respondents' Position*

1396. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Mitsubishi properly analysed the key design features of the SONGS RSG design. Notwithstanding the lack of a specific contractual breach claim underlying this broadly stated issue, Claimants have not met their burden to show that Mitsubishi failed to properly analyse the key design features of the SONGS RSGs.

Claimants generally make two claims regarding this issue. First, Claimants argue that Mitsubishi erred in its design of the SONGS RSGs because the Mitsubishi design had larger, more flexible tubes arrayed in a U-bend configuration with flat-bar AVBs rather than the more rigid square bend arrangement of the Combustion Engineering ("CE") original steam generators ("OSGs"), a greater number of more closely packed tubes with a fully-tubed center region (which had not been tubed in the OSGs because of a center "stay cylinder" support for the tubesheet), and alleged greater flow resistance that allegedly resulted in lower circulation ratios due to the downcomer design and broached hole tube support plate ("TSP") design (instead of the OSG egg-crate design). Second, Claimants assert that if Mitsubishi had properly analysed the key features of the SONGS RSG design in light of comparable industry experience, and not, as alleged, relied solely on its computer code predictions, Mitsubishi would have realized that the SONGS' RSGs would have "extreme" T/H conditions. Claimants are wrong on both counts.

To start, the key design features that Claimants now contend to be design errors of Mitsubishi—no stay cylinder, more flexible tubes in a U-bend arrangement, flat-bar AVBs, broached TSPs—were, in fact, well-established features of the Westinghouse-style (U-bend) steam generators manufactured by many vendors, including Mitsubishi. The old CE-type square bend array that had been used for the SONGS OSGs had proven ineffective at preventing wear and Edison made a conscious decision not to adopt the CE-type OSG design. Instead, Edison requested the Westinghouse U-bend type design that was

¹⁴⁶⁹ Claimants' RPHM, ¶¶ 99-104.

considered to be the state of the art. In fact, the very design features that Edison now claims were contributors to alleged “extreme” T/H conditions were requested by Edison, and were well-proven modifications of a CE design. Unsurprisingly, then, the three nuclear component vendors for the SONGS project that Edison evaluated as having the highest combined technical scores (Framatome now AREVA, Mitsubishi, and Doosan) incorporated the same design features that Claimants now contend to be deficient. Framatome, Mitsubishi, and Doosan all proposed Westinghouse-style RSGs with a U-bend configuration, flat bar AVBs, no stay cylinder and broached hole TSPs.

Further, the T/H conditions that Claimants say were caused by Mitsubishi’s alleged failure to analyse the key design features were the direct and inevitable result of Edison’s design requirements. The Edison design specification required that the “[t]hermal capacity (heat transfer surface area) of each RSG shall be maximized within the limits imposed by the pertinent physical parameters specified in Table 3A-3.” This maximization of thermal capacity was to be accomplished at lower operating temperatures than the OSGs while using tubes made of Inconel 690 (which has lower heat conductivity than the original SG tube material). At the same time, the RSG Contract specified and limited the maximum physical size of the RSGs so that they would fit within the same physical envelope as the OSGs in order to satisfy 10 C.F.R. §50.59, and thereby avoid a potentially lengthy NRC licensing review by installing like-for-like replacements. As a result, the basic T/H parameters of the RSGs, which Claimants now allege Mitsubishi failed to properly analyse, were determined by Edison itself. And because, “the T/H conditions in the RSGs were driven by the [Edison] design specification,” only limited design features could be modified during the design and still meet Edison’s specification. The limited choices available to bidders on the SONGS project that desired to meet Edison’s specification is further confirmed by the fact that other bidders proposed substantially similar designs to the Mitsubishi design. For example, the design of the bidder that received the highest technical score from Edison, Framatome (now AREVA), had more tubes with the same tube pitch and essentially the same heat transfer area as did the Mitsubishi design, a lower recirculation ratio than the Mitsubishi design, and no stay cylinder (the same as the Mitsubishi design).

Additionally, and as outlined more fully below, the SONGS RSG T/H conditions were fully consistent with the T/H conditions of other large replacement steam generators for CE type nuclear plants, and thus cannot be considered “extreme” in terms of comparable industry experience. Indeed, during the design phase, Edison and Mitsubishi attempted to reduce the void fraction of the RSGs. But after evaluating potential changes to the design, all

of which “were considered to be drastic,” they found that little could be done to reduce void fraction without violating the constraints of the Edison design specification. This evaluation led Mr. Boguslaw Olech, Edison’s main engineer on the SONGS project and someone Edison failed to call as a witness, to conclude that “the design is close to optimum for all the important parameters.”

In short, even if the T/H conditions in the SONGS RSGs were “extreme” as repeatedly alleged by Claimants, they were the direct consequence of Edison’s requirements for the SONGS RSG design and not the result of Mitsubishi failing to properly analyse key design features. As stated by Mr. Paul Langford, whom Claimants hold out as an expert in vibration issues, given that “SCE wanted to replace something inside the same size envelope that would produce this amount of power,” it was “an obvious fact and constraint of life,” that the RSGs “would have extremely high void fractions.”

Moreover, Mitsubishi did properly analyse the design features of the SONGS RSGs that were “key” and necessary to prevent FEI, taking into account comparable industry experience. The most important design feature for preventing tube vibration, tube natural frequency, is controlled by the length of an unsupported tube span. Mitsubishi fully took this key design feature into account. During the design period, Mitsubishi added AVBs to its RSG design, which decreased the unsupported span length between adjacent AVBs, thereby increasing the tubes’ natural frequency and reducing the potential for tube vibration. With the additional set of AVBs, the SONGS RSGs had more AVBs than other large comparable RSGs for CE type plants.

Further, contrary to the Claimants’ assertion that Mitsubishi ignored relevant, comparable industry experience, as part of the joint AVB design team effort Mitsubishi and Edison collected operating experience related to tube vibration and wear from many large RSGs. This included information concerning the █████ RSGs, which were the U-bend steam generators closest in size and thermal loading to the SONGS RSGs. █████ had been operating for three cycles (four years) with little wear. Compared to the █████ RSGs, the SONGS tube spans were shorter and the tubes were stiffer. The shorter tube spans were the result of the fact that SONGS had a greater number of AVBs, providing more vibration margin. Mr. Langford noted in September 2005 that this comparison to █████ demonstrated “real” margin against tube vibration. Subsequent calculations performed by Messrs. █████ and Langford confirmed that the SONGS RSG tube vibration potential was approximately 60% of the vibration potential of the █████ RSGs, which Mr. Langford described as “most convincing that SONGS will perform better than █████” As discussed further in section B.4(b) below, this comparison was based on

first principles and was not dependent on any FIT-III (or ATHOS) T/H computer code calculations, which highlights another of Claimants' many fallacies in its argument. Contrary to Claimants' claim, Mitsubishi did not rely solely upon its computer code predictions to assure itself that the SONGS vibration design was acceptable.¹⁴⁷⁰

(iii) The Tribunal's Determination

1397. As a preliminary manner, the Tribunal is not convinced by the Respondents' assertions that the consequences of any design choices in this regard rest with the Claimants. As determined by the Tribunal in Section XIII.C(iii) above, and generally admitted by the Respondents in Section XIII.C(ii) above, the Respondents had the contractual responsibility for the design of the RSGs and the professional responsibility to do so as an ASME N-stamp holder.
1398. While it is not disputed that, on account of the Gap Velocity Error alone, the Respondents failed to accurately calculate velocities and void fractions, the Claimants have not established that the Respondents "fail[ed] to properly" analyze its design choices. To the contrary, the Tribunal finds that the evidentiary record supports the position that the Respondents were aware of issues regarding lower than expected velocities and void fractions, investigated those, and concluded that nothing was amiss. The record further supports that the Respondents took appropriate design steps, given such concerns, by both providing additional AVBs and configuring those AVBs in a 3 x 2V configuration in order to address T/H conditions and prevent FIV and/or FEI.¹⁴⁷¹
1399. The Claimants further submit that the Respondents failed to heed Mr. Langford's concerns regarding flow velocity.¹⁴⁷² However, the record shows that the Respondents investigated Mr. Langford's concerns regarding flow velocities.

¹⁴⁷⁰ Respondents' Position Statement on the Revised List of Issues, ¶¶ 66-73.

¹⁴⁷¹ See Section VII.D(e)(iv) above.

¹⁴⁷² Mr. Langford appeared at the request of the Claimants.

Following Mr. Langford's raising of his concerns, MHI investigated the issue and document its efforts in a chronology. The Claimants exhibit this chronology as proof that Mr. Langford's concerns were never resolved.¹⁴⁷³

1400. That chronology does not indicate that Mr. Langford's concerns were satisfied, as indeed the RSGs were designed with this Gap Velocity Error, but does indicate that MHI, SCE, Mr. Langford, and Mr. Wilson, the Respondents' consultant (who had similar concerns), were eventually satisfied that the potential wear consequences of the concerns were addressed in the totality of the RSG design and manufacturing processes. To recall, MHI's contemporary chronology, dated 24 March 2006, of efforts to address Mr. Langford's concerns states as follows:¹⁴⁷⁴

October 15 2005

On October 15, 2005, in advance of the #6 Design Review Meeting ("DRM"), which was scheduled for October 17, 2005 between MHI and SCE, Mr. Langford provided comments regarding the draft version of the "Design Review of Anti-Vibration Bar" presentation to MHI. In these comments, Mr. Langford noted that "the overall gap velocity distributions appear to be lower than my expectations." See Attachment 1 (showing Mr. Langford's comments).

October 18 2005

On October 18, 2005, attendees at the #6 Design Review Meeting reviewed a slide that showed that the work rate from the domestic SG was [REDACTED] that of the SONGS RSGs potentially because the SONGS fluid velocity appeared much lower than the fluid velocity of the domestic plant. Consequently, MHI generated Action Item 31. See Attachment 2 (providing the origin and text of Action Item 31).

¹⁴⁷³ Memorial, ¶ 133; Exh. JX-577.

¹⁴⁷⁴ See ¶ 306 above.

Action Item 31: "MHI to review the wear calculation and explain the reasons why the SONGS velocity and consequential wear calculations are so different than those for the domestic SG - 11/28/05."

November 29 2005

On November 29, 2005, in advance of the Technical Discussion Meeting ("TDM") which was scheduled for December 7, 2005, ██████████ sent a draft presentation to Mr. Langford and Mr. Wilson, among others. See Attachment 3 (showing this transmittal). Slide 31 of this draft presentation shows that MHI was at the time reperforming the SONGS wear calculation using the revised thermal hydraulic condition (FIT-III flow velocity distribution including the AVB peaking effect) in a more conservative condition (consecutive inactive supports and one-sided wear) in light of Langford's comments. See Attachment 4. This draft presentation did not, however, provide findings or conclusions regarding the resolution of Action Item 31. See Attachment 5 (including the full draft presentation as sent to Mr. Langford for his review).

December 1 2005

On December 1, 2005, Mr. Langford provided comments regarding the draft presentation to ██████████ and Mr. Wilson, among others. Mr. Langford noted that the extent to which the substance of slide 31 responds to Action Item 31 was unclear. The material which Mr. Langford reviewed was a draft and did not include the revised wear calculation. Mr. Langford suggested that MHI undertake a parametric study to determine the parameter that was responsible for the difference between the work rate in the domestic SG and the work rate in the SONGS RSGs. See Attachment 6 (providing Mr. Langford's comments regarding the draft presentation).

December 7 2005

Based on Mr. Langford's suggestion, MHI performed a wear calculation for both domestic SG and SONGS RSG and discussed the influential elements to the wear calculation by comparison. At the December 7, 2005 TDM, MHI presented the findings and conclusions of that study to SCE. MHI and SCE consequently agreed to close Action Item 31. See Attachment 7a (stating that MHI has reperformed the wear calculation),

7b (comparing the key wear-related parameters for the domestic plant and for SONGS), 7c (comparing the flow characteristics for the domestic plant and for SONGS).

February 21 2006

On February 21 2006, Mr. Wilson responded to an email from [REDACTED] and suggested that MHI develop a comparison of the wear potential between SONGS RSGs and [REDACTED] RSGs, which were successful RSGs at 2006, in order to demonstrate that SONGS RSG was in acceptable range of wear potential. See Attachment 8 (showing Mr. Wilson's suggestion). MHI consequently developed that comparison.

February 22 2006

On February 22, 2006, and in response to Mr. Wilson's suggestion, [REDACTED] sent a comparison of vibration potential between [REDACTED] and SONGS to Mr. Langford and Mr. Wilson, among others. See Attachment 9 (showing this transmittal) and Attachment 10 (showing a table that compares the vibration potential between [REDACTED] and SONGS). [REDACTED] noted that although MHI could perform wear depth analyses on the [REDACTED] SGs, that doing so is not necessary as the principles of engineering approach shows conclusively that SONGS has a lower potential for wear than does [REDACTED]

February 24 2006

On February 24, 2006, Mr. Langford provided comments regarding the table that compares the vibration potential between [REDACTED] and SONGS to [REDACTED] and Mr. Wilson, among others. Mr. Langford noted that it would be beneficial to compare SONGS and [REDACTED] using a single T/H code, i.e., either FIT-III or ATHOS, so as to allow a detailed comparison of wear potential among the SGs of those plants. See Attachment 11 (showing Mr. Langford's comments and outlining his revisions to the table as provided by [REDACTED] and Attachment 12 (showing the table with Mr. Langford's revisions).

Later that day, Mr. Wilson responded to Mr. Langford's comments, and noted that although he has doubts regarding the accuracy of FIT-III,

ATHOS, and PORTHOS, that he supports using those tools whenever possible. See Attachment 13.

February 28 2006

On February 28, 2006, and in advance of the TDM, which was scheduled for March 13, 2006 between MHI and SCE, Mr. Wilson provided comments on the table that compares the vibration potential between [REDACTED] and SONGS as revised by Mr. Langford to [REDACTED] and Mr. Wilson, among others. See Attachment 14.

March 4 2006

On March 4, 2006, Mr. Langford responded to Mr. Wilson's February 27, 2006 comments, noting that he would review them prior to attending MHI's internal meeting, which was scheduled for March 9 and 10, 2006. See Attachment 15.

March 9-10 2006

On March 9 and 10, 2006, MHI met with Mr. Langford and Mr. Wilson to discuss the content of the Technical Discussion Meeting, which was scheduled for March 13, 2006 between MHI and SCE. The attendees concluded that the comparison of vibration potential between [REDACTED] and SONGS was acceptable and that MHI should not perform an additionally-detailed analysis for the reasons that [REDACTED] provided on February 22 2006. They also concluded that MHI should focus its efforts on AVB fabrication and tube-bundle assembly.

March 13 2006

On March 13, 2006, MHI presented to SCE a comparison of the vibration potential of the SONGS RSGs to the [REDACTED] SGs. This comparison concluded that the vibration potential of the SONGS RSGs is 60% that of the [REDACTED] SGs. See Attachment 16a (providing a summary of the wear analysis evaluation), 16b (comparing the vibration potential between the SONGS RSGs and the [REDACTED] SGs), and 16c (providing the resolution of Action Items 30 and 31). Mr. Langford stated that this comparison provided convincing evidence that the SONGS RSGs would perform better than the [REDACTED] SGs. Mr. Wilson recommended that

MHI's effort be focused on the control of manufacturing variables to produce small, uniform gaps - rather than to expend excessive effort in performing vibration and wear analysis. See Attachment 17.

Based on these consultants' comments, MHI concentrated its efforts on the precise tube-to-AVB gap control after this meeting.¹⁴⁷⁵

1401. In light of the above, the Tribunal considers the following process was put in place: (i) an issue was identified in the design of SONGS; (ii) that issue was investigated; and (iii) a solution was adopted.
1402. Thus, while the Gap Velocity Error persisted, the Tribunal considers that the Respondents did "properly analyze" an element of a design that raised concerns.
1403. The Claimants have also identified that the Respondents failed to heed warnings from MHI's Consultant, Mr. Wilson, with regard to void fraction. To recall, in a 29 July 2005 e-mail, Mr. Wilson followed up on comparable plant data and reported that:¹⁴⁷⁶

The [REDACTED] RSG and the [REDACTED] RSG both have $\frac{3}{4}$ " tubes. The [REDACTED] tube pitch is 6% greater than that of [REDACTED]. Both of these tube bundles are approximately the same size and have similar circulation ratios. The [REDACTED] average-to-maximum void fraction difference is 7.5% while the [REDACTED] difference is 11%. This demonstrates that tighter tube packing causes the void fraction to be elevated. The larger SONGS RSG tube bundle has nearly twice as many tubes with the same tube spacing, yet the FIT-III average-to-maximum void fraction difference is almost the same (i.e. [REDACTED] Vs. [REDACTED]). This suggests that the number of tubes or size of the U bend does not significantly influence the maximum void fraction (according to FIT-III results). Therefore, for tube bundles with the SONGS tube spacing (1.0" triangular pitch with 3A" tubes) the average-to-maximum FIT-III void fraction difference is [REDACTED]. The average exit void fraction can be calculated using the [REDACTED] model based on the average exit quality. And the average exit quality is the inverse of the circulation ratio. So, the

¹⁴⁷⁵ Exh JX-577.

¹⁴⁷⁶ See ¶ 294 above.

maximum FIT-III void fraction can be estimated if the circulation ratio is known.¹⁴⁷⁷

1404. Mr. Wilson appears to have identified a discrepancy, in that the SONGS RSG average to maximum void fraction relationship for SONGS was nearly identical to that at Ft. Calhoun, while it had nearly twice the tubes than those at Ft. Calhoun. To recall, the void fraction relationship in question is that a higher number of tubes, all things being equal, should result in a higher void fraction. Mr. Wilson interpreted this data as indicating that this expected void fraction relationship was not actually a factor in increased void fraction, and not an indication of a potential problem with the FIT-III calculation of void fraction, as was later discovered following the Incident. Whether or not such interpretation was correct, the Respondents have shown that they did take Mr. Wilson's concerns regarding void fraction into account in developing the overall RSG design.
1405. With respect to the Claimants' witness Dr. Asadi's testimony that the OSGs had a void fraction of 98% (using ATHOS) such that the Respondents should have been on notice when FIT-III calculated a lower void fraction in a more powerful RSG, the Respondents submitted that this calculation was only done in the course of 2012, i.e., in hindsight, when void fractions calculations with ATHOS were undertaken.¹⁴⁷⁸ The Tribunal does not find that fault can be assigned to the Respondents for failing to design during 2003 through 2008, based upon information obtained in 2012. Only once data was obtained on the void fraction of the OSG would SCE and MHI have been on notice as to a potential concern with the void fraction data of the RSGs.
1406. Furthermore, with respect to the Claimants' general allegation of a lack of experience in the Respondents' designers, the Claimants submit that errors were more likely.

¹⁴⁷⁷ Exh. JX-453; See also Exh. JX-455.

¹⁴⁷⁸ Transcript, p. 3567; Exh. JX-1592.

According to the Claimants, a failure to analyze properly occurred on account of this lack of experience.

1407. The Tribunal is not convinced by these allegations. While the Claimants have demonstrated that the Respondents witnesses themselves did not have the entirety of the expertise required to design a steam generator, MHI employed engineers and scientists in addition to those who testified at this Hearing who were responsible for design elements of the RSGs.¹⁴⁷⁹ In addition, MHI retained various consultants to supplement its experience and to advise on its designs.
1408. In particular, the Tribunal is not convinced by the Claimants' efforts at demonstrating that MHI personnel lacked expertise outside their area of expertise. For example, the Claimants identify that ██████████ who testified for the Respondents, was the MHI individual responsible for AVB design but then submit he lacked experience in a number of areas, such as materials, structural strength, performance evaluation, etc.¹⁴⁸⁰ However, the Claimants have also identified that MHI employees ██████████ and ██████████ were responsible for materials, ██████████ ██████████ and ██████████ were responsible for structural strength, and ██████████ and ██████████ for performance evaluation.¹⁴⁸¹
1409. Furthermore, with respect to the Claimants' submission that the Respondents did not examine comparable plant data, there is no dispute that the Respondents did not, at the time in question,¹⁴⁸² conduct comparative analysis of void fractions and velocities between SONGS and other SGs, such as ██████████ as recommended by the Respondents' consultants Mr. Wilson and Mr. Langford in February 2006.¹⁴⁸³

¹⁴⁷⁹ See e.g. Claimants Daily Opening Presentation (1 April 2016), slides 3-4.

¹⁴⁸⁰ Transcript, pp. 3246-3247.

¹⁴⁸¹ See e.g. Claimants Daily Opening Presentation (1 April 2016), slides 3-4.

¹⁴⁸² Confidential Videotaped Deposition of Dr. Langford, p. 79.

¹⁴⁸³ Exh. JX-563; Exh. JX-567.

Rather, it appears that the Respondents conducted alternative analysis and elected to add additional AVBs to address these concerns.

1410. A number of additional items raised by the Claimants are addressed below.
1411. The Claimants have generally asserted that the Respondents failed to engage in cumulative analysis of design changes. This allegation is based upon version 0 of MHI's root cause analysis, which determined that:

The MHI design process did not require the systematic identification of operationally significant changes from the current design to the new design and require the comprehensive evaluation of the effects of individual changes and the cumulative effect of all changes to assure risks associated with the changes were understood and addressed.¹⁴⁸⁴

1412. The Respondents submit that this self-analysis is indicative of a lack of formal procedure for documenting cumulative analysis.¹⁴⁸⁵ In this regard, the Tribunal is convinced by the Respondents' position. A review of the design era documents demonstrates that cumulative effects were analyzed for various design choices. To the extent that this analysis could have been better documented or undertaken in a systematic way does not constitute a failure to analyze the design of the RSGs.
1413. Moreover, the Claimants submit that the Respondents had insufficient indexing of the tube bundle.¹⁴⁸⁶ Indexing refers to having additional tube spacing between tubes in the U-bend. In hindsight, the Claimants' submission that greater indexing could have been beneficial is convincing, as more space between the tubes may have minimized in-plane TTW. However, a review of the design era documents demonstrates that indexing of the tube bundle was discussed between MHI and SCE

¹⁴⁸⁴ Exh. JX-1447, p. 26.

¹⁴⁸⁵ Counter-Memorial ¶¶ 353-355.

¹⁴⁸⁶ See ¶¶ 1394 and 1395 above.

and that indexing of the tube bundle was implemented in the design. In any event, the Claimants' contention that the Respondents should have undertaken greater indexing falls short of evidence of a failure to analyze.

1414. In light of the above, there is no dispute that the Respondents incorrectly calculated flow velocities, nor that void fractions were, presumably, under-predicted. The present Issue is not whether the Respondents made any calculation errors, but rather, whether the Respondents failed to properly analyze for flow velocities and void fractions. In that regard, the evidence highlighted in the Tribunal's reasoning above and the design chronology set forth in generally in Section VII.D(e) above, and in particular in Sections VII.D(e)(ii) above(void fraction) and VII.D(e)(iii) above (velocities) shows that the Respondents did engage in proper analysis of these T/H conditions.

1415. Accordingly, the Tribunal answers Issue B.4(a) in the negative. MHI did not fail to properly analyze the key design features of its RSG design.

(b) Did Mitsubishi under-predict the thermal-hydraulic conditions, potential for tube vibration, and potential for tube wear in its RSG design? (Issue B.4(b))

1416. Issue B.4(b) concern the question whether Mitsubishi under-predicted the thermal-hydraulic conditions, potential for tube vibrations, and potential for tube wear in its RSG design.

(i) The Claimants' Position

1417. In their Responses to Joint List of Issues, the Claimants submit the following:

Mitsubishi's analyses to predict the thermal-hydraulic conditions (including Mitsubishi's use of FIT-III and its associate pre- and post-processors), potential for tube vibration, and potential for tube wear in the RSGs were flawed. The effect of these errors and flawed analyses was Mitsubishi's under-prediction of the thermal-hydraulic conditions, vibration, and wear in its RSG design.

Following the failures, in its August 30, 2012 Technical Evaluation Report, Mitsubishi itself stated: “it is *concluded* that the thermal-hydraulic conditions in the SG secondary side, namely high void fraction (steam quality) and high flow velocity, are the *main causes* of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs.” Before the failure, Mitsubishi represented that the RSGs had no potential to experience FEI, which all parties now agree occurred in Unit 2, in Unit 3, in-plane, and out-of-plane. FEI and random vibration caused four different types of tube wear on more than 3,400 tubes.¹⁴⁸⁷

1418. In addition, in response to the Respondents’ particularized submissions, the Claimants, in their C-RPHM, contend the following:

➤ ***Mitsubishi Under-Predicted Thermal-Hydraulic Conditions***

During design, Respondents relied on their proprietary code FIT-III to predict the void fractions and velocities within the RSGs. FIT-III predicted that the maximum void fraction would be [REDACTED] and that the maximum velocity, which varies by tube, would be approximately [REDACTED]. After the failures of the RSGs, Respondents switched to the much more widely used ATHOS code. Comparing the results of Respondents’ post-failure ATHOS analysis to their design era FIT-III analysis shows that Respondents greatly under-predicted the maximum void fraction (ATHOS yielded 99.6%) and under-predicted velocities by [REDACTED]. As Claimants demonstrated, the disparity between the FIT-III and ATHOS results stems from the many errors embedded in FIT-III, its preprocessor (SSPC), and its postprocessor.

In Respondents’ SSPC, Claimants’ experts identified three main errors:

- Friction Error. Respondents’ use of the [REDACTED] while “good for relatively low velocities, . . . can[not] be us[ed] . . . in the range” in which Respondents used it. It is “physically impossible.”
- Contractions Error. The contractions error involved “a transcription error or the use of a wrong equation.”
- Downcomer Turn Error. “Mitsubishi selected a mathematical formula that has no scientific basis . . . and tried to match [it,] best it could[,]” to experimental data. More “alarming[ly],” “[f]luid mechanics dictates that

¹⁴⁸⁷ Claimants’ Responses to Joint List of Issues, ¶ B.4(b).

. . . if you have a high width ratio, [the pressure loss coefficient] actually has to go to 1,” but Mitsubishi’s “scientifically incorrect extrapolation” trends to 0.

These errors caused Respondents to “calculate[] a circulation ratio that was erroneously high and a void fraction that was erroneously low.” Other than a conclusory statement that “[t]he errors alleged to occur in SSPC are . . . baseless,” Respondents do not meaningfully dispute the existence of these errors in their SSPC, which is consistent with Claimants’ position that “Mitsubishi accepts, to some degree, these errors.”

In addition to the conceded Gap Velocity Error, which caused Respondents to under-predict velocities (and therefore stability ratios) by a factor of 2.3, Respondents do not meaningfully contest the Porosity Error, by which FIT-III “uses a porosity that is greater than 1, which is simply physically impossible.” Respondents claim that their use of this physical impossibility “was not a mistake; this was a conscious choice” to account for indexing. As Dr. Kytömaa explained, however, “Mitsubishi’s methodology . . . [of] chang[ing] a porosity in one location to alter the flow distribution and void fraction distribution . . . is not how 3D codes work. You can’t go and change something over here and hope that that accounts for a change of geometry over there and captures the velocity distribution and void fraction. That is just bad physics.” Nor do Respondents point to a single contemporaneous document reflecting this “decision” to use a physically impossible value for porosity.

Respondents do dispute four of the FIT-III errors identified by Claimants.

- Drift Flux Gradient Error. Respondents admit they “did not include a drift flux gradient term in FIT-III.” This caused FIT-III to violate Newton’s Second Law of Motion. Respondents reply that ██████ commits this same error. Even if true, that another code commits the same error does not render FIT-III non-erroneous. As Dr. Lahey noted, failure to include the drift flux gradient term is “not an engineering judgment. It’s a fundamental problem with the conservation equation.”
- Velocity Directional Error. Respondents’ contention that Claimants are misreading Mitsubishi documents is belied by those very documents. Mitsubishi’s documents from both before and after the failures show that Respondents wrongly used only the in-plane component of velocity in their FEI analysis.
- Interfacial Velocity Error. Respondents argue that they did not use interfacial velocity for the RSG design. But this argument flies in the face

of the FIT-III Manual, which states that it follows the dictates of the JSME, which uses interfacial velocity.

- Two-Phase Pressure Drop Error. Respondents argue that Claimants' experts are "misread[ing] the FIT-III Manual" when they posit that FIT-III contains an extra two-phase multiplier. They argue the correct equation is contained in Chapter 8 of the Manual. Respondents' expert, Dr. Hibiki, admitted that Chapter 5 of the FIT-III Manual contains equations that include this error. Even if FIT-III uses the Chapter 8 equation, the presence of the conflicting equations in the FIT-III Manual establishes, at the very least, "huge problems with quality assurance."

Claimants have amassed powerful evidence that these four errors are present in FIT-III or its associated post-processor, and the difference in the velocity predictions of FIT-III versus ATHOS show that they exist.

The fact that Respondents had the opportunity to prove the non-existence of these errors by producing the FIT-III source code but chose not to do so strongly suggests that these—or other—errors are embedded in that source code. Indeed, not only did Respondents refuse to produce the FIT-III source code in this confidential arbitration, they also failed to produce a single witness with knowledge of the source code or even a witness who ran the FIT-III code in connection with the SONGS design.

Respondents further argue that it cannot be said that "Mitsubishi under-predicted the T/H conditions in the SONGS RSGs because the actual T/H conditions are unknown" and the values predicted by ATHOS are unsupported. While localized void fractions and velocities are not measured in operation, that does not mean that FIT-III is just as accurate as ATHOS (or other industry codes) or that the values produced by ATHOS are unsupported. Quite the contrary. The NRC found that "[o]ther independent code calculations, including an analysis by Westinghouse using their in-house modified version of ATHOS and an analysis by AREVA using their French code CAFCA4 showed similar thermal-hydraulic results (up to 4 times higher velocities than FIT-III) as those computed in the Mitsubishi ATHOS results," not FIT-III. In other words, there was better agreement among the non-FIT-III thermal-hydraulic codes as to the conditions in the SONGS RSGs, which demonstrates that the ATHOS values better reflect reality. Moreover, Dr. Lahey testified that the errors Claimants identified in FIT-III are not in ATHOS; this testimony was un rebutted.

This post-failure result cannot be surprising to Respondents, as it is consistent with the advice they received—unbeknownst to Edison—from their

consultants during the SONGS project. In comparing FIT-III results to measured data from the CLOTAIRE tests, Respondents' own consultant, Robert "Con" Wilson, noted "that where the answers were easy, all codes got them right, but where the answers were complicated—like in the U-bend, FIT-III was very far away from the data and most other codes came closer." FIT-III's outlier status in the CLOTAIRE experiments as well as in the post-failure analysis of the RSGs shows that FIT-III under-predicted the thermal-hydraulic at SONGS.

Respondents' invocation of the alleged "good agreement between FIT-III and [the 10 MW Freon] test results" does not alter this conclusion. Respondents used the 10 MW Freon test to "tune" FIT-III, "ma[king] adjustments to its . . . code to make it match the results of the . . . test the best they could." Such tuning is not validation—it is akin to retaking an exam with the answer key in hand.

Finally, Respondents' defense that all thermal-hydraulic codes operate with significant "uncertainties" fails to hold up to scrutiny. First, uncertainty cannot explain Respondents' gross under-prediction of velocities. ██████ testified that FIT-III has a "margin of uncertainty . . . of ██████" Even granting ██████ such "uncertainty," if Respondents predicted a maximum flow velocity of ██████ uncertainty provides a band of error between ██████ and ██████ for that tube. Maximum flow velocities at SONGS, however, were often closer to ██████ more than ██████ than Respondents predicted. Such massive under-prediction of flow velocities cannot be chalked up to uncertainty.

Second, under the RSG Contract and industry practice, code uncertainty is no excuse. Respondents were responsible for controlling the thermal-hydraulic conditions, regardless of uncertainties. In building components for nuclear power plants, responsible steam generator designers directly account for uncertainty by first understanding the bounds of that uncertainty and then adding margin to their design. The RSG Contract both defines and requires Respondents to utilize margin in its design. Numerous of Respondents' witnesses acknowledged the need for margin in steam generator design. If Respondents' proprietary codes produce such unpredictable "estimates," a competent, safety-conscious designer would have taken such uncertainty into account during design. As the NRC observed, Respondents did not do this, and "the SONGS replacement generators were not designed with adequate thermal hydraulic margin to preclude the onset of fluid-elastic instability."

Respondents' failures to predict the extreme thermal-hydraulic conditions are not inconsequential errors. Thermal-hydraulic conditions are crucial inputs for determining—and the drivers of—a tube's susceptibility to vibration, instability, and wear. Unlike at the Hearing, where Respondents sought to

obscure the connection between thermal-hydraulic conditions and resulting vibration and wear by injecting the concept of “excitation forces,” Respondents’ Tutorial clearly shows that flow velocities drive both random vibration and FEI. Further underscoring the link between thermal-hydraulic conditions and flow-induced vibration, Respondents’ ██████████ noted the interaction between thermal-hydraulic conditions and AVB design: “[I]t [i]s necessary for [a designer] to evaluate the thermal-hydraulic conditions predicted . . . in order to determine how the AVB assembly structure should be laid out.” Respondents’ failure accurately to predict the thermal-hydraulic conditions led directly to their failure to predict the extreme vibration and wear that occurred and caused the failures of the RSGs.

➤ ***Mitsubishi Under-Predicted the Potential for Tube Vibration and Wear***

Respondents’ design errors and mistakes led it to improperly and mistakenly promise that the RSGs had no potential to experience FEI. Both sides now agree that both in-plane and out-of-plane FEI occurred in Units 2 and 3. Putting aside the tube-to-tube wear that led to the leak, Respondents’ Dr. Begley classified the SONGS Units as “wear challenged” based solely on the “excessive” tube-to-AVB wear. Dr. Egan testified that the tube-to-AVB wear at SONGS alone was “among the highest, if not the highest, ever observed in the United States. Dr. Begley also told Edison after the failures that “the tube to tube wear degradation in Unit 3 makes it the worst case degraded steam generator in the history of domestic nuclear power.” In short, Respondents’ failure to predict the extreme thermal-hydraulic conditions led directly to their failure to predict the occurrence of FEI, which in turn led directly to severe, life-limiting tube wear that Respondents’ own experts admit was “excessive” and the “worst case” of degradation ever seen in the United States.

Respondents declare that “[w]hile many errors are alleged, from the Gap Velocity Error to the supposed two two-phase multipliers in FIT-III, these errors could only have impacted Respondents’ analysis of out-of-plane FEI. Unless Claimants link the out-of-plane FEI analysis to their damages, the alleged errors are of no legal consequence and cannot support a finding that Claimants’ damages resulted from Respondents’ gross negligence.” As an initial matter, Respondents purposefully set up a false construct. Respondents’ primary errors and the legal consequences flowing from those errors start with their defective thermal-hydraulic codes. The introduction of first-of-a-kind, off-the-charts thermal-hydraulic conditions led to stability ratios over 1.0 and, as a consequence, out-of-plane and in-plane FEI. Those forms of instability, in turn, caused destructive tube-to-tube and tube-to-support wear never before seen in the industry that proved life-limiting for SONGS. Furthermore, as

Respondents admit, the increased gaps caused by out-of-plane FEI creates the environment for in-plane FEI:

Mr. Schiller: Could I ask another question? This is sort of important. Somewhere else Mr. Langford testified before the Tribunal that there was out-of-plane FEI that occurred perhaps a couple of times and increased gaps, and that preceded the in-plane FEI. I think you've talked about that with us in your examination. Is that possible, what Langford is describing?

...

Dr. Begley: Well, yeah, at some point you get wear and gaps get bigger, then gap-limited FEI has to occur. So with the bigger gap sizes, yeah, it has to occur. And actually I said in my deposition the same thing. At some point it has to occur and has to be a bigger contributor. So you can get, yes, gap-limited FEI that contributes to the wear and then opens up gaps, and eventually you can get classic in-plane fluid elastic instability.

As discussed below, in addition to the fact that while Respondents' out-of-plane analysis was independently non-conservative and improper, the errors in the thermal-hydraulic codes flowed into the FIVATS stability ratio analysis, rendering it incapable of producing accurate results.¹⁴⁸⁸

(ii) *The Respondents' Position*

1419. In their Position Statement on the Revised List of Issues, the Respondents particularize the following contentions:

➤ ***Mitsubishi did not under-predict the thermal-hydraulic conditions in the SONGS RSGs***

Claimants have generally alleged that Mitsubishi under-predicted the thermal-hydraulic conditions in the SONGS RSGs, including circulation ratio, void fraction and velocity. Claimants have, in particular, focused heavily on the allegation that the SONGS RSGs had a maximum void fraction of 99.6% or 99.8% calculated by ATHOS, and thus "extreme" T/H conditions. But Claimants cannot establish that Mitsubishi under-predicted the T/H conditions in the SONGS RSGs because the *actual* T/H conditions in the SONGS RSGs are unknown. Claimants cannot establish that Mitsubishi under-predicted an

¹⁴⁸⁸ Claimants' RPHM, ¶¶ 105-118.

unknown. The actual circulation ratio, void fraction, or velocity at SONGS may be consistent with the values predicted by SSPC and FIT-III.

But Claimants have ignored the actual T/H conditions in the SONGS RSGs and instead relied on output from a modified SSPC and the ATHOS code to try to establish the purported “actual” thermal-hydraulic conditions at SONGS. But in order to do so, Claimants also ignore the fact that none of these codes are established to be accurate. In fact, as Dr. Hibiki testified, the accuracy of the original SSPC, before Exponent’s modifications, was approximately [REDACTED] [REDACTED] Exponent failed to establish that its modified version of SSPC would be more accurate. Exponent in fact did nothing to validate the accuracy of its modified code and admitted at the hearing that it did not have the information necessary to determine the circulation ratio for SONGS, leaving it uncertain how Exponent could have any faith in the accuracy of its own predictions.

Claimants also failed to support the values predicted by ATHOS. Claimants’ experts Exponent admitted at the hearing that they did not attempt to “quantify” the accuracy, that is the bias or the uncertainty, of the ATHOS code. While Claimants have ignored the accuracy of the code upon which they base their allegations, Respondents offered undisputed evidence showing that the accuracy of both ATHOS and FIT-III is comparable [REDACTED] of the actual void fraction value). Respondents also offered evidence that ATHOS tends to over-predict void fraction, more so than FIT-III. This is confirmed with multiple pieces of validation data in the record that shows both ATHOS and FIT-III to be approximations with roughly the same band of uncertainty. As can be seen by the results of the CLOTAIRE test comparisons, codes such as FIT-III and ATHOS often produce different results, and rarely match the actual, measured conditions that they are meant to predict.

Predictions made utilizing the ATHOS code tend to vary widely based on the choices made by the user of the code. This is illustrated by the fact the various users of the ATHOS code came up with different predicted T/H conditions for SONGS when running the same code with Claimants using the highest value as the maximum void fraction as the “true” value for the purposes of their allegation that Mitsubishi under-predicted void fraction.

Claimants have attempted to show that ATHOS is more accurate than FIT-III by alleging that FIT-III contains a variety of errors that purportedly resulted in FIT-III under-predicting the T/H conditions. Not only does this argument exalt ATHOS to a level unsupported by the evidence, when compared against measured test data FIT-III is able to predict void fraction and velocity well. Graphs comparing ATHOS and FIT-III to velocity measurements from the 10 MW Freon test show good agreement between FIT-III and the test data, and

good agreement can also be seen in the void fraction comparisons. This clearly demonstrates that FIT-III doesn't have a tendency to under-predict T/H conditions, leaving no room for Claimants' alleged errors to serve as evidence that FIT-III is less accurate than ATHOS.

The FIT-III errors alleged by Claimants' experts are also simply wrong. Of the six FIT-III and FIT-III post-processor "errors" alleged by Exponent (and repeated by Dr. Lahey), Exponent admitted that it was unable to quantify the impact of five of the alleged errors. The only alleged error that can be quantified is the communication issue over the use of the correct gap velocity. However, that was not an error in FIT-III, as Claimants' experts had to ultimately admit and it had no impact on the RSG design as discussed below. During the hearing, Respondents also demonstrated that in order to try to manufacture errors in FIT-III where none existed, Claimants' experts had to ignore industry practice, ignore documents in the record, and misread the FIT-III manual.

➤ ***Mitsubishi correctly predicted that there was no tube vibration potential (due to out-of-plane FEI) in the SONGS design***

As discussed in sections B4(c) and (e), Mitsubishi predicted tube wear and vibration in accordance with industry practice. As noted in the hearing, Mitsubishi did use incorrect gap velocities in FIVATS (using the wide gap velocity instead of the narrow gap velocity) when determining SR to predict vibration (specifically out-of-plane FEI) at the time of design. But even using the FIT-III corrected gap velocities (or even the ATHOS gap velocities), the out-of-plane SR were still well below 1.0 with all supports active. Mitsubishi accordingly would not have predicted vibration in the form of FEI or changed the design had it known of the Gap Velocity Error, meaning this communication error had no impact on the RSG design.

Mitsubishi also accurately predicted the potential for FEI at the time of the design by using a basic first principles analysis. Mitsubishi and its consultant, Mr. Langford, performed a first principles analysis to establish the adequacy of the design without relying on any 3D analysis such as FIT-III. This first principles approach was not unlike the industry's original steam generator designs which were designed without the help of 3D computer codes and operated to prevent Mitsubishi from being overly reliant on computer modelling that contains inherent uncertainties. As a result of this first-principles comparison, Mitsubishi and Mr. Langford determined that the SONGS RSGs had 61% of the instability potential of the ██████████ RSGs, as discussed with Edison in March 2006. The value of this macro-type comparison was proven when it was later compared with the results of 3D

analysis conducted post-leak using ATHOS. A Westinghouse analysis of the █████ RSGs assuming one ineffective support resulted in a peak SR of █████ while a post-leak Westinghouse analysis of the SONGS RSGs, also assuming one ineffective support, produced a maximum SR of 1.0. Comparing the two Westinghouse analyses indicates that the SONGS RSGs had approximately 67% of the relative instability potential of the █████ RSGs. This is substantially the same instability margin as determined in the macro-level analysis performed at the time of the design.¹⁴⁸⁹

(iii) The Tribunal's Determination

1420. As a preliminary matter, the Tribunal recalls that its determinations as to the alleged design errors, which would result in an incorrect prediction of the thermal-hydraulic conditions, are set out in Sections XI and XII above.
1421. The Parties disagree as to their approach to this Issue. The Claimants assert that T/H conditions, tube vibration and tube wear were worse than expected in the RSGs. The Respondents rebut that there is uncertainty in the calculation of T/H conditions and that they did correctly predict that out-of-plane FEI would not occur.
1422. There is both calculation and measurement uncertainty in the use of any thermal hydraulic code or bi-optical probe. The Tribunal considers it pertinent to briefly set forth the evidence on these issues.
1423. An early bi-optical probe was developed in or around the 1980s.¹⁴⁹⁰ █████ one of the Respondents' experts, developed a bi-optical probe between 1992-2000¹⁴⁹¹ and published a paper on its use in 1996.¹⁴⁹² He has indicated that in measuring void

¹⁴⁸⁹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 74-81.

¹⁴⁹⁰ Transcript, p. 310.

¹⁴⁹¹ Expert Witness Statement of █████ ¶ 61; Rebuttal Expert Witness Statement of Dr. Hibiki, ¶ 35; Exh. JX-143.

¹⁴⁹² Exh. JX-143.

fractions the probes have a standard deviation of 5% and for velocity a standard deviation of 6.9%.¹⁴⁹³

1424. During the Hearing, the Claimants' expert Dr. Kytömaa, from Exponent, illustrated the function of a bi-optical probe.¹⁴⁹⁴ Dr. Kytömaa explained that the probe measures the steam/water mixture using light refraction and calculates velocities by having two optical probes at different distances.¹⁴⁹⁵
1425. The Claimants' expert Dr. Lahey has opined that while bi-optical probes "work reasonably well for bubbly/slug flows, and even froth flows,¹⁴⁹⁶ they cannot be used for the annular flow regimes associated with void fractions greater than (...) 80% because the interfaces of the small liquid droplets, and any waves in the flow regime, do not easily penetrate the probe tips."¹⁴⁹⁷ In rebuttal, the Respondents' expert Dr. Hibiki opines that Dr. Lahey's opinion dates to his 1981 paper on the issue, but that the bi-optical probe developed by ██████████ around 1996 is indeed reliable for annular flow regimes.¹⁴⁹⁸ During the Hearing, MHI's expert ██████████ testified that he has demonstrated and used his bi-optical probe to validate void fractions of up to 87% in annular flows, and that therefore calculations of void fraction up to ██████████ using FIT-III can be accurate.¹⁴⁹⁹ ██████████ has opined that as void fractions between ██████████

¹⁴⁹³ Expert Witness Statement of ██████████ ¶ 22; Expert Report of Dr. Blandford, ¶ 62 (Dr. Blandford indicates that in a 2001 paper by ██████████ et. al., it was explained that "the measurement accuracy of the bi-optical probes for void fraction measurement is $\pm 10\%$ ").

¹⁴⁹⁴ Exh. JX-2280.

¹⁴⁹⁵ Transcript, pp. 309-310; See also Expert Report of Dr. Blandford, ¶ 46.

¹⁴⁹⁶ "Froth flows" are the same as "churn flows" (See Expert Witness Statement of Dr. Lahey, ¶ 37).

¹⁴⁹⁷ Expert Witness Statement of Dr. Lahey, ¶ 55.

¹⁴⁹⁸ Rebuttal Expert Witness Statement of Dr. Hibiki, ¶¶ 35-36.

¹⁴⁹⁹ Transcript, pp. 3432-3435; Exh. JX-2299.

have the same “laminar flow” patterns, they have the same characteristics, thereby justifying this extrapolation.¹⁵⁰⁰

1426. Whether this extrapolation is proper is in dispute between the Parties. Further, whether it was reasonable for Respondents to have done so during the design of SONGS is further in dispute, given that confirmation that this may be reasonable was only obtained following the 2011 publication of an Oklahoma state research paper that analyzed prior research into this question.¹⁵⁰¹
1427. The existence of uncertainty, and specifically uncertainty as to whether ATHOS or FIT-III or any other code is closer at calculating the actual void fractions, is however, not determinative of this Issue.
1428. Regarding T/H conditions, the Respondents admit that they under-predicted flow velocities in the RSGs.¹⁵⁰² As for void fraction, the Tribunal considers that while the FIT-III calculated void fraction would presumably be higher but for the Gap Velocity Error, it is unknown whether or not the actual void fraction was under-predicted or not on account of the challenge of measuring high void fractions. The evidence does, however, support the conclusion that the Respondents may have adopted different design choices, such as additional AVBs, had a higher void fraction been calculated.¹⁵⁰³
1429. What is evident is that the T/H conditions, both void fractions and velocities, were at such a level that they caused in-plane FEI (in combination with inadequate in-plane support). This is evidenced by the Respondents’ own contemporary investigations,

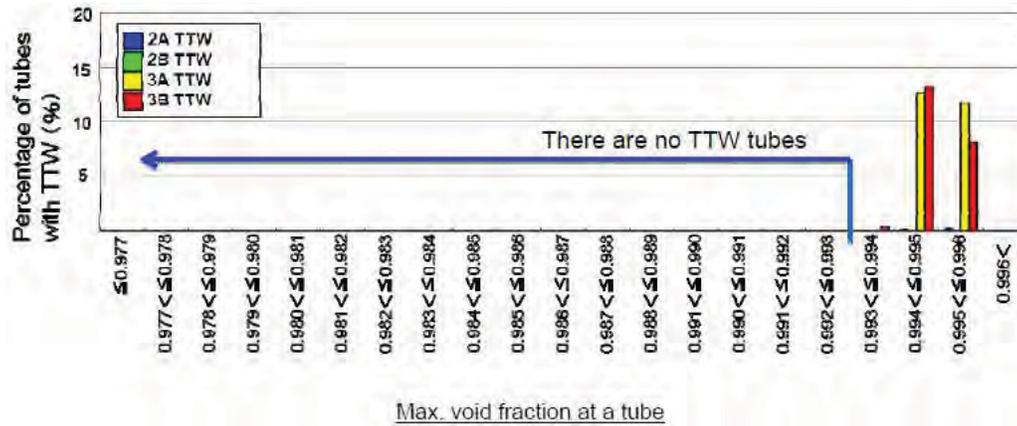
¹⁵⁰⁰ Transcript, p. 3420.

¹⁵⁰¹ Transcript, pp 3492-3493.

¹⁵⁰² See Counter-Memorial, ¶ 322.

¹⁵⁰³ Exh. JX-1114, p. 28.

during the repair era, identifying that in-plane FEI occurred above certain velocities and void fractions:¹⁵⁰⁴



1430. What is equally evident is that tube vibration and associated wear at SONGS occurred. While wear is expected in large steam generators, in-plane FEI wear was not expected, based on industry standards at the time of the design.¹⁵⁰⁵ Further, the Respondents admit that the Gap Velocity Error inevitably resulted in increased vibrations and wear, as velocity and vibration are positively correlated.¹⁵⁰⁶

1431. Accordingly, the Claimants have convincingly established that MHI did under-predict the thermal-hydraulic conditions, potential for tube vibration, and potential for tube wear in its RSGs.

¹⁵⁰⁴ Exh. JX-1087, pp. 54-56; See also Exh. JX-1734, p. 16, Exh. JX-1471, p. 21 (Exh. JX-1471, p. 43 has a similar table for tube-to-AVB wear).

¹⁵⁰⁵ See ¶ 496 above.

¹⁵⁰⁶ Respondents’ Tutorial, p. 38.

(c) **Did Mitsubishi fail properly to analyze for out-of-plane fluid elastic instability? (Issue B.4(c))**

1432. Issue B.4(c) concerns the question whether Mitsubishi failed to properly analyze for out-of-plane fluid elastic instability.

(i) *The Claimants' Position*

1433. In their Responses to Joint List of Issues, the Claimants submit the following:

The Gap Velocity Error, which Mitsubishi admits, resulted in the under-prediction of all of the out-of-plane SR that it presented to Edison by a factor of 2.3. These design era SR, when corrected for Mitsubishi's admitted error, *predict* the very out-of-plane FEI that occurred at SONGS.

Significantly, Mitsubishi itself admits that there was out-of-plane FEI in the RSGs:

- “[T]here was the occurrence of gap-limited out-of-plane FEI” in Unit 2. [Y]ou had the occurrence of gap-limited out-of-plane fluid elastic instability” in Unit 3.
- “I think that there was some contribution from gap-limited FEI” in Unit 2. “I think that there was some contribution of gap-limited FEI to the wear in the out-of-plane direction for Unit 3.”
- “[T]here is an effect from out-of-plane gap-limited FEI” in either Unit 2 or Unit 3 at SONGS.
- “I believe also that there is always an appreciation that there is likely to be some level of gap-limited FEI in every steam generator.”¹⁵⁰⁷

1434. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

¹⁵⁰⁷ Claimants' Responses to Joint List of Issues, ¶ B.4(c).

Respondents attempt to walk back from these admissions in their Post-Hearing Memorial by again claiming that out-of-plane FEI in the “classical sense” did not occur at SONGS. “Classical” FEI vs. “gap-limited” (or “amplitude-limited”) FEI is a false distinction which has no basis in Respondents’ own contemporaneous design documents. First, FEI is FEI, no matter what qualifier Respondents now choose to use. Indeed, the parties agree:

- Instability (no matter what you call it) should be avoided;
- Instability (regardless of qualifier) is predicted by a single calculation (Connors equation), which produces a stability ratio;
- Instability (regardless of qualifier) occurs when the stability ratio exceeds 1.0;
- Stability ratios must be less than 1.0 assuming one ineffective support; and
- Stability ratios should be kept below 0.75—or even 0.5—to ensure a safety margin.

Simply put, tube instability is a singular phenomenon that occurs at a stability ratio greater than 1.0. Once a tube goes unstable, it will hit an object—either a tube or a support such as an AVB. What the unstable tube ultimately hits is the only difference between Respondents’ post hoc distinction between “gap-limited” FEI and “classical” FEI. Respondents do not dispute that the underlying phenomenon is the same and occurs once the stability ratio exceeds 1.0. Second, Respondents’ arbitration position requires them to disclaim, ignore, and contradict their own design documents. Those design documents do not draw a distinction between forms of FEI and instead promise to avoid all FEI.

Moreover, the occurrence of out-of-plane FEI should not be surprising. It was the natural consequence of Respondents’ layers of design failures. In addition to the impact of their thermal-hydraulic errors on their FEI analysis, Respondents also made independent errors in analyzing for FEI. As Dr. Asadi testified, Respondents’ inputs to their stability ratio analysis were inappropriate. Specifically, Respondents relied on unacceptably high values for damping and the K factor, thus overpredicting tube stability, i.e., Respondents’ non-conservative inputs (completely divorced from the actual design decisions they were making for the SONGS RSGs) predicted artificially low stability ratios. Respondents failed to analyze tubes in the area of the highest thermal-hydraulic conditions, used a stability ratio threshold of 1.0, and dismissed the

case they ran with the most appropriate inputs as “too conservative.” Had Respondents utilized the correct inputs, they would have realized their design was unstable and reconfigured it, as Dr. Asadi testified B&W did with its design for the China Project. The cumulative effect of Respondents’ errors is RSGs that Respondents promised to last 40 years failed after only 11 months of operation.

Despite the overwhelming proof of numerous errors in Respondents’ design era FEI analysis, supported by clear, credible testimony from Claimants’ experts, Respondents only admit one: the Gap Velocity Error. Assuming *arguendo* that the Gap Velocity Error were the only error Respondents made during design—an assumption which Drs. Morse, Kytömaa, Lahey, Elder, and Asadi have thoroughly disproven—it is still evident that Respondents failed to properly analyze for out-of-plane FEI. The admitted Gap Velocity Error resulted in Respondents under-predicting all out-of-plane stability ratios by a factor of 2.3. When correcting for just this error (and none of Respondents’ other thermal-hydraulic or vibration errors), out-of-plane stability ratios in all four of their design test cases are over 1.0, assuming one ineffective support.

Stability ratios greater than 1.0 (predicted when each of Respondents’ four design era test runs are corrected for the Gap Velocity Error) violate Respondents’ own design requirements, acceptance criteria, and promises to Edison. Further, Respondents’ design era stability ratios, when corrected for Respondents’ admitted velocity error, predict the very out-of-plane FEI that occurred at SONGS. Respondents’ expert Dr. Au-Yang said it best: “Now you say, if I correct this [gap velocity] factor, then these tubes should be unstable. According to this calculation, yes. According to MHI’s definition.” In light of this prediction of instability, Dr. Kytömaa testified that Respondents should have “gone back to the drawing board to change the design and then re-initiate the analysis process.” Respondents’ own witnesses testified that, with stability ratios greater than 1.0, Respondents:

- Should have considered calculating stability ratios for more than just nine tubes;
- Should have investigated every other potential error (including the errors identified by Drs. Kytömaa, Morse, and Lahey);
- Should have informed Edison;
- Should have realized the design was inadequate; and
- Should not have shipped the RSGs.

Despite this damning testimony from their own witnesses, Respondents still tell the Tribunal that Respondents “would not have . . . changed the design had [they] known of the Gap Velocity Error.”

Respondents attempt to invalidate the consequences of the corrected stability ratio analyses by contradicting a number of their own design era documents. For example, Respondents’ arbitration filings boldly changed the name of two of their design era stability ratio cases from “Actual Case 1” and “Actual Case 2” to “Conservative Case 1” and “Conservative Case 2” in an attempt to make it seem like their own design stage analysis should not have been relied upon. Accordingly, while Respondents told Edison during design that these inputs represented an “Actual” scenario, they tell the Tribunal almost 10 years later that this is a “Conservative” case by misleadingly altering text from their own documents.

Respondents also claim that the assumption of one ineffective support when performing their FEI analysis for SONGS was only done during design for purposes of a “wear analysis.” That newly conjured explanation is belied by the very design documents that Respondents prepared and gave to Edison back on the job—Respondents’ unambiguous definition of out-of-plane FEI during design included stability ratios over 1.0 with one ineffective support. Respondents provided that definition to Edison and specifically promised to prevent that result. Indeed, this was Respondents’ own “acceptance criteria,” “design requirements,” and “design criteria,” which Respondents promised would “[p]revent[] . . . FIV failure” and “[a]void fluid elastic instability”—without qualifier. Furthermore, calculating stability ratios assuming one ineffective support is what Respondents now claim is done to analyze for “gap-limited” FEI. Accepting Respondents’ position as true, this can only lead to one logical conclusion: Respondents calculated for what it now calls “gap-limited” FEI during design and incorrectly assured Edison there was “no potential” for it.

Respondents also attempt to invalidate the importance of the corrected stability ratios by relying on Westinghouse’s 2012 analysis, stating that Westinghouse “concluded that even assuming one ineffective support, all SONGS stability ratios were less than or equal to 1.0.” As Dr. Morse testified, Westinghouse’s calculation was performed still using the incorrect circulation ratio of 3.3—if it had used the correct circulation ratio of 2.9, the stability ratio would have been above 1.0. Regardless, Westinghouse concluded that some tubes at SONGS had as many as 12 ineffective supports. With 12 ineffective supports, Westinghouse calculated a stability ratio of 9.00. Therefore, Respondents’ reliance on Westinghouse’s 2012 analysis of stability ratios with one

ineffective support is erroneous and misleading and actually undermines Respondents' position.

Respondents further argue that the Tribunal should overlook the misprediction and eventual occurrence of out-of-plane FEI at SONGS because most of the tube-to-AVB wear was caused by random vibration. First, the gap data refutes Respondents' contention:

- The design era feeler gauge measurements support the conclusion that large tube-to-AVB gaps existed in the RSGs from the beginning.
- Dr. Begley testified that “gap-limited” out-of-plane FEI creates bigger gaps over time.
- AREVA's post-failure measurements show that tube-to-AVB gaps increased toward the region in the U-bend that experienced tube-to-AVB wear.
- Dr. Begley testified that, if wear is observed where gaps are large, it is due predominantly to gap-limited FEI.

Therefore, by Dr. Begley's own testimony, Respondents' own measurements, and AREVA's independent measurements, out-of-plane FEI was the predominant cause of the tube-to-AVB wear at SONGS—not random vibration.

Second, Dr. Egan testified that even assuming random vibration caused all the support wear and that tube-to-tube wear ceased to occur, support wear alone would have caused the RSGs to fail in 0.6 years for Unit 3 and 3.3 years for Unit 2. Accordingly, even if this destructive wear was caused solely by random vibration as Respondents claim, the RSGs would have fallen far short of a 40-year operating life. Regardless, Respondents' attempt to make the Tribunal play an apportionment game to discover what phenomenon—random vibration or out-of-plane FEI—caused more tube-to-AVB damage is nonsensical and immaterial. Respondents promised Edison that they would “minimize vibration-induced tube wear or fatigue in the tube bend area of the tube bundle” and “address flow-induced and turbulence-induced vibration [random vibration] . . . to demonstrate that . . . wear of the tubes will not occur”—things

Respondents admit they did not do. For the foregoing reasons, Respondents failed to properly analyze for out-of-plane FEI during design.¹⁵⁰⁸

(ii) *The Respondents' Position*

1435. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have failed to demonstrate that Mitsubishi committed a design error by failing to properly analyze for out-of-plane FEI. First of all, out-of-plane FEI *did not occur* in the SONGS RSGs. This fact makes Claimants' allegations regarding Mitsubishi's analysis of out-of-plane FEI entirely irrelevant to these proceedings. Moreover, out-of-plane FEI would not have been predicted to occur at the time of the design even had Mitsubishi used ATHOS, narrow-gap velocities, and a lower circulation ratio. Even Westinghouse, using its own tools *after the leak occurred*, did not conclude out-of-plane FEI would have occurred in the SONGS RSGs. Only Exponent was able to "predict" out-of-plane FEI at SONGS by assuming one ineffective support. This is an inappropriate assumption in conflict with industry practice; Exponent's analyses stand for the proposition that *Exponent* failed to properly analyze for out-of-plane FEI, not Mitsubishi.

➤ ***Out-of-Plane FEI did not occur***

The physical evidence, that is the wear experienced by the SONGS RSGs, simply does not support a conclusion that out-of-plane FEI occurred. Classic instability "has a rapid onset" that "quickly leads to destructive wear" with tube failure within "a few days to a few months." Even Claimants' experts have acknowledged that FEI is defined as a "large amplitude vibration of the tubes in a steam generator, *resulting in destructive wear in a very short amount of time.*" Therefore, as stated by the NRC, FEI cannot be managed; the timeframe associated with the phenomena is "too short and too unpredictable" and tube failure can occur too quickly. As Edison admitted in its Root Cause Evaluation, this does not fit the description of the wear at SONGS that was not otherwise generated by in-plane FEI ("non-tube-to-tube wear").

FEI results in destructive wear in a short period of time because it is characterized by large amplitude vibration that results in high energy tube-to-tube impacts and rapid tube-to-tube wear. In contrast, tube-to-AVB impacts caused by fluid elastic excitation are characterized by much smaller amplitude

¹⁵⁰⁸ Claimants' RPHM, ¶¶ 119-128.

vibration and impact energy. As Dr. Begley described at the hearing, the force caused by fluid-elastic excitation is proportional to the distance travelled by the tube before it contacts another object, while the energy generated is proportional to the square of that factor. A tube typically travels 250 mils (or 0.25 inches) before it impacts another tube, while a tube may only need to travel 5 mils (0.005 inches) before contacting an AVB. As a result, tube-to-tube contact generates 50 times the force of tube-to-AVB contact, and 2500 times the energy. Put another way, the presence of the AVB halts the motion of the tube, reducing the impact force by 50 times and the impact energy by 2500 times. The resulting tube-to-AVB wear is manageable, whereas the high energy tube-to-tube impacts and rapid wear are not. Thus, tube-to-AVB wear cannot be indicative of classical instability, but rather it's an indication that the AVB is working. As Westinghouse notes, "classical displacement cannot happen in the U-bend as the tubes would close the gaps between AVBs and prevent large displacements."

Thus, classic FEI is characterized by tube-to-tube contact, not tube-to-AVB contact. At SONGS there was no tube-to-tube contact or tube-to-tube wear in the out-of-plane direction, thus there was no out-of-plane FEI. As Westinghouse put it, "the out-of-plane excitation ratios [SR with ineffective points] above 1.0 are gap-limited and are not unstable in the classical sense. ... the out-of-plane vibration can be classified as a rattling of the tube."

➤ ***Mitsubishi would have not predicted out-of-plane FEI***

Claimants conflate classic instability with this rattling of the tube to allege that out-of-plane FEI occurred. The rattling, known as gap-limited fluid elastic instability (or excitation in the Westinghouse report), is an "unavoidable" phenomenon with unremarkable consequences, that in some instances may only "polish" the tube. As described above, the presence of an AVB halts the motion of the tube, limiting the energy and force of the tube movement, precluding the development of classical FEI. Because the AVB has this beneficial effect, its presence is taken into account when analysing actual tube instability. Nonetheless, Claimants now contend that Mitsubishi should have assumed that the AVB was not physically present when calculating SR for out-of-plane FEI. Indeed, when Exponent assumed that one support was "ineffective" for each of its SR analyses, it was assuming that the support was non-existent. But this assumption clearly does not comport with the classic definition of FEI.

Nor does it comport with physical reality. Contrary to Exponent's prediction of over 3,000 tubes with a SR above 1.0 per RSG, a much smaller number of tubes in the RSGs actually experienced the very common phenomenon of tube-

to-AVB wear, let alone the rapid, destructive wear with tube-to-tube contact that is the hallmark of FEI. As Respondents' expert Dr. Au-Yang testified at the hearing and in his expert report, the Exponent "calculations were very wrong" and "[i]n the real world, [they] cannot happen."

Because it is not meant to predict instability, the assumption of one ineffective support is not used in the industry to predict out-of-plane FEI. The non-mandatory ASME code section, often referenced by Claimants, provides a method of analysis beyond which "instability is almost certainly not a problem," but does not require or even suggest the assumption of one ineffective support, as Claimants' experts had to acknowledge. While nuclear component vendors will compute SR with one ineffective support, they do so for the purpose of evaluating the potential for wear. Such computed SR are commonly above 1.0. For example, the Westinghouse analysis for the ANO-2 RSGs included cases with one ineffective support with a maximum SR of [REDACTED]. Westinghouse did not revise its design; rather it evaluated the potential for tube wear. Analyses of the St. Lucie-2 RSGs shows even higher SR than SONGS assuming one ineffective support. If steam generators were designed with the assumption of ineffective supports, the ANO-2 and St. Lucie-2 steam generators would not have been built.

If anything, the absolute reliance on SR calculations with one ineffective support demonstrates that Exponent failed to properly calculate stability ratios, not Mitsubishi. Like Westinghouse on ANO-2, Mitsubishi used the one ineffective support case to assess wear, not predict FEI. Mitsubishi's analyses for actual instability, or classic FEI, were performed assuming that all supports were effective. Even correcting for the admitted Gap Velocity Error, these analyses do not predict that out-of-plane FEI will occur. As noted above, Westinghouse, in a separate, post-leak analysis and using its own tools, also did not predict out-of-plane FEI in the SONGS RSGs, just "a rattling of the tubes."

➤ ***Gap-limited FEI and classic FEI are different, as Edison knows***

To support their use of one ineffective support, Claimants' experts at Exponent deliberately conflate gap-limited FEI and classic FEI, claiming that "[a]mplitude-limited FEI is the same as FEI, is the same as gap-limited FEI." Exponent even goes so far as to say that all of the forms of FEI are "analyzed the exact same way." This is incorrect; as we have established, the assumption of one ineffective support adopted by Exponent renders their stability ratio analyses meaningless for the prediction of the classic FEI that causes rapid destructive wear.

Claimants and Exponent persist and now allege that Westinghouse acknowledged out-of-plane FEI at SONGS in its 2012 Operational Assessment. Westinghouse did *not* say that out-of-plane FEI occurred in the SONGS RSGs; it said that “[o]ccurrence of appreciable AVB wear requires *fluidelastic excitation*.” But Claimants now say, as Dr. Morse testified, that “fluid elastic excitation is the same thing as FEI,” “it’s the same thing and really any suggestion it’s a different thing *is just not correct*.”

In 2012, when Edison was relying on “world-renowned” experts with “broad experience in the nuclear industry” from a variety of companies such as MPR, AREVA, Intertek, B&W Canada, and Westinghouse, it would have disagreed. Edison wanted to make it clear to readers of the Westinghouse report that gap-limited FEI (renamed FEE) was not FEI. As Mr. Langford testified in his deposition: “We wrote the reports with instability in there, and was [*sic*] asked by SCE to remove that and to call it excitation.” Edison wanted to distinguish between the destructive consequences of classical FEI and “the consequences of fluid elastic excitation” that could result in tube-to-AVB wear, which Edison repeatedly told its regulators was manageable. Such tube-to-AVB wear is a far cry from the “rapid onset” and “destructive wear” described by Exponent as a consequence of FEI.

As requested by Edison, Westinghouse revised its language to clearly distinguish between classic FEI and the consequences of FEE (or gap-limited FEI):

When it is used in the discussion of movement in the out-of-plane direction, it should be noted that the tube is not considered to be "unstable" in the classical sense, where displacements can increase significantly with small increases in U-bend velocity. This classical displacement cannot happen in the U-bend as the tubes would close the gaps between AVBs and prevent large displacements.

....

As indicated earlier, out-of-plane excitation ratios calculated for the U-bend that are greater than 1.0 are not considered to be "unstable" in the classical sense. *The only time where this would be considered to actually result in an unstable tube is if an excitation ratio greater than 1.0 was calculated for the condition where all supports were active.* If this were the case, then the tube would not have an AVB to contact during vibration, and would hit neighboring tubes instead.

For purposes of this dispute, Edison now wishes to undo those changes made by Westinghouse in order to conflate gap-limited FEI and classic FEI and prop up the erroneous analyses of its experts at *Exponent*, individuals who cannot claim to be experts in steam generators. Exponent has simply disregarded the analysis for classic FEI – instead focusing on the Westinghouse analysis for FEE and attempting to conflate the terms. But Respondents have performed the analysis for classic FEI, and have clearly demonstrated that it would not be predicted in the SONGS RSGs.

➤ ***Mitsubishi’s out-of-plane FEI analysis was consistent with the industry practice***

No code or other requirement dictates the manner in which a designer must calculate a tube’s stability ratio. Non-mandatory Appendix N to the ASME Boiler and Pressure Vessel Code only offers guidance on stability ratio calculations. Mitsubishi calculated the out-of-plane stability ratios of the most-limiting tubes based on conservative Connors’ constants and total damping ratios that were consistent with those provided in non-mandatory Appendix N. Mitsubishi compared the resulting ranges of out-of-plane stability ratios against the recommended acceptance criterion (1.0). This comparison showed that all tubes in the SONGS RSGs would be stable in the out-of-plane direction, even with the more conservative ATHOS analysis.

Mitsubishi’s analysis of the stability ratios of the tubes in the SONGS RSGs was consistent with the calculations performed by other vendors. For example, Westinghouse and AREVA documents show that they used higher, less conservative Connors’ constant values than Mitsubishi for their stability ratio calculations.

And, regardless of Claimants’ allegations regarding the adequacy of Mitsubishi’s damping ratios and Connors’ constants used to analyse out-of-plane FEI, a simple fact remains: Westinghouse also did not predict out-of-plane FEI at SONGS. The Westinghouse 2012 analysis calculated that out-of-plane stability ratios were less than 1.0 with all effective supports, demonstrating no instability in a classical sense. This 2012 analysis concluded that even assuming one ineffective support, all SONGS stability ratios were less than or equal to 1.0.¹⁵⁰⁹

¹⁵⁰⁹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 82-97.

(iii) The Tribunal's Determination

1436. In considering this Issue B.4(c), the Tribunal recalls the following findings made above:

- i. That FEI calculations are a ratio of effective velocity (i.e., the T/H conditions) over critical velocity (i.e., the ability of a tube to withstand those forces, in large part based upon AVB supports);¹⁵¹⁰
- ii. The T/H force that causes out-of-plane FEI is always present in a large scale operating SG;¹⁵¹¹
- iii. The T/H conditions are largely established by the operating requirements of the SG and the tube bundle geometry;¹⁵¹²
- iv. While out-of-plane FEI can be mitigated, in part, through T/H damping and while higher velocities exert greater force on tubes, the primary means of avoiding out-of-plane FEI is through additional AVBs.¹⁵¹³ The unsupported tube span length is a primary determinate as to whether out-of-plane FEI would occur;¹⁵¹⁴
- v. During the design of SONGS, the Respondents undertook SR calculations under multiple scenarios, including under scenarios with one missing AVB support;¹⁵¹⁵

¹⁵¹⁰ See Section VII.A(d) (¶¶ 170-179) above.

¹⁵¹¹ Transcript, pp. 1077, 3258, 5112, 5119, 5120.

¹⁵¹² Expert Witness Statement of ██████████ ¶ 15; Witness Statement of ██████████ ¶ 13; Expert Report of Mr. Wilson, ¶ 29.

¹⁵¹³ See Section VII.A(d) (¶¶ 170-179) above.

¹⁵¹⁴ See Section VII.A(d) (¶¶ 170-179) above.

¹⁵¹⁵ See VII.D(e)(iv)I.A(a)(i)(1) above.

- vi. During the design of SONGS, the Respondents' SR calculations under the various scenarios, including with one missing AVB support, indicated that out-of-plane FEI would not occur as SR was calculated to be less than 1.0;¹⁵¹⁶
- vii. The post-incident investigation did not identify out-of-plane TTW, which would be evidence of out-of-plane FEI. Exceptionally, two tubes in Unit 2 were found to have TTW.¹⁵¹⁷ Investigations into the wear at SONGS offered hypothesis that these two tubes may have experienced out-of-plane FEI. Other explanations were also considered possible;¹⁵¹⁸
- viii. The wear consequences of out-of-plane FEI are dependent on the distance between the vibrating tube and the nearest object. Small gaps between a tube and an AVB may lead to mere polishing of the tube. Large gaps increase the distance the tube can travel and therefore the force (and wear consequences) of any impact;¹⁵¹⁹
- ix. Correcting for the Respondents' Gap Velocity Error requires multiplying SRs by 2.3.¹⁵²⁰ By consequence, performing SR calculations with one missing AVB support results in predicted SR greater than 1.0 for certain tubes;
- x. Generally, the Parties' experts and witnesses in this arbitration who have been asked to opine on the question of whether out-of-plane FEI

¹⁵¹⁶ See VII.D(e)(iv)I.A(a)(i)(1) above.

¹⁵¹⁷ See ¶ 500 above.

¹⁵¹⁸ See ¶ 586 above; Exh. JX-1407, p. 4.

¹⁵¹⁹ See ¶ 1435 above.

¹⁵²⁰ See ¶¶ 233, 301, 1088, 1098 above.

has occurred have agreed that gap-limited (which is the same as amplitude limited) out-of-plane FEI (or FEE) has occurred.¹⁵²¹

1437. In addition, the Respondents admit that on account of the Gap Velocity Error, out-of-plane stability ratio calculations at SONGS under-predicted the potential for out-of-plane FEI.
1438. A calculation error is, however, not equated with a failure to analyze.
1439. In this regard, the Tribunal considers pertinent the Respondents' evidence that had the Gap Velocity Error been identified, the most likely consequence would have been the addition of further AVBs. The addition of AVBs decreases tube length span and, therefore, reduces the SR.
1440. The Claimants have identified various actions that the Respondents' witnesses testified should have been taken, had the Gap Velocity Error been identified: calculating SR for additional tubes, investigating other possible errors, informing Edison, adjusting the design to correct the inadequacy, and not shipping the RSGs as is.¹⁵²² These answers are entirely consistent with a decision to add further AVBs to correct the design. The Claimants have however not provided convincing evidence that the RSGs would have been re-designed in a manner that would have avoided in-plane FEI had the Gap Velocity Error been identified beforehand.
1441. In this regard, the parameters for the replacement Unit 3 RSGs with lower T/H conditions are not determinative.¹⁵²³ Those RSGs were specifically designed to have

¹⁵²¹ See e.g. Transcript pp. 4355 (Dr. Begley); 4382 [REDACTED] A number of other witnesses and experts testified similarly.

¹⁵²² Claimants' PHM, ¶ 48.

¹⁵²³ Exh. JX-1697.

lower T/H conditions based upon lessons learned regarding in-plane FEI following the Incident.

1442. Beyond a “what if” retrospection, whether the Respondents properly analyzed for out-of-plane FEI is answered by the question of whether out-of-plane FEI occurred in the as-built RSGs. In this regard, the Tribunal is provided with mostly undisputed evidence that gap-limited out-of-plane FEI occurred.¹⁵²⁴ To recall, gap-limited FEI is FEI where tube-to-AVB wear occurs as opposed to tube-to-tube wear.

1443. This raises the core aspect in dispute between the Parties on this Issue B.4(c):

Is gap-limited FEI, the FEI that the Respondents were required to design against?

1444. The Tribunal answers this question in the negative.

1445. The Respondents submit that “there is likely to be some level of gap-limited FEI in every steam generator.”¹⁵²⁵ [REDACTED] the Respondents’ witness, has testified that “irrespective of the [steam generator], there is gap-limited FEI always present.”¹⁵²⁶ As Mr. Langford, the Claimants’ witness, testified, sometimes the consequences of this gap-limited FEI is merely the “polishing” of the tube.¹⁵²⁷ This is further evident by the Claimants’ expert Dr. Morse’s answer to the Tribunal’s question that the underlying phenomenon is the same between gap-limited and classic FEI:

FEI is a type of flow-induced vibration where the flow around the tubes imparts energy on the tubes and causes it to vibrate with an amplitude higher than what you would get just through turbulence alone. That’s

¹⁵²⁴ See ¶ 1436.x.

¹⁵²⁵ Transcript, p. 5121.

¹⁵²⁶ Transcript, p. 3258.

¹⁵²⁷ Transcript, pp. 781-782.

FEI. Now, if you're wondering what happens next, okay, so the tube's unstable, the amplitude is increasing, what happens next? Well does it just vibrate and the amplitude just increases? Or does it hit something else? If it hits something else, its gap-limited FEI. So that's still FEI, gap limited FEI is a sub category of FEI, if you want to think of it that way, and it's really just describing what are the consequences after FEI.¹⁵²⁸

1446. Similarly, the Respondents submit that the underlying force that causes FEI (fluid elastic instability), known as fluid elastic excitation (“**FEE**”) is always present.¹⁵²⁹ Whether FEE turns into FEI is determined by the factors in the Stability Ratio equation, namely, whether the force, i.e., Effective Velocity, exceeds the Critical Velocity of the tube. In the Tribunal's understanding, the purpose of AVBs is to prevent TTW, including TTW on account of FEE. As is evident in SR calculations, where one or two AVBs are removed, the SR increases and may surpass 1.0. The Respondents have identified that SR greater than 1.0 have also been calculated in the design of other SGs under an assumption of fewer effective supports.¹⁵³⁰
1447. Classic FEI is exceedingly destructive, cannot be managed, and leads to tube leaks and bursts.¹⁵³¹ AVBs prevent classic FEI and limit the phenomenon to only gap-limited FEI, where, if properly analyzed, over the 20, 30 or 40 year life of the SG, the effect on the tubes is either polishing or non-life limiting wear.
1448. Given this, the Tribunal considers that the Respondents have persuasively demonstrated that analyzing for out-of-plane FEI is in effect a question of keeping SR lower than 1.0 through the use of a sufficient number of AVBs to ensure adequate

¹⁵²⁸ Transcript, p. 991 (Dr. Morse); Claimants' PHM, ¶ 40.

¹⁵²⁹ Transcript, p. 5120 (Counsel).

¹⁵³⁰ See Transcript pp. 58-59 (Counsel).

¹⁵³¹ Exponent Design Review, ¶ 193.

conservatism in design. In this regard, the Tribunal recalls that the SONGS RSGs had more AVBs than similarly sized plants.¹⁵³²

1449. A remaining aspect of this Issue is the purpose of design assumptions surrounding the use of one missing AVB. The Respondents submit that this is a wear consideration, as the AVB is physically present. The Claimants appear to submit that this was a design standard put forward by the Respondents as a means of obtaining design conservatism.
1450. The Tribunal concurs with both submissions for the following reasons.
1451. As the Claimants submit (to which the Respondents do not appear to disagree), given engineering uncertainty, it is necessary to design with sufficient margin.
1452. The margin to instability in SR calculations is, as indicated, represented by the difference between instability ($SR > 1.0$) and the calculated value. The SONGS SR margin was calculated as [REDACTED] with one ineffective support,¹⁵³³ which itself included a 20% additional margin per Section 3.8.2 of the RSG Contract. The Claimants have demonstrated that the Gap Velocity Error reduced this margin to instability such that under an assumption of one missing support, instability is present.¹⁵³⁴ However, assuming all supports are effective, there remains a margin to instability, even after accounting for the Gap Velocity Error.¹⁵³⁵
1453. The Tribunal has reviewed the Claimants' allegations regarding the Respondents' design choices of variables in stability ratio calculations in Section XII.C above.

¹⁵³² Expert Witness Statement of [REDACTED] ¶ 39; Exh. JX-483, p. 12.

¹⁵³³ Exh. JX-813, p. 75; See also Exh. JX-1219, p. 7 (The SR margin is 1 minus [REDACTED]).

¹⁵³⁴ See Exponent Design Review, ¶ 286, Table 24.

¹⁵³⁵ Exponent Design Review, ¶ 287.

1454. Physical proof of the failure to analyze properly for out-of-plane FEI at SONGS would be in the fact that out-of-plane TTW was found. The evidence indicates that no such out-of-plane TTW was found.
1455. The evidence does not support that TTW occurred at the tubes calculated to have out-of-plane FEI with one missing support, namely R142C88 and R47C7. The two tubes that experienced TTW in SONGS Unit 2 are R111C81 and R113C81.¹⁵³⁶ These two tubes are not in proximity to the tubes calculated to have out-of-plane FEI, assuming one ineffective support, after adjusting for the Gap Velocity Error.
1456. This is the case as even if one calculates SR assuming one ineffective support, that tube is merely missing for the purposes of the calculation, the tube is still physically present in the SG, as submitted by the Respondents.
1457. In light of the above, the Tribunal considers that the one ineffective AVB assumption, in addition to being a conservative design tool, is also, as the Respondents submit, a tool for wear calculation. That is, as SR over 1.0 with one missing support would indicate, a large tube-to-AVB gap at that support point is likely to result in tube wear that may be significant. Significant wear may well limit the life of the tube and result in tube plugging and potentially a limited life of an entire unit.¹⁵³⁷
1458. The Tribunal concludes that the failure to properly analyze for out-of-plane FEI may be linked with a failure to properly design against life-limiting wear caused by gap-limited FEI. The question of whether the Respondents failed to adequately design to prevent life limiting wear is addressed in Section XIII. D(e) below.

¹⁵³⁶ Exh. JX-1141, 12.

¹⁵³⁷ See RSG Contract, Section 3.9.1 (Only 8% of the tubes in an RSG may be plugged prior to it reaching its end of life).

1459. Taking into account the above, the Tribunal considers that while the Respondents' SR calculations were incorrect on account of the Gap Velocity Error, they do not amount to a failure to properly analyze out-of-plane FEI, as the wear patterns do not indicate that out-of-plane FEI occurred at tubes where, but for that error, SR exceeded 1.0.
1460. Accordingly, the Tribunal answers Issue B.4(c) in the negative. The Respondents did not fail to properly analyze for out-of-plane FEI, despite their calculations being erroneous. No out-of-plane TTW on account of FEI was found at SONGS.

(d) Did Mitsubishi have a sufficient basis for not analysing in-plane fluid elastic instability, independently or otherwise? (Issue B.4(d))

1461. This Issue B.4(d) concerns the question whether Mitsubishi did have a sufficient basis for not analyzing in-plane fluid elastic instability, independently or otherwise.

(i) The Claimants' Position

1462. In their Responses to Joint List of Issues, the Claimants submit that "Mitsubishi's own expert witnesses, J. Thomas Boyd and Dr. M. K. Au-Yang, both testified that they calculated in-plane modal shapes and analyzed for in-plane FEI well before the SONGS RSGs were designed and manufactured. This testimony was perfectly consistent with Dr. Asadi's experience at Babcock & Wilcox during which he also analyzed in-plane modal shapes to ensure there would be no in-plane FEI. Indeed, Dr. Asadi noted that it is "harder not to calculate [in-plane FEI]."¹⁵³⁸
1463. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

¹⁵³⁸ Claimants' Responses to Joint List of Issues, ¶ B.4(d).

Respondents argue that their “failure to predict in-plane FEI cannot constitute gross negligence, as Mitsubishi acted in accordance with the industry practice at the time, . . . [which] did not account for in-plane FEI.” This is false. Respondents’ own expert witnesses, J. Thomas Boyd and Dr. M. K. Au-Yang, both testified that they calculated in-plane modal shapes and analyzed for in-plane FEI well before the SONGS RSGs were designed and manufactured. This testimony was consistent with Dr. Asadi’s experience at Babcock & Wilcox during which he also analyzed in-plane modal shapes to ensure there would be no in-plane FEI. Indeed, Dr. Asadi noted that it is “harder not to calculate [in-plane FEI].” Dr. Au-Yang insisted that, had he been involved in the stability ratio calculations for the design of the SONGS RSGs, he would have calculated “200 modes or more” of “both in-plane and out-of-plane modes.” If the lowest mode was in-plane, he would have conducted an in-air test and potentially a flow test. He would have wanted to prove in-plane FEI was not a concern through testing before shipping the RSGs to Edison. None of that was done by Respondents during the design of SONGS.

Respondents not only failed to analyze for in-plane FEI—they proactively turned off the very analytical tool that would have performed such analysis. This information was not revealed to Claimants or the Tribunal until three weeks into the Hearing—a complete contrast to the testimony of Respondents’ witnesses in deposition, at which they denied any knowledge of whether FIVATS was even capable of calculating in-plane modes. Furthermore, while Respondents attempt to claim the “new and unpredicted phenomenon” of in-plane FEI “was the direct result of Mitsubishi and Edison’s attempt to surpass the industry’s best practices,” Edison was never given a choice about whether or not to analyze for in-plane FEI. Respondents unilaterally made the decision to ignore one of the very phenomena that forced SONGS to shut down. When asked about that decision, ██████████ shrugged it off, stating that “it is normal for a designer to not calculate those things that don’t need to be calculated.” Such a callous response is hard to believe: in-plane FEI did occur at SONGS and it led to a tube leak, excessive tube wear, and the retirement of the facility. Respondents’ Mr. Boyd testified that he could not imagine a scenario where a designer would want to exclude the in-plane mode from its analysis—he was not even aware that a designer could “shut off one or the other of the planes.” Respondents did not have a sufficient basis for failing to analyze in-plane FEI, much less for taking proactive steps to ensure in-plane modes would not be calculated.

Finally, Respondents have consistently insisted that it was industry standard to assume in-plane FEI would not occur if out-of-plane FEI was avoided. First, even if such an industry standard existed, it is improper (and dangerous) to

blindly rely on any standard when designing steam generators with first-of-a-kind thermal-hydraulic conditions that are “beyond the envelope of successful industry experience” and when using design codes that were never validated for the thermal-hydraulics anticipated. Second, Dr. Asadi testified in response to the President’s questions that the ASME Code, Appendix N, recommends analyzing for all modes and, even at the time of the RSG design, there was a publication showing that even “if you control out-of-plane, there is a risk that in-plane will happen.” Third, even assuming (contrary to the evidence) that this was the industry standard, Respondents failed to meet it. Assuming *arguendo* that the Gap Velocity Error was the only error Respondents made during design, correcting for just that error demonstrates that many tubes had stability ratios over 1.0 and supports the conclusion that the RSGs experienced out-of-plane FEI. Therefore, by their own logic, Respondents had no basis to assume in-plane FEI would be prevented—much less to be so foolhardy as to turn off the very tool that would have predicted its occurrence. The first-of-a-kind thermal-hydraulic conditions were, as Respondents repeatedly admitted after the tube leak, the “main” cause of the in-plane FEI, and Dr. Begley’s testimony establishes that Respondents’ failure to preclude out-of-plane FEI created the environment for in-plane FEI. In other words, not only were Respondents at fault for not predicting the occurrence of in-plane FEI and analyzing for it, the first-of-a-kind thermal-hydraulic conditions and out-of-plane FEI actually created the environment for the phenomenon to occur. For the foregoing reasons, Respondents did not have a sufficient basis for not analyzing for in-plane FEI during the design of the RSGs.¹⁵³⁹

(ii) *The Respondents’ Position*

1464. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have failed to demonstrate that Mitsubishi committed any design error when analysing for fluid elastic instability. Mitsubishi’s practice of analysing for out-of-plane instability, and not independently analysing for in-plane instability, was consistent with industry practice.

As noted above, no document, including the ASME Boiler and Pressure Vessel Code, specifies requirements for the evaluation of tube stability, either in the out-of-plane or the in-plane direction. Appendix N to the ASME Code (and certain scholarly publications) provides non-mandatory guidance regarding the

¹⁵³⁹ Claimants’ RPHM, ¶¶ 129-131.

performance of that calculation, but it provides no guidance for evaluating in-plane FEI. The lack of such guidance at the time of the SONGS RSG design is evidenced by the current efforts of ASME to develop such a guide for in-plane FEI.

In the absence of a requirement to evaluate a tube's margin to instability in the in-plane direction (through the calculation of an in-plane stability ratio), steam generator designers have uniformly evaluated a tube's margin to instability in the out-of-plane direction. This practice was based on designers' long-standing knowledge that out-of-plane FEI occurs at lower steam flow velocities than in-plane FEI. Thus, it was understood that by preventing out-of-plane FEI a designer ensured that in-plane FEI will not occur. This understanding was rooted in decades of operational experience and testing showing that, for the same support conditions, a tube subject to cross flow will become unstable in the out-of-plane direction at a lower cross flow velocity than it will in the in-plane direction, i.e., the out-of-plane Critical Velocity is lower than the in-plane Critical Velocity. Scholarly research had confirmed this industry practice and indicated that in-plane FEI was unlikely to occur in an operating steam generator.

Therefore, the standard practice at the time of the SONGS design, which the NRC acknowledged, was to design tube bundles to prevent out-of-plane FEI. This was understood by all to prevent in-plane FEI as well. As the NRC said in its Lessons' Learned Report,

[The] industry design practice for commercial reactors in both the United States and Japan (as well as other countries using nuclear technology), at the time the San Onofre replacement steam generators were designed, did not specifically address in-plane fluid-elastic instability of the U-bends. Rather, industry's practice relied on actively controlling out-of-plane fluid-elastic instability of the U-bends, which is a more likely form of instability.

Edison agreed, stating in its Root Cause Evaluation that there was no code requirement or operating experience for in-plane FEI. Mr. Palmisano echoed this sentiment when he spoke at an NRC public meeting on November 30, 2012 and acknowledged the industry's uniform understanding, stating that the "information had shown that if you adequately designed against normal vibration and adequately design against what is called out-of-plane vibration you will have substantial margin to this in-plane vibration of fluid elastic instability. That's were [*sic*] the research had taken us." Other major nuclear component vendors (Westinghouse and AREVA) confirmed in testimony

before the NRC Commissioners that they did not model for in-plane FEI during the design of steam generators. Mitsubishi followed this prevailing industry practice at the time of the SONGS design.

Dr. Asadi claimed to disagree with the statement by the NRC in its Lessons Learned report that the prevailing practice at the time of the SONGS design was to rely on actively controlling out-of-plane fluid-elastic instability of the U-bends and not specifically address in-plane fluid-elastic instability. However, Dr. Asadi had “no idea” why the NRC made this statement.

MR. HINCHEY: That's true, but this report was drafted in 2015, and yet they made that statement again. Do you have any opinion as to why this statement was made by the NRC about this particular design?

DR. ASADI: Actually, I have no idea why they have done it, because my understanding is that this has been the first case. Before that in this scale there has not been any steam generator, and all the information collected has been related to a smaller unit with lower thermal-hydraulic conditions.

MR. HINCHEY: So do you disagree with the statement by the NRC about prevailing practice at the time they wrote it? Do you disagree with that statement?

DR. ASADI: Yes, sir.

Further, Dr. Asadi readily acknowledged on cross examination that he did not know what AREVA was doing, what Westinghouse was doing, or indeed what “most people” were doing. Indeed, when pressed about whether B&W did two separate calculations for in-plane and out-of-plane FEI, Dr. Asadi acknowledged that they the “same calculation.” The B&W model showed both in-plane and out-of-plane mode shapes “simultaneously.” But as Mr. Boyd, a B&W engineer for more than three decades, testified, while B&W’s computer program automatically calculated both out-of-plane and in-plane natural frequencies, B&W ignored the in-plane natural frequencies because the in-plane stability ratios were always bounded by the out-of-plane stability ratios. Dr. Asadi did not testify otherwise. Thus, B&W, like Westinghouse and AREVA, relied upon actively controlling out-of-plane fluid-elastic instability and did not address in-plane instability.

At the hearing Claimants repeatedly emphasized the fact that Mitsubishi artificially restrained its calculation of natural frequencies such that its code (FIVATS) would output only out-of-plane natural frequencies. Claimants' emphasis on this topic is misplaced. This calculation is just one of the initial steps in the calculation of an in-plane stability ratio, and has no merit other than eventual use in an in-plane stability ratio calculation. Mitsubishi artificially restrained the in-plane natural frequency because it is not the critical natural frequency (all other input variables to the calculation held constant). The fact that Mitsubishi artificially restrained the code merely explains the process Mitsubishi employed in not calculating the in-plane stability ratio. Mitsubishi has repeatedly noted that it did not calculate in-plane stability ratios, and Claimants have long known this. It is clear, as explained by Dr. Au-Yang, that restraining the calculation of in-plane frequencies was equivalent to the more prevalent industry practice at the time of computing, but ignoring, values for in-plane frequencies. For example, B&W's practice was to calculate the in-plane natural frequencies because its computer programs automatically did so, but then B&W ignored those calculations, believing that out-of-plane stability ratios would provide the bounding stability calculation for a tube.¹⁵⁴⁰

(iii) The Tribunal's Determination

1465. The Respondents admit that they did not calculate for in-plane FEI, the phenomenon that occurred at SONGS.¹⁵⁴¹ The decision not to calculate for in-plane FEI was not inadvertent, but a deliberate choice made by the Respondents. This decision was based on account of limitations in FIVATS and a desire to perform more out-of-plane calculations.¹⁵⁴² As ██████████ testified:

FIVATS has a limitation to ██████████ and if it is set so that in-plane and out-of-plane directions are to be calculated, then I don't think that it would be able to do so sufficient numbers of calculation for the out-of-plane ██████████. So in order to make sure that there would be enough ██████████ calculated in the out-of-plane direction, the in-plane

¹⁵⁴⁰ Respondents' Position Statement on the Revised List of Issues, ¶¶ 98-105.

¹⁵⁴¹ See ¶ 1481 below.

¹⁵⁴² Transcript, p. 3367 ██████████

direction was set purposely so that there would not be in-plane direct vibration.¹⁵⁴³

1466. Issue B.4(d) concerns the question whether the Respondents had a “sufficient basis” for their decision.
1467. In this connection, the Respondents submit that they did have a sufficient basis, as it was understood that given the same support conditions, out-of-plane FEI bounds in-plane FEI, i.e., out-of-plane FEI occurs first.¹⁵⁴⁴ The Claimants submit that in-plane SR calculations could be performed and at B&W such calculations were performed.
1468. The Tribunal finds that the Respondents did have a sufficient basis for not analyzing for in-plane FEI. In this regard, the Tribunal is convinced that such a practice was industry standard at the time of the RSG design and that the Respondents had a good reason to do so in terms of both the technical understanding of the likelihood of in-plane vibration and in terms of maximizing the use of FIVATS.¹⁵⁴⁵
1469. That not analyzing for in-plane FEI was industry standard is supported by no less an authority that the NRC’s lessons learned report on the SONGS Incident:

[The] industry design practice for commercial reactors in both the United States and Japan (as well as other countries using nuclear technology), at the time the San Onofre replacement steam generators were designed, did not specifically address in-plane fluid-elastic instability of the U-bends. Rather, industry’s practice relied on actively controlling out-of-plane fluid-elastic instability of the U-bends, which is a more likely form of instability.¹⁵⁴⁶

¹⁵⁴³ Transcript, p. 3367 [REDACTED]

¹⁵⁴⁴ Transcript, pp. 4134-4136 (Mr. Wilson), 3752-3753 (Mr. Boyd); Expert Witness Statement of Mr. Boyd, ¶¶ 14-15; Expert Statement of Dr. Begley, ¶ 44.

¹⁵⁴⁵ See ¶ 1465 above.

¹⁵⁴⁶ Exh. JX-1999, p. 33.

1470. That the industry only modeled for out-of-plane FEI is further supported by the statements of representatives from Westinghouse and AREVA before a NRC panel that such was indeed the practice.¹⁵⁴⁷
1471. The Tribunal heard testimony regarding the practice at B&W from Dr. Asadi for the Claimants and Mr. Boyd for the Respondents. Both Dr. Asadi and Mr. Boyd previously worked for B&W. The Tribunal considers Dr. Asadi's testimony to be persuasive, insofar as B&W obtained results regarding in-plane frequencies and that these results were obtained jointly with the calculation results of out-of-plane frequencies.¹⁵⁴⁸ The Tribunal also finds Mr. Boyd's testimony convincing that B&W, after having obtained these results, ignored them.¹⁵⁴⁹
1472. Dr. Au-Yang, Respondents' expert, has testified that in his research, he calculates for "200 modes or more" in the in-plane and out-of-plane direction and that had he hypothetically calculated that the lowest mode (i.e., the greater risk for FEI) was in-plane, he would have conducted further tests to ensure that the RSGs could be safely operated.¹⁵⁵⁰ Dr. Au-Yang, however, also testified that he "let[s] the computer grind out all the modes, but then [he] ignore[s] the in-plane modes so it is the same approach" as that used by the Respondents.¹⁵⁵¹
1473. While industry practice is relevant, it is not entirely conclusive. Indeed, an entire industry may have a common practice, but that is not issue determinative of whether the practice is sound. The Claimants have submitted convincing evidence of research into the possibility of in-plane FEI dating from the early 1980s through 2005.¹⁵⁵²

¹⁵⁴⁷ Exh. JX-1659, pp. 78-79.

¹⁵⁴⁸ Transcript, pp. 935-936 (Dr. Asadi).

¹⁵⁴⁹ Transcript, p. 3751 (Mr. Morse); Rebuttal Expert Witness Statement of Mr. Boyd, ¶ 10.

¹⁵⁵⁰ Transcript, pp. 3107-3118 (Dr. Au-Yang).

¹⁵⁵¹ Transcript, p. 3111 (Dr. Au-Yang).

¹⁵⁵² Exponent Design Review, ¶¶ 208-225.

That research appears to identify that flatbar AVBs provide little restraint in the in-plane direction, absent positive contact force, such that in-plane FEI was a possibility.¹⁵⁵³

1474. As determined in the post-Incident investigations, a tube span with too many (over six) consecutive inactive AVB supports resulted in that tube suffering from in-plane FEI.¹⁵⁵⁴
1475. However, it is far from clear to the Tribunal that, even if the Respondents had analyzed for in-plane FEI they would have undertaken that analysis assuming a sufficient number of inactive support points such that in-plane FEI would be predicted. The Tribunal recalls that in the out-of-plane mode, MHI stability ratio calculations were undertaken with up to 1 missing AVB support. Other designers modeled with 1-2 missing AVB supports. There is no convincing evidence that any designers modeled assuming over six consecutive missing AVB supports, the condition required for in-plane FEI.
1476. Therefore, the Tribunal determines that the Respondents did not fail to properly analyze for out-of-plane FEI. The Respondents' approach was consistent with the research indicating that out-of-plane FEI bound in-plane FEI and was consistent with industry practice at the time of the RSG design. Even if the Respondents had undertaken an in-plane analysis, it is not evident that they would have identified the conditions likely to cause in-plane FEI.
1477. Accordingly, the Tribunal considers that the Respondents did have a sufficient basis for not analyzing in-plane FEI, independently or otherwise.

¹⁵⁵³ Exponent Design Review, ¶¶ 208-225.

¹⁵⁵⁴ Exh. JX-1185, pp. 24, 26; Exh. JX-1066, p. 11.

(e) **Did Mitsubishi fail to properly analyze for wear due to random vibration? (Issue B.4(e))**

1478. This Issue B.4(e) concerns the question whether Mitsubishi failed to properly analyze for wear due to random vibration.

(i) *The Claimants' Position*

1479. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi’s analysis of random vibration was deeply flawed. While Mitsubishi predicted at the design stage that the tube would last over [REDACTED] when Mitsubishi “corrected” its random vibration wear analysis, IVHET predicted the tube would hit its 35% through-wall in [REDACTED] from just random vibration alone. This was unrebutted by Mitsubishi during the Hearing and falls far short of the 40-year RSG life promised by Mitsubishi.”¹⁵⁵⁵

1480. In response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Both sides agree that the wear observed at SONGS was “excessive” and significantly higher than predicted by Respondents during design. As Dr. Begley testified, “[n]ot MHI or actually anybody who designs a replacement steam generator expects that they’re going to have a large number of wear indications.” This goes far beyond mere expectations, however. Respondents promised Edison in the RSG Contract that they would “minimize vibration-induced tube wear or fatigue in the tube bend area of the tube bundle” and “address flow-induced and turbulence-induced vibration [random vibration] . . . to demonstrate that . . . wear of the tubes will not occur.” Consequently, whether they characterize the tube-to-AVB wear as occurring from FEI or random vibration, Respondents guaranteed that no such wear would occur.

The only thing consistent about Respondents’ analysis of random vibration from design through the Hearing is its inconsistency. After the failures at SONGS, in order to support their position that the tube-to-AVB wear at SONGS was primarily “due to random vibration,” Respondents reverse

¹⁵⁵⁵ Claimants’ Responses to Joint List of Issues, ¶ B.4(e).

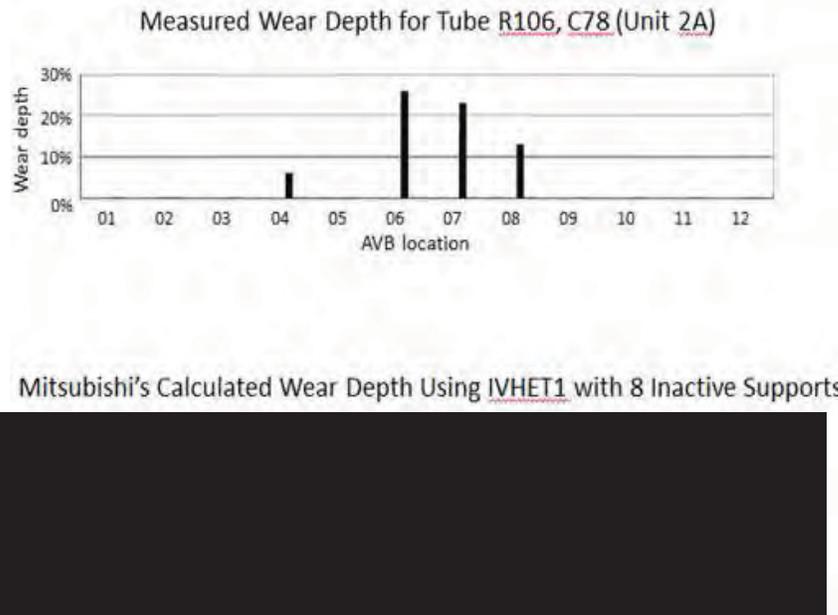
engineered their random vibration wear analysis. Respondents selected input values in an attempt to “match” the wear observed at SONGS. However, Respondents’ “analysis” only served to highlight the errors they made in their random vibration wear predictions during design—namely the use of an excessively low wear coefficient and work rate.

While Respondents predicted at the design stage that the tube would last over [REDACTED] when their random vibration wear analysis is corrected using their own values, their analysis predicts that the tube would reach its 35% through-wall limit in [REDACTED] from just random vibration alone. This was unrebutted by Respondents during the Hearing or in their Post-Hearing Memorial. Furthermore, Respondents’ “corrected” analysis only confirms the breach of their promises to “minimize” and “address” random vibration and to provide RSGs with a 40-year service life.

Respondents attempt to minimize the changes between its design era and post-failure random vibration wear analyses by claiming that “the wear analysis always changes with the development of operating data.” However, these were not small changes—the comparison between the two analyses shows “[a]n enormous difference between design stage and the post leak stage.” Respondents’ “corrected” wear rate was [REDACTED] higher than their design era wear rate—that is not a “development,” it is an admission of error:

Wear Rate = Wear Coefficient × Work Rate				
	Wear Coefficient (10 ⁻¹⁵ m ³ /J)	Work Rate (mW)	Wear Rate (mm ³ /year)	Time to 35% through-wall
MHI Design Stage	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
Corrected	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Respondents’ post-hoc attempt to match the wear observed at SONGS to its random vibration “analysis” not only served to demonstrate their liability, it also highlighted additional errors made by Respondents post-failure. Even with the benefit of 20/20 hindsight, Respondents were still unable to match the wear. The actual measured wear depth for a particular tube in Unit 2 showed that most of the wear occurred at the center AVBs in what has been referred to as “single humped behavior.” Yet, Respondents’ revisionist random vibration wear analysis predicted a “two-humped behavior” pattern that does not match the actual wear observed at SONGS. The conflicting patterns are clearly illustrated in the following graphic:



Respondents half-heartedly attempt to rebut these clear errors in their design era and post-failure random vibration wear analyses by alleging that “Claimants rely on Exponent to establish whether or not Mitsubishi properly analyzed for wear due to random vibration, though Exponent did not even perform a wear analysis in support of its claims.” Respondents’ rebuttal, however, proves Claimants’ point (a point repeatedly emphasized by Drs. Morse and Kytömaa at the Hearing): much of Exponent’s analysis did not utilize or even require any subjective analysis but instead focused on identifying the assumptions, inputs, and calculations utilized by Respondents and demonstrating that they were inconsistently deployed. Exponent identified the errors detailed above by merely comparing Respondents’ own values and pointing out the differences—Exponent did not change any of the inputs or choose any of the numbers. In fact, in the chart shown above comparing Respondents’ design stage inputs with its “corrected” inputs chosen post-failure, Dr. Kytömaa explained that the “white line there where it says ‘corrected’ was MHI’s recalculation of the wear after the leak, so these are MHI’s own corrected values. . . . The columns 1,2 and 3 are Mitsubishi’s numbers.” Respondents’ so-called “defense” is only what Claimants and Exponent have been asserting all along—merely looking at Respondents’ own analysis, without employing any subjectivity, is enough to identify the glaring errors in their design era random vibration wear analysis.

Respondents also argue that Exponent’s claims are “internally inconsistent” because Exponent makes parallel arguments that (1) Respondents’ design era

wear rate was too low and (2) the post-failure wear rate did not accurately predict the wear observed at SONGS. These arguments are not mutually exclusive. Exponent's analysis demonstrates that the post-failure wear rate used by Respondents in their "corrected" analysis was more in line with industry standards than the design era wear rate. However, even with a more accurate wear rate, the predicted wear did not match the observed wear. This does not mean the wear rate was not an appropriate input, it simply proves Exponent's conclusion that the observed wear was predominantly caused by out-of-plane FEI, not random vibration.

Respondents' attempt to draw the Tribunal's attention to other nuclear plants is equally irrelevant. As detailed by Claimants in their Post-Hearing Memorial, this argument puts Respondents in the position of arguing that the tube-to-AVB wear displayed at SONGS makes it tied for the worst performing steam generator in nuclear history. The fact that Respondents are relying on such a "defense" to the shutdown of a nuclear power plant is nothing short of absurd.

Putting aside the absurdity of the argument, these other plants are irrelevant as admitted by Respondents' own testifying experts. Oconee is a once-through steam generator that has no bearing on the experience of a recirculating steam generator like SONGS, and St. Lucie's tube-to-support wear was entirely attributable to random vibration, not out-of-plane FEI. Additionally, St. Lucie has more margin against FEI than SONGS. Furthermore, none of these plants experienced in-plane or out-of-plane FEI, as Respondents admit occurred at SONGS. No other plant is relevant to what occurred at SONGS or to this Tribunal's decision.¹⁵⁵⁶

(ii) *The Respondents' Position*

1481. In response to the Respondents' submissions, the Claimants contend the following:

Claimants have failed to demonstrate that Mitsubishi committed a design error by failing to properly analyse for wear due to random vibration.

First, it is worth noting that Claimants rely on Exponent to establish whether or not Mitsubishi properly analysed for wear due to random vibration, though Exponent did not even perform a wear analysis in support of its claims. Exponent's claims are also internally inconsistent. On one hand, Exponent alleges that Mitsubishi should have used the post-operational wear rate during the design, while on the other hand alleging that the post-operational wear rate

¹⁵⁵⁶ Claimants' RPHM, ¶¶ 132-140.

is also incorrect (as the observed tube wear could not have been caused by that wear rate, thus indicating that gap-limited out-of-plane FEI must have occurred). The reality is much simpler than the convoluted and inconsistent theories advanced by Exponent: random wear calculations are partially empirical and highly dependent on individual support conditions. While Mitsubishi analysed tube-to-AVB wear at the time of the design in a manner appropriate for a new design and consistent with industry standards, the wear analysis always changes with the development of operating data. Necessarily, tube wear calculations during design are performed without the benefit of data regarding tube wear during operation; data regarding tube wear during operation allows engineers to more accurately predict future tube wear during subsequent operation. The uncertainty in these analyses is accounted for with tube plugging margin.

Mitsubishi analysed tube-to-AVB wear resulting from both turbulence-induced excitation and fluid-elastic excitation during the design stage of the SONGS RSGs, consistent with the industry's approach at the time. Specifically, Mitsubishi used the Electric Power Research Institute ("EPRI") methodology, a well-known method in the industry for analysing tube-to-AVB wear that could result from both of these excitation mechanisms.

Second, while unexpected tube-to-AVB wear did occur due to random vibration, as explained by Dr. Begley, this wear occurred as a result of Mitsubishi's achieving the fabrication of the uniform hot-zero gap design. Further, as also explained by Dr. Begley, other plants' RSGs have experienced comparable, unexpected first-cycle tube-to-AVB wear and are expected to operate for their full service lives. For example, the St. Lucie Unit 2 RSGs experienced large amounts of unexpected tube-to-AVB wear in their initial cycle of operation comparable to the tube-to-AVB wear experienced at SONGS, as did the Oconee RSGs at tube support plates. As Edison recognized prior to this arbitration, however, such wear is manageable under the steam generator management program and, as such, tube-to-AVB wear did not threaten the continued, safe operation of SONGS.

Nonetheless, Claimants allege that Mitsubishi analysed tube-to-AVB wear in the SONGS RSGs by relying on an incorrect wear coefficient, an erroneous work rate, and a model which did not accurately reflect the geometry in an as-fabricated SONGS U-bend. To support these claims, Claimants rely on the fact that Mitsubishi's 2012 tube-to-AVB wear analysis employs a larger wear coefficient, a larger work rate, and a different model (reflecting a different geometry) than did Mitsubishi's design-era calculations. Claimants'

conclusions regarding Mitsubishi's wear analysis at the time of design are mistaken.

In brief, and as addressed in more detail in [REDACTED] Expert Witness Statement, the turbulence induced force input to the design stage wear rate calculation differed from the turbulence induced force input to the post-operation wear rate calculation, and that difference was the dominant contributor to the resulting different wear rates. The design stage wear calculations relied on an EPRI-suggested input for the turbulence-induced force, whereas the post-operation wear calculations incorporated the results of turbulence-induced force testing performed after the design of the SONGS RSGs.

Further, the design-era tube wear model and wear coefficient differed from the post-operational model because the latter was based on information developed from Mitsubishi's root cause analysis of the observed SONGS tube wear. The design-era wear model included both large gaps (up to [REDACTED] to model gap-limited out-of-plane FEI) as well as zero gaps (to model the design conditions). The post-operational wear model incorporated different support conditions to account for the presence of the observed tube-to-AVB wear at SONGS based on information developed from Mitsubishi's root cause analysis of the SONGS tube wear in order to model consecutive supports that did not stop in-plane motion. Dr. Begley explained that this tube wear resulted from achieving the agreed upon design-era objective of uniform, hot-zero gaps. Likewise, because the vibration models are different, the wear coefficient was similarly changed. The design-era calculation showed that fretting wear (due to pure sliding) would be most-limiting; therefore, a [REDACTED] coefficient was (appropriately) used in the design-era calculation. Other vendors similarly used a [REDACTED] coefficient during design. However, the observed tube wear due to operation showed that use of an [REDACTED] coefficient was more appropriate; Mitsubishi therefore used the [REDACTED] coefficient for all of its post-operation wear calculations.

Thus, Mitsubishi analysed tube-to-AVB wear consistent with industry practice during the design of the SONGS RSGs. Claimants have shown no departure from accepted industry practice at the time of design. Their claims rest solely on Mitsubishi's revision of its wear calculation to explain the root cause of the unexpected wear, which was "the drive for uniformity, small contact forces, small gaps," called for by the Edison design specification and the accepted industry objective at the time of the SONGS design. The fact that unexpected wear occurred is not a basis to conclude that a departure from industry practice had occurred. Indeed, no vendors' designs anticipate appreciable tube-to-AVB

wear. Nonetheless, tube-to-AVB wear is a common occurrence in the industry, and the presence of tube-to-AVB wear cannot be said to be evidence of an error in design. As stated by Dr. Begley, who has extensively reviewed and analysed the unexpected tube wear that has occurred in other wear-challenged steam generators, “[a]s far as I am aware, none of these vendors [whose designs exhibited high levels of wear in initial operating cycles, i.e., B&W, AREVA, and Mitsubishi] concluded from design work rate calculations that any tubes would be plugged due to wear.”¹⁵⁵⁷

(iii) *Tribunal’s Determination*

1482. The Claimants’ case that the Respondents failed to properly analyze for wear due to random vibration is based on the allegation that the Respondents’ wear calculations was significantly erroneous such that the design life of the Units was [REDACTED] rather than over [REDACTED].¹⁵⁵⁸ To arrive at this conclusion, the Claimants’ experts, Exponent, recalculated the Respondents’ design era wear calculations using the same variables as the Respondents used in their repair era analysis.¹⁵⁵⁹

1483. The Claimants’ evidence in this regard is summarized in their Post-Hearing Memorial:¹⁵⁶⁰

Wear Rate = Wear Coefficient × Work Rate				
	Wear Coefficient ($10^{-15} \text{ m}^3/\text{l}$)	Work Rate (mW)	Wear Rate (mm^3/year)	Time to 35% through-wall
MHI Design Stage	[REDACTED]			
Corrected				

¹⁵⁵⁷ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 106-113.

¹⁵⁵⁸ Transcript, pp. 239 (Dr. Kytömaa), 959-960, 965-918 (Dr. Morse); Exponent’s Design Review, p. 118.

¹⁵⁵⁹ Claimants’ PHM, ¶ 61.

¹⁵⁶⁰ Claimants’ PHM, ¶ 62.

1484. The Tribunal is not convinced by the Claimants' submissions in this regard for the reasons set out by the Respondents' submissions on this Issue.¹⁵⁶¹
1485. In addition, while the wear at SONGS is higher than expected, it is consistent with wear at other large steam generators, namely St. Lucie 2. The Claimants submit that St. Lucie 2 should not be a comparable plant as it did not suffer from in-plane FEI. The Tribunal does not consider that aspect to be a pertinent consideration in answering this particular Issue B.4(e), which concerns the distinct matter of wear from random vibration.
1486. The Claimants are correct that under Section 3.9.3.9 of the RSG Contract random wear is to be avoided or minimized. However, Section 3.9.3.9 must be read in conjunction with Section 1.29.2.2 of the RSG Contract, which imposes liquidated damages of \$3,000 per plugged tube (on account of wear or otherwise) and Section 3.9.1 of the RSG Contract, establishing the tube plugging limit of 8%. Read together, the RSG Contract demonstrates that while the Parties agreed that tube wear was to be minimized, some amount of wear was to be expected. Some amount of wear appears to be an expected occurrence in steam generators, as Mr. Palmisano, the Claimants' witness and Chief Nuclear Office for SONGS, presented at a NRC public meeting regarding the post-Incident inspection of the RSGs:

We found more wear than we expected, more normal wear. Tube to anti-vibration wear and tube to support plate wear. That wear is manageable on a going forward basis if that was all the issue.¹⁵⁶²

1487. At the Hearing, Mr. Palmisano also testified that at SONGS the post-Incident inspection revealed that:

¹⁵⁶¹ Section XIII.D(e)(ii) above.

¹⁵⁶² Exh. JX-1539, p. 15.

There was a large amount of what I would call normal wear where you might expect cycle-to-cycle, but the amount of wear in Unit 2 in one operating cycle and Unit 3 in only 11 months was very concerning (...)¹⁵⁶³

1488. Despite some amount of wear being normal, the Tribunal is also convinced by Mr. Dietrich’s testimony that SCE “contracted [the design and manufacture of SONGS] to be done with Mitsubishi because they professed to be the best at addressing normal wear (...).”¹⁵⁶⁴
1489. Taking this evidence into account, it appears that while MHI was to avoid the occurrence of wear, some wear was to be expected nonetheless.
1490. In addition, to the extent that the Claimants’ allege that the Respondents failed to properly analyze for random wear on account of data only obtained during operation, the Tribunal does not find this submission convincing. The Respondents have proven that wear calculations were conducted in the design era using data from EPRI.¹⁵⁶⁵ The Tribunal considers this to be an appropriate design choice.
1491. Accordingly, the Claimants have not established that the Respondents failed to properly analyze for random wear.
1492. However, even if the Tribunal’s determination on Issue B.4(e) were opposite, the Tribunal considers that the consequence would be that this amounts to a Defect in the form of inadequate tube support. Issue B.4(e), regarding wear from random vibration, is similar to Issue B.4(b) above,¹⁵⁶⁶ regarding vibration and wear. Accordingly, the consequence of vibration wear under Issue B.4(e) would be the

¹⁵⁶³ Transcript, pp. 83-84; See also Transcript, pp. 107-108, 129 (Mr. Palmisano).

¹⁵⁶⁴ Transcript, p. 2111 (Mr. Dietrich).

¹⁵⁶⁵ EPRI is the Electric Power Research Institute.

¹⁵⁶⁶ See Section XIII.D(b) above.

same as Issue B.4(b), as is further addressed in Issue B.4(i) above regarding the consequences of such a finding.¹⁵⁶⁷

(f) **Did Mitsubishi fail to execute an effective quality assurance program to catch and correct the alleged design errors, as alleged by Claimants? (Issue B.4(f))**

1493. This Issue B.4(f) concerns the question of whether Mitsubishi failed to execute an effective quality assurance program to catch and correct the alleged design errors, as alleged by the Claimants.

(i) *The Claimants' Position*

1494. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi failed to implement an effective QA program as required by the applicable regulations (Appendix B and the ASME Code), RSG Contract, its own QA Manual, and industry standards. Edison and other customer audits from the time of the RSG design indicate an adverse trend in Mitsubishi’s design control (including design verification) and deficiencies in its corrective action measures. The multitude of errors in Mitsubishi’s proprietary codes, including the Gap Velocity Error, further demonstrate a wealth of deficiencies in design control and other Appendix B criteria, signifying a programmatic breakdown in design control. Mitsubishi’s weak quality assurance program and programmatic breakdown in design control resulted in non-conforming nuclear equipment that caused the RSG failures and the eventual shutdown of the plant.”¹⁵⁶⁸

1495. In addition, the Claimants supplement the aforesaid submissions, in their C-RPHM, by contending the following:

¹⁵⁶⁷ See Section XIII.D(j) below.

¹⁵⁶⁸ Claimants’ Responses to Joint List of Issues, ¶ B.4(f).

The 18 criteria of Appendix B establish a comprehensive set of requirements “necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service.” The evidence demonstrates that Respondents’ design failed to comply with several of the 18 criteria and resulted in nuclear components placed into service that had severe defects and failed in less than one cycle.

Many of Respondents’ design errors failed to comply with Criterion III, Design Control—the “heart” of quality assurance. Design Control necessitates that proper measures are put in place to ensure that design requirements are accurately translated into documents, there is adequate coordination between organizations, design calculations are independently verified, and components are suitable for their intended application. This was not done.

For example, Respondents admit that they failed to convert the gap value outputs from FIT-III to the proper values for calculating flow velocities and stability ratios—critical information for predicting the thermal-hydraulic conditions within the RSGs and the potential for tube vibration and wear. The NRC identified this as a failure to ensure that adequate interfacing controls were established between the design teams in Kobe and Takasago. The NRC noted that “the output of [] FIT-III ... and input to [] FIVATS ... were not verified to be in accordance with MHI design requirements” and issued a Notice of Nonconformance in design control, which Respondents did not contest.

In addition to Gap Velocity Error, Respondents issued itself 18 other CARs, three of which the NRC concluded were additional design control deficiencies, including Respondents’ failure to dedicate their commercial grade codes such as FIT-III, FIVATS, and IVHET. Additionally, the evidence showed that Respondents committed numerous other errors in their proprietary codes that constitute deficiencies in design control.

Mr. Merschoff, a former NRC executive who spent 25 years at the NRC including as Chief of the Vendor Inspection Branch, concluded that had the NRC been aware of the nature and number of the design control deficiencies, it would have found a programmatic breakdown in design control. “Programmatic breakdown” is a term used by the NRC to characterize systemic quality assurance issues in any part of a quality assurance program, as distinguished from an isolated adverse quality event. Respondents’ underlying design control issues affected activities related to thermal-hydraulic design, vibration and structural response, and computer code development. These deficiencies led Respondents to significantly underestimate the thermal-

hydraulic conditions in the Units, which resulted in severe and unprecedented wear.

Respondents' response to the evidence is unpersuasive. Respondents' implication that Mr. Merschoff "introduced" the phrase "programmatic breakdown" as if it were some obscure or made-up term is incorrect. 10 CFR 50.55(e) expressly references a situation in which there is "a significant breakdown in any portion of the quality assurance program." In the context of 50.55(e), which governs the construction of new facilities, a finding of such a "breakdown" not only requires the organization to report the issue to the NRC, but also exposes it to significant violations with potential civil penalties. The NRC Enforcement Policy provides further guidance, noting that a level II violation is exemplified by QA deficiencies "related to more than one work activity," and "involve the [] failure to ... take prompt corrective actions ..." or "[m]ultiple structures, systems, or components [] completed in such a manner that it would have an adverse effect on the safety of operations."

Furthermore, the phrase "programmatic breakdown" explicitly appears in the NRC Enforcement Manual. The manual uses the term in noting that an organization that only addressed "isolated symptoms" of a violation and "failed to recognize the common root cause and take the necessary comprehensive action" should not receive credit for identifying "the problem requiring corrective action (e.g. the programmatic breakdown)." Significantly, this is exactly what happened here. At most, Respondents identified "symptoms" of the programmatic breakdown, such as the Gap Velocity Error, commercial grade dedication, and problems with their code manuals. Respondents "failed to recognize the common root cause and take the necessary comprehensive action" to address the underlying systemic design control issues in their QA program. As a result, Respondents failed to catch the numerous errors in its codes, resulting in the failures of the RSGs.

The difficulty Respondents and their experts have had with this commonly used NRC term and responding to Mr. Merschoff's conclusions underscores their unfamiliarity and inexperience with NRC enforcement. Mr. Mitchell even admitted to making up his own definition of the term even though he had not heard of it before his deposition. Mr. Mitchell, however, ultimately agreed with Mr. Merschoff, admitting that multiple errors in multiple codes could constitute systemic QA issues.

Mr. Merschoff's finding that there was an adverse trend in design control which amounted to a programmatic breakdown is supported by audit reports contemporaneous to the design of the RSGs. Edison's first audit of Respondents revealed incorrect technical information in design documents and

issues with design verification. Contemporaneous audit reports from other customers of Respondents similarly identified design control deficiencies. When viewed in light of the discovery of deeply embedded errors in Respondents' proprietary codes and resulting failures, Respondents' QA deficiencies identified in these reports cannot be viewed as isolated issues, but examples of a pervasive breakdown in design control.

In addition to deficiencies in design control, Mr. Merschoff identified additional deficiencies in corrective action and other Appendix B criteria. For example, Edison's 2004 audit noted that prior CARs addressing design control issues needed improvement and that deficiencies identified by other utilities in prior audits had not been sufficiently addressed. In its follow up surveillance in March 2005, Edison discovered that Respondents had not appropriately addressed the issues raised by the 2004 audit.¹⁵⁶⁹

1496. Further, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents continue to emphasize that the Gap Velocity Error and other related errors were self-identified, demonstrating effective corrective action. This is incorrect and represents a fundamental (and no doubt intentional) misunderstanding of the quality assurance and design review process. The errors were discovered after the failure of the RSGs; thus, they were "self-revealing," not "self-identified." The NRC does not give credit to an organization for identifying errors found as a result of an operational failure. Indeed, the failure to identify errors before they are designed into nuclear equipment and put into operation is itself a deficiency.

Relying on Mr. Mitchell's testimony, Respondents for the first time argue that a QA program is only ineffective when "an organization is aware of weaknesses, does not enter them into the corrective action program (or enters them improperly into the corrective action program), does not take appropriate actions to resolve the weaknesses, and has issues with the corrective action program and internal audit program." Mr. Mitchell, however, never worked at the NRC and otherwise failed to establish himself as an expert on NRC inspections and enforcement during the Hearing. Moreover, Mr. Mitchell's assertion is nonsensical and profoundly disturbing. It implies that an

¹⁵⁶⁹ Claimants' RPHM, ¶¶ 141-150.

incompetent vendor with a deeply flawed QA program nonetheless has effective QA if it lacks the competence to identify the flaws in the first place.

Nevertheless, even if the Tribunal applied this fundamentally flawed QA framework, Respondents cannot show its QA program was effective for the SONGS project. First, despite telling Edison the contrary, Respondents were well aware of weaknesses with their program and potential issues in the design, which their consultants repeatedly warned about. Despite this notice, Respondents failed to take appropriate action to resolve these identified weaknesses and design issues. Second, the evidence points to significant problems with Respondents' Corrective Action program, as discussed above, and deficiencies with regard to Respondents' internal audits. Finally, the fact that the errors went undetected for so many years alone further demonstrates issues with Respondents' corrective action and audits.

Respondents' continued reliance on third party audits and inspections of their QA program to support their assertion that the program was de facto effective is also misplaced. Audits and inspections only look at a sampling of a vendor's QA program and the reports themselves explicitly disclaim that they constitute an endorsement of the QA program overall. Additionally, many of the errors were deeply embedded in Respondents' codes and were not the type of errors that would be identified by audits, as recognized by Respondents' own experts.

Respondents assert in their Post-Hearing Memorial that the "audit reports" from the ASME demonstrate that the QA program was compliant. But these alleged reports are not in the record! Claimants and the Tribunal are unable to know what the auditors reviewed and what deficiencies the audits may have revealed. Respondents alone had access to these reports and chose only to produce single-page certificates, not the underlying reports which would have indicated whether the ASME discovered any deficiencies that Respondents would have had to address before being recertified for its N-Stamps.

Respondents' reliance on the results of prior NRC inspections is also misguided. There were only three NRC inspections related to the SONGS project, two of which occurred after the RSG failures. Significantly, the pre-failures 2008 inspection did not review any of the relevant design control areas, rendering its lack of findings irrelevant. The post-outage inspection in 2012 was limited to assessing the open-air mockup and found two nonconformances, and the final NRC inspection conducted in 2013 identified a significant nonconformance in design control.

Finally, the vendor audits conducted by Edison and other of Respondents' customers expressly reject Respondents' claims. Many of these audit reports

identified deficiencies in design control, corrective action, internal audits, and other areas of Respondents' QA program.

The evidence overwhelmingly demonstrates that Respondents failed to implement an effective QA program to catch and correct their numerous design errors.¹⁵⁷⁰

(ii) *The Respondents' Position*

1497. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

The parties agree that the CDS requires Mitsubishi to design and fabricate the SONGS RSGs consistent with the requirements of 10 C.F.R. Part 50 Appendix B. Mitsubishi did so.

10 C.F.R. Part 50 Appendix B establishes the high-level "quality assurance requirements for the design, manufacture, construction, and operation of [the] structures, systems, and components" used in nuclear power plants. Vendors develop quality assurance programs which effectuate the requirements of Appendix B and apply them to all activities implicated by the Appendix.

Claimants argue that Mitsubishi's QA program suffered from a "programmatic breakdown," as if that term describes an industry-wide standard against which QA programs are judged. Claimants, however, have not identified any law, regulation, guidance, or standard that uses, much less defines, that phrase. Mr. Merschoff incorrectly testified that the NRC "uses the term 'programmatic breakdown' in its regulations," and that "[i]t appears in [10 C.F.R.] 50.55(e). . . ." 10 C.F.R. §50.55(e) does not use the term "programmatic breakdown." Indeed, that term does not appear anywhere in federal regulations applicable to the NRC. In fact, the Parties' three quality assurance experts could not even agree among themselves as to what the term "programmatic breakdown" means.

More importantly, Claimants' position that Mitsubishi's QA program suffered from some sort of systemic problem is not supported by the facts. Mitsubishi's experts have testified, and documents in the record show, that Mitsubishi maintained an adequate and effective QA program for all relevant periods. Claimants merely point to isolated issues regarding design control from a few third-party audits and state that these issues represented an adverse trend.

¹⁵⁷⁰ Claimants' RPHM, ¶¶ 151-158.

Claimants, however, ignore a robust body of evidence, such as decades of audit reports performed by the ASME, several nations' regulators (including the NRC), and customers (including Edison itself) that illustrate Mitsubishi's QA program has been, and continues to be, adequate and effective.

For example, the ASME first issued Mitsubishi an N-Certificate in 1974. Mitsubishi currently holds five ASME certifications. The ASME has recertified Mitsubishi every three years (for a total of 42 N-type certifications) since that time as a result of thorough inspections of Mitsubishi's activities. The ASME would not have reissued Mitsubishi's N-certificate for forty years if Mitsubishi's QA program was inadequate. Indeed, each of the ASME inspections concluded that Mitsubishi was maintaining an adequate and effective QA program. During the MHI application for a reissuance of the N-Certification in 2007 and 2010, the ASME inspection team reviewed the SONGS project evaluating the manner in which MHI was applying the ASME code to ongoing work and MHI's QA program. The ASME reissued the N Certification, the NPT Certification, the NA Certification, and the NS Certification as a result of inspections conducted during the time the SONGS project was ongoing and after the tube leak at SONGS occurred.

The NRC has inspected Mitsubishi's activities as a consequence of its involvement in the U.S. nuclear industry. Between 2004 and the present, the NRC inspected MHI's activities, including MHI's QA program, in 2008, 2012, and 2013. These inspections, and their findings, are addressed in turn below.

- 2008 Inspection: This inspection did not identify a single finding. According to the NRC inspection report, "[t]he NRC inspectors concluded that the inspected portions of Mitsubishi's QA and 10 C.F.R. Part 21 programs were appropriately controlled and implemented."
- 2012 Inspection: Although this inspection resulted in the NRC issuing two minor non-conformances, the NRC team concluded that "MHI's QA policies and procedures comply with the applicable requirements of 10 C.F.R. Part 21 and Appendix B to 10 C.F.R. Part 50, and that MHI personnel are implementing these policies and procedures effectively."
- 2013 Inspection: This inspection resulted in a single non-conformance, a non-conformance which Mitsubishi had previously identified and reported to the NRC.

In addition, Mitsubishi's U.S. customers conducted nine quality assurance audits of Mitsubishi between 2003 and the present. Edison was involved in four of those audits. Importantly, and despite the fact that three of those four inspection teams included experts in the very same design control area which Edison now maligns, none of those four audits that Edison was directly involved in suggested that Mitsubishi's QA program was anything other than adequate and effective. And none of the other customer audits (which totalled 9 including the ones Edison was directly involved in) suggested that Mitsubishi's QA program was anything other than adequate and effective.

Moreover, Edison stationed one or more Edison employees in Kobe during the entire design and fabrication of the SONGS RSGs. These employees were intimately involved in reviewing and documenting the design and fabrication of the SONGS RSGs. Oftentimes, Edison's QA and engineering personnel were in Kobe overseeing the design and fabrication of the SONGS RSGs. None of those Edison personnel ever suggested that Mitsubishi's QA program was anything other than adequate and effective.

Similarly, Mitsubishi's third-party, ASME-authorized inspectors were present in Kobe while the SONGS RSGs were fabricated. Those inspectors were involved in shop activities, QA documentation, and maintaining records related to fabrication of the SONGS RSGs. They never suggested that Mitsubishi's QA program failed to meet requirements or was inadequate or ineffective.

Despite this overwhelming evidence that Mitsubishi maintained an adequate and effective QA program during all relevant periods, Claimants nonetheless allege that Mitsubishi's QA program was inadequate (and further that these alleged inadequacies caused the occurrence of in-plane FEI and the resulting tube-to-tube wear). Perhaps because Claimants cannot rely on the conclusions of the many inspection reports, none of which assert that Mitsubishi's QA program was inadequate, Claimants have introduced the phrase "programmatic breakdown" and claim that the design control function of Mitsubishi's program suffered that "programmatic breakdown." In doing so, Claimants have failed to articulate an applicable regulatory standard against which to judge the quality of Mitsubishi's QA Program.

Indeed, in applying its standard, neither of two post-leak inspections of Mitsubishi's programs performed by the NRC suggested, much less found, a breakdown in Mitsubishi's QA program. As Mr. Johnson testified,

It is very difficult for me to even speculate that there could have been a programmatic failure of Mitsubishi's QA program that would not have been detected by the intense scrutiny that

Mitsubishi and Edison received from the NRC. The atmosphere surrounding the SONGS outage resulting from the steam generator leak was politically charged. . . . Following two NRC vendor inspections of Mitsubishi after the SONGS shutdown from the steam generator leak, the NRC did not identify a significant QA failure, much less a programmatic QA failure.

In addition, even if one were to adopt Mr. Merschhoff's understanding of the term "programmatic breakdown," no such breakdown occurred in this case. Mr. Merschhoff admitted that his opinion relied on "the number and nature" of errors identified by Exponent, and that he accepted Exponent's findings as being correct. The record in this case, however, shows that Exponent was wrong -- Mitsubishi made only one error that was self-identified and documented through Mitsubishi's QA program (relating to gap velocity). Accordingly, Mr. Merschhoff's opinion on this issue baseless.

Further, Claimants' position is also contradictory on its face.

First, Edison assessed the quality assurance and quality control programs of Ansaldo, Doosan, ENSA, FANP, and MHI in 2004 as a part of its evaluation of those entities' bids to perform the SONGS project. While Claimants contend in this arbitration that the "programmatic breakdown" (however defined) commenced in 2004, at that time Edison assessed Mitsubishi's quality assurance program and quality control programs as being higher than the programs of any of the other bidders, and indeed nearly twice as high as Ansaldo's QA/QC program.

Second, on the one hand, Claimants point to certain findings regarding design control in a few third-party inspection reports (none of which identified significant design errors) and claim that these findings represented a negative adverse trend. On the other hand, Claimants ignore the findings of every other inspection report documenting decades of inspections performed by the ASME, several nations' regulators (including the NRC), and customers (including Edison itself) that illustrate Mitsubishi's QA program has been, and continues to be, adequate and effective.

Third, Claimants impliedly allege that the mere presence of findings in an inspection report and the resulting corrective action requests are evidence of the failure of an entity's QA program. This is not correct. QA findings are evidence that entities are being meaningfully inspected, and allow identified weaknesses to be entered in an entity's corrective action program as a means to continually improve the entity's practices and documentation.

Finally, and perhaps most importantly, Claimants have not, and indeed cannot, show that any design or fabrication error, alone or in conjunction with one or more errors (including the gap-velocity conversion error and those errors alleged by Exponent and refuted by Respondents' experts), caused the Unit 3 RSGs to experience in-plane FEI. To the extent that these alleged errors form the factual basis of any element of Claimants' specific breach claims, it is Claimants' burden to demonstrate the appropriate nexus between Mitsubishi's conduct and the specific contractual provisions alleged to have been violated. Claimants have failed to demonstrate this.

Thus, the record overwhelmingly shows that Mitsubishi maintained an effective quality assurance program during all relevant periods.¹⁵⁷¹

(iii) The Tribunal's Determination

1498. Issue B.4(f) relates to the requirements of Section 2.8.2 of the RSG Contract. Section 2.8.2 of the RSG Contract requires that MHI design and manufacture the RSGs in accordance with Appendix B of 10 CFR 50. This obligation requires MHI to have a written quality assurance ("QA") program that meets NRC standards. Further, Section 2.8 of the RSG Contract requires that MHI's QA program "cover quality control, inspections, examinations, and tests required by the Purchase Order and this Specification."
1499. The Tribunal considers that QA and QA programs fulfil two functions, that is ensuring quality and documenting the assurance of quality.
1500. In the context of MHI's QA and QA programs, the Parties have made various references to audits of MHI, including of its QA program, that have identified both non-conformances over the years¹⁵⁷² and also identified the strength of MHI's QA.
1501. Furthermore, the Claimants have submitted evidence that MHI's internal documents are critical of its own QA.¹⁵⁷³ It is worthwhile noting that the Claimants' evaluation

¹⁵⁷¹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 114-131.

¹⁵⁷² Claimants' PHM, ¶ 88-93.

¹⁵⁷³ Exh. JX-821; Exh. JX-340 (See Claimants' PHM, ¶¶ 71-72).

of the bids for the RSG Replacement Project awarded the Respondents the highest QA score of any of the competitors.¹⁵⁷⁴

1502. While it is evident that the Respondents have seen their ASME N-stamp renewed over the years, it is not determinative of whether or not the Respondents had an effective QA program that should have caught the alleged design errors. This is similarly the case for the fact that the Respondents have undergone many QA audits over the years.
1503. The Claimants characterize the Respondents' QA program as suffering from a "programmatic breakdown."¹⁵⁷⁵ In their view, according to the NRC Enforcement Manual, a "programmatic breakdown" is one where there is a failure "to recognize the common root cause and [to] take the necessary comprehensive actions."¹⁵⁷⁶ In rebuttal, the Respondents submit that the term "programmatic breakdown" does not have a particular regulatory definition. They further contend that, it appears that the Claimants' experts use the term as indicative of a wide scale, systemic breakdown in which identified errors are not corrected and in which there are broad problems.¹⁵⁷⁷
1504. Regardless of the precise definition of what constitutes a "programmatic breakdown," the Claimants' expert Mr. Merschhoff in significant part bases his conclusion of a "programmatic breakdown" in QA on the Claimants' expert Exponents' identifications of alleged significant errors in the Respondents' design:

¹⁵⁷⁴ Exh. JX-313.

¹⁵⁷⁵ See ¶ 1494 above.

¹⁵⁷⁶ Claimants' RPHM, ¶ 146; See also Exh. JX-1827, p. 51.

¹⁵⁷⁷ Respondents' Position Statement on the Revised List of Issues, n. 284.

Mr. Merschhoff: That's correct. Had [the] NRC been aware of the number and nature of those findings, I believe they would have concluded a programmatic breakdown in Criterion III.¹⁵⁷⁸

1505. That design errors in (or in the use of) the Respondents' software codes can constitute a QA violation in breach of NRC regulations is evidenced by the NRC's issuance of a notice of non-conformance following the Respondents' self-reporting of the Gap Velocity Error. The NRC informed MHI on 20 September 2013 that:

Criterion III of Appendix B to Title 10 of the Code of Federal Regulations (10 CFR) Part 50, states, in part, that, "measures shall be established to assure that applicable regulatory requirements and the design basis ... are correctly translated into specifications, drawings, procedures, and instructions. It also states, in part, that, "measures shall be established for the identification and control of design interfaces and for coordination among participating design organizations. These measures shall include the establishment of procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces.

Contrary to the above, during the design of replacement steam generators for Southern California Edison, from approximately 2004 to 2008, MHI did not establish measures for control of design interfaces between the MHI Steam Generator Design Section and the MHI Takasago Research and Development Center, related to the thermal hydraulic and vibration analyses used for aspects of the San Onofre Nuclear Generating Station, Unit 2 and Unit 3 replacement steam generator design. Specifically, the output of the FIT-III thermal-hydraulic code and input to the flow induced vibration analysis software (FIVATS) vibration code were not verified to be in accordance with MHI design requirements. MHI failed to convert the wide gap flow velocity output results from the FIT-III analysis to narrow gap flow velocities needed as input for the FIVATS vibration analysis code.¹⁵⁷⁹

¹⁵⁷⁸ Transcript, p. 1297 (Mr. Merschhoff).

¹⁵⁷⁹ Exh. JX-1867.

1506. In the event that the Respondents' self-identified error were to be combined with all or most of the alleged errors as identified by the Claimants' expert Exponent, the Tribunal might accept that the NRC would have identified these as non-conformities as well, amounting to a QA failure. As the Claimants submit: "as a result [of a "programmatic breakdown" the] Respondents failed to catch the numerous errors in its codes, resulting in the failures of the RSGs."¹⁵⁸⁰
1507. The Tribunal concurs in principle with the Claimants on the point that if all or most of the alleged errors by the Claimants did occur, this would be an indication of a failure of an ineffective QA program, as it failed to correct these alleged design errors, which may have amounted to a "programmatic breakdown," under any definition of the term.
1508. On account of this, and on account of Mr. Merschhoff's opinions and testimony, the Tribunal considers that the Issue of whether the Respondents have an effective QA program that allegedly failed to "catch and correct the alleged design errors" is tied to the Tribunal's determination on the Claimants' allegations of those design errors.
1509. However, as determined by the Tribunal in Sections XI and XII above, the design errors as alleged by the Claimants did not occur or to the extent the Tribunal considers the Claimants' allegations to be convincingly proven, do not amount to design errors that evidence a failed QA program.
1510. Accordingly, the Tribunal answers Issue B.4(f) in the negative. Taking into account, the difference between the design errors as alleged by Claimants, but not proven, MHI did not fail to execute an effective quality assurance program to catch and correct the alleged design errors.

¹⁵⁸⁰ Claimants' RPHM, ¶ 147.

(g) **As Respondents contend, can a quality assurance program be effectively implemented and not identify the design errors alleged by Claimants? (Issue B.4(f)(i))**

1511. This Issue B.4(f)(i) concerns the question of whether, as the Respondents contend, a quality assurance program can be effectively implemented and not identify the design errors alleged by the Claimants.

(i) *The Claimants' Position*

1512. In their Responses to Joint List of Issues, the Claimants submit that “[a] proper quality assurance program that complied with the 18 criteria of Appendix B, including proper design control and adequate corrective action, would have identified and prevented these errors. These regulations and requirements, documented in such processes as design verification reports and design review checklists, are put in place to catch the very errors that were made by Mitsubishi. Mitsubishi’s numerous design errors, such as the Gap Velocity Error, should have and could have been caught if a proper quality assurance program that complied with the regulations had been in place.”¹⁵⁸¹

1513. In addition, in their C-RPHM, the Claimants contend the following:

While QA does not demand perfection, it does require a designer to prevent the occurrence of errors that affect the safe operation of nuclear equipment and cause RSGs to fail in less than half of a cycle. That errors causing such unexpected and unprecedented thermal-hydraulic conditions and tube wear went undetected and wound up in an operating nuclear power plant such that the nuclear equipment was unable to perform safely and operate as intended demonstrates that Respondents’ QA program was ineffective. Even Respondents’ own experts admit that if the design errors alleged by Claimants in fact occurred, their QA program was deficient.

Respondents’ design errors would have been caught and corrected by a QA program compliant with NRC the requirements, such as independent design

¹⁵⁸¹ Claimants’ Responses to Joint List of Issues, ¶ B.4(f)(i).

verification, proper documentation, and adequate communication between design organizations. For example, the Gap Velocity Error went undetected by Respondents for 20 years, even when their own consultant advised their designers to check whether the proper conversion was done. Moreover, had Respondents dedicated their commercial grade codes upon learning of this requirement in December 2008—prior to the delivery of the RSGs to SONGS—they would have caught the Gap Velocity Error.

Additionally, proper verification of design documents and calculations—i.e. checking manuals, documents, and calculations against the regulations—would have revealed such errors. Respondents' failure to catch and correct their design errors signifies a defective QA program. Respondents' contention to the contrary is unsupported even by their own experts.¹⁵⁸²

(ii) *The Respondents' Position*

1514. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

An organization's quality assurance program can be adequate and effective even if it does not identify every deficiency, weakness, and error in the organization's activities.

The fact that Mitsubishi's QA program did not identify the gap velocity conversion error during the RSG design process does not demonstrate that the program was ineffective. As Mr. Mitchell testified, although the goal of every QA program is to identify all potential errors in the design and fabrication of a piece of equipment, it is not possible to uncover every one. In fact, according to Mr. Merschoff, 70% to 75% of the NRC's inspections of QA programs identify deficiencies, weaknesses, and/or errors. No QA program would be deemed effective if perfection was required all of the time.

On the contrary, a quality assurance program in the nuclear industry is ineffective only when an organization is aware of weaknesses, does not enter them into the corrective action program (or enters them improperly into the corrective action program), does not take the appropriate actions to resolve the weaknesses, and has issues with the corrective action program and the internal audit program. There is no evidence in this case that Mitsubishi's QA program suffered from those issues. In fact, as described above, Mitsubishi's QA

¹⁵⁸² Claimants' RPHM, ¶¶ 159-161.

program has been found effective for decades through a wide range of audits, inspections, and reviews by a variety of parties.¹⁵⁸³

(iii) The Tribunal's Determination

1515. While the Tribunal agrees with the Respondents that an effective QA program may not identify every error in a design process, the Tribunal considers that alleged errors of the size and scope put forth by the Claimants would amount to a failure of the Respondents' QA program, as the Respondents' Experts Mr. Mitchell and Johnson agreed during the Hearing.¹⁵⁸⁴
1516. However, as determined by the Tribunal in Sections XI and XII above, the design errors as alleged by the Claimants did not occur or to the extent the Tribunal considers the Claimants' allegations to be convincingly proven, do not amount to consequential design errors that would demonstrate a failed QA program.
1517. Accordingly, the Tribunal answers Issue B.4(f)(i) in the negative. A QA program is not effective if it would have failed to catch all of the errors as alleged by the Claimants' experts at Exponent.

(h) Did Mitsubishi fail to execute an adequate design review to catch and correct the alleged design errors, as alleged by Claimants? (Issue B.4(g))

1518. This Issue B.4(g) concerns the question whether Mitsubishi failed to execute an adequate design review to catch and correct the alleged design errors, as alleged by the Claimants.

(i) The Claimants' Position

1519. In their Responses to Joint List of Issues, the Claimants submit that “[p]roper design review at each phase of the design process that challenged and questioned

¹⁵⁸³ Respondents' Position Statement on the Revised List of Issues, ¶¶ 132-134.

¹⁵⁸⁴ Transcript, p. 4989; See also Transcript pp. 4834-4835.

Mitsubishi's assumptions and decisions would have identified [and addressed] many of the errors that resulted in the failure of the RSGs. Mitsubishi's design review procedure required Mitsubishi to complete design review checklists. However, Respondents have neither produced such documents nor attempted to explain their absence. Mitsubishi's lack of checklists, meeting minutes, and other documentation of internal design reviews demonstrates that Mitsubishi failed to implement a system of checks to ensure that any errors and mistakes in the SONGS RSG design would be caught and corrected."¹⁵⁸⁵

1520. In addition, the Claimants supplement the aforesaid submissions, in their C-RPHM, by contending the following:

Rigorous design reviews are standard practice among designers in the nuclear industry. Significantly, Respondents were obligated by the RSG Contract to conduct internal design reviews for all design documents. But Respondents failed to meet this obligation, producing evidence of only two internal design review meetings. Additionally, Respondents' design review procedure required Respondents to complete design review checklists. However (...), Respondents' lack of checklists, meeting minutes, and other documentation of design reviews demonstrates their failure to implement a compliant design review regime.

In an attempt to show they complied with the RSG Contract and industry standards, Respondents point to joint design reviews held by Edison and Mitsubishi. But these are no substitute for the internal design reviews that Respondents were required to conduct. The joint design reviews lacked independence as the vast majority of Mitsubishi's design review team members were either supervisors or members of the design team. Moreover, Edison was not responsible for the design and was not an expert in designing and fabricating RSGs. While Edison asked tough questions and challenged design assumptions, its ability to adequately review the design was limited by its lack of expertise and to the information it was given by Respondents. Indeed, Edison repeatedly questioned the accuracy of Respondents' codes and predictions; Respondents repeatedly assured Edison that it was all correct. Respondents did not share with Edison the internal concerns of their

¹⁵⁸⁵ Claimants' Responses to Joint List of Issues, ¶ B.4(g).

consultants and failed to provide Edison with accurate information to properly assess the design due to the errors embedded in Respondents' codes.

Moreover, as discussed above, Edison's involvement and interest in the design do not change Respondents' obligations to conduct internal design reviews and produce a design that is safe and effective. Respondents cannot now blame Edison, their customer, for a deeply flawed design, especially when their errors could have been prevented had they acted as a responsible designer and conducted design reviews as required by the RSG Contract and industry practice.¹⁵⁸⁶

(ii) *The Respondents' Position*

1521. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

The record in this arbitration lacks proof supporting the allegation that Mitsubishi failed to execute an adequate design review. The record evidence shows that Mitsubishi, its outside experts, *and Edison* worked together to extensively review the SONGS design. Mitsubishi, Edison and their outside experts held more than 25 major design review and other technical discussion meetings over the course of the design and manufacturing of the SONGS RSGs. These were multi-day meetings that covered all the major aspects of the RSG design and fabrication and addressed various questions posed by Edison and its consultants as well as by Mr. Langford and Mr. Wilson, experienced Westinghouse engineers in steam generator design and tube vibration. While Edison did not design steam generators, the engineers at Edison were "very skilled" with a knowledge of "engineering fundamentals." Edison's engineers were specialists in mechanical engineering, nuclear analysis, metallurgy, structural engineering, and thermal hydraulics.

The evidence shows that throughout the design review process, Edison maintained "intrusive oversight" of Mitsubishi's activities and in some ways dictated the design. From the beginning of the project, Edison requested a 10-15% increase in heat transfer surface area and specified the thermal power, secondary pressure, primary and secondary water volume, steam pressure, primary side temperature, primary coolant flowrate, feedwater temperature, and a range for the shell size and center of gravity. These Edison requirements were incorporated in the Edison design specification that was part of the Contract. Further, Edison participated in the many design review meetings,

¹⁵⁸⁶ Claimants' RPHM, ¶¶ 162-164.

technical review meetings, biweekly AVB design meetings as well as over 200 videoconferences and 18 executive-level meetings. Additionally, one or more Edison employees were stationed at Mitsubishi's Kobe facility throughout the design and fabrication process and were instructed by Edison to conduct "intrusive, extensive oversight" of "all elements of MHI's design and fabrication efforts" in order to provide "[i]ndependent verification of MHI work results...." Edison would make its own pronouncements on how to design the steam generators. According to Mr. Wharton at the hearing, "...we would challenge, we would question, we would continually explore the basis for Mitsubishi's assumptions, the use of the tools, why they were valid for what they were doing here."

Mitsubishi expert witness Robert Wilson explained that this intrusive oversight went beyond typical utility practice. In his written testimony he explained that "[b]ased on [his] experience at Westinghouse, which included many RSG projects, Edison's control over the RSG design was far greater than [he] had experienced with other RSG customers." At the hearing, Mr. Wilson reaffirmed that Edison was involved to a greater degree than he had ever experienced. In discussing a particular action item at the hearing, he added that because of Edison's extensive involvement "they knew more about it than I did."

As a result of this intrusive oversight, Edison received thousands of documents associated with the design and fabrication of the steam generators. According to Mr. Wharton, Edison was ultimately able to satisfy itself that optimal design, fabrication and performance was achieved, fabrication sequences achieved intended results, unintended consequences would not occur, and that Mitsubishi met all specification, code, and standard requirements.

Now Claimants allege that Mitsubishi made fundamental errors during the design that "illustrate a basic lack of understanding of science and engineering" and that Mitsubishi failed to execute an adequate design review process. This argument is rebutted by the undisputed evidence of Edison's oversight of Mitsubishi during the design. Edison's engineers had an admitted knowledge of "engineering fundamentals" and would surely notice a basic lack of understanding of science and engineering. If Mitsubishi's design review process were woefully inadequate, surely Edison, a company responsible for the safe operation of a nuclear power plant, would notice and would not have been assured that the optimal design was achieved.

Many of the areas of allegedly insufficient review that are supposedly demonstrative of Mitsubishi's fundamental errors were discussed in detail in the design review meetings. For example, Claimants have made much of the

supposedly “extreme” T/H conditions in the SONGS RSGs. Claimants and their experts have alleged that Mitsubishi should have known that the void fraction in the steam generators would be over 98%, based on the void fraction of the OSGs. But Claimants have failed to establish that Mitsubishi was aware of the void fraction of the OSGs at the time of the design, and indeed that was not the case. Claimants’ experts merely assumed that Mitsubishi would be aware of the OSG void fraction. On the contrary, as the recipient of an ATHOS analysis performed by its prior vendor, *Edison* was aware of the maximum calculated OSG void fraction at the time of the design, which was 96.1%. The OSG void fraction of 98%, referred to by Claimants’ experts, was first calculated by Mitsubishi after the incident. Edison was also well aware of the projected RSG void fraction of [REDACTED] at the time of the design. As noted by Mr. Wharton in his testimony at the hearing, Mitsubishi and Edison had detailed discussions on lowering the void fraction at the time of the design, but determined that the options evaluated would only have produced a marginal gain and it could not be lowered further without violating the requirements of the Edison specification.

This is not the only area where Edison was involved in reviewing the design. The low gap velocity was an action item that was discussed and jointly agreed to by Edison and Mitsubishi. Further, as discussed in sections B.4(a) and B.4(b) above, Mitsubishi and its experts also performed an alternative, first-principles comparison against [REDACTED] to assure margin against flow induced vibration. Claimants now also allege that Mitsubishi should have considered in-plane FEI, but tellingly this analysis was never suggested at the time of the design. Mr. Langford and Mr. Wilson did not suggest or request an analysis of in-plane FEI, nor did Edison’s engineers, or Mitsubishi’s experts.

Edison, Mitsubishi, and Mitsubishi’s experts also discussed the input for the stability ratio analysis. As noted by [REDACTED] at the hearing, the three additional stability ratio cases that were performed for the SONGS design, with varying damping values, were performed for Mr. Langford. Mr. Langford agreed with the analyses performed by Mitsubishi at the time of the design, and when asked about the stability ratio analysis now suggested by Claimants’ experts, Mr. Langford stated it is “not something [he] would do.”

Dr. Elder, who asserted that the design review process was insufficient, was not there during the design. He based his conclusions on a limited number of documents, only those received during discovery, while he was unaware of the thousands of documents and 60 binders of QA materials held by Edison from the time of the design. For example, Dr. Elder criticized the level of indexing at SONGS compared to ANO-2, but Edison, Mitsubishi, and Mitsubishi’s

consultants, who were personally involved in the design of ANO-2, discussed the indexing value at the time of the SONGS design. Of note, the one Edison witness who was there at the time of the design, Mr. Wharton did not raise a similar concern.

Based on this record, it is clear that Claimants have failed to show that Mitsubishi's design review process was inadequate.¹⁵⁸⁷

(iii) The Tribunal's Determination

1522. The Claimants' submissions on this Issue are based in large parts on the expert opinion of Dr. Elder. Dr. Elder identified two categories of design failures: (i) alleged failures to meet ASME or NRC standards of design; and (ii) conclusions based upon the Claimants' expert Exponent's alleged design errors.
1523. Regarding general alleged design failures, the Tribunal set out the design process in Section VII.D above. That design process included what, in the Tribunal's view, consisted of a significant number of meetings between the Parties and evolving versions of various design documents. In this connection, the evidence shows that Dr. Elder is critical of an apparent insufficient number of design checklists that should have been required as part of the design. While it is not entirely clear what these checklists consist of, the Tribunal notes that design documents, such as MHI's "Design of Anti-Vibration Bars" reports do include a "check sheet" that has been completed.¹⁵⁸⁸
1524. The Claimants' expert Dr. Elder identified the failure of the Respondents to produce their "design checklists" as evidence that such checklists do not exist and as such are a design deficiency of the Respondents.¹⁵⁸⁹ Dr. Elder testified that there should be 18 of such checklists.

¹⁵⁸⁷ Respondents' Position Statement on the Revised List of Issues, ¶¶ 135-144.

¹⁵⁸⁸ Exh. JX-782, p. 9.

¹⁵⁸⁹ Expert Witness Statement of Dr. Elder (Design Era Testimony), ¶ 132.

1525. In this connection, the Tribunal notes that the PAR includes a reference to 18 design documents, such as the “Design of Anti-Vibration Bar” report, in addition to the RSG Contract (Revision 3).¹⁵⁹⁰ Whether, like the “Design of Anti-Vibration Bar” report that is exhibited, the other such reports identified in the PAR also contained “check sheets” is unknown to the Tribunal. The Respondents submit that Dr. Elder was not present during the design of SONGS and that there are thousands of design era documents.
1526. The record shows that SCE was heavily involved in reviewing the design process. If there were obvious QA design deficiencies, such as a failure to complete checklists or a failure to have independent review of designs, as alleged by Dr. Elder, such would likely have been raised during the significant number of design meetings. While in this Arbitration the Claimants suggest impropriety in alleged lack of independence between the drafters and checkers of MHI’s various design reports, those reports identify who was responsible for drafting and review. The Tribunal has not received convincing evidence of objections to MHI’s review process from the design era.
1527. To the extent that Dr. Elder may have identified procedural design errors and deficiencies in MHI’s design process, it is not evident that those errors lead to any errors in the design of SONGS. To put it simply, a failure to follow a proper procedure does not necessarily imply a failure to “catch and correct the alleged design errors, as alleged by [the] Claimants.”
1528. In any event, as determined in Sections XI and XII above, the Tribunal considered that the majority of the alleged design errors did not occur and that those design errors that did occur were of minimal impact.

¹⁵⁹⁰ Exh. JX-813, p. 80.

1529. Accordingly, the Claimants have not convincingly established that Mitsubishi failed to execute an adequate design review to catch and correct the alleged design errors.

(i) **If Claimants have shown the failures in (a), (b), (c), (d), (e), (f) and/or (g), did extreme thermal-hydraulic conditions, vibration, and/or tube wear occur? (Issue B.4(h))**

1530. This Issue B.4(h) concerns the question of if the Claimants have shown the failures in Issues B.4(a), (b), (c), (d), (e), (f) and/or (g) above, did extreme thermal-hydraulic conditions, vibration, and/or tube wear occur?

(i) *The Claimants' Position*

1531. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi’s failure to:

- analyze design features
- correctly predict thermal-hydraulic conditions, vibration, and wear
- properly analyze for out-of-plane fluid elastic instability
- properly analyze for random vibration
- execute an effective quality assurance program; and
- failure to execute an adequate design review

all contributed – both individually and collectively – to cause the extreme thermal-hydraulic conditions, vibration, and tube wear that occurred in the SONGS RSGs.”¹⁵⁹¹

1532. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

To prevail on their claims, Claimants do not need to show that the thermal-hydraulic conditions, tube vibration, or tube wear was “extreme.” That said,

¹⁵⁹¹ Claimants’ Responses to Joint List of Issues, ¶ B.4(h).

expert after expert, including AREVA, Respondents' own experts, and the NRC, have concluded that the thermal-hydraulic conditions in the SONGS RSGs were extreme and outside the envelope of successful operating experience. Those first-of-a-kind thermal-hydraulic conditions created the environment for in-plane and out-of-plane FEI to occur and caused the significant tube wear that led to the shutdown of SONGS.

➤ ***Extreme Thermal-Hydraulic Conditions Occurred***

SONGS had a maximum void fraction, as calculated by Respondents after the failures, of 99.6% and maximum velocities, as calculated by Respondents, of [REDACTED]. According to the NRC, SONGS had extreme thermal-hydraulic conditions: Respondents' RSG design resulted in "secondary side thermal hydraulic conditions" that "were beyond the envelope of successful industry experience." This conclusion had previously been voiced by AREVA: "At 100% power, the thermal-hydraulic conditions in the u-bend region of the SONGS replacement steam generators exceed the past successful operational envelope for U-bend nuclear steam generators" Respondents make no effort to undercut either the NRC's or AREVA's (including Dr. Begley before he became a witness for Respondents) conclusion on this score. The opinion of the NRC (as well as that of AREVA) provides conclusive proof that the thermal-hydraulic conditions at SONGS were first of a kind.

Respondents' sole retort actually substantiates the conclusion that the thermal-hydraulic conditions were extreme. Respondents proffered a chart of "ATHOS Maximum void fraction[s]" for [REDACTED] and SONGS. SONGS' void fraction is the highest of these four "CE-type steam generators." Respondents argue that this comparison shows that "SONGS and other large CE-type steam generators . . . are within 1% of each other," but that comparison obscures the relevant metric—water content. It is the liquid water, not the percentage of steam, that provides vibration damping. Comparing [REDACTED] which had the highest void fraction between it, [REDACTED] and [REDACTED] to SONGS shows that [REDACTED] (even at such high void fractions) had three times more liquid water than SONGS.

Of equal if not more importance, Respondents do not even attempt to defend the extreme flow velocities that occurred at SONGS. Flow velocity is the driving force behind FEI. The extreme velocities at SONGS resulted in out-of-plane FEI—not present in plants like St. Lucie-2—and in-plane FEI—a phenomenon designed out of every other steam generator. This first-of-a-kind vibration was caused by the first-of-a-kind velocities at SONGS.

➤ ***Extreme Tube Vibration and Tube Wear Occurred***

Claimants have established that Respondents' design defects contributed—both individually and collectively—to cause extreme thermal-hydraulic conditions, vibration, and tube wear in the SONGS RSGs. Such defects include Respondents' failure to (1) analyze design features; (2) correctly predict thermal-hydraulic conditions, vibration, and wear; (3) properly analyze for out-of-plane FEI; (4) properly analyze for in-plane FEI; (5) properly analyze for random vibration; (6) execute an effective quality assurance program; and (6) execute an adequate design review.

Respondents falsely claim that, “[o]f the wear found at SONGS, only the tube-to-tube wear caused by in-plane FEI was beyond normal industry experience.” This is false. Dr. Egan testified that the tube-to-AVB wear at SONGS alone was “among the highest, if not the highest, ever observed in the United States,” and that it would have proven to be independently life limiting. Respondents' expert Dr. Begley also testified that, based solely on the “excessive” tube-to-AVB-wear, he would classify the SONGS Units as “wear challenged.” Furthermore, Respondents' current claim is inconsistent with its own statements. Following the failures, in its August 30, 2012 Technical Evaluation Report, Respondents stated: “it is concluded that the thermal-hydraulic conditions in the SG secondary side, namely high void fraction (steam quality) and high flow velocity, are the main causes of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs.”

Therefore, post-failure Respondents admitted the tube-to-AVB wear was “unexpected” and “excessive” in both Units. Indeed, FEI and random vibration caused four different types of tube wear on more than 3,400 tubes. Now, Respondents' litigation position is that only the tube-to-tube wear was beyond normal industry experience and Unit 2 only had “slight tube-to-tube wear.” However, Dr. Begley—now Respondents' expert but at the time AREVA's consultant—told Edison that the tube-to-tube wear made SONGS the “worst case degraded steam generator in the history of domestic nuclear power,” and that it was “fortunate that a very local wall penetration occurred in one tube leading to a leak rather than proceeding to a burst.” He also testified that in-plane FEI had begun in Unit 2 and it “could have become quickly full-blown instability[, i]nvolving more tubes, deeper wear depths, deeper tube-to-tube wear depths.” Therefore, it has been established that extreme tube vibration and wear did occur as a result of Respondents' design failures.¹⁵⁹²

¹⁵⁹² Claimants' RPHM, ¶¶ 165-171.

(ii) *The Respondents' Position*

1533. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have failed as a factual matter to prove that there were alleged design failures as outlined in [the Respondents' submissions concerning Issue] B.4, sub-issues (a), (b), (c), (d), (e), (f) and (g) above or that these alleged failures led to extreme T/H conditions, vibration or tube wear.

➤ ***Extreme T/H conditions did not occur as a result of any failures alleged in B4(a) – B4(g)***

As noted in [the Respondents' submissions concerning Issue] B.4(b), none of the computer-generated predictions of the T/H conditions at SONGS provide the *actual* conditions in the SONGS RSGs; no one knows the actual conditions. So Claimants have failed to establish the actual T/H conditions in the SONGS RSGs. Claimants have also failed to demonstrate that the T/H conditions, such as velocity and void fraction, are “extreme.” In particular, Claimants have not even attempted to establish that the velocity is “extreme,” and omit any discussion of velocity from the Reply Memorial section titled, “When Corrected, Mitsubishi’s Design Analysis Predicts Extremely High void fractions and High Velocities.” Claimants have provided no context for the velocity predictions at SONGS, focusing on comparing the ATHOS predictions for narrow gap to FIT-III predictions for a wide gap on one tube—a pointless comparison. Lacking are the comparisons with other RSGs, to demonstrate how “extreme” these velocity predictions really are.

Claimants have attempted to establish the void fraction as “extreme,” mainly by comparing FIT-III and ATHOS results, but have ignored the only *data* that has been presented in this case. As demonstrated in the table below, a comparison of the ATHOS-predicted void fractions for SONGS and other large CE-type steam generators show that they are within 1% of each other, which is well within the band of uncertainty of ATHOS. Stated another way, the SONGS steam generators could have the same void fraction conditions as these other CE-type steam generators or SONGS could actually be lower.

Facility	ATHOS Maximum void fraction
██████████	98.5%

██████████	98.7%
██████████	98.5%
SONGS (MHI Analysis)	99.6%

Additionally, Claimants have failed to even establish that the void fraction is relevant to this case, because Claimants have failed to establish that the RSGs' void fraction caused in-plane FEI. As discussed in the Post-Hearing Memorial, despite having identical T/H conditions, the two Unit 3 RSGs had 160 to 165 tubes each with tube-to-tube wear due to in-plane FEI compared to only *two* tubes in the Unit 2 RSGs with slight tube-to-tube wear, even though Unit 2 operated twice as long. Since the thermal-hydraulic conditions, including void fraction, were identical for all 4 RSGs the different performance of Units 2 and 3 shows that void fraction was not the driving cause of in-plane FEI. Rather, as acknowledged by Claimants to its regulators, the differences in support conditions between Unit 2 and Unit 3 were the main cause of the in-plane FEI that occurred in the SONGS RSGs.

All of the SONGS RSGs had the same void fraction, but only Unit 3 experienced a significant amount of tube-to-tube wear. And Claimants allegation that the damping changes drastically between a void fraction of ██████████ and 99.6% has no impact on Mitsubishi's stability ration calculation: in both cases Mitsubishi assumes essentially no two-phase damping. As a result, using a void fraction of 99.6% instead of ██████████ would have little impact on the stability ratio analysis and the prediction of FEI. And it would have no impact on the prediction of in-plane FEI, given that in-plane was not part of the analysis at the time.

➤ ***Extreme tube vibration and wear did not occur as a result of any failures alleged in B4(a) – B4(g)***

Claimants have also failed to establish that their alleged design failures led to extreme vibration or tube wear. Of the wear found at SONGS, only the tube-to-tube wear caused by in-plane FEI was beyond normal industry experience. Thus, only that form of wear and vibration mechanism could be considered extreme, and Mitsubishi acted in accordance with industry practice by focusing on the prevention of out-of-plane FEI, before in-plane FEI. Additionally, the thicker-AVB repair proposed by Mitsubishi would have stopped the in-plane FEI at SONGS, allowing for the restart of both Units, if Edison had chosen to adopt the repair.

Edison has acknowledged that the wear that was not caused by in-plane FEI at SONGS was not extreme but rather within industry experience. In statements made to the NRC and the public in late 2012, Edison attributed the other wear to random vibration, concluding that the “wear is manageable on a going forward basis” and while the wear at SONGS was at the “high end,” “a couple of plants [] have similar numbers.” And in 2013, well after the Operational Assessments were completed and Edison had applied for restart, Edison told the NRC Commissioners that the other wear at SONGS *would allow safe operation of the Unit 2 steam generators at 100% power*. At the hearing Mr. Palmisano also confirmed that the other wear in the SONGS RSGs was “normal wear,” and that Edison found the conditions in the Unit 2 steam generators to be satisfactory.¹⁵⁹³

(iii) *The Tribunal’s Determination*

1534. As determined in Section XIII.D(b) above when addressing Issue B.4(b), the Claimants have demonstrated that MHI did under-predict the thermal-hydraulic conditions, potential for tube vibration and potential for tube wear in the RSG design.¹⁵⁹⁴
1535. By consequence, the Tribunal is required to determine whether “**extreme** thermal-hydraulic conditions, vibration, and/or tube wear occurred” (emphasis added).
1536. The Parties have not defined how the term “extreme” should be interpreted. In line with the ordinary meaning of the term “extreme,” the Tribunal interprets it as either a very great departure from industry expectations or one where the effects are very serious or severe.
1537. Regarding the question of whether extreme thermal-hydraulic conditions occurred, the Tribunal considers both the void fraction and velocities in the RSGs below.
1538. Regarding void fraction, the record shows that:

¹⁵⁹³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 146-151.

¹⁵⁹⁴ See ¶ 1431 above.

- i. Using FIT-III, the as designed RSGs were calculated to have a maximum void fraction of [REDACTED]¹⁵⁹⁵
- ii. Using ATHOS, the maximum void fraction in the RSGs was calculated at 99.6%;¹⁵⁹⁶
- iii. Using ATHOS, the maximum void fraction in the original SONGS steam generators was calculated at 98%;¹⁵⁹⁷
- iv. Other large steam generators are calculated, using ATHOS, to have maximum void fractions of 98.5% [REDACTED], 98.7% [REDACTED], and 98.5%, [REDACTED]¹⁵⁹⁸

1539. In addition, the Tribunal considers pertinent:

- i. The NRC conclusion that “secondary side thermal hydraulic conditions in the U-bend were beyond the envelope of successful industry experience.”¹⁵⁹⁹
- ii. MHI’s determination that in-plane FEI occurred in Unit 3 at void fractions exceeding 99.3%.¹⁶⁰⁰
- iii. That Unit 3 and Unit 2 have the same T/H conditions.¹⁶⁰¹

¹⁵⁹⁵ See ¶ 1245 above.

¹⁵⁹⁶ Exh. JX-1106, p. 10.

¹⁵⁹⁷ See ¶ 1405 above.

¹⁵⁹⁸ Witness Statement of [REDACTED] ¶ 14.

¹⁵⁹⁹ Exh. JX-2000, p. 31.

¹⁶⁰⁰ Exh. JX-1734, p. 16; See also Exh. JX-1471, p. 21 (Exh. JX-1471, p. 43 has a similar table for tube-to-AVB wear).

¹⁶⁰¹ See Respondents’ PHM, ¶ 148.

1540. While it is evident that the void fraction at SONGS exceeds void fraction calculated for other plants, it is less clear that this departure represents “extreme” T/H conditions. The Respondents have emphasized that the SONGS void fraction is within 1% of its peers.¹⁶⁰² The Claimants have emphasized that these comparable plants have “*three times* more liquid water than SONGS.”¹⁶⁰³ Presumably this conclusion is reached by comparing the water content at SONGS (i.e., 0.4%) versus the other plants mentioned in the table in ¶ 1533 above (i.e., 1.3-1.5%), which mathematically demonstrates that indeed these other plants have 3 (or almost 4) times the amount of water.
1541. However, given the evidence before the Tribunal of the minimal benefits of two-phase damping at such levels, it is less apparent that this fact is relevant. Considering that Unit 2 did not experience in-plane FEI despite twice the operating period, the record shows that the limited damping from the two-phase flow at maximum void fraction is of minimal relevance in preventing in-plane FEI if support conditions are adequate, as they were in Unit 2.
1542. The Tribunal does not consider the void fraction at SONGS to be one that departs drastically from prior operating experience of the OSGs or of other comparable steam generators such as ██████████ or ██████████. In all such cases, the two-phase damping benefits appear minimal given the high void fractions.¹⁶⁰⁴
1543. As determined below,¹⁶⁰⁵ the Tribunal, however, considers that the void fraction at SONGS resulted in in-plane FEI, given the support conditions as found in Unit 3, such that this resulted in a very serious or severe effect, the first occurrence of in-

¹⁶⁰² Expert Report of Dr. Hibiki, ¶ 9.

¹⁶⁰³ Claimants’ RPHM, ¶ 167.

¹⁶⁰⁴ See ¶ 1533 above.

¹⁶⁰⁵ See Section XV.C(b)(iii)I.A(a)(i)(1) below.

plane FEI.¹⁶⁰⁶ The conclusive evidence of this is the Respondents' own finding that had void fraction been just slightly less, at 99.3% rather than 99.5% or 99.6%, then in-plane FEI would have been avoided.¹⁶⁰⁷

1544. Consequently, the void fraction at SONGS was an extreme thermal-hydraulic condition.
1545. Turning to velocity, briefly, the Tribunal similarly concludes that given the occurrence of unprecedented in-plane FEI, the velocities at SONGS, namely effective velocity, exceeded critical velocity such that there was instability. Given the rapidly destructive effects of FEI, the Tribunal also considers that the secondary side two-phase flow velocities at SONGS were an extreme T/H condition.
1546. Accordingly, the Tribunal finds that the T/H conditions at SONGS were extreme.
1547. Regarding vibration and wear, the Tribunal finds that given the occurrence of in-plane FEI was an unprecedented phenomenon in the industry, there was extreme vibrations in SONGS Unit 3.
1548. With respect to the other types of wear in Unit 2 and Unit 3, the Tribunal does not consider the random wear at SONGS to be extreme. As SCE testified to the NRC, this "wear is manageable on a going forward basis" and was similar to other plants.¹⁶⁰⁸
1549. In light of the above, the Tribunal answers Issue B.4(h) in the affirmative. MHI under-predicted the thermal-hydraulic conditions, potential for tube vibration and

¹⁶⁰⁶ See Transcript, p. 734 (Dr. Elder).

¹⁶⁰⁷ Exh. JX-1734, p. 16; See also Exh. JX-1471, p. 21 (Exh. JX-1471, p. 43 has a similar table for tube-to-AVB wear).

¹⁶⁰⁸ Exh. JX-1539, p. 15.

tube wear in the RSGs, and extreme thermal-hydraulic conditions, vibration, and wear occurred.

(j) **If Claimants have shown the failures in (a), (b), (c), (d), (e), (f), (g) and/or (h), does such failure or failures, individually or in combination, provide evidence of Claimants' breach of contract claim? (Issue B.4(i)) If so, what is the consequence, if any? (Issue B.4(i)(i))**

1550. Issues B.4(i) and B.4(i)(i) are addressed together below and concern the questions of if the Claimants have shown the failures in Issues B.4(a), (b), (c), (d), (e), (f), (g) and/or (h) above, does such failure or failures, individually or in combination, provide evidence of the Claimants' breach of contract claim and, if so, what is the consequence, if any?

(i) *The Claimants' Position*

1551. With respect to the Issue B.4(i), the Claimants, in their Responses to Joint List of Issues, submit that “[e]ach design failure – both individually and in taken together – bears on the specific breaches of contract discussed in [the Claimants’ submissions concerning Issue] B.6 below. These issues represent the main factual disputes among the parties and Claimants are not required to prove each of these in order to make out a breach of contract. Rather, at its core, evidence of design failures generally shows that the RSGs did not conform to the contract—i.e. the RSGs were not “capable of being operated safely, normally and continuously in accordance with the requirements of the Specification, the Purchase Order, all Applicable Laws, Applicable Standards and the Documentation associated therewith at all operating conditions and modes specified in the Specification, the Scope of Work or other applicable Documentation.””¹⁶⁰⁹

¹⁶⁰⁹ Claimants’ Responses to Joint List of Issues, ¶ B.4(i).

1552. With respect to the Issue B.4(i)(i), the Claimants, in their Responses to Joint List of Issues, submit the following:

This material breach with regard to the design of the RSGs frustrated the purpose of the RSG Contract. Whether a breach is material “depends on the importance or seriousness thereof and the probability of the injured party getting substantial performance.” *Brown v. Grimes*, 192 Cal. App. 4th 265, 278 (2011) (quoting 1 Witkin, Summary of Cal. Law (10th ed. 2005) Contracts, § 852, pp. 938-940).

Mitsubishi failed to deliver RSGs that would operate safely for 40 years and instead delivered—due to a systemically defective design process—fundamentally defective machines that experienced extensive and excessive wear, a breach of the reactor coolant pressure boundary, and a severe loss of tube integrity in one cycle of operation or less.¹⁶¹⁰

(ii) *The Respondents’ Position*

1553. With respect to the Issue B.4(i), the Respondents, in their Position Statement on the Revised List of Issues, contend the following:

Even if Claimants had established the purported failures outlined in the subsections above, Claimants have failed to meet their burden to establish that any of or all of these purported design errors results in a breach of contract. As noted above, these purported design failures in sections 4(a) through 4(f) are – in Claimants own words – “factual questions...intended to guide the Tribunal.” Claimants have not even attempted to establish the contractual basis for the issues in sections 4(a) through 4(f) at any point in these proceedings. So, even if the factual determinations in sections 4(a) through 4(f) are answered affirmatively, Claimants still need to link these allegations to the breach of a specific contract section.

Additionally, for the alleged breach of contract to be actionable, the breach must have caused the shutdown of SONGS and must have caused Claimants’ damages. Only the tube-to-tube wear caused by in-plane FEI could have caused the shutdown. As Edison’s Peter Dietrich stated before the Nuclear Regulatory Commission in 2013, the other wear was “within the experience of other operating plants” and would “allow safe operation of the Unit 2 steam generators at 100% power.” Thus, the alleged errors would have to relate to the

¹⁶¹⁰ Claimants’ Responses to Joint List of Issues, ¶ B.4(i)(i).

prediction of in-plane FEI before they could become actionable; only Issue B4(d) fits this description, but in this instance Mitsubishi complied wholly with the industry practice.

Even if Claimants could establish the breach of a specific contractual provision and a link to damages, all breach of contract claims are subsumed into Mitsubishi's warranty obligations. The alleged failures listed above could be remedied under section 1.17.1.3 of the RSG Contract through a repair or replacement, or through liquidated damages under section 1.29. As discussed in section C, Mitsubishi met its warranty obligations and/or was excused by Edison actions.¹⁶¹¹

1554. In addition, with respect to the Issue B.4(i)(i), the Respondents, in their Position Statement on the Revised List of Issues, contend that “[i]f the Tribunal finds that the purported failures outlined in the subsections to Issue 4 occurred the Tribunal would still need to determine if an actionable breach of contract occurred. If the Tribunal affirmatively decides the factual determinations outlined in the subsections to Issue 4, the Tribunal would still need to determine if Claimants met their burden of proving that these purported design errors were breaches of the RSG Contract, caused the tube-to-tube wear, the shutdown, and Claimants’ damages, and that the Warranty remedy failed. As Respondents have shown, Claimants have failed to meet that burden.”¹⁶¹²

(iii) Tribunal’s Determination

1555. Below, the Tribunal addresses Issues B.4(i) and B.4(i)(i) together.
1556. As held above, the Claimants have demonstrated that there were extreme thermal-hydraulic conditions, vibration and wear at SONGS.¹⁶¹³

¹⁶¹¹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 152-154.

¹⁶¹² Respondents’ Position Statement on the Revised List of Issues, ¶ 155.

¹⁶¹³ See ¶¶ 1544-1547 above.

1557. Having concluded in Issue B.1 that the PAR is not a contractual document, but a deliverable under the RSG Contract,¹⁶¹⁴ by consequence, the extreme thermal-hydraulic conditions of the RSGs do not, in and of themselves, constitute a contractual breach.
1558. At best, under Sections 1.16.1.3 and 1.16.2 of the RSG Contract, regarding “Acceptance” of the RSGs, the departure from the PAR may have triggered the warranty obligations as if there was a defect in the RSGs. Sections 1.16.1.3 and 1.16.2 of the RSG Contract provide in relevant parts as follows:

1.16.1 “Acceptance” shall mean that all of the following have occurred for the RSG Units:

(...)

1.16.1.3 The RSG Units have been in operation for a sufficient period to demonstrate that they are capable of being operated safely, normally and continuously in accordance with the requirements of the Specification, the Purchase Order, all Applicable Laws, Applicable Standards and the Documentation associated therewith at all operating conditions and modes specified in the Specification, the Scope of Work or other applicable Documentation.

(...)

1.16.2 (...) Supplier shall have the option of (i) declaring Acceptance of the Work and Supplier shall then be required to pay liquidated damages in accordance with Section 1.29.1 or (ii) correcting such failure in accordance with Section 1.17.1.3 as if such failure were a Defect in order for the Apparatus to satisfy such Guaranteed Performance Levels.

¹⁶¹⁴ See ¶ 1317 above.

1559. Furthermore, the occurrence of extreme vibration and/or tube wear does constitute a violation of Section 3.9.3.7 of the RSG Contract regarding tube support. Section 3.9.3.7 of the RSG Contract provides in pertinent part as follows:

The RSG shall be equipped with tube supports that adequately support the tube bundle and facilitate internal circulation. The tube supports shall be of a broached plate type and shall be designed in accordance with ASME Section III, Subsection NF. (...).

1560. While most of Section 3.9.3.7 of the RSG Contract is in regard to the TSPs, the Tribunal considers that it also provides specifications in regard to support from AVBs, which provide tube support in the tube bend area:

Specifically, the Supplier shall demonstrate that its design will minimize vibration-induced tube wear or fatigue in the tube bend area of the tube bundle. The Supplier shall perform a stability analysis of the tubes both in the tube bend region and over the straight length.

1561. The failure to provide adequate tube support constitutes a defect of the RSG Contract under Section 1.2.13, triggering the Supplier's, i.e., the Respondents' warranty obligations under Section 1.17 of the RSG Contract. Section 1.2.13 of the RSG Contract provides as follows:

Defect: Work that (i) does not conform to the requirements of the Purchase Order, (ii) is not new as of the date of delivery or of uniform good quality as required pursuant to the Purchase Order, (iii) is not free from defects or deficiencies in design, application, materials, manufacture or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order, or (iv) would adversely affect, contrary to the requirements of the Purchase Order, (a) the performance of the Apparatus under operating conditions consistent with those contemplated in the Purchase Order, (b) the continuous safe operation of the Apparatus during the Apparatus's design life, or (c) the structural integrity of the Apparatus and/or (v) are not suitable for the use as set forth in the Purchase Order; provided that (i) if Supplier fails to satisfy a Guaranteed Performance Level, such failure shall not be considered a Defect provided Supplier has paid the liquidated

damages applicable to such Guaranteed Performance Level for such failure, and/or (ii) cosmetic changes in appearance over time shall not be considered a Defect. Anything to the contrary notwithstanding, the Parties agree that Work shall be considered to be defective if it does not conform to the Applicable Standards or Applicable Laws.

1562. Accordingly, the Claimants have shown that the failures identified in Issue B.4(b) constitute a “Defect” as defined in Section 1.2.13 of the RSG Contract, which in turn triggers the warranty provisions of the RSG Contract under Section 1.17.
1563. The Tribunal considers it pertinent to also address the question of whether the higher than predicted T/H conditions in the as-designed RSGs in and of themselves constitute a “Defect” as defined in Section 1.2.13 of the RSG Contract. The Tribunal concludes they do not. Generally, the definition of “Defect” under Section 1.2.13 of the RSG Contract includes work that does not meet the standards of the Purchase Order, which includes, per Section 1.2.40 of the RSG Contract, the Contractual Design Specifications (i.e., the RSG Contract). As determined by the Tribunal in Issue B.1, the PAR, which lists the T/H conditions at issue, does not constitute part of the RSG Contract. Further, the Tribunal considers that while the definition of “Defect” under Section 1.2.13 of the RSG Contract is broad, it is limited by the requirement that a condition “adversely affect[s]” the RSGs. The T/H conditions in and of themselves, do not adversely affect the RSGs. Rather, it is the T/H conditions in combination with inadequate tube support that cause tube wear in the RSGs. The Tribunal’s interpretation is further supported by the caveat provided in Section 1.2.13 that “cosmetic changes in appearance over time shall not be considered a Defect.” As explained by Mr. Langford, high T/H conditions with adequate tube support result in a mere “polishing” of the tubes.¹⁶¹⁵ In sum, the Tribunal does not consider the high

¹⁶¹⁵ See ¶ 1455 above.

T/H conditions in the RSGs a Defect, only the wear consequence of such conditions is a defect, as set forth immediately above.

E. DID MITSUBISHI HAVE KNOWLEDGE OF ANY OF THE ALLEGED DESIGN ERRORS IN ISSUE B.4? (ISSUE B.5)

1564. The Claimants submit that the Respondents received numerous warnings, which made them aware or should have made them aware of the eventual design errors in the RSGs. The Respondents reject these allegations.

(i) The Claimants' Position

1565. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi received and ignored multiple warnings that its thermal-hydraulic predictions were wrong. These warnings came from the very consultants Mitsubishi retained to “make up for the fact that [it] didn’t have any large steam generator design experience” [- Mr. Robert “Con” Wilson and Mr. Paul Langford.] The warnings concerned void fraction, velocity, fluid damping, and gap velocity, among others.”¹⁶¹⁶

1566. In addition, the Claimants supplement these submissions, in their C-RPHM, by contending the following:

Consistent with Claimants’ experts’ reaction to the FIT-III thermal-hydraulic predictions compared to the design features of the SONGS RSGs, Mr. Langford questioned FIT-III’s void fraction results. He “expected the SONGS void fraction to be ... somewhere in the ■ plus percent range” and “communicate[d] that view to Mitsubishi at the time.” There is no evidence that Respondents checked their FIT-III void fraction predictions in light of Mr. Langford’s concern.

Similarly, Mr. Wilson communicated express concern regarding FIT-III’s void fraction and velocities results. In September 2005, Mr. Wilson wrote to Respondents: “[C]omparing test data with FIT-III and all the other [computational fluid dynamic] codes used for SG tube bundles you will see . .

¹⁶¹⁶ Claimants’ Responses to Joint List of Issues, ¶ B.5.

. that where the answers were easy, all codes got them right, but where the answers were complicated - like in the U-bend, FIT-III was very far away from the data and most other codes came closer.” Because of these concerns, Mr. Wilson asked Respondents “to show that they add some ‘margin’ to the FIT-III results”—“assume FIT-III under-predicts” “void fraction and fluid damping” as well as “the velocity and the fluid density” “and make design choices accordingly.” At the Hearing, Mr. Wilson testified that he does not know if Respondents followed his advice, but clearly, they did not:

- With respect to high void fraction, Mr. Wilson instructed Respondents to “assume zero damping and make design choices accordingly.” Respondents did not do so. In all of the stability ratio cases they ran, Respondents assumed some contribution from fluid damping.
- With respect to high velocities, Mr. Wilson instructed Respondents, “[f]or tube vibration,” to “increase the velocity . . . by ~20% and make design choices accordingly.” Again, Respondents did not do so. There is no indication of 20% added margin to the velocities used in Respondents’ Evaluation of Tube Vibration.

Even more disturbingly, Respondents were warned about the Gap Velocity Error, which when corrected predicts the out-of-plane instability that led to such significant wear in the RSGs. In October 2005, just one month after Mr. Wilson raised his concerns with FIT-III’s predictions on velocities, Mr. Langford told Respondents:

[T]he overall gap velocity distributions appear to be consistently lower than my expectations. . . . Does MHI have any way of demonstrating the changes in design that reduce peak velocities from more than [REDACTED] for domestic designs to about [REDACTED] for SONGS? *Is there any possibility that the plotted distributions represent bulk flow that should be multiplied by $p/(p-d)$ to obtain gap velocity distributions?*

Mr. Wilson testified that he shared Mr. Langford’s concern. Yet neither Mr. Wilson nor [REDACTED] knew whether Respondents checked that they were using the correct gap measurements in calculating velocities. [REDACTED] also testified that he did not know if Respondents confirmed that the gap velocity was correctly converted for the SONGS RSGs.

These concerns with FIT-III led Messrs. Wilson and Langford to ask Respondents to compare their results for SONGS with other plants. Respondents compared their SONGS results to results from Tihange and Fort Calhoun but Respondents came up “empty handed.” Mr. Wilson asked [REDACTED]

██████████ to compare the SONGS design to ██████████ using Respondents' computer modeling, but ██████████ refused to do so because it "takes a lot of time, effort, and money" and from Respondents' perspective, the "SONGS AVB design ha[d] already been finalized." At the time, ██████████ also stated that a detailed comparison would create "unnecessary discussion," but such "unnecessary discussion" likely could have identified the Gap Velocity Error (at a minimum). Mr. Langford told ██████████ that he disagreed with Respondents' decision not to do code-based comparison of SONGS to another operating steam generator, like ██████████. Mr. Wilson also told ██████████ that [he] wanted to see an apples-to-apples comparison: "comparing FIT-III results for SONGS and ██████████ or ATHOS results for SONGS and ██████████." This was never done because it would have been too expensive, taken too much time and the SONGS design had been "finalized" and sent for manufacture.¹⁶¹⁷

1567. Further, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents argue that their "first-principles comparison" between SONGS and ██████████ demonstrated that SONGS had better vibration margin than ██████████. This is incorrect. As Dr. Morse testified, "Westinghouse determined that the stability ratios in ██████████ with one ineffective support were less than 1." Respondents' contention to the contrary is based on an incorrect reading of Westinghouse's flow-induced vibration analysis of ██████████. Mr. Wilson walked through that report during his testimony and noted the difference between Section 6, titled "Vibration Analysis," and Section 7, titled "Operating Experience." Namely, Section 6 contains "[r]esults [which] characterize flow-induced vibration response and provide a basis for demonstrating satisfaction of fluid elastic instability limits" while Section 7 "provides a description of the Model F design and the related tube vibration and wear operating experience." This distinction demonstrates that Respondents' reliance on Section 7 as support for its claim that ██████████ had better vibration margin than SONGS is incorrect. Rather, Section 6 is the correct section to reference for this analysis—in fact, Section 7 explicitly states that "[t]he previous section [Section 6] provided calculations showing very low vibration response and satisfaction of conservative fluidelastic stability limits . . ." Section 7 contains "[m]ore conservative calculations . . . used as a basis for making consistent comparisons with operating Model F steam generators." Therefore, Section 6 contains the data for predicting the bounding stability ratios for the ██████████

¹⁶¹⁷ Claimants' RPHM, ¶¶ 176-179.

steam generators while Section 7 reflects an “[e]xcessive[ly] conservativ[e]” analysis “used only for comparison to the [REDACTED] steam generators.”

Looking at the correct section of Westinghouse’s flow-induced vibration analysis of [REDACTED]—Section 6—Table 6-4 provides stability ratios for “postulated bounding conditions for U-bend region.” The highest stability ratio is [REDACTED] for the tube located at row 149, column C90:

TABLE 6-4
SUMMARY VIBRATION ANALYSIS RESULTS FOR POSTULATED BOUNDING CONDITIONS FOR U-BEND REGION

		Fluidelastic			Turbulence	
		Maximum FSR	Frequency @ Max FSR (Hz)	Stress (psi)	Amplitude (RMS) Peak (10 ⁻³ in)	Stress (RMS) Peak (psi)
Tubes with 9-10 Double-Sided Supports (Rows 96-150)	R149C90	[REDACTED]	44.4	1678	(3.96) 13.7	(247) 1100
Tubes with 7-8 Double-Sided Supports (Rows 64-95)	R95C90	0.678	46.0	0	(2.44) 8.4	(170) 756
Tubes with 5-6 Double-Sided Supports (Rows 41-63)	R63C84	0.834	56.9	0	(2.16) 7.5	(189) 839
Tubes with 3-4 Double-Sided Supports (Rows 24-40)	R40C73	0.564	55.3	0	(1.32) 4.6	(111) 492
Tubes with 1-2 Double-Sided Supports (Rows 9-23)	R23C4	0.985	35.3	0	(7.01) 24.2	(295) 1311
Tubes with No Double-Sided Supports (Rows 1-8)	R8C3	0.454	26.1	0	(3.10) 10.7	(120) 535

In order to know how many supports are considered ineffective in that analysis, the reader has to cross-reference Appendix B, where the conditions of the tube supports are itemized. A review of Appendix B makes it clear (albeit in fine print) that the data points for row 149, column C90 include results with up to two supports inactive:

ANO	Cylindrical With a Down Corner Model, R149C90 AVB 2 and AVB 3 Inactive
ANO	Cylindrical With a Down Corner Model, R149C90 AVB 3 and AVB 4 Inactive
ANO	Cylindrical With a Down Corner Model, R149C90 AVB 4 and AVB 5 Inactive

Therefore, the stability ratio of [REDACTED] found in Table 6-5 is the stability ratio at [REDACTED] assuming two ineffective supports. Assuming two ineffective supports at SONGS resulted in a stability ratio of [REDACTED]. This shows that SONGS had less vibration margin than [REDACTED]—the direct opposite conclusion than the one Respondents espouse.

Finally, while Mr. Langford told Respondents that he believed that the void fraction would be “in the [REDACTED] plus percent range,” Edison was told that the maximum void fraction would be in the [REDACTED] range.¹⁶¹⁸

(ii) *The Respondents’ Position*

1568. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Because Mitsubishi disputes the existence of all but one of Claimants’ alleged design errors, it naturally disputes that it had prior knowledge of those errors. Mitsubishi only acknowledges the existence of the Gap Velocity Error, but Claimants have presented no evidence Mitsubishi had knowledge of this error prior to the tube leak at SONGS. While both Mr. Langford and Mr. Wilson had raised questions concerning the magnitude of the gap velocities during the design, Mitsubishi went back and reviewed the SONGS velocities and could not find an error in its calculations. Further, as discussed above, subsequent to Mr. Langford and Mr. Wilson raising their concerns, [REDACTED] and Langford performed comparisons of the vibration potential of SONGS to that of [REDACTED], which showed that “SONGS had more design margin than [REDACTED] with respect to out-of-plane FEI.” This showing that SONGS had more vibration margin than [REDACTED] which had been operating successfully for four years, confirmed the acceptability of the SONGS RSG design and eliminated any concern regarding the SONGS calculated velocities. As shown in this arbitration, even after correcting for the Gap Velocity Error all stability ratios are less than 1.0.¹⁶¹⁹

(iii) *Tribunal’s Determination*

1569. It is undisputed between the Parties that the Respondents’ consultants raised concerns regarding flow velocities and void fractions during the design of the RSGs.

1570. As set out by the Tribunal in Sections VII.D(e)(ii) and VII.D(e)(iii) above, the concerns referenced by the Claimants, as raised by Mr. Langford and Mr. Wilson, MHI’s consultants, were investigated. The eventual design solution of the

¹⁶¹⁸ Claimants’ RPHM, ¶¶ 180-182.

¹⁶¹⁹ Respondents’ Position Statement on the Revised List of Issues, ¶ 156.

Respondents was to increase the number of AVBs beyond comparable plants, improving SR.

1571. The Claimants have not, however, convincingly established that the Respondents knew of any errors in their design. While it is evident that on occasion MHI's consultants came close to identifying the Gap Velocity Error, this is insufficient proof of knowledge of that error. In particular, as set out above, it may be within the realm of the possible that the Respondents' evaluation of Mr. Langford's and Mr. Wilson's concerns could have discovered the Gap Velocity Error.¹⁶²⁰ However, MHI's contemporary investigations of those concerns and the design choice to improve stability ratios through AVBs were reasonable.
1572. To the extent that the Claimants submit that FIT-III diverged from the test results of other codes in the CLOTAIRE¹⁶²¹ program, in reliance on Mr. Wilson's comment that "where the answers were easy all codes got them right, but where the answers were complicated – like in the U-bend, FIT-III was very far away from the data and most other codes came closer,"¹⁶²² the Tribunal does not consider this to be persuasive evidence of the Respondents having knowledge of a design error.
1573. The Tribunal has already considered above¹⁶²³ that there may be potential measurement uncertainty in taking void fraction and velocity measurements on account of imprecision in bi-optical probes. There also appears to be a calculation margin between results calculated by a code and those measured. Combined, this may well be an indication of the need for conservatism in design and adopting

¹⁶²⁰ See ¶¶ 1399-1404 above.

¹⁶²¹ The CLOTAIRE program was a joint effort of a number of nuclear steam generator designers, such as MHI and FRAMATONE (AREVA) to evaluate T/H codes, such as FIT-III, ATHOS, and other proprietary codes against test data obtained from a steam generator.

¹⁶²² Exh. JX-480, p. 3.

¹⁶²³ See ¶¶ 1423-1426 above.

sufficient margin against instability. However, the existence of a difference between what FIT-III calculates, what other codes calculate and what a test measures are insufficient to demonstrate that MHI knew of any errors in FIT-III.

1574. Further, as the Respondents have submitted, differences in the CLOTAIRE test between FIT-III results and other codes represent, at least in part, different velocity definitions.¹⁶²⁴

1575. Accordingly, the Tribunal answers Issue B.5 in the negative. The Claimants have not successfully proven that MHI had knowledge of any of the alleged design errors.

(b) **If so, did Mitsubishi improperly withhold such knowledge from Claimants? (Issue B.5(a)) If Mitsubishi had knowledge of any alleged design errors in Issue B.4 and improperly withheld that knowledge from Claimants, did Mitsubishi fail to act to correct the alleged design errors? (Issue B.5(b)) If so, what is the consequence, if any? (Issue B.5(c))**

1576. To recall, when considering Issue B.5, the Tribunal held that MHI did not have knowledge of any of the design errors alleged by the Claimants. Taking into account that Issues B.5(a) through (c) are follow-up questions to Issue B.5 that need to be determined in the event that the Tribunal would have found that MHI did have knowledge of any of the design errors, the Tribunal does not need to address these Issues.

F. DID MITSUBISHI FAIL TO DELIVER RSGS THAT CONFORMED TO THE RSG CONTRACT? (ISSUE B.6)

1577. The Parties disagree as to whether the Respondents delivered RSGs that conformed to the RSG Contract.

¹⁶²⁴ Transcript, p. 3661 (Dr. Hibiki).

(i) The Claimants' Position

1578. In their Responses to Joint List of Issues, the Claimants submit that “[i]n signing the RSG Contract, Mitsubishi promised that the RSGs would have “no leakage from the primary to secondary side under any normal operating condition” and that “[n]o RSG parts or components [would] require replacement during the stipulated RSG service life” of “40 calendar years.” It is undisputed that a radioactive leak occurred in one of the Unit 3 RSGs after only eleven months of operation.”¹⁶²⁵
1579. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that the “Respondents concede that they breached at least one provision of the RSG Contract (§ 1.16.5.7). In this way (and in others discussed more fully below), it is undisputed that Respondents failed to deliver RSGs that conformed to the Contract.”¹⁶²⁶

(ii) The Respondents' Position

1580. In their Position Statement on the Revised List of Issues, the Respondents contend that “[a]s described in the subsections of [the Respondents’ submissions concerning] Issue B.6 that follow, Mitsubishi supplied RSGs that conformed to the requirements of the RSG Contract. If the RSGs subsequently failed to conform to the RSG Contract in a manner that would qualify as a Defect, the Warranty would be triggered and such Defect would be curable with the Warranty remedy.”¹⁶²⁷

(iii) Tribunal's Determination

1581. The Tribunal will address this Issue B.6 when addressing Issues B.6(a) and following below.

¹⁶²⁵ Claimants’ Responses to Joint List of Issues, ¶ B.6.

¹⁶²⁶ Claimants’ RPHM, ¶ 190.

¹⁶²⁷ Respondents’ Position Statement on the Revised List of Issues, ¶ 162.

(a) **Did Mitsubishi fail to supply RSGs that complied with RSG Contract Section 3.7.1.1? (Issue B.6(a))**

(i) *The Claimants' Position*

1582. In their Responses to Joint List of Issues, the Claimants submit that the “Respondents failed to supply four RSGs with a service life of 40 calendar years from the date of startup following their installation. It is undisputed that a radioactive leak occurred in one of the Unit 3 RSGs after only *eleven months* of operation.”¹⁶²⁸

1583. In addition, the Claimants, in their C-RPHM, contend that “Section 3.7.1.1 defines the “service life of the RSGs” as “be[ing] 40 calendar years from the date of startup following their installation.” It is undisputed that Unit 3 operated for only 338 days, and Unit 2 operated for only a single operating cycle of 22 months. Therefore, Respondents failed to supply RSGs that complied with the Contract’s 40-calendar-year service life.”¹⁶²⁹

(ii) *The Respondents' Position*

1584. In their Position Statement on the Revised List of Issues, the Respondents contend that “Mitsubishi complied with RSG Contract Section 3.7.1.1 by using a 40-year service life as the basis for Mitsubishi’s calculations of the fatigue analysis, corrosion, erosion, fretting, wear and the number of chemical cleanings.”¹⁶³⁰

(iii) *Tribunal's Determination*

1585. Section 3.7.1.1 of the RSG Contract states as follows:

The service life of the RSGs shall be 40 calendar years from the date of startup following their installation (this includes periods of wet or dry layup subsequent to the initial heatup). This duration is to be used as the

¹⁶²⁸ Claimants’ Responses to Joint List of Issues, ¶ B.6(d).

¹⁶²⁹ Claimants’ RPHM, ¶ 191.

¹⁶³⁰ Respondents’ Position Statement on the Revised List of Issues, ¶ 163.

basis for fatigue analyses and for determining the effects of corrosion, erosion, fretting, wear, and the number of chemical cleanings.

1586. Considering the Defects in Units 2 and 3 as determined by the Tribunal,¹⁶³¹ the RSGs did not have a service life of 40 years.
1587. Independent of this fact is the question of whether the Respondents designed SONGS to have a 40 year service life, in accordance to the requirements of Section 3.7.1.1 of the RSG Contract.
1588. The determination of this question requires the resolution of the next Issue, Issue B.6(a)(i) below.

(b) **In this connection, should the RSGs have a service life of 40 calendar years, as Claimants contend, or have been designed using a 40-year service life, as Respondents contend? (Issue B.6(a)(i))**

1589. In connection with the question under Issue B.6(a), this Issue B.6(a)(i) concerns the question of whether the RSGs should have a service life of 40 calendar years, as contended by the Claimants, or should have been designed using a 40-year service life, as submitted by the Respondents.

(i) *The Claimants' Position*

1590. In their Responses to Joint List of Issues, the Claimants submit that “[t]he RSGs should have a service life of 40 calendar years. Section 3.7.1.1 of the RSG Contract states: “The service life of the RSGs shall be 40 calendar years from the date of startup following their installation.” The provision makes clear that “service life”

¹⁶³¹ Sections XI and XII above.

refers to the operation of the RSGs, which is calculated following installation *and* that duration (40 years) is to be used for analyses.”¹⁶³²

1591. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents seek to avoid an adverse result by arguing that the 40-calendar-year service life only refers to the period to use “in its engineering calculations.” Respondents are correct that Section 3.7.1.1 does specify that the 40-calendar-year service life is the duration to be used for a number of specific, contractually required analyses, but by no means does this additional requirement alter the plain-language definition of service life in the prior sentence. The plain language of Section 3.7.1.1 demonstrates that “service life” refers to the operation of the RSGs, which is calculated following installation and that duration (40 calendar years) is to be used for various “engineering calculations.”

Interpreting Section 3.7.1.1 as Respondents urge would render other provisions of the RSG Contract nonsensical, in contravention of clear California law regarding contract interpretation. Section 1.17.5.1 specifies:

The Supplier warrants it shall make available to [Edison] replacement parts at a price equal to Supplier’s cost plus an appropriate mark-up percentage not to exceed ten (10%) percent for the Apparatus during the Warranty Period set forth in Section 1.17.1.2 and for the remainder of the service life of the RSG Units as stated in Section 3.7.1.1

If the 40-calendar-year service life were given the narrow “analysis only” construction proposed by Respondents, this obligation would make no sense. Even more, the reference to the 40-calendar-year service life undermines the suggestion that Respondents only undertook to provide RSGs that would last for the 20-year Warranty Period. Respondents’ obligation in Section 1.17.5.1 expressly covers a period beyond the 20-year Warranty Period and to the natural construction of Section 3.7.1.1—the guaranteed operating “service life” of the RSGs, specified in that section to be “40 calendar years.”¹⁶³³

¹⁶³² Claimants’ Responses to Joint List of Issues, ¶ B.6(d)(i).

¹⁶³³ Claimants’ RPHM, ¶¶ 192-194.

(ii) The Respondents' Position

1592. In their Position Statement on the Revised List of Issues, the Respondents contend that the “RSG Contract Section 3.7.1.1 states that “the service life of the RSGs shall be 40 calendar years,” and that “[t]his value is to be used as the basis for fatigue analysis, and for determining the effects of corrosion, erosion, fretting, wear, and the number of chemical cleanings.” Claimants have failed to show that the Tribunal should disregard the plain language of the contract, which defines service life as the duration to be used in design calculations. Claimants have provided no evidence that suggests that Mitsubishi failed to satisfy its obligation to design the RSGs to have a 40-year service life. On the contrary when conducting these analyses and determining the effects of corrosion or erosion, Mitsubishi used a 40-year service life where required in its engineering calculations. Section 3.7.1.1 does not obligate Mitsubishi to provide RSGs that would last for 40 years. The warranty provisions in Section 1.17 of the RSG Contract and the performance requirements established therein constitute Mitsubishi’s post-delivery warranty obligations. The warranty period is defined under the RSG Contract as having a duration of 20 years. Mitsubishi had no obligation to guarantee that the RSGs would operate for 40 years. In fact, the Purchase Order issued by EMS states that at the expiration of the initial warranty period of 20-years, EMS could extend the warranty for an additional 10 years at a cost of \$234,000 per year, provided certain tube plugging thresholds had not been reached at a comparable plant.”¹⁶³⁴

(iii) The Tribunal's Determination

1593. Given the Parties’ divergent positions on this Issue, the Tribunal considers it pertinent to quote Section 3.7.1.1 of the RSG Contract once more:

The service life of the RSGs shall be 40 calendar years from the date of startup following their installation (this includes periods of wet or dry

¹⁶³⁴ Respondents’ Position Statement on the Revised List of Issues, ¶ 164.

layup subsequent to the initial heatup). This duration is to be used as the basis for fatigue analyses and for determining the effects of corrosion, erosion, fretting, wear, and the number of chemical cleanings.

1594. Section 3.7.1.1 of the RSG Contract requires that the Respondents (perform design calculations for the life of the steam generator on the basis of a 40 year service life..
1595. In this connection, the Respondents' submission that they are only required to provide a warranty for extendable 20 years appears to be irrelevant given that the Incident occurred after only 11 months of operation and the RSGs were subsequently shut down.
1596. The Tribunal considers that on account of the wear at SONGS in the RSGs as delivered, there is uncertainty as to whether the RSGs would have lasted for 40 years.
1597. In essence, the resolution of this Issue B.6(a)(i) is determined by whether Section 3.7.1.1 of the RSG Contract is an obligation of means, as generally submitted by the Respondents, or an obligation of results, as generally submitted by the Claimants. If Section 3.7.1.1 of the RSG Contract were to be interpreted as an obligation of means, the consequence would be that the RSGs would have to be designed to meet the 40 year life. If, in contrast, Section 3.7.1.1 of the RSG Contract were to be interpreted as an obligation of results, the consequence would be that the RSGs would have to last for 40 years.
1598. In this connection, the Tribunal notes that in comparison, Section 1.17.1.2 of the RSG Contract provides an obligation of results, that the Respondents warranted an operating life of the RSGs of 20 years:

The warranty period for discovery of Defects in an RSG Unit (and associated portion of the Apparatus) (which, for purposes of this Section 1.17 shall be considered part of the RSG Unit) shall (subject to Section 1.16.4), commence upon Acceptance of the RSG Unit and continue for twenty (20) years unless this period is extended for an additional ten (10)

year period by EMS's exercise of an option that is described in the Purchase Order (such period as extended, "Warranty Period"). (...)

1599. In light of this, the Tribunal considers that Section 3.7.1.1 of the RSG Contract to represent technical specifications to be adopted in the design of the RSGs. It sets forth the design parameters and, therefore, establishes the obligation of means while Section 1.17.1.2 sets forth the obligation of results when it comes to the life of the RSGs. Thus, the Respondents' submission in this regard is to be followed.
1600. Contrary to the Claimants' submission, the Tribunal does not consider that Section 1.17.5.1 of the RSG Contract, which provides that replacement parts are to be available for the 40 year service life renders the Respondents' submitted interpretation nonsensical. Section 3.7.1.1 of the RSG Contract specifies a 40 year period. Section 1.17.5.1 of the RSG Contract is a comprehensible and enforceable provision regardless of whether service life is interpreted as a 40 year design life or a 40 year operating life. In either case, MHI is required under Section 1.17.5.1 of the RSG Contract to provide replacement parts for a 40 year period.
1601. For certainty, the conclusion on this Issue does not constitute a determination of the Tribunal as to whether or not the RSGs as delivered would indeed last for 20 or 40 years, per the RSG Contract.
1602. The Tribunal answers Issue B.6(a)(i) by finding that under Section 3.7.1.1 MHI was to provide RSGs designed to have a service life of 40 years.
1603. Furthermore, the Tribunal answers the above Issue B.6(a) in the negative. MHI did not fail to supply RSGs that complied with Section 3.7.1.1 of the RSG Contract.

(c) **Did Mitsubishi fail to supply RSGs that did not require parts or components to be replaced for their full service life (RSG Contract Section 3.7.1.2)? (Issue B.6(b))**

1604. This Issue B.6(b) concerns the question of whether MHI failed to supply RSGs that did not require parts of components to be replaced for their full service life.

(i) *The Claimants' Position*

1605. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi supplied fundamentally defective machines that experienced extensive and excessive wear, a breach of the reactor coolant boundary, and a severe loss of tube integrity in one cycle of operation or less. It is undisputed that eight tubes failed in-situ pressure testing—an unprecedented occurrence. More than 3,400 tubes across all four RSGs suffered tube wear in one cycle (or less, in the case of Unit 3) of operation, including tube-to-tube wear in both Units. Such a repair would have required either parts (such as thicker AVBs) or components to be replaced (such as replacement of the entire tube bundle) in order for the RSGs to have operated again.”¹⁶³⁵

1606. In addition, in their C-RPHM, the Claimants contend the following:

Section 3.7.1.2 states, “No RSG parts or components are allowed to require replacement during the stipulated RSG service life, unless specifically identified for routine replacement in the Vendor Manual as described in Section 3.21.3.” Despite the plain-language obligation set forth in this section, Respondents argue that this section merely “sets forth design criteria, not performance or warranty obligations.” Such a construction finds no footing in the text of Section 3.7.1.2 or the RSG Contract as a whole. As noted above, the obligations in Section 3.7 are not limited to “design criteria”; rather, they must be read in the context of the entire RSG Contract as imposing (1) a 40-calendar-year operating life for the RSGs and (2) a requirement that parts and components will not need to be replaced during this time, except as otherwise specified. Indeed, Section 3.7.1.2’s guarantee that there will be no need for replacement parts of components during the 40-calendar-year service life

¹⁶³⁵ Claimants’ Responses to Joint List of Issues, ¶ B.6(b).

provides further proof that Section 3.7.1.1 does not merely set forth a duration to be used in analyses.

The fundamentally defective RSGs supplied by Respondents experienced such extensive and excessive wear in one cycle of operation (Unit 2) or less (Unit 3) that they could not be operated without a repair. Such a repair would have required either parts (such as the proposed thicker AVBs) or components to be replaced (such as replacement of the entire tube bundle) in order for the RSGs to have operated again. As a result, Respondents breached Section 3.7.1.2 as well.¹⁶³⁶

(ii) The Respondents' Position

1607. In their Position Statement on the Revised List of Issues, the Respondents contend that “[a]s with the service life issue, Section 3.7.1.2 sets forth design criteria, not performance or warranty obligations. Section 3.7.1.2 obligated Mitsubishi to design the RSGs such that components would not be replaced for their full service life. Claimants have presented no evidence that Mitsubishi failed to design the RSGs consistent with this obligation, but even if there were, the Warranty provisions would address any required repair or replacement. In addition, Mitsubishi has shown that while tube bundle replacement was an available remedy under the RSG Contract, replacement was not required in order to correct the root cause of the tube-to-tube wear at SONGS. Component replacement was also not required to address any other wear mechanism present at SONGS.”¹⁶³⁷

(iii) Tribunal's Determination

1608. Section 3.7.1.2 of the RSG Contract provides:

No RSG parts or components are allowed to require replacement during the stipulated RSG service life, unless specifically identified for routine replacement in the Vendor Manual as described in Section 3.21.3.

¹⁶³⁶ Claimants' RPHM, ¶¶ 194-195.

¹⁶³⁷ Respondents' Position Statement on the Revised List of Issues, ¶ 165.

1609. It is not disputed that the RSGs required either repair or replacement following the Incident.
1610. As in relation to Section 3.7.1.1 of the RSG Contract analyzed in Issue B.6(a) above,¹⁶³⁸ the Tribunal considers that Section 3.7.1.2 of the RSG Contract sets out the design requirements for the RSGs. Section 3.7.1.2 provides that the Respondents design RSGs is such that only components specifically identified would require routine replacement. Other components would have to be designed to last for the service life of the steam generator.
1611. There is no convincing evidence that RSG parts or components were not designed to last for the service life of the RSGs resulting in the breach of Section 3.7.1.2 RSG Contract.
1612. That the RSGs did, in fact, require repair or replacement, is, in the Tribunal's view, addressed in Section 1.17 of the RSG Contract regarding warranties. The Claimants' interpretation of Section 3.7.1.2 of the RSG Contract would render ineffective the warranty provisions of the RSG Contract.
1613. Accordingly, the Tribunal answers Issue B.6(b) in the negative. MHI did not fail to supply RSGs that did not require parts or components to be replaced for their full service life under Section 3.7.1.3 of the RSG Contract.

¹⁶³⁸ See ¶¶ 1599-1602 above.

(d) **Did Mitsubishi fail to supply RSGs equipped with tube supports that adequately supported the tube bundle, minimized tube wear, and precluded tube damage caused by flow-induced and turbulence-induced vibration of the tubes and tube supports (RSG Contract Sections 3.9.3.7, 3.8.2)? (Issue B.6(c))**

1614. This Issue B.6(c) concerns the question of whether MHI failed to supply RSGs equipped with tube supports that adequately supported the tube bundle, minimized tube wear, and precluded tube damage caused by flow-induced and turbulence-induced vibration of the tubes and tube supports under Sections 3.9.3.7 and 3.8.2 of the RSG Contract.

(i) *The Claimants' Position*

1615. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi supplied fundamentally defective machines that experienced extensive and excessive wear, a breach of the reactor coolant boundary, and a severe loss of tube integrity in one cycle of operation or less. It is undisputed that eight tubes failed in-situ pressure testing—an unprecedented occurrence. More than 3,400 tubes across all four RSGs suffered tube wear in one cycle (or less, in the case of Unit 3) of operation, including tube-to-tube wear in both Units.”¹⁶³⁹

1616. In addition, in their C-RPHM, the Claimants contend the following:

Respondents failed to supply RSGs equipped with tube supports that adequately supported the tube bundle, minimized tube wear, and precluded tube damage caused by flow-induced and turbulence-induced vibration of the tubes and tube supports. Respondents contracted, inter alia, to provide tube supports that would “adequately support the tube bundle and facilitate internal circulation,” “[p]reclude tube damage due to wear caused by flow induced vibration (FIV),” and provide uniform “tube-to-tube support clearances.”

¹⁶³⁹ Claimants' Responses to Joint List of Issues, ¶ B.6(c).

As discussed above, Respondents under-predicted the thermal-hydraulic conditions in the RSGs. Respondents treated the FIT-III velocity and void fraction results as true maximums and designed the RSGs support structure accordingly. Once the support structure was put in place, it proved to be unable to contain the first-of-a-kind thermal-hydraulic conditions that were actually present. In other words, there is no indication that Respondents designed the RSGs' support structure to withstand the actual velocities and dry-out present during the operation of the RSGs.

Despite the unprecedented failure observed at SONGS, Respondents state in a conclusory fashion that “the RSGs were designed to prevent tube damage caused by tube wear.” To support this statement, Respondents make the same arguments debunked by Claimants above. Respondents also claim that the parties to the RSG Contract “anticipated that there would be some tube wear”—emphasizing that they only had a duty under the contract to “minimize” vibration-induced tube wear. It is absurd to think that either party ever contemplated the absolute failure of the RSG's essential purpose necessitating a shutdown of both RSGs after one cycle or less. As Dr. Begley testified, “[n]ot MHI or actually anybody who designs a replacement steam generator expects that they're going to have a large number of wear indications.”¹⁶⁴⁰

(ii) *The Respondents' Position*

1617. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

RSG Contract section 3.9.3.7 falls under section 3.9.3 (“Detailed Design Requirements”) and identifies other design requirements of the RSG Contract. This provision required Mitsubishi to design the tube supports so as to prevent tube damage due to wear caused by flow induced vibration (FIV) and in fact, the RSGs *were* designed to prevent tube damage caused by tube wear. Mitsubishi properly analysed its design to prevent out-of-plane FEI. Claimants' experts – primarily Exponent but also Dr. Lahey – claim that Mitsubishi's T/H Code (FIT-III) contains multiple errors that resulted in an under-prediction of the T/H conditions in the RSGs. But Mitsubishi methodically debunked each of these alleged errors during the Hearing. The fallacy of Exponent's and Dr. Lahey's expert reports and testimony is illustrated by their insistence that Mitsubishi used interfacial velocity in its analysis. This is simply wrong, and

¹⁶⁴⁰ Claimants' RPHM, ¶¶ 196-198.

if Claimants' experts had only looked more closely at some of the very graphs they relied on, they would have quickly realized that Mitsubishi used mixture velocity, because the RSGs are triangular arrays; interfacial velocity is only used when designing square array steam generators.

Mitsubishi also undertook a macro analysis of its RSG design against the [REDACTED] RSGs, to confirm the design margin of the SONGS RSGs, showing that the tube bundle would be stable. The SONGS RSGs had more AVBs than did the [REDACTED] RSGs, providing a greater margin against tube vibration.

Despite allegations to the contrary, there was no standard for designing to prevent in-plane FEI at the time of the RSG design. Rather, the industry standard was to prevent out-of-plane FEI, which in turn would ensure that in-plane FEI would not occur. Appendix N to the ASME Code provides no direction regarding analysing for in-plane FEI, and Claimants' experts could point to no other Code or requirement mandating such an analysis.

Mitsubishi in fact achieved its design goal: out-of-plane FEI did not occur. FEI, of course, is characterized by rapid onset that quickly leads to destructive wear. The Exponent witnesses had no choice but to acknowledge that FEI is a "large amplitude vibration of tubes in a steam generator, resulting in destructive wear in a very short amount of time." And the physical evidence does not support the conclusion that such large amplitude vibration occurred in the out-of-plane direction – only in the in-plane direction. Exponent based its conclusion that out-of-plane FEI had occurred in part because it calculated stability ratios greater than 1.0 – but only when it assumed one ineffective support. Westinghouse concluded precisely the opposite, calling into question all of Exponent's opinions on FEI and stability ratios. The 2012 analysis Westinghouse performed on the SONGS RSGs determined that even assuming one ineffective support, the highest calculated stability ratio in the tube bundle was 1.0; with all supports effective, all stability ratios were well below 1.0. Making the point clearly, Westinghouse wrote: "The only time where [stability ratios greater than 1.0] would be considered to actually result in an unstable tube is if an excitation ratio greater than 1.0 was calculated for the condition *where all supports were active*." This directly contradicts Exponent's assumptions and opinions.

Mitsubishi's wear analysis performed during the RSG design was proper, consistent with the prevailing approach in the nuclear industry at the time. Once again, Claimants rely on Exponent to support their wear allegations, but Exponent did not even undertake its own wear analysis. Moreover, Exponent's claims regarding wear are not internally consistent. The fact that a tube leak or tube wear occurred does not mean that Mitsubishi failed to comply with its

design obligations; tube wear is inevitable in recirculating steam generators, and the tube leak caused by in-plane FEI was the result of insufficient contact force in the in-plane direction due to Edison's zero gap specification and Mitsubishi's belief that achieving this gap tolerance at operating conditions was the best way to minimize tube wear. That this turned out not to be true was a paradigm shift that sent seismic shock waves throughout the industry.

The RSG Contract is silent as to what constitutes tube damage but it is apparent from the plain language of the RSG Contract that the parties anticipated that there would be some tube wear. RSG Contract section 3.9.3.7 states that "Supplier shall demonstrate that its design will *minimize* vibration-induced tube wear or fatigue in the tube bend area of the tube bundle" necessarily contemplating that some wear will occur in the U-bend. Additionally, the parties negotiated liquidated damages for tube plugging in the RSG Contract, providing Edison with a ready remedy for tube wear.

Even if the Tribunal decides that Mitsubishi did not comply with this provision, Mitsubishi could have cured any resulting Defect under section 1.17.1.3. The thicker-AVB repair or an RSG replacement would be designed with tube supports meant to preclude unacceptable tube damage due to wear.

RSG Contract section 3.8.2 does not address tube supports, tube wear, flow induced vibration, turbulence induced vibration or tube supports. RSG Contract section 3.8.2 requires that Mitsubishi prepare and submit a Performance Analysis Report. Mitsubishi complied with this provision by preparing and submitting a Performance Analysis Report to Edison, with the final revision dated Oct. 28, 2008. This is the only obligation generated by RSG Contract section 3.8.2.¹⁶⁴¹

(iii) The Tribunal's Determination

1618. As set out above, the Tribunal considers that Section 3.8.2 of the RSG Contract requires that the Respondents prepare a PAR providing various operating and design parameters of the RSGs. The Tribunal has already concluded that the PAR is not a contractual document, but that it contains numerous technical details that MHI calculated as being representative of the behavior and design of the RSGs.¹⁶⁴²

¹⁶⁴¹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 166-175.

¹⁶⁴² See generally Section XIII.A above.

1619. Section 3.9.3.7 of the RSG Contract provides that the RSGs shall be designed with adequate tube support, including both TSPs and AVBs, setting forth the standards for adequate tube support in the RSGs:

Tube Supports

The RSG shall be equipped with tube supports that adequately support the tube bundle and facilitate internal circulation. The tube supports shall be of a broached plate type and shall be designed in accordance with ASME Section III, Subsection NF. In addition, the tube support design shall:

- Preclude tube damage due to wear caused by flow induced vibration (FIV).
- Address the dynamic frequencies imposed on the RSG by the reactor coolant pumps.
- Minimize secondary side pressure loss.
- Provide the tube-to-tube support contact length such as to minimize tube wear.
- Provide line contact length, such as to minimize the potential for deposition of corrosion and corrosion-causing impurities.
- Provide line contact length such as to facilitate NDE of the tubes.
- Ensure that the relative tube/tube support motions during normal and accident transients shall not result in tube lockup.
- Ensure that tube-to-tube support clearances are uniform; the Supplier shall quantify the ability to achieve uniformity and provide a mean value and standard deviation of the clearances resulting from the proposed fabrication method.
- The leading and trailing edges of the lands on the tube support holes shall be chamfered to preclude tube surface damage during insertion.

The Supplier shall address analytically support design as related to RSG thermal-hydraulic performance (flow rates, pressure drops, circulation ratios, vibrations, etc.) and corrosion product buildup. The open flow area of each tube support, both in terms of magnitude and as a fraction of the tube bundle unobstructed flow area, shall be provided by the Supplier. The tube holes of the support plates shall be configured to maximize flow adjacent to the tubes.

Tube supports shall be designed to ensure that the potential for "dryout" (presence of high quality fluid) is minimized at the tube-to-tube support intersections. The Supplier shall specify the parameters of "minimum dryout" (maximum fluid quality) and state the maximum anticipated superheat at a tube-to-tube support intersection. The Supplier shall provide experimental justification demonstrating that "dryout" does not occur with the optimized design selected for the tube supports and tube bend supports.

The Supplier shall address flow-induced and turbulence-induced vibration of the tube supports to demonstrate that fatigue failures, and excessive fretting and wear of the tubes will not occur. The tube arrangement and support design shall ensure that the effective cross-flow velocity at design conditions for any span will be such that a sufficient margin exists to prevent tube highcycle fatigue. The analysis shall account for reduced damping associated with fouling of the gaps between the tubes and tube supports. Specifically, the Supplier shall demonstrate that its design will minimize vibration-induced tube wear or fatigue in the tube bend area of the tube bundle. The Supplier shall perform a stability analysis of the tubes both in the tube bend region and over the straight length. All thermal-hydraulic aspects of the tube support design listed above shall be documented in the Performance Analysis Report.

The tube support system shall be adequately designed for LOCA, MSLB, and FWLB plus seismic loadings, as required by the ASME Code. All code aspects of the tube support design shall be documented in the Certified Design Report.

The tube support plates shall be made of Type 405 stainless steel. If tie-rod material is low alloy steel, the selection shall be justified with respect to the effects of galvanic corrosion, chemical cleaning and be compatible with the materials of other components with regards to mechanical properties (i.e., thermal expansion).

1620. It is undisputed between the Parties that after a single cycle for Unit 2 and a half cycle for Unit 3, the RSGs at SONGS suffered tube wear at thousands of tubes, that a tube leaked, and that eight tubes failed *in-situ* pressure testing.¹⁶⁴³
1621. Section 3.9.3.7 of the RSG provides distinct language with regard to the different types of wear:
- Provide the tube-to-tube support contact length such as to minimize tube wear.
- Preclude tube damage due to wear caused by flow induced vibration
1622. In this connection, the Tribunal is convinced by the Respondents' understanding that Section 3.9.3.7 of the RSG Contract does not require that wear be avoided entirely, but only minimized.
1623. The "tube-to-tube support" referred to in Section 3.9.3.7 of the RSG Contract is provided by AVBs and TSPs. The evidence shows that wear from random vibration at such locations is effectively unavoidable.
1624. This is consistent with the liquidated damages of \$3,000 per tube that is required to be removed from service on account of wear, pursuant to Section 1.29.1.1 of the RSG Contract.
1625. In contrast, according to Section 3.9.3.7 of the RSG Contract, "flow induced vibration" is to be precluded. The Respondents have submitted that "flow induced vibration" is an umbrella term that covers both fluid elastic excitation force and

¹⁶⁴³ See ¶ 481 above.

turbulence excitation force.¹⁶⁴⁴ This distinction is reflected in Section 3.9.3.7 of the RSG Contract, which states:

The Supplier shall address flow-induced and turbulence-induced vibration of the tube supports to demonstrate that fatigue failures, and excessive fretting and wear of the tubes will not occur.

1626. As explained by Dr. Au-Yang, for Respondents, fatigue failure is failure of a tube suffering from FEI even in the absence of impact.¹⁶⁴⁵
1627. Excessive fretting and wear would include tube wear brought on by FEI.
1628. Section 3.9.3.7 of the RSG Contract further provides that MHI was to provide adequate margin against “high cycle fatigue,” i.e., FEI and that stability ratios were to be calculated.
1629. MHI was to document how it was meeting its obligations under Section 3.9.3.7 of the RSG Contract in the PAR.
1630. In considering the sum of the varied obligations under Section 3.9.3.7 of the RSG Contract, the Tribunal determines that on account of the Gap Velocity Error alone, the Respondents failed to meet their obligations under Section 3.9.3.7. The Respondents failed to accurately calculate the margin against instability.
1631. Regarding random vibration/turbulence induced vibration, the Tribunal considers that the wear occurring at the SONGS RSGs is comparable to the wear experienced in similar large steam generators, such as St. Lucie 2 and ANO-2. In evaluating whether the Respondents met their obligation to minimize wear, the Tribunal considers that this is a relative obligation, i.e., that whether Respondents have met

¹⁶⁴⁴ See Respondents’ PHM, FIV Categorization Chart.

¹⁶⁴⁵ Transcript, pp. 3075, 3076, 3904, (Dr. Au-Yang); 5113 (Counsel).

their obligation to minimize wear is determined by comparison to the wear experienced at comparable steam generators. Given that the wear at SONGS is comparable, this obligation is met. The Tribunal's conclusion in this regard is consistent with the Purchase Order, which allowed only the warranty obligation to be extended by assessment of wear at another plant.¹⁶⁴⁶

1632. Regarding whether wear from flow-induced vibration has occurred, it is not disputed that in-plane FEI occurred such that the Respondents failed to meet their obligation under Section 3.9.3.7 of the RSG Contract.
1633. In light of the above, the Tribunal considers that the Respondents failed to meet their obligation under Section 3.9.3.7 of the RSG Contract.
1634. Thus, the Tribunal answers Issue B.6(c) in the affirmative. MHI failed to supply RSGs equipped with tube supports that adequately supported the tube bundle, minimized tube wear, and precluded tube damage caused by flow-induced vibration of the tubes and tubes supports, in violation of its obligation under Section 3.9.3.7 of the RSG Contract.

(e) **Did Mitsubishi fail to comply with the provisions of U.S. legal and professional codes, referenced by the parties, including 10 C.F.R. Part 50 Appendix B and the ASME Boiler and Pressure Vessel Code section III (RSG Contract Sections 2.0, 2.6.5, 2.8.2, 2.8.5, 3.15, 3.4, 3.5, 3.6, 3.9.6.1)? (Issue B.6(d))**

1635. This Issue B.6(d) concerns the question of whether MHI failed to comply with the provisions of U.S. legal and professional codes, referenced by the Parties, including 10 CFR Part 50 Appendix B and the ASME Boiler and Pressure Vessel Code Section

¹⁶⁴⁶ See e.g. Exh. JX-321, p. 3 (OHI Unit 3, in Ōi, Fukui Prefecture, Japan); See also revisions to Purchase Order.

III, pursuant to Sections 2.0, 2.6.5, 2.8.5, 3.4, 3.5, 3.6, 3.9.6.1 and 3.15 of the RSG Contract.

(i) *The Claimants' Position*

1636. In their Responses to Joint List of Issues, the Claimants submit the following:

The RSG Contract required Mitsubishi to comply with NRC Regulations, including 10 CFR Part 50, Appendix B and 10 CFR Part 21, the ASME Code, and other industry standards and guidelines. Mitsubishi failed to comply with each of these codes. Mitsubishi's numerous errors in its design process, proprietary codes, and resulting design failed to conform with several of the 18 QA criteria set out in Appendix B and NQA-1 of the ASME Code, including Criterion III governing design control (i.e. inadequate design verification, errors in design documents and manuals, and insufficient interfacing controls) and Criterion XVI requiring corrective action measures.

Additionally, the RSG Contract specifically required Mitsubishi to dedicate its commercial grade items in accordance with industry standards (EPRI NP-5652 and NP-6406). This is also a requirement under 10 CFR Part 21. Following the RSG failures, Mitsubishi issued CAR-12-037 noting its failure to dedicate FIT-III, IVHET, and FIVATS – Mitsubishi's commercial grade thermal-hydraulic codes.

Mitsubishi also failed to meet Appendix N of the ASME Code, which sets out a recommended method for analyzing the potential for fluid elastic instability. Mitsubishi chose to use this recommended method for its analysis. Despite this, Mitsubishi did not properly follow the ASME Code and admitted its error in CAR 12-028.

Finally, the RSG Contract required Mitsubishi to retain documentation in accordance with applicable regulations and standards. Yet Mitsubishi failed to retain several revisions of CARs, which Respondents' expert admitted was a quality control deficiency and is a clear violation of Mitsubishi's obligations under the RSG Contract.¹⁶⁴⁷

1637. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM contend that the "Respondents' assertion that it complied with Appendix B

¹⁶⁴⁷ Claimants' Responses to Joint List of Issues, ¶ B.6(d).

is simply false. Respondents admitted to the nonconformance with Criterion III for failing to convert the gap velocity values and do not now deny that they made this error. Edison’s satisfaction with Respondents’ compliance with the codes and standards prior to installation of the RSGs is entirely inapposite. Edison was unaware of every one of the numerous errors in Respondents’ design. It was not until after the leak and, in many cases not until this arbitration, that Edison learned of Respondents’ design errors and failure to comply with the applicable regulatory codes.”¹⁶⁴⁸

(ii) *The Respondents’ Position*

1638. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have failed to prove that Mitsubishi did not comply with provisions of U.S. legal and professional codes. Claimants have alleged that Mitsubishi failed to comply with 10 C.F.R. Part 50 Appendix B (“Appendix B”) and with the provisions of the ASME Boiler and Pressure Vessel Code section III (“ASME BPVC section III”). Neither allegation is true. In fact, prior to installation of the RSGs, Edison was satisfied that Mitsubishi’s design complied with all applicable codes and standards as part of its regular audits.

First, as addressed above in response to section B.4.f, Mitsubishi complied with the requirements of 10 C.F.R. Part 50 Appendix B.

Second, Mitsubishi constructed the SONGS RSGs in accordance with the mandatory provisions of the ASME BPVC. Claimants have not proven otherwise. Respondents also designed and fabricated the SONGS RSGs by taking into account the provisions provided in non-mandatory Appendix N, as addressed in more detail above in section B.4.c, above.

Finally, the project manager for Edison on the SONGS RSGs testified in these proceedings that as a part of its intrusive oversight Edison was satisfied that Mitsubishi complied with all applicable codes and standards at the time of the design.¹⁶⁴⁹

¹⁶⁴⁸ Claimants’ RPHM, ¶ 201.

¹⁶⁴⁹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 176-179.

(iii) The Tribunal's Determination

1639. Under the RSG Contract, Section 3.5 requires that MHI comply with various professional codes and standards in the design and manufacture of the RSGs.
1640. As a preliminary matter, the Tribunal considers that the Claimants have convincingly shown that due to the Gap Velocity Error alone, MHI failed to comply with the non-mandatory Appendix N of the ASME code.¹⁶⁵⁰ At the very least, MHI's failure to adequately document the methodology employed by FIT-III and the FIT-III post-processor regarding the Gap Velocity Error appears a violation of the applicable professional code(s).
1641. Regarding the need for commercial dedication of the Respondents' T/H codes, the Tribunal does not find this to be a violation of the RSG Contract or the applicable codes. That commercial dedication was required by the NRC only became evident after the design of SONGS.¹⁶⁵¹
1642. In this connection, the RSG Contract requires at Section 3.15.4 that:

The use of commercial grade items shall be in accordance with the nuclear industry standards (EPRI NP-5652 and NP-6406) and shall be properly documented in the Commercial Grade Item Dedication Reports. Commercial grade dedication, if proposed for any material, shall be approved by Edison. Commercial grade dedication process, if applicable, shall be described in Supplier's QA Program Manual.

1643. It is undisputed between the Parties that the Respondents' codes were not commercially dedicated at the time of the RSG design. According to the Claimants' witness Mr. Merschoff, the NRC held a public meeting in 2008 to express its expectation for commercial dedication of software.¹⁶⁵² This requirement was put into

¹⁶⁵⁰ Exh. JX-1158, p. 2.

¹⁶⁵¹ See ¶ 1643 below.

¹⁶⁵² Transcript, p. 1337 (Mr. Merschoff).

effect in 2009 by the NRC.¹⁶⁵³ While MHI dedicated certain of its codes then, MHI only concluded that its design codes required dedication in 2012.¹⁶⁵⁴

1644. The Claimants also submit that the Respondents violated their legal obligations regarding document retention. There is no factual dispute that the Respondents “obsoleted” a number of prior versions of several corrective action requests.¹⁶⁵⁵ In this connection, Section 2.8.5 of the RSG Contract allows for the Claimants to obtain possession of “quality records” following the completion of the work. While it is not entirely clear whether the “obsoleted” documents are of a type that were required to be retained, the Tribunal accepts, for the present purposes, the Claimants’ allegations in this regard, which do not appear to be vigorously contested by the Respondents.
1645. Accordingly, the Tribunal answers Issue B.6(d) in the affirmative. MHI failed to comply with the provisions of U.S. legal and professional codes, referenced by the Parties, including 10 CFR 50 Appendix B and the ASME Boiler and Pressure Vessel Code Section III.

(f) **Did Mitsubishi fail to supply RSGs that experienced no primary-to-secondary leakage under normal operating conditions (RSG Contract Sections 1.16.5.7, 3.20.2.4)? (Issue B.6(e))**

1646. This Issue B.6(e) concerns the question whether MHI failed to supply RSGs that experienced no primary-to-secondary leakage under normal operating conditions under Sections 1.16.5.7 and 3.20.2.4 of the RSG Contract.

¹⁶⁵³ Transcript, pp. 1404-1405 (Mr. Avella).

¹⁶⁵⁴ Exh. JX-1213; Transcript p. 4986 (Respondents’ Counsel).

¹⁶⁵⁵ Exh. JX-2080.

(i) The Claimants' Position

1647. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi designed, manufactured, and delivered grossly defective RSGs that experienced primary-to-secondary leakage—this fact is undisputed by the parties.”¹⁶⁵⁶
1648. In addition, in their C-RPHM, the Claimants submit that “Section 1.16.5.7 provides that there shall be no primary-to-secondary leakage in the RSGs. It is undisputed that a radioactive leak occurred in one of the Unit 3 RSGs after only eleven months of operation—and subsequently eight tubes failed in-situ pressure testing (an unprecedented occurrence in the U.S. nuclear industry). Indeed, Respondents concede that they breached this provision of the Contract.”¹⁶⁵⁷

(ii) The Respondents' Position

1649. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

It is undisputed that there was a primary-to-secondary leak in one tube in one of the Unit 3 SONGS RSGs. Preventing Primary-to-Secondary Leakage is a “Guaranteed Performance Level” under section 1.16.5.7 of the RSG Contract. section 1.16.5 establishes both these Guaranteed Performance Levels and the remedy for failing to achieve them:

Supplier guarantees the Apparatus shall achieve the guaranteed performance levels set forth in this section 1.16.5 and shall be liable for the performance liquidated damages set forth in section 1.29.1 in the event it fails to satisfy such performance obligations.

In addition, the RSG Contract specifies that the failure to meet a Guaranteed Performance Level is not considered a Defect if the Supplier pays the applicable liquidated damages, in this case \$1.4 million per section 1.29.2.1. Mitsubishi made a \$45.4 million payment to Edison in January 2013 from which this liquidated amount may be chargeable as outlined in Issue B.7(a)

¹⁶⁵⁶ Claimants' Responses to Joint List of Issues, ¶ B.6(e).

¹⁶⁵⁷ Claimants' RPHM, ¶ 205.

below. As outlined herein, Mitsubishi was also prepared to implement a thicker-AVB repair or replacement that would correct the root cause of the primary-to-secondary leak and prevent its recurrence.¹⁶⁵⁸

(iii) Tribunal's Determination

1650. There is no dispute between the Parties that primary-to-secondary leakage occurred.

1651. Accordingly, answering Issue B.6(e), MHI failed to supply RSGs that experienced no primary-to-secondary leakage under normal operating conditions.

(g) If Claimants have shown the failures in (a), (b), (c), (d) and/or (e), did extreme thermal-hydraulic conditions, vibration, and/or tube wear occur? (Issue B.6(f))

1652. This Issue B.6(f) concerns the question of if the Claimants have shown the failures in Issues B.6(a), (b), (c), (d) and/or (e) above, did extreme thermal-hydraulic conditions, vibration and/or tube wear occur.

(i) The Claimants' Position

1653. In their Responses to Joint List of Issues, the Claimants submit that “[t]he NRC concluded that the thermal-hydraulic conditions “were beyond the envelope of successful industry experience.” The parties agree that both Units 2 and 3 experienced in-plane and out-of-plane FEI. More than 3,400 tubes across all four RSGs suffered tube wear in one cycle (or less, in the case of Unit 3) of operation, including tube-to-tube wear in both Units. According to Mitsubishi’s expert, the SONGS RSGs were “the worst case degraded steam generator[s] in the history of domestic nuclear power.”¹⁶⁵⁹ Further, in their C-RPHM, the Claimants make a reference to their submissions concerning Issue B.4(h), above.¹⁶⁶⁰

¹⁶⁵⁸ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 180-181.

¹⁶⁵⁹ Claimants’ Responses to Joint List of Issues, ¶ B.6(f).

¹⁶⁶⁰ Claimants’ RPHM, ¶ 206.

(ii) The Respondents' Position

1654. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

As discussed in response to Issue B.4(a) and B.4(h) above, the thermal-hydraulic conditions in the SONGS steam generators were not “extreme” for this class of steam generator and were inherent in the Edison specification. While it is acknowledged that vibration and tube wear occurred at SONGS, with the exception of the tube-to-tube wear caused by in-plane FEI, the vibration and other tube wear was manageable and consistent with tube wear in similar steam generators. Non-tube-to-tube wear would not have prevented the safe operation of SONGS at 100% power as Edison has repeatedly admitted.

This issue, as stated, also assumes a causal connection between the conduct in subsections (a)-(e) that has not been established by Claimants.¹⁶⁶¹

(iii) Tribunal's Determination

1655. As set out in relation to Issue B.4(b), the Tribunal determined that extreme thermal-hydraulic conditions, vibration, and/or tube wear did occur.¹⁶⁶²

1656. The Tribunal also determined that the Claimants have shown that the Respondents failed to meet the contractual obligations under Issue B.6(c) regarding tube support,¹⁶⁶³ Issue B.6(d) regarding provisions of U.S. legal and professional codes,¹⁶⁶⁴ and Issue B.6(e) regarding primary to secondary side leakage.¹⁶⁶⁵

1657. Accordingly, the Tribunal determines Issue B.6(f) in the affirmative to the extent that it relates to the Tribunal's considerations that the Claimants have shown the Respondents' failures in relation to Issues B.6(c), (d) and (e) above.

¹⁶⁶¹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 182-183.

¹⁶⁶² See ¶ 1431 above.

¹⁶⁶³ See ¶ 1634 above.

¹⁶⁶⁴ See ¶ 1645 above.

¹⁶⁶⁵ See ¶ 1651 above.

(h) If Claimants have shown the failures in (a), (b), (c), (d) and/or (e), does such failure or failures, individually or in combination, provide evidence of Claimants' breach of contract claim? (Issue B.6(g)) If so, what is the consequence, if any (Issue B.6(g)(i))

1658. Issues B.6(g) and B.6(g)(i) concern the questions if the Claimants have shown the failures in relation to Issues B.6(a), (b), (c), (d) and/or (e) above, does such failure or failures, individually or in combination, provide evidence of the Claimants' breach of contract claim and, if so, what is the consequence, if any.

(i) The Claimants' Position

1659. With respect to Issue B.6(g), the Claimants, in their Responses to Joint List of Issues, submit that “[e]ach of these failures – both individually and in taken together – demonstrates a material breach of the RSG Contract. Whether a breach is material “depends on the importance or seriousness thereof and the probability of the injured party getting substantial performance.” *Brown v. Grimes*, 192 Cal. App. 4th 265, 278 (Cal. App. 2011) (quoting 1 Witkin, Summary of Cal. Law (10th ed. 2005) Contracts, § 852, pp. 938-940). Due to the above described failures, both individually and collectively, the RSGs were not “capable of being operated safely, normally and continuously in accordance with the requirements of the Specification, the Purchase Order, all Applicable Laws, Applicable Standards and the Documentation associated therewith at all operating conditions and modes specified in the Specification, the Scope of Work or other applicable Documentation”—the purpose of the contract. Each of these breaches are therefore material. After 16 months, there was no prospect that Mitsubishi would be able to deliver goods that even substantially conformed to the requirements of the contract through repair or otherwise.”¹⁶⁶⁶

¹⁶⁶⁶ Claimants' Responses to Joint List of Issues, ¶ B.6(g).

1660. Further, with respect to Issue B.6(g)(i), the Claimants, in their Responses to Joint List of Issues, while making reference to their submissions concerning Issue H, and Issue F, submit the following:

If the Tribunal finds a material breach, it must determine what damages were caused by the breach. *See infra* section H.

Even if the Tribunal finds that not all of the individual breaches described above were material, evidence of any or all breaches presented remain relevant to Claimants' case. Specifically, evidence of the severity of the design errors and breaches of contractual requirements are relevant to: (1) Claimants' breach of warranty claim as they bear on whether Mitsubishi was even capable of repairing or replacing the RSGs within a reasonable time—*i.e.* whether the repair or replace remedy failed of its essential purpose *see infra* section F; (2) Claimants' alternative argument that the limitations of liability cannot be enforced because Respondents' conduct was grossly negligent or fraudulent *see infra* section F.3-4; or (3) Claimants' misrepresentation claims as they demonstrate the promises and false assurances made to induce Edison to enter the contract *see infra* section D, G.1.¹⁶⁶⁷

(ii) *The Respondents' Position*

1661. In their Position Statement on the Revised List of Issues, the Respondents, with respect to Issue B.6(g), contend that “[a]ll breach of contract claims are subsumed into Mitsubishi’s warranty obligations. Each alleged failure listed above, if proven, could be remedied under Section 1.17.1.3 of the RSG Contract including through repair or replacement, or the backcharge or default options, or through liquidated damages under section 1.29. As discussed in [the Respondents’ submissions concerning Issue] C, Mitsubishi met its warranty obligations and/or was excused by Edison’s actions. Even if the Tribunal determines that a breach of contract right exists that is not subsumed into Mitsubishi’s warranty obligations, Claimants have failed to

¹⁶⁶⁷ Claimants’ Responses to Joint List of Issues, ¶ B.6(g)(i).

establish that any of these alleged failures constitute a breach of contract or that any such breach caused any of their alleged damages.”¹⁶⁶⁸

1662. Further, with respect to Issue B.6(g)(i), the Respondents contend that “[t]here is no consequence to any finding above unless Claimants can prove that any of the alleged failures outlined in Section B.6 constitute “Defects” that Mitsubishi was obligated to but failed to remedy and was not otherwise excused, or that the above resulted in an obligation to pay liquidated damages that Mitsubishi refused to pay.”¹⁶⁶⁹

(iii) The Tribunal’s Determination

1663. In order to determine Issues B.6(g) and B.6(g)(i), it is necessary and appropriate to set out (i) the Tribunal’s findings concerning each of the Sub-Issues of B.6(a) through (e); and (ii) the relevant provisions of the RSG Contract in order to assess the consequences of any of the failures by the Respondents established by the Claimants.

1664. The Tribunal determined Issues B.6(a) and B.6(b) in the negative.¹⁶⁷⁰ By consequence no further consideration under Issues B.6(g) and B.6(g)(i) is required.

1665. Regarding Issue B.6(c) above, the Tribunal considers that the Respondents’ failure to provide adequate tube supports triggered the warranty obligations under Section 1.17 of the RSG Contract for the following reasons.¹⁶⁷¹

1666. Section 1.17.1.3 provides in relevant parts that:

Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner,

¹⁶⁶⁸ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 184-185.

¹⁶⁶⁹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 186.

¹⁶⁷⁰ See ¶¶ 1603, 1613 above.

¹⁶⁷¹ See ¶ 1634 above.

1667. A “Defect” in the RSG Contract is defined in Section 1.2.1.3 of the RSG Contract as follows: “the Parties agree that Work shall be considered to be defective if it does not conform to the Applicable Standards or Applicable Laws.” The Respondents’ failure to provide adequate tube supports is, thus, a Defect.
1668. Since a Defect triggers MHI’s warranty obligations under Section 1.17 of the RSG Contract, the Respondents’ failure to provide adequate tube supports triggered the warranty obligations.
1669. With respect to Issue B.6(d),¹⁶⁷² the Tribunal considers that the consequences of a failure to meet any technical standards in those codes triggers the warranty obligations under the RSG Contract to the extent that the failure to meet a code standard resulted in a Defect. The Tribunal does not consider there to be any consequences regarding the obsoleting of prior documents.
1670. Regarding Issue B.6(e),¹⁶⁷³ the Tribunal considers that the occurrence of primary-to-secondary leakage triggers the liquidated damages provision in Section 1.29.1.5 of the RSG Contract for the following reasons.
1671. In addition, the Tribunal recalls that under the definition of Defect of the RSG Contract, “if [the] Supplier fails to satisfy a Guaranteed Performance Level, such failure shall not be considered a Defect provided Supplier has paid the liquidated damages applicable to such Guaranteed Performance Level for such failure.” Primary-to-Secondary leakage is a “Guaranteed Performance Level” under Section 1.16.5.7 of the RSG Contract.
1672. It should be noted that the Tribunal concurs with the Claimants’ submission that any of the factual findings under Issue B may be applicable to the Claimants’ submissions

¹⁶⁷² See ¶ 1645 above.

¹⁶⁷³ See ¶ 1651 above.

on other Issues in this arbitration, including Issues D and F regarding gross negligence and misrepresentations. That is, the Claimants' case on gross negligence and misrepresentations relies upon the same factual underpinning as addressed in the Claimants' breach of contract case considered in Issue B.

G. DID MITSUBISHI TIMELY PAY EDISON'S INVOICES BACK-CHARGING MITSUBISHI FOR EXPENSES THAT ARE MITSUBISHI'S RESPONSIBILITY (RSG CONTRACT SECTIONS 1.17.1.3; 1.9.4; 1.12.2; 1.17.6)? (ISSUE B.7)

1673. This Issue, B.7, relates to the amounts invoiced by SCE to MHI spread over seven invoices, which serve to back-charge the Respondents for the expenses incurred by SCE for its attempts to inspect, repair and restore the RSGs to service (**SGIR "costs" or "Damages"**).

1674. These costs pertain to MHI's warranty obligations contained in Section 1.17 of the RSG Contract, to be read with Sections 1.9.4 and 1.12.2, the relevant parts of which are as follows:

1.9.4. Backcharges: The Supplier shall pay invoices from EMS for backcharges, pursuant to Section 1.17.1.3(b) within thirty (30) days after receipt of such invoice.

1.12.2. If EMS or Edison is required to modify any engineering, Documentation, shipping, hardware, or configuration of any portion of SONGS (excluding the Apparatus) directly due to the Apparatus not conforming to the Certified Drawings, the Supplier shall reimburse EMS for the actual costs that EMS and Edison incur as a result thereof.

1.17.1.3. Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner, by the Supplier at its sole expense with due diligence and dispatch by repairing or replacing (as appropriate) any defective part and other portion of the Work affected by such Defect. Supplier shall be responsible for all costs and expenses associated with such repair or

replacement, including but not limited to (i) any necessary adjustments, modifications, change of design, removal, repair, replacement or installation of the Apparatus, and (ii) all parts, materials, tools, equipment, transportation charges and labor as may be necessary for such repair or replacement, except those specified in Section 1.17.7.4

(...)

(b) Should the Supplier fail to take action to correct any Defect within two (2) days after [sic] upon notification to the Supplier or fails to diligently continue performing such correction to completion thereafter, then the Edison Representative may perform or EMS or Edison may have performed such necessary warranty work and backcharge the Supplier for such direct costs for repair or replacement and/or declare Supplier to be in default pursuant to Section 1.24. Such EMS or Edison performed warranty work shall not be construed as to void the warranty provisions and such warranty work shall be subject to Supplier's warranty obligations hereunder as if such warranty work had been performed by Supplier.

1.17.6. Interference

During the period of any RSG repair or replacement, the Supplier warrants that should EMS or Edison incur additional costs from its installation contractor, or if EMS or Edison is required to use its own construction forces or third party crews, because of: (i) any Defect or shipment of incorrect or nonconforming components of the Apparatus; (ii) interference between the Apparatus and EMS's or Edison's facility caused by the Supplier; or (iii) component parts of the Apparatus do not properly fit together in accordance with the Certified Drawings when being assembled, then the Supplier shall reimburse EMS for such direct costs.

1675. Issue B.7 is intrinsically linked to the Issue of the adequacy of supporting documentation (Issue B.7(a) below). Further, this Issue also bears relevance to the Respondents' counterclaims (Issue H below), a majority of which seek a reimbursement for the amounts allegedly expended by MHI in fulfillment of its warranty obligations.

(i) The Claimants' Position

1676. In their Responses to Joint List of Issues, the Claimants submit that “[b]efore commencing this arbitration, Edison sent Mitsubishi a total of seven invoices requesting reimbursement for charges that Edison incurred solely for the purpose of returning the RSGs to service. Mitsubishi paid the first invoice, totalling just over \$45 million, approximately three months after receiving it, but now claims that was only “as a gesture of good faith” and “without prejudice to [its] right to challenge the legitimacy of any charges included” in that invoice. Mitsubishi refused to pay any of the other invoices.”¹⁶⁷⁴
1677. In addition, in their C-RPHM, the Claimants contend that “[o]ver the course of the sixteen-month period between the tube leak and the permanent retirement of SONGS, Claimants spent approximately \$181 million to inspect the RSGs, investigate the causes of the leak, and attempt to return the units to service. Respondents admit that Claimants incurred these costs and that they are direct damages under California law. They do not argue that the vast majority of these charges were incurred for any reason other than the RSG failures. Instead, Respondents suggest that Edison provided insufficient documentation to verify that these charges were incurred as part of the effort to return the RSGs to service. This claim is not credible in light of the amount and specificity of supporting information that Edison provided, and it stands in stark contrast to Respondents’ position on the amount and quality of documentation necessary to approve the thicker-AVB repair concept. Respondents’ claim is also legally insufficient to rebut a claim for direct damages. Therefore, consistent with the plain language of the RSG Contract, the Tribunal’s Award should order Respondents

¹⁶⁷⁴ Claimants’ Responses to Joint List of Issues, ¶ B.7.

to reimburse Claimants for the full amount of their Steam Generator Inspection and Repair (“SGIR”) expenses: \$227 million in present-value 2016 dollars.”¹⁶⁷⁵

(ii) *The Respondents’ Position*

1678. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Edison first invoiced Mitsubishi for a portion of its alleged Steam Generator Inspection and Repair (“SGIR”) costs in mid-September, 2012. Mitsubishi promptly requested supporting documentation from which it could determine whether and how much of the back-charges were properly chargeable under the terms of the parties’ contract. Due to Edison’s insistence on reimbursement and Mitsubishi’s insistence on documentation of the amounts incurred so that it could test their chargeability under the Contract, the parties negotiated a Memorandum of Understanding (“MOU”) that permitted Mitsubishi to make a provisional payment of the first invoice in full, without waiving or otherwise prejudicing its right to contest its undocumented amounts in the future. On December 24, 2012, in advance of the deadline set forth in the MOU, Mitsubishi wired payment of the entire amount of invoice RSG-001 (\$45.4 million) to Edison.

Edison sent Mitsubishi six more invoices, but despite repeated demands for adequate documentation from both Mitsubishi and the forensic consultant it retained, the amount of supporting documentation never improved. As discussed in Issue 7, Subsection (a), immediately below, Mitsubishi retained both FTI Consulting and Mr. J. Michael Wade to review Edison’s invoices and backup to determine the extent to which any of the items billed were (a) chargeable under the terms of the contract, and (b) adequately documented. As a result of an in-depth review of each vendor invoice (and, again, as discussed below) Mitsubishi concluded that the amount that was both chargeable and reasonably substantiated was approximately \$32.8 million of the \$148.6 million billed—far less than the \$45.4 million paid to Edison pursuant to the MOU. In addition, Edison was entitled to invoice Mitsubishi for \$2.357 million in liquidated damages for the leak and tube plugging. Thus, although Mitsubishi did not pay Edison the amounts invoiced in excess of the initial

¹⁶⁷⁵ Claimants’ RPHM, ¶ 210.

payment of \$45.4 million, Mitsubishi clearly paid all amounts which Edison properly substantiated in a timely fashion.¹⁶⁷⁶

(iii) Tribunal's Determination

1679. The Claimants have claimed SGIR costs amounting to a total of \$181,352,160. While SCE had originally invoiced \$148,630,206, the expert retained by SCE, Mr. Kenneth P. Metcalfe, President of the Kenrich Group LLC, in his Report dated 27 July 2015 includes within the SGIR costs an additional \$32,721,955 and thereby increases the claimed SGIR costs to \$181,352,160.¹⁶⁷⁷
1680. This Issue pertains only to the originally invoiced \$148,630,206 and does not address the viability of the subsequently claimed total of \$181,352,160. The subsequently claimed amount, and the pecuniary consequences thereof, are addressed in Issue H, below.
1681. The initially invoiced \$148,630,206 were spread across seven invoices in the following manner:¹⁶⁷⁸
- i. \$45,361,817 charged under SCE Invoice RSG-001;
 - ii. \$8,187,324 charged under SCE Invoice RSG-002;
 - iii. \$52,343,892 charged under SCE Invoice RSG-003;
 - iv. \$20,386,928 charged under SCE Invoice RSG-004;
 - v. \$12,442,730 charged under SCE Invoice RSG-005;
 - vi. \$6,873,967 charged under SCE Invoice RSG-006;

¹⁶⁷⁶ Respondents' Position Statement on the Revised List of Issues, ¶¶ 187-188.

¹⁶⁷⁷ Expert Report of Mr. Metcalfe, n. 5.

¹⁶⁷⁸ Exh. JX-2179.

vii. \$3,033,548 charged under SCE Invoice RSG-007.

1682. It is an admitted position between the Parties that MHI has paid \$45,361,817 in satisfaction of the first invoice numbered SCE Invoice RSG-001. This payment was wired to SCE on 24 December 2012.¹⁶⁷⁹
1683. This payment was made pursuant to the agreement reached between the Parties recorded in the Memorandum of Understanding dated 20 December 2012 (“MoU”) where-by MHI agreed in Section 1 to “make a payment to SCE on invoice RSG-001 in the amount of \$45,361,816.94 on or before December 26 2012.”¹⁶⁸⁰ This MoU was entered into subsequent to SCE having incurred the said amount “in response to the tube leak and discovery of tube wear in the RSGs,” which amount SCE considered to be “MHI’s responsibility under the terms of the Contract.” Further, the MoU was also intended to account for MHI’s contention “that it had not had an opportunity to thoroughly review the supporting documentation for Invoice RSG-001.”¹⁶⁸¹
1684. The Claimants do not dispute that this payment was made by MHI, albeit three months after MHI received the invoice.¹⁶⁸² However, the three-month delay in making the payment is not an Issue in dispute between the Parties.
1685. It is also an admitted position between the Parties that MHI did not pay the amounts charged to it in the remaining invoices, i.e., SCE Invoice RSG-002 to RSG-007.
1686. However, the Parties stand at odds, regarding the motivations behind MHI’s non-payment of the amounts charged to it in the remaining invoices. Whereas the

¹⁶⁷⁹ Exh. JX-1583.

¹⁶⁸⁰ Exh. JX-1572.

¹⁶⁸¹ Exh. JX-1572, Preamble.

¹⁶⁸² Claimants’ RPHM, ¶ 211.

Claimants contend that MHI “refused to pay any of the other invoices,”¹⁶⁸³ the Respondents submit that “although Mitsubishi did not pay Edison the amounts invoiced in excess of the initial payment of \$45.4 million, Mitsubishi clearly paid all amounts which Edison properly substantiated in a timely fashion.”¹⁶⁸⁴ The Respondents’ argument on substantiation of the amounts leads the Tribunal to the issue pertaining to the adequacy of the supporting documentation provided by the Claimants in support of their claims, which shall be dealt with next (Issue B.7(a) below).

1687. A further aspect of this Issue is whether the expenses being charged by SCE are “Mitsubishi’s Responsibility.”
1688. The Tribunal concludes that this is the case for the following reasons. Section 1.17.1.3 of the RSG Contract clearly specifies that the “Supplier shall be responsible for all costs and expenses associated with such repair or replacement.” As is evident, SCE incurred itself various charges in carrying out efforts to repair or replace the defective RSGs. The Tribunal finds that under a plain reading of the RSG Contract, these expenses are MHI’s responsibility.
1689. Accordingly, the Tribunal answers Issue B.7 in the negative, MHI did not timely pay Edison’s invoices back-charging MHI for expenses that are MHI’s responsibility. It is apparent that MHI has not paid the amounts charged to it in SCE’s invoices RSG-002 to RSG-007, and has only made the payment of \$45,361,817 in satisfaction of SCE Invoice RSG-001.

¹⁶⁸³ Claimants’ RPHM, ¶ 211.

¹⁶⁸⁴ Respondents’ Position Statement on the Revised List of Issues, ¶ 188.

(a) **If not, was Edison’s documentation supporting the charges inadequate, such that Mitsubishi was excused from paying any such invoices due to Edison’s inadequate documentation supporting the changes? (Issue B.7(a))**

1690. Given that the Tribunal answers Issue B.7 in the negative, it is essential for it to address Issue B.7(a). This Issue, B.7(a), addresses the question of whether the documentation supporting the originally invoiced SGIR costs, amounting to \$148,630,206, was inadequate, such that this inadequacy resulted in excusing Mitsubishi from paying such invoices.

(i) *The Claimants’ Position*

1691. In their Responses to Joint List of Issues, the Claimants submit that “[t]he amount and specificity of supporting information that Edison provided regarding the charges was adequate.”¹⁶⁸⁵

1692. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

The SGIR costs were the direct result of the tube leak, and were incurred solely to support efforts to restore the RSGs to service. Respondents’ expert accountant, Mr. Paul Ficca, admits that Edison actually incurred the charges for which it invoiced Respondents. Claimants produced more than 6,000 pages of documentation to support the first invoice alone, and ultimately produced more than 18,000 pages of employee time records, work orders, third party invoices, and other documents. This documentation “included transaction-level detail from cost reports extracted from Edison’s accounting system, as well as third-party supplier purchase orders, change orders, and invoices.” To further verify that Edison only invoiced Respondents for charges that were incurred to restore the RSGs to service, Mike Wharton and other knowledgeable Edison personnel examined the work orders and confirmed that they were dedicated to the SGIR efforts.

Respondents’ position on this issue is best characterized as willful blindness to Claimants’ evidence mixed with speculation about unspecified documents that

¹⁶⁸⁵ Claimants’ Responses to Joint List of Issues, ¶ B.7(a).

may or may not exist. For example, Respondents continue to assert that “Edison passed on a USD 10.5 million . . . invoice[] [to Mitsubishi] . . . supported by nothing more than a one page coversheet,” but ignore that those costs were billed against a detailed purchase order, and recorded to a specific Work Order that was generated for “[d]evelopment and installation costs for the unique split stabilizer, a method of controlling tube vibration after the tube is plugged and removed [from] service.” Rather than respond to that evidence, Respondents rely on the testimony of their expert, Mr. Wade, who stated that he was “confident that SCE has substantial additional invoicing information from its vendors that it has chosen not to share with Mitsubishi.” Mr. Wade did not specify what additional information he would have expected Edison to possess, nor how that information would have been superior to the mountain of documentation that Claimants produced and that he allegedly reviewed. Based on this record, the Tribunal should find that Edison’s documentation was adequate and order Respondents to pay the full amount of Claimants’ SGIR expenses.¹⁶⁸⁶

(ii) *The Respondents’ Position*

1693. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Edison’s documentation supporting the charges was woefully inadequate. Claimants’ claims for SGIR costs can be divided into two groups - USD 148.6 million which was the subject of Invoices RSG-001 through RSG-007, and USD 32.7 million which was never invoiced to Mitsubishi, but appeared for the first time in Mr. Metcalfe’s July 27, 2015 Expert Report.

Mitsubishi retained Mr. Paul Ficca, a forensic accounting consultant to review Edison’s supporting documentation and to deal directly with Edison in attempting to gather supporting documentation. In addition, Mitsubishi retained industry experts to review the individual vendor invoices and supporting documentation to determine whether the amounts billed and scopes of work covered in each vendor invoice were adequately documented so that a determination could be made of whether the amounts billed matched the reasonable costs of the work being done under the circumstances and whether the scopes of work included in the invoices were chargeable under the terms of the RSG Contract. Despite negotiating a Non-Disclosure Agreement between FTI Consulting and AREVA, for example, which allowed FTI to review

¹⁶⁸⁶ Claimants’ RPHM, ¶¶ 212-213.

proprietary supporting information from AREVA, and despite producing thousands of pages of documentation, Edison refused to produce documentation for the vast majority of its alleged SGIR costs. For example, Edison passed on a USD 10.5 million, an USD 8.3 million, and six USD 1+ million AREVA invoices, each supported by nothing more than a one page coversheet. Indeed, Mr. Wade, who had served as Resident Site Manager for Westinghouse and its predecessor firm at the SONGS facility for over 20 years, testified that:

Based on my experience working with SONGS personnel for 21 years, I am confident that SCE has substantial additional invoicing information from its vendors that it has chosen not to share with Mitsubishi.

No witness has contradicted this statement.

Mr. Wade reviewed each and every invoice, work order and all supporting documentation received by Mitsubishi to see if (a) the invoice was adequately supported to determine what work was performed, and (b) the work performed was chargeable to Mitsubishi under the terms of the RSG Contract. In addition to his written testimony, he presented two extensive documents. First, he prepared a 54-page spreadsheet that categorized each vendor invoice by several categories and detailed how much of each vendor invoice was approved as chargeable, estimated as properly chargeable although not fully supported or non-chargeable pursuant to various identified provisions of the Contract. Second, he prepared a 23-page "Invoice Reasoning Table" in which he verbally explained his rationale for approving or rejecting vendor invoices. He concluded that, despite invoicing Mitsubishi over USD 148 million, Claimants had properly supported only USD 27.3 million in invoices, and that he had sufficient information to estimate that Edison had incurred another USD 3.2 million in properly chargeable amounts, for a total of USD 30.5 million. In addition, Mr. Ficca computed that Edison was entitled to liquidated damages of USD 2,357,000 for tube plugging and primary-to-secondary leakage. Thus, only USD 32.8 million of the USD 148 million invoiced was established by Edison with reasonable certainty.

The second component of this claim is the USD 32.7 million that first appeared in Mr. Metcalfe's expert report, and for which no third party vendor invoices or payment records were ever produced. Although both Mr. Ficca and Mr. Wade attempted to analyse these charges on the little information provided, neither had sufficient information to make a meaningful analysis of these charges, and these charges should be rejected in their entirety.

Given this amazing lack of documentation in support of its charges, Edison should be precluded from recovering more than the USD 32.8 million agreed to by Messrs. Wade and Ficca.¹⁶⁸⁷

(iii) Tribunal's Determination

1694. Before determining whether Edison's documentation supporting the charges invoiced to MHI was inadequate, as a first step, it is essential to determine the standard of certainty that such documentation is required to meet in order to be considered adequate. For the reasons set forth below, that standard is a standard of reasonable certainty regarding the nature and origin of the damages. The Claimants have the burden of proof of meeting that standard.
1695. It must be noted that the Parties' submissions with respect to the standard of certainty of supporting documentation are part of their Positions on the Issue of Damages (Issue I below). However, the Tribunal deems it helpful to consider these submissions, under this Issue, B.7(a). In turn, the Tribunal shall extrapolate its conclusions on the standard of certainty to the remainder of the Issues in dispute, including the Issue on Damages.
1696. The Parties' disagreement centers around the standard of certainty that the supporting documentation is required to satisfy in order to be considered adequate.
1697. Further, the Parties also dispute whether the documentation provided by SCE in support of its invoiced SGIR costs meets the standard of certainty so as to be considered adequate, and to what extent.
1698. The Tribunal considers each of these questions in the order in which they are mentioned.

¹⁶⁸⁷ Respondents' Position Statement on the Revised List of Issues, ¶¶ 189-193.

1699. *Standard of certainty*: The Claimants' position in respect to the standard of certainty is that they are required only to establish the fact of Damages with reasonable certainty, and not their amount or extent.¹⁶⁸⁸ They predicate their submissions on the decisions of the Californian Court of Appeal in *Asahi Kasei Pharma Corp. v. Actelion Ltd.*¹⁶⁸⁹ and the United States Court of Appeal (2nd Circuit) in *Tractebel Energy Marketing, Inc. v. AEP Power Marketing, Inc.*¹⁶⁹⁰
1700. In contrast, the Respondents submit that the Claimants are required to prove both the occurrence and the extent of Damages with reasonable certainty.¹⁶⁹¹ They rely on the decisions of the Californian Supreme Court in *Sargon Enterprises, Inc. v. Univ. of S. Cal.*¹⁶⁹² and the Federal District Court of California (San Jose Division) in *FiTeq Inc v. Venture Corporation et al.*¹⁶⁹³
1701. As a preliminary matter, the Tribunal notes that the RSG Contract does not contain any indication as to the standard of certainty that supporting documentation should meet in order to be considered adequate.
1702. However, this standard of certainty can be sourced firstly, from the MoU dated 20 December 2012 executed between the Parties and, secondly, from general legal and accounting practice.
1703. In this connection, attention must be directed to Section 3 of this MoU, which records the Parties' agreement with respect to the supporting documentation as follows:

¹⁶⁸⁸ Claimants' RPHM, ¶¶ 705-712.

¹⁶⁸⁹ 222 Cal. App. 4th 945.

¹⁶⁹⁰ 487 F.3d 89 (2d Cir. 2007).

¹⁶⁹¹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 539-541.

¹⁶⁹² 55 Cal. 4th 747 (2012).

¹⁶⁹³ 2016 WL 693256 (N.D. Cal. Feb. 22, 2016).

Subject to SCE's cooperation in providing MHI with reasonably necessary supporting documentation, MHI will present by January 31, 2013 a detailed, written statement of adjustments ("Statement of Adjustments") it contends are necessary to remove costs it believes are not properly chargeable to MHI under the terms of the Contract (...)

1704. This Section of the MoU entitles MHI to receive supporting documentation with respect to the amounts invoiced in SCE Invoice RSG-001. Further, it provides a cursory indication as to the standard of certainty in the words "reasonably necessary" prefixing "supporting documentation."
1705. As will be evident from the forthcoming discussion, the Tribunal considers that this standard aligns itself with the general legal and accounting practice with respect to the adequacy of supporting documentation. As such, this generally applicable standard of certainty extends to all amounts claimed by the Claimants.
1706. With respect to this generally applicable standard of certainty, the Parties are in agreement that the standard must be that of reasonable certainty.¹⁶⁹⁴ Similarly, the Respondents' expert, Mr. Paul Ficca, also confirmed this standard during the hearings, as being the standard applicable in general practice.¹⁶⁹⁵ The only disagreement between the Parties is whether this standard of reasonable certainty is applicable only to the fact or the occurrence of Damages, or also to their amount or extent.
1707. While the Claimants suggest that the standard applies only to the fact of the occurrence of Damages, the Respondents contend that the standard, in addition to applying to the fact or occurrence of Damages, also applies to their amount and extent. When making these submissions, the Parties discuss at considerable length

¹⁶⁹⁴ Claimants' RPHM, ¶¶ 705-712; Respondents' Position Statement on the Revised List of Issues, ¶¶ 539-541.

¹⁶⁹⁵ Deposition of Mr. Paul Ficca, pp. 181-182.

the distinction between how the standard applies to unestablished businesses and how it applies to established businesses.¹⁶⁹⁶

1708. The Tribunal considers that the question of whether the standard of reasonable certainty applies to the amount or extent of the damages, in addition to the fact of their occurrence, is not relevant for the claimed SGIR costs.
1709. Instead, this question becomes relevant only with respect to costs claimed for lost profits. It is only in the context of such damages that this question has arisen in California law.
1710. Each of the cases relied upon by the Parties was decided in the context of damages claimed for lost profits. It appears only in this limited context that the Californian courts have differentiated between the standard of reasonable certainty as applicable to both occurrence and the extent of damages, and the standard as applicable only to the fact or occurrence of damages, and not the extent.¹⁶⁹⁷ While the former application of the standard is considered appropriate for established businesses,¹⁶⁹⁸ the latter is considered appropriate for unestablished ones.¹⁶⁹⁹
1711. In either case, under the applicable California law, establishing damages for lost profits is subjected to a considerably stringent application of the standard of reasonable certainty.

¹⁶⁹⁶ Clamants' RPHM, ¶¶ 705-712.; Respondents' Position Statement on the Revised List of Issues, ¶¶ 540-541.

¹⁶⁹⁷ Exh. CL-138 (*Sargon Enterprises, Inc. v. Univ. of S. Cal*, 55 Cal. 4th 747 (2012)).

¹⁶⁹⁸ Exh. CL-53 (*Asahi Kasei Pharma Corp. v. Actelion Ltd*, 222 Cal. App. 4th 945).

¹⁶⁹⁹ Exh. CL-294 (*FiTeq Inc v. Venture Corporation et al.*, 2016 WL 693256 (N.D. Cal. Feb. 22, 2016)).

1712. In fact, the Californian Supreme Court in its decision in *Sargon Enterprises, Inc. v. Univ. of S. Cal.*,¹⁷⁰⁰ which forms the central aspect of contention between the Parties, relied on the Californian Supreme Court decision in *Lewis Jorge Construction Management, Inc. v. Pomona Unified School Dist.*¹⁷⁰¹ This latter decision had explained how damages for lost profits stand on a different pedestal as compared to other “general damages” and, thus, are generally subjected to a more stringent application of the standard of reasonable certainty:

Lost profits, if recoverable, are more commonly special rather than general damages (...), and subject to various limitations. Not only must such damages be pled with particularity (*Mitchell v. Clarke*, supra, 71 Cal. at p. 164, 11 P. 882), but they must also be proven to be certain both as to their occurrence and their extent.¹⁷⁰²

1713. From the aforesaid extract, it is evident that the standard of reasonable certainty as it has manifested itself for claims of lost profits should not be extended to other damages or costs arising out of breach of contractual obligations.

1714. Instead, for all other claims of damages, resort must be had to the default rule contained in Section 3301 of the California Civil Code, which states:

No damages can be recovered for a breach of contract which are not clearly ascertainable in both their nature and origin.

1715. This rule also requires the claims of Damages to be proved up to a standard of reasonable certainty, but only as to the nature and origin of the damages. In other words, if it can be reasonably ascertained that the damages were “within the

¹⁷⁰⁰ Exh. CL-138 (55 Cal. 4th 747 (2012)).

¹⁷⁰¹ Exh. CL-109 (22 Cal.Rptr.3d 340 (2004)).

¹⁷⁰² Exh. CL-109 (*Lewis Jorge Construction Management, Inc. v. Pomona Unified School Dist.*, 22 Cal.Rptr.3d 340, 351 (2004)).

contemplation of the parties,”¹⁷⁰³ and were not “uncertain, hypothetical and entirely speculative,”¹⁷⁰⁴ the standard stands satisfied. It does not require the Claimants to establish the nature and origin of Damages with absolute certainty or mathematical precision.¹⁷⁰⁵

1716. The Tribunal considers this formulation of the standard of reasonable certainty to be less stringent than the standard applicable for claims of lost profits, which, as shown above, is not only subjected to burdensome presumption, but also requires proof as to the fact and extent of damages.
1717. The SGIR costs, being claims for Damages arising out of breach of contractual obligations, should benefit from this default standard of reasonable certainty contained in Section 3301 of the California Civil Code. There is no reason for them to be governed by the standard of reasonable certainty in the manner in which it applies to claims of lost profits.
1718. This is in line with California law, as well as the stipulation of “reasonably necessary supporting documents” contained in Section 3 of the MoU between the Parties dated 20 December 2012.
1719. Consequently, the Tribunal considers that the standard of certainty that the supporting documentation needs to meet in order to be considered adequate is that of reasonable certainty as to the nature and origin of the damages.
1720. *Whether the documentation provided by SCE in support of its claimed damages meets the aforesaid standard of certainty:* The Claimants submit that they produced more

¹⁷⁰³ Exh. CL-109 (*Lewis Jorge Construction Management, Inc. v. Pomona Unified School Dist.*, 22 Cal.Rptr.3d 340, 345 (2004)).

¹⁷⁰⁴ Exh. CL-138 (*Sargon Enterprises, Inc. v. Univ. of S. Cal*, 55 Cal. 4th 747 (2012)).

¹⁷⁰⁵ Exh. CL-138 (*Sargon Enterprises, Inc. v. Univ. of S. Cal*, 55 Cal. 4th 747 (2012)).

than 6,000 pages of documentation to support SCE Invoice RSG-001 alone, and ultimately produced more than 18,000 pages of documentation for all seven invoices cumulatively. This included employee time records, work orders, third party invoices, Purchase Orders, and Change Orders and other internal documents, such as cost reports extracted from Edison's accounting system.¹⁷⁰⁶

1721. The Respondents rebut the Claimants' submission, stating that the Claimants had adequately supported only \$27.3 million of the total invoiced amount of over \$148 million. In particular, the Respondents, through their expert Mr. Paul Ficca, point to inadequacies in the documentation, such as:

- i. The Claimants provided only one page coversheets of invoices and failed to provide any log sheets or other documentation to substantiate the dates or hours of employee time records;¹⁷⁰⁷
- ii. The Claimants provided certain supporting documents that were defective due to reasons of illegibility;¹⁷⁰⁸
- iii. All documents supporting SCE's labor costs were deficient, as SCE only produced summary labor reports indicating hours, amounts claimed, and employee classifications.¹⁷⁰⁹

1722. The Tribunal considers that the Respondents' objections to the adequacy of the Claimants' documentation appear to place a higher burden on the Claimants than what is contemplated under the standard of reasonable certainty.

¹⁷⁰⁶ Claimants' RPHM, ¶¶ 212-213.

¹⁷⁰⁷ Expert Report of Mr. Paul Ficca, ¶ 32.4.

¹⁷⁰⁸ Expert Report of Mr. Paul Ficca, ¶ 34.

¹⁷⁰⁹ Expert Report of Mr. Paul Ficca, ¶ 36.10.

1723. Based on the correspondence exchanged between the Parties surrounding these invoices and the supporting documents produced by the Claimants, the Tribunal finds that the SGIR costs were not only within the contemplation of the Parties, but were also not uncertain, hypothetical or entirely speculative.
1724. In this connection, it is essential to note that the Respondents' expert, Mr. Paul Ficca, admits that the supporting documents produced by the Claimants establish a likelihood that SCE has incurred the SGIR costs claimed.¹⁷¹⁰
1725. However, despite admitting the incurrence of the SGIR costs, the Respondents contend that the supporting documentation does not establish the chargeability of the SGIR costs to the Respondents.
1726. Notably, while the Respondents contest the adequacy of the supporting documents produced by the Claimants, they do not, at any point in time dispute that the inspection and repair works were indeed performed by the Claimants and the third party service providers.
1727. In fact, it is evident from the following correspondences that the Respondents were well aware of the involvement of these third party service providers, such as AREVA, Westinghouse & Babcock and Wilcox and of the efforts being undertaken by SCE itself regarding inspection and repair works.
1728. In this connection, it must be noted that SCE published a Request for Information dated 25 April 2012, requesting that repair submissions from potential bidders be submitted by the end of June 2012.¹⁷¹¹

¹⁷¹⁰ Expert Report of Mr. Paul Ficca, ¶ 36.10.

¹⁷¹¹ Exh. JX-1133.

1729. This Request was not only accessible to the Respondents, but was issued after informing MHI of SCE's intention to seek third party assistance regarding repair services.
1730. Specifically, on 18 February 2012, SCE formally informed MHI that it would be seeking independent assessments of the problems at SONGS and would be charging MHI, per the RSG Contract, for its efforts in investigating and repairing the RSGs.¹⁷¹² MHI replied on 21 February 2012, acknowledging that AREVA was engaging in an investigation.¹⁷¹³
1731. Similarly, the letter of 8 January 2013 from SCE to MHI shows that SCE was "looking to Mitsubishi to make SCE and its customers whole for all resulting damages."¹⁷¹⁴
1732. Moreover, internal communications within MHI evidence that it was aware of the likelihood of SCE back-charging MHI for inspection and repair works. This is apparent from the internal email dated 23 April 2012 stating "[b]ased on informal discussion with various SCE people, it is clear that SCE intend to back-charge MNES for everything related to the repairs up to the LOL."¹⁷¹⁵
1733. It was pursuant to this awareness that MHI raised requests for supporting documentation to determine whether and how much of the back-charges were properly chargeable to MHI.¹⁷¹⁶ Further, as discussed above, MHI's request of supporting documentation was recorded in the MoU dated 20 December.¹⁷¹⁷

¹⁷¹² Exh. JX-1046.

¹⁷¹³ Exh. JX-1048.

¹⁷¹⁴ Exh. JX-1610.

¹⁷¹⁵ Exh. JX-1130.

¹⁷¹⁶ Exh. JX-1374; Exh. JX-1397; Exh. JX-1451.

¹⁷¹⁷ See ¶ 1703 above.

1734. In fact, MHI was not only aware of these third parties providing inspection and repair services for the SONGS project, but was also corresponding with them on certain issues. For instance, between 5 August 2012 to 9-10 August 2012, MHI corresponded with Babcock & Wilcox regarding the tests that were needed to be performed at the AECL Chalk River testing facilities in Canada to validate the repair.¹⁷¹⁸
1735. Further, AREVA frequently prepared reports in response to MHI's repair proposals, for instance its review of MHI's thicker AVB repair method,¹⁷¹⁹ or MHI's U-Bend Repair Proposal¹⁷²⁰ and in turn also provided a budget proposal to MHI in order to undertake the necessary work, for instance to further develop the thicker AVB repair effort.¹⁷²¹
1736. Therefore, the record shows that the SGIR costs were within the contemplation of the Parties. Specifically, the Respondents were continuously made aware of the inspection and repair services being undertaken by third party service providers and by SCE. In addition, they were also aware that they were likely to be charged for the same, pursuant to Sections 1.9.4 and 1.17.1.3 of the RSG Contract, which set out in relevant parts:

1.9.4.

Backcharges: The Supplier shall pay invoices from EMS for backcharges, pursuant to Section 1.17.1.3(b) within thirty (30) days after receipt of such invoice.

1.17.1.3.

¹⁷¹⁸ Exh. JX-1303.

¹⁷¹⁹ Exh. JX-1761.

¹⁷²⁰ Exh. JX-1792.

¹⁷²¹ Exh. JX-1809.

(...)

Supplier shall be responsible for all costs and expenses associated with such repair or replacement, including but not limited to (i) any necessary adjustments, modifications, change of design, removal, repair, replacement or installation of the Apparatus, and (ii) all parts, materials, tools, equipment, transportation charges and labor as may be necessary for such repair or replacement, except those specified in Section 1.17.7.4.

(...)

(b) Should the Supplier fail to take action to correct any Defect within two (2) days after upon notification to the Supplier or fails to diligently continue performing such correction to completion thereafter, then the Edison Representative may perform or EMS or Edison may have performed such necessary warranty work and backcharge the Supplier for such direct costs for repair or replacement and/or declare Supplier to be in default pursuant to Section 1.24. Such EMS or Edison performed warranty work shall (...) be subject to Supplier's warranty obligations hereunder as if such warranty work had been performed by Supplier.

1737. Moreover, the Tribunal considers that the supporting documentation provided by SCE to MHI in support of the seven invoices is adequate to ensure that the SGIR costs are not uncertain, hypothetical or entirely speculative.

1738. The supporting documentation that has been provided by the Claimants broadly falls within two categories:

- i. Third party related documents that include Purchase Orders, Change Orders and invoices;¹⁷²²
- ii. Non-third party related documents that include SAP Accounting data, namely transaction based cost reports,¹⁷²³ for SONGS indicating the

¹⁷²² Exh. JX-2035, Tab C, D.

¹⁷²³ Expert Report of Mr. Kenneth Metcalfe, ¶ 50.

costs incurred on labor, staff augmentation, materials and others expenditures.¹⁷²⁴

1739. From the \$148,630,206 originally invoiced to MHI, the costs supported by third party Purchase Orders are \$115,499,894;¹⁷²⁵ and the costs supported by third-party invoices are \$123,044,178.¹⁷²⁶ Further, the costs supported by non-third party documentation, namely SCE's internal SAP Accounting data or transaction-based cost reports, are \$35,360,749.¹⁷²⁷

1740. In addition, the entirety of the invoiced amount, i.e., \$148,630,206, is supported by a total of 359 work orders. Specifically, the SGIR costs are allocated between five categories of work orders in the following manner:

- i. Steam generator inspections, repairs and support: 25 separate work orders totaling approximately \$97 million¹⁷²⁸ (direct cost \$87,043,599¹⁷²⁹);
- ii. Steam generator recovery team effort: 40 separate work orders totaling approximately \$44 million¹⁷³⁰ (direct cost \$38,317,192¹⁷³¹)

¹⁷²⁴ Exh. JX-2035, Tab E.

¹⁷²⁵ Exh. JX-2035.

¹⁷²⁶ Exh. JX-2035.

¹⁷²⁷ Exh. JX-2035.

¹⁷²⁸ Expert Report of Mr. Kenneth Metcalfe, ¶ 52.

¹⁷²⁹ Exh. JX-2035.

¹⁷³⁰ Expert Report of Mr. Kenneth Metcalfe, ¶ 53.

¹⁷³¹ Exh. JX-2035.

- iii. Steam generator recovery plant support effort: 182 separate work orders totaling approximately \$31 million¹⁷³² (direct cost \$24,403,077¹⁷³³)
- iv. Long-term plant equipment preservation: 81 separate work orders totaling approximately \$3 million¹⁷³⁴ (direct cost \$2,266,980¹⁷³⁵)
- v. Required new or refurbished equipment: 31 separate work orders totaling approximately \$7 million¹⁷³⁶ (direct cost \$6,374,079¹⁷³⁷)

1741. The Tribunal considers that the aforesaid documentation cannot be considered to be inadequate.
1742. The only purpose that the supporting documentation is required to serve is that of establishing that the claimed costs are not uncertain, hypothetical or entirely speculative.
1743. The collection of Work Orders, Purchase Orders, Change Orders, third party invoices, and SAP Accounting data, namely transaction based cost reports, for SONGS indicating the costs incurred on labor, staff augmentation, materials and others expenditures extend up to more approximately 18,000 pages.
1744. While these documents may not demonstrate absolute certainty with respect to the SGIR costs, they certainly do not render the SGIR costs hypothetical or entirely speculative.

¹⁷³² Expert Report of Mr. Kenneth Metcalfe, ¶ 54.

¹⁷³³ Exh. JX-2035.

¹⁷³⁴ Expert Report of Mr. Kenneth Metcalfe, ¶ 56.

¹⁷³⁵ Exh. JX-2035.

¹⁷³⁶ Expert Report of Mr. Kenneth Metcalfe, ¶ 60.

¹⁷³⁷ Exh. JX-2035.

1745. Accordingly, the Tribunal considers that the documentation supporting the SGIR costs are not inadequate. Thus, MHI was not excused from paying the seven invoices that were issued to it, namely SCE Invoice Nos. RSG-001 to 007 subject to the liability cap discussed with respect to Issue F, below. The pecuniary consequences are determined in Issue H, below.

1746. Thus, the Tribunal answers Issue B.7(a) in the negative, Edison's documentation supporting the charges was adequate, such that MHI was not excused from paying any such invoices, subject to the liability cap discussed with respect to Issue F, below.

H. DID THE RSG CONTRACT (SECTION 1.9.6) OBLIGATE MITSUBISHI TO ALLOW CLAIMANTS TO EXAMINE RELEVANT DOCUMENTS AND RECORDS? (ISSUE B.8)

1747. The Parties disagree as to whether Section 1.9.6 of the RSG Contract allowed SCE to obtain access to MHI's technical documents and source codes or whether that provision only allows the Claimants to audit pertinent accounting data related to the RSG Contract.

(i) The Claimants' Position

1748. In their Responses to Joint List of Issues, the Claimants submit the following:

Under section 1.9.6 of the RSG Contract, Claimants were entitled to examine all of Mitsubishi's documents that were "related and relevant" to the RSG project. Section 1.9.6 provides, in relevant part:

Edison, its representatives and agents may examine and copy, during the office hours of the Supplier and at a time mutually agreed to by the Parties, with the understanding that EMS will use reasonable efforts to avoid conducting audits during Supplier's quarterly and annual fiscal closing periods, the Supplier's books, accounts, relevant correspondence, specifications, time cards, drawings, designs, and other documentation, to the extent that these are related and relevant to the Work under the Purchase Order or insofar as may be necessary to verify items paid by EMS or Edison pursuant to the Purchase Order[.]

The “Work” is defined in section 1.2.59 of the Contract as follows:

The [RSGs], together with all engineering, analysis (including without limitation analysis of the impact of installation and use of the Apparatus on then-existing SONGS facilities), design, manufacturing, fabrication, assembly, inspection, testing, Documentation, Technical Services and all other obligations of the Supplier to be performed or furnished as required by the Purchase Order.

The “Apparatus” is defined in section 1.2.4 of the Contract as follows:

The RSG Units . . . and any and all other equipment, machinery, material, supplies, special tools, accessories, purchased components, computer hardware and firmware, to be furnished by the Supplier and purchased by EMS under the Purchase Order.

Read together, section 1.9.6 and its defined terms establish Claimants’ right to examine and copy Respondents’ “drawings, designs, and other documentation” to the extent that these are “related and relevant” to “the RSGs . . . and all other obligations of Respondents under the Contract.” This right is limited only by Respondents’ office hours and Claimants’ “reasonable efforts” to avoid examining documents during Respondents’ quarterly closings. The Tribunal concluded in December 2014 that Claimants had established a *prima facie* case on the merits and were entitled to specific performance of section 1.9.6.¹⁷³⁸

1749. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents’ only defense to their failure to comply with this contractual obligation is to allege that “Edison was clearly attempting to invoke Section 1.9.6 in anticipation of arbitration and in contravention of the Parties’ election that ICC Rules govern their disputes.” Respondents’ position is beside the point: it fails to respond to whether Section 1.9.6 obligates Respondents to allow Claimants to examine relevant documents and records.

Section 1.9.6 provides, in relevant part: Edison, its representatives and agents may examine and copy, during the office hours of the Supplier and at a time mutually agreed to by the Parties, with the understanding that EMS will use

¹⁷³⁸ Claimants’ Responses to Joint List of Issues, ¶ B.8.

reasonable efforts to avoid conducting audits during Supplier's quarterly and annual fiscal closing periods, the Supplier's books, accounts, relevant correspondence, specifications, time cards, drawings, designs, and other documentation, to the extent that these are related and relevant to the Work under the Purchase Order or insofar as may be necessary to verify items paid by EMS or Edison pursuant to the Purchase Order[.]¹⁷³⁹

(ii) *The Respondents' Position*

1750. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Section 1.9.6 was not intended to be used as a substitute for discovery, which is the only context in which Claimants have attempted to use it. Discovery was always intended by the Parties to be managed in an arbitration established pursuant to the dispute resolution provisions outlined in section 1.22 of the RSG Contract. Although Claimants argue that audit requests were made prior to a dispute arising between the parties, a simple timeline shows that Claimants are being disingenuous:

9/30/04	Purchase Order is signed by Mitsubishi.
1/31/12	Tube leak discovered at SONGS Unit 3.
10/26/12	Edison sends a document preservation notice to Mitsubishi.
11/15/12	Edison and Mitsubishi sign a tolling agreement.
1/8/13	Edison's Senior Vice President and Chief Nuclear Officer, Peter Dietrich, delivers a formal letter declaring that Mitsubishi is in violation of the Purchase Order and the limitation of liability no longer applies.

¹⁷³⁹ Claimants' RPHM, ¶¶ 215-216.

1/10/13	Edison sends its first audit request.
4/26/13	Edison sends its revised audit request.
6/7/13	Edison announces that it will permanently decommission SONGS.

Edison’s “audit” request came only two days after Mr. Dietrich sent Mitsubishi a formal letter alleging that Mitsubishi had failed to present a repair with “dispatch,” that “any contractual limitations on liability are no longer applicable,” and that Edison would now “be looking to Mitsubishi to make SCE and its customers whole for all resulting damages.” Edison was clearly attempting to invoke section 1.9.6 in anticipation of arbitration and in contravention of the Parties’ election that ICC Rules govern their disputes.

As specified in its Opposition to Claimants’ Request for Interim Relief, Mitsubishi also continues to maintain that section 1.9.6 only applies to documents of a financial nature.¹⁷⁴⁰

(iii) Tribunal’s Determination

1751. On 10 January 2013 and 26 April 2013, SCE requested that MHI provide it with various documents under a purported exercise of its rights under Section 1.9.6 of the RSG Contract.¹⁷⁴¹

1752. Section 1.9.6 of the RSG Contract reads as follows:

Edison, its representatives and agents may examine and copy, during the office hours of the Supplier and at a time mutually agreed to by the Parties, with the understanding that EMS will use reasonable efforts to avoid conducting audits during Supplier's quarterly and annual fiscal closing periods, the Supplier's books, accounts, relevant correspondence, specifications, time cards, drawings, designs, and other documentation, to the extent that these are related and relevant to the Work under the Purchase Order or insofar as may be necessary to verify items paid by EMS or Edison pursuant to the Purchase Order or as otherwise required by any Governmental Authority, provided, however, in no event shall Edison be entitled to (a) except as allowed by Section 1.23.3, audit the

¹⁷⁴⁰ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 194-196.

¹⁷⁴¹ See ¶¶ 657 and 694 above.

composition of any specified percentages or other agreed profit margins referenced in the Purchase Order, (b) except as allowed by Section 1.23.3, review costs which would disclose internal calculations of the Supplier related to indirect costs of the Purchase Order, or (c) review items which are subject to attorney-client privilege. The rights of Edison given hereunder shall be valid for a period of no less than five (5) years after Acceptance of the Second RSG Unit and delivery by Supplier of all Documentation required under the Purchase Order and Supplier shall retain such books, accounts, relevant correspondence, specifications, time cards, drawings, designs and other related documents and records for such period. All accounting records (and supporting documentation) related to amounts invoiced under the Purchase Order shall be maintained in accordance with generally accepted accounting principles. EMS shall use reasonable efforts to minimize the number of audits conducted under this provision.

1753. It is readily apparent that the purpose of SCE's request was to obtain access to MHI documents in contemplation of dispute resolution. SCE provided no explanation as to why it was requesting these documents in its original letter, merely exerting a contractual right to do so. In SCE's 26 April 2013 letter, SCE specifies that "should the parties find it necessary to resort to litigation, SCE must necessarily reserve its right to seek all of the documents identified in our January 10, 2013 letter, as well as additional relevant materials under Section 1.9.6 and through discovery."¹⁷⁴²
1754. Regardless, the exercise of a purported contractual right to obtain access to documents in contemplation of litigation is not an improper purpose of such a right. SCE's motivations for the execution of a purported contractual right are of no bearing as to whether it had such a right.
1755. The Claimants rightly submit that the proper interpretation of a clause is one that gives all its words meaning. It is equally the case that proper contractual interpretation requires that words be interpreted in the context of their use.

¹⁷⁴² Exh. JX-1750.

1756. Section 1.9 of the RSG Contract, titled “Commercial Terms,” generally provides for various accounting aspects of the Work, including milestone payment (Section 1.9.1), Technical Services Payments (Section 1.9.2), which includes determinations of payment of hourly rates, air travel reimbursement, living expense reimbursement, and invoices, taxes (Section 1.9.3), backcharge payments for warranty repairs (Section 1.9.4), currency (Section 1.9.5), and the conditions of final payments (Section 1.9.7).
1757. Section 1.9.6, the clause in dispute, provides that SCE “may examine and copy” MHI’s “books, accounts, relevant correspondence, specifications, time cards, drawings, designs, and other documentation” (i) “to the extent that these are related and relevant to the Work;” or (ii) “insofar as may be necessary to verify items paid;” or (iii) “as otherwise required by any Governmental Authority.”
1758. Section 1.9.6 of the RSG Contract contemplates that MHI must allow the examination either “related and relevant to the work,” required for a financial audit, or as required by a governmental authority, which is broadly defined to include a court or an arbitration tribunal.
1759. The Respondents’ position that the documents covered by Section 1.9.6 of the RSG Contract are limited to documents required for a financial audit appears as such overly restrictive, in particular on account of the obligation to allow access ordered by a governmental authority. While a contextual interpretation of Section 1.9.6 would support the Respondents’ submission that this Section should be limited to financial audits, a plain reading of the provision suggests a more expansive definition.
1760. Accordingly, the Tribunal answers Issue B.8 in the affirmative. Section 1.9.6 of the RSG Contract does require the Respondents to allow the Claimants to examine the relevant documents and records.

(a) If so, did Mitsubishi breach that obligation? (Issue B.8(a))

1761. The Claimants submit that the Respondents failed to make available documents to which they were entitled under the RSG Contract.

(i) The Claimants' Position

1762. In their Responses to Joint List of Issues, the Claimants submit the following:

After breaching its contractual and Warranty obligations, Mitsubishi summarily refused to provide Claimants access to the documents underlying its design. This is a clear and intentional breach of a duty under the contract.

It was only after the Tribunal partly granted Claimants' Request for Production that Claimants gained access to some of Respondents' documents that are "related and relevant" to the failed RSGs. Even under the order to produce, Respondents provided Claimants with few internal Mitsubishi communications. In addition, Respondents withheld several documents until very late in this proceeding and never produced several others that it claimed to have misplaced or simply refused to produce. As a consequence, Claimants still do not know the full extent of Respondents' design errors, or what and when Respondents knew about their flawed RSG design. Respondents' unwillingness to comply with the plain terms of the RSG Contract and give Claimants full information about their own RSGs gives rise to the strong inference that there is additional evidence of Mitsubishi's errors, mistakes, and misdeeds in the documents withheld.¹⁷⁴³

1763. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents contend that "Mitsubishi did not breach any obligation pursuant to Section 1.9.6 because the provision was not intended to be used as a substitute for discovery, which is the only context in which Claimants attempted to invoke Section 1.9.6." For the reasons stated supra, it was only after the Tribunal partly granted Claimants' Request for Production that Claimants gained access to some of Respondents' documents that are "related

¹⁷⁴³ Claimants' Responses to Joint List of Issues, ¶ B.8(a).

and relevant” to the failed RSGs. Even under the order to produce, Respondents provided Claimants with few internal Mitsubishi communications.¹⁷⁴⁴

(ii) *The Respondents’ Position*

1764. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Mitsubishi did not breach any obligation pursuant to section 1.9.6 because the provision was not intended to be used as a substitute for discovery, which is the only context in which Claimants attempted to invoke section 1.9.6.

Even if the Tribunal determines that Mitsubishi was obligated to provide Claimants with an opportunity to examine and copy certain documentation in Kobe, and did not do so, there must be some associated harm for Claimants to now bring a claim, and Claimants have failed to identify or provide any evidence regarding any such harm. Claimants have contended that denial of their request under section 1.9.6 deprived Claimants of an opportunity to review Mitsubishi’s root cause analysis and repair plans. This is demonstrably false. Edison’s January 10, 2013 Audit Request did not ask for information related either to repair or Mitsubishi’s root cause analysis. It instead focused on information related to “SCE’s initial benchmarking activities ... as well as documents and records related to the design, manufacture, delivery, installation, and operation of [the] RSGs.”

But the evidence shows that Edison was not interested in reviewing Mitsubishi’s repair options in 2013 and had received analysis related to the root cause throughout 2012. Nor is there any specific allegation that a request for information from Edison’s SGRT was denied by Mitsubishi’s repair team, who were on site and working to implement a repair or replacement and who the evidence shows were eager to move forward in 2013.¹⁷⁴⁵

(iii) *Tribunal’s Determination*

1765. It is undisputed that the Respondents denied SCE’s requests under Section 1.9.6 of the RSG Contract to inspect the Respondents documents.

¹⁷⁴⁴ Claimants’ RPHM, ¶ 219.

¹⁷⁴⁵ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 197-199.

1766. Accordingly, the Tribunal answers Issues B.8(a) in the affirmative. Respondents breached their obligation under Section 1.9.6 of the RSG Contract.

(b) **If so, does that obligation include source codes? (Issue B.8(b)).**
If so, did Mitsubishi breach that obligation? (Issue B.8(b)(i)).

1767. The Claimants have requested that the Respondents submit their source codes for review. The Respondents have declined to do so.

(i) *The Claimants' Position*

1768. With respect to Issue B.8(b), the Claimants, in their Responses to Joint List of Issues, submit that “[u]nder Section 1.9.6 of the RSG Contract, Claimants were entitled to examine all of Mitsubishi’s documents that were “related and relevant” to the RSG project. The FIT-III, FIVATS, and IVHET source codes all fit squarely within this contractual provision.”¹⁷⁴⁶

1769. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that the “Respondents argue that source codes are not included within the type of information available to Edison pursuant to Section 1.9.6, which includes “books, accounts, relevant correspondence, specifications, time cards, drawings, designs and other related documents and records for such period.” However, Respondents omit that under Section 1.9.6, Claimants were entitled to examine all of Respondents’ documents that were “related and relevant” to the RSG project. The FIT-III, FIVATS, and IVHET source codes all fit squarely within this contractual provision.”¹⁷⁴⁷

1770. Further, with respect to Issue B.8(b)(i), the Claimants, in their Responses to Joint List of Issues, submit that “Mitsubishi continuously refused [including in this

¹⁷⁴⁶ Claimants’ Responses to Joint List of Issues, ¶ B.8(b).

¹⁷⁴⁷ Claimants’ RPHM, ¶ 220.

proceeding,] to produce the FIT-III source code, the relevant lines of the source code or present *any witness* with knowledge of its contents.”¹⁷⁴⁸

(ii) *The Respondents’ Position*

1771. With respect to Issue B.8(b), in their Position Statement on the Revised List of Issues, the Respondents contend the following:

Edison sent multiple letters requesting documents under section 1.9.6. None of these letters requested source code. This sub-issue accordingly raises a question that is not a part of Edison’s claims under section 1.9.6 and has no bearing on these proceedings.

Moreover, Mitsubishi was not obligated to provide source codes pursuant to Edison’s 2013 requests pursuant to section 1.9.6 because source codes are not included within the type of information available to Edison pursuant to section 1.9.6, which is limited to “books, accounts, relevant correspondence, specifications, time cards, drawings, designs and other related documents and records for such period.”

In addition, the source codes do not implicate a document of a financial nature.¹⁷⁴⁹

i. If so, did Mitsubishi breach that obligation?

1772. With respect to Issue B.8(b)(i), the Respondents, in addition to referring to the aforesaid submissions concerning Issue B.8(b), contend that “because Edison only requested information as a substitute for discovery, Mitsubishi was not obligated to provide it.”¹⁷⁵⁰

(iii) *Tribunal’s Determination*

1773. The Tribunal addresses Issue B.8(b) and B.8(b)(i) together.

¹⁷⁴⁸ Claimants’ Responses to Joint List of Issues, ¶ B.8(b)(i).

¹⁷⁴⁹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 200-202.

¹⁷⁵⁰ Respondents’ Position Statement on the Revised List of Issues, ¶ 203.

1774. While the phrase “other documentation” may be relatively broad, it is not to be understood as to include the source code of the Respondents’ proprietary software for the following reasons.
1775. The contextual interpretation of “other documentation in Section 1.9.6 (“Supplier’s books, accounts, relevant correspondence, specifications, time cards, drawings, designs, and other documentation”) suggests that documentation refers to other work product similar to drawings, designs, and specifications on which the RSGs were constructed. While this would include the manuals for the source codes, the Tribunal does not consider the category of “other documentation” to be as broad as to include the source code of the Respondents’ software. Source code itself is sufficiently distinct and definable that if the Parties wished to allow access, it would have been specifically mentioned in Section 1.9.6.
1776. In light of the above, the Tribunal answers Issue B.8(b) in the negative. The Claimants’ rights under Section 1.9.6 of the RSG Contract do not give it a right to access the Respondents’ source codes. Therefore, in relation to Issue B.8(b)(i), no determination is required.

I. HAVE CLAIMANTS ESTABLISHED THAT ANY OR ALL OF THE ALLEGED FAILURES, INDIVIDUALLY OR IN COMBINATION, CONSTITUTE A MATERIAL BREACH OF CONTRACT THROUGH ANY OR ALL OF THE PROVISIONS OF THE RSG CONTRACT? (ISSUE B.9)

1777. The Tribunal considers whether the Claimants have established that any or all of the alleged failures, individually or in combination, constitute a material breach of contract through any or all of the provision of the RSG Contract.

(i) The Claimants’ Position

1778. In their Responses to Joint List of Issues, the Claimants, while referring to its submissions concerning the preceding issues, submit the following:

As outlined in the issues above, Mitsubishi indisputably breached the RSG Contract, and such breaches were material. See *Superior Motels, Inc. v. Rinn Motor Hotels, Inc.*, 195 Cal. App. 3d 1032, 1051 (1987) (defining a breach to be material “if it is so dominant or pervasive as in any real or substantial measure to frustrate the purpose of the contract” (citation omitted)). As laid out in sections B.3 and B.4 above, Mitsubishi had sole design responsibility for the RSGs and committed numerous design errors. Next, as laid out in section B.5 above, Mitsubishi had knowledge of these design errors and the deficiencies. section B.6 above lays out the specific breaches of RSG specifications that are material. Finally, sections B.7 and 8 point to further breaches of Mitsubishi’s obligations that occurred post-failure.

As stated above, whether a breach is material “depends on the importance or seriousness thereof and the probability of the injured party getting substantial performance.” *Brown v. Grimes*, 192 Cal. App. 4th 265, 278 (Cal. App. 2011) (quoting 1 Witkin, Summary of Cal. Law (10th ed. 2005) Contracts, § 852, pp. 938-940). As discussed above, whether the Tribunal looks at the breaches individually or collectively, they rise to a material breach because they resulted in Mitsubishi failing to deliver RSGs that were “capable of being operated safely, normally and continuously in accordance with the requirements of the Specification, the Purchase Order, all Applicable Laws, Applicable Standards and the Documentation associated therewith at all operating conditions and modes specified in the Specification, the Scope of Work or other applicable Documentation.”

Mitsubishi has not and indeed could not deliver even substantial performance under the contract. Mitsubishi then failed to provide a viable, validated, and licensable repair even 16 months after the RSGs failed. The RSG Contract states that “[t]ime is of the essence” for delivery of the RSGs and all supporting Documentation (as defined in the RSG Contract). Further, Mitsubishi was required to repair the RSGs with “due diligence and dispatch.” “[W]hen time is made of the essence of a contract, a failure to perform within the time specified is a material breach of the contract.” *Gold Mining & Water Co. v. Swinerton*, 23 Cal.2d 19, 27 (1943). As detailed in Claimants’ Post-Hearing Memorial, Mitsubishi not only failed to timely deliver the RSGs that Edison contracted for—it failed to deliver the as-promised RSGs at all. Mitsubishi’s failures constitute material breaches of the RSG Contract.¹⁷⁵¹

¹⁷⁵¹ Claimants’ Responses to Joint List of Issues, ¶ B.9.

(ii) The Respondents' Position

1779. In their Position Statement on the Revised List of Issues, the Respondents, while referring to its submissions concerning the preceding issues, contend that “[a]s outlined above, Claimants have failed to establish a breach of contract for any or all of the alleged breaches outlined above, let alone a material breach. Under California law, “[a] cause of action for breach of contract requires pleading of a contract, plaintiff's performance or excuse for failure to perform, defendant's breach and damage to plaintiff resulting therefrom.” As outlined above, Claimants have no separate breach of contract claim outside of the remedial provisions in the RSG Contract and even if they had separate breach claims they have failed to establish them as a factual or legal matter.”¹⁷⁵²

(iii) Tribunal's Determination

1780. The Tribunal considers that the consequence of any alleged design failures is subsumed under Section 1.17 of the RSG Contract. That is, inadequate tube support (Issue B.6(c)¹⁷⁵³) and the tube-leak (Issue B.6(e)¹⁷⁵⁴) triggered the Respondents' obligations under the warranty provisions of the RSG Contract (and the liquidated damages provisions).

1781. While the Tribunal accepts the Claimants' submission that, in principle, a failure to perform a repair with due diligence and dispatch under Section 1.17 of the RSG Contract would constitute a material breach of contract, as determined in Issue C below,¹⁷⁵⁵ the Respondents are not found to have violated this requirement.

¹⁷⁵² Respondents' Position Statement on the Revised List of Issues, ¶ 204.

¹⁷⁵³ See ¶ 1634 above.

¹⁷⁵⁴ See ¶ 1651 above.

¹⁷⁵⁵ See Section XV below.

1782. Similarly, the Respondents are not found to have breached the RSG Contract by delivering RSGs that required repair or replacement under the RSG Contract. Such an eventuality is envisioned under the contract itself, which provides the contractual machinery for the resolution of just such an issue.
1783. However, the non-payment of the Claimants' invoices, as determined in Issue B.7 above¹⁷⁵⁶ constitutes a material breach of the RSG Contract giving rise to Damages to be awarded, as determined in Issue H.
1784. As per *Brown v. Grimes*,¹⁷⁵⁷ cited by the Claimants, whether a breach is material "depends on the importance or seriousness thereof and the probability of the injured party getting substantial performance."¹⁷⁵⁸ The non-payment of the Claimants' invoices has left the Claimants with millions of dollars of expenses incurred to repair the SONGS RSGs that should, under Section 1.17 of the RSG Contract be payable by the Respondents.
1785. The Tribunal does not consider the Respondents' failure to allow access to the Respondents' documents, Issue B.8,¹⁷⁵⁹ to be a material breach of the RSG Contract. The Claimants have obtained reasonable access to the Respondents' documents in this arbitration. Under Section 1.9.6 of the RSG Contract, access to documents is required as directed by a governmental authority, which is defined to include an arbitration tribunal. This Tribunal ordered the Respondents to produce various documents as part of the document production phase of this arbitration. Accordingly, any of the Claimants' rights that were not met at the time of their original request

¹⁷⁵⁶ See ¶ 1689 above.

¹⁷⁵⁷ Exh. CL-95 (192 Cal.App.4th 265 (2011)).

¹⁷⁵⁸ Exh. CL-95 (192 Cal.App.4th 265, 278 (2011)).

¹⁷⁵⁹ See ¶¶ 1760 and 1766 above.

were remedied by the Tribunal during the document production phase of this arbitration such that there is no material breach of the RSG Contract.

J. SUMMARY OF ISSUE B

1786. As determined above, the Tribunal concludes that:

- i. In regard to Issue B.1, the Performance Analysis Report is not a contractual document, but a deliverable under the RSG Contract;
- ii. In regard to Issue B.2, except as otherwise specified, the contractual breaches alleged by the Claimants are subsumed under the Respondents' warranty obligations under the RSG Contract;
- iii. In regard to Issue B.3, the Respondents had the design responsibility under the RSG Contract;
- iv. In regard to Issue B.4, except as otherwise determined by the Tribunal, the Respondents did not commit the design errors as alleged by the Claimants;
- v. In regard to Issue B.5, Mitsubishi did not have any knowledge of alleged design errors;
- vi. In regard to Issue B.6, the RSGs as delivered did conform to the Contract, except where otherwise identified;
- vii. In regard to Issue B.7, MHI did not pay Edison's invoices under Section 1.17.1.3 of the RSG Contract;
- viii. In regard to Issue B.8, Section 1.9.6 of the RSG Contract does allow SCE access to MHI's documents;

- ix. In regard to Issue B.9, none of the above issues constitutes a material breach of the RSG Contract.

XIV. REPAIR AND REPLACEMENT BACKGROUND

1787. Issue C below sets forth the Issues that the Tribunal is required to address concerning the Claimants' breach of warranty allegations. That breach is based upon the repair and replacement history, as set forth in Section VII.G above.
1788. To facilitate the Tribunal's analysis of the repair history, a number of factual events will be analyzed and determined in greater detail at this stage before considering Issue C.
1789. In particular, the Tribunal addresses two fundamental questions: (i) would the proposed thicker AVB repair achieve successful results; and (ii) would that repair be licensable?

A. REPAIR AND REPLACEMENT OPTIONS

1790. As described in Section VII.G above, the options available to MHI and SCE consisted of two categories of repair options (Type 1 and Type 2) and two categories of replacement options (Type 3 and Type 4).¹⁷⁶⁰ Of these options, the Type 1 was the least intrusive repair option and the Type 3 was the least intrusive replacement option.¹⁷⁶¹ The evolution of the repair and replacement options converged towards a Type 1 Repair or a Type 3 replacement.

¹⁷⁶⁰ Witness Statement of Mr. Avella, ¶¶ 19-22.

¹⁷⁶¹ The Type 2 repair options were more intrusive, requiring the removal of the upper dome of the steam generator to facilitate access to the tube bundle. The Type 4 replacement called for the complete replacement of the RSGs, as opposed to a replacement of just the tube-bundle in a Type 3 replacement. The Type 4 options would have required cutting into the concrete barrier of the nuclear power plant.

(a) Repair Process

1791. As described in Section VII.G above, the period following the January 2012 Incident consisted of an investigation into the cause(s) of that Incident, an assessment of the wear in Unit 2 and Unit 3, and the development of initial repair concepts.
1792. Nearly six months after the Incident, SCE reorganized its personnel tasked with resolving the Incident. SCE's initial team was led by John Brabec, a SCE project manager. On 20 June 2012, SCE's Tom Palmisano re-organized his staff, creating a Steam Generator Recovery Project Team, led by Mr. Brabec as Project Manager, and a Steam Generator Repair Team (defined above as "SGRT"¹⁷⁶²), led by Mr. Edward ("Ed") Avella, as Project Manager.¹⁷⁶³ Mr. Brabec was tasked with the return to service efforts for Unit 2, while Mr. Avella and the SGRT were tasked with the "intermediate and long term strategy" for Unit 3.¹⁷⁶⁴
1793. The Respondents submit that this re-organization marked a changing point for SCE.¹⁷⁶⁵ According to the Respondents, Mr. Avella's team "immediately began to shift Mitsubishi's emphasis away from the viable thicker-AVB repair and towards replacement of the tube bundles."¹⁷⁶⁶ The Respondents submit that Mr. Avella was unreasonably requiring that MHI either improve T/H conditions or replace the steam bundle.¹⁷⁶⁷
1794. On 2 July 2012, MHI presented options for T/H improvements, concluding that while individual options to improve T/H were not effective, some combination may

¹⁷⁶² See ¶ 187 above.

¹⁷⁶³ Exh. JX-1225.

¹⁷⁶⁴ Exh. JX-1225.

¹⁷⁶⁵ Respondents' Rejoinder, ¶ 170.

¹⁷⁶⁶ Respondents' Rejoinder, ¶ 170.

¹⁷⁶⁷ Respondents' Rejoinder, ¶ 160.

minimally reduce void fraction and flow velocities.¹⁷⁶⁸ SCE's meeting notes of 3 August 2012 reflect that SCE understood that T/H improvements were unlikely:

All options presented provide for 'improvement' but not 'resolution'. The only effective method to recover design parameters (identified to date) is to reconfigure the tube bundle.

Based on the options present, the only likely success path will be through reconfiguring the bundle by replacement of the bundle or entire steam generator.¹⁷⁶⁹

1795. The Respondents' case is that as of July 2012, following Mr. Avella's appointment, SCE was effectively forcing MHI into offering a replacement through impossible criteria. According to MHI, as demonstrated in its 2 July 2012 presentation, the only way to substantially improve T/H conditions would be through a replacement option.¹⁷⁷⁰
1796. The Respondents also submit that SCE was requiring onerous test data to prove that the repair would be effective absent improvement of the T/H conditions.¹⁷⁷¹
1797. During the Hearing, the Tribunal heard submissions from the Claimants and testimony from a number of the Claimants' witnesses and experts regarding this testing.¹⁷⁷² The Claimants did not provide a convincing submission as to what testing they required or they believed the NRC required. Instead, the Claimants submitted that various forms of prototypical testing in similar operating thermal hydraulic conditions as experienced at SONGS were required. The Respondents submit that

¹⁷⁶⁸ Exh. JX-1238; Exh. JX-1241.

¹⁷⁶⁹ Exh. JX-1287; Exh. JX-1289.

¹⁷⁷⁰ Exh. JX-1238; Exh. JX-1241.

¹⁷⁷¹ Respondents' Rejoinder, ¶ 158.

¹⁷⁷² See Transcript, pp. 1522-1523, 1771, 1772, 4703, 4975 (Claimants' Daily Opening); Transcript, pp. 1895, 1955, 1956, 2001, 2002 (Mr. Leeds); Transcript, pp. 2058, 2059 (Mr. Strosnider); Transcript, p. 1648 (Mr. Avella).

this type of testing is an unprecedented requirement and was not required for the approval of the repair.¹⁷⁷³

1798. It is unclear to the Tribunal how prototypical testing data of the repair's effectiveness could be obtained absent the construction of a replica to SONGS to test the repair. While the Claimants' witnesses and experts have nuanced these requirements, stating at times that perhaps a smaller scale steam generator may have been sufficient,¹⁷⁷⁴ or not have been sufficient,¹⁷⁷⁵ or that testing at AECL's facilities in Chalk River,¹⁷⁷⁶ or at MHI's research facilities in Takasago¹⁷⁷⁷ would have been sufficient, the Claimants' perspective is that it was up to MHI to determine what testing was required¹⁷⁷⁸ to prove that the repair would be successful.
1799. In the Tribunal's view, the Claimants, therefore, developed two burdensome and unnecessary criteria for the Respondents' repair, which required the Respondents to either (i) markedly improve T/H conditions to some unspecified value, which SCE knew was not possible absent a replacement design; or (ii) prove that the repair would function in the same operating conditions as SONGS, which may not have been possible absent a SONGS RSG replica of sufficient scale to replicate the T/H conditions.¹⁷⁷⁹
1800. These choices appear to have left the Respondents with no choice but to transition to a replacement recommendation, as will be discussed in Section XIV.A(c) below, (while continuing to refine their preferred option, a repair of the RSGs).

¹⁷⁷³ See Transcript, p. 1775 (Respondents' Daily Opening); Transcript, p. 4627 (Mr. Russel).

¹⁷⁷⁴ Transcript, p. 2002 (Mr. Leeds).

¹⁷⁷⁵ See Transcript, p. 1648 (Mr. Avella).

¹⁷⁷⁶ See Transcript, p. 1630 (Mr. Avella).

¹⁷⁷⁷ See Transcript, pp. 2476-2478 [REDACTED]

¹⁷⁷⁸ See Transcript, p. 1864 (Mr. Moran).

¹⁷⁷⁹ See Transcript, p. 1866 (Mr. Moran).

1801. The Tribunal first considers it pertinent to further address the testing history of the Claimants' Type 1 Repair.

(b) **Testing of the Repair**

1802. As set forth in ¶¶ 499 and 525 above, MHI undertook two basic tests of its proposed RSG repair. These basic tests involved issues of insertability of the thicker AVBs and determination of how much contact force was required to prevent in-plane FEI. Had a Type 1 Repair been approved by SCE, further testing would have been carried out using a full size implementation mockup to develop and practice installation techniques.¹⁷⁸⁰

1803. Under Section 1.17.1(c) of the RSG Contract, the Respondents are required to:

undertake a technical analysis of the problem and correct the "root cause" unless Supplier can demonstrate to the Edison Representative's satisfaction that there is not a risk of the reoccurrence of such problem.

1804. Meeting this obligation required that MHI either demonstrate that the root cause would be addressed by a repair/replacement or demonstrate that the problem was unlikely to re-occur. In either case, proof is required.

1805. Mr. Avella testified that, during the repair era, his team "repeatedly reminded Mitsubishi that any repair had to be supported by sufficient engineering analysis and testing to allow SCE to present the proposal to the NRC."¹⁷⁸¹

1806. For example, during a 2 July 2012 meeting between SCE and MHI, SCE's Mr. Olech stated that SCE required the "verification of adequacy of any AVB modification as a long term repair" and that "this verification will not only demonstrate contact or

¹⁷⁸⁰ See Transcript, p. 5225 (Mr. Bohn).

¹⁷⁸¹ Witness Statement of Mr. Avella, ¶ 29.

geometrical restraint of in-plane vibration, but also verify acceptable tube wear.”¹⁷⁸²

Mr. Olech recommended the “physical testing of mockup using Takasago shaker table, or similar.”¹⁷⁸³ MHI agreed to provide a repair methodology for verification testing.

1807. One avenue of further testing was to conduct tests at Atomic Energy of Canada Limited’s (AECL) facilities at Chalk River, Canada, in co-operation with B&W. As of August 2012, it was determined that a first phase of testing there would require 39 weeks and that testing could not be undertaken at a void fraction of 99.6%.¹⁷⁸⁴ MHI’s internal notes following this meeting reflect that SCE was dissatisfied with a possible 23 week period to perform testing as well as with a potential Freon test.¹⁷⁸⁵ To recall, a Freon test is a test of tube behavior in simulated T/H conditions in Freon gas. It is noted that while SCE’s notes reflect that testing at a 99.6% void fraction could not be achieved, B&W indicated that such testing was possible in an air/water test, but not in Freon.¹⁷⁸⁶
1808. B&W reported that the Chalk River testing would be a “multi-faceted, multi-year program.”¹⁷⁸⁷ However, B&W also stated that “it was not clear if MHI desires such a program” and rather proposed a focus on “the simplest possible tests to verify that the proposed repair strategy will work,” such as a simpler test that could be conducted in the form of both “air-water tests and Freon tests to simulate both instability and the benefits of the repair options.”¹⁷⁸⁸

¹⁷⁸² Exh. JX-1239.

¹⁷⁸³ Exh. JX-1239.

¹⁷⁸⁴ Exh. JX-1309.

¹⁷⁸⁵ Exh. JX-1313.

¹⁷⁸⁶ Exh. JX-1303, p. 15.

¹⁷⁸⁷ Exh. JX-1303, p. 11

¹⁷⁸⁸ Exh. JX-1303, p. 11

1809. Regarding some of the other tests, such as Mr. Olech's desire for a test on tube wear, B&W provided that:

(...)

“work rate measurement at the onset of FEI is an extensive, multi-year program that may not be necessary to support a repair strategy. Measuring work rate is time consuming, even for a single test condition, and becomes a very large test program for variable conditions.

The Phase 1 goal is to confirm the effectiveness of the fix to suppress FEI and this must be the first concern.¹⁷⁸⁹

1810. On a different type of wear, B&W also provided that:

Fretting-wear needs to be taken into account when considering the lifetime of the components. However, as discussed in the previous item, fretting-wear tests are difficult and time-consuming, so these tests may best be done in subsequent phase of the program.¹⁷⁹⁰

1811. Regarding a requested test on a type of T/H damping at high void fractions, B&W also provided:

These tests will definitely provide valuable information but are not immediately required to verify the effectiveness of the proposed repair. Such tests could be considered in “Phase II” (...)¹⁷⁹¹

1812. Mr. Avella has testified that the Chalk River tests would not be adequate:

Although the Chalk River laboratory was very useful for certain types of testing, the Chalk River test loop was not a comparable mockup to the RSGs, as its test tubes were made of a different material than the RSG tubes, did not have tubes in a U-bend shape, and could not replicate the

¹⁷⁸⁹ Exh. JX-1303, p. 13.

¹⁷⁹⁰ Exh. JX-1303, p. 15.

¹⁷⁹¹ Exh. JX-1303, p. 15.

thermal-hydraulic conditions in the RSGs. Some of these limitations could have been addressed, but the fact that the test loop could not produce the high void fractions and velocities seen in the RSGs meant that this test loop could not be used to validate a repair for the RSGs.¹⁷⁹²

1813. The Tribunal recalls the apparent discrepancy between SCE's internal notes and the report provided by B&W as to whether testing at sufficiently high void fractions was possible at the Chalk River facilities.¹⁷⁹³
1814. Considering the contemporary and current view of Mr. Avella and the contemporary views expressed by B&W and AECL, what is apparent is a disconnect between the purposes of the testing. It is apparent that B&W and AECL thought that the priority should be on testing sufficient to validate the proposed thicker AVB (and also the 30°) repair option. In contrast, SCE's concerns focused on the need for long term wear considerations and matching the exact conditions of the SONGS RSGs.
1815. A possible explanation of this divergence is found in SCE's repair conditions, which required that MHI "restore the plant to 100% Power for 40 Year life."¹⁷⁹⁴ In effect, the testing required to prove that the fact that a thicker AVB repair would be successful and that the repair would last for 40 years are different. While SCE may have had good commercial grounds to require a repair that would last for 40 years, it does not follow that a repair would be ineffective if it lasted for a shorter term. SCE itself appears to acknowledge this, providing that a repair that did not meet all of their criteria would nonetheless be considered as an interim repair.¹⁷⁹⁵

¹⁷⁹² Witness Statement of Mr. Avella, ¶ 41.

¹⁷⁹³ See ¶ 1807 above.

¹⁷⁹⁴ See ¶ 575 above; Exh. JX-1289, p. 1; See also Exh. JX-1287, p. 1.

¹⁷⁹⁵ See ¶ 1848 below; Exh. JX-1504.

1816. Considering the above, the Tribunal concludes that SCE's requirements for testing were overly onerous. The Tribunal's conclusion is further bolstered by consideration of the NRC's review of MHI's repair mockup, as provided below.
1817. On account of the NRC CAL (Confirmatory Action Letter),¹⁷⁹⁶ SCE would have to prove its repair to the NRC, demonstrating both that Unit 3 could be restarted safely and developing an inspection cycle to verify that repair's effectiveness.¹⁷⁹⁷
1818. As no response to the CAL was ever provided to the NRC regarding a Unit 3 restart, the Tribunal does not have conclusive evidence as to what sort of testing the NRC would have required. Rather, the Tribunal is provided with both the contemporary records of the NRC's investigation and the review of MHI's repair mockup and the opinion evidence of NRC experts in this arbitration.
1819. The NRC reviewed MHI's testing of its implementation mockup in October 2012. As described in an email from the NRC inspector to MHI:

The purpose of this inspection is to observe the full-scale mockup and testing of re-designed anti-vibration bars (AVBs) that may be used as a long-term repair of both Unit 2 and Unit 3 SONGS Steam Generators.¹⁷⁹⁸

1820. SCE's summary of the site inspection states that the NRC inspectors identified three issues with the mockup; (i) that verification records of checks were missing in two cases; and (ii) that a micrometer gauge was used rather than a laser light for measuring tube diameter.¹⁷⁹⁹ SCE's notes mention that "no [other] issues [were] identified by the NRC."¹⁸⁰⁰

¹⁷⁹⁶ For CAL, see Section VII.F(c) above.

¹⁷⁹⁷ See ¶ 464 above.

¹⁷⁹⁸ Exh. JX-1356, p. 5.

¹⁷⁹⁹ Exh. JX-1514, p. 4.

¹⁸⁰⁰ Exh. JX-1514, p. 4.

1821. The Parties are diverged as to the significance of these findings. The Claimants submit that they amount to deficiencies in MHI's repair mockup. The Respondents submit that they are mere documentary deficiencies.
1822. The Tribunal is not persuaded by the Claimants' position. The NRC-identified issues with the repair mockup appear to be minor quality assurance issues with documentation rather than aspects that put the viability of the proposed thicker-AVB repair into question.
1823. The late Mr. Arthur Howell, a former NRC official active during the repair era, submitted a witness statement in this arbitration, testifying that the NRC's questions with regard to the proposed thicker AVB repair were answered:

Regarding the mockup, during the meetings and the testing, individuals from the NRC asked numerous questions regarding the applicability and implementation of quality assurance provisions and standards, as well as validation of the feasibility of the AVB repair. We also asked questions regarding how Mitsubishi would provide reasonable assurance that the repair would work and that the process for installing the AVBs would be practicable. As far as I can recall, Mitsubishi had previously considered every issue that we raised and was able to thoughtfully respond to our questions.¹⁸⁰¹

1824. On account of the passing of Mr. Howell, the Claimants were unable to cross-examine him. Rather, the Claimants submitted a series of particularized objections to his testimony. No objections were provided to the above cited passage, which is consistent with the notes taken by SCE's representative at the NRC inspection.
1825. For SCE, Mr. Treadway attended the NRC's October 2012 site-inspection.¹⁸⁰² Mr. Treadway testified that testing was undertaken during the inspection,¹⁸⁰³ but further

¹⁸⁰¹ Witness Statement of Mr. Howell, ¶ 15.

¹⁸⁰² Reply Witness Statement of Mr. Treadway, ¶ 12.

¹⁸⁰³ Reply Witness Statement of Mr. Treadway, ¶ 13.

he testified that the “mockup also did not recreate the thermal-hydraulic environment in the RSGs,” that the “mockup could not prove that thicker AVBs could be installed,” nor that the repair would “prevent FEI from continuing and would not introduced additional forms of tube degradation.”¹⁸⁰⁴

1826. Regarding the hypothetical view of the NRC, in this arbitration, the Tribunal heard from Mr. Strosnider and Mr. Leeds for the Claimants and Mr. Johnson and Mr. Russell for the Respondents. All four experts are former NRC officials.

1827. Mr. Strosnider and Leeds submitted joint expert reports to the Tribunal for the Claimants. Mr. Jack Strosnider, for the Claimants, has over 35 years of experience with the NRC, where he served as the Director of the Office of Nuclear Material Safety and Safeguards, Deputy Director of the Office of Nuclear Regulatory Research, and Director of the Division of Engineering in the Office of Nuclear Reactor Regulation.¹⁸⁰⁵ Earlier in his career, in the 1970s, he worked on licensing and inspection of steam generators and in the 1980s acted as a supervisor of such activities.¹⁸⁰⁶ Mr. Leeds, also for the Claimants, also has over 35 years of experience, including as the Director of the Office of Nuclear Reactor Regulation from 2008 through 2014, where, he was responsible for the safety regulation of all US commercial nuclear reactors, including SONGS. Notably, Mr. Leeds was the individual responsible for determining whether SONGS had met its obligations under the CAL and was tasked with either approving or rejecting a hypothetical restart request for Unit 3 had one been provided.¹⁸⁰⁷

¹⁸⁰⁴ Reply Witness Statement of Mr. Treadway, ¶ 16.

¹⁸⁰⁵ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 2.

¹⁸⁰⁶ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶¶ 2-7.

¹⁸⁰⁷ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶¶ 8-14.

1828. Mr. Johnson and Mr. Russell have submitted individual reports to the Tribunal for the Respondents. Mr. Jon Johnson served for 24 years at the NRC, including as the Deputy Director of the NRC' Office of Reactor Regulation. In that role, he supervised the staff that undertook technical and administrative reviews of license amendment request (defined above as "LARs"¹⁸⁰⁸).¹⁸⁰⁹ Mr. William Russell has over 48 years of experience in nuclear plant licensing, supervision and safety oversight, including 20 years with the NRC, rising to the office of Director of Nuclear Reactor Regulation, a position he held until 1996.¹⁸¹⁰ Following that, he has acted as a consultant advising nuclear operators on licensing issues and, notably, serving on SCE's Nuclear Oversight Board.¹⁸¹¹
1829. Mr. Strosnider and Mr. Leeds testified that "the NRC would not have accepted for review an LAR for the thicker AVB repair prior to completion of necessary testing."¹⁸¹² A LAR is a license amendment request. Regarding the type of testing required, they testified that the NRC required unrealistic and impossible-to-obtain testing:

[The mockup testing] did not subject the tube bundle mockup to actual thermal-hydraulic loading in order to demonstrate the effectiveness of the thicker AVBs in eliminating FEI. Given the importance of elimination FEI in the RSGs, Mitsubishi's failure to prove the viability of its repair concept through a full experimental demonstrated represented a gap in the technical justification for the proposed repair method. While full scale experimental demonstration may not have been required for other, previous steam generator repairs, no other U-bend designs had ever suffered in-plane FEI. Mitsubishi would have needed to provide results of testing under the thermal-hydraulic conditions in the RSGs. This type of testing would have been difficult, and **it may not**

¹⁸⁰⁸ See ¶ 689 above.

¹⁸⁰⁹ Expert Witness Statement of Mr. Johnson, ¶¶ 3-9.

¹⁸¹⁰ Expert Witness Statement of Mr. Russell, ¶¶ 1-10.

¹⁸¹¹ Expert Witness Statement of Mr. Russell, ¶ 7.

¹⁸¹² Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 90.

have been realistic to perform such testing due to the difficulties identified by Mitsubishi in its Counter-Memorial, *i.e.*, “building an actual steam generator and a large heat source.”¹⁸¹³ (emphasis added)

1830. For the Respondents, Mr. Russell summarized that the testing that MHI performed to prove both effectiveness and feasibility is as follows:

Accordingly, Mitsubishi performed technical evaluations and testing to identify repairs that would correct the non-confirming condition. Among other things, Mitsubishi studied whether the Thicker-AVB repair was feasible. Mitsubishi developed and tested tooling to expand the gap between steam generator tubes to allow installation of thicker AVBs. Mitsubishi also performed testing and analysis to determine the number and thickness of additional AVBs required. Mitsubishi began designing engineering mockups to demonstrate the validity of the Repair and to train the staff that would install it.¹⁸¹⁴

1831. Mr. Johnson provided an affirmatory opinion of Mr. Russell’s conclusions as to what testing was required and confirmed that such testing could be provided to the NRC, for instance, in the form of data from the repair-mockup.¹⁸¹⁵
1832. In their rebuttal report, Mr. Strosnider and Mr. Leeds testified that the Respondents, in providing further evidence of the validation of their repair for the purposes of this arbitration, demonstrated that further testing was required.¹⁸¹⁶ In responding to the statement of Mr. Wilson that prototypical testing was not required, the Claimants’ experts, Mr. Strosnider and Mr. Leeds, opine to the contrary.¹⁸¹⁷ Mr. Strosnider and Mr. Leeds do not appear to provide any further technical justification for their

¹⁸¹³ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 92; See also ¶¶ 94, 102.

¹⁸¹⁴ Expert Witness Statement of Mr. Russell, ¶ 12; See also ¶ 45.

¹⁸¹⁵ Expert Witness Statement of Mr. Johnson, ¶ 43.

¹⁸¹⁶ Rebuttal Expert Statement of Mr. Strosnider and Mr. Leeds, ¶ 5(f).

¹⁸¹⁷ Rebuttal Expert Statement of Mr. Strosnider and Mr. Leeds, ¶¶ 69-73.

opinion, rather asserting that the fact that such testing would be expensive and would take a long period of time were not reasons for such testing to not be required.

1833. The Tribunal does not accept the Claimants' position that the NRC would have required prototypical testing at the same void fractions as reached at SONGS in order to validate the proposed thicker-AVB repair. There was no need for MHI to construct a replica of SONGS Unit 3. A replica already existed with the same operating conditions, in the form of Unit 2, which had not suffered from in-plane FEI. The only apparent difference between Unit 2 and Unit 3 was not in T/H conditions, but rather in tube-to-AVB contact force. As such, MHI's approach of determining what contact force was required to prevent in-plane FEI, something that MHI tested itself, and could have tested further at Chalk River if necessary, appears sufficient to prove the repair.
1834. On 14 December 2012, MHI informed SCE that based upon the mockup tests it had undertaken, which had been witnessed by the NRC and SCE on 12 October 2012, "Mitsubishi has determined that the insertion of thicker AVBs is a practical and viable repair option."¹⁸¹⁸
1835. A summary of MHI's testing was provided in its 4 April 2013 repair report.¹⁸¹⁹
1836. The Respondents submitted further evidence of testing that was conducted, for the purposes of this arbitration, in order to demonstrate that the repair was viable. The Claimants, relying on their witnesses, have submitted that this shows that the repair, as it was proposed, was not ready as of 2012-2013 and that this demonstrates that 2-3 years of testing were required. Even if the Claimants are correct that up to three

¹⁸¹⁸ Exh. JX-1559.

¹⁸¹⁹ Exh. JX-1735.

years would have been required for testing the repair, that simply demonstrates that a repair requiring that period of time would not have been unreasonable.

1837. The Tribunal disagrees. The Tribunal considers that the Respondents have persuasively established that this evidence was in part collected to facilitate the understanding of the Tribunal as to the efficacy of the repair proposal.¹⁸²⁰ Further, this Arbitration’s submission schedule of expert reports, a number of which are drafted by semi-retired individuals working part-time, is not indicative as to the speed at which any further efforts could have been accomplished had SCE requested (or MHI initiated) further testing to assist in either its own decision making or for provision to the NRC.¹⁸²¹ For example, the Respondents’ assembled experts comprising their “United States Field Team” tasked with developing parts of the Type 1 repair generally consisted of semi-retired individuals who testified they were “working on a leisurely schedule” and that the “work could have been done that we did in those six and a half months in roughly eight to 12 weeks” had it been undertaken during the repair era.¹⁸²²

1838. The Tribunal addresses one final element. The Parties’ experts are disagreed as to whether operational experience could be used to confirm the proposed thicker AVB repair.¹⁸²³ Mr. Strosnider and Mr. Leeds testify that:

Mr. Leeds was cautioned directly by the Chair of the NRC not to allow an experiment to be conducted in the SONGS reactor as part of

¹⁸²⁰ Transcript, p 2048 (Respondents’ Daily Opening).

¹⁸²¹ See Joint Rebuttal Expert Witness Statement of Mr. Russell, Mr. Wade, and ██████████ ¶ 9; See generally ¶¶ 6-19.

¹⁸²² Expert Report of Mr. Bohn and ██████████ on Implementation of the Thicker-AVB Repair, ¶¶ 17-22; Transcript, p. 5242 (Mr. Bohn).

¹⁸²³ Rebuttal Expert Statement of Mr. Strosnider and Mr. Leeds, ¶¶ 74-76; citing to Expert Witness Statement of Mr. Johnson, ¶ 38.

determining the acceptability of corrective actions for the SONGS RSGs' abnormal tube degradation.¹⁸²⁴

1839. In this regard, the Tribunal considers the following passage from Mr. Craver's report to the Board of EIX, exhibited by the Claimants, pertinent:

Typically NRC Staff is delegated responsibility for deciding matters of nuclear safety involving individual plants (such as our restart decision), while the NRC Commissioners reserve authority to decide policy issues affecting multiple plants or the nuclear industry as a whole. However, our restart decision has become unusually politicized, with staff from the Senate Environment and Public Works Committee (EPW), chaired by Senator Boxer, exerting unusual attention and pressure on the NRC Staff. Much of this challenge to the Staff's work may be a holdover from the revolt by the NRC Commissioners and Staff against the former Chairman Greg Jaczko, a protégé of Harry Reid, which ultimately resulted in his forced resignation.¹⁸²⁵

1840. The Tribunal also recalls that the CAL as provided to SCE required the creation of a post-repair inspection schedule to verify the development of any tube wear.¹⁸²⁶
1841. To the extent that there was heightened political sensitivity to the SONGS Incident, as evident in the activities of Senator Boxer, of California, and by the community, such as Friends of the Earth, the Tribunal does not consider that this political environment would necessarily have changed the regulatory standards that SCE and MHI were required to meet to prove a repair would be safe and effective, as required by the CAL.

¹⁸²⁴ Rebuttal Expert Statement of Mr. Strosnider and Mr. Leeds, ¶ 76.

¹⁸²⁵ Exh. JX-1650, p. 3.

¹⁸²⁶ See ¶ 464 above.

(c) RSG Replacement Proposals

1842. When MHI was unable to develop a repair proposal that SCE found satisfactory, they proceeded to develop an alternative replacement proposal.
1843. On 19 December 2012, Mr. Avella requested that MHI provide a single recommendation for resolving the issues with Unit 3.¹⁸²⁷
1844. On 20 December 2012, MHI wrote to SCE, providing a replacement recommendation while also remaining committed to a repair option.¹⁸²⁸ On 21 December 2012, MHI proposed to SCE a replacement option while stating that they did not believe they were required to submit only a single option.¹⁸²⁹ On 27 December 2012, MHI provided a single recommendation, a Type 3 replacement.¹⁸³⁰
1845. On 8 January 2013, Mr. Dietrich, for SCE responded to MHI's single recommendation of a replacement option, finding MHI in breach of its contractual obligations:

An outage spanning at least seven years does not constitute a repair or replacement with "dispatch" and far exceeds any reasonable repair period that was contemplated in the contract. For these and other reasons, we believe it clear that any contractual limitations on liability are no longer applicable. We will therefore be looking to Mitsubishi to make SCE and its customers whole for all resulting damages. While we remain willing to discuss with you the path forward for SONGS, we believe that Mitsubishi must bear all costs associated with developing and implementing any plan to restore the units to service. Moreover, as we have previously informed you, SCE must reserve all rights and remedies in connection with the contract.¹⁸³¹

¹⁸²⁷ Exh. JX-1594.

¹⁸²⁸ Exh. JX-1571.

¹⁸²⁹ Exh. JX-1579.

¹⁸³⁰ Exh. JX-1590.

¹⁸³¹ Exh. JX-1610.

1846. There is nothing inherently improper in the Claimants' development of a negotiating position or litigation position, as provided in Mr. Dietrich's letter. The Claimants had acquired RSGs they expected to operate for some 40 years, two of which had failed without even a complete year of operation and two others displaying wear after the initial scheduled operation. It is reasonable that the Claimants would seek to obtain the maximum compensation for their losses. However, the RSG Contract's terms limited the Claimants' ability to recover for many of the heads¹⁸³² of damages and amount¹⁸³³ of those losses. These are considered in Issue H, below.

(d) Evaluation of the Claimants' Repair Criteria

1847. A consequence of the Claimants' litigation position is that it calls into question contemporary criticisms of the Respondents' repair efforts and the requirements that the Claimants imposed on that repair. SCE's four warranty criteria and screening criteria are set out in ¶¶ 573 - 575 and 628 above.

1848. Mr. Dietrich's letter of 8 January 2013, on behalf of SCE, expressly states, after finding that the replacement timeline voided the limitation of liability provisions, that SCE remained "willing to discuss with you the path forward for SONGS" and that "Mitsubishi must bear all costs associated with developing and implementing any plan to restore the units to service."¹⁸³⁴ Mr. Dietrich was under the impression that there was a path forward to restore the Units to service, and this despite having just identified a replacement timeline as excessive.

¹⁸³² RSG Contract, Section 1.21.1.

¹⁸³³ RSG Contract, Section 1.17.1.4.

¹⁸³⁴ Exh. JX-1610.

1849. The record¹⁸³⁵ and Mr. Avella's testimony, indicate that a repair that failed to meet SCE's warranty criteria may nonetheless be considered as an interim repair. This also finds mention in the letter by Mr. Avella to MHI dated 13 November 2012:

Using the [Screening Criteria], SCE will evaluate the MHI proposal and provided feedback within fifteen (15) days of receipt of a comprehensive submittal. A repair found not acceptable as a permanent repair will be separately assessed as an Interim repair."¹⁸³⁶

1850. As described in meeting notes from a meeting between SCE and MHI of 27 November 2012:

MHI questioned how the response on Nov. 30th will be used by SCE. SCE explained that the primary purpose is to evaluate the options for a "final" repair. Beyond the final repair, any interim options would be considered by the RTS group for interim resolution.

SCE clarified that SGT_T is responsible for the design and implementation of a permanent repair. The selection of any interim repair will be done by the Return to Service (RTS) team. Implementation of any interim repair would be performed by SGRT.¹⁸³⁷

1851. SCE's Mr. Palmisano similarly testified before the California Public Utilities Commission (CPUC):

Q. So if I were [REDACTED] how would I distinguish between what Edison was calling a permanent repair and an interim repair?

A. I think we made it pretty clear to MHI going back to SCE-24¹⁸³⁸ with the four criteria what an acceptable repair was going to be. And if

¹⁸³⁵ Exh. JX-1473 (23 October 2012 Meeting Notes); Exh. JX-1495 (5 November 2012 Meeting Notes).

¹⁸³⁶ Exh. JX-1504.

¹⁸³⁷ Exh. JX-1528, p. 1.

¹⁸³⁸ SCE-24 at the CPUC hearing is Exh. JX-1500 in this arbitration, i.e., Mr. Avella's letter of 8 November 2012, setting forth the four warranty criteria for the evaluation of a repair (See Exh. JX-1781, p. 129).

something didn't meet that and they proposed a multiple step repair, we would look at that and then decide what would be interim as opposed to permanent.¹⁸³⁹

1852. During the Hearing, Mr. Avella, for SCE, testified:

... We said if a repair plan is evaluated and it can't meet all of those four conditions, we'll either review for an interim repair – maybe it could support a restart of the unit at a different power level. In fact, I had conversations with one of the Mitsubishi representatives, [REDACTED] that if we can – get your repair and it doesn't get us to 100 percent power, I'll move that forward to my superiors and obviously look to see if we can make an arrangement between the companies.¹⁸⁴⁰

1853. Mr. Avella testified as to his understanding of what an interim repair was as follows:

It's something that would support starting a unit, making some power for our customers, right, getting it back operational and then working on what the final or permanent repair would be.¹⁸⁴¹

1854. SCE's Mr. Moran also testified:

Mr. Allen: So go/no go doesn't mean go/no go? Is that your testimony?

Mr. Moran: It means that from our standpoint with our team, that would be either acceptable or it would be not acceptable. If Mitsubishi presented something else that says we don't meet all of the criteria, that does not mean – or it doesn't limit us or MHI from discussing it further with – putting together the risks and then bringing it to a higher decision-maker than us.¹⁸⁴²

1855. Mr. Avella also made a distinction about SCE's screening criteria:

¹⁸³⁹ Exh. JX-1781, p. 148.

¹⁸⁴⁰ Transcript, pp. 1373-1374.

¹⁸⁴¹ Transcript, p. 1477.

¹⁸⁴² Transcript, p. 1853

This letter¹⁸⁴³ was talking about the acceptance criteria, not about what our final answer was going to be to Mitsubishi.¹⁸⁴⁴

1856. Mr. Avella further put into context SCE's repair criteria:

Mr. Heisse: If [MHI] came back to you with a repair plan that did not improve thermal-hydraulic conditions materially and required a lower power level operation in order to work, you would move that forward to your management and see if that would float, correct?

Mr. Avella: Correct.¹⁸⁴⁵

1857. Mr. Avella testified that a repair that did not meet the screening criteria, would still be considered:

Interim, or permanent repair, or what would come with that? Those are management decisions. This screening criteria is the engineering answer. It works or it doesn't work based on that screening criteria. If it doesn't, then I have to move that up my management chain for their review and approval.¹⁸⁴⁶

1858. From the above, it appears that SCE was open to considering a repair with respect to the SONGS Unit 3 that did not meet its warranty or screening criteria. However, it is evident that SCE's warranty and screening criteria would never be met by any Type 1 or Type 2 repair option proposed by MHI, or by any other vendor, but only a Type 3 or 4 replacement option.

1859. Even so, SCE has repeatedly evidenced during the repair era and testified in this arbitration that a repair that did not meet its requirements would nonetheless be considered acceptable. This inconsistent position casts a doubt on the requirements

¹⁸⁴³ Exh. JX-1504.

¹⁸⁴⁴ Transcript, p. 1490.

¹⁸⁴⁵ Transcript, p. 1488.

¹⁸⁴⁶ Transcript, p. 1489.

for testing and T/H improvements that SCE was demanding during the repair era. That SCE repeatedly evidences that a repair that did not meet their warranty or screening criteria would nonetheless be considered, demonstrates that SCE's criteria exceed what would be required to safely repair SONGS Unit 3 and satisfy the NRC's CAL requirements for a Unit 3 restart.¹⁸⁴⁷ In addition, the Tribunal recalls that the testing to evaluate MHI's proposed Type 1 Repair included both what B&W described as acceptable tests to validate the repair and long term tests to determine the growth of tube wear.¹⁸⁴⁸

1860. Therefore, the Tribunal determines that SCE's criteria and criticism of MHI's repair proposal for a thicker AVB repair are not determinative as to whether a thicker AVB repair would have been effective, licensable, and implementable. Rather, SCE's warranty and screening criteria appear to have been attempts to force MHI into a replacement recommendation, which SCE used to declare MHI in breach of contract, overturn the contractually negotiated limitation of liability provision, and establish a strong bargaining or litigation position for the resolution of the SONGS Incident.¹⁸⁴⁹ This is apparent in Mr. Dietrich's letter to MHI of 8 January 2013, as quoted above.¹⁸⁵⁰

1861. Given this conclusion, the Tribunal considers that the persuasive evidence in weighing whether MHI's repair proposal would meet the obligations under the RSG Contract are the evaluations of MHI's 4 April 2013 Repair proposal.¹⁸⁵¹ Whether a

¹⁸⁴⁷ See Section VII.F(c) above.

¹⁸⁴⁸ See Section XIV.A(b) above.

¹⁸⁴⁹ As a hypothetical, in response to the Concurring and Dissenting Opinion, the Majority notes that it is consistent with the Claimants' position to have demanded an interim repair to address the Defect in this case, while pursuing a replacement as a long term strategy to ensure that RSGs would last for the expected forty year life of the RSG Contract. The ASLB decision interrupted any such ongoing negotiation.

¹⁸⁵⁰ Exh. JX-1610.

¹⁸⁵¹ Exh. JX-1734.

repair would be effective in eliminating in-plane FEI wear, and controlling other wear, is reviewed by the Tribunal below.

B. EFFECTIVENESS OF THE PROPOSED THICKER AVB REPAIR

1862. In this arbitration, the Parties have exhibited expert reports on the adequacy of MHI's proposed thicker AVB repair. For the Claimants, Dr. Elder opined that MHI's proposed repair remains inadequate. For the Respondents, ██████████ Mr. Wilson, and Dr. Begley have submitted a joint report on the validation of the U-bend repair. The Respondents have also offered an expert report by Mr. Bohn and ██████████ ██████████ on the implementation of the repair. This report was accompanied by a demonstrative video, showing the repair being implemented in the U-bend mockup. The Respondents' experts also addressed aspects of the repair in their individual fact and/or expert reports.
1863. In considering the effectiveness of the proposed repair, the Tribunal places significant weight on the Respondents' proposed U-bend repair report of 4 April 2013,¹⁸⁵² SCE's review comments of 25/26 April 2013,¹⁸⁵³ MHI's draft answers to those comments of 10 May 2013¹⁸⁵⁴ (as exhibited on 29 April 2016), AREVA's 30 May 2013 independent review of that proposed repair,¹⁸⁵⁵ MHI's answer to AREVA's comments of 30 December 2015 (prepared for the purposes of this arbitration by ██████████¹⁸⁵⁶ and the expert statements of Mr. Stewart on both those answers and the repair proposal.

¹⁸⁵² Exh. JX-1734.

¹⁸⁵³ Exh. JX-1748; Exh. JX-1749.

¹⁸⁵⁴ Exh. JX-2309; Exh. JX-2310.

¹⁸⁵⁵ Exh. JX-1797.

¹⁸⁵⁶ Exh. JX-2190.

1864. In considering whether the proposed repair is effective, the Tribunal considers the question of whether that repair would prevent in-plane FEI and could be implemented within the confines of the steam generators.
1865. Other aspects of the proposed repair, set out in a letter of SCE of 8 November 2012, such as whether it would meet the Claimants' four repair criteria¹⁸⁵⁷ and the evaluation of the proposed repair according to the Claimants' four screening criteria¹⁸⁵⁸ categories set forth by SCE on 13 November 2012 are considered, but are not determinative of whether the repair is effective.
1866. Licensability of the proposed repair will be considered as a distinct question in Section XIV.C below.
1867. The technical questions surrounding the proposed repair can be split into what Mr. Bohn, for the Respondents, has described as so-called "big E" engineering and so-called "little e" engineering.¹⁸⁵⁹ "Big E" refers to the overarching analytical questions of developing a repair, such as determining what that repair concept is, refining that concept, testing it, and proving its effectiveness. "Little e" engineering relates to the technical implementation of that proposed repair.
1868. While it concerns the conceptually latter step of implementation, the Tribunal first addresses the "little e" aspects, as demonstrated to the Tribunal in a repair implementation video and report.

¹⁸⁵⁷ Exh. JX-1500.

¹⁸⁵⁸ Exh. JX-1504.

¹⁸⁵⁹ Transcript, pp. 5215, 5225, 5236.

(a) **Repair Implementation Video and Site Visit**

1869. During the repair efforts, an aspect under consideration was whether a repair could be carried out within the confines of the RSG.

1870. To answer this hypothetical, the Tribunal relies upon two aspects. The one being the site visit conducted by the Tribunal to Kobe, where the repair mockup was viewed. The other being a 17-minute video of the repairs being implemented in that mockup.¹⁸⁶⁰

1871. Based upon the site visit and evidence, the Tribunal considers that MHI’s repair concept could be performed at SONGS, had approval been granted by SCE.

1872. The repair implementation video shows workers entering the RSG, [REDACTED] grinding open the weld of the entry hatchway into the U-bend area while using [REDACTED] [REDACTED] workers entering the U-bend area, [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] installation of a thicker AVB, and final torquing¹⁸⁶⁴ and crimping of the installed thicker AVBs.¹⁸⁶⁵ The video concludes with the removal of

¹⁸⁶⁰ Exh. JX-2202.

[REDACTED]

¹⁸⁶⁴ Torqueing is a final tightening of the installation bolts.

¹⁸⁶⁵ Exh. JX-2202.

██████████ welding shut of the bottom deck access manplate, and removal of all equipment.¹⁸⁶⁶

1873. The insertion of a single thicker AVB requires ██████████¹⁸⁶⁷ An additional period of approximately ██████████ is required for the set-up of the expansion bladders and positioning guide.

1874. The video also shows supervisors outside the RSG work area with cameras to engage in foreign materials control and quality control verification of the repair work.

1875. At the conclusion of the video, key statistics are provided:

- i. Workers are in the U-bend area of each steam generator for less than 3.5 hours;
- ii. The time to install the thicker AVBs in each steam generator is two hours;
- iii. The “critical path”¹⁸⁶⁸ duration is of 5.3 days for Unit 3 and 7.9 days for Unit 2;
- iv. Dose exposure is 1.0 manRem for Unit 3 and 9.4 manRem¹⁸⁶⁹ for Unit 2.

1876. The cost for the RSG Repair is approximately \$30 million.¹⁸⁷⁰

¹⁸⁶⁶ Exh. JX-2202.

¹⁸⁶⁷ Exh. JX-2202, minutes 11:20-11:50.

¹⁸⁶⁸ The critical path, as explained by Mr. Bohn, is “the amount of time that the AVB work would be controlling the site schedule.” (Transcript, p. 5205).

¹⁸⁶⁹ These figures are non-dangerous dosages, similar to what an average person experiences from usual background radiation.

¹⁸⁷⁰ Exh. JX-2202.

1877. For the Claimants, Dr. Elder has opined that the provision of a repair implementation plan and video “2.5 years after SONGS retired is too little, too late.”¹⁸⁷¹ Mr. Merschhoff, Exponent, Mr. Strosnider and Mr. Leeds included the repair implementation video amongst the documents reviewed for their rebuttal reports. They have not provided any convincing criticism thereof.
1878. During the Hearing, Mr. Bohn, for the Respondents, provided the Tribunal with a commentary on the repair implementation video.¹⁸⁷² The Claimants cross-examined Mr. Bohn on the repair proposal but did not ask any questions directly pertaining to the video of the repair; or which challenged the Respondents’ basic premise, which is that the repair could be performed.
1879. The Claimants’ raised three allegedly notable differences between the repair as implemented in the video and the U-bend repair proposal as submitted in April 2013 by the Respondents. The Claimants raised concerns over whether the repair was being performed in [REDACTED] whether a [REDACTED]¹⁸⁷³ was used, and the use of [REDACTED]¹⁸⁷⁴
1880. The original repair proposal called for the repair being performed [REDACTED] [REDACTED] [REDACTED]¹⁸⁷⁶ The repair implementation in the video was [REDACTED]

¹⁸⁷¹ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶ 86.

¹⁸⁷² Transcript, pp. 5191-5206.

¹⁸⁷³ [REDACTED]

¹⁸⁷⁴ See Transcript, p. 2612ff (Claimants’ Daily Opening); See also Transcript, pp. 5221-5223 (Cross-Examination of Mr. Bohn).

¹⁸⁷⁵ Whether a repair is performed [REDACTED]

¹⁸⁷⁶ See Transcript, p. 2612ff (Claimants’ Daily Opening).

1881. The original repair proposal called for the use of a [REDACTED] AVB. MHI changed this, using a [REDACTED]¹⁸⁷⁷
1882. The original repair called for using a [REDACTED] but was eventually performed with [REDACTED] As displayed at the Hearing, an [REDACTED]
[REDACTED]
[REDACTED]
1883. The Claimants have raised the Issue that MHI did not inform SCE of these changes during the 2012-2013 repair timeframe.¹⁸⁷⁸
1884. The Tribunal considers that the Claimants have convincingly shown that the Respondents did not adequately communicate these changes in the repair methodology.
1885. There is, however, no convincing evidence in the record that shows that had these changes been communicated earlier, SCE would have approved the repair. Neither is there evidence that demonstrates that these changes had any significance on the repair's effectiveness or danger to workers from radiation exposure. The Claimants' primary criticism is in relation to the use of [REDACTED]
1886. Exponent has opined that the use of the [REDACTED]
[REDACTED] that were not specifically studied by MHI.¹⁸⁷⁹ The Tribunal does not find this criticism convincing. While MHI does not appear to have studied the effect of the [REDACTED] MHI did study the 40-year effect of the insertion of the thicker AVBs.¹⁸⁸⁰

¹⁸⁷⁷ See Transcript, pp. 2627-2628 (Respondents' Daily Opening).

¹⁸⁷⁸ See Transcript, p. 2612ff (Claimants' Daily Opening).

¹⁸⁷⁹ Exponent Rebuttal, ¶ 271.

¹⁸⁸⁰ Exh. JX-1734, p. 72ff.

1887. In light of the above, Tribunal concludes that it was physically possible for the repair to be implemented.

(b) **Repair Proposal and Criticism**

1888. In May 2012, MHI first proposed its thicker AVB repair concept to resolve in-plane FEI in Unit 3.¹⁸⁸¹ Nearly a year later, MHI submitted its April 2013 thicker AVB repair proposal, the U-Bend Repair Report.¹⁸⁸²

(i) *MHI's Proposed Repair*

1889. In the U-Bend Repair Report, MHI purportedly demonstrates that its proposed thicker AVB repair meets SCE's four repair criteria of November 2012, i.e., the minimum warranty conditions for repair.¹⁸⁸³

1890. Criteria 1 was the "resolution of thermal hydraulic conditions such that SONGS can operate at all power levels without undue tube vibration or unacceptable wear."¹⁸⁸⁴ MHI proposed that reducing void fraction to below 99.2% would eliminate in-plane FEI.¹⁸⁸⁵ This reduction would be accomplished by increasing the circulation ratio from 3.3 to ■¹⁸⁸⁶ through increasing the water level in the steam generator, reducing the feedwater¹⁸⁸⁷ temperature, and increasing the temperature of the primary water.¹⁸⁸⁸ The combined effect of these changes was a reduction in void fraction (VF)

¹⁸⁸¹ Exh. JX-1191.

¹⁸⁸² Exh. JX-1734.

¹⁸⁸³ Exh. JX-1734.

¹⁸⁸⁴ Exh. JX-1500.

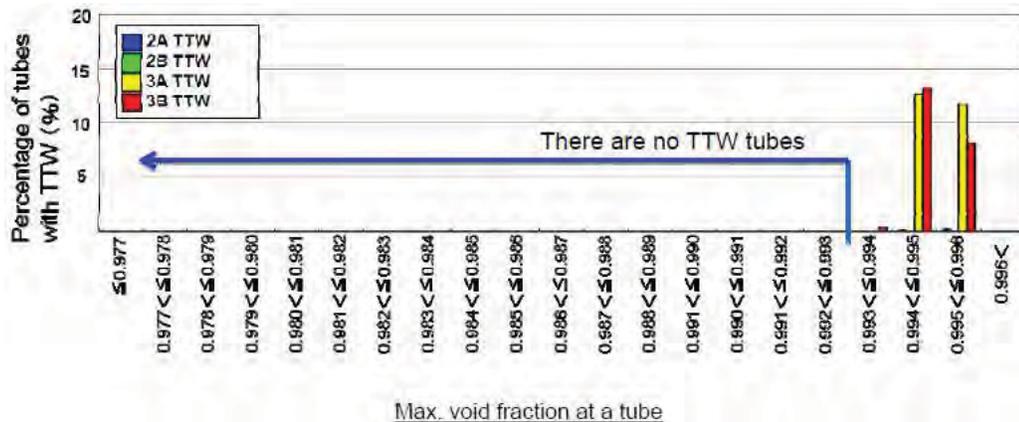
¹⁸⁸⁵ Exh. JX-1734, pp. 13-14, 17-18.

¹⁸⁸⁶ The Tribunal notes that in its determination of the alleged SSPC errors (Section XI.A), the conclusion was reached that the as calculated circulation ratio was not 3.3, but erroneously lower. The Tribunal is in no position to calculate what the void fraction would be if this error is taken into account. However, the Tribunal notes that the resolution of T/H conditions in addition to the thicker AVB repair put forth by MHI was at SCE's request. That is, a successful repair required addressing either T/H conditions or contact forces, not both.

¹⁸⁸⁷ The feedwater is water being added to the RSGs to account for the loss of water in circulation.

¹⁸⁸⁸ Exh. JX-1734, p. 19.

to [REDACTED].¹⁸⁸⁹ That a VF of 99.2% or below would prevent in-plane FEI is illustrated in the following table from the U-Bend Repair Report, which was also included in MHI’s October 2012 Supplemental Technical Evaluation Report:¹⁸⁹⁰



1891. Criteria 2 was “the restoration of the design to ensure a thermal capacity of each steam generator of at least 1729 MWt.”¹⁸⁹¹ The U-Bend Repair Report affirms that the repair meets this criteria.¹⁸⁹²

1892. Criteria 3 was the “restoration of the full life of the steam generator components to 40 years.”¹⁸⁹³ The U-Bend Repair Report affirms, through wear rate calculations,¹⁸⁹⁴ that the repaired RSGs have a service life of at least 40 years.¹⁸⁹⁵

¹⁸⁸⁹ Exh. JX-1734, p. 19.

¹⁸⁹⁰ Exh. JX-1734, p. 16, Exh. JX-1471, p. 21 (Exh. JX-1471, p. 43 has a similar table for tube-to-AVB wear).

¹⁸⁹¹ Exh. JX-1500.

¹⁸⁹² Exh. JX-1734, p. 6.

¹⁸⁹³ Exh. JX-1500.

¹⁸⁹⁴ Wear rate calculations estimate the amount of through wall wear that would occur on account of interactions between the tubes and the support structure (i.e. AVBs). A tube must be plugged if within the next cycle it would experience wear that would reach 35% through the tube wall.

¹⁸⁹⁵ Exh. JX-1734, pp. 72-105.

1893. Criteria 4 was the “restoration of the tube plugging margin to less than 8% at End of Life.” The same work rate calculations also demonstrate that the plugging margin¹⁸⁹⁶ would not be exceeded over the 40 year life of the RSGs.¹⁸⁹⁷

(ii) SCE’s Comments on the U-Bend Repair Report

1894. SCE prepared response comments to MHI’s proposed U-Bend Repair Report of April 2013.¹⁸⁹⁸ MHI’s own response to these comments was prepared on 10 May 2013.¹⁸⁹⁹

1895. However, MHI’s comments were not provided to SCE either during the repair era, or during the document production phase of this arbitration. They were also not exhibited by the Respondents with their submissions. Rather, the comments were first produced during the final week of the Hearing, retracted, and then ordered to be produced by the Tribunal. MHI’s technical comments responding to SCE’s comments are marked “Attorney Client-Work Product Privileged and Confidential.” During the Hearing, the Respondents submitted this was a defensible designation and explained why these documents were not previously produced.¹⁹⁰⁰

1896. The Tribunal has reviewed SCE’s April 2013 comments on the U-Bend Repair Report and MHI’s May 2013 responses thereto.

1897. SCE’s comments vary in type, including requested clarifications, typographical corrections, requests for additional information, and requests for justifications.¹⁹⁰¹

¹⁸⁹⁶ Only 8% of a the tubes in a single RSG can be plugged before the entire unit must be removed from service. This is a safety requirement.

¹⁸⁹⁷ Exh. JX-1734, pp. 72-105.

¹⁸⁹⁸ Exh. JX-1748; Exh. JX-1749.

¹⁸⁹⁹ Exh. JX-2309; Exh. JX-2310.

¹⁹⁰⁰ Transcript, pp. 5251, 5254 (Counsel).

¹⁹⁰¹ Exh. JX-1748; Exh. JX-1749.

1898. The Tribunal's review of MHI's responses finds that SCE's comments are generally addressed in a satisfactory manner. Some information would still be required, such as the development of an implementation plan (i.e., the so-called "little e" engineering, to use Mr. Bohn's expression). Further, MHI's response provides that obtaining NRC approval was up to SCE, although MHI provided it was willing to assist in providing required data.
1899. Considering the above, the Tribunal finds nothing significant in SCE's comments that would call into question the viability of the thicker AVB repair. It is however clear that the U-Bend Repair Report was not a complete repair proposal. Thus, it is technically accurate, consistent with the Claimants' case that the Respondents never provided a complete repair proposal for the Claimants' review.

(iii) AREVA's Evaluation

1900. At SCE's request, MHI's U-Bend Repair Report was reviewed by AREVA.¹⁹⁰² During the Hearing, Mr. Moran, SCE's SGRT Engineering Manager/Chief Engineer, testified that AREVA's Report considered SCE's four warranty criteria.¹⁹⁰³
1901. AREVA's Report concludes that:

The report displays strong evidence of intensive design, analysis and testing efforts by MHI. The Independent Review however concludes the subject thick-AVB repair approach requires further substantiation in several discipline areas before it can be installed and operated with confidence, and as such is not sufficient as a repair plan to implement as presented. The primary concerns are about long term operability.¹⁹⁰⁴

¹⁹⁰² Exh. JX-1797.

¹⁹⁰³ Transcript, pp. 1838-1838 (Mr. Moran).

¹⁹⁰⁴ Exh. JX-1797, p. 4.

1902. The AREVA Report further concludes that “it is feasible to implement the thick AVB repair design concept” and that implementing the repair was likely to require a LAR,¹⁹⁰⁵ as it did not fit well in the 10 CFR 50.59 process.¹⁹⁰⁶
1903. AREVA identified nearly 100 areas of concern that would have to be addressed.
1904. In this arbitration, MHI prepared responses to these areas of concern. Those responses were reviewed by Mr. Stewart, the lead drafter of the AREVA Report.

(iv) MHI's Response

1905. MHI's response to the AREVA Report and supporting documents consists of hundreds of pages, including:
- i. ██████████ Response to AREVA Report, a 155-page item by item response to each of AREVA's concerns;¹⁹⁰⁷
 - ii. ██████████ and ██████████ Design Reconciliation Report, a 66-page evaluation of the calculations used in the design of the RSG and how those would be affected by the repair;¹⁹⁰⁸
 - iii. ██████████ and ██████████ Analytical Methods Reconciliation Report, a 34-page report regarding evaluation and input parameters used in the design of the RSGs, the Unit 2 restart and the Unit 3 repair;¹⁹⁰⁹

¹⁹⁰⁵ LAR is a license amendment request. A LAR requires that the NRC review the repair.

¹⁹⁰⁶ Exh. JX-1797, pp. 4-5.

¹⁹⁰⁷ Exh. JX-2190.

¹⁹⁰⁸ Exh. JX-2191.

¹⁹⁰⁹ Exh. JX-2208.

- iv. [REDACTED] Analytical Methods Report, a 81-page report on the “calculation methods, input values, and results for the work rate, pinning force, and stability ratio calculations described in the Validation Report”;¹⁹¹⁰
- v. [REDACTED] ABAQUS Contact Force Analysis Report, a 110-page report on the contact forces used in the repair;¹⁹¹¹ and
- vi. [REDACTED] Summary of Pinning Force, Reaction Force and Friction Damping Tests, a 53-page report on the repair’s effectiveness.¹⁹¹²

1906. In addition to the above, various expert reports were submitted in this arbitration which further summarize and explain the response to the AREVA Report as well as other technical reports. Notably these include the Respondents’ Validation Report prepared by [REDACTED] Dr. Begley and Mr. Wilson.

1907. Mr. Stewart, the lead preparer of the AREVA Report, concluded that MHI had adequately addressed the concerns as raised by AREVA.¹⁹¹³

(v) The Claimants’ Criticism of the Proposed Repair Report

1908. Dr. Elder and the Claimants have identified various inadequacies of the Respondents’ U-Bend Repair Report.

1909. Dr. Elder’s primary critiques of MHI’s U-Bend Repair Report include:

¹⁹¹⁰ Exh. JX-2209.

¹⁹¹¹ Exh. JX-2192.

¹⁹¹² Exh. JX-2210.

¹⁹¹³ Expert Witness Statement of Mr. Stewart, ¶¶ 27-30, 53; Reply Expert Witness Statement of Mr. Stewart, ¶ 9.

- i. That MHI did not evaluate its repair in regard to tube dinging and denting, which could “at a minimum (...) increase the duration and costs of steam generator inspections” and increase the long-term potential for plastic deformation;¹⁹¹⁴
- ii. That the repair did not address the potential for in-plane FEI wear outside of the designated repair zone and that pinning the tubes could result in puckering;¹⁹¹⁵
- iii. That the repair did not confirm that out-of-plane FEI would not occur, nor did it address the potential for ballooning;¹⁹¹⁶
- iv. That MHI failed to consider the potential for additional tube-to-TSP wear;¹⁹¹⁷
- v. That MHI failed to address the potential for tube-to-AVB wear.¹⁹¹⁸

1910. In general, Dr. Elder also criticizes MHI for still not having undertaken adequate testing.¹⁹¹⁹

¹⁹¹⁴ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶¶ 55-57.

¹⁹¹⁵ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶¶ 58-62.

¹⁹¹⁶ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶¶ 63-65.

¹⁹¹⁷ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶¶ 66-68.

¹⁹¹⁸ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶¶ 69-71.

¹⁹¹⁹ Rebuttal Expert Witness Statement of Dr. Elder (Rebuttal Testimony on Repair Efforts), ¶ 72.

(vi) The Respondents' Response to the Claimants' Criticism

1911. The Respondents' experts have provided reply opinions regarding the U-Bend Repair Report opining that the repair would be effective.
1912. ██████████ has provided a rebuttal to Dr. Elder's criticisms.
1913. For example, regarding Dr. Elder's comments on the potential for in-plane FEI outside of the repair zone, ██████████ provides that a single tube in the repair mockup, on which Dr. Elder based his opinion, was loose in the mockup and that he concluded this loose tube was not a concern.¹⁹²⁰

(vii) The Tribunal's Determination

1914. During the Hearing, the experts' opinions regarding the proposed repair were subject to substantial examination in both direct and cross.
1915. Considering the examination, and the expert reports, the Tribunal is not convinced that the Claimants have demonstrated that the repair was not an effective means of resolving in-plane FEI in Unit 3. To the contrary, the repair, as described in the U-Bend Repair Report, was a potentially effective means of repairing Unit 3 that required the development of further implementation plans and the resolution of concerns as raised by the independent reviewer, AREVA. Further, AREVA's non-regulatory concerns appear to have been adequately addressed. The Tribunal further considers these issues in its analysis of Issue C.3(b)(i) below.¹⁹²¹

¹⁹²⁰ Rebuttal Expert Witness Statement of ██████████ ¶ 48.

¹⁹²¹ Section XV.C(e) below.

C. NRC EVALUATION OF THE PROPOSED REPAIR

1916. Having determined that the proposed repair would be effective, the Tribunal next considers whether that proposed repair would have satisfied the requirements of the CAL.
1917. In this regard, the Claimants have presented evidence from Mr. Strosnider and Mr. Leeds. They have testified that, in their (former) roles as seniors NRC officials responsible for approving any proposed repair at the time in question, they would not have granted such an approval.¹⁹²²
1918. In rebuttal, the Respondents have submitted expert evidence from Mr. Johnson and Mr. Russell, also former NRC officials, to the effect that the NRC would have granted authorization for the repair.¹⁹²³
1919. In the Tribunal's consideration, the Claimants' position is not convincing. In their NRC roles, Mr. Strosnider and Mr. Leeds would have relied upon many technical experts to review the proposed Unit 3 repair.¹⁹²⁴ Had this technical review been completed by the NRC staff, Mr. Leeds' opinion as to how he would have reacted would be more persuasive. The Tribunal considers Mr. Leeds' competency and professionalism to be significant and has no doubt that he would not have pre-judged a SONGS repair option absent the evidence and technical evaluation required.¹⁹²⁵ The Tribunal considers that those technical experts would have evaluated the Unit 3 Repair, as was done for the proposed Unit 2 restart, and concluded that it could be

¹⁹²² Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ IX.A; Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ IV.

¹⁹²³ Expert Witness Statement of Mr. Johnson, ¶ 71; Rebuttal Expert Witness Statement of Mr. Johnson, ¶ III; Expert Witness Statement of Mr. Russell, ¶ 19; See generally Thicker-AVB Repair Licensing Report of Mr. Russell; Rebuttal Expert Statement of Mr. Russell.

¹⁹²⁴ Transcript, pp. 1989-1991 (Mr. Leeds).

¹⁹²⁵ See generally Transcript, pp. 1911, 1915-1916. (Mr. Leeds).

safely returned to service. This would have been consistent with AREVA's conclusions, and Mr. Stewart's testimony, that the thicker AVB repair could have been effective.

1920. The regulatory process regarding a proposed repair, as described by the experts, is set forth below.

(a) **Regulatory Process**

1921. Licensability is a question in a number of the Issues set forth for the Tribunal's determinations under Issue C.¹⁹²⁶ To facilitate that analysis, the Tribunal addresses further details on the regulatory process below.

1922. The RSG Contract requires that the RSGs be licensable:

In accordance with Table 3-1, the Supplier shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end.¹⁹²⁷

1923. This was to be achieved by conforming the design of the RSGs to the specifications of the OSGs, such that replacement was possible under the 10 CFR 50.59 rule, absent NRC's review:

Edison intends to replace the steam generators under the 10 CFR 50.59 rule. Consequently, Edison requests that the RSGs be as close as possible to the existing steam generators in form, fit, and function, subject to additional requirements and limitations stated elsewhere in this Specification.¹⁹²⁸

¹⁹²⁶ Section XV below.

¹⁹²⁷ RSG Contract, Section 3.6.1.2.

¹⁹²⁸ RSG Contract, Section 3.6.1.1.

1924. MHI was required to ensure that its design met the standards under SCE’s Updated Final Safety Analysis Report (UFSAR), which consisted of the safe operating standards specific to SONGS as approved by the NRC.

1925. The presence of in-plane FEI is a violation of the UFSAR. Specifically, Section 5.4.2.1 of the SONGS UFSAR requires that:

The steam generator was designed to ensure that critical vibration frequencies are well out of the range expected during normal operation and during abnormal conditions. The tubing and tubing supports are designed and fabricated with considerations given to both secondary side flow induced vibration and reactor coolant pump induced vibration.¹⁹²⁹

1926. As explained by Mr. Russell, for the Respondents, the presence of in-plane FEI violates this, as the RSGs are operating above the range of “critical vibration frequencies.”¹⁹³⁰ Item 7 of the CAL for Unit 3 requires that SCE demonstrate that SONGS can operate safely, i.e., that it would meet the requirements of Section 5.4.2.1 of the SONGS UFSAR.

1927. The warranty provisions¹⁹³¹ of the RSG Contract appear silent on the question of licensability. It is, however, evident that the requirement that any repair or replacement be performed in a “mutually agreeable manner” implicitly grants SCE the right to request that any proposed repair or replacement be licensable.¹⁹³²

1928. As further described below, licensability implies that a proposed repair or replacement is acceptable to the NRC. This is achieved either through the licensee,

¹⁹²⁹ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 12, n. 5, Appendix 5.

¹⁹³⁰ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 12, n. 5.

¹⁹³¹ RSG Contract, Section 1.17.

¹⁹³² RSG Contract Section 1.17.1.3

i.e., SCE, determining that the change does not trigger an assessment under the 10 CFR 50.59 criteria or the NRC approving a license amendment request (LAR).

1929. In addition to the above standard procedure, it is evident that a restart of Unit 3 was conditional on meeting the requirements of the CAL.¹⁹³³ Failure to do so would have seen the NRC issue an order preventing restart.¹⁹³⁴

(i) Modification According to 10 CFR 50.59

1930. The NRC regulations permit a licensee to make changes without regulatory oversight where the change does not “create more than a minimal increase in the chance or consequence of an accident or malfunction of a component important to safety.”¹⁹³⁵ This is set forth in 10 CFR 50.59(c):

(c)(1) A licensee may make changes in the facility as described in the final safety analysis report (as updated), make changes in the procedures as described in the final safety analysis report (as updated), and conduct tests or experiments not described in the final safety analysis report (as updated) without obtaining a license amendment pursuant to Sec. 50.90 only if:

(i) A change to the technical specifications incorporated in the license is not required, and

(ii) The change, test, or experiment does not meet any of the criteria in paragraph (c)(2) of this section.

(2) A licensee shall obtain a license amendment pursuant to Sec. 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

¹⁹³³ See Section VII.F(c) above.

¹⁹³⁴ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 18(1).

¹⁹³⁵ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 26.

- (i) Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final safety analysis report (as updated);
- (ii) Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the final safety analysis report (as updated);
- (iii) Result in more than a minimal increase in the consequences of an accident previously evaluated in the final safety analysis report (as updated);
- (iv) Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the final safety analysis report (as updated);
- (v) Create a possibility for an accident of a different type than any previously evaluated in the final safety analysis report (as updated);
- (vi) Create a possibility for a malfunction of an SSC important to safety with a different result than any previously evaluated in the final safety analysis report (as updated);
- (vii) Result in a design basis limit for a fission product barrier as described in the FSAR (as updated) being exceeded or altered; or
- (viii) Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses.

1931. As persuasively explained by the Claimants' experts, "if a proposed change meets the 50.59 Criteria, a licensee can implement the change without delay caused by the need to obtain prior NRC approval," while noting that "regulatory oversight is not

absent” as the licensee must still document the change and submit it in a report after the fact.¹⁹³⁶

1932. In relation to the Type 1 Repair, the record shows particular concerns with regard to whether that repair would “create a possibility for an accident of a different type than any previously evaluated” (criteria (v)) on account of the insertion of thicker AVBs, such as the possibility of the existing AVBs being loose.
1933. Mr. Strosnider and Mr. Leeds have testified that “even though NRC approval is not needed for changes that meet the 50.59 Criteria, it is not uncommon for licensees to discuss such changes with the NRC, especially for more major changes.”¹⁹³⁷ As such, informal discussions may occur in which the NRC can indicate any preliminary concerns.

(ii) 10 CFR 50.59(c) Screening

1934. In order to determine whether a licensee is required to undertake a 10 CFR 50.59(c) assessment, the first step is for that licensee to determine if that assessment is required.¹⁹³⁸ As explained by Mr. Russell, five screening criteria were developed by an industry trade organization, the Nuclear Energy Institute, whose use was approved by the NRC. Those criteria are:

1. Does the proposed activity involve a change to a structure, system or component that adversely affects a design function described in the Unit’s UFSAR?

¹⁹³⁶ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 27.

¹⁹³⁷ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 34.

¹⁹³⁸ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 30.

2. Does the proposed activity involve a change to a procedure that adversely affects how a design function described in the UFSAR is performed or controlled?

3. Does the proposed activity involve revising or replacing an evaluation methodology described in the UFSAR that is used to establish the Unit's design bases or in the Unit's safety analysis?

4. Does the proposed activity involve a test or experiment not described in the UFSAR, where a structure, system or component is utilized or controlled in a manner that is outside the bounds of that structure, system, or component's design or is inconsistent with the analyses or descriptions in the SONGS UFSAR?

5. Does the proposed activity require a change to the Unit's license or technical specifications?¹⁹³⁹

1935. If any of these five questions are answered in the affirmative, this results in the licensee having to engage with the 10 CFR 50.59(c) criteria to determine if an LAR is required.¹⁹⁴⁰

1936. SCE's Mr. Palmisano has testified, that during the repair era, SCE did not undertake an assessment of the screening criteria (nor the further 10 CFR 50.59(c) assessment) for the proposed Type 1 Repair.¹⁹⁴¹

1937. For the Respondents, Mr. Russell's review concluded that the answer to these five questions¹⁹⁴² was no, such that the licensee, i.e., SCE, would not be required to undertake a 10 CFR 50.59(c) analysis.¹⁹⁴³ Mr. Russell concludes:

¹⁹³⁹ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 24.

¹⁹⁴⁰ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 25.

¹⁹⁴¹ Transcript, p. 94 (Mr. Palmisano).

¹⁹⁴² See ¶ 1934 above.

¹⁹⁴³ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 31.

- i. Regarding question 1: a thicker AVB repair does not adversely affect a design function of the RSGs, as (i) the effect of the physical presence of the AVBs on the steam flow is below that of measurement uncertainty; (ii) the increased pressure from the thicker AVBs is small and acceptable such that a design function is not affected; and (iii) the potential for wear from the unsupported thicker AVB leg was comparable to random wear that is managed under the SONGS existing Steam Generator Program for wear inspections;
- ii. Regarding question 2: the only potentially affected procedure was on water level stability on account of a potential increase in flow resistance, but that this was found to not have a material impact;
- iii. Regarding question 3: the Type 1 Repair does not affect the integrity of a reactor coolant pressure boundary, such that this is not a concern;
- iv. Regarding question 4: the Type 1 Repair restores the RSGs to their design requirements, rather than bringing the RSGs outside those requirements, and as such is not a concern;
- v. Regarding question 5: the Type 1 Repair does not change the RSGs' license or technical specifications.¹⁹⁴⁴

1938. Mr. Strosnider and Mr. Leeds did not undertake a screening evaluation in their original expert report.

1939. In their rebuttal report, Mr. Strosnider and Mr. Leeds opine that “the repair could have resulted in new or exacerbated tube degradation that would have adversely

¹⁹⁴⁴ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 31ff.

affected the ability to maintain steam generator tube integrity as described” in the design basis of the UFSAR, Section 5.4.2.1¹⁹⁴⁵

1940. Specifically, this new type of degradation appears to be the risk of potential vibration of the existing AVBs and the creation of loose parts from such vibration.¹⁹⁴⁶

1941. This concern was raised in AREVA’s 30 May 2013 report:

The increased double-sided gap on the existing AVBs would exist over rows where the new bar is thick [REDACTED]

[REDACTED]

1942. AREVA notes [REDACTED]
[REDACTED]
[REDACTED]¹⁹⁴⁸

1943. Mr. Strosnider and Mr. Leeds do not appear to take into account MHI’s answer to this concern as provided in MHI’s response to the AREVA report.¹⁹⁴⁹

1944. Mr. Strosnider and Mr. Leeds do not appear to identify which of the screening criteria the potential for new forms of degradation violates.¹⁹⁵⁰ It appears however that their concern would fall under the first screening criteria:

¹⁹⁴⁵ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 56.

¹⁹⁴⁶ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 22.

¹⁹⁴⁷ Exh. JX-1797, p. 9.

¹⁹⁴⁸ Exh. JX-1797, p. 9

¹⁹⁴⁹ Exh. JX-2190, pp. 16-24.

¹⁹⁵⁰ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 56.

Does the proposed activity involve a change to a structure, system or component that adversely affects a design function described in the Unit's UFSAR?

1945. In the Tribunal's view, Mr. Russell has provided a convincing case that following the screening criteria does not appear to result in a determination that the licensee is required to undertake a 10 CFR 50.59(c) evaluation to determine if a LAR is required. The Claimants' experts skipped this process in their initial report and provided a perfunctory single paragraph assessment in their rebuttal report.¹⁹⁵¹

1946. Mr. Strosnider and Mr. Leeds do, however, submit that:

The Type 1 Repair concept would not have satisfied the 50.59 criteria themselves, thus it is not logical to conclude that the approach would have "screened out" before even needing a full 50.59 evaluation.¹⁹⁵²

1947. The Tribunal concludes that while it is not evident that the SONGS Type 1 Repair would fail the 10 CFR 50.59(c) screening criteria, given the significance of in-plane FEI, the CAL, and the NRC interest in Unit 2, prudence would dictate that SCE would and should have also considered whether the proposed Type 1 Repair would have met the 10 CFR 50.59(c) requirements.

(iii) 10 CFR 50.59(c) Assessment

1948. Mr. Palmisano has testified, that during the repair era, SCE did not undertake an assessment of the 10 CFR 50.59(c) criteria for the proposed Type 1 Repair.¹⁹⁵³

1949. In this connection, Mr. Strosnider and Mr. Leeds opine that the Claimants could not have concluded the 10 CR 50.59(c) criteria was met:

¹⁹⁵¹ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 56.

¹⁹⁵² Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 56.

¹⁹⁵³ Transcript. p. 94 (Mr. Palmisano).

Given [the proposed Type 1 Repair] was [a] first of a kind, that the repair would not have brought the thermal-hydraulic conditions back into the range of industry-demonstrated acceptable performance, and that the repair risked new mechanisms of degradation, Edison could not have concluded that the 50.59 Criteria were met.¹⁹⁵⁴

1950. In particular, Mr. Strosnider and Mr. Leeds opine that criterion (i), (ii), (v) and (vii) of 10 CFR 50.59(c)(2) would not be met.¹⁹⁵⁵ To recall, these criterion are that the proposed repair should:

(i) Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final safety analysis report (as updated);

(ii) Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the final safety analysis report (as updated);

(v) Create a possibility for an accident of a different type than any previously evaluated in the final safety analysis report (as updated);

(vii) Result in a design basis limit for a fission product barrier as described in the FSAR (as updated) being exceeded or altered.

1951. Mr. Strosnider and Mr. Leeds have not elaborated as to how or why that is the case, merely noting that the Type 1 Repair “could have” “increased the frequency of an RSG tube rupture” or “tube leak,” created “the possibility of multiple tube failures,” or “resulted in levels of tube degradation that violated the acceptable stress levels” per the ASME.¹⁹⁵⁶

¹⁹⁵⁴ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 83.

¹⁹⁵⁵ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 83.

¹⁹⁵⁶ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 83.

1952. For the Respondents, Mr. Russell does not appear to substantially address whether the repair would fail to meet the 10 CFR 50.59(c) assessment, having determined that the same was not required under the above discussed five screening criteria. Mr. Strosnider and Mr. Leeds concur in this regard, opining that the Parties' experts "appear to agree that Edison would have needed a license amendment from the NRC in order to implement a Type 1 Repair."¹⁹⁵⁷

1953. Considering the above, the Tribunal concludes that had SCE undertaken a 10 CFR 50.59(c) evaluation, it appears that they would have concluded that a LAR was required.

(iv) No Significant Hazards Determination

1954. If a licensee determines that a LAR is required, it will concurrently request a "no-significant hazards" ("NSH") determination from the NRC under Section 10 CFR 50.92(c), which reads as follows:

(c) The Commission may make a final determination, under the procedures in § 50.91, that a proposed amendment to an operating license or a combined license for a facility or reactor licensed under §§ 50.21(b) or 50.22, or for a testing facility involves no significant hazards consideration, if operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or

(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) Involve a significant reduction in a margin of safety.

¹⁹⁵⁷ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 34.

1955. An NSH determination generally accompanies a LAR. As stated by Mr. Strosnider and Mr. Leeds, “in practice, we are not aware of any licensee having submitted a LAR to the NRR [i.e., Nuclear Reactor Regulation] staff when the licensee was unable to make a finding of no significant hazards.”¹⁹⁵⁸
1956. The consequence of a NSH determination is that the NRC staff, having evaluated the proposed LAR, can determine that the licensee may go ahead and perform the proposed operation prior to the occurrence of a public hearing. If an NSH determination is not granted, the NRC staff “cannot grant the amendment until completion of a public hearing.”¹⁹⁵⁹
1957. Mr. Strosnider and Mr. Leeds determine that the NRC would not have granted an NSH as “the repair concept was [a] first-of-a-kind and would not have brought the thermal-hydraulic conditions back into the range of industry demonstrate acceptable performance.” They also base their opinion on their understanding that “the repair concept risked introducing new degradation modes into the RSGs.”¹⁹⁶⁰
1958. For the Respondents, Mr. Russell opines that a NSH determination would have been granted on account of the three criteria under 10 CFR 50.92(c):¹⁹⁶¹

i. The first criteria is met as the thicker AVBs would “correct a non-conforming condition” and there would be no change in plant operations, design functions or changes to safety analysis that “verifies the capability of a system, structure or component to perform a design function;”

¹⁹⁵⁸ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 43.

¹⁹⁵⁹ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 44.

¹⁹⁶⁰ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 97.

¹⁹⁶¹ Thicker-AVB Repair Licensing Report of Mr. Russell, ¶ 38.

- ii. The second criteria is met as the thicker AVBs would increase the margin to instability by preventing in-plane FEI and hence “no significant increase in the probability that the tubes would fail or leak” during an operating cycle;
- iii. The third criteria is met as the thicker AVB repair imposes greater contact force on tubes that suffered from in-plane FEI such that the margin to instability is improved.

1959. In their rebuttal report, Mr. Strosnider and Mr. Leeds disagree that a NSH determination would be issued, as they find that the Type 1 Repair was inadequate as it did not “correct the adverse thermal hydraulic conditions” and it “had the potential to create additional and unintended modes of degradation.”¹⁹⁶² Mr. Strosnider and Mr. Leeds base their opinion in regard to the latter on the 30 May 2013 AREVA Report.¹⁹⁶³

1960. Accordingly, the assessment as to whether or not a NSH determination would be granted is based upon the technical evaluation as to whether or not a repair was required to address T/H conditions and whether AREVA’s concerns regarding new forms of degradation were addressed.

(v) Discretionary Hearing Risk

1961. Mr. Strosnider and Mr. Leeds testify, for the Claimants that regardless of the technical determinations of the NRC staff, there remained a risk that the NRC commissioners would order a discretionary hearing “based on the unique nature of

¹⁹⁶² Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 44.

¹⁹⁶³ Rebuttal Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶¶ 44-45.

the RSG tube degradation at SONGS and the level of public and congressional interest regarding restart of SONGS.”¹⁹⁶⁴

1962. The Tribunal concurs with the Claimants’ experts. The record indicates that there was a high level of public interest in SONGS (as described in Section XIV.C(b) below) and a high level of political interest as well.

(b) Likelihood of a Public Hearing

1963. While not entirely clear, the Tribunal notes that the ASLB decision itself appears to have granted FoE a public hearing request on the restart of Unit 3 even though SCE had yet to submit a restart plan for approval under the CAL.¹⁹⁶⁵
1964. In any event, given the ASLB’s findings regarding Unit 2, the Tribunal considers it likely that a Unit 3 repair plan would also have been subject to a legal challenge from Friends of the Earth.¹⁹⁶⁶ This would have caused a delay in a restart of Unit 3.
1965. This petition is likely to have been successful and resulted in the ASLB ordering a public hearing. The ASLB provided in an *obiter dictum* to the Unit 2 decision the following:

In this decision, we focus principally on Unit 2, because SCE has not yet submitted a “Unit 3 Return to Service Report.” However, because SCE concedes that the tube-to-tube wear in Unit 3 is “far more extensive and severe” than in Unit 2 [citation removed], our conclusion on the first referred issue [cross reference removed] would perforce apply to Unit 3 if SCE sought to restart it without a license amendment.¹⁹⁶⁷

¹⁹⁶⁴ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 57.

¹⁹⁶⁵ Exh. JX-1777, p. 38.

¹⁹⁶⁶ Friends of the Earth is an NGO group that launched the administrative actions resulting in the ASLB decision.

¹⁹⁶⁷ Exh. JX-1777, p. 10.

1966. The Respondents' NRC expert, Mr. Johnson has identified various regulatory machinery that could be operated to mitigate the likelihood of a public hearing.¹⁹⁶⁸ Nonetheless, the Tribunal considers that either the ASLB already ordered a public hearing for the restart of Unit 3 or finds the likelihood of a public hearing being ordered to have been particularly high.
1967. However, and as will be further discussed in Issue C.3(d) of the List of Issues,¹⁹⁶⁹ the Tribunal considers that it is the Claimants who bore the risk of public hearings and any associated delay to the restart of Unit 3 since SCE is the utility subject to regulation.

(c) **Regulatory Timelines**

1968. The Parties' regulatory experts are significantly diverged as to how long it would take for a potential review of a LAR and, if ordered, a public hearing. This Issue is of particular concern in weighing whether a repair or replacement could be carried out "with dispatch" as required under Section 1.17.3 of the RSG Contract. Who bears the risk of these regulatory delays is addressed in Section XV.C(k) below.
1969. Mr. Strosnider and Mr. Leeds, the Claimants' experts estimate the following timelines for a repair:
- i. SCE would require 3 to 12 months to draft a LAR;
 - ii. NRC would require 1 to 3 months to accept LAR;
 - iii. NRC would require 24 to 30 months to review LAR; and

¹⁹⁶⁸ See generally Expert Witness Statement of Mr. Johnson; Rebuttal Expert Witness Statement of Mr. Johnson.

¹⁹⁶⁹ See XV.C(k)(iii) below.

iv. Public hearings would take 17 to 33 months.¹⁹⁷⁰

1970. Mr. Russell, for the Respondents, provides the following timeline, based upon the hypothetical that SCE had provided a green light to move forward with a Type 1 Repair option in the summer of 2012:

i. By 31 December 2012, SCE drafts a LAR;

ii. By 9 January 2013, NRC notifies its acceptance of the LAR; and

iii. By 31 May 2013, NRC issues a NSH determination.¹⁹⁷¹

1971. Thus, under the Claimants' perspective, some three to six years would be required to review a Type 1 Repair, following which that repair would be rejected, while under the Respondents' perspective, SONGS could have been restarted by 1 June 2013, on account of the repair being implemented while the LAR was under review.

1972. The major differences between the Parties and their respective experts are threefold, (i) whether repair and review efforts could proceed in tandem; (ii) how long the NRC would take for its review; and (iii) and the length of a public hearing.

1973. The Respondents' expert, Mr. Russell, opines that SCE and MHI could have carried out the physical repair while the NRC was undertaking its review.¹⁹⁷² That is, NRC approval is only required to approve the restart post-repair, not the repair itself. The Claimants submit that this is a "risky" proposition. Foreshadowing this concern, Mr. Russell also opines that had SCE waited, this would have extended the repair period by six weeks.

¹⁹⁷⁰ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 107.

¹⁹⁷¹ Thicker-AVB Repair Licensing Report of Mr. Russell, p. 26.

¹⁹⁷² Thicker-AVB Repair Licensing Report of Mr. Russell, p. 23.

1974. However, the Respondents rely on their expert, Mr. Russell, who opines that the NRC would have taken three months to review the LAR. This contrasts with the two to two and a half years that Mr. Strosnider and Mr. Leeds, for the Claimants, opine is required.
1975. The NRC's internal goals are to review 95% of LARs within 12 months and 100% within 24 months.¹⁹⁷³ Mr. Strosnider and Mr. Leeds opine that a longer period would be required on account of the Type 1 Repair being complex and a first of a kind proposal, which did not address the T/H conditions.¹⁹⁷⁴ Mr. Strosnider and Mr. Leeds refer to a number of examples where the LAR review process exceeded the usual 12 month timeline.¹⁹⁷⁵ In these examples, a repair appears to have been proposed in a situation where the condition being repaired was a primary barrier or component that was leaking, bursting, or cracking.
1976. The Tribunal is not convinced that the NRC would require such an extensive period of time to review an LAR for a Type 1 Repair, as submitted by the Claimants. The NRC had become familiar with SONGS through the CAL Response for Unit 2. The NRC would have been aware that apparent better restraints from the AVBs in Unit 2 prevented FEI from occurring and the risks of FEI were reviewed by the NRC for Unit 2. In addition, the NRC had previously conducted the October 2012 site visit to MHI's facilities in Japan where NRC officials reviewed the repair mockup and sought answers to a number of questions they had regarding the mockup. Therefore, while there is no dispute that in-plane FEI was a first of a kind phenomenon, the Tribunal is not convinced that the proposed thicker AVB repair, while being a first-

¹⁹⁷³ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 45.

¹⁹⁷⁴ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 45.

¹⁹⁷⁵ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, Appendix B.

of-a-kind, is so distinct as to exceed the capacity of the NRC to conduct a review within a 12 month timeframe.

1977. Accordingly, the Tribunal considers that the NRC could have conducted a review within its usual twelve month time period.
1978. Regarding the likelihood of public hearings, the Tribunal is convinced by the Respondents' evidence that a no significant hazards determination could have been granted in regard to a Type 1 Repair. As such, under normal circumstances, the repair could have been carried out prior to a public hearing process. However, the Tribunal's determination on this hypothetical is rendered moot on account of the ASLB, which the Tribunal considers would have also granted a public hearing request had the Friends of the Earth sought one on Unit 3.

D. REPLACEMENT UNDER THE RSG CONTRACT

1979. As discussed above,¹⁹⁷⁶ in December 2012, MHI proposed a replacement of the RSGs.¹⁹⁷⁷ Following this proposal, SCE declared MHI to be in breach of the warranty provisions of the RSG Contract, as a replacement was not a repair with "due diligence and dispatch" as required by Section 1.17.1.3 of the RSG Contract.¹⁹⁷⁸
1980. The Tribunal considers the RSG Contract as one that includes within its scope the replacement of the RSGs. Section 1.17.1.3 of the RSG Contract states "[a]ny Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner, by the Supplier at its sole expense with due diligence and dispatch by repairing or replacing (as appropriate) any defective

¹⁹⁷⁶ Section VII.G(i) above.

¹⁹⁷⁷ Exh. JX-1571.

¹⁹⁷⁸ Exh. JX-1608.

part and other portion of the Work affected by such Defect. Supplier shall be responsible for all costs and expenses associated with such repair or replacement (...)” (underline added).¹⁹⁷⁹ Section 1.2.4 of the RSG Contract defines the “Apparatus” in the plural as “the RSG Units.”

1981. While neither Party foresaw the requirement to replace two or four RSGs as a likely scenario, the unambiguous wording of the RSG Contract provides for this possibility.
1982. A replacement would take approximately five years at a cost of several hundred million,¹⁹⁸⁰ exceeding the liability cap set at the purchase price of the RSGs.¹⁹⁸¹ The Tribunal agrees with the Claimants that, as a factual matter, an outage spanning a period of five years does not, in typical situations, constitute a repair with dispatch.¹⁹⁸² However, the Tribunal, as a question of contractual interpretation, considers that a repair with due diligence and dispatch is to be interpreted relative to the task being undertaken. As the RSG Contract provides for the replacement of the entire Apparatus, whether that replacement is done with dispatch must be weighed as a relative, and not an absolute, matter.
1983. However, any action on Unit 3 required, as a practical matter, that the Unit 2 RSGs receive permission to restart such that SONGS would be generating electricity and revenue. This process was curtailed by the decision of the NRC ASLB.

¹⁹⁷⁹ Section 1.17.1.3 goes on to provide that “...Supplier shall be responsible for all costs and expenses associated with such repair or replacement, including but not limited to (i) any necessary adjustments, modifications, change of design, removal, repair, replacement or installation of the Apparatus....”

¹⁹⁸⁰ Exh. JX-1610.

¹⁹⁸¹ RSG Contract, Section 1.21.2.

¹⁹⁸² Exh. JX-1608.

E. SHUTDOWN DECISION

1984. On 7 June 2013, 25 days after the ASLB decision, SCE and its parent company Edison International (EIX) announced the decision to retire SONGS.¹⁹⁸³
1985. The Tribunal considers that SCE and EIX acted reasonably in this regard. The considerable uncertainties of a public hearing for Unit 2, in combination with the effect of a long-term shutdown on SCE's rate base and the regional electrical grid, required that a commercial decision be made to shutdown SONGS.

XV. WARRANTY & REPAIR/REPLACEMENT (ISSUE C)

1986. A primary determination under Issue B was whether the Respondents' failure to meet their obligations to correctly predict the potential for tube wear (Issue B.4(b) above)¹⁹⁸⁴ triggered the Respondents' warranty obligations under Section 1.17.3 of the RSG Contract. The consequences of this determination are addressed in Issue C below.

A. DID MITSUBISHI DELIVER RSGs THAT WERE FREE FROM DEFECTS, AS DEFINED IN THE RSG CONTRACT? (ISSUE C.1)

1987. This Issue C.1 concerns the question whether Mitsubishi delivered RSGs that were free from Defects, as defined in the RSG Contract. The Claimants submit that the Respondents delivered RSGs that contained Defects, as defined in the RSG Contract, in violation of Section 1.17 of the RSG Contract.

(i) The Claimants' Position

1988. In their Responses to the Joint List of Issues, the Claimants submit the following:

Pursuant to the RSG Contract, "Defect" covers any work that, among other things, "does not conform to the requirements of the Purchase Order," "is not

¹⁹⁸³ Exh. JX-1815.

¹⁹⁸⁴ See Section XIII.D(b) above.

free from defects or deficiencies in design, application, materials, manufacture, or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order.”

Respondents’ RSGs did not meet the promised design, manufacturing and performance parameters—all of which constitute a Defect. Claimants’ Warranty claims focused on these Defects to the extent they resulted [in] FEI that led to a tube breach and leak of radioactive coolant.

The RSG Contract also states that “Defect” includes work that “would adversely affect...the performance[,] ... the continuous safe operation[,] ... and the structural integrity” of the steam generators, as well as any work that “does not conform to the Applicable Standards or Applicable Laws.”

Therefore, the extreme thermal-hydraulic conditions, uncontrolled (and unanticipated) vibration, and tube leak that adversely affected the performance of the RSGs were Defects in and of themselves. These Defects rendered the RSGs structurally unstable and unfit for operation under conditions contemplated and agreed by the parties.¹⁹⁸⁵

1989. Further, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents claim that “Claimants presented no evidence that the RSGs, as delivered, contained Defects or failed to conform to Edison’s specifications.” Without question, Respondents’ position lacks foundation. Respondents warranted that the RSGs would be “free from Defects.” “Defect” broadly covers any Work that “does not conform to the requirements of the Purchase Order” or that “is not free from defects or deficiencies in design, application, materials, manufacture or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order.” “Defect” also includes Work that:

would adversely affect, contrary to the requirements of the Purchase Order, (a) the performance of the Apparatus under operating conditions consistent with those contemplated in the Purchase Order, (b) the continuous safe operation of the Apparatus during the Apparatus’s design life, or (c) the structural integrity of the Apparatus.

¹⁹⁸⁵ Claimants’ Responses to Joint List of Issues, ¶ C.1.

“Defect” also includes work that “does not conform to the Applicable Standards or Applicable Laws.”

The material facts are undisputed: a tube in Unit 3 leaked radioactive coolant, and eight tubes failed in-situ pressure testing—an unprecedented occurrence in the U.S. nuclear industry. Both Units experienced both in-plane FEI and out-of-plane FEI. More than 3,400 tubes showed indications of severe wear after operating for just one cycle or less. The RSGs experienced four separate types of tube wear—including tube-to-tube wear in both Units. As Respondents’ expert Dr. Begley previously stated, the SONGS RSGs were “the worst case degraded steam generator[s] in the history of domestic nuclear power.” Such facts stand in stark contrast to, and cannot be reconciled with, Respondents’ baseless claim that there is “no evidence” that the RSGs contained Defects.

Respondents delivered defective RSGs by, among other things, failing to:

- supply RSGs that were “free from defects or deficiencies in design, application, materials, manufacture or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order;”
- supply RSGs that performed consistently with the operating conditions as contemplated in the Purchase Order, operated safely, and maintained structural integrity;
- supply RSGs with a service life of 40 calendar years from the date of startup following their installation;
- supply RSGs that did not require parts or component replacement for their full design life of 40 years;
- supply RSGs equipped with tube supports that adequately supported the tube bundle;
- supply RSGs equipped with tube supports that minimized tube wear;
- supply RSGs equipped with tube supports that precluded tube damage caused by flow-induced vibration;
- address flow-induced and turbulence-induced vibration of the tube supports to demonstrate that fatigue failures and excessive fretting and wear of the tubes would not occur;

- ensure uniform tube-to-AVB gaps;
- demonstrate that its design minimized vibration-induced tube wear and fatigue in the U-bend;
- fabricate and assemble the tube bundle and supports in such a way as to ensure subsequent operation of the RSGs with minimal vibration;
- perform an accurate stability analysis of the tubes;
- accurately document the thermal-hydraulic aspects of the tube support design in the Performance Analysis Report;
- accurately document the code aspects of the tube support design in the Certified Design Report;
- deliver an RSG design that was licensable;
- provide RSGs that complied with Applicable Laws, Applicable Standards and the other terms, conditions and requirements of the RSG Contract;
- comply with all the applicable provisions of U.S. legal and professional codes, including American Society of Mechanical Engineers (“ASME”) Boiler and Pressure Vessel Code Section III; and
- supply RSGs that experienced no primary-to-secondary leakage under normal operating conditions.¹⁹⁸⁶

(ii) The Respondents’ Position

1990. In their Position Statement on the Revised List of Issues, the Respondents contend that they “[acknowledge] that the Specification defines “Defect” very broadly. But Claimants presented no evidence that the RSGs, as delivered, contained Defects or failed to conform to Edison’s specification. Edison tested and accepted the RSGs upon delivery.”¹⁹⁸⁷

¹⁹⁸⁶ Claimants’ RPHM, ¶¶ 225-227.

¹⁹⁸⁷ Respondents’ Position Statement on the Revised List of Issues, ¶ 205.

(iii) Tribunal's Determination

1991. Before considering the question of whether Mitsubishi delivered RSGs that were free from Defects as defined in the RSG Contract, the Tribunal finds it necessary to address a preliminary matter in dispute between the Parties.
1992. Thus, the Tribunal will first deal with the question of whether this Issue C.1 should be interpreted narrowly, as submitted by the Respondents, to focus on whether the RSGs were free from Defects at the time of delivery, or broadly, as contended by the Claimants, to determine whether there were Defects at all.
1993. The Tribunal rejects the Respondents' narrow focus on whether the RSGs were "delivered" free from Defects as the Tribunal considers the principal question in Issue C to be whether there was a Defect in the RSGs, not whether that defect was present at the time of delivery or developed over time.
1994. In order to determine whether Mitsubishi delivered RSGs that were free from Defects, as defined in the RSG Contract, the Tribunal first recalls that a major problem of the RSGs, as determined above,¹⁹⁸⁸ concerns the fact that in-plane FEI occurred, at least in part, on account of inadequate in-plane tube support from the AVBs.
1995. At the Hearing, the Tribunal inquired with the Claimants what the Defect in this case was. The Claimants submitted that the Defect constituted "unprecedented tube wear which ultimately, of course, led to a radioactive leak."¹⁹⁸⁹ The Tribunal considers it pertinent to cite at length from the Claimants' submission in this regard:

THE PRESIDENT: Mr. Wald, could you help me here?

¹⁹⁸⁸ See Section XIII.F(d) above.

¹⁹⁸⁹ Transcript, p. 5141 (Counsel).

MR. WALD: Yes.

THE PRESIDENT: Step back. What's the defect here in this case?

MR. WALD: We would say unprecedented tube wear which ultimately, of course, led to a radioactive leak.

THE PRESIDENT: Tube wear is the Defect, with capital "D."¹⁹⁹⁰

1996. The Claimants' submissions as to what the Defect is in this case at the Hearing parallels their submission as to the Defect emphasized in their Memorial, i.e., "excessive and extensive vibration and wear:"

"Defect" is broadly defined in Section 1.2.13 of the RSG Contract. Any part of the RSG design that "does not conform to the requirements" of the RSG Contract is defective. Any condition that would "adversely affect" the "performance" of the RSGs, the "continuous safe operation" of the RSGs, or the "structural integrity" of the RSGs, among other things, is considered a "Defect" under the Contract. Mitsubishi does not dispute that the RSGs suffered from serious defects. As discussed above, contrary to the provisions of the RSG Contract, Mitsubishi's FIT-III computer code was not properly validated for use with the RSG design, and Mitsubishi's tube support structures were inadequate to prevent excessive vibration and wear. Unit 3 experienced a breach of the reactor coolant pressure boundary and a primary-to-secondary leakage, a result of degraded structural integrity which necessitated shut down and which prevented continuous safe operation. The excessive and extensive vibration and wear throughout all four RSGs adversely affected the performance of both Units 2 and 3, required an extended safety outage, prevented a timely repair, and ultimately culminated in the permanent retirement of the plant.¹⁹⁹¹

1997. In order to determine whether the inadequate in-plane tube support from the AVBs, as determined in addressing Issue B.4(b),¹⁹⁹² would constitute a basis for determining

¹⁹⁹⁰ Transcript, p. 5141.

¹⁹⁹¹ Cl. Memorial, ¶ 349.

¹⁹⁹² See Section XIII.D(b) above.

that the Respondents delivered RSGs with a Defect, as defined in the RSG Contract, requires analysis of the definition of Defects under Section 1.2.13 of the RSG Contract. This Section provides as follows:

Defect: Work that (i) does not conform to the requirements of the Purchase Order, (ii) is not new as of the date of delivery or of uniform good quality as required pursuant to the Purchase Order, (iii) is not free from defects or deficiencies in design, application, materials, manufacture or workmanship, or that contain improper or inferior workmanship contrary to the requirements of the Purchase Order, or (iv) would adversely affect, contrary to the requirements of the Purchase Order, (a) the performance of the Apparatus under operating conditions consistent with those contemplated in the Purchase Order, (b) the continuous safe operation of the Apparatus during the Apparatus's design life, or (c) the structural integrity of the Apparatus and/or (v) are not suitable for the use as set forth in the Purchase Order; provided that (i) if Supplier fails to satisfy a Guaranteed Performance Level, such failure shall not be considered a Defect provided Supplier has paid the liquidated damages applicable to such Guaranteed Performance Level for such failure, and/or (ii) cosmetic changes in appearance over time shall not be considered a Defect. Anything to the contrary notwithstanding, the Parties agree that Work shall be considered to be defective if it does not conform to the Applicable Standards or Applicable Laws.

1998. Considering the definition of Defect under the RSG Contract, the Tribunal considers that in-plane FEI “adversely affect[s], contrary to the requirements of the [RSG Contract] (...) the continuous safe operation of the Apparatus during the Apparatus’ design life” and “the structural integrity of the Apparatus.” In-plane FEI, as is evident from the Incident in the Unit 3 RSG, is destructive and can lead to tube leaks.
1999. In their Reply PHM submissions, the Claimants have further particularized what constitutes a Defect in this case.¹⁹⁹³ The Claimants list 18 alleged defects, which generally correspond with the alleged contractual breaches considered in Issue B.

¹⁹⁹³ See ¶ 1989 above.

The Claimants established that Defect(s) triggered the Respondents' Warranty obligations under Section 1.17.1.3 of the RSG Contract.

2000. The Tribunal determined that the Claimants have shown that the Respondents failed to meet the contractual obligations under Issue B.6(c) regarding tube support,¹⁹⁹⁴ Issue B.6(d) regarding provisions of U.S. legal and professional codes,¹⁹⁹⁵ and Issue B.6(e) regarding primary to secondary side leakage.¹⁹⁹⁶
2001. However, the Tribunal considers that not all of the Claimants' alleged Defects constitute Defects under the RSG Contract.
2002. Issue B.6(e),¹⁹⁹⁷ regarding "primary to secondary leakage," does not constitute a Defect, as defined in the RSG Contract. As Section 1.2.13 of the RSG Contract provides, failure "to satisfy a Guaranteed Performance Level" "shall not be considered a Defect provided Supplier has paid the liquidated damages applicable." Section 1.16.5.7 of the RSG Contract, in turn, identifies the avoidance of "primary-to-secondary leakage" as a Guaranteed Performance Level. In consequence, to the extent that MHI pays the associated liquidated damages of \$1.4 million, this does not constitute a Defect:

Upon detection by Edison of any detectable primary to secondary leak, the Supplier shall pay one million four hundred thousand (\$1,400,000) U.S. dollars per RSG for each such leak that requires a SONGS unit to shut down on a forced outage basis.¹⁹⁹⁸

¹⁹⁹⁴ See ¶ 1634 above.

¹⁹⁹⁵ See ¶ 1645 above.

¹⁹⁹⁶ See ¶ 1651 above.

¹⁹⁹⁷ Section XIII.F(f) above.

¹⁹⁹⁸ RSG Contract, Section 1.29.2.1.

2003. In light of the above, the Tribunal answers Issue C.1 in the negative. Accordingly, the RSGs are not free from Defects, as defined in the RSG Contract.
2004. Considering that the Tribunal has found that the Claimants have established the existence of Defect(s) under the RSG Contract,¹⁹⁹⁹ it is not necessary to determine whether every one of the eighteen particularized Defects in the Claimants' RPHM submission constitutes a Defect or not.
2005. The Tribunal considers it pertinent to briefly address the Claimants' submissions, at the Hearing, as to the consequences of the Defect they identified in this case. The above cited passage,²⁰⁰⁰ continues:

THE PRESIDENT: Tube wear is the Defect, with capital "D." Then the next step is now you have to define what is then the root cause of this and, as we understand it, there are two analyses, insufficient supports and thermal-hydraulic conditions that are extreme. If, then, a repair is being offered that says -- at least this is what Respondents say -- we can alleviate the problem concerning the tube wear by adding supports, then the defects are not solved at that point in time?

MR. WALD: We would say that the conformance to the Contract requires them to deliver the thermal-hydraulic conditions that they promised, precisely because of the uncertainty about whether or not this was going to work and restore the 40-year life.

THE PRESIDENT: Leaving that aside, assuming that it works with the supporting AVBs -- I am not expressing an opinion on this but assuming that works and the wear comes back within normal acceptable ranges, what's then the problem?

MR. WALD: That's a large assumption, Mr. President -- understood. And here's my problem with it: 1.17.1.3 says that Mitsubishi needs to make the case to the satisfaction of the buyer that the problem -- that there won't

¹⁹⁹⁹ See ¶ 2000 above.

²⁰⁰⁰ See ¶ 1995.

be a risk of reoccurrence, and when you combine that with the promise to deliver a particular package of thermal-hydraulic conditions, our submission is that we are entitled under the contract to insist that those thermal-hydraulic conditions be delivered to us precisely so that we don't have the risk of reoccurrence. In other words, your hypothetical is, in a sense, static. It assumes that you fix a problem and it's done. And what we're talking about here is the risk over 40 years that these problems will reoccur.

THE PRESIDENT: I see the issue about whether or not it can be demonstrated that it will not reoccur. That's a separate issue. But once they have said, look, we have a repair here, assume this is the repair, and we can demonstrate that it will work and will not reoccur. Would that then solve the problem?

MR. WALD: In our submission, Mr. President, we are entitled under the Contract and under the PAR to a particular set of thermal-hydraulic conditions, which is what we bargained for. And we bargained for them for a reason, which was to reduce, to the maximum extent possible, the uncertainty that these kinds of problems would reoccur.

THE PRESIDENT: But there are two things that enter, then, into the equation, if I may call it that way. One is what are the specifications of the Contract, is that Table 3-A or is it also what is defined in the Performance Analysis Report? That is one thing. The other question is what about the safety margin, the margin of safety, that we need a conservative plan. If you go back to my hypothetical, then I wonder whether that is the approach or not.

MR. WALD: Well, on its own terms, of course, Mr. President, you appreciate that we don't believe that they demonstrated the viability. But yes, I would say that there are two different ways that our case is demonstrated. One, because they didn't demonstrate the technical viability, the licensability and the timeliness of the Type 1 repair, and, 2, because the Type 1 repair does not restore the thermal-hydraulic conditions to the level that was promised, and what we were buying was protection against these risks.²⁰⁰¹

²⁰⁰¹ Transcript, pp. 5142-5145.

2006. The Tribunal notes from the above passage that (i) the Defect in this case is the tube wear and associated leak; (ii) in resolving this Defect, the Claimants considered it paramount that a repair provide certainty as to the duration of the repair; and (iii), in the Claimants submission, the means that certainty was to be achieved was the return of T/H conditions to those allegedly bargained for, as provided in the PAR. The Tribunal emphasizes that there is a distinction between the Defect and the Claimants' desired remedy of that Defect. There is a further distinction between a repair which addresses the problem in the now and then (what the Claimants may characterize as an interim repair) and the question of whether that repair is effective in the long term.

(b) If not, is such failure a breach of the RSG Contract's warranty? (Issue C.1(a))

2007. This Issue C.1(a) is a follow-up question to Issue C.1 of whether if Mitsubishi did not deliver RSGs free from Defects, such failure is a breach of the RSG Contract's warranty.

(i) The Claimants' Position

2008. In their Responses to the Joint List of Issues, the Claimants submit that "[i]n section 1.17.1 [of the RSG Contract], Mitsubishi "warrants that the Apparatus shall be free from Defects" for a period of at least 20 years. As described above in C.1(a), Respondents failed to do this in several respects causing multiple Defects, thereby breaching the warranty."²⁰⁰²

2009. Further, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents claim that the "existence of a Defect during operation does not constitute a breach of warranty but rather triggers Mitsubishi's warranty obligations." Such a claim runs counter to the express language of the RSG

²⁰⁰² Claimants' Responses to Joint List of Issues, ¶ C.1(a).

Contract. In Section 1.17.1, Respondents “warrant[ed] that the Apparatus shall be free from Defects” for a period of at least 20 years. Moreover, the warranty prescribes that the remedy for breach of the warranty is repair or replacement of the RSGs. (...) [T]he RSGs contained multiple Defects, and thus Respondents breached the warranty by failing to deliver RSGs “free from Defects.”²⁰⁰³

(ii) The Respondents’ Position

2010. In their Position Statement on the Revised List of Issues, the Respondents contend that “[t]here was no Defect at the time of delivery of the SONGS RSGs. The existence of a Defect during operation does not constitute a breach of warranty but rather triggers Mitsubishi’s warranty obligations. In the context of a repair situation, to be an actionable breach of warranty Claimants must show that Mitsubishi breached its obligation to repair or replace a Defect that caused it damages. Any other failure to correct a Defect is a technical breach that has no consequence. In this case, Mitsubishi discharged its warranty obligations and/or was excused from further performance as a result of Edison closing the plant and refusing to give reasonable consideration to Mitsubishi’s proposed repair and replacement options.”²⁰⁰⁴

(iii) Tribunal’s Determination

2011. In Issue C.1 above, the Tribunal considered that the RSGs have Defects, as defined in the RSG Contract. Therefore, the Tribunal is required to determine whether such failure is a breach of the RSG Contract’s warranty. In this respect, Section 1.17.1.3 of the RSG Contract is of relevance. It provides as follows:

Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner, by the Supplier at its sole expense with due diligence and dispatch by

²⁰⁰³ Claimants’ RPHM, ¶ 228.

²⁰⁰⁴ Respondents’ Position Statement on the Revised List of Issues, ¶ 206.

repairing or replacing (as appropriate) any defective part and other portion of the Work affected by such Defect

2012. The Tribunal considers that the contractual mechanism was such that any Defect would trigger the Respondents' warranty obligations. However, a distinction should be made between a Defect and breach of a warranty obligation. While a Defect triggers the warranty obligations, it does not, in and of itself, *per se*, breach the warranty provision of Section 1.17.1. Once the warranty obligations are triggered by a Defect, the question arises whether the party providing the warranty complies with its warranty obligations, which question is addressed in the next Issues C.2 and C.2(a).
2013. Accordingly, the Tribunal answers Issue C.1(a) in the negative, that the failure to deliver the RSGs with a Defect, as defined in the RSG Contract, does not constitute in and of itself a breach of the RSG Contract's warranty.

B. DID MITSUBISHI FAIL TO REPAIR OR REPLACE THE RSGS IN A MUTUALLY AGREEABLE MANNER WITH DUE DILIGENCE AND DISPATCH? (ISSUE C.2) IF SO, IS SUCH FAILURE A BREACH OF THE RSG CONTRACT'S WARRANTY? (ISSUE C.2(A))

2014. Issues C.2 and C.2(a) concern the question of whether Mitsubishi failed to repair or replace the RSGs in a mutually agreeable manner with due diligence and dispatch and, if so, whether such failure is a breach of the RSG Contract's warranty.
2015. The Claimants submit that the Respondents failed to repair or replace the defects in the RSGs in a mutually agreeable manner with due diligence and dispatch. The Respondents rebut that the Claimants failed to provide them with an opportunity to perform their recommended repair.

(i) The Claimants' Position

2016. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi failed to repair or replace the RSGs with due diligence and dispatch. Indeed, Mitsubishi failed even to develop a viable proposal for repair for more than 16 months after the Unit 3 tube leak caused SONGS to cease operations.”²⁰⁰⁵

2017. In addition, in their C-RPHM, the Claimants submit the following:

Respondents also warranted that, if any Defects were to occur, the RSGs would be “repaired or replaced, in a mutually agreeable manner, by [Mitsubishi] at its sole expense with due diligence and dispatch” Contrary to their claim, and as discussed in detail below, Respondents failed to fulfill their promise. Indeed, Respondents were nowhere near developing a viable repair—much less with “due diligence and dispatch”—by the time SONGS was shut down 16 months after the failures.

(...)

[A]s of June 2013, Respondents had failed to develop a viable repair plan or demonstrate that the repair would correct the cause of the RSG failures, prevent the risk of new modes of failure, and be acceptable to the NRC. Claimants’ expert Jack Strosnider testified that the NRC’s technical review of the Type 1 Repair proposal would have taken 24-30 months. More significantly, Mr. Strosnider and Mr. Leeds concluded that, after completing its technical review, the NRC would not have accepted the LAR. In total, development of an LAR and regulatory review would have likely taken over 8 years, on top of the year-and-a-half Respondents spent considering repair options—with no likelihood of success.²⁰⁰⁶

2018. Further, with respect to Issue C.2(a), i.e., “[i]f so, is such failure a breach of the RSG Contract’s Warranty?,” the Claimants submit that “[t]he warranty provides that if any defects were to occur, the RSGs would be “repaired or replaced, in a mutually

²⁰⁰⁵ Claimants’ Responses to Joint List of Issues, ¶ C.10.

²⁰⁰⁶ Claimants’ RPHM, ¶¶ 229-230.

agreeable manner, by [Mitsubishi] at its sole expense with due diligence and dispatch....” Respondents breached this promise.”²⁰⁰⁷

2019. In response to the Respondents’ submissions, in their C-RPHM, the Claimants contend that “[c]ontrary to their claims, and as discussed in detail below, Respondents’ failure to repair or replace the RSGs in a mutually agreeable manner with due diligence and dispatch and at their sole expense constitutes a breach of the RSG Contract’s Warranty.”²⁰⁰⁸

(ii) The Respondents’ Position

2020. In their Position Statement on the Revised List of Issues, the Respondents contend that “[i]t is undisputed that, with the exception of minor repairs to assist with short-term operation, the SONGS RSGs were not repaired or replaced in a mutually agreeable manner prior to their permanent shutdown. However, the obligation of mutual agreement means that Mitsubishi could not unilaterally repair the RSGs. Mitsubishi acted in accordance with its obligations to act with “due diligence and dispatch” and tendered viable repair and replacement options to Edison. Edison unreasonably refused to implement those options, thereby excusing Mitsubishi’s further performance.”²⁰⁰⁹
2021. Further, with respect to Issue C.2(a), i.e., “[i]f so, is such failure a breach of the RSG Contract’s Warranty?,” the Respondents submit that “[b]ecause Mitsubishi acted with due diligence and dispatch until Edison made the unilateral decision to reject Mitsubishi’s viable repair or replacement options and shut the plant down, Mitsubishi did not breach the RSG Contract’s Warranty even though no repair or replacement was implemented at SONGS. Because the RSG Contract required “mutual

²⁰⁰⁷ Claimants’ Responses to Joint List of Issues, ¶ C.10(a).

²⁰⁰⁸ Claimants’ RPHM, ¶ 231.

²⁰⁰⁹ Respondents’ Position Statement on the Revised List of Issues, ¶ 207.

agreement,” whether or not a repair or replacement was actually implemented cannot be the standard to evaluate whether Mitsubishi breached its warranty obligations. In addition, Edison had an obligation to act in an objectively reasonable manner if it determined to withhold its “mutual agreement.” It did not do so.”²⁰¹⁰

(iii) Tribunal’s Determination

2022. The record shows that the RSGs were not repaired or replaced following the Incident. Rather, such repair or replacement efforts were interrupted by the ASLB decision and the subsequent decision of SCE to shutdown SONGS.²⁰¹¹
2023. The Tribunal considers that the Respondents were acting with due diligence and dispatch during the course of the repairs for the following reasons.
2024. As determined by the Tribunal above,²⁰¹² the Tribunal considers that the term “dispatch” must be granted a relative interpretation that varies in accordance with the repair or replacement efforts being undertaken.
2025. Despite acting with due diligence and dispatch, the repair efforts on Unit 3 were halted following the ASLB decision regarding Unit 2. No repair was completed prior to this shutdown decision.
2026. Accordingly, the Tribunal answers Issue C.2 in the affirmative that the Respondents failed to repair or replace the RSGs in a mutually agreeable manner as SONGS was permanently shutdown prior to a repair or replacement having been implemented.
2027. The Tribunal will consider Issue C.2(a) in the following Issues.

²⁰¹⁰ Respondents’ Position Statement on the Revised List of Issues, ¶ 208.

²⁰¹¹ Sections VII.G(n)(i) and VII.G(o) above.

²⁰¹² See ¶ 1982 above.

C. REGARDING MITSUBISHI’S PROPOSED REPAIR: (ISSUE C.3)

- (a) **Was Mitsubishi obligated to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” of the Defect or alternatively, demonstrate that the problem(s) would not recur, as required in RSG Contract Section 1.17.1.3(c)? (Issue C.3(a))**

2028. This Issue C.3 deals in general with the Respondents’ proposed repair. Issue C.3(a), in particular, concerns the question of whether Mitsubishi was obligated to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” of the Defect, or, alternatively, demonstrate that the problem(s) would not reoccur, as required in Section 1.17.1.3(c) of the RSG Contract.

2029. The Parties disagree as to the extent of the repair required under the RSG Contract.

(i) The Claimants’ Position

2030. In their Responses to the Joint List of Issues, the Claimants submit the following:

The RSG Contract is clear:

If Supplier is obligated to repair or replace the Apparatus or any part thereof under this section 1.17, “Supplier *will undertake a technical analysis* of the problem and *correct the ‘root cause’* unless Supplier can *demonstrate* to the Edison Representative’s satisfaction that *there is not a risk of the reoccurrence* of such problem.”

To meet its contractual obligations, Mitsubishi had to undertake a technical analysis and demonstrate that it’s repair would correct the root cause of *any* Defect—*i.e.* bring it in conformance with the contract—or demonstrate to the Edison’s representative’s satisfaction that even if it did not conform to the contract, the problem would not recur. In essence, this provision protected Edison from repairs that would not cure any or all Defects or, alternatively,

provided an avenue for Mitsubishi to present a repair that would solve the problem.²⁰¹³

2031. In response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that the "Respondents do not dispute their obligations to undertake a technical analysis of the problem and to correct the "root cause" or, alternatively, demonstrate that the problem(s) would not recur. (...) Respondents were required to restore the RSGs to their promised 40-year life. As Respondents' expert Mr. Olszewski testified, a vendor must "fix the problem and make sure it doesn't reoccur," and a "customer should not approve a repair that doesn't resolve the root cause." To meet its obligations, Respondents were required to act with "due diligence and dispatch."²⁰¹⁴

(ii) The Respondents' Position

2032. In their Position Statement on the Revised List of Issues, the Respondents contend that "Mitsubishi's obligations in the event of a Defect are enumerated in the RSG Contract. Mitsubishi was contractually required to: (1) perform a technical analysis of the problem; (2) correct the "root cause" unless it satisfied Edison that there was not a risk of the problem recurring; (3) act with "due diligence and dispatch"; and (4) warrant the repair for the remainder of the Warranty Period."²⁰¹⁵

(iii) The Tribunal's Determination

2033. The Parties are agreed that the Respondents' obligations in relation to this Issue C.3(a) are set out in Section 1.17.1.3(c) of the RSG Contract, which reads as follows:

If Supplier is obligated to repair or replace the Apparatus or any part thereof under this Section 1.17, Supplier will undertake a technical analysis of the problem and correct the "root cause" unless Supplier can

²⁰¹³ Claimants' Responses to Joint List of Issues, ¶ C.11(a).

²⁰¹⁴ Claimants' RPHM, ¶¶ 232-233.

²⁰¹⁵ Respondents' Position Statement on the Revised List of Issues, ¶ 209.

demonstrate to the Edison Representative's satisfaction that there is not a risk of the reoccurrence of such problem.

2034. There is no dispute that MHI was required to meet this contractual obligation.
2035. Accordingly, with respect to Issue C.3(a), the Tribunal considers that Mitsubishi was obligated to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” of the Defect or alternatively demonstrate that the problem(s) would not reoccur.

(b) If so, did Mitsubishi undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” of the Defect or demonstrate that the problem(s) would not recur? (Issue C.3(a)(i))

2036. Issue C.3(a)(i) concerns the question whether, if Mitsubishi was obligated to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” of the Defect or alternatively demonstrate that the problem(s) would not recur, did, in fact, Mitsubishi undertake a technical analysis of the problem to that (i) its proposed repair corrects the “root cause” of the Defect, or whether the problem(s) would not recur.

(i) The Claimants' Position

2037. In their Responses to the Joint List of Issues, the Claimants submit the following:

Mitsubishi neither undertook a sufficient technical analysis of the problem nor demonstrated that its proposed repair (the thicker AVB concept) would fix the extreme thermal-hydraulic conditions—the “main cause” of the RSGs failures and one of the two root causes identified by Mitsubishi—or the extreme vibration and wear. Because Mitsubishi did not resolve one root cause of the tube wear—the extreme thermal-hydraulic conditions—or at the very least Edison had a reasonable belief that it did not, Mitsubishi was required to demonstrate that the tube wear would not reoccur.

Mitsubishi argues it had formally recommended a repair as of May 2012, yet Mitsubishi's sales representative ██████████ testified that Mitsubishi had not

“concluded that the thicker AVBs would resolve the root cause,” “that the insertion of thicker AVBs would not cause other problems,” “that the thicker AVBs would restore the 40-year design life,” or “that the thicker AVBs would be approved by the NRC.” Respondents’ expert witness James Olszewski confirmed that Mitsubishi had not “concluded that the thicker AVB repair would resolve the root cause,” and ██████████ admitted that “Mitsubishi’s thicker AVB repair certainly wasn’t ready to go in May of 2012.”

As late as June 2013, Mitsubishi failed to show that its repair would correct the extreme thermal-hydraulic conditions that placed the RSGs beyond successful operating experience and that drove the excessive vibration and wear. Mitsubishi likewise refused to conduct any testing under the thermal-hydraulic conditions in the RSGs.

Mitsubishi also failed to show that the repair would prevent in-plane FEI, out-of-plane FEI, excessive tube vibration, and unacceptable TSP wear. Indeed, Mitsubishi failed even to analyze for out-of-plane vibration post-repair, yet Mitsubishi’s experts testified that out-of-plane FEI would continue post-repair and would create the environment for in-plane FEI to continue as well. As of June 2013, Mitsubishi had no intention of conducting any additional testing or analysis.²⁰¹⁶

2038. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, particularize their allegations regarding Mitsubishi’s conduct, in the following manner:

Respondents claim that (1) “Claimants have not disputed that Mitsubishi . . . identified the root cause of the tube leak with a sense of urgency commensurate with the problem” and that (2) the proposed thicker AVB repair would correct the root cause of the Defect “without necessitating any change to the RSG thermal hydraulic conditions.” Contrary to Respondents’ claims, Claimants have shown that Respondents failed to conduct an appropriate technical analysis, correct the cause of the RSG failures, or demonstrate that the problems would not recur.

- ***Mitsubishi’s thicker AVB repair failed to correct the thermal-hydraulic conditions, which Mitsubishi repeatedly called the “main cause” of the failures.***

²⁰¹⁶ Claimants’ Responses to Joint List of Issues, ¶ C.11(a)(i).

Respondents continue to acknowledge that the extreme thermal-hydraulic conditions were, at minimum, one of the two root causes of the RSG failures. Yet, Respondents accuse Claimants of relying on “the false premise that the [thermal-hydraulic] conditions at SONGS were the main or primary cause of the tube leak.” But this was not Claimants’ “false premise”; it was Respondents’ conclusion, as repeatedly stated to Edison:

- July 13, 2012: “Consequently, it is postulated that the thermal hydraulic condition of the secondary side, namely **high void fraction (steam quality) and high flow velocity**, is the **main cause** of the unexpected tube wear in SONGS Unit 2 and Unit 3.”
- July 17, 2012: “Consequently, it is postulated that the thermal hydraulic condition of the secondary side, namely **high void fraction (steam quality) and high flow velocity**, is the **main cause** of the unexpected tube wear in SONGS Unit 2 and Unit 3.”
- August 10, 2012: “Consequently, it is postulated that the thermal-hydraulic conditions in the SG secondary side, namely **high void fraction (steam quality) and high flow velocity**, are the **main causes** of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs.”
- August 30, 2012: “Consequently, it is concluded that the thermal-hydraulic conditions in the SG secondary side, namely **high void fraction (steam quality) and high flow velocity**, are the **main causes** of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs.”
- September 14, 2012: “Consequently, it is concluded that the thermal-hydraulic conditions in the SG secondary side, namely **high void fraction (steam quality) and high flow velocity**, are the **main causes** of the excessive tube vibration and unexpected wear in the SONGS Unit 2 and Unit 3 SGs.”

As Dr. Elder testified, the “extreme thermal-hydraulic conditions are the drivers for the vibration and wear, and one of the things particularly NRC insists on is you got to solve the root cause.” Yet, Respondents’ repair did not even address, much less resolve, the extreme thermal-hydraulic conditions that placed the RSGs beyond successful operating experience and that drove the excessive vibration and wear.

In response, Respondents continue to rely on logical fallacies. First, they essentially argue that if thermal-hydraulic improvements are “unachievable,” they are unnecessary. But an unachievable repair is not, by definition, unnecessary. Rather, here, Respondents’ inability to fix the thermal-hydraulic conditions that led to the extreme vibration and wear only further shows how deeply defective, unsafe, and incapable of repair the SONGS RSGs were. Second, Respondents assert that “Claimants have yet to settle on a position as to why” thermal-hydraulic improvements were necessary, as if only one reason can exist. Yet, each of the reasons Respondents list—Respondents’ contractual promises, the fact that the thermal-hydraulic conditions caused the failure, the advice of experts, NRC requirements, and the need for margin—are mutually supportive and strengthen the reasonableness of Edison’s request during the recovery period.

- ***Mitsubishi refused to conduct thermal-hydraulic testing to demonstrate that the problems would not recur even if the thermal-hydraulics were not altered***

Respondents now accuse Edison of backpedaling on its request for thermal-hydraulic improvements and insisting that it would have accepted a proven repair that did not correct the thermal-hydraulic conditions. In doing so, Respondents set up a false dichotomy. In 2012 and 2013, Edison repeatedly and consistently stated that, if Respondents believed their repair was viable and the first-of-a-kind thermal-hydraulic conditions in the RSGs did not need to be mitigated, they should conduct testing under those thermal-hydraulic conditions to prove the repair’s viability. Respondents claim that “Claimants are [] disingenuous in their suggestion that they had requested such testing at the time.” Yet, Respondents’ [REDACTED] and Mr. Olszewski both testified that Edison “never deviated” from its request for simulated thermal-hydraulic testing.

While Respondents also assert that such a request for testing was mistaken and unreasonable, Edison’s request was both made in good faith and was completely reasonable. The thermal-hydraulic conditions in the RSGs were unprecedented and the repair was first-of-a-kind, putting SONGS outside of prior experience and validation efforts. Even Respondents’ [REDACTED] testified that Edison’s desire for further verification was “a reasonable request.” While Respondents continue to rely on their open-air mockup testing, which Claimants have shown to be limited and flawed, they do not dispute that they never conducted testing under the thermal-hydraulic conditions present in the RSGs.

The NRC would have demanded such testing. Mr. Leeds, the NRC official responsible for approving restart after any repair, and Mr. Strosnider, the former Director of the Division of Engineering in the NRC's Office of Nuclear Reactor Regulation, testified that "Mitsubishi would have needed to provide results of testing under the thermal-hydraulic conditions in the RSGs." Mr. Leeds and his staff at the NRC would have "demanded confirmatory testing" given that the repair did not "have operational experience, it's precedent setting."

According to Respondents' Dr. Au-Yang, testing is preferable to computer analysis, given that testing is "much simpler, easier to check, and it's more convincing. It's less error, less possibility of making errors in tests." In fact, Respondents themselves wanted testing under the thermal-hydraulic conditions in the RSGs until they realized such testing would require a significant amount of time. Respondents were "very insistent on testing with void fractions at 0.996," i.e. 99.6%. In August 2012, B&W outlined a testing plan in response to Respondents' request, stating that "a multi-faceted, multi-year program will be needed to cover all aspects of in-plane instability in detail." B&W stated that the "first phase" would be "strongly focused on the simplest possible tests to verify that the proposed repair strategy will work" and would include "both air-water and Freon tests." Those tests would be followed by "testing to understand the magnitude of normal contact force" between tubes and AVBs, with "[a]ir-water testing" as a "parallel activity." Edison, B&W, and Mitsubishi even visited the Chalk River laboratory in Canada to explore testing options.

But Respondents switched course. In September 2012, Respondents told Edison that "if MHI felt a test loop was required, then we [MHI] could undertake it at Takasago," Japan. Despite having earlier insisted on thermal-hydraulic testing, possessing the ability to perform such testing, and knowing of Edison's request for such testing, Respondents refused to conduct the tests, with ██████████ telling Edison that such testing "was not necessary." These facts belie Respondents' arbitration claim that "Mitsubishi would . . . have been willing to pursue such testing."

Respondents' refusal to conduct thermal-hydraulic testing was unreasonable and a clear impediment to NRC approval. Respondents' expert Mr. Olszewski agrees:

MR. WEISSMANN: And should Mitsubishi have cooperated with Edison on those requests for testing?

MR. OLSZEWSKI: Certainly.

- ***Mitsubishi failed to correctly determine that out-of-plane FEI caused tube wear or demonstrate that out-of-plane FEI would not continue post-repair.***

From January 2012 until the 2016 Hearing, Respondents consistently claimed that random vibration alone—not out-of-plane FEI of any type—caused all of the tube-to-AVB wear. In their Counter-Memorial and Rejoinder Memorial, Respondents repeatedly stated that no out-of-plane FEI occurred at SONGS. At the Hearing, however, Respondents agreed with the testimony of their former consultant Mr. Langford and acknowledged that out-of-plane FEI did occur.

Further, Respondents admit that post-repair out-of-plane stability ratios needed to be calculated to establish the viability of the repair and to seek licensing, and the RSG Contract states that the “Supplier shall perform a stability analysis of the tubes both in the tube bend region and over the straight length.” Yet, Respondents admit that they never analyzed for out-of-plane FEI, however defined, post-repair. Rather, Respondents took affirmative steps to artificially prevent their computer code from calculating any out-of-plane stability ratios post-repair.

Respondents also admit that (gap-limited) out-of-plane FEI, which Respondents had promised to avoid in design and which led to excessive tube wear, ***would continue post-repair***. Respondents further admit that (gap-limited) out-of-plane FEI ***creates the environment for in-plane FEI to occur***. Thus, Respondents acknowledge that they had not shown that their repair would prevent either out-of-plane or in-plane FEI post-repair. Far from providing sufficient information to show the viability of the repair, Respondents’ admissions establish that they failed to meet their contractual obligations.

- ***Mitsubishi failed to show that the repair would prevent in-plane FEI and tube-to-tube wear.***

In attempting to demonstrate that the thicker AVB repair would prevent in-plane FEI from recurring, Respondents used incorrect input values (e.g., an incorrect critical (K) factor and incorrect damping values) in their stability ratio analyses. When corrected, post-repair in-plane stability ratios are greater than 1.0, meaning that the RSGs would remain at risk of in-plane FEI. Respondents also failed to justify the minimum pinning force needed to prevent in-plane FEI and failed to use a proper coefficient of friction, thus underestimating the required pinning force.

- ***Mitsubishi failed to properly analyze random vibration post-repair, failed to show that excessive tube wear would not recur, and failed to show that unacceptable TSP wear would not continue.***

Claimants have established that Respondents' analysis of tube wear post-repair was flawed. In analyzing for random vibration, Respondents had no valid basis for selecting the two tubes they evaluated, and for those tubes, Respondents failed even to accurately calculate the wear rate. When that error is corrected, Respondents' own input values show that one of the tubes they analyzed would have experienced through-wall wear post-repair in only [REDACTED]. Likewise, despite the fact that the RSGs had experienced unprecedented TSP wear, the U-Bend Repair Report failed to address continued TSP wear, much less prove that such wear would abate.

Respondents attempt to dismiss these concerns by stating that, but for tube-to-tube wear, "other wear types were common and manageable going forward." Yet, through detailed analysis, Claimants' expert Dr. Geoffrey Egan established that—even assuming that tube-to-tube wear ceased and random vibration caused all of the AVB and TSP wear—Units 2 and 3 would have failed in 3.3 years and 0.6 years, respectively, due to support wear alone.

- ***Mitsubishi failed to analyze the AVB twist and wear patterns in the as-found post-outage RSGs***

During the design of the RSGs, Respondents considered two AVB configurations, denominated the "2Vx3" and the "[REDACTED] staggered." Although the 2Vx3 was expected to yield a higher maximum void fraction and was considered "unstable in fabrication," Respondents determined that it was "[b]etter than [REDACTED] staggered" for the RSGs. Respondents advised Edison that the difficulties with "manufacturability" of the 2Vx3 configuration "c[ould] be resolved."

Respondents provided Edison with detailed plans for the fabrication and assembly of AVBs, describing, inter alia, the acceptable movement and nose position of the AVBs, a method for preventing the AVBs from shifting position during manufacturing, and Respondents' gap-control methodology. Internally, Respondents had further in-depth discussions with their consultant, Mr. Langford, about how to control AVB twist and weld shrinkage. Mr. Langford cautioned Respondents that AVB "twist can rapidly increase wear depths" and expressed his "concern[]that MHI [wa]s not . . . sensitive to this variable."

Given that Respondents' AVB design was unstable and susceptible to slippage and twist during fabrication, Westinghouse conducted a detailed examination

of wear patterns and AVB positioning after the failure of the RSGs. The Westinghouse team, which included Mr. Langford, also studied the location and magnitude of AVB asymmetry throughout the tube bundle. Westinghouse recorded instances of AVBs that were in some cases several inches out of alignment and surmised that, “[i]t is not likely that the middle of an AVB can be displaced this much in-plane without introducing significant bending and twist beyond design expectations.” Indeed, in these areas, “Westinghouse observed highly twisted AVBs.”

The severely twisted AVBs resulted in tubes with multiple ineffective supports. According to Westinghouse, these lack of supports contributed to out-of-plane FEI in both Units. As Mr. Langford explained, “there were many [more] unsupported or ineffective gaps in Unit 3 compared to Unit 2.” In fact, Westinghouse found some tubes in Unit 3 had as many as 12 ineffective supports (i.e., they were completely unsupported by the AVBs), while in Unit 2 the maximum unsupported span was “eight consecutive gaps.” According to Mr. Langford, this lack of support in Unit 3 led to more severe in-plane instability and the tube leak.

Based on these wear patterns, Westinghouse rejected the notion that the presence of in-plane instability at SONGS represented a “paradigm shift” away from the conventional wisdom that in-plane instability follows out-of-plane. As Mr. Langford explained, the SONGS RSGs had “out-of-plane instability in one mode followed by out-of-plane instability in a second mode, followed not far behind by in-plane instability The Westinghouse point and the basis for this entire 400 page report is that in-plane instability is not something that happens unexpectedly.”

During the Hearing, Respondents erroneously suggested that Westinghouse’s conclusions were a “theory” or a matter of Mr. Langford’s “opinion.” On the contrary, the findings detailed above are thoroughly documented in the Westinghouse Operational Assessments and reflect careful analysis of eddy current data. The existence of up to 12 ineffective supports, wide tube-to-AVB gaps, displaced AVBs, and the gouging wear pattern associated with twisted AVBs are all matters of empirical fact and speak directly to the defective design and manufacturing of the SONGS RSGs.

In light of these facts, Mr. Langford opined that the number and magnitude of twisted AVBs indicate an extreme spread in the center of the upper tube bundle that very likely resulted from errors in manufacturing. He cited the thinness of the AVBs, Respondents’ inexperience fabricating AVBs, and the process of tube bundle rotation as potential flaws in the process. During design, Mr. Langford expressed concerns about Respondents’ manufacturing practices,

their “willingness to use whatever data is available rather than development of a robust procedure,” and concluded Respondents’ analysis was “very troubling in several respects.” According to Mr. Langford, who was Mitsubishi’s consultant during design and manufacture of the RSGs, the post-outage eddy current data proved that the as-built support structures in the RSGs did not match the tolerances of the approved design concept.

➤ ***Mitsubishi never presented Edison with a detailed design report***

Respondents’ April 5, 2013 U-Bend Repair Report was the first repair report they provided that was prepared under Mitsubishi’s QA program. Respondents claim that that report “explained how the thicker-AVB repair would correct the root cause of the tube-to-tube wear.” Yet, Respondents’ lead thicker AVB designer, ██████████ testified that the U-Bend Repair Report was not a detailed design report and that Respondents “never provided Edison with a detailed design report for purposes of the repair.” Its primary drafter, Mr. Wilson, testified that the report did not present analysis, merely results. Nor did the U-Bend Repair Report contain any new, additional testing or analysis. Instead, it simply “summar[ized] all the work that Mitsubishi had done in 2012.” Further, Mr. Wilson testified that the U-Bend Repair Report’s discussion of reducing void fraction to ██████████ with certain plant operating changes was flawed, “plac[ing] an emphasis on maximum void fraction that would go beyond the accuracy of those calculations.” Moreover, the suggested changes to plant operating conditions were not feasible. Likewise, as the Tribunal heard, Respondents presented Edison with false information on the shape of the AVBs and the number of expansion bladders needed to perform the repair—despite having known of the accurate information since November 2012.

➤ ***AREVA’s May 2013 Independent Third-Party review of the thicker AVB repair demonstrates that Mitsubishi failed to demonstrate the viability of the repair***

Respondents criticize Edison for failing to “take advantage of third-party resources . . . at least until May 2013.” Yet, immediately after receiving the U-Bend Repair Report, the first repair report Mitsubishi delivered (which still was not a detailed design report), Edison commissioned AREVA to conduct a third-party review. On May 30, 2013, AREVA delivered its report. Contrary to Respondents’ claim, AREVA raised serious concerns regarding the repair’s ability to correct the defects in the RSGs and documented Respondents’ lack of progress in developing a repair. As just a few examples (see also Section C.3(b) *infra*), AREVA concluded:

- “The Independent Review however concludes that the subject thick-AVB repair approach requires further substantiation in several discipline areas before it can be installed and operated with confidence, and as such is not sufficient as a repair plan to implement as presented.”
- “TH modeling should be considered for completeness.”
- “[N]either the section 5.3.4.2, nor elsewhere in the report addresses any long term effects of continued wear on already heavily worn TSP intersections, even though those tubes are plugged.”
- “A disposition on the duration and dose realized for the effort cannot be offered until the details of the hardware, installation tooling, and implementation method are more clearly defined.”
- “The report does not provide a detailed status of the repair of the hardware. As such it is not known if the specific AVB thickness for each location has been fully determined and if adequate bounding studies/tests have been performed to qualify the hardware for installation.”
- “The report does not have a text matrix or other information to demonstrate that mockup testing bounds potential installation conditions. For example, the ‘tight’ bundle insertion test was performed with a [REDACTED] maximum thickness AVB (pg 45), with some additional testing at [REDACTED]. At [REDACTED] the AVBs were still insertable, meaning the [REDACTED] [REDACTED] to allow insertion of the wide AVB. However figure 5.3.3-2 (pg 62) and onward text indicates the targeted thickness AVB is [REDACTED].”
- “The report covers the basic steps for inserting an AVB into the tube bundle. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]”

Mr. Stewart testified that, at the time he worked for AREVA, the AREVA report was accurate and did not overstate any of AREVA’s concerns. AREVA never suggested to Edison that it needed more time or a bigger budget to complete its independent review. Edison’s only reasonable and responsible course of action was to take AREVA’s concerns seriously. As AREVA concluded, the U-Bend Repair Report lacked engineering detail and proof and raised serious technical risks that prevented Edison from adopting the repair as of May 2013. Respondents had nearly a year and half to identify, investigate

and analyze those questions and concerns, many of which struck at the heart of the Type 1 Repair proposal, but failed to do so.

➤ ***Mitsubishi needed nothing from Edison to conduct the testing and analysis that its experts say was required***

Notwithstanding Edison's requests for validation and its support for Respondents' efforts, Respondents failed to perform necessary testing and analysis, prove its repair would correct the root cause, show that no secondary effects would result, and provide the necessary engineering documentation to Edison for review. As Mr. Denton testified:

Question: Had Mitsubishi completed its work on the Type 1 AVB repair by June 7, 2013?

[Mr. Denton's] Answer: No, they had not.

Question: They still had more work to do to develop and validate the repair?

Answer: To the best of my knowledge, that's true.

Claimants' experts testified to a laundry list of additional testing and analysis that Respondents needed to undertake even as late as June 2013. Edison repeatedly asked for testing under the thermal-hydraulic conditions in the RSGs, which Claimants' experts testified was necessary for validation and NRC approval and which Respondents chose not to perform.

At the Hearing, Respondents' experts testified to a series of additional tests and analyses that Respondents needed to perform—and had not performed—as of June 2013:

- Respondents should have performed a test to analyze the potential for the unsupported original AVBs to vibrate and cause wear post-repair.
- Respondents should have performed testing to determine the force at which a tube would be pinned. Dr. Au-Yang refused to reach his opinions without such testing, which he did not receive until late 2013 or 2014.
- Respondents had not completed all of the analyses needed to understand the effect of restraining the U-bend region with thicker AVBs, given that the thicker AVBs would lock the upper U-bend in place. Respondents still needed to analyze the effects of heat-ups and cool-downs with the

tubes pinned and locked in place because the original tube design report assumed that the tubes were unrestrained. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until 2015.

- Respondents had not addressed the applied loading on the retaining bars and the effect of heat-ups and cool-downs as a result of putting thicker AVBs into the RSGs. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until late 2014.
 - Respondents had not sufficiently addressed the changed flow resistance in the U-bend due to the thicker AVBs and how that changed flow resistance would impact water level stability and water level control. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until January 2016.
 - Respondents had not analyzed for the change in mass in the RSGs post-repair. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until January 2016.
 - Respondents had not identified the affected design basis documents and calculations. Mr. Russell had to ask Respondents to undertake that process in order to come to his opinions in this arbitration.
- ***Mitsubishi had no intention of conducting additional testing or analysis to demonstrate to Edison the viability of the thicker AVB repair***

In order to demonstrate the viability of the thicker AVB repair, Respondents—at a very minimum—needed to conduct a significant amount of additional testing and analysis. Yet, as of June 2013, Respondents had no intention of performing such work. ██████████ (lead designer of thicker AVB repair) testified that “[h]ad Edison allowed the SONGS RSGs to be repaired, MHI would not have conducted such testing and analyses, as post-repair operational experience would have confirmed the conclusions provided in the [U-Bend] Repair Report.” ██████████ (technical lead of Respondents’ repair team) agrees. Mr. Wilson (primary drafter of U-Bend Repair Report) testified that “[h]ad Edison decided to install the Repair, the Repair’s ability to stop in-plane FEI and TTW for 40 years of projected RSG operation would have been confirmed by the operation of the repaired RSGs. Edison’s decision to

decommission the plant prevented this form of validation.” Dr. Begley (validation team member) testified that “[h]ad Edison decided to install the Repair, the success of that Repair in stopping the recurrence of in-plane FEI and TTW would have been proven by the operation of the repaired RSGs. However, such validation was thwarted by Edison’s decision to decommission the plant.” Mr. Johnson (former NRC official) testified that mid-cycle inspections would have been an acceptable way to “have removed any lingering questions regarding concerns about potential new modes of tube degradation and to have confirmed the repair’s effectiveness.”

Especially in light of the safety focus of the nuclear industry, Respondents’ position is untenable. As Mr. Merschoff testified, the suggestion that a utility can permit a vendor to run an experiment on a nuclear power plant “indicates a lack of experience in dealing with the NRC.” Further, it is directly contradicted by the series of additional tests that Edison requested and that Respondents’ experts would have—and did—require, as outlined above.

➤ ***Mitsubishi’s work to validate the repair, undertaken only for this arbitration, is incomplete and irrelevant***

Respondents’ own submissions to the Tribunal highlight both the need for additional testing and analysis and the flaws and shortcomings in the information they provided to Edison as of June 2013. While Respondents admittedly had no intention of performing additional testing or analysis for Edison, they had their experts work on repair validation efforts for 2.5 years—from spring 2013 until January 2016. In January 2016, Respondents submitted over 1,200 pages of new “validation” materials—new tests, new analyses, improved modeling, new measurements, refined codes, etc.—in an attempt to convince the Tribunal that their repair was viable. Respondents assert that, “[w]ithout exception, these tests and analyses confirmed the key conclusions of Mitsubishi in 2012.” Yet, in their arbitration work, Respondents completely changed their approach, analyzing different tubes, using different work rates and wear coefficients, and employing a different version of its IVHET computer code. Moreover, Respondents continued to make systematic and fundamental errors, including improperly analyzing for vibration of the existing AVBs, relying on erroneous damping values, choosing the wrong tubes to evaluate, using an inadequate and inaccurate contact force model, and failing to validate their computer codes. Furthermore, Respondents provided no evidence that their new validation work was performed under Mitsubishi’s quality assurance program or complied with 10 CFR Part 50, Appendix B.

Respondents also claim that “Claimants did not even attempt to rebut Dr. Au-Yang’s conclusion that the Repair would have prevented the recurrence of in-

plane FEI.” To the contrary, Claimants’ expert did rebut Dr. Au-Yang’s conclusions. Further, on cross-examination, Dr. Au-Yang admitted he did not conduct any computer modeling of stability ratios or wear rates and was “not testifying on the accuracy of Mitsubishi’s work to prove its thicker AVB repair proposal,” including Mitsubishi’s coefficient of friction, pinning force analysis, stability ratio calculations, wear analysis, or computer code validation. Dr. Au-Yang’s analysis—provided for this arbitration only in 2016—was based on “first principles” and “simplified” and “approximate” “hand calculations” and did not result in precise calculations. In fact, Dr. Au-Yang testified that additional computer modeling or testing would be necessary, and his preference was testing. Dr. Au-Yang also made clear that he “would not have signed [his] name to [his] testimony” with test data that Mitsubishi provided him in late 2013 or 2014 for purposes of this arbitration. Thus, far from proving that the repair would prevent in-plane FEI, Dr. Au-Yang established that Respondents had failed to demonstrate the viability of the repair to Edison by June 2013.

To this day, Respondents have never performed testing under the first-of-a-kind thermal-hydraulic conditions in the RSGs. As multiple experts testified, the repair would still impose extraordinarily high pinning forces, locking the tubes in place and risking plastic deformation, while at the same time leaving the existing AVBs loose and free to vibrate. Respondents still have not analyzed for or calculated post-repair out-of-plane stability ratios.

All of Respondents’ work to validate the repair in this arbitration—since June 2013—is irrelevant to actually validating the repair. Respondents had no intention of performing such work and never would have done so as part of the effort to return SONGS to service. In fact, in their Position Statement on the Revised List of Issues, Respondents acknowledged that all of this work was done “[i]n preparation for this arbitration” only.

- ***Mitsubishi failed to demonstrate that its thicker AVB repair was implementable and has since rejected its proposed implementation approach***

Respondents claim that they have “demonstrated in this proceeding that the thicker-AVB repair could have been successfully implemented.” Notably, Respondents rely on expert analysis that they prepared for and submitted to the Tribunal for the first time in January 2016. This work is irrelevant to whether Respondents had demonstrated the viability of the repair to Edison when Edison was seeking a repair to the RSGs. As of June 2013, Respondents failed to prove that the thicker AVB repair could be safely installed. As Mr. Olszewski testified, Respondents failed to “provide enough information to say

it was validated and ready for field implementation.” In fact, Respondents were nowhere close. Mr. Bohn, Respondents’ implementation expert, testified that he “would expect that Mitsubishi would have made more progress between May of 2012 and the April 2013 U-Bend Repair Report in connection with implementation.” For example, Respondents should have presented “more detailed tooling design” and “more detailed implementation procedure steps.”

Respondents also should have begun a Failure Modes & Effects Analysis in mid-2012, yet did not prepare one until July 2014—and only for purposes of this arbitration. Likewise, Respondents should have prepared an engineering requirements document to ensure the repair would be installed consistent with the relevant testing and analysis. Yet, Respondents had not completed such a document as of June 2013 and did not do so until this arbitration. Respondents did not assemble their field implementation team until late 2013 and did not conduct any testing until mid-2014—all for this arbitration only.

But Respondents went beyond failing to develop the necessary information for implementation of the repair. Respondents chose to affirmatively present false information to Edison. Despite knowing as of November 2012 that AVBs thicker than [REDACTED] would require [REDACTED] Respondents presented a [REDACTED] thicker AVB in their U-Bend Repair Report that would be installed with [REDACTED] alone. Further, while Respondents told Edison that the thicker AVBs would be installed with the U-bend region [REDACTED] Mr. Bohn testified that Respondents’ plan as “presented to Edison was not fully developed.” [REDACTED] testified that, as of the fall of 2012, Respondents knew that the repair would be installed [REDACTED] a switch Edison did not learn until this arbitration. In fact, Respondents presented none of this information or these changes to Edison. Nor can such failures be blamed on Edison: Respondents needed no information from Edison in order to develop a sufficient implementation process, such as the one it attempted to present to the Tribunal.

➤ ***The repair would not have returned the RSGs to their design basis***

Beyond the problems discussed above, Respondents’ proposed thicker AVBs would not have returned the RSGs to their design basis and would not have rendered the RSGs conforming goods. While “design basis” has a specific definition in NRC regulations, the industry and the NRC also use it to refer to the design criteria on which the design is based. Thus, in its official report on the SONGS failures, the NRC referred to the RSG Contract and the Design of Anti-Vibration Bar report, among other documents, as “DESIGN BASIS DOCUMENTS.”

➤ ***Post-repair, the RSGs would not have conformed to the RSG Contract's provisions regarding gap sizes***

The RSGs' design basis was effective "zero" gap, i.e. no tube-to-AVB contact force and no large tube-to-AVB gaps. In Revision 2 of the RSG Contract, Respondents promised "an effective 'zero' tube-to-flat bar gap," with the "gap statistical size" not to "exceed 0.003." Respondents were required to seek a Supplier Deviation Request, i.e. permission from Edison, to exceed that limit. In November 2008, Respondents requested and received a Supplier Deviation Request stating that "statistical outer-most tube-to-AVB gaps shall not exceed 0.021," given that "[s]ome anomalous gaps in the outer-columns are relatively large" and "slightly exceed the CDS requirement." The final RSG Contract required Respondents to meet the "support clearance requirements."

Post-repair, the RSGs clearly would not meet this effective "zero" gap requirement. "Each Thicker AVB would have been approximately [REDACTED] the thickness of an existing AVB," and the repair would impose a first-of-a-kind support structure that represented a vast departure from prior U-bend steam generator designs, in at least two respects. First, the gaps at tube-to-existing AVB intersections would increase, resulting in large gaps. Second, the thicker AVBs would impose extreme contact forces (exceeding [REDACTED] in some places), forcibly locking the tubes in place. The post-repair gaps would not, therefore, conform to the RSG Contract's requirement that even the largest gaps be less than 21 mils or that the tubes be loosely held. The repair would violate the RSG Contract provisions requiring Respondents to "[e]nsure that the relative tube/tube support motions during normal and accident transients shall not result in tube lockup," "[e]nsure that tube-to-tube support clearances are uniform," and prevent "excessive fretting and wear of the tubes." The post-repair gaps and contact forces also would have deprived Edison of the margin that Respondents had promised in the RSG Contract—margin that would have been desperately needed if, as Respondents proposed, the unprecedented thermal-hydraulic conditions would remain unchanged.

➤ ***Post-repair, the RSGs would not have conformed to the RSG Contract's thermal-hydraulic and stability ratio requirements***

Design margin is a fundamental tenet of the nuclear industry, as recognized by the RSG Contract, which defines margin as:

The difference between the performance/design parameter value as included in the Specification or proposed by the Supplier and the minimum regulatory and/or design criteria value as of the date of the Purchase Order.

The RSG Contract also required Respondents to “prepare and submit for Edison’s approval a Performance Analysis Report documenting all thermal-hydraulic aspects of the RSG design,” and the Purchase Order “incorporate[d] by reference . . . the Specification and other referenced documents, all of which form the contract between the Parties.” Thus, contrary to Respondents’ claim, the Performance Analysis Report formed a part of the parties’ contract, and the RSG Contract specified that “[a]ll thermal-hydraulic aspects of the tube support design . . . shall be documented in the Performance Analysis Report.”

In the Performance Analysis Report (prepared, checked, and/or approved by [REDACTED] and [REDACTED] Respondents stated that the maximum void fraction in the RSGs would be [REDACTED] Respondents further confirmed that “[f]or the U-bend region, it has been confirmed that stability ratios are less than 1.0 even if 1 support is inactive” and documented that the highest calculated out-of-plane stability ratio would be [REDACTED] In the RSG Contract, Respondents warranted that the Performance Analysis Report was accurate and agreed that it could not change the Performance Analysis Report without Edison’s consent.

Notwithstanding these promises, Respondents’ repair would have left the maximum void fraction at almost 100% and the maximum velocities at [REDACTED] [REDACTED] times greater than predicted in design. Further, Respondents have conceded that, even post-repair, out-of-plane stability ratios would be greater than 1.0 (with one ineffective support). Thus, Respondents’ repair would have deprived Edison of the margin promised in the RSG Contract, would have risked new modes of failure, and thus would have failed to deliver conforming RSGs.

➤ ***Respondents’ conduct during recovery paralleled Respondents’ flawed and deficient conduct during design***

Respondents’ conduct following the RSG failures exhibits disconcerting similarities to Respondents’ conduct during design. Respondents artificially restrained FIVATS from analyzing a particular mode of FEI in both design (the in-plane mode) and repair (the out-of-plane mode), despite the need to analyze both modes and the difficulty in imposing that artificial computer restraint. Respondents ignored internal warnings from their expert advisors in design (Mr. Wilson, Mr. Langford) and repair (Mr. Kudla, [REDACTED]) who were hired specifically to ensure that Respondents met their design and/or repair obligations.

Just as Respondents failed to have the vast majority of their design team testify in the arbitration, Respondents chose not to have the vast majority of their repair team appear before the Tribunal. Finally, like Respondents’ design team,

Respondents chose to assemble a repair team that lacked experience repairing steam generators. In fact, [REDACTED] the individual Respondents appointed lead designer of the thicker AVB repair, had no steam generator design or repair experience prior to the RSG failures. Thus, Respondents had an inexperienced team, proposed a first-of-a-kind repair to an unprecedented failure, and refused to perform the necessary testing and analysis. Edison acted in good faith and, as a responsible utility, could not proceed with Respondents' unproven repair, especially under those circumstances.²⁰¹⁷

(ii) *The Respondents' Position*

2039. In their Position Statement on the Revised List of Issues, the Respondents make the following particularized submissions:

➤ ***Mitsubishi performed a technical analysis and identified the root cause of the tube-to-tube wear***

Claimants have not disputed that Mitsubishi, working with other steam generator experts at the SONGS site, identified the root cause of the tube leak with a sense of urgency commensurate with the problem. In summary:

Within days of the incident, Mitsubishi personnel were on site.

Within a month of the incident, Mitsubishi had approximately 70 personnel working on the issue.

Within a month of the incident, in-plane FEI had been identified as the cause of the tube-to-tube wear in Unit 3.

By the end of March 2012, Mitsubishi had identified a combination of insufficient supports in the in-plane direction and high T/H conditions as the root cause of the tube-to-tube wear in Unit 3.

While Mitsubishi's March 30, 2012 Technical Evaluation Report was revised several times, the fundamental conclusion that the tube-to-tube wear was caused by a combination of insufficient supports and high thermal-hydraulic conditions never changed.

²⁰¹⁷ Claimants' RPHM, ¶¶ 233-279.

The root cause of the tube-to-tube wear was therefore a combination of insufficient supports in the in-plane direction and high T/H conditions. Edison publicly and privately agreed to this root cause on many occasions in 2012 and 2013, including in testimony to the NRC. Claimants' witness Mr. Palmisano still supports this conclusion today. He stated at the hearing that "I think my statements here today make it clear it's a combination of adverse thermal-hydraulics and lack of support."

➤ ***Mitsubishi's repair would have corrected the root cause***

Because in-plane FEI in the SONGS RSGs occurred as a result of the presence of both insufficient supports in the in-plane direction and high thermal hydraulic conditions, and because remedying either one or both of those conditions would have stopped the in-plane FEI and the resulting tube-to-tube wear, an acceptable repair needed to address one or both of those conditions. The Thicker-AVB Repair would have increased the contact forces at tube-to-AVB intersections, thereby adding sufficient support and correcting the root cause without necessitating any change to the RSG thermal hydraulic conditions.

Eddy current test results showed that the tube-to-tube wear only occurred at approximately the 45-degree and 135-degree points on approximately 160 tubes in the center of the U-bends in only the Unit 3 RSGs. Mitsubishi established a repair zone that would encompass all of the tube-to-tube wear and almost all of the tube-to-AVB wear ("Zone 1"). The Thicker-AVB Repair would have involved inserting ■ Thicker AVBs into Zone 1 between alternating columns of tubes at approximately the 45-degree and 135-degree points, thus targeting the exact area that had experienced the problematic tube wear.

Each Thicker AVB would have been approximately ■ the thickness of an existing AVB. These thicker AVBs would have increased the contact forces at the tube-to-AVB intersections in both Zone 1 and toward the periphery of the U-bends ("Zone 2"). The following figure identifies these zones, as well as the wear in Units 3A and 3B, and shows that Zone 1 encompasses all of the tube-to-tube wear and almost all of the tube-to-AVB wear.



RSG 3A & 3B, Combined Row & Column U-bend Tube Wear Map

Zone 1: The thicker AVBs would have been inserted into Zone 1 and would have deflected the adjacent tubes and “pushed” those tubes toward the periphery in a columnwise [sic], out-of-plane direction, such that they would have come into contact with the existing AVBs on the opposite sides of the tubes. The Thicker AVBs, thus, would have created a three-point bend condition in those tubes, and would have pinned those tubes at six key tube-to-AVB intersections.



Installation Location of Thicker AVBs (showing Six Key Intersections)

Zone 2: The presence of the thicker AVBs in Zone 1 would have deflected both the tubes and the existing AVBs in Zone 1 toward the periphery in a columnwise [sic], out-of-plane direction toward the tubes and AVBs in Zone 2. This deflection would have deflected the tubes and AVBs in Zone 2 as well and would have “pushed” those tubes toward the periphery in a columnwise [sic], out-of-plane direction such that they would have come into contact with the existing AVBs on the other side of the tubes. The tubes in Zone 2 would have been pinned at four key tube-to-AVB intersections along their lengths.

A tube cannot move relative to an AVB at a pinned intersection, and, therefore, the Repair would have prevented the tubes from moving at their 45 and 135 degree points. Mitsubishi conservatively calculated that a contact force of ■

██████████ would have been sufficient to have pinned the most-limiting intersection of the most-limiting tube at 100% power. The thicker-AVB repair would have created contact forces far in excess of ██████████. Almost all of the contact forces in Zones 1 and 2 would have exceeded ██████████ more than ██████████ times larger than the ██████████ pinning force criterion established for the Repair. Therefore, the Repair conservatively provides large margins that would have ensured the pinning of the tubes so as to prevent the recurrence of in-plane FEI.

As explained by Dr. Begley, pinning the tubes at these key intersections would have materially shortened the tubes' vibrating spans, thereby increasing the tubes' natural frequencies by a factor of approximately ██████████. Because a tube's Critical Velocity (i.e., the fluid velocity required to make the tube become unstable) is directly proportional to the tube's natural frequency, the Critical Velocity at which the tube would become unstable would also increase by the same factor. Because the stability ratio would be decreased (i.e., improved) by the same factor, the Repair would have improved the stability of the tube by a factor of ██████████ or more so as to prevent the recurrence of in-plane FEI.

Further, the Repair would have been effective for 40 years. As explained by Dr. Begley, because a tube cannot move relative to the AVB at a pinned location, wear would not have occurred at the pinned locations such that the contact forces at the pinned tube-to-AVB intersections would have remained basically unchanged over the life of the plant. Thus, neither in-plane FEI nor the resulting tube-to-tube wear could have occurred in a repaired SONGS RSG for 40 years. Additionally, the Repair would have greatly mitigated tube-to-AVB wear by a factor of ██████████ or more, resulting in total tube plugging over 40 years of operation well below the 8% tube plugging margin established by Edison. Therefore, had Edison acted on Mitsubishi's recommendation and implemented the thicker-AVB repair, SONGS would have been able to operate for its full life.

➤ ***Mitsubishi demonstrated its repair would prevent recurrence of the in-plane FEI and tube-to-tube wear***

As seen above, Mitsubishi's thicker-AVB repair addressed in-plane FEI and the resulting tube-to-tube wear by correcting for the insufficient supports, and so would have corrected the root cause. In addition, however, demonstrating that the repair would prevent recurrence satisfies Mitsubishi's contractual obligations regardless of whether or not the Tribunal believes that Mitsubishi's repair would correct the "root cause." Beginning in the spring of 2012, Mitsubishi demonstrated to Edison in increasing levels of detail how

Mitsubishi's thicker-AVB repair would prevent recurrence of the tube-to-tube wear, consistent with its separate obligation to act with due diligence and dispatch. Throughout the summer of that year, Mitsubishi provided Edison with updates on testing that was planned and ongoing. In the fall, Mitsubishi showed Edison that inserting thicker AVBs into the tube bundle at SONGS was possible. And in December 2012, Mitsubishi showed Edison that its repair (when combined with the minor T/H improvements it had previously suggested) would reduce stability ratios in the area subject to in-plane FEI to under ■ well below the threshold for fluid elastic instability and providing sufficient margin against instability by any objective standard.

The following table sets forth examples of what Mitsubishi told Edison at key meetings in 2012 about its thicker-AVB repair.

Date	Detail Provided
May 7, 2012	<p>Mitsubishi:</p> <ul style="list-style-type: none"> • Explained the status of its investigation, testing, and mockup construction, and explained its concept for overcoming in-plane FEI by inserting additional AVBs (JX-1150-01) which had “thicker section[s] to increase tube-to-AVB contact force by the elastic deformation of tubes”; • Advised that “the most realistic countermeasure is adding AVB to improve contact forces;” • Presented schematics of the thicker-AVBs, which would taper so as to provide the appropriate amount of contact force to all tubes; • Provided diagrams depicting how the insertion of thicker AVBs between alternating rows of tubes would create high contact forces; • Presented the results to date of Basic Test 1, describing the design and operation of testing apparatus and use of the test data, presenting plots of the measured contact forces generated by the thicker-AVBs, and explaining the use of the test to measure the effect of the thicker-AVB on gaps to determine the likelihood of dings and to show the effect of the thicker-AVBs on natural frequency;

	<ul style="list-style-type: none"> • Explained Basic Test 2 (which would explore the force required to insert a thicker-AVB into the tube bundle and the movement of the tubes during that insertion) and provided a schedule for the completion of that Test; • Presented a detailed schematic of the full-scale mockup to be used to more precisely quantify the contact forces generated by the repair, and explained that the full-scale mockup would “be utilized both for repair plan verification and crew training;” and • Presented a schedule showing the planned restart and mid-cycle shutdowns of Units 2 and 3 and the exploration and testing of a repair which incorporated thicker-AVBs;
May 31, 2012	<p>Mitsubishi:</p> <ul style="list-style-type: none"> • Described its plan to further “develop the repair program using a full size mockup, tooling, and procedures, all developed in Japan,” using an American vendor to facilitate a workable and qualified program acceptable to SCE, and ultimately shipping “the mockup, tooling, etc., to the SONGS site for further training and qualification;” • Explained that the thicker-AVBs would increase contact forces, the tubes’ in-plane natural frequencies, and critical velocities, and in turn decrease the tubes’ stability ratios, and proposed to install the thicker-AVB repair by May 2013; • Explained potential adverse effects of the Repair (potential for tube dings and increased tube-to-AVB gap sizes at tube-to-existing AVB intersections); and • Presented its evaluation of schedules for investigation, development, and implementation, as well as the repair’s accessibility, workability, effectiveness and reliability, and radiation dose, and explained that of the four “effective and applicable” repair methods considered, it “recommends installation of additional ‘thicker AVBs’.”
July 2, 2012	<p>Mitsubishi explained that the additional thicker-AVBs would “maximize the unit operating time up to . . . a full fuel cycle without violating SG performance.” That presentation:</p>

	<ul style="list-style-type: none"> • Suggested that a thicker-AVB might be used in one of two geometries; • Noted that the thicker-AVBs could cause some tube-to-AVB gaps to expand, possibly effecting tube-to-AVB wear; • Provided a list of methods to assess the likelihood of post-repair tube-to-AVB wear (including the evaluation of tube-to-AVB gaps and contact forces via a 3D computer model); • Concluded that the thicker-AVBs would prevent in-plane FEI, and that “analysis and mockup test are to be performed to investigate whether contact force is sufficient;” • Demonstrated the insertion method of the thicker-AVBs, confirming that the “ [REDACTED] ” and [REDACTED] ” and • Concluded that thicker AVBs inserted between AVBs [REDACTED] and [REDACTED] (and between [REDACTED] and [REDACTED]) would be effective in-plane and out-of-plane, could be installed, and would create tube-to-AVB contact force at the additional support points.
<p>August 3, 2012</p>	<p>In addition to explaining the results of its assessments of 26 methods for reducing the T/H conditions in the RSGs (which Mitsubishi undertook in response to Edison’s request), Mitsubishi explained and the further development of the thicker-AVB repair. Specifically, Mitsubishi:</p> <ul style="list-style-type: none"> • Updated Edison regarding the ways to access to the tube bundle; • Updated Edison regarding the assembly and testing of the full-scale mockup; and • Updated the schedule for selection of a Repair.
<p>August 17, 2012</p>	<p>Mitsubishi transmitted a 91-page Mock-up Test Plan to Edison that provided every detail of the forthcoming testing in the full-scale mockup. The Mock-up Test Plan:</p>

	<ul style="list-style-type: none"> • Provided the locations in the full-scale mockup for insertion of the Thicker-AVBs; • Provided the shape and dimensions of the thicker-AVBs; • Provided the locations in the mockup where contact forces would be measured with strain gauges; • Provided the detailed test procedure, including the insertion and fixing of the Thicker-AVBs [REDACTED] [REDACTED] for the testing of the Thicker-AVBs in the full-scale mockup, and for measuring gap sizes with ECT probes; and • Provided a Test Schedule. <p>The Mock-up Test Plan included four appendices, each of which provided additional detail regarding design and fabrication of the mockup and the forthcoming testing.</p>
August 30, 2012	Mitsubishi provided Edison and the NRC with the schedule for testing the full-scale mockup beginning on September 9, 2012, to verify that the thicker-AVB repair would generate large contact forces.
September 9, 2012	Mitsubishi presented photographs of the full bundle mockup with thicker-AVBs inserted into the tube array and secured to a fixing bridge.
September 21, 2012	In presenting a Repair Option Matrix to Edison, Mitsubishi included as option 1.1 (i.e., the first option) the Thicker-AVB Repair and provided a schematic of a side view and two schematics of a top view of an installed repair.
September 25, 2012	Mitsubishi demonstrated the insertion of a thicker-AVB to Edison in the full-scale mockup. In an email regarding the day's activities in Kobe, Edison engineer Mr. Craig Harberts wrote: "The shop tour was very informative and ... ended at the mockup and MHI demonstrated the technique of inserting a thicker AVB. The demonstration went well with no issues."
October 5, 2012	Mitsubishi transmitted its "Mock-up Test for SONGS SG Repair" presentation to Edison in advance of the NRC's inspection. That presentation explained:

	<ul style="list-style-type: none"> • That the mockup included 9,727 tubes and 6 AVBs separating each column of tubes and that the thicker-AVBs would reinforce tube-to-AVB contact forces; • That the thicker-AVBs would be installed between every other column of tubes; • That the thicker-AVBs would be mechanically fixed to a bridge; • The three potential options for accessing the tube bundle; • That the post-repair contact conditions would be evaluated via an ABAQUS model, the validity of which would be verified by the full-scale mockup; and • The AVB [REDACTED] (through photographs of both [REDACTED] condition). <p>During the weekly status meeting, Mitsubishi also explained that the ABAQUS model had been validated by sagging and dent distribution methods, and would be further validated against contact forces in the full-scale mockup test.</p> <p>Mitsubishi further explained the analysis methods that it would use in evaluating the repair, i.e., ABAQUS, IVHET, and FIVATS, and provided the methodology that it would use to evaluate the effectiveness of the Thicker-AVB Repair after 40 years of operation.</p>
November 1, 2012	Mitsubishi explained the use of IVHET to calculate a tube's vibratory response and the calculation of the pinning force and the schedule for the continued testing of the several repair candidates in the full-scale mockup.
November 16, 2012	<p>Mitsubishi presented its "Verification of Repair Method for Tube Vibration Issue," which described the testing of the thicker-AVB repair that had occurred in the full-scale mockup, and concluded that the thicker AVB would be "applicable." (The effectiveness of thicker AVB will be confirmed by analysis.)</p> <p>The presentation also:</p>

	<ul style="list-style-type: none"> • Explained that the thicker-AVBs would [REDACTED] • Confirmed the insertability [sic] of the thicker AVBs; • Provided the results of testing with 3 different thicknesses of thicker-AVBs, in terms of gaps and contact forces; and • Assessed the workability of the repair in terms of time and exposure.
December 14, 2012	<p>Mitsubishi sent Edison a letter advising that, “Based on the results of technical analyses of critical factors and these mockup tests, Mitsubishi has determined that the insertion of ‘thicker AVBs’ is a practical and viable repair option” and that “This option introduces tube to AVB contact forces in excess of [REDACTED] ... which will prevent tube in-plane displacement and tube-to-tube contact. The thicker bars will also increase the effectiveness of other tube support locations throughout the U-bend. The stability ratios for fluid elastic instability are significantly smaller and tube wear due to random vibration is greatly reduced.”</p> <p>Mitsubishi also provided a detailed presentation addressing all key elements of the thicker-AVB repair, almost all of which had been conveyed through prior presentations and meetings, including:</p> <ul style="list-style-type: none"> • MHI’s selection of the repair method; • The improvement of T/H conditions in the SONGS RSGs; • An evaluation of the effectiveness of the thicker-AVB repair; • The implementation schedule for the thicker-AVB repair; and • The validation of the ABAQUS Contact Force Model to the full-scale mockup.

Edison showed little interest in Mitsubishi’s repair in fall of 2012, and explicitly rejected it on December 14, 2012. While Mitsubishi took actions to proactively convince Edison that the repair would work even after it was clear

that Edison would not give the repair fair consideration, Edison's lack of interest ultimately caused Mitsubishi to temporarily suspend its repair efforts. Mitsubishi resumed work on the repair in 2013 only after Edison professed "interest" in repair. In April 2013, Mitsubishi provided Edison with its Repair Report that again explained how the thicker-AVB repair would correct the root cause of the tube-to-tube wear.

Following Mitsubishi's submission of the Repair Report, Edison and AREVA both offered comments on the proposed repair. But none of these comments went to the key point of whether the repair would stop the in-plane FEI and tube-to-tube wear that caused the tube leak at SONGS. To the contrary, the evidence shows that questions raised by the comments were routine, did not challenge the viability of the repair, and were easily addressed. For example, AREVA's questions were what one would expect to be addressed in a third-party design review. Edison, of course, never shared the AREVA comments with Mitsubishi at the time. Once the comments were obtained through this arbitration, Mitsubishi was able to respond fully and satisfactorily to resolve the AREVA questions. As Mr. Stewart, the principal author of the AREVA comments, testified in his expert report:

I am confident that the thicker-AVB repair would more than adequately provide the contact force necessary to prevent in-plane FEI and tube-to-tube wear. The thicker-AVB repair is technically sound, validated in the engineering mockup and testing, practical in its simplicity to implement, and would provide the necessary contact force and bundle stiffness to preclude instability in the SONGS RSGs.

In addition, Mitsubishi at the time had prepared draft responses to Edison's draft comments, but did not transmit them to Edison because Mitsubishi was told that a final version of Edison's questions would be forthcoming.

As outlined above, Mitsubishi, satisfied its obligation to provide a repair with due diligence and dispatch that would correct the root cause of the tube-to-tube wear. Mitsubishi also demonstrated that the problem would not recur, and that its repair would prevent in-plane FEI and control other forms of vibration.

➤ ***Confirmatory testing and analyses have further validated Mitsubishi's thicker-AVB repair***

In preparation for this arbitration, Mitsubishi conducted additional tests and analyses to further demonstrate the viability of the thicker-AVB repair. These tests and analyses were confirmatory in nature and would not have been necessary to convince a reasonable utility to agree to the thicker-AVB repair.

Without exception, these tests and analyses confirmed the key conclusions of Mitsubishi in 2012—that the thicker-AVB repair would have prevented the recurrence of in-plane FEI for the life of the plant, greatly mitigated tube-to-AVB wear not associated with in-plane FEI (which was already manageable), and caused no adverse effects. Further, these efforts confirmed that the recurrence of in-plane FEI could be prevented and tube-to-AVB wear could be significantly reduced without changing the T/H conditions.

In addition to these confirmatory tests and analyses, one of the world’s leading flow-induced vibration experts, Dr. M.K. Au-Yang, conducted a conservative, independent, third-party, first-principles review of the extent to which the Thicker-AVB Repair would have prevented the recurrence of in-plane FEI. Dr. Au-Yang concluded that, “Even under the uttermost conservative assumptions . . . I calculated that instability would not occur after the repair in the SONGS steam generators. My calculations demonstrate that the thicker-AVB repair overwhelms the vulnerability of the SONGS steam generators to in-plane FEI and tube-to-tube wear due to the lack of in-plane tube support in the high thermal-hydraulic conditions specified for the SONGS steam generators.” Claimants did not even attempt to rebut Dr. Au-Yang’s conclusion that the Repair would have prevented the recurrence of in-plane FEI.

➤ ***The thicker-AVB repair could have been implemented***

In addition to being viable, Mitsubishi has demonstrated in this proceeding that the thicker-AVB repair could have been successfully implemented. To support that conclusion, Mitsubishi submitted a Repair Implementation Report, a Repair Implementation Video, and expert witness testimony of Mr. Lyle Bohn, and ██████████ Mitsubishi’s evidence unequivocally shows that the thicker-AVB repair could have been implemented in the SONGS steam generators (1) safely; (2) within a short period of time; (3) with worker radiation doses well within U.S. nuclear industry standards; and (4) at a cost significantly less than the RSG Contract’s limitation of liability. Claimants raised no significant challenges to those conclusions.

Mitsubishi (led by ██████████) and its experts (“United States Field Team” or “USFT”) (led by Mr. Bohn) produced a Repair Implementation Report that provides a detailed step-by-step description of how the repair would have been implemented. Mitsubishi and the USFT also prepared a video showing workers installing the repair in a full-scale mockup, a demonstration that was also separately witnessed by the Tribunal when it visited Kobe in 2015. The USFT completed its work on a part-time basis over the course of seven months. However, as Mr. Bohn testified, had a team been formed to focus full-time on

implementation details, that work would have been performed in a much shorter time, such as 8 to 12 weeks.

As the Implementation Report explains, Mitsubishi and the USFT reached the following conclusions:

Workers implementing the thicker-AVB repair would have been in the U-bend area (higher radiation dose area) in each steam generator for less than 3.5 hours.

The total time to actually install the thicker AVBs in each generator would have been approximately 2 of these 3.5 hours.

The “critical path” time (i.e. the time that the thicker-AVB installation would be controlling the plant’s outage schedule) would have been 5.3 days for Unit 3 and 7.9 days for Unit 2.

The radiation dose exposure received for the implementation would have been 1.0 manRem per generator for Unit 3, and 9.4 manRem per generator for Unit 2, both of which are well within U.S. nuclear industry standards.

The USFT also concluded that the repair could have been implemented for approximately \$30 million, and that workers implementing the repair would have been on the SONGS site for approximately 5 ½ weeks. Based on his 40 years of experience providing services to nuclear plants to resolve emergent problems in the field, Mr. Bohn testified there was “no question” in his mind that Mitsubishi’s thicker-AVB repair could have been successfully implemented.

During the hearing, Claimants raised no substantive challenges to the repair implementation process. The rebuttal testimony of Mr. Bohn and ██████████ which will not be repeated here, addressed the very minor and inconsequential challenges to the implementation plan raised in Claimants’ prior written submittals.

➤ ***Other wear types would not prevent safe operation of SONGS***

The evidence also shows that Mitsubishi investigated other types of tube wear, such as tube-to-AVB wear, tube-to-TSP wear or tube-to-retainer bar wear. As Edison’s May 2012 Root Cause Evaluation for Unit 3 describes, tube-to-tube wear caused by in-plane FEI was the wear mechanism of concern and other

wear types were common and manageable going forward. The evidence also shows that there was consensus on this point among the “world-renowned” industry experts Edison gathered in 2012 that had been working to identify the cause of the problems in 2012 and restart SONGS Unit 2.²⁰¹⁸

(iii) The Tribunals’ Determination

2040. Before determining this Issue C.3(a)(i), the Tribunal notes that a significant portion of the Parties’ case on the adequacy of the Respondents’ Type 1 Repair proposal is addressed in this present Issue C.3(a)(i).

2041. The Tribunal structures its answer to the Parties’ respective cases under this Issue C.3(a)(i) to follow the headings as put forth in the Claimants’ RPHM.

(1) What is the Root Cause of the Unit 3 Tube Leak?

2042. The Parties fundamentally diverge as to whether the Root Cause of the Unit 3 tube leak was the T/H conditions found in the RSGs, as put forth by the Claimants, or a combination of T/H conditions and inadequate tube support, as submitted by the Respondents.

2043. This determination is significant. While the Respondents have identified various tweaks to the RSGs that could somewhat reduce T/H conditions,²⁰¹⁹ notably reducing them below where Respondents calculated in-plane FEI would occur (i.e., below a void fraction of 99.3%), it is not disputed between the Parties that any greater reduction in T/H conditions required a redesign and replacement of the RSGs.²⁰²⁰

²⁰¹⁸ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 210-230.

²⁰¹⁹ See ¶ 562 above (MHI’s later repair recommendations also identified minor T/H improvements).

²⁰²⁰ See Section VII.G(b)(v) above.

2044. An evaluation of the Unit 3 tube leak is set forth in the various versions of MHI's Technical Evaluation Report. As cited by the Claimants, that Report provides in relevant part as follows:

Consequently, it is postulated that the thermal hydraulic condition of the secondary side, namely high void fraction (steam quality) and high flow velocity is the main cause of the unexpected tube wear in SONGS Unit 2 and Unit 3.²⁰²¹

2045. This conclusion is provided under Section 5.1 of MHI's Technical Evaluation Report, titled, "Thermal Hydraulic Condition of the Secondary Side." It is followed by Sections 5.2, titled "Evaluation of U-bend Supports Conditions" with subsections on both out-of-plane and in-plane support.

2046. Section 5 of MHI's Technical Evaluation Report introduces these two subsections by stating:

Generally, the potential causes for the phenomenon of tube bundle vibration are judged to be the thermal hydraulic conditions of the secondary side and supporting conditions of the tube bundle.²⁰²²

2047. Accordingly, the Claimants appear to emphasize the conclusion that T/H conditions are a root cause by relying on the section of MHI's Technical Evaluation Report particularly addressing those specific conditions.

2048. In contrast, MHI identifies that in the theoretical case of any type of wear, the cause will either be T/H conditions and/or support conditions.

²⁰²¹ Exh. JX-1256, p. 52 (See also other versions as cited in Claimants' RPHM, ¶ 234).

²⁰²² Exh. JX-1256, p. 52.

2049. As mentioned above,²⁰²³ MHI also prepared a “Root Cause Analysis Report for tube wear identified in the Unit 2 and Unit 3 Steam Generators” of SONGS (“Root Cause Analysis Report”).²⁰²⁴ This Root Cause Analysis Report was submitted to the NRC on 25 February 2013, as it happens to be by the late Mr. Arthur Howell at the NRC.²⁰²⁵ Regarding TTW, and in particular TTW on account of in-plane FEI, the Tribunal finds it useful to quote once more the relevant passages of the Root Cause Analysis Report that found that FEI:

was due to a combination of a lack of effective contact forces between the tube and AVB in the in-plane direction and localized thermal-hydraulic (T/H) conditions (high steam quality (void fraction) and high fluid velocity).²⁰²⁶

2050. MHI’s Root Cause Analysis Report continued, elaborating that “the average contact force in the Unit 3 RSGs was smaller than the average contact force in the Unit 2 RSGs” and that “therefore the contact forces of the Unit 3 RSGs were more likely to be ineffective in preventing in-plane motion of tubes [and] that the Unit 3 RSGs were more susceptible to in-plane tube vibration than those in Unit 2.”²⁰²⁷

2051. SCE’s own root cause evaluation report provides similarly that a combination of T/H Conditions and insufficient contact force are the root cause:

The mechanistic cause of the tube-to-tube wear was identified as FEI, involving the combination of localized high steam/water velocity (tube vibration excitation forces), high steam void fraction (loss of ability to

²⁰²³ See ¶ 676 above.

²⁰²⁴ Exh. JX-1447.

²⁰²⁵ Exh. JX-1676.

²⁰²⁶ Exh. JX-1447, p. 18.

²⁰²⁷ Exh. JX-1447, pp. 18-19.

dampen vibration), and insufficient tube to AVB contact forces to overcome the excitation forces.²⁰²⁸

2052. That a combination of T/H conditions and inadequate tube support is at the root cause of the Unit 3 FEI was explained by SCE's Mr. Dietrich to the NRC, the US Nuclear Regulatory Commission, which, as set out above, is the agency tasked with ensuring public safety regarding the safe operation of power plants.²⁰²⁹ This explanation was further provided to the NRC as part of SCE's response to the CAL Action Item 1, in order to restart Unit 2:

SCE determined the cause of the TTW in the two Unit 3 SGs was fluid elastic instability (FEI), resulting from the combination of localized high steam velocity, high steam void fraction, and insufficient contact forces between the tubes and the anti-vibration bars (AVBs).²⁰³⁰

2053. SCE further provided as response to the CAL Action Item 2:

Given that the thermal hydraulic conditions are essentially the same in both units, the significantly lower level of TTW in Unit 2 has been attributed to manufacturing differences that resulted in greater contact between the tubes and AVBs in Unit 2, providing greater tube support.²⁰³¹

2054. Despite SCE and MHI identifying a combination of factors as a root cause to the NRC, in this arbitration, the Claimants have adopted a different approach, submitting that the T/H conditions were the sole root cause.

²⁰²⁸ Exh. JX-1149, p. 4.

²⁰²⁹ See ¶¶ 671-672 above.

²⁰³⁰ Exh. JX-1420, p. 2.

²⁰³¹ Exh. JX-1420, p. 3.

2055. The Claimants' position is not convincing. It is contradicted by their own contemporaneous submissions to the NRC, as set out in the preceding paragraphs above.
2056. Furthermore, it is contradicted by the fact that Unit 2 operated twice as long as Unit 3, with the same T/H conditions, and yet did not suffer from in-plane FEI.
2057. In addition, the Claimants' submissions are contradicted by a basic understanding of the stability ratio formula as established above.²⁰³² To recall, in this respect, FEI occurs where effective velocity exceeds critical velocity, which is in large part determined by the tube support conditions and natural frequency of the tubes.
2058. Therefore, the root cause of in-plane FEI TTW was what SCE and MHI found it to be during their efforts to restore SONGS to service: a combination of high velocities, insufficient damping, and inadequate tube support.
2059. By consequence, addressing either the T/H conditions or the inadequate in-plane tube support, whether individually or jointly, would resolve the root cause of in-plane FEI.
2060. Nonetheless, the Claimants have submitted that a restoration of T/H conditions would be required to obtain an NRC approval for Unit 3. They rely on the expert evidence of Mr. Strosnider and Mr. Leeds:

The NRC would have been concerned regarding any proposal that did not address the thermal-hydraulic conditions. The NRC would have needed a credible basis for concluding that tube degradation would have been effectively controlled while operating outside the range of thermal-hydraulic conditions known at that time to have supported safe operation without FEI in U-bend steam generators.²⁰³³

²⁰³² See ¶ 170 above.

²⁰³³ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 91.

2061. The Tribunal considers that the NRC would have reviewed a LAR provided to them and determined whether thicker AVBs would provide the necessary tube support, given the T/H conditions, and would also have evaluated the data as provided. The Tribunal does not consider that the NRC would have analyzed only the T/H conditions for Unit 3 or only the support conditions. Rather, the Tribunal considers that the NRC would have conducted a holistic approach to Unit 3 that would have inquired as to whether a post-repair Unit 3 would be unstable by considering the Stability Ratio formula and accordingly consider both T/H conditions and support conditions, as opined by Mr. Johnson, the Respondents' expert.²⁰³⁴
2062. Moreover, the Tribunal does not consider there to be any particular difference between a void fraction of 99.6% and 98.5-7% as calculated for comparable plants. It does not appear that high void fractions are in and of themselves a cause of FEI. This is evident given that Unit 2 operated for nearly twice as long, in the same T/H conditions, as Unit 3 and yet did not suffer in-plane FEI.
2063. Accordingly, the root cause of the Unit 3 tube leak was a combination of T/H conditions and insufficient tube support.

(2) Was T/H Testing Required?

2064. In Section XIV.A(b) above, the Tribunal set forth its review of what testing was undertaken and what testing was not undertaken. In addressing this Issue, the Tribunal expands on its review to address the question of whether (additional) T/H testing was required.

²⁰³⁴ Expert Witness Statement of Mr. Johnson, ¶ 32.

2065. The Claimants submit that in order to demonstrate the effectiveness of the Type 1 Repair, T/H testing was required in comparable operating conditions as experienced by SONGS.
2066. In the Respondents' perspective, the effectiveness of the Type 1 Repair had been and could be demonstrated with its tests at its facilities in Japan.²⁰³⁵ In brief, the Respondents' position was that the repair is proven effective once the contact force required to prevent in-plane FEI to occur was determined. Wear calculations were then undertaken to assess if the RSGs would last for the remainder of the 40 year period.
2067. The Tribunal concurs with the conclusion of the Respondents' expert Dr. Au-Yang during cross-examination that:
- testing is preferable to computer analysis, given that testing is "much simpler, easier to check, and it's more convincing. It's less error, less possibility of making errors in tests."²⁰³⁶
2068. It is also apparent that MHI's willingness to conduct tests in comparable T/H conditions met a dead end when it was determined that the full range of desired tests was a multi-year affair, following the Chalk River visit.²⁰³⁷
2069. However, as determined by the Tribunal in Section XIV.A(b) above, B&W recommended that certain tests be undertaken to further verify the repair while other tests, on wear rates for example, be put off to a future stage.
2070. In this connection, the Tribunal is not convinced by the Claimants' argument that because the thicker AVB repair was a first-of-a-kind repair to a first-of-a-kind

²⁰³⁵ Respondents' Position Statement on the Revised List of Issues, ¶ 219.

²⁰³⁶ Transcript, p. 2505 (Dr. Au-Yang).

²⁰³⁷ See ¶ 1808 above.

problem, that somehow the NRC would be paralyzed and unable to proceed to undertake a review of the proposal, absent the construction of a replica steam generator to test the repair in prototypical conditions.

2071. In particular, Mr. Johnson, one of the Respondents' regulatory experts, has testified that the NRC "has an extensive technical staff" and could call upon "whatever experts they needed to evaluate – to do their job and evaluate a first-of-a-kind repair."²⁰³⁸ This opinion is shared by Mr. Leeds, expert for the Claimants, who has testified that "the NRC accepts first-of-a-kind repairs and first-of-a-kind designs, and we do that as a matter of course" and the NRC has "done that throughout our history."²⁰³⁹ Mr. Leeds, however, cautioned that the NRC would carefully scrutinize the "analytics" behind the proposal and insist on "confirmatory testing."²⁰⁴⁰

2072. The Tribunal acknowledges that the NRC would have required confirmatory testing. What this Tribunal is not convinced of is that prototypical testing was required to address "unintended consequence[s]" of a proposed thicker AVB repair.²⁰⁴¹ In particular, the Tribunal is not convinced by Mr. Leeds' testimony that such prototypical testing would be required:

Q: Can you tell the Tribunal your view of the importance of prototypical testing of a Type 1 Repair if you're going to assume that the NRC would have even considered a repair proposal that did not address thermal-hydraulics?

A. I thought it was imperative that you did testing. You've heard a lot about the thermal-hydraulics, and you've heard a lot about the thermal-hydraulics. You've got to realize, the operating conditions within these steam generators is a very severe environment. These steam generators

²⁰³⁸ Transcript, pp. 4871-4872 (Mr. Johnson).

²⁰³⁹ Transcript, p. 1892 (Mr. Leeds).

²⁰⁴⁰ Transcript, p. 1892 (Mr. Leeds).

²⁰⁴¹ Transcript, p. 1828 (Mr. Moran).

operate at 600 degrees Fahrenheit and 1,000 pounds per square inch. And you think about the size of them, you can imagine the force and the energy that goes through those steam generators.²⁰⁴²

2073. While Mr. Leeds has painted a vivid picture of the T/H conditions of steam generator operating conditions, it has not been established why the SONGS RSGs differ from other steam generators. Presumably, those other steam generators also have a “very severe environment,” operate at or around 600 degrees Fahrenheit and at a pressure of 1,000 pounds per square inch. Therefore, the Tribunal fails to see any connection between the environment at SONGS and the requirement that a repair at SONGS requires prototypical testing as opposed to other types of testing or analysis as the NRC has required for other plants.
2074. Mr. Leeds, for the Claimants, did further testify, without elaboration, that because the Type 1 Repair called for pinning of the tubes, it was different from other kinds of repair.²⁰⁴³ In their expert statement, Mr. Strosnider and Mr. Leeds reference the May 2013 AREVA report which identifies the risk of a new form of degradation on account of tubes being “locked-in by the pinning forces at the AVBs.”²⁰⁴⁴ What this means, however, appears in dispute.
2075. The Claimants’ expert, Dr. Asadi, appears to believe that this “violates a paradigm that allows free expansion of the tubes relative to the rest of the structure.”²⁰⁴⁵ However, as explained by Mr. Lagally, the Respondents’ expert, the pinning force of the thicker AVBs would still allow movement, “because the AVB assembly rides with the U-bend.”²⁰⁴⁶

²⁰⁴² Transcript, p. 1895 (Mr. Leeds).

²⁰⁴³ Transcript, p. 1895 (Mr. Leeds).

²⁰⁴⁴ Expert Witness Statement of Mr. Strosnider and Mr. Leeds, ¶ 81, n. 59.

²⁰⁴⁵ Transcript, p. 3928 (Mr. Lagally); Expert Witness Statement of Dr. Asadi, ¶ 79(d).

²⁰⁴⁶ Transcript, p. 3928 (Mr. Lagally).

2076. It is apparent that Mr. Leeds' opinion of what is required is determined by a technical understanding of what MHI's Type 1 Repair would do. Mr. Leeds has highlighted the qualities and capabilities of the NRC and affiliated entities with whom he used to work. The exact type of testing that would be required appears to depend on what conclusions the NRC staff would reach, based upon an evaluation of whatever repair would be put forward by SCE and MHI for review.

2077. The Tribunal finds that the "confirmatory" testing²⁰⁴⁷ and analysis undertaken by the Respondents' experts in preparation of this arbitration to be convincing. In this respect, Dr. Au-Yang's conclusion, for the Respondents, is persuasive:

My calculations demonstrate that the thicker-AVB repair overwhelms the vulnerability of the SONGS steam generators to in-plane FEI and tube-to-tube wear due to the lack of in-plane support in the high thermal-hydraulic conditions specified for the SONGS steam generators.²⁰⁴⁸

2078. Accordingly, the Tribunal concludes that the Respondents had provided adequate testing during the development of the Type 1 Repair to demonstrate its potential effectiveness. They had also provided adequate confirmatory testing in preparation of this arbitration that the NRC would have found convincing. Moreover, the Tribunal considers that there is no reasonable basis for the conclusion that T/H testing in a replica SONGS steam generator would be required to validate the proposed Type 1 Repair.

(3) Was there a risk of out-of-plane FEI?

2079. The Claimants submit that there was a risk of out-of-plane FEI at SONGS, as evidenced by the testimony of the Respondents' own witnesses and experts.²⁰⁴⁹

²⁰⁴⁷ Respondents' Validation Report of the U-Bend Repair, ¶¶ 3, 131.

²⁰⁴⁸ Expert Witness Statement of Dr. Au-Yang, ¶¶ 7-11.

²⁰⁴⁹ See Section XV.C(b)(i) above.

2080. The Tribunal is not convinced by the Claimants' position.
2081. As set forth in Section XIII.D(c)(iii) above, the Claimants have established, through the cross-examination of the Respondents' experts, that gap-limited out-of-plane FEI occurred at SONGS. However, the Tribunal considers the Respondents to have convincingly shown that gap-limited FEI is a distinct phenomenon as compared to classic FEI and one that is manageable under a steam generator wear management program.
2082. The Tribunal further finds that the risk of gap-limited out-of-plane FEI following a thicker AVB repair is also reduced, given that the gaps between the thicker AVBs and the tubes in the repair region of the U-bend are eliminated. As explained by Dr. Begley, the Respondents' expert, wear cannot occur at a pinned tube-to-AVB intersection.²⁰⁵⁰

(4) Whether MHI demonstrated that the Type 1 Repair would prevent in-plane FEI and tube-to-tube wear?

2083. The Claimants submit that the Respondents did not demonstrate that the repair would prevent in-plane FEI and tube-to-tube wear. In their RPHM they make three main allegations:
- i. That Respondents employed an incorrect Connors Constant and damping in stability ratio analysis;
 - ii. That corrected post-repair in-plane stability ratios would exceed 1.0; and
 - iii. That the Respondents did not justify the required force for the thicker AVBs and used an incorrect coefficient of friction.²⁰⁵¹

²⁰⁵⁰ Transcript, pp. 4365-4366 (Dr. Begley).

²⁰⁵¹ Claimants' RPHM, ¶ 246.

2084. First, with respect to the Claimants' contention that the Respondents employed an incorrect damping in stability ratio analysis, item (i) in the preceding paragraph, the Claimants' expert Exponent identified that MHI used squeeze film damping in an evaluation of the in-plane stability ratios during the repair era.²⁰⁵²
2085. However, as Exponent states, the testing at the plant in Chalk River, requested by AREVA, later evidenced that squeeze-film damping was not effective for in-plane damping.
2086. In this arbitration, MHI corrected for this. The Tribunal finds no fault in MHI assuming, to the extent that it did, some squeeze film damping in in-plane stability ratios post-repair. This appears to have been industry practice prior to the Chalk River discovery.
2087. The Claimants have not alleged that discounting squeeze-film damping is consequential. To the contrary, MHI's analysis for this arbitration continues to support the effectiveness of a thicker AVB repair. Mr Russell, for the Respondents, has testified that "the repair did not require the use of squeeze film damping" and that "MHI chose to use [squeeze film damping] to stay consistent with the methods that were used in the restart proposal."²⁰⁵³
2088. Also in respect of item (i) in ¶ 2083 above, the Claimants take issue with MHI's methodology in determining the Connors' Constant for in-plane stability ratio assessments. In this respect, they rely on their expert Exponent.²⁰⁵⁴

²⁰⁵² Exponent Design Review, ¶¶ 396-397.

²⁰⁵³ Transcript, p. 4728 (Mr. Russell).

²⁰⁵⁴ Exponent Design Review, ¶¶ 399-405.

2089. Specifically, the Claimants submit that MHI adopted values of ■ through ■ for Connors' Constant, depending on the tube, based upon analytical evaluations of other experiments rather than conducting their own experimentation.
2090. As stated above, the Claimants, through their expert Exponent, are critical of MHI adopting a K that differs from the ASME recommended K of 2.4 absent experimentation.²⁰⁵⁵
2091. The Tribunal does not find the Claimants' criticism convincing. While the Tribunal concurs with the Claimants that experimentation is an appropriate means of a steam generator designer adopting a different K value,²⁰⁵⁶ the Tribunal notes that Mr. Langford, for the Claimants, testified that Westinghouse's experimentation concluded that a Connors' Constant of 7.8 could be used, and was used by Westinghouse, in the in-plane direction.²⁰⁵⁷ Recalling that a smaller K is a more conservative design estimate, the Tribunal sees no particular consequence to MHI adopting a Connors' Constant of ■, which is not even ■ of that adopted by Westinghouse.
2092. Second, with respect to the Claimants' submission that corrected post-repair in-plane stability ratios would exceed 1.0, item (ii) in ¶ 2083 above, and that MHI incorrectly calculated the in-plane stability ratios, the Claimants base their submission on their evidence presented by their expert Exponent.²⁰⁵⁸
2093. The Claimants' expert Exponent's calculations are on account of "correcting" the in-plane stability ratio calculation from using a higher Connors' Constant to a Connors' Constant of 2.4, per the ASME standard. The Tribunal does not consider this

²⁰⁵⁵ See generally Section XII.C(a)(ii) above.

²⁰⁵⁶ See Transcript, p. 866 (Dr. Asadi).

²⁰⁵⁷ See Transcript, p. 1755 (Mr. Langford).

²⁰⁵⁸ Exponent Design Review, ¶¶ 406-407.

correction reasonable. As determined above, the Tribunal does not find any particular fault in the Respondents having undertaken calculations to determine what in-plane Connors' Constant should be used.²⁰⁵⁹

2094. Third, with respect to the Claimants' contention that the Respondents did not justify the required force for the thicker AVBs and used an incorrect coefficient of friction, item (iii) in ¶ 2083 above, the Claimants rely once more on their expert Exponent.
2095. As explained by Exponent, MHI only calculated pinning force for two tubes in the repair and had no basis or an insufficient basis for concluding that its IVHET code, used for wear rate calculations, was also suitable in calculating required pinning forces.²⁰⁶⁰ The Respondents do not appear to significantly dispute this alleged error.²⁰⁶¹ However, the Respondents set forth that the Claimants' concern regarding this matter is moot given that "almost all of the contact forces in Zones 1 and 2 would have exceeded [REDACTED]" such that any aspects surrounding the alleged improper calculations of the required pinning force of [REDACTED] (as MHI originally calculated) are inconsequential.²⁰⁶²
2096. The Respondents' explanation is convincing. While the Claimants appear to have identified some deficiencies in the Respondents' analysis, those do not appear consequential. Accordingly, MHI has demonstrated that its repair would prevent in-plane FEI.

(5) Did MHI address post-repair random wear?

2097. The Claimants' primary case in this regard is that wear rate analysis, as undertaken by the Claimants' expert Dr. Egan, concludes that Unit 2 and Unit 3 would fail in 3.3

²⁰⁵⁹ See ¶ 2091 above.

²⁰⁶⁰ Exponent Design Review, ¶¶ 409-4014.

²⁰⁶¹ Respondents' RPHM, ¶ 217.

²⁰⁶² Respondents' RPHM, ¶ 217.

and 0.6 years respectively, even without accounting for any FEI wear.²⁰⁶³ The Tribunal is not convinced by the evidence presented by the Claimants for the following reasons.

2098. Dr. Egan’s assessments are based upon a crucial hypothesis:

Without inspection data from subsequent operating periods, it is reasonable and prudent to expect the damage to progress at the same rate as it did in the first cycle of operation.²⁰⁶⁴ (emphasis added)

2099. As SONGS was shut down after a single cycle (in fact, less than a cycle for Unit 3), there is only a single data point for how much wear was experienced at SONGS. Dr. Egan’s assumption is to assume constant wear growth. The alternative assumption is to assume that there is wear attenuation.²⁰⁶⁵ In such scenarios, the rate of wear growth decreases with subsequent plant cycles. As explained by the Respondents’ expert Dr. Begley, “a small difference in attenuation factor makes a large difference in projected growth rates and future tube plugging.”²⁰⁶⁶

2100. The Claimants’ argument on this Issue is overly speculative as there is insufficient data to conclude that the SONGS RSGs would fail from random wear after a few more months of operation, particularly after the proposed repair. Specifically, absent additional evidence, the Tribunal is unable to accept the Claimants’ argument that SONGS would fail rapidly rather than continue to operate smoothly, as is the case with the St-Lucie 2 plant, which the Tribunal recalls, was another wear challenged plant that has undergone a power uprate.²⁰⁶⁷

²⁰⁶³ Claimants’ RPHM, ¶ 248.

²⁰⁶⁴ Expert Witness Statement of Dr. Egan, ¶ 14(1).

²⁰⁶⁵ Expert Witness Statement of Dr. Begley, ¶ 105.

²⁰⁶⁶ Expert Witness Statement of Dr. Begley, ¶ 115.

²⁰⁶⁷ Transcript, pp. 4393, 5126 (Respondents, citing Mr. Wilson and Dr. Begley).

2101. In contrast, the Respondents calculated, using IVHET, that the post-repair Unit 3 would last for 40 years. It is evident that the Respondents, during the repair era, recommended that the repair be evaluated with post-repair operation data that would have be of used in predicting future wear growth.²⁰⁶⁸
2102. Accordingly, the Tribunal considers that the Respondents did address post-repair random wear.

(6) Did MHI analyze AVB twist and wear patterns?

2103. The Tribunal does not accept the Claimants' position that Respondents failed to analyze issues surrounding AVB twist and wear patterns for the following reasons.
2104. For the Respondents, ██████████ testified that AVB twist was analyzed in Appendix 9 of MHI's Technical Evaluation Report on tube wear in Unit 3.²⁰⁶⁹ That Report provides:

In the manufacturing dispersion analyses, much higher reaction forces are generated at AVB bending portion in Unit-2 than Unit-3, because AVB nose thickness and twist for Unit-2 is larger than those of Unit-3 due to difference of ██████████²⁰⁷⁰

2105. Furthermore, ██████████ stated that:

In Unit-2, AVB which twist deviates from the tolerance is needed to be flattened and touched up by hand, so that AVB twist satisfies the tolerance. In Unit-3, it comes to be not necessary to touch up after the ██████████ ██████████ adopted.²⁰⁷¹

²⁰⁶⁸ Exh. JX-1734, pp. 60ff, 94ff.

²⁰⁶⁹ Transcript, pp. 4422-4423 ██████████

²⁰⁷⁰ Exh. JX-1759, p. 359.

²⁰⁷¹ Exh. JX-1759, p. 366.

2106. The Respondents' position is that it is exactly these types of manufacturing differences between Unit 2 and Unit 3 that led to in-plane FEI occurring in Unit 3 where, for example, the existence of up to 12 ineffective supports existed, in the in-plane direction.
2107. The Claimants have raised a number of issues in this respect. They submit that the choice of a 2V X 3 AVB design²⁰⁷² increased void fraction in the RSG Design.²⁰⁷³ The Respondents rebut that this increase was of only [REDACTED] and that MHI's and SCE's design era evaluation of the 2V x 3 AVB design was an overall better choice when considering all the relevant factors, and not just void fraction.²⁰⁷⁴
2108. As relied upon by the Claimants, Mr. Langford has developed theories explaining that the occurrence of in-plane FEI at SONGS surround aspects of manufacturing defects and inadequate control of AVB twist that related to MHI's alleged inexperience in the manufacture of AVBs.²⁰⁷⁵
2109. The Tribunal is not convinced by the Claimants' position on the theory of a manufacturing deficiency. As the Respondents have submitted:
- Mr. Langford did not know which Unit was manufactured first, and his theories regarding the AVB "learning curve" and changes to the AVB processing process would seem to provide an explanation only if Unit 3 had been manufactured before Unit 2. In fact the opposite is true.²⁰⁷⁶
2110. Thus, while Mr. Langford's theories may have merit in the abstract, they appear insufficiently supported by the facts in question.

²⁰⁷² See Section VII.D(e)(iv)I.A(a)(i)(4) above.

²⁰⁷³ Claimants' RPHM, ¶¶ 249-251.

²⁰⁷⁴ See Exh. JX-501, p. 78.

²⁰⁷⁵ Claimants' RPHM, ¶ 255.

²⁰⁷⁶ Respondents' RPHM, Appendix 1, ¶ 47.

2111. Accordingly, the Tribunal considers that the Respondents did sufficiently analyze issues of AVB twist and wear patterns.

(7) Did MHI fail to provide SCE with a detailed design report?

2112. The Tribunal considers that the Claimants have shown that they were never provided with a design for the thicker AVB repair proposal that contained every detail required for an implementation.

2113. However, the Tribunal considers that the Respondents have persuasively demonstrated that the approval of a repair in the nuclear industry generally proceeds in an iterative process, as described by the Respondents' expert, Mr. Olszewski:

(...) I know on May 31st [2012] by reading that total package, that Edison clearly recognized this was just a – it was a viable repair at that point in time. And that's what MHI proposed, a viable repair, and all they thought it was. It needed a lot of work. It needed some benchmark – some testing, some engineering analysis, and that needed to happen in this evolving iterative process which a repair development is, and I've been through a number of times.²⁰⁷⁷

2114. It would have been open to the Claimants to provide initial support to a repair proposal by the Respondents, with the understanding that the normal evaluation process would be undertaken to refine and approve that repair. Mr. Olszewski further convincingly opined that:

With the consideration that the effort is a recovery, an evolutionary, iterative type process, and, really, it's a joint responsibility, in my opinion, between the utility and the vendor.

Certainly the vendor, Mitsubishi in this case, had responsibility to drive the technical aspects of it and the technical recovery, but certainly the

²⁰⁷⁷ See Transcript, p. 2829 (Mr. Olszewski); See also Expert Witness Statement of Mr. Olszewski.

utility needs to be engaged every step of the way, involved in the decisions from the beginning to the end.²⁰⁷⁸

2115. That a repair proceeds in an iterative process was also addressed by Mr. Wade, for the Respondents:

Mr. Hinchey: So you would consider that iterative process to be normal in developing a repair for a steam generator such as at songs?

Mr. Wade: Yes, sir. Every – every project, no matter how large or small, is an iterative process when you’re taking about a vendor working with a utility.²⁰⁷⁹

2116. A further aspect of this is the “big E” and “small e” engineering as addressed by the Tribunal in Section XIV.A(a) above. The Tribunal considers it reasonable that a repair plan first addresses the “big E” issues, such as repair design, and only then addresses the details of “small e” aspects, such as repair implementation.

2117. The Tribunal considers that the iterative process, as described by the Respondents’ experts, could have been employed at SONGS in evaluating the Unit 3 repair.²⁰⁸⁰

2118. The Claimants have submitted²⁰⁸¹ that MHI did not require anything from SCE in order to develop the repair and further test it to prove it would work, an Issue further discussed below.²⁰⁸² While that Issue will be addressed, the Tribunal considers that regardless of whether MHI required any particular assistance or information from SCE, what MHI did require to move forward was a buy-in from SCE, at least as to

²⁰⁷⁸ Transcript, p. 2733 (Mr. Olszewski).

²⁰⁷⁹ Transcript, p. 4600.

²⁰⁸⁰ See Transcript, p. 2829 (Mr. Olszewski); Expert Witness Statement of Mr. Olszewski.

²⁰⁸¹ Claimants’ RPHM, ¶¶ 259-261.

²⁰⁸² See ¶¶ 2128-2131 below.

the repair concept. That is, SCE needed to signal that it agreed in principle that a repair should be pushed forward.

2119. From one perspective, the Parties appear to have found themselves in a catch-22. The Claimants submit that in order to approve a Type 1 repair, they required a developed repair plan, more than the PowerPoint presentations that MHI provided in April/May 2012.²⁰⁸³ The Respondents, while developing such a plan, as submitted for 4 April 2013,²⁰⁸⁴ also had to focus on developing alternative repair models, investigating T/H improvements, and developing a replacement option, all at the Claimants' request.²⁰⁸⁵ Accordingly, the Respondents do not appear to have received sufficient direction from the Claimants as to whether the Claimants were genuinely interested in a Type 1 repair.
2120. As determined by the Tribunal in Section XIV.A above, the Claimants imposed T/H repair conditions that could not be met by any repair, only a replacement. In the Tribunal's determination, the Claimants were not interested in a Type 1 repair, or at least, they were only interested in a Type 1 repair as an interim repair while also pushing forward for a long term replacement option.²⁰⁸⁶
2121. Consequently, while MHI did fail to provide SCE with a detailed design report, the Tribunal does not consider that MHI was required to have done so given SCE's failure to provide an approval in principle for a Type 1 Repair proposal. If SCE had provided that approval in principle, the evidence shows that MHI was willing to subsequently furnish a detailed design as part of the normal iterative process.

²⁰⁸³ Claimants' RPHM, ¶¶ 298-300.

²⁰⁸⁴ Exh. JX-1734.

²⁰⁸⁵ See generally Section XIV.A above.

²⁰⁸⁶ See generally Section XIV.A above.

(8) Did the 2013 AREVA review determine that MHI failed to demonstrate the viability of the repair?

2122. With respect to the Claimants' contention that the 2013 AREVA review determined that MHI's failed to demonstrate the viability of the repair, the Tribunal notes that it is not disputed that the AREVA report identified numerous concerns and questions regarding MHI's April 2013 repair proposal.

2123. In this respect, Mr. Stewart, the main drafter of that 2013 AREVA Report, has testified, on behalf of the Respondents, that:

Upon my completion of the "cursory review" of the MHI U-Bend Repair Report and submittal of the AREVA Report in May 2013, I believed that the proposed thicker-AVB repair of the SONGS RSGs could have been optimized quickly, the key technical questions in the AREVA Report could have been addressed satisfactorily to allow the repair to move forward expeditiously, the repair could have been installed; and that it would have prevented the recurrence of in-plane FEI.²⁰⁸⁷

2124. The Tribunal has also reviewed the extensive response to the AREVA Report prepared by ██████████ for the Respondents in this arbitration.²⁰⁸⁸ This response was reviewed by Mr. Stewart, the Respondents' expert.

2125. The combination of a review of AREVA's concerns, Mr. Stewart's expert statement(s), and ██████████ response are convincing evidence that the concerns raised by AREVA were indeed surmountable. This is further considered by the Tribunal in Issue C.3(b)(i) below.²⁰⁸⁹

2126. This is further illustrated by AREVA's letter to ██████████ of MHI, of 4 June 2013, in which AREVA proposes to review, modify and optimize the MHI draft thicker

²⁰⁸⁷ Expert Witness Statement of Mr. Stewart, ¶ 15.

²⁰⁸⁸ Exh. JX-2190.

²⁰⁸⁹ Section XV.C(e)(iii) above.

AVB installation process by 22 August 2013, i.e., over approximately a 6 week period.²⁰⁹⁰ AREVA concluded its letter by stating that it “look[ed] forward to the opportunity of working with MHI and are committed to providing our support in successful installation of MHI[‘s] proposed repair.”²⁰⁹¹

2127. The Tribunal considers that while AREVA had concerns, it was committed to assisting the Respondents in resolving those concerns within a short time period. As considered further below, in this arbitration, the Respondents have demonstrated that AREVA’s concerns could indeed be resolved.²⁰⁹²

(9) Did MHI require assistance from SCE to conduct the testing and analysis that its experts say was required?

2128. The Tribunal considers that the Claimants are correct in submitting that, on a technical level, SCE was not required to provide MHI with anything in order to conduct further tests.
2129. However, the Tribunal also considers that SCE was required to provide MHI with an affirmation that it was not only interested, but prepared to go forward on an iterative basis with a proposed Type 1 Repair, as the Tribunal determined in Section C(b)(iii)(7) above.²⁰⁹³
2130. On this, after considering the evidence as set forth by the Parties and addressed in Section XIV above, the Tribunal concludes that SCE, while appearing to be open to a Type 1 Repair as an “interim” repair, nonetheless insisted on conditions that could only be satisfied by a permanent repair.

²⁰⁹⁰ Exh. JX-1809, pp. 2, 8.

²⁰⁹¹ Exh. JX-1809, p. 1.

²⁰⁹² See Section XV.C(e)(iii) below.

²⁰⁹³ See ¶ 2121 above.

2131. In consequence, SCE never provided the affirmations that it was sufficiently interested in a Type 1 Repair that would justify MHI conducting further testing.

(10) Did MHI have any intention of conducting additional testing or analysis to demonstrate to Edison the viability of the thicker AVB repair?

2132. With respect to the question of whether the Respondents had any intention of conducting additional testing or analysis to demonstrate to the Claimants the viability of the thicker AVB repair, the Tribunal considers the following.

2133. As determined above, by virtue of the ALSB decision on Unit 2, the Tribunal considers that a hypothetical challenge by Friends of the Earth to a restart of Unit 3 would result in a public hearing on account of the Unit 3 restart being considered a test or experiment triggering a public hearing.²⁰⁹⁴

2134. Furthermore, the Tribunal is convinced by the Respondents' evidence presented. The Respondents' experts set out that post-repair data could have been used to further verify the effectiveness of the repair. In particular, the Tribunal considers that a mid-cycle inspection would have been an acceptable way to have "removed any lingering concerns about potential new modes of tube degradation and to have confirmed the repair's effectiveness."²⁰⁹⁵

2135. In this regard, the Tribunal finds persuasive the evidence that SCE itself has provided, as supported by the operational assessments of Westinghouse, AREVA, and Intertek for a restart of Unit 2.²⁰⁹⁶ All their assessments considered that post-restart, mid-cycle inspections were an effective and permitted means to determine if Unit 2 was safely operating. The NRC staff did not disagree with such an approach.

²⁰⁹⁴ See Section XIV.C(b) above.

²⁰⁹⁵ Expert Witness Statement of Mr. Johnson, ¶ 38.

²⁰⁹⁶ Exh. JX-1420.

Indeed, the CAL itself called for the establishment of a “protocol of inspections” to verify the restart of Unit 2.²⁰⁹⁷

2136. Accordingly, the Tribunal concludes that while MHI did not conduct further testing, it was prepared to undertake confirmatory testing had such been required by SCE or for the NRC’s review, thereby obviating the need for MHI to demonstrate a present intent to conduct confirmatory testing.

(11) Is MHI’s work to validate the repair, undertaken only for this arbitration, incomplete and irrelevant?

2137. The Claimants submit that the Respondents’ work to validate the repair was allegedly undertaken only for this arbitration and is incomplete and irrelevant.²⁰⁹⁸
2138. The Respondents do not dispute that significant portions, if not all, of the additional testing and reviews were undertaken, as the Claimants state, “in preparation for this arbitration.”²⁰⁹⁹
2139. Nonetheless, the Tribunal considers that the Respondents’ have provided evidence in this arbitration, as set forth above,²¹⁰⁰ to the effect that the efforts of the Respondents could have been undertaken in 2013 had SCE not shut down SONGS. Thus, MHI’s validation analysis prepared for purposes of this arbitration is not to be considered irrelevant.
2140. The Tribunal does not consider the Respondents’ work inadequate or irrelevant, despite concerns raised by the Claimants regarding, for example, the failure to follow standard QA programs for such testing.²¹⁰¹ To the contrary, the Tribunal considers

²⁰⁹⁷ Exh. JX-1080.

²⁰⁹⁸ Claimants’ RPHM, ¶¶ 264-267.

²⁰⁹⁹ Respondents’ Position Statement on the Revised List of Issues, ¶ 223.

²¹⁰⁰ See Section XIV.B above.

²¹⁰¹ Claimants’ RPHM, ¶ 264.

that it further proves that the proposed Type 1 repair was a workable means to effectuate a repair that would have addressed in-plane FEI and minimized wear. Any portions lacking, such as a failure to follow a standard QA program, are not material.

2141. Accordingly, the Claimants have not convincingly shown that the Respondents' work to validate the repair, while mostly undertaken for the purposes of this arbitration, was inadequate or irrelevant. The fact that such work may have been incomplete is immaterial, considering Edison's unwillingness to go forward with the Type 1 repair.

(12) Did MHI fail to demonstrate that its thicker AVB repair was implementable and reject its proposed implementation approach?

2142. For the reasons set forth in Section XIV above, the Tribunal does not consider that the changes undertaken to the implementation method of the Respondents' proposed thicker AVB repair are significant. Rather, the changes are normal parts of refining an implementation.
2143. Moreover, the Claimants' contentions appear to be contradictory in this respect. For example, the Claimants object that the "Respondents did not assemble their field implementation team until late 2013 and did not conduct any testing until mid-2014 – all for this arbitration only."²¹⁰² Given the Claimants' developing focus in late 2012 on having the Respondents develop a replacement proposal²¹⁰³ and given the decision to shut down SONGS, it appears rather reasonable that the Respondents did not have an implementation team established to implement a repair that SCE had neither approved, nor shown sufficient interest in.
2144. That the Respondents have completed tests and prepared reports demonstrating that the Type 1 repair could be implemented and would be effective, for the purpose of

²¹⁰² Claimants' RPHM, ¶ 269.

²¹⁰³ See Section XIV.A(c) above.

this arbitration, is convincing evidence that such work could have been undertaken in 2012-2013 had a decision to move forward with a Type 1 Repair been approved by the Claimants.

(13) Would the repair have returned the RSGs to their design basis?

2145. The Claimants submit that the “design basis” includes the values set forth in the PAR.²¹⁰⁴ The Parties agree that “design basis” also has a regulatory meaning.²¹⁰⁵
2146. It is evident that the proposed thicker AVB repair would not return the RSGs to the specifications as found in the PAR.²¹⁰⁶ On account of the Gap Velocity Error and on account of the SSPC errors, thermal hydraulic values and stability ratios calculated and set forth in the PAR are incorrect.²¹⁰⁷
2147. In this respect, however, the Tribunal considers that there is no binding requirement that a mutually agreeable repair under the RSG Contract return the RSGs to these values, which the RSGs never physically had. It is true that the values recorded in the PAR were incorrect. However, as the Tribunal determined above,²¹⁰⁸ the PAR is not a contractual document which sets forth the design variables which the RSG was required to meet. The PAR was rather a deliverable which recorded the specifications of the RSGs as designed. If there is a discrepancy between the recorded variables in the PAR and the actual characteristics of the RSGs as built, the remedy, as provided in Section 1.17.3 of the RSG Contract, was to change the PAR, not change the RSGs:

²¹⁰⁴ Claimants’ Opening Presentation (12 April 2016).

²¹⁰⁵ Claimants’ Opening Presentation (12 April 2016), slide 3; Respondents’ Opening Presentation (12 April 2016), slide 7.

²¹⁰⁶ Section XI.C(a) above.

²¹⁰⁷ Section XI.C(a)

²¹⁰⁸ See Section XIII.A (¶ 1317) above.

The Supplier warrants that the Documentation shall be free from Defects, accurate and as specified in the Purchase Order. The Supplier shall, at its cost, correct any nonconforming Documentation discovered within five (5) years after its Acceptance, which shall be the warranty period for the Documentation.

2148. The Claimants have also identified that the term “design basis” has a regulatory definition.²¹⁰⁹ The Tribunal concludes that any mutually agreeable repair would have to meet the “design basis” as required under NRC regulations and under the UFSAR. The Tribunal concludes that a proposed Type 1 Repair would have to meet, and would have met, the design basis under the NRC Regulations and the UFSAR.²¹¹⁰

(14) Would the post-repair RSGs have conformed to the RSG Contract’s provisions regarding gap sizes?

2149. The Claimants submit that post-repair, the RSGs would have too large gap sizes and too large contact force.²¹¹¹

2150. Regarding large gap sizes, the Claimants cite to MHI’s U-Bend Repair Report:

The inactive AVB intersections are assumed to have from [REDACTED] to [REDACTED] gaps on each side with the tube centered between them.²¹¹²

2151. The Claimants omit the prior sentence of the Report, though, which provides that:

The IVHET model for the after-repair condition is assumed to have six active tube support points at B03, S01, B04, B08, S02 and B10 with the remaining existing AVBS assumed to be inactive.²¹¹³

²¹⁰⁹ Claimants’ RPHM, ¶ 271.

²¹¹⁰ See Sections XIV.C(a)(iv) above and XV.C(e)(iii) below.

²¹¹¹ See Section XV.C(b)(i) above.

²¹¹² Exh. JX-1735, p. 75; Claimants’ RPHM, ¶ 273, n. 831.

²¹¹³ Exh. JX-1735, p. 75.

2152. In-plane FEI occurred in Unit 3, and not Unit 2, because Unit 3 had fewer active contact points between the AVBs and the tubes. As determined above, these manufacturing imperfections in Unit 2 provided stability to prevent in-plane FEI.²¹¹⁴ Specifically, the root cause investigations showed that FEI occurred where there were multiple inactive and therefore ineffective supports in the in-plane direction. The above cited omission by the Claimants from their submission demonstrates that the IVHET calculation is being conservative in assuming that even post repair, some supports are ineffective. This assumption is not proof of a failure to meet gap spacing limits under the RSG Contract, which would be proven by measurement data.
2153. To the extent that the thicker AVB repair does increase some gaps at areas where thicker AVBs are not inserted, the Tribunal is not convinced that this is a concern on wear, given the supportive effects of the proposed thicker AVB repair.
2154. However, of greater significance is the Claimants' insistence on the repair meeting RSG Contract design specifications that appear to be the exact cause of in-plane FEI.
2155. The evidence demonstrates that the Claimants' insistence on "zero-gap" requirements for Unit 3 was an important factor that led to the Incident. As will be shown below, the manufacturing improvements made from Unit 2 to 3 are a cause of the inadequate in-plane tube support. The Respondents have presented convincing evidence in this respect. Thus, Mr. Wilson, for Respondents, testified as follows:

The Industry has been striving to get gap control, is the name – trying to get gaps as small as possible and to get the best alignment between tubes and supports. The industry has been doing this.

[...]

²¹¹⁴ See ¶ 489 above; See also ¶ 2155 below.

B&W, an independent company, built six steam generators for Oconee, Units 1, 2, and 3. All of them started up with thousands of wear sites. Completely a surprise. The old generators didn't have it. And these had the same straight tubes with the same number of support plates.

St Lucie, when it happened, built with gap control, yet thousands of wear indications. SONGS Unit 2 and 3, thousands of wear indications with gap control. So the common threat is that these units have achieved really good alignment between the tubes and the supports.

[...]

Under pressure from Edison to continually get better, the first two generators had good gap control, but the next two had – we did better, we even got – the tubes were a tighter dimension and the AVBs were pressed flatter. So the net effect was the gap control was better in Unit 3 than in Unit 2.

[...]

Closer to perfection, better alignment. When a tube is not – if it's out of alignment, it's pressed against its support and it's held still. But if it happens to be just barely kissing it with no contact force or very small contact force, it chatters and wears. At least that is the current paradigm that's replaced the old paradigm.²¹¹⁵

2156. The Respondents have also provided persuasive evidence by their witness Mr. Wilson as to why the Claimants' evidence of Mr. Langford, his alternative theories in this regard, are not adequately supported by the physical evidence of the RSGs.²¹¹⁶
2157. The Claimants also submit that the RSG Contract's requirements concerning avoiding tube lockup would not be met by the proposed thicker AVB repair. In this

²¹¹⁵ Transcript, pp. 3965-3966 (Mr. Wilson).

²¹¹⁶ See Transcript, pp. 3972-3973 (Mr. Wilson).

respect, Section 3.9.3.7 of the RSG Contract is relevant. It provides in relevant part as follows:

Ensure that the relative tube/tube support motions during normal and accident transients shall not result in tube lockup.

2158. The Tribunal construes Section 3.9.3.7 of the RSG Contract regarding lockup to be a requirement to avoid pinning forces on the tube bundle in conditions, which, as Dr. Asadi convincingly explains, could be harmful during start-up conditions.²¹¹⁷ However, as testified by Mr. Lagally, for the Respondents:

But in a U-Bend, when you think about the structure, you have to understand that the AVB structure floats with the U-bend. In other words, if the tubes want to move 2 inches up, or however much, above the U-bend, the AVB structure floats with the U-bend. So the only concern is the relative displacement from tube-to-tube.²¹¹⁸

2159. Accordingly, given that the AVBs float with the tube bundle in the U-bend, the requirements of Section 3.9.3.7 regarding lockup are met by the proposed Type 1 repair.
2160. The Claimants further submit that the thicker AVB repair is somehow deficient as it would not have prevented “excessive fretting and wear of the tubes.”²¹¹⁹ The Claimants submission is supported by Section 3.9.3.7 of the RSG Contract. The Tribunal concludes that there are reasonable concerns as to whether the repaired RSGs would have prevented excessive fretting and wear over the remainder of the 40 year life of the tubes. While the Respondents have submitted expert evidence and

²¹¹⁷ Expert Witness Statement of Dr. Asadi, ¶ 67.

²¹¹⁸ Transcript, p. 3899 (Mr. Lagally).

²¹¹⁹ Claimants’ PHRM, ¶ 273

reports indicating that wear would not be life limiting, absent further operational data from the RSGs, the Tribunal considers there is a degree of uncertainty in this regard.

2161. The Claimants submit that there will be large contact forces on the tubes, of up to [REDACTED] violating the design requirements of the RSG Contract.²¹²⁰ Mr. Lagally, for the Respondents, has testified that a force of [REDACTED] “was applicable to only three tubes” and that prior industry testing had found that tubes could withstand forces of up to [REDACTED] without suffering from plastic, i.e., permanent, deformation.²¹²¹ MHI also undertook a type of compression test and determined that the force being applied on the tubes under a Type 1 Repair was not a concern.²¹²² The Tribunal is not convinced that the requirement of a mutually agreeable repair required that the Respondents meet any contractual requirement for a zero-contact force environment following the determination that it is precisely this zero-contact force environment, achieved in Unit 3 and not Unit 2, that was a critical cause of in-plane FEI.
2162. In addition, the Claimants submit that the proposed thicker AVB repair did not provide the promised margin under the RSG Contract.
2163. The margin against FEI is set forth in the PAR, which the Tribunal determined in Issue B was not a contractual document.²¹²³ However, the Tribunal concludes that the proposed AVB repair in fact provided sufficient margin against instability.
2164. Demonstrating that there is sufficient margin, the Respondents have exhibited out-of-plane stability ratios, corrected by taking into account the Gap Velocity Error.²¹²⁴ These demonstrate that there is considerable margin to instability. Under MHI’s

²¹²⁰ Claimants’ RPHM, ¶ 273.

²¹²¹ Transcript, pp. 3858-3859.

²¹²² Transcript, p. 3858 (Mr. Lagally).

²¹²³ See Section XIII.A above.

²¹²⁴ Exh. JX-730, pp. 7, 93; Respondents’ Closing Statement, slides 56-57.

“extreme conservative case,” a stability ratio of ■ is calculated as the highest expected stability ratio. The Tribunal considers this to be an adequate margin against instability, which occurs at a stability ratio above 1.0. The Tribunal’s consideration in this regard is supported by the analysis that Westinghouse undertook regarding Units 2 and 3:

Analysis indicates that if all AVBs were effective, or if one AVB was ineffective, all tubes would be stable with respect to out-of-plane fluidelastic tube excitation for the 100% power condition.²¹²⁵

2165. Considering the above, the Tribunal concludes that the post Type 1 repair RSGs would have met the requirements of the RSG Contract, except where those requirements were unreasonable on account of the lessons learned from the SONGS Incident.

(15) Would the Post-Repair RSGs have conformed to the RSG Contract’s thermal-hydraulic and stability ratio requirements?

2166. The T/H Conditions, namely void fraction, and stability ratio requirements the Claimants reference are contained in the PAR, not the RSG Contract. The Tribunal determined, in Issue B above, that the PAR is not a contractual document.²¹²⁶ There is, therefore, no basis for the Claimants’ submission that a repair had to restore the RSGs to contractually agreed values in the PAR.

(16) Was the Respondents’ conduct during recovery flawed and deficient?

2167. The Claimants submit that the Respondents acted improperly in not calculating out-of-plane stability ratios in their repair evaluation.

²¹²⁵ Exh. JX-1322, p. 134.

²¹²⁶ See Section XIII.A above.

2168. The RSGs did not experience out-of-plane FEI. Given that operational experience did not demonstrate that classic out-of-plane FEI occurred,²¹²⁷ it is not apparent to the Tribunal why calculations should be undertaken to determine if out-of-plane FEI would occur when the data demonstrates it did not occur.
2169. The Claimants have raised concerns that “the vast majority of [the Respondents’] design team,” and repair team did not testify in this arbitration.²¹²⁸ The Respondents presented many witnesses and experts in this arbitration. If the Claimants had required that additional individuals be made available for examination, they were at liberty to apply to the Tribunal in this regard, as the Claimants did to obtain a deposition for Mr. Langford.²¹²⁹
2170. To the extent that the Claimants allege²¹³⁰ that the Respondents’ employees lacked the technical ability to develop and test a repair, the Tribunal is not convinced for the following reasons.
2171. The Claimants have not provided persuasive evidence establishing that SCE raised concerns regarding the capabilities of the Respondents’ technical personnel, either during the design or repair era.
2172. Further, the Claimants retained peer reviews of the Respondents’ repair proposals, and it was open to the Claimants to request that the Respondents co-operate in developing a repair with other suppliers. AREVA submitted bids to further refine the repair. Other suppliers, such as Westinghouse and B&W were equally available to assist with the SONGS repair effort. Indeed, a substantial portion of the invoices that

²¹²⁷ See Section XIII.D(c)(iii) above.

²¹²⁸ Claimants’ RPHM, ¶ 279.

²¹²⁹ See ¶ 89 above.

²¹³⁰ Claimants’ RPHM, ¶ 279.

the Claimants sent to the Respondents concerned costs incurred for third party expertise in an effort to restore SONGS to service.

2173. Accordingly, the Tribunal does not consider that the Respondents conduct in the repair era was flawed and deficient.

(17) Conclusion

2174. In light of the above, the Tribunal answers Issue C.3(a)(i) in the affirmative. The Respondents did undertake a technical analysis of the problem sufficient to demonstrate that their proposed Type 1 repair would have corrected the “root cause” of the Defect.

- (c) **If Mitsubishi was obligated but failed to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” or demonstrate that the problem(s) would not recur, was Mitsubishi excused from its obligation due to Claimants’ actions? (Issue C.3(a)(ii)); and If Mitsubishi was obligated but failed to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” or demonstrate that the problem(s) would not recur, and Mitsubishi was not excused due to Claimants’ actions, what are the consequences of that failure? (Issue C.3(a)(iii))**

2175. Considering the Tribunal’s determinations on Issue C.3(a) and C.3(a)(i), Issues C.3(a)(ii)-(iii) are rendered moot.

- (d) **Did the RSG Contract obligate Mitsubishi to demonstrate that its proposed repair would not cause other modes of failure? (Issue C.3(b))**

2176. This Issue C.3(b) concerns the question whether the RSG Contract obligates the Respondents to demonstrate that their proposed repair would not cause other modes of failure.

(i) The Claimants' Position

2177. In their Responses to the Joint List of Issues, the Claimants submit the following:

In order to demonstrate that the Defect would be cured or the extreme tube wear would not reoccur, Mitsubishi had to show that a repair would not “adversely affect” the safe operation of the RSGs at 100% power over a 40 year life or the “structural integrity” of the U-bend tubes, *i.e.* the pressure boundary between the primary and secondary sides of the plant. Any repair had to, among other things:

- Provide “tube supports that adequately support the tube bundle and facilitate internal circulation,”
- “Preclude tube damage due to wear caused by flow induced vibration (FIV),”
- “Ensure that the relative tube/tube support motions during normal and accident transients shall not result in tube lockup,”
- “Ensure that tube-to-tube support clearances are uniform,”
- Prevent “excessive fretting and wear of the tubes,”
- “[M]inimize vibration-induced tube wear and fatigue in the tube bend area of the tube bundle,” and
- “[E]nsure no damage to the tubes and subsequent operation of the RSG with minimal vibration.”

Mitsubishi also had to ensure that the repaired RSGs would meet the requirements of the ASME Code and 10 CFR Part 50, Appendix B, among other codes and standards.²¹³¹

2178. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that the “Respondents acknowledge that “[i]mplicit in the RSG

²¹³¹ Claimants’ Responses to Joint List of Issues, ¶ C.11(b).

Contract’s warranty provision . . . is an obligation that Mitsubishi provide a reasonable assurance that the Repair would work, and a repair that created an unreasonable risk of other modes of failure could justifiably be rejected.” This obligation was more than implicit. Respondents warranted that the RSGs would be “free from Defects,” and “Defect” is broadly defined (...) The parties agree that, if Respondents failed to demonstrate that the repair did not create the risk of other modes of failure, Edison could justifiably reject the repair.”²¹³²

(ii) The Respondents’ Position

2179. In their Position Statement on the Revised List of Issues, the Respondents contend that “[t]here is no provision in the RSG Contract that obligated Mitsubishi to affirmatively demonstrate that its proposed repair would not cause other modes of failure. Implicit in the RSG Contract’s warranty provision, however, is an obligation that Mitsubishi provide a reasonable assurance that the Repair would work, and a repair that created an unreasonable risk of other modes of failure could justifiably be rejected. Claimants appear to have taken the position that Mitsubishi was required to demonstrate to a scientific certainty that no other modes of failure were possible in order for a repair to be deemed “mutually agreeable” to Edison. This is a commercially and technically unreasonable standard that has no basis in the RSG Contract or in industry practice as a whole. Claimants have presented no evidence, expert or otherwise, that supports such a standard.”²¹³³

(iii) The Tribunal’s Determination

2180. The Parties are in agreement that “implicit in the RSG Contract’s warranty provision (...) is an obligation that Mitsubishi provide a reasonable assurance that the Repair

²¹³² Claimants’ RPHM, ¶¶ 333-335.

²¹³³ Respondents’ Position Statement on the Revised List of Issues, ¶ 249.

would work, and that repair that created an unreasonable risk of other modes of failure could justifiably be rejected.”²¹³⁴

2181. Accordingly, the Tribunal answers Issues C.3(b) in the affirmative. The RSG Contract did obligate MHI to demonstrate that its proposed repair would not cause other modes of failure.

(e) **If so, did Mitsubishi demonstrate that its proposed repair would not cause other modes of failure? (Issue C.3(b)(i))**

2182. This Issue C.3(b)(i) concerns the question that if the RSG Contract obligated the Respondents to demonstrate that their proposed repair would not cause other modes of failure, did the Respondents demonstrate that their proposed repair would not cause other modes of failure.

(i) *The Claimants’ Position*

2183. In their Responses to Joint List of Issues, the Claimants submit the following:

Mitsubishi’s expert Mr. Olszewski addressed this issue definitively:

MR. WEISSMANN: At any time prior to 15 June 7, 2013, had Mitsubishi provided Edison with enough information to establish that the thicker AVB repair would not cause secondary effects that could lead to new modes of tube bundle damage?

MR. OLSZEWSKI: No.

The repair reflected “sloppy” engineering that imposed unacceptably large contact forces and created the risk of plastic deformation and the stresses imposed by the repair would violate the ASME Code. Further, Mitsubishi failed to analyze the out-of-plane bending stress on the tubes; failed to show that the repair would not create out-of-plane tube-to-tube wear post-repair; and

²¹³⁴ See ¶¶ 2178 and 2179 above.

failed to show that the original AVBs, which would be looser, would not cause vibration and tube wear.²¹³⁵

2184. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents claim that Claimants' experts "provided no evidence of analysis or testing that supports their claims that adverse impacts might arise from the Repair." In addition to being incorrect, as discussed herein, Respondents are improperly flipping the burden. Respondents, not Edison, had the contractual obligation to demonstrate that the repair would correct the RSG failures and not risk introducing new Defects. By failing to do so, Respondents breached the warranty.

Respondents also rely heavily on the expert materials they submitted to the Tribunal in 2016. These materials are entirely irrelevant to the issue in dispute: whether Respondents demonstrated that the repair would not risk new failure modes to Edison as of 2013. Because Respondents did not conduct such work, had no intention of performing such work, and still makes material errors, the answer is clearly "no."

➤ *Testimony from Mitsubishi's own experts showed that Mitsubishi failed to demonstrate that its proposed repair would not cause other modes of failure*

Respondents failed to show that its repair would not introduce new modes of failure. Respondents' Mr. Olszewski addressed this issue definitively:

MR. WEISSMANN: At any time prior to June 7, 2013, had Mitsubishi provided Edison with enough information to establish that the thicker AVB repair would not cause secondary effects that could lead to new modes of tube bundle damage?

MR. OLSZEWSKI: No.

As Claimants' and Respondents' witnesses testified, these concerns included the following.

The repair reflected "sloppy" engineering that imposed unacceptably large contact forces and risked plastic deformation: Respondents claim that

²¹³⁵ Claimants' Responses to Joint List of Issues, ¶ C.11(b)(i).

they have demonstrated that the loads the thicker AVBs would place on the tubes would not have been too large. Yet, according to Respondents' experts, plastic deformation refers to imposing a force such that "the tube would be deformed to the point that it cannot bounce back to the original shape," and the potential for plastic deformation exists at forces above [REDACTED] Respondents calculated that the repair would impose contact forces greater than [REDACTED] Respondents' Dr. Au-Yang testified that a repair that risks plastic deformation would represent unacceptable and sloppy engineering:

Question: What, in your mind, would be a large contact load on the tube by a thicker AVB?

[Dr. Au-Yang's] Answer: If it—it cause plastic deformation, I will say it is too large.

...

Question: And what's the concern with plastic deformation?

[Dr. Au-Yang's] Answer: Some people say it won't be a problem with the new material Inconel 690, but I am more conservative than that. Because Inconel 690 has not yet accumulate enough operational experience like Inconel 600, which has 30 years of operational experience.

Question: Why do you need to be more conservative when you don't have a lot of operational experience?

[Dr. Au-Yang's] Answer: I'm thinking in terms of the customer. I don't want to propose a—a fix that would fix it for five years, and then ten years later the tube start to crack.

Question: Why don't you want to propose a repair like that?

[Dr. Au-Yang's] Answer: Because it's not good engineering.

Question: Why not?

[Dr. Au-Yang's] Answer: You just patch it up and then—and cause more problem later. That is not what I call engineering.

Question: What would you call that?

[Dr. Au-Yang's] Answer: I would call it sloppy.

The stresses imposed by the repair would violate the ASME Code: Respondents incorrectly claim that they sufficiently analyzed the stresses that the thicker AVBs would impose on the tubes, incorrectly interpreting the ASME Code requirements. Contrary to Respondents' claim, which Claimants' Dr. Asadi undisputedly disproved at the Hearing, the ASME Code required Respondents to consider both the thermal and mechanical load created by the thicker AVBs and to keep the total stress range below a specified limit. Yet, above a contact force of [REDACTED] the thicker AVBs would impose loads that would violate the ASME Code. Because most of the thicker AVBs would impose loads greater than [REDACTED] Respondents' repair violated the ASME Code. Dr. Asadi is the more credible source on this topic: in addition to his interpretation conforming with the language of the ASME Code, Dr. Asadi holds a Ph.D. in Mechanical Engineering with a specialty in structural dynamics and stress analysis, and, until the end of 2014, he led a team of structural engineers working on steam generator design at B&W. In contrast, Respondents' Mr. Wilson has not been in a design firm's stress analysis group, or overseen such a group, since at least 1977, and he acknowledges that stress calculations have changed considerably since then.

Respondents failed to analyze the out-of-plane bending stress on the tubes.

Respondents failed to show that the repair would not create out-of-plane tube-to-tube wear post-repair.

Respondents failed to show that the original AVBs, which would be looser, would not cause vibration and tube wear: Respondents acknowledge that the repair would increase the gaps between the tubes and the existing AVBs but claim that they demonstrated no such risk would exist. Respondents cite only to the U-Bend Repair Report (2013) and irrelevant expert materials prepared for this arbitration (2016). In fact, Respondents failed to analyze the existing AVBs for relevant vibratory phenomena. After independently reviewing the U-Bend Repair Report, AREVA agreed. For example, Respondents failed to present any evaluation of flutter, a known form of FEI. As of June 2013, Respondents also failed to conduct—and had no intention of conducting—any testing of AVB vibration, which Dr. Au-Yang testified would have been the preferred approach. Because the existing AVBs would be unsupported, they would be at unacceptable risk of flutter and other forms of vibration and wear.

➤ *Mitsubishi needed nothing from Edison to conduct the testing and analysis that its experts say was required*

As also discussed in Section C.3(a)(i) supra, Claimants' experts testified to a laundry list of additional testing and analysis that Respondents needed to

undertake even as late as June 2013. At the Hearing, Respondents' experts testified to a series of additional tests and analyses that Respondents needed to perform—and had not performed—as of June 2013:

- Respondents should have performed a test to analyze the potential for the unsupported original AVBs to vibrate and cause wear post-repair.
- Respondents should have performed testing to determine the force at which a tube would be pinned. Dr. Au-Yang refused to reach his opinions without such testing, which he did not receive until late 2013 or 2014.
- Respondents had not completed all of the analyses needed to understand the effect of restraining the U-bend region with thicker AVBs, given that the thicker AVBs would lock the upper U-bend in place. Respondents still needed to analyze the effects of heat-ups and cool-downs with the tubes pinned and locked in place because the original tube design report assumed that the tubes were unrestrained. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until 2015.
- Respondents had not addressed the applied loading on the retaining bars and the effect of heat-ups and cool-downs as a result of putting thicker AVBs into the RSGs. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until late 2014.
- Respondents had not sufficiently addressed the changed flow resistance in the U-bend due to the thicker AVBs and how that changed flow resistance would impact water level stability and water level control. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until January 2016.
- Respondents had not analyzed for the change in mass in the RSGs post-repair. Respondents needed nothing from Edison in order to perform this analysis, yet Respondents did not complete this analysis until January 2016.
- Respondents had not identified the affected design basis documents and calculations. Mr. Russell had to ask Respondents to undertake that process in order to be able to come to his opinions in this arbitration.

analysis in an attempt to validate their repair—all work Respondents had no intention of doing for Edison in 2012 and 2013.²¹³⁶

(ii) *The Respondents' Position*

2185. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Mitsubishi provided a reasonable level of technical assurance that its repair would not cause other modes of failure. Before Edison closed the plant, Mitsubishi evaluated the effect of the thicker-AVB repair on the potential for local tube stresses, tube dinging, and wear caused by an unsupported AVB, and concluded either that those effects would not occur, or that they would not result in an adverse effect during future operation.

If Edison had been more interested in Mitsubishi's thicker-AVB repair and had followed its own design review practice, any doubts regarding potential adverse effects of the Repair could have been resolved in the normal course of a design review. For example, the AREVA Report (which was commissioned by Edison on May 10, 2013 and provided by AREVA to Edison May 24, 2013, but which Mitsubishi did not receive until this arbitration) raised the types of questions concerning potential adverse impacts that might have been raised in a proper design review. But as shown by Mitsubishi's Response to the AREVA Report, the AREVA Report did not present any insurmountable technical issues regarding the proposed thicker-AVB repair, including issues associated with potential adverse effects.

Claimants' experts nevertheless assert that Mitsubishi's thicker-AVB repair might have introduced adverse impacts into the operation of the SONGS RSGs had it been installed. In making these assertions, however, Claimants' experts also only raise questions of the sort that would be resolved in a design review (and which, as above, were ultimately resolved in a timely fashion). Furthermore, Claimants' experts provided no evidence of analysis or testing that supports their claims that adverse impacts might arise from the Repair; indeed, Dr. Elder repeatedly confirmed that he had done no analysis or testing to support his claims. Also, Dr. Asadi acknowledged that neither he nor B&W had "performed any analysis of the Unit 3 RSGs using B&W's design stage analysis methods." Against this lack of evidence, Respondents and their experts have proven that the Repair would not have had any of the negative

²¹³⁶ Claimants' RPHM, ¶¶ 336-347.

impacts on the operation of the SONGS RSGs alleged by Claimants. These allegations are addressed below.

➤ ***Unsupported AVB:***

Claimants' experts allege that Mitsubishi's thicker-AVB repair would have created unsupported lengths of existing AVBs, which would have been free to vibrate, and which would have caused problematic tube wear in a repaired SONGS RSG. Again, these allegations are unsupported by any analysis or testing. In contrast, Mitsubishi has conducted significant analysis and testing which shows that an unsupported AVB would not cause unacceptable tube wear:

- First, because Mitsubishi understood from the outset that the potential impact of an unsupported AVB required analysis, Mitsubishi performed analysis to determine the extent to which the vibrating unsupported length of an existing AVB might cause tube wear. This analysis concluded that the amount of resulting tube wear would have been acceptably small.
- Second, and as part of its validation effort, Mitsubishi conducted an air-water flow test that confirmed Mitsubishi's repair conclusion that any resulting tube wear would have been acceptably small. Indeed, this testing confirmed that Mitsubishi's Repair Report analysis was conservative.
- Third, and in response to questions and comments in the AREVA Report, Mitsubishi further evaluated the tube wear that could have resulted from an unsupported length of an existing AVB. These further evaluations once again confirmed that any resulting tube wear would have been acceptably small and resolved the questions presented in the AREVA Report to the satisfaction of the AREVA team leader, Mr. Don Stewart.
- Fourth, Mitsubishi also directly responded to the unsubstantiated claims of Claimants' experts. For example, as explained by Dr. Au-Yang, the unsupported AVB would be subject to neither FEI nor flutter as demonstrated further by Mitsubishi calculations.

➤ ***Tube Stresses Induced by the Repair***

The stresses created by the thicker AVBs are displacement-limited stresses, which the ASME Code classifies as secondary stresses. The magnitude of a displacement-limited secondary stress depends on how far from its original position the tube is displaced; here, the displacement is approximately equal to the thickness of the additional AVBs. Once the tubes are displaced, and the thicker AVB is inserted between them, the forces and resulting tube stresses stop at that level, and do not continue to increase. Other examples of displacement-limited secondary stresses are the tube bending stress caused by the bending the tubes into the shape of a U-bend and the stress created by the hydraulic expansion of the tubes into the tubesheet. These other, acceptable, manufacturing-induced stresses are much larger in magnitude than the stresses associated with the insertion of the thicker AVBs.

Because displacement-limited secondary stresses are self-limiting, the ASME code imposes no limitation on their magnitude. The ASME code does, however, require that secondary stresses produced by such displacement-limited loadings be evaluated for their effect on cyclical structural criteria such as fatigue. Mitsubishi and its experts have demonstrated by conservative evaluation that the Repair does not create any adverse structural effect and satisfies the requirements of the ASME Code. The relevant Code requirement to consider for the Repair is whether the stress intensity range is acceptable. That range is calculated by determining the highest stress intensity and the lowest stress intensity that occur during all transient (e.g., cyclic) loadings. Since the Repair adds a constant stress condition, its net effect is to shift all of the stress intensities for all of the transients by a constant amount, such that it does not change the tube structural margin for cyclic loadings. Therefore, the stresses induced by the thicker AVBs do not reduce the tube fatigue margin or the margin for other cyclical structural criteria.

Claimants' expert Dr. Asadi, nonetheless, claims that Mitsubishi's stress analysis is "glaringly incomplete" because it does not account for the "bending stress" caused by the thicker AVBs. The fallacy of Dr. Asadi's claim is laid bare by the fact that the bending stresses resulting from the thicker AVB are negligible compared to the stress resulting from bending the tubes into a U-bend shape, a fact nowhere acknowledged or discussed by Dr. Asadi. As explained by Mr. Wilson, the claims of Dr. Asadi are premised on a fundamental misreading of the ASME Code. Mr. Wilson, a member of the ASME code Working Group for Nuclear Vessels (which is responsible for this portion of the code), and author of a recent clarifying change to the code section at-issue, testified that "[i]t is clear from [Dr. Asadi's] statements and his calculation" that he "does not understand the ASME Code requirements for a loading that is self-limiting."

➤ ***Puckering:***

Claimants' expert Dr. Asadi alleges that Mitsubishi's thicker-AVB repair might have caused pinned tubes to "pucker" due to the different thermal and pressure changes." Dr. Asadi makes this allegation without explaining either the mechanism at issue or the (presumably deleterious) effect of this mechanism. Nor does he provide any analysis or testing to support the allegation. Indeed, Dr. Asadi appears to be merely parroting a similar observation made by AREVA in its May 2013 report. However, upon receiving the AREVA report as part of this arbitration, Mitsubishi analysed this issue and concluded that puckering would not have occurred in a repaired SONGS RSG. Mr. Donald Stewart, the lead author of the AREVA Report, has testified that Mitsubishi's analysis provides a satisfactory response to the question presented in the AREVA Report.

➤ ***Ding and Dents:***

Claimants' expert Dr. Elder alleges (without analysis) that the thicker-AVB repair would have resulted in dings and dents at certain tube-to-AVB intersections in a repaired SONGS RSG. First, Dr. Elder notes that ■ tubes might have experienced contact forces sufficient to cause tube dings and asserts that the presence of tube dings could require more frequent, and potentially more time consuming, ECT inspections. Dr. Elder does not suggest that tube dinging has any effect on tube integrity (because it does not). Mitsubishi evaluated the potential presence of dings as a consequence of the repair in 2012, and concluded that any effect would be negligible and acceptable. As a part of its validation effort, Mitsubishi confirmed this understanding, and documented that confirmation in the Validation Report and in the Response to AREVA Report.

Second, Dr. Elder asserts (without analysis) that tube denting might occur in a repaired SONGS RSG during startup and shutdown and that (again without analysis) that the presence of tube dents could require more frequent, and potentially more time consuming, ECT inspections. Dr. Elder misunderstands the denting mechanism. As explained in the Validation Report, the denting mechanism is a load-controlled process that is potentially capable of crushing tubes to the point that an ECT probe could not pass. Such gross deformation is irrelevant in the case of the repair proposed by Mitsubishi, which produces a modest flexing of the tubes to achieve increased contact forces. Mitsubishi confirmed that the ECT probe could pass through each of the tubes in the engineering mockup with the thicker AVBs installed; had denting occurred, the ECT probe would not have been able to pass through affected tubes.

Further, Dr. Asadi asserts (yet again without analysis) that the corner of the thicker AVBs might cause “local deformation denting” of the tubes. Nonetheless, Mitsubishi conducted eddy current testing (ECT) inspection of every tube-to-AVB intersection in the full-scale mockup with the thicker AVBs installed, and determined that [REDACTED] of the key AVB intersections on the [REDACTED] tubes had no detectable ECT signals, and only [REDACTED] was greater than [REDACTED] (and less than [REDACTED]). As Mr. Wilson testified, “[t]o put this in context, each of the four RSGs had ECT signals in excess of [REDACTED] that Edison accepted for long-term operation during the pre-startup acceptance tests.”

Therefore, both Dr. Elder’s and Dr. Asadi’s grim warnings about dings and dents are unfounded.

➤ ***Other claimed adverse impacts:***

Dr. Elder raises other alleged adverse impacts, for example, tube ballooning. Again, Dr. Elder performed no analysis to verify these claims, which are addressed in the Validation report, and shown to lack any technical merit. As he acknowledged at the hearing, Dr. Elder has done no equivalent analysis to the Validation Report that would contradict its conclusions.²¹³⁷

(iii) The Tribunal’s Determination

2186. Following MHI’s submission of its April 2013 U-Bend Repair Report, that Report was reviewed by AREVA and by SCE. Those reviews identified concerns regarding other possible modes of failure.
2187. Before MHI even received the AREVA report, however, SCE made the decision to shut down SONGS.
2188. Therefore, it is indisputable and quite obvious that MHI did not, in 2013, address the concerns raised in the May 2013 AREVA Report that it had never seen.
2189. In this connection, the Respondents submit that any other modes of failure concerns raised by the thicker AVB repair could be addressed. They have purported to have done so in the hundreds of pages of expert reports submitted in this arbitration, some

²¹³⁷ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 250-262.

of which are listed in ¶ 1905 above. The Claimants challenge the relevance of MHI's response to the AREVA Report. The Tribunal considers MHI's reports and expert witness testimony regarding their May 2013 repair proposal, as prepared for this arbitration, to be relevant evidence of what could have been undertaken "but for" the shutdown decision. Accordingly, the Tribunal interprets this present Issue as inquiring as to whether Mitsubishi *could* demonstrate that its proposed repair would not cause other failure modes. The Tribunal recalls that this question is of significant importance in any potential NRC review under 10 CFR 50.59(c)(2)(v), which requires that the repair not:²¹³⁸

(v) Create a possibility for an accident of a different type than any previously evaluated in the final safety analysis report (as updated);

2190. The Claimants have submitted that, per the 2013 AREVA Report, MHI's repair proposal "created secondary effects which are deemed not sufficiently analyzed and could lead to new modes of tube bundle damage."²¹³⁹ The Claimants have identified nine particularized risks, as reviewed by their experts Dr. Elder and Asadi.²¹⁴⁰ Some but not all of these concerns include questions that the AREVA Report identified as being of particular concern. The Tribunal considers that the nine concerns raised by the Claimants are those they consider the most serious allegedly non-analyzed risks. These nine are, therefore, reviewed by the Tribunal below.

²¹³⁸ See ¶ 1950 above.

²¹³⁹ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 265.

²¹⁴⁰ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 265.

(1) Tube Dinging and Denting

2191. The Claimants submit that the Respondents failed to prove that the Type 1 Repair would not cause tube dings and/or dents.²¹⁴¹ A ding is an eddy current audible signal caused by a tube deformation while a dent is a tube deformation.²¹⁴²
2192. The Respondents submit that they did undertake an analysis for dings and dents. The Respondents reference the 2013 U-Bend Repair Report, which provides that they conducted a “Confirmation Test for Ding Load” and determined that no ding signals were detected below a force of ██████ to ██████ and that the upper force in the repair was ██████.²¹⁴³ The Tribunal considers that the Respondents adequately considered the risk of ding signals. This is particularly the case given the Respondents’ explanation that “the concern for tube dinging is that it produces an eddy current signal that may require monitoring in future inspections” and as “most dings (or marks) on the tube surface are slight imperfections that do not affect tube integrity or long-term operation.”²¹⁴⁴
2193. The Respondents further submit that they conducted an inspection for denting on their repair mockup following the insertion of the thicker AVBs that indicated that there were minimal concerns.²¹⁴⁵ The Tribunal considers that the Respondents, accordingly, did undertake an analysis of this risk and that it is not a significant risk.

²¹⁴¹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 266.

²¹⁴² Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 266.

²¹⁴³ Exh. JX-1735.

²¹⁴⁴ Exh. JX-1735, p. 107.

²¹⁴⁵ Respondents’ RPHM, ¶¶ 259-261.

(2) Tube Fatigue and Stress

2194. According to the Claimants, “tube fatigue refers to loading that can weaken a tube and result in failure.”²¹⁴⁶
2195. The Claimants submit that the Type 1 Repair could cause tube fatigue over time on account of the force on the tubes from the thicker AVBs.²¹⁴⁷ The Respondents submit that “any additional stresses on tubes resulting from the repair would have been small, localized secondary stresses and would not have impacted the tubes’ structural integrity”²¹⁴⁸
2196. The Tribunal considers that the Respondents did analyze for the concerns of tube fatigue and stress in their U-Bend Repair Report, which contains a section on this issue.²¹⁴⁹
2197. The 2013 AREVA Report identifies, in comment 3.2, that they “believe there should be an assessment of potential for new fatigue risks, (low cycle / high stress for example).”²¹⁵⁰ The AREVA Report does not flag comment 3.2 as an issue of “prime importance for resolution.”²¹⁵¹
2198. The Respondents’ response to the AREVA Report provides that “fatigue has been considered and found to be negligible.”²¹⁵² The Respondents’ response specifies that

²¹⁴⁶ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 267.

²¹⁴⁷ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 267.

²¹⁴⁸ Respondents’ Rejoinder ¶ 211.

²¹⁴⁹ Exh. JX-1735, p. 107.

²¹⁵⁰ Exh. JX-1797, p. 16.

²¹⁵¹ Exh. JX-1797, p. 7.

²¹⁵² Exh. JX-2190, p. 97.

the fatigue stress is calculated to be █████ of the ASME allowed limit for tube stress.²¹⁵³

2199. In support of this Issue, the Claimants have referenced calculations by Dr. Asadi regarding bending stress.²¹⁵⁴ Dr. Asadi calculates that a “bending stress” of 35 ksi is imposed on the tubes.²¹⁵⁵ In contrast, the Respondents calculate █████ from fatigue stress.²¹⁵⁶ While it is not evident that “bending” stress is the same as “fatigue” stress, even if Dr. Asadi’s figure of 35 ksi is used rather than MHI’s figure of █████ this remains below the ASME maximum limit of █████ that the Respondents identify.²¹⁵⁷
2200. In conclusion, the Tribunal considers that the Respondents have adequately considered the risk of tube fatigue and stress and demonstrated that any such issues could have been resolved in due course.

(3) In-Plane Ballooning or Deformation of Tubes, In-plane FEI, and Additional In-plane TTW

2201. As explained by the Claimants, ballooning is a deformation of the tubes between the AVB points caused by the pressure at the AVB points.²¹⁵⁸ This is also known as “puckering.”²¹⁵⁹

²¹⁵³ Exh. JX-2190, p. 50.

²¹⁵⁴ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 267, n. 714 (citing to the Expert Witness Statement of Dr. Asadi, ¶¶ 72-73).

²¹⁵⁵ Expert Witness Statement of Dr. Asadi, ¶¶ 72-73.

²¹⁵⁶ Exh. JX-2190, p. 50.

²¹⁵⁷ Exh. JX-2190, p. 50.

²¹⁵⁸ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 268.

²¹⁵⁹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 268.

2202. The Claimants identify two risks from this. First, that ballooning could decrease the gaps in the in-plane direction between tubes, increasing the risk of TTW.²¹⁶⁰ Second, this could result in permanent deformation.²¹⁶¹
2203. The Respondents submit that following the installation of the thicker AVBs, in-plane FEI would be impossible as the thicker AVBs would prevent movement that would result in TTW.²¹⁶²
2204. The AREVA Report addresses this issue in comment 3.7, where it states that “u-bends are designed to allow some sliding relative to the AVB” [REDACTED]
[REDACTED].²¹⁶³ AREVA identified comment 3.7 as an issue of more significant concern.
2205. Dr. Asadi, for the Claimants, also explained this concern as the thicker AVB forces would “restrain the tubes from sliding in between the AVBs and risked causing the tubes to deform, bend, or balloon between pinned support locations.”²¹⁶⁴
2206. During the Hearing, Mr. Lagally, for the Respondents, testified that Dr. Asadi’s opinion is based upon a misunderstanding as to whether the tubes are pinned by the AVBs, thus preventing movement. In fact, the tubes are not actually pinned but are restrained by friction force, which allows relative motion of the tubes to AVBs.²¹⁶⁵ Moreover, as Mr. Lagally further explained, the AVB structure “floats with the U-bend” such that it is not pinned.²¹⁶⁶ In addition, under further cross-examination, Mr.

²¹⁶⁰ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 268.

²¹⁶¹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 268.

²¹⁶² Respondents’ Rejoinder, ¶ 211.

²¹⁶³ Exh. JX-1797, p. 16; see also p. 4.

²¹⁶⁴ Expert Witness Statement of Dr. Asadi, ¶ 68.

²¹⁶⁵ Transcript, p. 3865.

²¹⁶⁶ Transcript p. 3899.

Lagally opined that he did not know if this was adequately explained in MHI's U-Bend Report.²¹⁶⁷

2207. MHI's response to comment 3.7 in the AREVA Report provides that puckering does not occur, nor is there as risk of TTW.²¹⁶⁸
2208. The Tribunal considers that the concerns raised in the AREVA Report, as seconded by Dr. Asadi, are adequately addressed by MHI's response to the AREVA Report and the explanation provided by Mr. Lagally. It appears that this concern relates to an imprecise explanation in MHI's U-Bend repair proposal.
2209. Accordingly, the Tribunal considers that MHI did or could have adequately addressed this concern by a more accurate explanation of its Type 1 Repair.

(4) Out-of-Plane Ballooning or Deformation of Tubes and Out-of-Plane TTW

2210. The Claimants submit that the concerns raised regarding in-plane ballooning also apply in the out-of-plane direction.²¹⁶⁹
2211. The Respondents submit that these concerns are not an issue in a triangular pitch array, as adjacent tubes are arranged in a triangular pitch, not next to each other, such that the risk described by the Claimants is not applicable.²¹⁷⁰

²¹⁶⁷ Transcript, p. 3900.

²¹⁶⁸ Exh. JX-2190, p. 102.

²¹⁶⁹ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 269.

²¹⁷⁰ Respondents' Rejoinder, ¶ 211.

2212. This issue is raised in the AREVA Report in comment 2.2.6.²¹⁷¹ It is highlighted as a significant concern to be addressed and that analysis is required [REDACTED]
[REDACTED].²¹⁷²
2213. MHI's response to the AREVA report emphasizes the triangular pitch configuration and, after considering the dimensions in question, concludes that the "probability of tube-to-tube contact is negligible."²¹⁷³
2214. The Claimants rely upon Dr. Elder's further analysis of this issue.²¹⁷⁴ Dr. Elder is critical of the risk of TTW on account of the tubes now being closer together.
2215. The Tribunal is convinced that the Respondents did adequately analyze this concern and could have analyzed this concern had the Type 1 Repair process continued.

(5) Additional Tube to TSP Wear

2216. The Claimants submit that the repair would result in additional risk of tube to TSP wear on account of "additional energy [that] would propagate down the tube bundle to the straight portion of the tubes" and by "changing the angle of the tubes as they passed through the TSPs."²¹⁷⁵ The Claimants' position is supported by Dr. Elder.²¹⁷⁶

²¹⁷¹ Exh. JX-1797, p. 10.

²¹⁷² Exh. JX-1797, p. 10.

²¹⁷³ Exh. JX-2190, p. 26.

²¹⁷⁴ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 269 (citing to Expert Witness Statement of Dr. Elder (Testimony on Repair and Replacement Efforts), ¶¶ 80-81).

²¹⁷⁵ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 270.

²¹⁷⁶ Expert Witness Statement of Dr. Elder (Testimony on Repair and Replacement Efforts), ¶¶ 82-83.

2217. The Respondents dispute that this is a concern, submitting that following a Type 1 Repair, all wear, including tube to TSP wear, would be reduced given that the thicker AVBs restrained tube movement.²¹⁷⁷
2218. The Claimants do not appear to have tied this issue to a concern raised in the AREVA Report. The Respondents submit this issue is raised in the AREVA Report in comment 2.19.²¹⁷⁸ Comment 2.19 in the AREVA Report does concern TSP wear, and specifically the difference between TSP wear in Unit 2 and Unit 3.²¹⁷⁹ However, AREVA did not flag this comment as an issue of significant concern. Nor does it appear to relate to the repair of Unit 3 but rather an issue with Unit 2.
2219. While the Tribunal is not convinced that comment 2.19 in the AREVA Report addresses the Claimants' concern, it is apparent that the Claimants have not identified that this issue is one that AREVA found was a concern that had to be analyzed. That is, AREVA does not appear to have identified a TSP concern as a potential other failure mode that required analysis.
2220. Accordingly, the Tribunal is convinced by the Respondents' submission that further restraining the tubes would generally reduce the amount of vibration wear in the RSGs.

(6) Additional Tube-to-Existing AVB Wear

2221. The Claimants submit that the Type 1 repair would increase the gaps between tubes and existing AVBs, leading to a risk of random vibration and FEI.²¹⁸⁰ The Claimants support their position by reference to MHI's U-bend Repair Report.

²¹⁷⁷ Respondents' Rejoinder, ¶ 211.

²¹⁷⁸ Respondents' Rejoinder, ¶ 211.

²¹⁷⁹ Exh. JX-1797, p. 13.

²¹⁸⁰ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 271.

2222. The Respondents submit that force on the tubes would prevent in-plane FEI and would reduce tube-to AVB wear.²¹⁸¹
2223. MHI's repair validation report calculates tube to AVB wear rate for the length of the RSGs expected operations and concludes that there are no concerns.²¹⁸²
2224. This issue does not appear to be one that is raised in the AREVA Report. Nor does it appear to be a new form of degradation of concern under 10 CFR 50.59(c)(2)(v).
2225. The Tribunal is not convinced that this is an issue that the Respondents failed to analyze. Further, the Tribunal finds that the Respondents did undertake an analysis of long term wear, as set forth in their validation report.

(7) Vibration and FEI of the Existing AVBs

2226. The Claimants submit that the Type 1 Repair would leave unsupported AVBs in the RSG which could be themselves subject of vibration and FEI, leading to tube wear.²¹⁸³
2227. The Respondents submit that the existing AVBs are not a concern as, following a Type 1 repair, the original AVBs would not be subject to FEE and any random vibration would be small and acceptable.²¹⁸⁴

²¹⁸¹ Respondents' Rejoinder, ¶ 211.

²¹⁸² Respondents' Validation Report of the U-Bend Repair, ¶ 69-70.

²¹⁸³ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 272.

²¹⁸⁴ Respondents' Rejoinder, ¶ 211.

2228. This issue is raised as comments 2.2.1 and 2.2.2 in the AREVA Report.²¹⁸⁵ The AREVA Report highlights these concerns as ones of “prime importance for resolution.”²¹⁸⁶
2229. MHI’s response to comment 2.2.1 of the AREVA Report identifies that the AVBs are not subject to FEE given the AVBs relatively large torsional stiffness in comparison to the T/H forces.²¹⁸⁷ That is, the AVBs can resist instability on account of the stiffness of the material they are made of. MHI’s report also provides that “vortex shredding,” a concern raised by AREVA, is not a concern as, on account of research by Dr. Pettigrew, a professor of thermal hydraulics at the Université de Montreal, vortex shredding does not occur at void fractions exceeding 15%.²¹⁸⁸ The Tribunal recalls that the void fractions in the RSGs exceed this amount. MHI’s validation report further provides that AVB flutter is not a concern given the dimensions of the AVBs.²¹⁸⁹
2230. MHI’s response to the AREVA Report provides further analysis on comment 2.2.1 in response to additional concerns regarding the existing AVBs.²¹⁹⁰
2231. The Tribunal determines that the Respondents have adequately demonstrated that an analysis of these concerns could have been undertaken during the design era to satisfactorily resolve the concerns raised in the AREVA Report.

²¹⁸⁵ Exh. JX-1797, p. 9.

²¹⁸⁶ Exh. JX-1797, p. 7.

²¹⁸⁷ Exh. JX-2190, p. 16.

²¹⁸⁸ Exh. JX-2190, p. 16.

²¹⁸⁹ Respondents’ Validation Report of the U-Bend Repair, ¶¶ 86-88.

²¹⁹⁰ Exh. JX-2190, pp. 21-24.

(8) Vibration of the Loose End of the Thicker AVBs

2232. The Claimants submit that the newly installed thicker AVBs, unlike the existing V shaped AVBs, are only attached on one end are therefore are at risk of vibrating and causing tube wear.²¹⁹¹
2233. The Respondents submit that the thicker AVBs are secured and cannot vibrate.²¹⁹²
2234. During the Hearing, the Respondents submitted that there is no loose end of the AVBs, as the end of the AVBs remains thicker than the space between the tubes.²¹⁹³ During cross-examination, Dr. Elder, the Claimants' expert, testified that he was not concerned about this issue at present, as there was no loose end to the AVBs, but that over time, it was possible that a loose end could develop.²¹⁹⁴ Similarly, Dr. Asadi, the Claimants' expert, also during cross-examination testified that he was more concerned with the fact that this issue had not been analyzed but could not identify any particular immediate risk.²¹⁹⁵
2235. The Tribunal is not convinced that there is any particular risk in this issue. While it is not apparent that the Respondents analyzed the risk from the loose end of the thicker AVBs, that appears to be because there is no loose end, the thicker AVBs have contact force with the tubes they are supporting.²¹⁹⁶ In the Tribunal's view, the requirements of 10 CFR 50.59(C)(2)(v) do not extend to non-plausible risks.²¹⁹⁷ That provision provides that modification to the steam generators must not "create a

²¹⁹¹ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 273 (citing to Expert Witness Statement of Dr. Asadi, ¶ 79(c)).

²¹⁹² Respondents' Rejoinder, ¶ 211.

²¹⁹³ Transcript, p. 889 (Dr. Asadi); See also Exh. JX-1735, p. 63.

²¹⁹⁴ Transcript, p. 747.

²¹⁹⁵ Transcript, pp. 912-917.

²¹⁹⁶ Transcript, p. 889 (Dr. Asadi); See also Exh. JX-1735, p. 63.

²¹⁹⁷ See Section XIV.C(a) above.

possibility for an accident of a different type than any previously evaluated in the final safety analysis report.” The Claimants have not convincingly demonstrated that the end of the AVBs is a “possible” risk that required evaluation. Further, it is not evident that vibration from a thicker AVB with the tubes creates a possibility of a different type of accident than vibration between the existing AVBs and the tubes. Tellingly, neither Party has identified that this was a concern raised in the AREVA Report and the Tribunal’s own review of the AREVA Report has not identified a concern with loose ends of the thicker AVBs.²¹⁹⁸

2236. Accordingly, the Tribunal does not consider that this is a non-analyzed issue.

(9) AVB Fatigue

2237. The Claimants submit that the existing AVBs could have suffered from FIV and “flutter,” a twisting of the AVB, that would have resulted in AVB fatigue such that the AVBs would have broken apart, causing damage to the tubes.²¹⁹⁹

2238. The Respondents submit that their analysis of this issue demonstrates that the risk of AVB fatigue is negligible.²²⁰⁰

2239. Dr. Asadi, the Claimants’ expert, opines that this review remains inadequate, testifying that a greater level of analysis should be undertaken.²²⁰¹ Dr. Asadi opines that Babcock and Wilcox, the steam generator designers he used to work for, would have undertaken more modeling and analysis of these risks.

²¹⁹⁸ Exh. JX-1797.

²¹⁹⁹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 274.

²²⁰⁰ Respondents’ Rejoinder, ¶ 211.

²²⁰¹ Transcript, p. 917.

2240. The AREVA report identifies this issue in comment 2.2.2.²²⁰² The AREVA Report identifies the potential for AVB fatigue as a concern of “prime importance for resolution.”
2241. MHI’s Response to comment 2.2.2 concludes that there is “no risk of fatigue” based upon its analysis.²²⁰³
2242. While Dr. Asadi, for the Claimants, identifies that Babcock & Wilcox could have performed a more detailed analysis of the risk of fatigue, the Tribunal considers that this in and of itself demonstrates that any required analysis of this risk could have been undertaken.
2243. Accordingly, the Tribunal determines that MHI has undertaken an analysis of this issue in response to the AREVA Report and could have undertaken an analysis of this issue during the repair era.

(10) Conclusion

2244. While the Respondents did not adequately address concerns about additional failure modes during the repair era, as the AREVA Report was never transmitted to the Respondents, the evidence presented in this arbitration, demonstrates that these concerns could have been addressed satisfactorily.
2245. Accordingly, the Tribunal answers Issues C.3(b)(i) in the affirmative. MHI could have demonstrated that questions surrounding possible new modes of failure could and would have been satisfactorily addressed, but for the shut down decision.

²²⁰² Exh. JX-1797, p. 9.

²²⁰³ Exh. JX-2190, p. 17.

(f) **If Mitsubishi was obligated but failed to demonstrate that its proposed repair would not cause other modes of failure, was Mitsubishi excused from its obligation due to Claimants' actions? (Issue C.3(b)(ii))**

2246. This Issue C.3(b)(ii) concerns the question that if the Respondents were obligated but failed to demonstrate that their proposed repair would not cause other modes of failure, were the Respondents excused from their obligation due to the Claimants' actions.

(i) *The Claimants' Position*

2247. In their Responses to Joint List of Issues, the Claimants submit that “[i]t was commercially reasonable for Edison to express skepticism and ask questions about the repair, namely, request that Mitsubishi provide technical justification and validation that its repair would correct the root causes, and likely obtain NRC approval not introduce new failure modes.”²²⁰⁴

2248. In addition, in their C-RPHM, the Claimants contend that “[c]ontrary to their claim, Respondents were not excused from their obligation to demonstrate that their proposed repair would not cause other modes of failure due to Claimants' actions (...) Edison acted in good faith in supporting Respondents' repair efforts and repeatedly made commercially reasonable requests for testing, analysis, and documentation that validated the efficacy, safety, and licensability of the repair—information that Respondents never provided. Edison's actions were consistent with those of a responsible, safety-conscious utility.”²²⁰⁵

(ii) *The Respondents' Position*

2249. In their Position Statement on the Revised List of Issues, the Respondents, in reference to their submissions on Issues C.3(a)(ii) and C.4(a)(iii), contend that “[i]f

²²⁰⁴ Claimants' Responses to Joint List of Issues, ¶ C.11(b)(ii).

²²⁰⁵ Claimants' RPHM, ¶ 348.

the Tribunal finds that Mitsubishi was obligated but failed to demonstrate that its Repair would not cause other modes of failure, Mitsubishi should be excused from its obligation.”²²⁰⁶

(iii) The Tribunal’s Determination

2250. While the Tribunal addressed Issue C.3(b)(i) from the perspective of a “but for” scenario,²²⁰⁷ which would render Issue C.3(b)(ii) moot, the Tribunal considers Issue C.3(b)(ii) as framed. The Tribunal’s analysis of this Issue supports the Tribunal’s adoption of a “but for” perspective in addressing Issue C.3(b)(i).
2251. Delays in proceeding with a Type 1 Repair were incurred on account of the Claimants’ lack of interest, demonstrated by taking unreasonable positions, in preference for pushing the Respondents into proposing a replacement option which the Claimants rejected and, potentially, developing a stronger litigation/negotiation position.
2252. Had the Claimants adopted an iterative design review process, the Tribunal considers that the Respondents could have more quickly developed a viable repair plan, such that any concerns regarding new forms of degradation raised in a review could have been reviewed sooner. The Claimants’ actions were, thus, crucial.
2253. Accordingly, the Tribunal answers Issue C.3(b)(ii) in the affirmative. MHI was excused from having developed answers to these technical issues during the repair era on account of the Claimants’ actions.

²²⁰⁶ Respondents’ Position Statement on the Revised List of Issues, ¶ 263.

²²⁰⁷ See ¶ 2189 above.

- (g) **If Mitsubishi was obligated but failed to demonstrate that its proposed repair would not cause other modes of failure, and Mitsubishi’s failure was not excused due to Claimants’ actions, what are the consequences of that failure? (Issue C.3(b)(iii))**

2254. As a consequence of the Tribunal’s determination on Issues C.3(b)(ii) above, the Tribunal does not need to consider this Issue C.3(b)(iii).

- (h) **Did the RSG Contract obligate Mitsubishi to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59? (Issue C.3(c))**

(i) *The Claimants’ Position*

2255. In their Responses to Joint List of Issues, the Claimants submit the following:

Mitsubishi had a clear contractual obligation to demonstrate that its proposed repair would be licensable and implementable either through a license amendment or under 10 C.F.R. 50.59. Section 3.6.1.2 of the RSG Contract requires that Mitsubishi “shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end.” “Relevant documents will be made available for review and use by [Mitsubishi].” Mitsubishi also promised to “prepare and submit for Edison’s approval a Licensing Topical Report demonstrating compliance of the RSG design will all SONGS licensing requirements.” Likewise, Mitsubishi promised to “include[e] all necessary analyses and evaluations” justifying application of 10 CFR 50.59.

Mitsubishi’s witness ██████████ testified that, under the RSG Contract, “any repair would have to be licensable in accordance with NRC requirements.” Mitsubishi has the burden of proving that the repaired RSGs would meet NRC requirements.²²⁰⁸

2256. In addition, in their C-RPHM, the Claimants’ contend the following:

Respondents had a clear contractual obligation to demonstrate that their proposed repair would be licensable and implementable either through a

²²⁰⁸ Claimants’ Responses to Joint List of Issues, ¶ C.11(c).

license amendment or under 10 C.F.R. 50.59. Section 3.6.1.2 of the RSG Contract requires that Respondents “shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end.” “Relevant documents will be made available for review and use by [Mitsubishi].” Respondents also promised to “prepare and submit for Edison’s approval a Licensing Topical Report demonstrating compliance of the RSG design will all SONGS licensing requirements.” Likewise, Respondents promised to “include[e] all necessary analyses and evaluations” justifying application of 10 CFR 50.59.

A repair that could not be ultimately licensed was a worthless repair, which is why licensability was one of the repair criteria. Back during the outage, Respondents well understood such a basic requirement. ██████████ Respondents’ witness and Mitsubishi consultant during the design and repair of the RSGs, testified that “any repair would have to be licensable in accordance with NRC requirements.” His understanding was based both on the RSG Contract terms and industry standards. Respondents’ current attempt to distance themselves from the requirement to ensure the repair could be licensed is unsupported by the Contract, testimony, and reason.²²⁰⁹

(ii) The Respondents’ Position

2257. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

The RSG Contract does not obligate Mitsubishi to demonstrate that the proposed repair was licensable. The warranty provision in the RSG Contract requires Mitsubishi to perform a technical analysis, and to correct the root cause of any Defect or demonstrate that the Defect will not recur. But the warranty is silent as to Mitsubishi’s licensing obligations for a repair. Claimants rely on section 3.6.1.2 of the Specification to argue that Mitsubishi was obligated to provide a repair that would be licensable. section 3.6.1.2 required Mitsubishi to guarantee that the original RSG design was licensable and provide support necessary to achieve that end. There is no requirement in section 3.6.1.2 or elsewhere in the Contract, however, requiring Mitsubishi to demonstrate that any licensing requirements are fully satisfied as a pre-condition to determining a mutually-agreeable repair under the warranty clause.

²²⁰⁹ Claimants’ RPHM, ¶¶ 350-351.

Practically speaking, any proposal by Edison to restart SONGS had to be approved by the NRC and Mitsubishi recognized that obtaining this approval would be part of the repair process. However, it was not reasonable or consistent with the Contract for Edison to insist that Mitsubishi demonstrate compliance with any licensing requirements before undertaking a process that involved Edison's cooperation and input. Edison, not Mitsubishi, is the NRC licensee that was familiar with NRC requirements and responsible for interacting with the regulator. Recognizing the limits that this structure placed on Mitsubishi, the Contract contemplates an iterative, cooperative process with respect to licensing matters. section 3.6.1.5 of the Contract required Edison to "be responsible for ensuring that the SONGS licensing requirements and commitments regarding RSG design, fabrication, inspection/testing, and operation are clearly communicated to the Supplier, both initially and throughout the duration of the Project." section 3.6.1.5 also states that "[w]here the RSG design, fabrication, inspection/testing, or operation does not meet these [licensing] requirements or commitments, *both* the Supplier and Edison shall be responsible for establishing exceptions and their bases, and providing required justification" This same provision adds that "Edison will be solely responsible for communicating such exceptions to the NRC"

However, the iterative process contemplated by the Contract never took place. Because Edison rejected Mitsubishi's Repair, discussions never advanced to the licensing phase. Indeed, Edison never held even a pre-licensing meeting with the NRC staff, a well-established practice for licensees contemplating a license amendment request.

As outlined below, Edison informed Mitsubishi that licensing matters were to be deferred until there was technical agreement on a repair. Rather than approach the NRC about licensing the Mitsubishi repair, Edison in fact disclaimed the repair effort when the NRC visited Kobe to inspect Mitsubishi's engineering mockup, and later provided NRC representative Art Howell with a presentation (which he requested) that clearly indicated Edison had no interest in repair.

Thus, Mitsubishi had no obligation to "demonstrate" that its repair was licensable as a pre-condition to moving forward with a mutually-agreeable repair. As described below, the licensing process contemplated by the RSG Contract (where the licensability of the Repair would have been "demonstrated") was thwarted by Edison. This conduct relieved Mitsubishi of responsibility for the failure of the Repair to be licensed. As a result, the Tribunal is left to speculate as to whether the Repair could be licensed because Edison never agreed to a repair, never communicated SONGS' licensing

requirements to Mitsubishi, never educated the NRC about how and why the Repair would work, and never pursued regulatory approval.²²¹⁰

(iii) Tribunal's Determination

2258. The Tribunal accepts that the question of licensability has both a technical and a regulatory element, requiring that the NRC be satisfied as to the safety of a proposed repair option and a commercial timeliness aspect, which is affiliated with the potential for public hearings.
2259. The Respondents are correct that the RSG Contract is silent on the question of whether a repair has to be licensable.
2260. The Respondents, however, concede that as a practical matter, a repair would have to be licensable.
2261. The Respondents submit that provisions on licensability in the RSG Contract concerning the design of the RSGs are not directly applicable to questions of repair under issue in this Issue C.3(c).
2262. Nonetheless, as an interim conclusion, the Tribunal finds that the Respondents had to put forward a licensable repair.
2263. Regarding the issue of whether the Respondents had to “demonstrate” that the repair was licensable, the Tribunal accepts the Respondents’ submission that the Claimants are the regulated licensee. It is for the Claimants to demonstrate to the NRC that a proposed repair is licensable.
2264. However, the Respondents have an obligation to co-operate in the development of a repair that is licensable.

²²¹⁰ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 265-269.

2265. In light of the above, the Tribunal answers Issue C.3(c) in the negative. The RSG Contract does not specifically require that the Respondents have to demonstrate that the repair is licensable.

2266. As a practical matter, and as a legal interpretation of what the Claimants could request for a mutually agreeable repair, the Respondents had an obligation to assist the Claimants in demonstrating to the NRC that any repair proposal approved of by the Claimants was licensable.

(i) **If so, did Mitsubishi demonstrate its proposed repair would either be licensable through a license amendment or implementable under 10 C.F.R. § 50.59? (Issue C.3(c)(i))**

(i) *The Claimants' Position*

2267. In their Responses to Joint List of Issues, the Claimants submit the following:

At the outset, Respondents' do not contest that once the ASLB ruled that the CAL was a *de facto* license amendment, the NRC would have had to issue a license amendment for a repair before Edison could restart either Unit. Thus, Edison would have needed to submit a license amendment request ("LAR") to the NRC and obtain written approval before implementing the thicker-AVB repair.

Respondents did not and have not demonstrated that their Type 1 Repair concept would have been licensable either in June 2013 or ever. Moreover, even before the ASLB decision, it would have been very unlikely that the thicker AVB repair would have met the 50.59 screening criteria and been able to be installed without a license amendment. As Mr. Leeds and Strosnider explained, because the Type 1 Repair did not restore the thermal-hydraulic conditions to industry operational experience, introduced a first-of-a-kind support philosophy, and created the potential for new forms of tube degradation, the repair would have failed to meet several 50.59 criteria, and the NRC would not have allowed the plant to restart without Edison obtaining a license amendment.

The May 2013 AREVA also concluded 50.59 was unavailable:

AREVA does not think this modification fits well in 10 CFR 50.59 space because to justify a change by 50.59 evaluation requires the

*plant to start from a known acceptable design, operation and licensing basis. Because of the problems with these generators with respect to tube wear and consequences, there is not a 'clean' basis to start from and the situation surrounding the current license amendment request is in flux.*²²¹¹

2268. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents never demonstrated that their proposed repair would be licensable by the NRC either through a license amendment or under 10 CFR 50.59 ("50.59"). As an initial matter, Edison would not have been able to implement Respondents' proposed repair under 50.59. A nuclear power plant must have a license from the NRC and must operate within that licensing basis, i.e. the limits set forth in the technical specifications incorporated into the license. While some changes to a nuclear plant may be made pursuant to 50.59, any deviations that present more than a minimal decrease in safety require a license amendment approved by the NRC.

Significantly, Respondents' experts admit that once the ASLB ruled that the CAL was a de facto license amendment, Edison would have needed to submit a license amendment request ("LAR") to the NRC for the thicker AVB repair and obtain written approval before restarting either Unit post-repair. Respondents' assertion that the ASLB's decision addressed only the issue of restart for Unit 2 is incorrect. The ASLB was asked to consider a much broader question: "whether any aspect of this CAL process, including a close-out of the CAL for Unit 2 that results in a plant start-up pursuant to SCE's Unit 2 Return to Service Plan, would constitute a de facto license amendment proceeding." The ASLB's conclusion that the CAL process in fact was "a de facto license amendment request subject to a hearing opportunity" meant that any plan to restart the plant, including Respondents' thicker AVB repair concept, would require the NRC's approval of a LAR before SONGS would be allowed to operate. Thus, while the ASLB did not explicitly discuss the Type 1 Repair concept, it addressed the licensability of the Type 1 Repair in a manner making it clear that any repair would have been processed as a LAR by the NRC.

Moreover, even without the ASLB decision, Respondents' proposed repair could not have been implemented under 50.59. As Messrs. Leeds and Strosnider explained, because the thicker AVB repair did not restore the

²²¹¹ Claimants' Responses to Joint List of Issues, ¶ C.11(c)(i).

thermal-hydraulic conditions to industry operational experience, introduced a first-of-a-kind support philosophy, and created the potential for new forms of degradation, the repair failed to meet several 50.59 criteria and, thus, required a license amendment. The May 2013 AREVA Report similarly concluded 50.59 was unavailable.

Respondents' own on-the-job repair implementation timeline includes an allocation for an NRC licensing period. There is little dispute—and no argument after the ASLB decision—that Edison needed a license amendment to restart SONGS with the proposed repair.

Respondents' assertion that the thicker AVB repair could be implemented under 50.59 like all other AVB repairs is unmerited. As discussed above, no other AVB repair used pinning forces to lock the tube bundle in place. As the Hearing testimony demonstrated, such an approach ran counter to engineering principals used to design and repair every other tube bundle. Had Edison tried to compare Respondents' repair concept to prior AVB repairs in front of the NRC, as Respondents suggest, it would have lost its credibility with the NRC. Edison only had “one shot at putting a repair in front of the NRC” and it had to be right.

Respondents never demonstrated that their repair concept was licensable either in June 2013 or at any point during this arbitration. In order for a repair to be licensable, the NRC would have to be satisfied that the repair would provide “reasonable assurance, as required by NRC regulations, that the unit[s] will operate safely.” Mr. Russell acknowledged that reasonable assurance is a “high standard” to meet. The NRC would have required reasonable assurance that Respondents' repair would have fixed the problems leading to the tube-to-tube wear and not introduce new forms of tube degradation.

Respondents' thicker AVB repair did not and could not have provided the NRC with reasonable assurance of safety. First, the repair failed to correct the extreme thermal-hydraulic conditions, which both the ASLB decision and the NRC's Lessons Learned Report (along with AREVA and Respondents' own expert Dr. Begley) concluded were outside industry operational experience. Operating beyond the envelope of successful operational experience creates immense uncertainty (in an industry whose very foundation is based on proven, known operational experience) as to whether reasonable assurance of safety can be achieved. As Mr. Merschoff explained at the Hearing:

[A]bout 2,000 of those reactor years[] are in pressurized water reactors. That's a lot of operating experience that gives a lot of confidence to the NRC that, if you stay in the box of known operating experience, it's

unlikely that you'll be surprised with some new consequence. ***This finding that San Onofre was, in fact, outside that experiential base is important because it turned San Onofre into an experiment of one.***

All agree that in-plane FEI, like at SONGS, has significant and serious safety implications. The NRC concluded that in-plane FEI had the potential to be a "substantial safety hazard" and that the "timeframe" of onset of FEI "is too short and too unpredictable to be effectively managed by the Steam Generator Program." Thermal-hydraulic conditions drive tube vibration and wear. By neglecting to address the thermal-hydraulic conditions and bring the RSGs back within successful industry operational experience, Respondents failed to provide Edison with a repair option that would give the NRC sufficient confidence that the dangerous wear mechanisms created by those thermal-hydraulic conditions (both tube-to-tube wear and tube-to-support wear) would be eliminated and the Units would operate safely.

Additionally, the thicker AVB repair relied on a first-of-a-kind support philosophy and created the potential for serious secondary effects. Respondents never resolved these concerns, failing to demonstrate that pinning tubes in place with as much as ██████ would give the NRC reasonable assurance of safety. Respondents' expert, Mr. Olszewski, even conceded that, as of June 7, 2013, Respondents had not provided Edison "with enough information to establish that the thicker AVB repair would not cause secondary effects that could lead to new modes of tube bundle damage." The same concerns that arise with first-of-a-kind thermal-hydraulic conditions exist with a first-of-a-kind repair. At the NRC, such repair concepts are "going to be scrutinized very carefully." The concept of using pinning forces to lock tubes in place was "counter to the original design of this steam generator" and "counter to one of the basic principles that engineers try to follow when they are designing heat exchangers." Such a concept would have been very difficult for the NRC to approve.

Because the repair did not bring the thermal-hydraulic conditions within operational experience and relied on a first-of-a-kind support philosophy, the NRC would have demanded substantial proof and likely would have conducted confirmatory testing of its own that replicated the thermal-hydraulic conditions at SONGS. Such confirmatory testing was exactly what Edison asked Respondents to perform and exactly the type of testing Respondents repeatedly refused to do.

Contrary to Respondents' arguments that there is no basis for the NRC's demand for such testing (even though Mr. Leeds, the individual at the NRC who would have determined whether SONGS could return to service, testified

that he would have required such testing), the NRC had requested that Edison perform testing to confirm the squeeze-film damping assumption in the proposal for partial restart of Unit 2. That prototypical testing would have been difficult to perform is no excuse. Moreover, Mr. Leeds testified that prototypical testing did not require a full replica of the RSGs:

The NRC has allowed half scale, quarter scale, even eighth scale testing to be done. There are a lot of different ways that the NRC has allowed licensees to do testing that we found acceptable. You don't necessarily have to use steam and water. You could use a Freon environment. So I think what we're saying here is they need to have testing that will satisfy the NRC that will show that the repair can survive in this type of environment. But whether you need to build a complete full-scale mockup? I don't think that's what we're saying.

Edison's request for additional analysis and testing was well founded—it is exactly what the NRC would have required. Respondents, however, were unwilling to conduct testing that would help assure the NRC that the repair would solve the problem and not introduce new ones, proposing instead to confirm its repair through actual operation of the plant. Mr. Merschhoff testified that Respondents' position "indicates a lack of experience in dealing with the NRC. To think that the NRC would not require testing and rather allow San Onofre to be used as an experiment to prove this modification is just not something the NRC would agree to." Respondents' position is dangerous, evinces a clear disregard for safety, and is purely the product of the necessities of litigation.

The decision of whether to grant SONGS a LAR was in the hands of the Office of Nuclear Reactor Regulation ("NRR") and, ultimately, its director, Mr. Leeds. Respondents do not contest that Mr. Leeds would have had the final word on whether SONGS would be permitted to restart. His signature was needed to lift the CAL, allowing Edison to put the plant back into operation. Mr. Leeds also had a supervisory role in the LAR approval process and would have had to concur in the outcome at SONGS due to the level of safety concern and public and political interest.

Although the parties agree that the decision would have been based on a consensus process, it appears that Respondents' view of what this means excludes the opinion of Mr. Leeds himself. There cannot be consensus without the director of the NRR's agreement. Respondents' view of the director's role does not comport with the testimony of their own expert, Mr. Russell, who was the former director of the NRR and, like Mr. Leeds, was personally involved in the review and ultimate approval decisions of LARs:

When I was there I would have the package that had been completed would come for my review and concurrence. I would ask questions about it. If I was satisfied, it would proceed. If I had questions I'd send the staff back and ask them to provide more information or clarify something.

There is no dispute here that Mr. Leeds would have been very involved in the LAR review and approval process and would have ultimately decided whether to allow SONGS to operate with Respondents' thicker AVB repair. As he unequivocally testified, neither he nor his staff would have approved a LAR for Respondents' proposed repair, and he would not have signed the CAL authorizing Edison to restart SONGS.

Respondents' assertion that there is "no basis" to conclude that the NRC would not allow SONGS to restart when every other plant that has experienced a tube leak has been approved to operate ignores the fact that no other plant in the history of the U.S. nuclear power industry has experienced thermal-hydraulic conditions as extreme as those seen at SONGS, in-plane FEI, a tube leak in less than half of a cycle, eight failed in situ tests, RSGs that exhibited the "worst case degraded steam generator[s]," or a repair that proposed introducing [REDACTED] of force to pin the tubes. As Mitsubishi's own expert, Dr. Begley, stated, SONGS was "fortunate" that a tube leak occurred, as opposed to a full tube burst. The tube leak put SONGS and the NRC on notice of the grave problems with Mitsubishi's design. Accordingly, the fact that other plants with tube leaks were eventually permitted to restart has no consequence on the problems faced at SONGS.

➤ ***Mitsubishi's Repair Concept Could Not Have Been Licensed In A Commercially Reasonable Timeframe***

Respondents never demonstrated that their proposed repair would have been licensed by the NRC. Nevertheless, even if Edison had ignored its NRC consultant, industry experts, and the NRC's and Respondents' conclusions regarding the cause of the failures, and instead sought to implement the thicker AVB repair, the development of a LAR and regulatory review likely would have taken over 8 years to complete. Such a timeframe clearly does not satisfy Respondents' warranty requirement to repair "with due diligence and dispatch."

The process of obtaining approval of a license amendment involves several key steps. First, the licensee must submit an LAR that is "complete and accurate." In other words, it must include the technical details of the repair, such as the size and shape of the thicker AVBs. If details of the repair change after the

LAR has been submitted, Edison would have been required to amend its request.

Respondents argue that Edison could have submitted a LAR to the NRC in December 2012. Yet, at no point before June 2013 did Respondents provide Edison with sufficient information and analysis regarding the thicker AVB repair to allow Edison to submit an LAR to the NRC. Indeed, Respondents' expert, Mr. Denton, conceded that, as of June 7, 2013, Respondents had not completed their work on the thicker AVB repair and "had more work to do to develop and validate that repair."

Mr. Russell testified to a long list of additional testing, analysis, and documentation that Edison needed from Respondents before they would have been able to submit a "complete and accurate" LAR to the NRC. Several necessary items for a LAR application were either entirely missing or incomplete as of June 2013 (and thus were certainly not ready by December 2012). For example, Mr. Russell acknowledged that an LAR would need to prove that the thicker AVBs would not cause adverse effects. Yet, as AREVA concluded, Respondents failed to show that adverse secondary effects would not result. Mr. Russell also conceded that, at the time Respondents claim Edison should have submitted an LAR, Respondents had not addressed:

- The applied loading on the retaining bars;
- The risks associated with the vibration of unsupported AVBs;
- Whether unsupported AVBs would be susceptible to flutter;
- What would happen in the tube bundle during heat ups and cool downs;
or
- How the change in flow resistance in the U-bend due to the thicker AVBs would impact water level stability and water level control.

Of importance, Respondents did not need anything from Edison to complete this additional work; Respondents' arbitration-era suggestion that Edison did not sufficiently "support" its repair efforts is, therefore, unfounded. Respondents' expert, Mr. Denton, testified that he would not have authorized implementation of the thicker AVB repair and would not have submitted the repair to the NRC before the concerns raised by AREVA's report were resolved.

Mr. Russell acknowledged further insufficiencies in Respondents' U-Bend Repair Report, namely that Respondents still needed to complete and make available to the NRC several other tests and analyses, such as:

- A description of its analysis and testing proving in-plane FEI would not recur;
- Analytical methods related to the thermal-hydraulic conditions and excitation forces on the tubes;
- Results of its engineering mockup testing and results of the eddy-current inspections performed on the mockup; and
- Details and results of the ABAQUS analysis for the repair that had been independently reviewed in accordance with Mitsubishi's QA program.
- The U-Bend Repair Report also lacked numerous key calculations and documents, including:
 - Updated design documentation with post-repair out-of-plane stability ratio calculations;
 - Updated original RSG design documentation based on the repair;
 - The Design Reconciliation Report and the Analytical Methods Report.

All of this necessary analysis and testing had to be performed in accordance with Appendix B. Yet, for all of the thousands of pages of additional reports Respondents submitted in January 2016 (solely for purposes of this proceeding), no indication exists that these documents and calculations were independently verified and approved. These arbitration filings, "necessary" for a licensing review, and Respondents' material changes to the AVB design do demonstrate, however, that Respondents had not proven their repair as of June 2013, let alone December 2012.

Following the submission of a LAR, the NRC conducts an acceptance review to determine if the application has the requisite level of detail. The NRR aims to complete an acceptance review of a LAR within a month, but more complex requests often take longer. Assuming Respondents eventually provided Edison with the necessary information to submit a complete and accurate LAR to the NRC, Messrs. Strosnider and Leeds testified that the NRC would have completed an acceptance review of the LAR for the thicker AVB repair in 1 to 3 months. In arriving at this conclusion, Messrs. Strosnider and Leeds relied

on their review of the relevant NRC guidance documents, timeliness goals, and the actual time of past NRC cases, along with their recent experience at the NRC. In response to this showing, Mr. Russell—who had not performed an acceptance review since 1980, did not review LIC-109: Acceptance Review Procedures, effective in July 2009, and did not conduct any research of NRC past precedent in conducting acceptance reviews,—testified that the review could be completed in one week. No convincing basis exists for Mr. Russell’s opinion.

Following the acceptance review, the NRC performs a No Significant Hazards Consideration Determination (“NSHCD”), which determines whether any change creates an increase in the probability of an accident or reduction in the margin of safety. If the NRC is unable to make such a determination, a public hearing would have to be completed before the NRC could grant a license amendment. Neither Edison nor the NRC likely could have made an NSHCD for the thicker AVB repair in light of the potential for new degradation modes and the failure to address the thermal-hydraulic conditions. The AREVA report supports this conclusion, recognizing that “the NRC may question if the computer code calculations are sufficient to ensure reduced wear without direct operating experience” and that the repair created the possibility of a new or different kind of accident than previously evaluated.

Even if the NRC found in favor of an NSHCD, the NRC may have still been required to complete a hearing prior to the approval of any LAR. One likely possibility was that the Commission could have ordered a discretionary hearing. Mr. Strosnider testified that there was a high likelihood of a discretionary hearing given public and Congressional interest. Respondents do not deny that significant public interest existed. Moreover, the Commission indicated its recognition of the high public interest when it referred the CAL to the ASLB. Despite this heightened interest, neither Mr. Russell nor Mr. Johnson addressed the possibility of a discretionary hearing. Additionally, even if the Commission did not order a public hearing, interested parties could have petitioned a federal court to order a hearing prior to issuance of a license amendment. The level of involvement from interested groups showed that this was a real possibility. Indeed, Friends of the Earth *did file a petition* in June 2012 arguing that the CAL was a de facto license amendment and asserting a right to a hearing.

After the above determinations have been made, the NRC conducts a detailed technical review of the application, which is typically accompanied by multiple rounds of Requests for Additional Information (“RAIs”) to the licensee. Messrs. Strosnider and Leeds estimated that a technical review of

Respondents' proposed repair would take 24-30 months. This is in stark contrast to Mr. Russell's estimate of five months, for which Mr. Russell neither reviewed LIC-101: License Amendment Procedures, which became effective in May 2012, nor conducted independent research.

Mr. Russell's estimate for a technical review of the thicker AVB repair also ignored the very real experience Claimants' faced in obtaining review of the partial restart proposal for Unit 2. For instance, Mr. Russell's five month estimate assumes the NRC would only issue one set of RAIs and would do so within one month of receiving the LAR, despite the fact that the NRC took 2.5 months to issue the first set of RAIs for Edison's Unit 2 partial restart request and issued multiple rounds of RAIs over the course of **8 months** (totaling 73 RAIs and nearly 200 requests for information ("**RFIs**")). Thus, Edison had spent 16 months trying to restart Unit 2 at **reduced power for 5 months**; yet, the NRC was still reviewing the responses to its hundreds of RAIs and RFIs and testing had called into question an assumption underlying the proposal when the ASLB ruled that the CAL was a de facto license amendment. Accordingly, there is no basis for the assertion that the NRC would have completed its review of Respondents' thicker AVB repair, which would allow the unprecedented thermal-hydraulic conditions to remain and which reflected a first-of-a-kind support philosophy, in five months.

Messrs. Russell and Johnson attempt to support their unreasonably abbreviated timeframe for NRC review by asserting that, given the root cause analysis conducted by Respondents and Edison and the Unit 2 partial restart efforts, the NRC would have already been "familiar with the contents of the submission" by the time Edison submitted the LAR. Such a position ignores facts: neither the root cause analysis nor the partial restart effort of Unit 2 would have informed the NRC of the details of the thicker AVB repair or somehow aided in shortening review of this first-of-a-kind repair concept to a brief five months.

The Unit 2 partial restart effort was not similar to Respondents' thicker AVB repair—they were completely opposite approaches. Respondents' repair did not return thermal-hydraulic conditions to industry operational experience, whereas the Unit 2 restart proposal did just that. Nor did the Unit 2 restart effort involve imposing extreme contact forces or making physical repairs to the RSG at all. This stands in stark contrast to the thicker AVB proposal, which sought to lock the tube bundle in place. Likewise, the root cause analysis focused on analyzing what caused the failures at SONGS, not on how to repair the RSGs.

Finally, Respondents' assertion that because SONGS was offline, the NRC would have reviewed it more quickly and approved it within a matter of months is incorrect. The NRC would never sacrifice safety to get a plant back online.

Mr. Russell's comparison and reliance on the NRC's review of North Anna in informing his estimate for NRC review and approval of Respondents' repair proposal is unmerited. North Anna was shut down pursuant to regulatory procedure following an earthquake. There were no design defects that rendered the plant inoperable and no need to repair the RSGs to ensure that extreme thermal-hydraulic conditions would not continue to cause never-before-experienced in-plane FEI and unprecedented wear. Nevertheless, the NRC's review still took months. The fact that SONGS was shut down does not support Respondents' abbreviated timeline.

The evidence overwhelmingly shows that Respondents did not and could not demonstrate that their thicker AVB repair would be licensed by the NRC.

➤ ***The NRC Would Have Reviewed Information Contained In The PAR***

Respondents' assertion that the PAR is unrelated to licensing is incorrect. Contrary to Respondents' claim, the NRC staff is not limited to what is contained in the UFSAR and SONGS' technical specifications. In reviewing a LAR, NRC staff may assess whatever relevant information they deem necessary. Information contained in the PAR, such as the thermal-hydraulic parameters, three dimensional thermal-hydraulic analysis, and tube vibration, would have been relevant to the NRC's review of a LAR for Respondents' thicker AVB repair concept.

While the NRC would not necessarily have dictated to Edison what the operational parameters of the RSGs should be post-repair, it would have required Edison to demonstrate that the thermal-hydraulic conditions would not have caused dangerous wear mechanisms, the tube degradation experience by the RSGs, or new forms of degradation. This would have necessitated review of any and all parameters that could have an impact on the thermal-hydraulic conditions in the RSGs, including void fractions, flow velocities, and any other applicable parameters. These issues, addressed in the PAR, have been central to this arbitration. To think the NRC would have ignored this information reflects a profound misunderstanding of the NRC's process for reviewing a LAR and its insistence that the utility adequately demonstrate reasonable assurance of nuclear safety.²²¹²

²²¹² Claimants' Responses to Joint List of Issues, ¶¶ 352-385.

(ii) The Respondents' Position

2269. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

[T]he RSG Contract did not obligate Mitsubishi to demonstrate (nor could it without Edison's cooperation) that its proposed repair would be licensable as a pre-condition to moving forward with a mutually-agreeable repair. However, the contemporaneous evidence shows that it was widely understood in 2012 that AVB repairs were licensable. The evidence shows that all prior AVB repairs in the U.S. nuclear industry were implemented pursuant to 10 C.F.R. §50.59, and therefore did not even require a license amendment. Edison could and should have explained this fact in detail to the NRC in an effort to gain support for the thicker-AVB repair.

The likelihood that the Repair could have been licensed is also reflected by the fact that AREVA, B&W and Westinghouse each included AVB repairs in their June 2012 responses to Edison's Request for Information that specifically asked for solutions that could be implemented pursuant to 10 C.F.R. §50.59. In July of 2012, AREVA again addressed the issue, noting that "[i]nsertion of additional AVBs involves a modification to the existing steam generator design, but is not judged to be one that will require a license amendment to implement." And at the hearing, Mr. Avella described a conversation with a colleague at B&W who told him that "I think we can [implement B&W's repair pursuant to 10 C.F.R. §50.59]."

Edison's return to service team also thought in the spring of 2012 that a thicker-AVB repair could be implemented pursuant to section 50.59. In a chart discussing all repair options under consideration, Edison engineer Bob Olech noted that thicker-AVB repairs could be implemented without a license amendment.

Claimants point to a statement from AREVA in its May 2013 evaluation of Mitsubishi's thicker-AVB repair as evidence that the Repair would have difficulty being licensed. But that document does not say the Repair is not licensable, which is Claimants' current position. Instead, it just evaluates *how* the Repair would be licensed, and notes that it may not be licensable under 10 C.F.R. §50.59. On the other hand, in its discussion about whether a no significant hazards determination could be made as part of a license amendment request, AREVA implied that it was certainly possible.

As explained below, Mitsubishi's experts in this hearing have further confirmed that the Repair was licensable either through a license amendment request or pursuant to 10 C.F.R. §50.59. Indeed, two-hundred-and-twelve nuclear plants have experienced outages in the U.S. due to a tube leak or tube rupture. It is uncontroverted that, in every such case, the plant received the NRC's authorization to return to power. There is no basis for the Tribunal to conclude that SONGS is the one case in the history of the U.S. nuclear power industry where the NRC would not have authorized restart of a plant that experienced a tube leak, had Claimants actually sought to do so through implementation of the thicker-AVB repair.

➤ ***Mitsubishi's Experts Showed that the NRC Likely Would Have Approved a License Amendment Request to Implement the Thicker-AVB Repair***

NRC procedures allow license amendment requests that are approved with a "no significant hazards consideration" ("NSH") determination to be implemented prior to a public hearing, if any hearing occurs at all. The NRC routinely issues license amendments with NSH determinations. The uncontroverted evidence in this case shows that, in 2013 alone, the NRC issued 186 such amendments.

Mitsubishi's expert witnesses – Mr. William Russell and Mr. Jon Johnson – provided reports and testimony setting forth credible opinions that the NRC likely would have approved a license amendment request to implement the thicker-AVB repair with a no significant hazards determination, if Edison had sought the NRC's approval. To support his opinion, Mr. Russell reviewed a wide range of documents and testing results, and determined that the thicker-AVB repair satisfied the three NSH criteria that the NRC would have applied. In summary, Mr. Russell testified that the NRC would have approved the Repair because it would have been effective in preventing recurrence of in-plane FEI and would have provided "reasonable assurance of public health and safety. If there's reasonable assurance or public health and safety, there is no substantial safety hazard."

Mr. Johnson agreed with Mr. Russell's analysis that the thicker AVB-repair was licensable by the NRC with a no significant hazards determination. In Mr. Johnson's opinion, the Repair would have satisfied the NRC's requirements because Mitsubishi had determined the root cause of the tube wear at SONGS and had proposed a repair that would have prevented that condition from recurring. As a nuclear engineer and a former regulator, Mr. Johnson testified that the Repair did not have to reduce the thermal-hydraulic conditions at SONGS in order to obtain NRC approval. Rather, he found that "from a basic

standpoint, this could either be solved by reducing the thermal-hydraulic conditions or increasing the force by the support to prevent the excessive vibration.” Mr. Russell similarly concluded that the NRC would have approved the license amendment request even though the Repair did not address thermal-hydraulic conditions. According to Mr. Russell, based on “[f]irst principles,” one can “increase the contact force sufficiently to overcome the thermal-hydraulic excitation”

➤ ***Claimants’ Position that the NRC Would Not Have Approved the Thicker-AVB Repair is not Credible***

Claimants’ witnesses – Mr. Leeds and Mr. Strosnider – stated that the NRC would not have approved a license amendment request to implement that repair for two reasons: (1) the Repair would not change the thermal-hydraulic conditions in the SONGS steam generators; and (2) the Repair would have introduced new modes of tube degradation. Their testimony, however, was not credible and does not reflect the technical opinion of any of the NRC subject matter experts that would have been evaluating the Repair but who were never briefed on any aspect of it.

As an initial matter, both Mr. Leeds and Mr. Strosnider admitted that they did not perform independent analyses to determine whether the thicker-AVB repair would have worked. Mr. Leeds testified: “[i]f you’re talking about did I run any codes or do any confirmatory analysis on the Type 1 Repair, no, I didn’t. I didn’t have enough information to do something like that.” Similarly, when Mr. Strosnider was asked whether he performed an independent analysis of the thicker-AVB repair, he replied: “No. As I stated earlier, my role was to provide a regulatory perspective. I was not brought onboard to do those types of analyses.”

Mr. Leeds and Mr. Strosnider provided no technical justification for their conclusion that the NRC would have *required* that an acceptable repair modify thermal-hydraulic conditions. They also provided no technical basis for their assertion that the thicker-AVB repair would have introduced new modes of tube degradation.

At the hearing, Mr. Leeds did not hold to the position in the witness statement he co-authored with Mr. Strosnider that a repair which failed to address thermal-hydraulic conditions would not be approved. Mr. Leeds testified that he was not intending to say in either his written statement or testimony at trial that the NRC could never have approved the Type 1 Repair. In fact, Mr. Leeds acknowledged that the joint statement was intended to tell the Tribunal that a repair proposal with a credible basis for concluding that tube degradation

would have been effectively controlled at SONGS without changing thermal-hydraulic conditions might have been acceptable to the NRC.

Claimants' assertion that the NRC would have required additional testing of the thicker-AVB repair under "prototypical thermal-hydraulic conditions" is also unsupported by the evidence. As Mr. Wilson explained, such testing was unnecessary, and would have been "prohibitively time-consuming and expensive." Even Mr. Leeds and Mr. Strosnider acknowledge that prototypical testing would have been "extremely difficult to perform"

In fact, the record evidence is undisputed that, although AVB repairs – including those using replacement, supplemental, expandable, or thicker AVBs – have been common in the nuclear power industry, the NRC has never previously required prototypic testing for such repairs. Indeed, all prior AVB repairs in the U.S. have been implemented pursuant to NRC regulations under 10 C.F.R. §50.59, without prior NRC approval. It is not credible for Claimants to argue that the NRC would have required such elaborate testing here, when the NRC not only has never required it in the past but never even had to provide its prior approval for AVB repairs.

Claimants' argument that the "first-of-a-kind nature of the RSG failures" would necessitate prototypical testing also lacks record support. Every prior mode of steam generator tube degradation (such as tube wall thinning, denting, outside diameter stress corrosion cracking, primary water stress corrosion cracking, and tube wear due to other modes of flow-induced vibration) that resulted in steam generator repairs in the past was at one point a first-of-a-kind problem for which the NRC did not require prototypical testing. Moreover, as Mr. Leeds stated and Mr. Strosnider confirmed: "the NRC accepts first-of-a-kind repairs and first-of-a-kind designs, and we do that as a matter of course. We've done that throughout our history."

➤ ***The Record Shows that NRC Decisions Regarding Licensing Matters are made on a Consensus Basis, not by the Director of NRR***

Claimants emphasize that Mr. Leeds was the "ultimate decision-maker" at the NRC regarding whether SONGS should be allowed to restart, and infer that his opinion regarding the thicker-AVB repair is dispositive. But the record, including Mr. Leeds' own testimony, shows that NRC decisions regarding licensing matters are made on a consensus basis, not by the Director of NRR.

As Mr. Leeds testified, the NRC's approval process "isn't a one-person review, this is a many-person review." According to Mr. Leeds, "[w]e can't allow one person to hijack the [approval] process" In fact, Mr. Leeds and Mr.

Strosnider acknowledged in their expert witness statement that NRC decision-making “is based on a consensus process.”

Mr. Leeds stated that a license amendment application to implement the thicker-AVB repair would have been received by NRR, sent to the technical staff, and would be subject to a review process that Mr. Leeds acknowledged “is very well laid out” and robust. As Mr. Leeds described:

I had a dedicated branch of experts, steam generator experts – all they reviewed were steam generators, some of those people had 20, 30 plus years of experience of reviewing, from the regulatory standpoint, anything to do with steam generators. Amendments, testing results, thermal-hydraulics. We had steam generator thermal-hydraulic experts. I had a whole branch of folks dedicated to steam generators.”

Mr. Leeds testified that he relied on those experts when applications related to steam generators were submitted. He did not “prejudice [his] staff” regarding what decisions to make, and would “try to let [his] staff do their job.” He further testified that he does not have technical knowledge regarding plants’ void fraction or gap velocities, and possesses no knowledge of prior AVB repairs (except for what he learned in this proceeding regarding a repair performed at SONGS Unit 1). Indeed, Mr. Leeds testified that he did not need to know such information, because he relied on “experts on my staff that were very well-versed in” such matters.

Mitsubishi’s witnesses Mr. Russell and Mr. Johnson agreed with Mr. Leeds that the Director of NRR does not perform technical reviews and that the review process involves consensus. In fact, neither Mr. Russell nor Mr. Johnson is aware of a single instance where the Director of NRR failed to follow the recommendation of his technical staff regarding whether a license amendment request should be approved.

It is undisputed that Edison never gave Mr. Leeds’ technical staff the opportunity to evaluate Mitsubishi’s proposed repair. In fact, as of June 7, 2013 (the shutdown date) neither Mr. Leeds nor his staff had formed any opinions regarding the acceptability of a license amendment request based on the Type 1 Repair because they had no information about it. Mr. Leeds, therefore, has no substantive basis for now claiming that the Repair would have been unacceptable to the NRC. As Mr. Johnson testified, it is hard to understand how Mr. Leeds could conclude that his technical staff would not have approved the Repair, when they never had a chance to see it.

➤ ***Mitsubishi's Testimony also Demonstrated that the Repair was Licensable within a Reasonable Period of Time***

Mitsubishi's expert witness testimony and "would-have-been" timeline estimated that – if Claimants had supported Mitsubishi's efforts to pursue the thicker-AVB repair – the Repair could have been implemented through a license amendment request by approximately June 1, 2013 (or, allowing for contingencies, by the end of 2013). That testimony and timeline were based on: (1) events that actually occurred; (2) estimates regarding when certain critical path events would have occurred with Claimants' cooperation (given how long those events actually took to perform at a later date); and (3) a detailed NRC licensing schedule that Mr. Russell prepared and Mr. Johnson supported.

Claimants' challenges to Mitsubishi's timeline during the hearing focused almost exclusively on NRC licensing issues, specifically whether (1) certain information was available to Claimants by December 31, 2012; and (2) the NRC would have approved a license amendment request within five months after its submittal.

Regarding the first point, Claimants sought to establish that there was a substantial amount of information needed to support a license amendment request that Mitsubishi allegedly failed to provide. As ██████████ testified, "[o]f course" Mitsubishi would have completed the tests that Claimants now argue were necessary for licensing, had Claimants requested them. However, as Mr. Russell explained, it is unreasonable to expect a vendor to complete all the analyses and tests necessary to support a license amendment application where a customer has shown no interest in pursuing a repair.

In any event, as ██████████ added, all the analyses raised by Claimants' counsel during the hearing involved calculations that could have been completed "within a month." And Mr. Russell testified that re-running the FIVATS, ABAQUS and ATHOS analyses that Claimants used to support their 70 percent restart proposal using parameters applicable to the thicker-AVB repair would have taken "[a] few weeks."

Regarding Claimants' second point, Mr. Leeds and Mr. Strosnider alleged that the NRC's review of a license amendment request to implement the thicker-AVB repair would have taken between 42 and 66 months. Claimants' witnesses cited three examples for support. The first two examples involved license amendment requests that were withdrawn after 16 months. Their third example involved a license amendment request that took 27 months to approve, and was submitted by an operating plant seeking authorization to increase its power

output (or “uprate”) during a subsequent scheduled shutdown, where there was no incentive for the NRC to act expeditiously. Claimants’ three examples do not form a reasonable basis upon which the Tribunal can accept Claimants’ 42-66 month regulatory approval timeline.

Mr. Russell’s estimated five months for NRC approval of a SONGS license amendment request is much more reasonable. As Mr. Russell testified, prior to December 31, 2012 the NRC had been reviewing issues surrounding the tube leak at SONG for nearly a year and had already spent a considerable amount of time understanding the issues at SONGS due to the investigations it conducted immediately after the leak and reviewing Edison’s restart plan. Accordingly, the NRC’s review of a license amendment request for the thicker-AVB repair would “not [be] starting out from ground zero.” Mr. Johnson agreed, stating that, under the circumstances, the NRC’s technical reviewers “would have already had a head start” on a license amendment request for the thicker-AVB repair.

The evidentiary record is also undisputed that (1) the NRC gives priority to license amendment requests for a plant seeking permission to restart; and (2) the NRC took only three months to complete its inspection review and approval allowing restart of the North Anna nuclear power plant in 2011 following an earthquake that exceeded the plant’s operating basis. Moreover, Mr. Strosnider testified that the NRC’s goal is to complete 95 percent of license amendment request reviews in one year and 100 percent within two years.

➤ ***The Thicker-AVB Repair could have been Implemented under the NRC’s regulations at 10 C.F.R. §50.59***

In addition to being licensable through a license amendment request, Mitsubishi has also shown in this proceeding that Claimants could have implemented the thicker-AVB repair without NRC prior approval under the Commission’s regulations at 10 C.F.R. §50.59. Mitsubishi’s expert licensing witness, Mr. Russell, performed a detailed analysis demonstrating that the Repair would have passed the 50.59 screening criteria. Mr. Johnson agreed with Mr. Russell’s analysis. In fact, as Mr. Lagally, Mr. Russell and Mr. Strosnider pointed out, every previous AVB repair was performed under that regulation, without NRC approval. As Mr. Russell testified, this option was available to Claimants at least until November of 2012, when the NRC referred to an ASLB the question of whether restart under the CAL was a de facto license amendment.

Neither Mr. Leeds nor Mr. Strosnider performed engineering analyses to determine whether the Repair would have satisfied the section 50.59 criteria.

Moreover, Claimants – the NRC licensee – never actually attempted to screen the Repair against those criteria.

➤ ***Responses to the Tribunal’s Questions Regarding Licensing***

During closing arguments, the Tribunal raised two questions regarding the NRC’s licensing of the thicker-AVB repair. First, Mr. Hinchey asked whether the May 13, 2013 decision by the NRC’s ASLB addressed the licensability of Mitsubishi’s proposed Type 1 Repair. Claimants’ counsel incorrectly answered “I believe that it did.” The ASLB decision, of course, did not in any way address, consider, or even mention the Type 1 Repair. As discussed above, Claimants never submitted to the NRC a license amendment request seeking to implement the Type 1 Repair. The ASLB’s decision addressed only the issue of whether Claimants’ proposal to restart SONGS Unit 2 at 70% – without a repair – was a request for a de facto license amendment.

Second, the President and Mr. Schiller posed a series of questions regarding whether Mitsubishi’s PAR was a document that the NRC reviewed when the RSGs were installed pursuant to 10 C.F.R. §50.59, and whether the NRC would have reviewed or considered the PAR when evaluating a license amendment for the thicker-AVB repair. Claimants’ counsel again answered those questions incorrectly. There is no support whatsoever, in the record or otherwise, for concluding that the NRC has reviewed or would review the PAR as part of the process for the licensing the RSGs or any repair thereto. The PAR is unrelated to licensing.

The Tribunal’s questions regarding the PAR are answered by simply referring to the RSG Contract. section 3.6 lists Mitsubishi’s obligations regarding the RSGs’ “Licensing Requirements,” and section 3.8 lists Mitsubishi’s obligations regarding the RSGs’ “Performance Requirements.” Under section 3.6.2, Mitsubishi must prepare a “Licensing Topical Report.” Under section 3.8.2, Mitsubishi must prepare a “Performance Analysis Report.” They are clearly two separate reports with different purposes – one addresses licensing matters and the other addresses steam generator performance.

More specifically, section 3.6.1 provides a detailed list of the “General Requirements” for licensing the RSGs, and section 3.6.2 states that Mitsubishi shall submit to Edison a Licensing Topical Report which contains the information necessary for Edison to prepare its evaluation of whether the RSGs could be installed under section 50.59. It states “[t]he report shall include an engineering evaluation, including all necessary analyses and evaluations, justifying that the RSGs can be replaced under the provisions of 10 C.F.R.

50.59 (without prior NRC approval).” The Licensing Requirements section of the Contract does not mention the PAR.

Section 3.21.2 confirms the fact that information relevant for NRC licensing is not set forth in the PAR. The first sentence of section 3.21.2 provides: “[t]he calculations/analyses addressing the RSG impact on the UFSAR analyses shall be a part of the Licensing Topical Report.” section 3.21.2 also states: “[a]ll calculations/analyses *other than* those required by the ASME section III Code and the Licensing Topical Report shall be part of the Performance Analysis Report.”

As set forth in Mr. Russell’s thicker-AVB licensing report, the “UFSAR” mentioned in section 3.21.2 of the Contract is the Updated Final Safety Analysis Report that is part of a nuclear facility’s licensing basis. The UFSAR describes the facility and its design requirements. It also includes the analyses showing that the facility is safe, and is the document that must be updated as the facility is changed. Mr. Russell’s Licensing Report identified portions of SONGS’ current licensing basis which could potentially be affected by the Repair, including the UFSAR and SONGS’ Technical Specifications. Appendix 5 of Mr. Russell’s report describes the relevant UFSAR sections, and Appendix 4 attaches the relevant Technical Specifications. They do not discuss the PAR or void fraction. According to the Nuclear Energy Institute’s Guidance document 97-04, Appendix B, a plant’s design bases must be included in its UFSAR. Since the SONGS UFSAR does not mention the PAR or void fractions, they are not part of the design basis and would not be reviewed by the NRC in licensing decisions.

Indeed, in its CAL inspection report, the NRC recognized that ATHOS (which calculates T/H parameters) “is not used for safety analysis and has not been reviewed or approved by the NRC.” This further shows that the NRC would not have required that a repair to SONGS must result in specific T/H conditions (including the void fraction set forth in the PAR).

For these reasons, there is no basis for concluding that the NRC would have considered the PAR in its licensing decisions regarding the SONGS RSGs or any repairs thereto.²²¹³

²²¹³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 270-309.

(iii) The Tribunal's Determination

2270. As a preliminary conclusion, it is apparent that given that the Claimants never submitted a request to the NRC regarding Unit 3, the Respondents were as of yet not required to have demonstrated that the proposed repair was licensable.
2271. The Respondents would have been required to demonstrate to SCE that the repair was licensable following the Claimants' acceptance of the Type 1 repair concept as part of a joint effort to have the NRC approve the repair.
2272. The Tribunal's general determinations on issues of licensability are set forth in Section XIV.C above. In particular, the Tribunal recalls that licensability has two components, the NRC technical review and the potential for a period of public hearings.²²¹⁴
2273. This current Issue C.3(c)(i) is addressed under two hypotheticals. First, regarding a hypothetical ASLB decision had Friends of the Earth challenged a Unit 3 repair and restart effort. Second, regarding a hypothetical submission by the Claimants as to the NRC.
2274. Prior to addressing either, the Tribunal considers what is meant by the question of licensability. The Tribunal accepts that the question of licensability has both a technical regulatory element, requiring that the NRC be satisfied as to the safety of a proposed repair option, and a commercial timeliness aspect, which is affiliated with the potential for public hearings.
2275. First, regarding a hypothetical ASLB decision that would have ordered public hearings, the Tribunal considers that this goes to the question of commercial timeliness. In this regard, the Respondents have no control over whether the ASLB

²²¹⁴ See ¶ 2258 above.

orders public hearings on account of the actions of a civil society group, such as Friends of the Earth. It is the Claimants that operated in a challenged political environment. The time it would take for a repair to be reviewed by the public is a question of licensability that the Respondents are not required to resolve.

2276. Second, the Respondents are required to assist the Claimants in obtaining NRC approval for a proposed repair.
2277. The Claimants' case appears to be that the NRC would be somehow paralyzed into inaction by the fact that in-plane FEI is a first-of-a-kind phenomenon that would require that the Respondents obtain prototypical testing (itself impossible to obtain) in order to justify that the thicker AVB would be effective.
2278. The Claimants and their experts have, however, moderated this position. As the Claimants identify, Mr. Leeds, at the Hearing, relaxed such requirements to allow for testing in a scaled down steam generator (at $\frac{1}{2}$, $\frac{1}{4}$, or $\frac{1}{8}$ th size) and to conduct the tests in air/water or Freon.
2279. As put forth by the Respondents' experts, the thicker AVB repair is a repair that meets fundamental first principles. FEI occurs where the stability ratio calculations exceed 1.0. Stability ratio calculations are dependent upon T/H conditions and, in large part, the effectiveness of tube support.
2280. The Claimants are certainly correct that the SONGS RSGs suffered considerable wear, that the failure of eight in-situ tests is significant, and that there were reasonable concerns that would have to be addressed to the NRC's satisfaction prior to a decision to restart Unit 3.

2281. As the Claimants put forth, and as required by the CAL, the NRC would require “reasonable assurances” that a proposed repair would resolve the root cause(s) of the RSG defects and that no new forms of degradation would occur.²²¹⁵
2282. The Tribunal finds that the proposed thicker AVB repair would have corrected the root cause of the RSG defects, and that the concerns raised by the AREVA report could have been addressed, such that Unit 3 could have been repaired and that no new forms of degradation would have materialized.
2283. Having heard from the NRC experts from both sides of this dispute, the Tribunal has no doubt that the NRC employs exceedingly competent staff that would be able to review a Type 1 Repair proposal and evaluate it within a commercially reasonable amount of time, being within one year as per NRC guidelines. Supported by the evidence put forth by Respondents, in particular the cross-examination testimony of Mr. Leeds, the Claimants’ expert, the Tribunal does not believe the NRC would require impossible to obtain prototypical testing. Rather, the Tribunal concludes that NRC engineers would have required testing similar to what B&W and Atomic Energy of Canada Limited (AECL) thought was reasonable in their phase one testing.²²¹⁶ That is, testing to prove that a Type 1 repair would address the root cause of the defect(s).
2284. Accordingly, the Tribunal does not consider that a review and approval of a thicker AVB repair was beyond the capabilities of the NRC. AVB repairs are a common practice in the nuclear industry. The Tribunal concludes that had the Claimants submitted a proposal to the NRC, the Respondents would have been able to provide

²²¹⁵ Exh. JX-1080.

²²¹⁶ See ¶¶ 1807 - 1814 above.

the supporting tests and data to the Claimants, such that the NRC could have undertaken its review.

2285. Accordingly, and strictly speaking, the Tribunal answers Issue C.3(c)(i) in the negative as the Respondents did not demonstrate that the repair was licensable during the repair era as the Parties never submitted a response to the CAL to restart Unit 3. The Tribunal however, concludes that had the Respondents been requested to so demonstrate, as part of a LAR or response to the CAL, the Respondents could have demonstrated that its proposed repair was licensable, as they have so done in this arbitration.

(j) **If Mitsubishi was obligated but failed to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59, was Mitsubishi excused from its obligation due to Claimants' actions? (Issue C.3(c)(ii)) and if Mitsubishi was obligated but failed to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59, and Mitsubishi was not excused due to Claimants' actions, what are the consequences of that failure? (Issue C.3(c)(iii))**

2286. On account of the Tribunal's determinations on Issue C.3(c) and C.3(c)(i) the Tribunal considers Issues C.3(c)(ii) and C.3(c)(iii) moot.

(k) **Which party bears the risk, contractually or otherwise, of the length of time it would take to secure any required regulatory approval? (Issue C.3(d))**

(i) *The Claimants' Position*

2287. In their Responses to Joint List of Issues, the Claimants submit the following:

Respondents were contractually obligated to provide a licensable repair. section 3.6.1.2 of the RSG Contract requires that Mitsubishi "shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end." The length of time it takes to secure required regulatory

approval (*i.e.*, the amount of time it takes the NRC to license the repair) falls to Mitsubishi.

When Mitsubishi supplied Edison with non-conforming goods requiring a repair, Mitsubishi assumed the risk of the length of time it would take to secure the required regulatory approval. As Claimants stated at the Hearing, “where the problem is so fundamental and so total, and where there is a safety-related event that has been occasioned by the delivery of non-conforming goods . . . there cannot be any question that risk falls on the Respondents.”

Mitsubishi had a duty to provide Edison with steam generators that conformed to the specifications detailed in the RSG Contract. Mitsubishi’s failure to do so led to excessive tube wear, a radioactive leak, which generated intense public scrutiny and regulatory reaction. All of these effects were occasioned by Mitsubishi’s breach of the RSG Contract, and the breaching party is in the best position to both prevent the consequences of its breach and internalize the costs of its failure to live up to its contractual promises.²²¹⁷

2288. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents argue that because Edison was the NRC licensee, Edison was responsible for the risk of delay caused by the need to secure regulatory approval. This is not only inconsistent with Section 3.6.1.2, but also defies principles of fairness. As they were quick to remind the Tribunal during the Hearing, Respondents were and are in the nuclear business. Respondents designed and manufactured steam generators for a nuclear power plant. When Respondents supplied Edison with non-conforming goods requiring a repair, Respondents assumed the risk of the length of time it would take to secure the required regulatory approval. A repair that cannot be approved by the NRC is no repair at all (and is no repair that any responsible utility would ever accept). As Claimants stated at the Hearing, “where the problem is so fundamental and so total, and where there is a safety-related event that has been occasioned by the delivery of non-conforming goods . . . there cannot be any question that risk falls on the Respondents.”

Respondents also point to Claimants’ recognition that “as an NRC licensee, Edison had an obligation to the regulators.” This quote is taken out of context. While Edison had an obligation to the regulators to ensure that the repaired

²²¹⁷ Claimants’ Responses to Joint List of Issues, ¶ C.11(d).

RSGs would operate safely, Respondents had the obligation to provide Edison with steam generators that conformed to the specifications detailed in the RSG Contract and were licensable. Respondents' failure to do so led to excessive tube wear and a radioactive leak, which generated intense public scrutiny and regulatory reaction. All of these effects were occasioned by Respondents' breach of the RSG Contract, and Respondents, as the designers and manufacturers of the RSGs, are in the best position to both prevent the consequences of their breach and internalize the costs of their failure to live up to their contractual promises.²²¹⁸

(ii) *The Respondents' Position*

2289. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants were responsible for the risk of delay caused by the need to secure regulatory approval. It is undisputed in this proceeding that since Edison was the NRC licensee, it was the only party that could pursue regulatory approval of the thicker-AVB repair. Mitsubishi was not the licensee and had no control over the NRC approval process.

The risk that repairs to the RSGs would have required regulatory approval is not only foreseeable, but was explicitly recognized by Claimants, who argued that "as an NRC licensee, Edison had an obligation to the regulators." While Mitsubishi understood the importance of supporting Edison's regulatory process, Mitsubishi could not apply for or obtain approval on its own. As owners of SONGS, Claimants had the duty to seek regulatory approval and thus bore the risk of delay due to regulation. In *G.W. Andersen Construction Co. v. Mars Sales*, an ordinance caused an 11-month delay in a construction project, which led the owner to claim performance was excused due to the delay. The court disagreed, and held that the owner "had a duty to cooperate and seek an exception" if it was available under the law. Failing to do so was a violation of the duty of good faith and fair dealing, and "having failed to avail themselves of methods provided for relief from ordinance restrictions, [owners] cannot be heard to complain that the ordinances made construction permanently impossible." *Id.*, at 338. Similarly, Claimants had regulatory pathways available to move forward with the Repair, and failed to pursue them. The consequences of that failure thus fall on Claimants.²²¹⁹

²²¹⁸ Claimants' RPHM, ¶¶ 392-393.

²²¹⁹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 317-318.

(iii) Tribunal's Determination

2290. As a preliminary matter, the Tribunal does not consider that Section 3.6.1.2 of the RSG Contract, as referenced by the Claimants, is applicable to this Issue:

In accordance with Table 3-1, the Supplier shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end.²²²⁰

2291. Rather, the Tribunal finds that the RSG Contract is silent on the question of who bears the risk of a regulatory delay for the approval of a repair.

2292. The Tribunal considers that this Issue is answered in three parts.

2293. The Claimants have persuasively shown that as the Respondents were responsible for the defective RSGs, it is the Respondents that bear the risk of proposing a repair that is licensable by the NRC. The Respondents had a duty to provide the required technical assistance that the NRC would require to undertake a technical review of the Type 1 Repair.

2294. However, the Tribunal also considers that the Respondents have convincingly demonstrated that the Claimants, as a matter of course, have a responsibility to diligently put forward to the NRC a repair proposal as agreed with the Respondents.

2295. As the Parties' experts have identified, in addition to the timeframe required for the regulatory review of a proposed repair, there is also a risk associated with public hearings and judicial challenges, such as that by Friends of the Earth. The Respondents are not the licensee and have no control over the public environment. It is the Claimants that are responsible for defending themselves in administrative and

²²²⁰ RSG Contract, Section 3.6.1.2.

judicial proceedings before the ASLB or otherwise. It is also the Claimants that are responsible for satisfying the public concerns regarding the risks of nuclear power.

2296. Accordingly, the Tribunal considers that depending upon the type of regulatory delay, either Party may bear such risk. In sum, it is (i) the Respondents that bear the risk of developing and proposing a repair that is licensable by the NRC ; (ii) accordingly, the Respondents had a duty to provide the technical assistance that the NRC would require to undertaken a technical review of the Type 1 repair; but (iii) as the Respondents have no control over the political or regulatory environment, it is the Claimants that have the burden of persuading the NRC regulators and public stakeholders to issue approvals and/or licenses. Therefore, it is the Claimants alone that bear the risk of regulatory delay. In essence, once the Respondents develop a repair plan, and provide the NRC with the required answers to technical questions, the burden of regulatory delays shifts to the Claimants

D. REGARDING MITSUBISHI’S PROPOSED REPLACEMENT (ISSUE C.4)

2297. The Tribunal considers in this Issue C.4 the Parties’ dispute regarding a replacement of the RSGs.

(a) Did Mitsubishi raise or preserve the issue of a proposed replacement in its Memorials? (Issue C.4(a))

2298. In this Issue C.4(a), the Tribunal considers whether the Respondents have raised the issue of a replacement of their submissions.

(i) The Claimants’ Position

2299. In their Responses to Joint List of Issues, the Claimants submit that the “Respondents never meaningfully raised Type 3 repair as a viable option in their memorials. Throughout their written submissions, Respondents focused solely on the Type 1

thicker AVB repair as a means to demonstrate Mitsubishi's compliance with its Warranty obligations under the RSG Contract."²²²¹

(ii) The Respondents' Position

2300. In their Position Statement on the Revised List of Issues, the Respondents make a reference to their "specific responses in subsections below."²²²²

(iii) The Tribunal's Determination

2301. The Respondents raise the Issue of a replacement option on a number of occasions in their submissions.

2302. The Tribunal further addresses this Issue in the Sub-Issues below.

(b) Has Mitsubishi raised the issue of replacement in its Counter-Memorial and Rejoinder Memorial? (Issue C.4(a)(i))

2303. The Tribunal considers in Issue C.4(a)(i) whether the Respondents have raised the issue of a replacement of the RSGs in their Counter-Memorial and/or Rejoinder Memorial.

(i) The Claimants' Position

2304. In their Responses to Joint List of Issues, the Claimants submit that the "Respondents only raised Type 3 to peddle the false narrative that Edison forced Mitsubishi to recommend replacement in order to declare Mitsubishi in breach for doing so."²²²³

2305. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that the "Respondents point to the fact that they "even footnoted the [replacement] argument," stating, "[n]otably, although the parties focus primarily on the repair aspect of the Limited Warranty Remedy, replacement is a separately

²²²¹ Claimants' Responses to Joint List of Issues, ¶ C.12(a).

²²²² Respondents' Position Statement on the Revised List of Issues, ¶ 319.

²²²³ Claimants' Responses to Joint List of Issues, ¶ C.12(a)(i).

contemplated and contractually provided for aspect of the warranty.” However, Respondents have never presented Type 3 as a viable warranty remedy; in fact, numerous of Respondents’ witnesses and Respondents’ own counsel communicated the exact opposite—that replacement of the tube bundles for both Units was not a contemplated warranty repair within the RSG Contract.”²²²⁴

(ii) The Respondents’ Position

2306. In their Position Statement on the Revised List of Issues, the Respondents contend that “Mitsubishi raised the issue of replacement in its Counter-Memorial at paragraphs 136-139, 195-197, 222 and 255-270, and in its Rejoinder Memorial at paragraphs 162-191. Mitsubishi also specifically raised its recommendation of replacement as being a factor in defeating Claimants’ argument that the warranty failed of its essential purpose. Mitsubishi argued directly in its Rejoinder that the warranty could not have failed of its essential purpose where Claimants did not avail themselves of the other options contained in the warranty – including replacement – and Mitsubishi even footnoted the argument by stating, “Notably, although the parties focus primarily on the repair aspect of the Limited Warranty Remedy, replacement is a separately contemplated and contractually provided for aspect of the warranty.””²²²⁵

(iii) The Tribunal’s Determination

2307. The Respondents have identified various portions of their submissions, in which the replacement option is discussed.

2308. Accordingly, the Tribunal answers Issue C.4(a)(i) in the affirmative, the Respondents raised the Issue of a replacement in their Counter-Memorial and Rejoinder Memorial.

²²²⁴ Claimants’ RPHM, ¶ 396.

²²²⁵ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 320-321.

(c) **Did Mitsubishi show that it notified Edison that replacement was a viable option to correct the root cause of the tube-to-tube wear? (Issue C.4(a)(ii))**

2309. In Issue C.4(a)(ii) The Tribunal considers whether MHI notified SCE that replacement of the RSGs was a viable option to correct the root cause to the TTW.

(i) *The Claimants' Position*

2310. In their Responses to Joint List of Issues, the Claimants submit the following:

Respondents' witness ██████████ stated bluntly, in August 2012, that "MHI will never agree to bundle replacement. It is beyond the scope of our agreement." Indeed, at the Hearing, Respondents' expert Robert Denton agreed with this conclusion, stating that replacement was "neither technically practical nor economically viable."

From the initial invocation of the dispute resolution provisions of the Contract by Edison, Mitsubishi made clear that replacement was not feasible: "the costly and time-consuming replacement of the entire tube bundle . . . would never be implemented because it was not economically or politically feasible."

None of Mitsubishi's expert witnesses even defended the viability of Type 3.

Indeed, Respondents' own counsel stated that "[r]eplacement of the RSGs would not be practical because you couldn't let the plant sit there for five years and wait."²²²⁶

2311. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that "[t]he sample communications that Respondents point to in their Response to the Joint List of Issues fail to demonstrate that Respondents notified Edison that replacement was a viable option to correct the root cause of the tube-to-tube wear—these communications are simply eight instances between September 28, 2012 and May 16, 2013 when Respondents either spoke to Edison or provided documents or PowerPoint presentations to Edison regarding the replacement concept. Respondents offer no evidence showing that they actually demonstrated to

²²²⁶ Claimants' Responses to Joint List of Issues, ¶ C.12(a)(ii).

Edison that the replacement concept was analyzed in detail such that it would fix the root cause (...) [T]his is because the Type 3 concept was still in its infancy.”²²²⁷

(ii) *The Respondents’ Position*

2312. In their Position Statement on the Revised List of Issues, the Respondents contend that “Mitsubishi routinely and repeatedly communicated with Claimants regarding the viability of replacement options. A sample of these communications includes:

September 28, 2012 – In response to the emphasis placed on replacement by Mr. Avella, Mitsubishi presented a 22 page PowerPoint detailing several “Alternative Replacement SG Design Options, as well as decision trees for the evaluation/selection process.

On October 11, 2012, ██████████ met separately with Mr. Dietrich and Mr. Avella. At these meetings Mitsubishi explained to Edison its proposed repair and replacement development timelines.

On December 14, 2012, ██████████ wrote Mr. Avella, advising, *inter alia*, that Mitsubishi had commenced a detailed “parametric study for the conceptual design of a new SG configuration to achieve the maximum practical improvement in the U-bend thermal hydraulic conditions associated with SONGS 100% power operation,” including the replacement of the tube bundle and, alternatively, the replacement of the entire steam generator.

On December 20, 2012, Mitsubishi provided the SGRT with intermediate results of the parametric study of replacement options, and formally provided those results by letter dated December 21, 2012.

On December 21, 2012, ██████████ wrote Mr. Avella, recommending the replacement of the bundle “as the technical basis for a mutually agreeable remedy.”

²²²⁷ Claimants’ RPHM, ¶ 400.

On December 27, 2012, at Mr. Dietrich's request, ██████████ formally confirmed that Mitsubishi was recommending replacement pursuant to the December 21 letter.

On March 11, 2013, ██████████ sent Mr. Avella a 97 page draft "Design Description Report of Tube Bundle Replacement" that would address and remedy the root cause of the tube wear at SONGS.

On May 16, 2013, Mitsubishi furnished Edison with a final draft of its "Design Description Report of Tube Bundle Replacement."²²²⁸

(iii) The Tribunal's Determination

2313. As a technical matter, the Tribunal was provided with no evidence sufficient to justify a doubt that a replacement to the RSGs in Unit 3 could be designed and manufactured, such that it did not suffer from in-plane FEI.
2314. As a commercial matter, it is equally evident that it would be extremely unlikely for SONGS would have remained inoperative for a period of five or more years while replacement RSGs were designed and manufactured.
2315. Similarly, it is apparent that the design, manufacturing, shipping removal and installation costs of replacement RSGs would drastically surpass the mutual liability cap as negotiated in the limitation of liability provision of the RSG Contract.²²²⁹
2316. Nonetheless, the record contains correspondence on this matter between senior personnel at SCE and MHI. A replacement proposal, albeit one in its infancy, was developed.²²³⁰ The Claimants' NRC experts opine that a replacement RSG would obtain NRC approval.

²²²⁸ Respondents' Position Statement on the Revised List of Issues, ¶ 322.

²²²⁹ RSG Contract, Section 1.21.

²²³⁰ Exh. JX-1697.

2317. Two further factual elements are determinative of this matter:

- i. That the Claimants expected to be able to restart Unit 2;
- ii. That the Claimants were willing to consider a Type 1 Repair as an interim repair.²²³¹

2318. It is sufficient to answer this Issue by stating that the Parties did engage in high level talks and efforts regarding a replacement option, despite the obvious timeframe such an option would require.

2319. Accordingly, the Tribunal answers Issue C.4(a)(ii) in the affirmative. The Respondents demonstrated that replacement could have been a viable option.

(d) If so, was Mitsubishi then excused by virtue of Edison's actions? (Issue C.4(a)(iii))

2320. In this Issue C.4(a)(iii), the Tribunal considers whether MHI was excused from developing a replacement option by SCE's actions.

(i) The Claimants' Position

2321. In their Responses to Joint List of Issues, the Claimants submit the following:

Under the RSG Contract and California law, Edison's only duty was to act in good faith and in a commercially reasonable manner in deciding whether to agree to a repair or replacement. Edison was not required to agree to a repair without assurance that it would fulfill Mitsubishi's Warranty obligations.

Edison's behavior surrounding Mitsubishi's fleeting January 2013 replacement recommendation was reasonable, including its conclusion that an "outage spanning at least seven years does not constitute a repair or replacement with 'dispatch.'" No dispute exists on this point. Respondents' expert witness Robert Denton testified that "replacement is "neither technically practical nor economically viable." Mitsubishi's own counsel in this arbitration admitted

²²³¹ See Section XIV.A(d) above.

that “[r]eplacement of the RSGs would not be practical because you couldn’t let the plant sit there for five years and wait.”

Unsurprisingly, on January 22, 2013, Mitsubishi backtracked on its replacement recommendation and reasserted the viability of its conceptual and unproven thicker AVB repair. On February 11, 2013, Mr. Dietrich informed Mitsubishi that it had never rejected any repair but reiterated—as Edison had done time and again for months—that Edison needed technical proof.²²³²

2322. In addition, in their C-RPHM, the Claimants contend that the “Respondents’ obligation to “repair or replace” is conditioned on conducting its Warranty response with “diligence and dispatch,” along with other obligations, including that it fix the root cause, ensure that defects were fixed, confirm that no negative secondary effects would occur, and certify that it be licensable.”²²³³ Further, with respect to Edison’s conduct “[t]hese actions by Edison are consistent with its duty was to act in good faith and in a commercially reasonable manner in deciding whether to agree to a repair or replacement.”²²³⁴

(ii) *The Respondents’ Position*

2323. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Mitsubishi was excused from pursuing its proposal to replace the RSGs because Edison unreasonably precluded it from doing so in at least three ways. First, Edison insisted on Mitsubishi paying for such replacements in full – even above the contractual limitation of liability. Second, Edison’s actions in 2013 prove that it was not seriously interested in pursuing replacement at that time. Third, and most significantly, Edison made a decision to close the plant 16 months after the tube leak at SONGS despite the fact that the parties were in agreement that it would take much longer for any replacement option to be installed. Once the plant was closed by Edison, Mitsubishi was precluded from installing any such replacement option.

²²³² Claimants’ Responses to Joint List of Issues, ¶ C.12(a)(iii).

²²³³ Claimants’ RPHM, ¶ 402.

²²³⁴ Claimants’ RPHM, ¶ 403.

Edison unreasonably required Mitsubishi to cover all costs above the limitation of liability. As described in significant detail in section F(2)(a)(ii), section 1.17.1.3 of the RSG Contract specifically contemplated replacement as an acceptable warranty remedy. Since replacement was a contemplated warranty remedy, it naturally follows that a party acting with due diligence and dispatch to install that remedy cannot be held in breach of its warranty obligations because of the normal amount of time it would take to install it.

Yet that is exactly what Edison tried to do when it sent Mitsubishi a letter on January 8, 2013, just two weeks after Mitsubishi recommended replacement as the “mutually agreeable” remedy at SONGS. Mr. Dietrich informed Mitsubishi that because replacement could take seven years to install, Mitsubishi was not operating with “dispatch” and therefore the limitation of liability no longer applied.

From that legal premise Mr. Dietrich then concluded that “we believe that Mitsubishi must bear all costs associated with developing and implementing any plan to restore the units to service.” In other words, Mitsubishi would be responsible for the design, the fabrication, and even *the installation* of any replacement tube bundles.

The consequence of this Edison position, of course, was that either (1) Mitsubishi would have to volunteer to pay more money than it was contractually obligated to pay or (2) replacements would never be installed. Putting Mitsubishi in that position was unreasonable, and Mitsubishi should be excused from replacing the tube bundles for that reason.

In 2013, Edison was more focused on legal strategy and saving money than actually moving forward with replacement. The evidence shows that in 2013 Edison was not really interested in implementing replacement tube bundles at SONGS. For example, on January 24, 2013, ██████████ had a discussion with Mr. Avella during which Mr. Avella complained to him about Edison’s legal department making it more difficult to move forward with technical discussions on replacement. ██████████ recalls a similar discussion with Mr. Avella five days later, during which “Mr. Avella stated that the Edison Legal Department had other priorities to work on, aside from working toward replacement of the RSGs. Mr. Avella also stated that the Edison lawyers were afraid any kind of commercial framework, including a non-disclosure agreement, could prejudice their position vis-à-vis the California Public Utility Commission and during arbitration. Therefore, Edison legal did not want to do anything with regard to a commercial agreement.”

In February 2013, Edison also decided to cease funding support activities for replacement. From the time this funding suspension began until the closure of the plant, Edison repeatedly informed Mitsubishi that funding would be restored after one more week. But such funding had not been restored when the plant closed in June. As just one example of how the funding suspension impacted the schedule, it prevented Westinghouse from completing a safety analysis of the replacement tube bundles. Such a safety analysis was required before the parties could agree on a certified design specification. And without a certified design specification, Mitsubishi could do no further work on its replacement design.

Of course, Edison's reluctance to move forward with replacement makes sense when viewed from its position that replacement would require payments from Mitsubishi above the limitation of liability, and Mitsubishi was unlikely to agree to those payments because they were inconsistent with the Contract. With this conclusion as the basis for all of its actions, Edison executives must have seen replacement as a futile effort, even as Mitsubishi was devoting significant resources to developing a basic design. Whatever Edison's motivation, however, it was certainly unreasonable for Edison to be anything less than a committed partner as Mitsubishi pursued replacement, particularly as Edison had pushed Mitsubishi to recommend replacement instead of the thicker-AVB repair. Because Edison was not, its actions warrant excusing Mitsubishi from replacing the tube bundles at SONGS.

Edison shut down the plant 16 months after the tube leak; it is undisputed that replacing the tube bundles would have taken many years. The simplest reason why Mitsubishi should be excused from its warranty obligation for replacing the tube bundles is that Edison foreclosed the opportunity by shutting the plant many years before either party contemplated it possible to replace the tube bundles. For example, Mr. Avella thought replacement would take between 3.5 to 5 years.²²³⁵

(iii) The Tribunal's Determination

2324. The Tribunal adopts the Respondents' submission that it would be impossible to move forward with a replacement option based on SCE's actions and following SCE's decision to permanently close SONGS.

²²³⁵ Respondents' Position Statement on the Revised List of Issues, ¶¶ 323-331.

2325. Accordingly, the Tribunal answers Issue C.4(a)(iii) in the affirmative. The Respondents were excused from developing a replacement option on account of SCE's actions, including the closing of SONGS.

(e) **If not, has Mitsubishi waived any right to claim that it offered replacement? (Issue C.4(a)(iv))**

2326. The Tribunal considers that this Issue is moot on account of the Tribunal's determination of Issues C.4(a)(i) to C.4(a)(iii) above.

(f) **If Mitsubishi has preserved a replacement claim: (Issue C.4(b))**

2327. The Parties have addressed this Issue in the Sub-Issues below.

(g) **Did Mitsubishi offer to replace the RSGs in a manner consistent with Mitsubishi's obligations under RSG Contract Section 1.17.1.3? (Issue C.4(b)(i))**

2328. Issue C.4(b)(i) concerns the question of whether Mitsubishi offered to replace the RSGs in a manner consistent with Mitsubishi's obligations under Section 1.17.1.3 of the RSG Contract.

(i) *The Claimants' Position*

2329. In their Responses to Joint List of Issues, the Claimants submit the following:

While the Contract anticipates that a "part or portion" of the RSGs may have to be replaced, the contracting parties never envisioned an event whereby all four RSGs were forced offline and required replacement (an effective "re-replacement" of the "replacement"). The more common situation in which replacement arises is when there is a need to replace a part of the steam generator, not replacement of the entire RSG. Respondents agree that it would not have been reasonable to make Claimants wait five to seven years for new steam generators.

Fundamental to section 1.17.1.3 is the requirement that the repair must be completed with "due diligence and dispatch." Mitsubishi not only focused on the Type 3 option far too late in time (December 2012), but also estimated that

replacing the RSGs would take over five years—from June 2013. A repair taking approximately seven years is incompatible with the “dispatch” requirement under the Contract. Relevant case law equates “dispatch” with “expeditious” or “speed.” Just as Respondents’ counsel informed Claimants during depositions, replacement was simply “not practical because you couldn’t let the plant sit there for five years.” This quote exemplifies precisely why Mitsubishi’s Type 3 concept was irreconcilable with its contractual obligations of repair with “due diligence and dispatch.”

RSG Contract section 1.17.1.3 also prescribes that Mitsubishi must bear the “sole expense” for repair or replacement. Mitsubishi refused to pay for Type 3 replacement. ██████████ reiterated to Ed Avella, head of the SGRT, that “the costs of replacement would exceed the liability cap in the Contract.” Consequently, back during the SONGS outage, Mitsubishi itself did not view the Type 3 replacement as contemplated by the Contract, practical or a duty it owed to Edison.²²³⁶

2330. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, clarify the following:

In responding to this issue, Respondents merely allege that “Mitsubishi made clear by conduct and in writing that it stood ready to replace the RSGs under Section 1.17.1.3.” Respondents fail to provide justification for this blanket statement, and the record evidence, including internal communications between Respondents’ employees, directly refutes this statement.

Respondents not only focused on replacement far too late in time (December 2012—nearly ten months after the Unit 3 leak), but also estimated that “the design, manufacture and delivery of either replacement tube bundles or entire new replacement steam generators[] would take five and a half years.” A repair taking approximately five and a half years is incompatible with the “dispatch” requirement under the Contract. Relevant case law equates “dispatch” with “expeditious” or “speed.”²²³⁷

(ii) The Respondents’ Position

2331. In their Position Statement on the Revised List of Issues, the Respondents contend that “Mitsubishi made clear by conduct and in writing that it stood ready to replace

²²³⁶ Claimants’ Responses to Joint List of Issues, ¶ C.12(b)(i).

²²³⁷ Claimants’ RPHM, ¶¶ 406-407.

the RSGs under Section 1.17.1.3. As noted in Section C(4)(a)(ii) above, in response to Claimants' request for one final recommendation, Mitsubishi specifically recommended the tube bundle replacement option on December 21, 2012 stating, "MHI recommends Option #3 [replacement of the tube bundles] as the technical basis for a mutually agreeable remedy in accordance with the Purchase Order and subject to negotiation and agreement of acceptable terms and conditions."²²³⁸

(iii) The Tribunal's Determination

2332. The Respondents offered to replace the RSGs in their letter of 21 December 2012, in which a replacement option was proposed:

MHI recommends Option #3 as the technical basis for a mutually agreeable remedy in accordance with the Purchase Order and subject to negotiation and agreement of acceptable terms and conditions.²²³⁹

2333. Had the Claimants not considered that replacement was a viable option, they could have informed the Respondents of the same. Having just recently undergone the steam generator replacement project, the Claimants were presumably aware as to the length of time a replacement option would require.

2334. The Tribunal accepts that a replacement option presents significant commercial challenges, especially in an environment where the ASLB had significantly delayed a restart of Unit 2.

2335. As determined by the Tribunal above, in its consideration of the background to Issue C, the RSG Contract allows for replacement of the RSGs as part of a valid warranty option.²²⁴⁰

²²³⁸ Respondents' Position Statement on the Revised List of Issues, ¶ 333.

²²³⁹ Exh. JX-1579.

²²⁴⁰ See Section XIV.D above.

2336. As also determined above, the Tribunal considers the warranty requirement for a repair or replacement to be undertaken with due diligence and dispatch to be a relative time requirement that should be interpreted in accordance with the scope of the repair or replacement being undertaken.²²⁴¹

2337. Accordingly, the Tribunal answers Issue C.4(b)(i) in the affirmative. The Respondents offered to replace the RSGs in a manner consistent with their obligations under the RSG Contract.

(h) Did Mitsubishi’s proposed replacement of the RSGs correct the “root cause” of the Defect or demonstrate that the problem(s) would not recur as set forth in RSG Contract § 1.17.1.3(c)? (Issue C.4(b)(ii))

2338. In this Issue C.4(b)(ii) the Tribunal considers whether MHI’s proposed replacement of the RSGs corrects the “root cause” of the Defect(s) or demonstrates that the problem(s) would not recur as set forth in Section 1.17.1.3(c) of the RSG Contract.

(i) The Claimants’ Position

2339. In their Responses to Joint List of Issues, the Claimants submit that “[t]he Type 3 replacement concept shows that the problems inherent in the RSG design could not be corrected without redesigning and replacing the entire tube bundle. The design changes that Mitsubishi proposed in connection with the Type 3 replacement were improvements over, and in direct contrast to, the design decisions made in the original RSG design. However, Mitsubishi failed to demonstrate at any point in time prior to the eventual shutdown of SONGS that its new design would prevent the same problems that occurred in the original RSGs. Claimants’ experts Gary Elder and Ghasem Asadi explained that in proposing the Type 3 concept, Mitsubishi:

²²⁴¹ See Section XIV.D above.

- failed to provide detail regarding tube and support structures
- failed to provide assurance and testing showing that IP and OOP FEI would not recur
- failed to conduct testing and analysis showing that random vibration would not occur

Furthermore, the Type 3 concept continued to reply on its flawed pre-processor code (SSPC) to calculate circulation ratio.”²²⁴²

2340. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that “[u]nlike Respondents’ claims regarding the Type 1 thicker-AVB repair, Respondents allege that the Type 3 concept corrected “both the insufficient support conditions and the thermal-hydraulic conditions of the RSGs (...) However, Respondents failed to demonstrate at any point in time prior to the eventual shutdown of SONGS that their new design would prevent the same problems that occurred in the original RSGs.”²²⁴³

(ii) The Respondents’ Position

2341. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Mitsubishi’s proposed tube bundle replacement would have corrected the root cause, which as stated was tube-to-tube wear caused by in-plane FEI due to a combination of insufficient support conditions and thermal hydraulic conditions. As described in Mitsubishi’s 104-page “Design Description Report of Tube Bundle Replacement,” Mitsubishi’s proposed bundle replacement would have addressed both the insufficient support conditions and the thermal-hydraulic conditions of the RSGs.

In order to modify the thermal-hydraulic conditions of the RSGs, Mitsubishi had to deviate from the limitations of Edison’s design specifications for the

²²⁴² Claimants’ Responses to Joint List of Issues, ¶ C.12(b)(ii).

²²⁴³ Claimants’ RPHM, ¶ 409.

RSGs. For example, the replacement bundle would have had fewer tubes and less heat transfer area than that specified for the RSGs. By doing so, the thermal-hydraulic conditions of the replacement tube bundle would have had an increased calculated circulation ratio of [REDACTED] and a reduced ATHOS-calculated void fraction of [REDACTED] into the range of FIT-III calculated void fractions found acceptable by Edison during design. The tube bundle replacement design also would have had sufficient active AVBs to ensure stability ratios below [REDACTED] for both out-of-plane and in-plane FEI. The maximum out-of-plane stability ratio (with all supports active) would be [REDACTED] and the maximum in-plane stability ratio with only one active support would be [REDACTED].²²⁴⁴

(iii) The Tribunal's Determination

2342. The Claimants do not dispute that a redesigned RSG could address in-plane FEI from a technical perspective. The Tribunal sees no evidence to demonstrate that the Respondents would not be capable of developing a new design for the RSGs that avoided in-plane FEI. The Respondents had submitted an initial design proposal to this effect to the Claimants.²²⁴⁵
2343. The Tribunal's determination of this Issue is not determinative of what the root cause of the Defect is. As the Tribunal determined in Issue C.3(a)(i) above,²²⁴⁶ the root causes of the Defects were a combination of T/H conditions and inadequate tube support. A replacement could have lower T/H conditions and improved tube support, addressing both root causes to further improve stability ratios.
2344. Consequently, the Tribunal answers Issue C.4(b)(ii) in the affirmative, MHI could have developed a replacement RSG that addressed in-plane FEI, and in turn corrected the root cause of the Defect.

²²⁴⁴ Respondents' Position Statement on the Revised List of Issues, ¶¶ 334-335.

²²⁴⁵ See ¶ 714.

²²⁴⁶ See Section XV.C(b)(iii) above.

(i) **Did Mitsubishi withdraw any offer to replace the RSGs, when Edison stated that Mitsubishi would be obligated to pay the full costs of the RSGs? (Issue C.4(b)(iii))**

2345. In this Issue C.4(b)(iii), the Tribunal considers whether MHI withdrew any offer to replace the RSGs when SCE stated that MHI would be obligated to pay the full costs of the RSGs.

(i) *The Claimants' Position*

2346. In their Responses to Joint List of Issues, the Claimants submit that “[f]ollowing the receipt of Mitsubishi’s December 2012 letter, on January 8, 2013, Mr. Dietrich acknowledged Mitsubishi’s Type 3 recommendation, but stated that a time period of five years needed for replacement did not constitute repair or replacement with “due diligence and dispatch.” Upon receipt of this letter, Mitsubishi abandoned its replacement recommendation and returned to pursuit of the Type 1 Repair concept.”²²⁴⁷

(ii) *The Respondents' Position*

2347. In their Position Statement on the Revised List of Issues, the Respondents contend that “Mitsubishi never withdrew any offer to replace the RSGs, nor did it ever offer to bear the full costs of replacing the RSGs. Although Mitsubishi always believed that repair was a more appropriate solution for reasons including time and cost, it continued to pursue replacement even after receiving Mr. Dietrich’s January 8, 2013 letter stating that the length of time to implement that option had voided the contractual limitations of liability. On the other hand, Mitsubishi’s December 21, 2012 letter recommending replacement was not an offer to pay more than the Liability Cap; indeed the letter noted that the replacement recommendation was “for a mutually acceptable remedy in accordance with the Purchase Order and subject to negotiation and agreement of acceptable terms and conditions.” The Purchase Order,

²²⁴⁷ Claimants’ Responses to Joint List of Issues, ¶ C.12(b)(iii).

of course included a limitation of Mitsubishi's liability for the cost of warranty repairs to \$137 million."²²⁴⁸

(iii) The Tribunal's Determination

2348. SCE's letter of 8 January 2016 is at the center of this Issue.
2349. The Claimants' have not convincingly shown that the Respondents abandoned work on a replacement option following Mr. Dietrich's letter of 8 January 2013.
2350. On 11 March 2013, i.e., following 8 January 2013, MHI submitted to Mr. Avella its design description report for a tube bundle replacement.²²⁴⁹
2351. Accordingly, the Tribunal finds that, at this time, MHI was in parallel pursuing both a repair and replacement option for the Claimants.
2352. Accordingly, the Tribunal answers Issue C.4(b)(iii) in the negative, MHI did not withdraw its replacement proposal.

(j) Was Mitsubishi excused from pursuing its proposal to replace the RSGs due to Claimants' responses and actions? (Issue C.4(b)(iv))

2353. In Issue C.4(b)(iv), the Tribunal considers whether MHI was excused from pursuing its proposal to replace the RSGs due to SCE's responses and actions.

(i) The Claimants' Position

2354. In their Responses to Joint List of Issues, the Claimants refer to their submissions concerning Issue C.4(a)(iii) and C.5(b).²²⁵⁰

²²⁴⁸ Respondents' Position Statement on the Revised List of Issues, ¶ 336.

²²⁴⁹ Exh. JX-1697.

²²⁵⁰ Claimants' Responses to Joint List of Issues, ¶ C.12(b)(iv).

(ii) The Respondents' Position

2355. In their Position Statement on the Revised List of Issues, the Respondents also refer to their submissions concerning Issue C.4(a)(iii).²²⁵¹

(iii) Tribunal's Determination

2356. Following the decision to shut down SONGS, there was no basis for the Respondents to keep pursuing a replacement option.

2357. Therefore, the Tribunal answers Issue C.4(c)(iv) in the affirmative. The Respondents were excused from continuing on their replacement efforts.

E. REGARDING WHETHER MITSUBISHI WAS EXCUSED FROM FURTHER PERFORMANCE: (ISSUE C.5)

2358. In this Issue C.5, the Tribunal considers whether MHI was excused from further performance.

(a) Was Edison obligated to agree to the repair proposed by Mitsubishi, under Section 1.17 of the RSG Contract? (Issue C.5(a))

2359. In this Issue C.5(a), the Tribunal considers whether, under Section 1.17 of the RSG Contract, SCE was obligated to agree to the repair proposed by MHI.

(i) The Claimants' Position

2360. In their Responses to Joint List of Issues, the Claimants submit that “Edison’s duty with respect to the repair was to act in good faith, including in deciding whether it could agree to any repair that Mitsubishi presented. In their Memorials, Respondents point to inapt case law in an effort to heighten this standard and imply that any action Edison took should be construed as impeding Mitsubishi’s repair. None of the cases

²²⁵¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 337.

support Mitsubishi's argument, or even involved a contract provision requiring "mutual agreement."²²⁵²

(ii) The Respondents' Position

2361. In their Position Statement on the Revised List of Issues, the Respondents contend that "Edison was obligated to evaluate Mitsubishi's repair in an objectively reasonable manner. Section 1.17.1.3 of the Contract required any defect to the Apparatus to have been replaced or repaired in a mutually agreeable manner. Mitsubishi crafted and presented to Edison an acceptable repair that would have cured the root cause. But before Mitsubishi could implement the repair, Edison needed to agree to it. Despite the viability of the repair, Edison unreasonably withheld its consent."²²⁵³

(iii) Tribunal's Determination

2362. The Respondents do not appear to specifically advocate that the Claimants were obligated to accept a repair proposal. Indeed, there can be no basis for the Claimants' obligations being any more than to act in good faith in evaluating the repair proposals as presented by the Respondents.

2363. Therefore, the Tribunal answers Issue C.5(a) in the negative. The Claimants were not obligated to accept the Respondents' repair proposals.

²²⁵² Claimants' Responses to Joint List of Issues, ¶ C.5(c).

²²⁵³ Respondents' Position Statement on the Revised List of Issues, ¶ 338.

(b) **Did Edison act in good faith in seeking a mutually agreeable repair or replacement under section 1.17 of the RSG Contract? (Issue C.5(b))**

2364. In this Issue C.5(b), the Tribunal considers whether SCE acted in good faith in seeking a mutually agreeable repair or replacement under Section 1.17 of the RSG Contract.

(i) *The Claimants' Position*

2365. In their Responses to Joint List of Issues, the Claimants submit the following:

California Commercial Code § 1304 provides that “[e]very contract or duty within this code imposes an obligation of good faith in its performance and enforcement.” “[W]here a contract confers on one party a discretionary power affecting the rights of the other, a duty is imposed to exercise that discretion in good faith and in accordance with fair dealing.” *California Lettuce Growers v. Union Sugar Co.*, 45 Cal.2d 474, 484 (1955); *accord Automatic Vending Co. v. Wisdom*, 182 Cal.App.2d 354 (1960). Good faith is specific to the industry, measured by “the observance of reasonable commercial standards of fair dealing in the trade.”

Under the RSG Contract, Mitsubishi alone was obligated to repair the RSGs—and with due diligence and dispatch. The contract guaranteed that the repair must be “mutually agreeable.” Edison never rejected Mitsubishi’s repair but instead reiterated its need for technical analysis and testing that it and its engineer of choice could formally review. Edison’s actions were taken, and its requests made, reasonably and in good faith. Again, those actions were consistent with Edison’s right to have Mitsubishi demonstrate that the repair would solve the root cause, and/or fix the problem. Given the unique safety risks and regulatory concerns in the nuclear industry, a utility must have a very high degree of confidence before seeking NRC approval and making a plant alteration. These considerations become even more acute when addressing a safety-significant, first-of-a-kind event like the failures of the RSGs.²²⁵⁴

2366. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

²²⁵⁴ Claimants’ Responses to Joint List of Issues, ¶ C.5(d).

Contrary to Respondents' claim, Edison acted in good faith in seeking a mutually agreeable repair or replacement under Section 1.17 of the RSG Contract. Respondents alone were obligated to repair the RSGs—with due diligence and dispatch. The contract guaranteed that the repair must be “mutually agreeable.” Edison's actions were taken, and its requests made, reasonably and in good faith.

(...)

Edison mobilized resources, supported Respondents' efforts, held regular meetings, sent personnel to Japan, repeatedly asked for back-up technical information, immediately reviewed and commented on the U-Bend Repair Report once Respondents provided it, and immediately commissioned AREVA to do the same. Given the first-of-a-kind thermal-hydraulic conditions in the RSGs that were a “main cause” of the failures, and given the first-of-a-kind nature of the repair, Edison was justified in requesting thermal-hydraulic changes and/or testing and technical validation—validation that Respondents never provided. Especially in light of the unique safety risks and regulatory concerns in the nuclear industry, a utility must have a very high degree of confidence before seeking NRC approval and making a plant alteration. These considerations become even more acute when addressing a safety-significant, first-of-a-kind event like the failures of the RSGs.²²⁵⁵

(ii) The Respondents' Position

2367. In their Position Statement on the Revised List of Issues, the Respondents, making a reference to their submissions concerning Issues C.3(a)(ii) and C.4(a)(iii), contend that “[t]he essence of the good faith covenant is objectively reasonable conduct.” Edison was objectively unreasonable in many respects.”²²⁵⁶

(iii) Tribunal's Determination

2368. In Section XIV above, the Tribunal set forth its factual determinations as to the Claimants' behavior regarding the repair and replacement options.

²²⁵⁵ Claimants' RPHM, ¶¶ 413-414.

²²⁵⁶ Respondents' Position Statement on the Revised List of Issues, ¶ 339.

2369. Based on its other determinations herein, the Tribunal considers this Issue immaterial to the resolution of this Arbitration and, accordingly, does not consider it necessary to render a determination as to whether Claimants' conduct constitutes bad faith behavior.
2370. Accordingly, the Tribunal finds it unnecessary to address Issue C.5(b).

(c) **As contended by Respondents, was Edison required to refrain from taking any actions that would interfere with Mitsubishi's ability to perform its obligations under Section 1.17 of the RSG Contract? (Issue C.5(c))**

2371. In this Issue C.5(c), the Tribunal considers if, as contended by the Respondents, SCE was required to refrain from taking any actions that would interfere with Mitsubishi's ability to perform its obligations under Section 1.17 of the RSG Contract.

(i) *The Claimants' Position*

2372. In their Responses to Joint List of Issues, the Claimants submit that the "Respondents' experts testified that nothing Edison did would have changed Mitsubishi's pursuit of the thicker AVB repair. Even as late as June 2013, the repair was not ready to go. Mitsubishi never made a commercial proposal with a repair that was technically validated, shown to be implementable, and shown to be licensable, that Edison could agree to. As explained above, even Mitsubishi's April 2013 U-Bend Repair Report was not a detailed report and did not provide underlying analysis that could be fully reviewed. In fact, Edison raised over 60 questions and concerns—that Mitsubishi discussed with its lawyers but never responded to—and AREVA raised over 90 concerns, showing that Mitsubishi's thicker AVB repair was not proven to correct the failure mechanisms, risked new and exacerbated modes of failure, and could not credibly be presented to the NRC for approval."²²⁵⁷

²²⁵⁷ Claimants' Responses to Joint List of Issues, ¶ C.5(e).

2373. In light of the aforesaid submissions, the Claimants, in their C-RPHM, contend that the issue of whether Edison did refrain from interfering with MHI's actions, is inapplicable.²²⁵⁸

(ii) The Respondents' Position

2374. In their Position Statement on the Revised List of Issues, the Respondents contend that "Edison was required to refrain from taking any actions that would interfere with Mitsubishi's ability to perform its contractual obligations. Under California law, "[i]f one party's cooperation is 'necessary for successful performance' by the other, the contract will generally be held to include an implied obligation to 'give that cooperation,' as well as to refrain from doing 'anything that prevents realization of the fruits of performance'"²²⁵⁹

2375. In addition, in reference to the issue of whether Edison did so refrain, the Respondents submit that "Edison was required to act reasonably in refraining from taking actions that would interfere with Mitsubishi's ability to meet its obligations to repair or replace the steam generators to preclude further tube-to-tube wear. Edison did not act reasonably."²²⁶⁰

(iii) Tribunal's Determination

2376. In Section XIV above the Tribunal set forth its factual determinations as to the Claimants' behavior regarding the repair and replacement options.

2377. The Tribunal generally concludes that SCE was required to act in good faith and cooperate in developing a mutually agreeable repair option.

²²⁵⁸ Claimants' RPHM, ¶ 416.

²²⁵⁹ Respondents' Position Statement on the Revised List of Issues, ¶ 340.

²²⁶⁰ Respondents' Position Statement on the Revised List of Issues, ¶ 341.

2378. Based on other determinations herein, the Tribunal does not consider it necessary to address Issue C.5(c).

(d) **Did Edison provide Mitsubishi with a reasonable opportunity to perform its obligations under the Warranty? (Issue C.5(d))**

2379. In this Issue C.5(d), the Tribunal considers whether SCE provided MHI with a reasonable opportunity to perform its obligations under the warranty.

(i) *The Claimants' Position*

2380. In their Responses to Joint List of Issues, the Claimants submit the following:

While Edison consistently pushed for a validated and substantiated repair recommendation, Mitsubishi delayed, postponed, and ultimately failed to deliver that recommendation. Edison did not need to wait interminably for the Mitsubishi to perform needed repairs. Indeed, Mitsubishi has made clear that it had no intention of conducting any additional testing or analysis as of June 2013—including the analysis and work it did for purposes of this arbitration.

Mr. Dietrich testified that Claimants “were willing to consider anything that Mitsubishi brought forward.” No witness from Mitsubishi testified as to anything Mitsubishi would have done differently if Edison was more “supportive” of the repair—in fact the opposite is true. Witnesses could not identify anything that would have been done differently.

Even Mitsubishi’s expert on implementation admitted that Claimants posed no obstacle to Mitsubishi’s study on the implementability of the Type 1 Repair--- which was not completed until after this arbitration commenced. Mitsubishi had ample opportunity to develop a plan for a viable, licensable repair, but failed to do so.²²⁶¹

(ii) *The Respondents' Position*

2381. In their Position Statement on the Revised List of Issues, the Respondents, while referring to their submissions concerning Issues C.3(a)(ii) and C.4(a)(iii), submits that “Edison unreasonably withheld its consent for Mitsubishi to move forward with

²²⁶¹ Claimants’ Responses to Joint List of Issues, ¶ C.5(f).

repair and replacement concepts. In addition, even assuming that Edison acted reasonably, 16 months is not an undue amount of time to implement a repair (and certainly replacement). Nuclear outages routinely last that length or longer prior to restart of nuclear plants. There have been at least 52 cases where nuclear power plants in the United States have returned to long-term service after outages of more than one year (including over 20 outages of more than two years). As one example, Claimants' expert and former utility executive Mr. Michael Morris noted that his plant was down "roughly three years" before it was able to be restarted."²²⁶²

(iii) Tribunal's Determination

2382. In Section XIV above the Tribunal set forth its factual determinations as to the Claimants' behavior regarding the repair and replacement options.
2383. The Tribunal considers that in light of its determination in Issues C.2,²²⁶³ C.3²²⁶⁴ and C.4²²⁶⁵ that this Issue is no longer relevant or material.
2384. Accordingly, the Tribunal does not consider it necessary to address Issue C.5(d).

(e) Was Edison obligated to hire another vendor to repair or replace any Defect and backcharge Mitsubishi under Section 1.17.1.3(b), as alleged by Respondents? (Issue C.5(e))

2385. In this Issue C.5(e), the Tribunal considers whether SCE was obligated to hire another vendor to repair or replace any Defect(s) and backcharge MHI under Section 1.17.1.3(b).

²²⁶² Respondents' Position Statement on the Revised List of Issues, ¶ 342.

²²⁶³ See Section XV.B above.

²²⁶⁴ See Section XV.C above.

²²⁶⁵ See Section XV.D above.

(i) The Claimants' Position

2386. In their Responses to Joint List of Issues, the Claimants submit the following:

The “backcharge” and “default” remedies referenced by Respondents are subsections of the Warranty obligations. The language of these subsections confirms that these remedies were at Edison’s option, triggered if Mitsubishi failed to act with due diligence and dispatch. These remedies were only available to Edison if Mitsubishi “fail[ed] to take action to correct any Defect within two (2) days after upon notification . . . or fail[ed] to diligently continue performing such correction to completion thereafter” Then, and only then, did Edison have the option to seek a repair elsewhere: Edison “may perform or [Edison] have performed such necessary warranty work and backcharge [Mitsubishi] for such direct costs for repair or replacement and/or declare [Mitsubishi] to be in default pursuant to Section 1.24.” Mitsubishi has never budged from in its contention that it acted diligently at all times, meaning that Edison’s option to hire another vendor was never triggered. It was not possible under the RSG Contract, let alone required.

A requirement that Edison hire another vendor to pursue a repair, while permitting Mitsubishi to pursue a repair, amounts to requiring Edison to double-spend against the limitation of liability. It would also be in violation of Section 1.17.12, which provides that “[i]n no event shall the [Mitsubishi] be relieved of any of its warranty obligations as a result of [Edison] making any payments to Supplier.”²²⁶⁶

2387. In addition, in their C-RPHM, the Claimants, while relying on *Cates v Morgan Portable Building Corp.*,²²⁶⁷ contend that “[a] requirement that Edison hire another vendor to pursue a repair, while permitting Mitsubishi to pursue a repair (...) would be (...) in violation of the law: “[I]f a seller of defective goods tells the buyer, don’t bother to go get the goods repaired [by a third party] – I’ll do it – the duty to mitigate is suspended ... the seller may not insist on mitigation when by its words or deeds it

²²⁶⁶ Claimants’ Responses to Joint List of Issues, ¶ C.5(g).

²²⁶⁷ 780 F.2d 683, 687 (7th Cir. 1985).

has led the buyer to believe that it has assumed what would otherwise be the buyer's burden of mitigation."²²⁶⁸

(ii) The Respondents' Position

2388. In their Position Statement on the Revised List of Issues, the Respondents contend that they "do not allege that Edison was **obligated** to hire another vendor under Section 1.17.1.3(b). Rather, Edison's failure to pursue this remedy option illustrates Claimants' failure to avail themselves of the remedies available to them under the Warranty. Accordingly, Claimants cannot argue that the Warranty failed of its essential purpose. *See* detailed discussion in Section F.2(a)(ii). As outlined in the designated deposition testimony of Jeffrey Ellis, Edison included the backcharge provision as a standard remedy in order to protect Edison if one of its vendors was acting too slowly in Edison's view. Claimants allege that Mitsubishi did not provide it a remedy in a timely fashion, yet they ignore that they had an available remedy in the backcharge and default provision under Section 1.17.1.3(b)."²²⁶⁹

(iii) Tribunal's Determination

2389. Section 1.17.1.3(b) provides in part:

b) Should the Supplier fail to take action to correct any Defect within two (2) days after upon notification to the Supplier or fails to diligently continue performing such correction to completion thereafter, then the Edison Representative may perform or EMS or Edison may have performed such necessary warranty work and backcharge the Supplier for such direct costs for repair or replacement (...)

2390. The Tribunal agrees with the Claimants that these remedies were only available to SCE if MHI "fail[ed] to take action to correct any Defect within two (2) days after upon notification . . . or fail[ed] to diligently continue performing such correction to

²²⁶⁸ Claimants' RPHM, ¶ 421.

²²⁶⁹ Respondents' Position Statement on the Revised List of Issues, ¶ 343.

completion thereafter” and that only then SCE did have the option to seek a repair elsewhere.

2391. The Respondents appear to agree with this position as they do not submit that the Claimants were obligated under Section 1.17.1.3(b) of the RSG Contract to hire another vendor in the present case.

2392. Accordingly, the Tribunal answers Issue C.5(e) in the negative as SCE was not required to hire another vendor under the circumstances.

(f) Was Mitsubishi excused from further performance under Section 1.17 because of Edison’s conduct in (b) and (c) above? (Issue C.5(f))

2393. In Issue C.5(f) the Tribunal considers whether MHI was excused from further performance under Section 1.17 because of SCE’s conduct as considered in Issues C.5(b) and C.5(c) above.

(i) The Claimants’ Position

2394. In their Responses to Joint List of Issues and their C-RPHM, the Claimants refer to their submissions “above.”²²⁷⁰

(ii) The Respondents’ Position

2395. In their Position Statement on the Revised List of Issues, the Respondents refer to their submissions concerning Issues C.3(a)(ii) and C.4(a)(iii).²²⁷¹

(iii) Tribunal’s Determination

2396. In Section XIV above the Tribunal set forth its factual determinations as to the Claimants’ behavior regarding the repair and replacement options.

²²⁷⁰ Claimants’ Responses to Joint List of Issues, ¶ C.5(h); Claimants’ RPHM, ¶ 422.

²²⁷¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 344.

2397. Based on other determinations herein, the Tribunal does not consider it necessary to render a determination on Issue C.5(f), whether the Claimants' behavior constitutes bad faith behavior or otherwise would excuse MHI from performance under Section 1.17 of the RSG Contract.
2398. Accordingly, the Tribunal elects not to address Issue C.5(f).

F. HAVE CLAIMANTS ESTABLISHED THAT ANY OR ALL OF THE ALLEGED FAILURES, INDIVIDUALLY OR IN COMBINATION, CONSTITUTE A MATERIAL BREACH OF CONTRACT THROUGH ANY OR ALL OF THE WARRANTY PROVISIONS OF THE RSG CONTRACT? (ISSUE C.6)

2399. In this Issue C.6, the Tribunal considers whether the Claimants have established that any or all of the alleged failures, individually or in combination, constitute a material breach of contract through any or all of the Warranty provisions of the RSG Contract.

(i) The Claimants' Position

2400. In their Responses to Joint List of Issues, the Claimants, while making a reference to their submissions concerning Issue B.6 and B.9, submit the following:

Mitsubishi breached the RSG Contract, and such breaches were material. *See Superior Motels, Inc. v. Rinn Motor Hotels, Inc.*, 195 Cal. App. 3d 1032, 1051 (1987) (defining a breach to be material "if it is so dominant or pervasive as in any real or substantial measure to frustrate the purpose of the contract" (citation omitted)). Whether a breach is material "depends on the importance or seriousness thereof and the probability of the injured party getting substantial performance." *Brown v. Grimes*, 192 Cal. App. 4th 265, 278 (Cal. App. 2011) (quoting 1 Witkin, Summary of Cal. Law (10th ed. 2005) Contracts, § 852, pp. 938-940).

Mitsubishi then failed to provide a viable, validated, and licensable repair even 16 months after the RSGs failed. The RSG Contract states that "[t]ime is of the essence" for delivery of the RSGs and all supporting Documentation (as defined in the RSG Contract). JX-923 at 016 (RSG Contract) § 1.5.1. Further, Mitsubishi was required to repair the RSGs with "due diligence and dispatch." JX-923 at 036 (RSG Contract) § 1.17.1.3. "[W]hen time is made of the essence of a contract, a failure to perform within the time specified is a material breach

of the contract.” *Gold Mining & Water Co. v. Swinerton*, 23 Cal.2d 19, 27 (1943).

Mitsubishi not only failed to *timely* deliver the RSGs that Edison contracted for—it failed to deliver the as-promised RSGs at all. Mitsubishi’s failures constitute material breaches that frustrated the purpose of the RSG Contract.²²⁷²

(ii) *The Respondents’ Position*

2401. In their Position Statement on the Revised List of Issues, the Respondents contend that the “Claimants have failed to establish that Mitsubishi breached its warranty obligations. To prevail on a breach of warranty claim, Claimants must show (1) the existence of a binding contract for the sale of goods, (2) the presence of an express or implied warranty within that contract, (3) breach, (4) damages, and (5) timely notice. Here there are only express warranties that are specifically enumerated in the RSG Contract. As outlined above, Mitsubishi was contractually required to: (1) perform a technical analysis of the problem; (2) correct the “root cause” unless it satisfied Edison that there was not a risk of the problem recurring; (3) act with “due diligence and dispatch”; and (4) warrant the repair for the remainder of the Warranty Period. Mitsubishi satisfied these obligations and/or was excused from further performance as a result of Edison’s objectively unreasonable conduct.”²²⁷³

(iii) *Tribunal’s Determination*

2402. Considering the entirety of the Issues as determined in Issue C, the Tribunal does not consider that the Claimants have established that the alleged failures, individually or in combination, constitute a material breach of contract through any or all of the warranty provisions of the RSG Contract.

²²⁷² Claimants’ Responses to Joint List of Issues, ¶ C.13.

²²⁷³ Respondents’ Position Statement on the Revised List of Issues, ¶ 345.

2403. The Tribunal accepts that the Respondents presented a Type 1 Repair proposal that could have eliminated in-plane FEI and allowed for a restart of Unit 3.
2404. The Tribunal also accepts that the Respondents' repair proposal was incomplete at the time of the SONGS shutdown. However, the Tribunal considers that the concerns raised by AREVA and the Claimants regarding the Respondents' repair proposal could have been addressed, and demonstrably were addressed in this arbitration.
2405. Furthermore, the NRC would have been capable of reviewing and approving a Type 1 Repair proposal within its standard 12 month repair period.
2406. The Tribunal also accepts that there would have been likely regulatory delays on account of the ASLB when the Friends of the Earth sought a public hearing, but that the Respondents do not bear the regulatory risk in this regard.
2407. Accordingly, the Tribunal answers Issue C.6 in the negative. The Claimants have not demonstrated a material breach of the Respondents' warranty obligations.

G. WHAT ARE THE CONSEQUENCES OF ANY FINDING REGARDING REPAIR OR REPLACEMENT FOR CLAIMANTS' BREACH OF WARRANTY CLAIM? (ISSUE C.7)

2408. In this Issue C.7, the Tribunal considers what are the consequences of any finding(s) regarding repair or replacement for the Claimants breach of warranty claim.

(i) The Claimants' Position

2409. In their Responses to Joint List of Issues, the Claimants, while making reference to their submission concerning Issue F, below, submit that the "Respondents' failure to repair or replace the RSGs with due diligence and dispatch constitutes a breach of warranty. Further, because Mitsubishi failed to repair or replace the RSGs, the

Tribunal should consider whether that breach caused the limited remedy to fail of its essential purpose such that the damages limitations do not apply.”²²⁷⁴

(ii) *The Respondents’ Position*

2410. In their Position Statement on the Revised List of Issues, the Respondents contend that “[i]f the Tribunal makes a finding that Mitsubishi did not meet its warranty obligations regarding repair or replacement and that it was not excused by Edison’s actions, it may find that Mitsubishi breached its warranty obligations. Notably, as determined by the California Court of Appeals in *Nunes Turfgrass*, a breach of warranty is not sufficient to invalidate a Liability Cap or Mutual Waiver. Therefore even if Mitsubishi is found to have breached the warranty, Edison’s recovery would be limited to direct damages caused by such breach up to the purchase price of the RSG Contract, less any offsets.”²²⁷⁵

(iii) *Tribunal’s Determination*

2411. On account of the Tribunal’s determination of Issue C.6, no determination is required on Issue C.7, which the Tribunal considers is rendered moot.

XVI. MISREPRESENTATION, FRAUD, AND TORT CLAIMS (ISSUE D)

2412. The Claimants’ claims in this Issue are directed towards Section 1.21.2 of the RSG Contract, which voids the limitation of liability provision on account of the Respondents’ alleged “gross negligence, fraud, willful misconduct or illegal or unlawful acts.”

²²⁷⁴ Claimants’ Responses to Joint List of Issues, ¶ C.14.

²²⁷⁵ Respondents’ Position Statement on the Revised List of Issues, ¶ 346.

(i) The Claimants' Position

2413. The Claimants make no submissions concerning this introductory aspect of Issue D. Rather, they make all their submissions in the Sub-Issues below.

(ii) The Respondents' Position

2414. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

As a threshold matter, to prevail on any of their misrepresentation claims, Claimants must prove that Mitsubishi made one or more *false* representations. In their Memorial and Reply Memorial, Claimants pointed to six statements in Mitsubishi's technical proposal as purported false misrepresentations. These statements all dealt with Mitsubishi's capabilities to design to eliminate harmful vibration and particularly with Mitsubishi's FIT-III and FIVATS.

Claimants' purported evidence showing that Mitsubishi's statements were false consists of five documents and a single witness. None of this evidence meets Claimants' burden of showing that Mitsubishi's statements were false.

First, Claimants contrast Mitsubishi's proposal statements with out-of-context statements in five documents dated years after Mitsubishi's proposal. As detailed in Mitsubishi's Rejoinder Memorial, none of this evidence proves that Mitsubishi's statements were false.

Second, at the hearing, Claimants only presented one witness to testify to the pre-contractual time period, Mr. Wharton. His basic testimony was that Edison had concerns that Mitsubishi had never designed a steam generator the size of SONGS but that Edison "got comfortable" with Mitsubishi because of representations that Mitsubishi knew how to address important design issues.

On cross-examination, Mr. Wharton admitted that he was not involved in the technical negotiations and had no personal knowledge of which statements in Mitsubishi's proposal Edison relied upon in choosing Mitsubishi as the designer and manufacturer of the steam generators. He also admitted that he was not aware that Mitsubishi's proposal included statements that FIT-III was accurate to ██████ despite having testified on the accuracy of FIT-III in his witness statement.

Because Claimants have not put forth credible evidence to show that Mitsubishi's pre-contractual statements were misrepresentations, Claimants'

claims for fraudulent inducement, fraud, and negligent misrepresentation must fail.²²⁷⁶

(iii) Tribunal's Determination

2415. The Respondents' preliminary observations are taken under advisement. The Tribunal addresses the substance of the Parties' submissions in the Sub-Issues below.

A. REGARDING CLAIMANTS' FRAUDULENT INDUCEMENT CLAIMS (ISSUE D.1)

2416. In this Issue D.1, the Tribunal considers the Claimants' contentions concerning certain statements and representations made by the Respondents during the bidding process regarding its experience and abilities, which allegedly constituted false representations. In turn, the Claimants contend that these false representations amounted to a fraudulent inducement, since all conditions of a claim of fraud under Section 1572 of the California Civil Code are satisfied.

(a) Did Mitsubishi procure the RSG Contract through false representations? (Issue D.1(a))

(i) The Claimants' Position

2417. In their Responses to Joint List of Issues, the Claimants, while making a reference to their submissions on Issues D.2(a)(i) and D.2(a)(ii), submit that "[d]uring the bidding process, Mitsubishi held itself out as an expert, N-stamp-certified steam generator designer and made numerous, unequivocal representations regarding its experience and capabilities in designing steam generators. Through these representations, Claimants were convinced that Mitsubishi had developed the necessary tools and expertise to model critical thermal-hydraulic conditions in the RSGs and thus prevent dangerous tube vibration and wear, [even if they had never previously designed or fabricated a steam generator the size of the RSGs]. Claimants also relied on

²²⁷⁶ Respondents' Position Statement on the Revised List of Issues, ¶¶ 347-352.

Mitsubishi's representations that it had sufficient expert knowledge and engineering skill to design effective tube support structures, including structures with "enough strength both for in-plane and out-of-plane forces."²²⁷⁷

~~2418.~~ In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that the "Respondents' argument that the integration clause in Section 1.37 of the RSG Contract supersedes any representations made by either party prior to the execution of the RSG Contract is irrelevant to Claimants' fraudulent inducement claim. Under California law, an integration clause does not preclude a party from recovering for intentional or negligent misrepresentations made during negotiation of a contract."²²⁷⁸

(ii) The Respondents' Position

2419. In their Position Statement on the Revised List of Issues, the Respondents contend that the "Claimants have failed to meet their burden to prove that Mitsubishi procured the RSG Contract through false representations. Claimants' fraudulent inducement claim has evolved through the rounds of briefing and Claimants have never clearly articulated the applicable legal standard for this claim. By contrast, the case law is clear that to prove fraudulent inducement, "one must show that the defendant did not intend to honor its contractual promises when they were made." In addition, to recover damages for fraud, a plaintiff must have sustained damages proximately caused by the misrepresentation (...) Claimants have not proven the elements of fraudulent inducement."²²⁷⁹

(iii) The Tribunal's Determination

2420. The Parties have referenced the entire agreement clause of the RSG Contract:

²²⁷⁷ Claimants' Responses to Joint List of Issues, ¶ D.15(a).

²²⁷⁸ Claimants' RPHM, ¶ 428.

²²⁷⁹ Respondents' Position Statement on the Revised List of Issues, ¶ 353.

1.37 ENTIRE AGREEMENT

The Purchase Order contains the entire agreement and understanding between the Parties and merges and supersedes all prior representations and discussions pertaining to the Purchase Order, including Supplier's proposal. Any changes, exceptions or different terms and conditions proposed by the Supplier, or contained in Supplier's acknowledgment of the Purchase Order, packaging, shipment documents, or invoice are hereby rejected unless expressly stated in the Purchase Order or incorporated therein by a Change Order.

2421. The Claimants submit that an entire agreement clause does not bar claims for intentional or negligent representations. Those are addressed in Issues D.1 and D.2 below.²²⁸⁰ The Claimants do not, however, appear to submit that the entire agreement clause does not bar false representation claims based on pre-contractual statements.
2422. The Tribunal concludes that it does for the following reasons. The express language employed in the entire agreement clause, states that the Purchase Order contains the “entire” agreement and understanding between the Parties and “supersedes all prior representations and discussions.”
2423. Notwithstanding this express bar on the pre-contractual statements, the Tribunal notes that a number of pre-contractual claims were reiterated in the RSG Contract itself, and were further made during the performance and execution of the RSG Contract.
2424. In the RSG Contract, MHI represented that it has the capabilities to perform the Work as per the agreed specifications:

1.41.1.9 Supplier, by itself and through its Subcontractors, has the full experience and proper qualifications to design and perform the Work in

²²⁸⁰ See Section XVI.B below.

accordance with the requirements of the Purchase Order, including performance of any warranty Work described herein

2425. In addition to the above mentioned general representation, statements made in the course of the Parties' relationship, as provided in Appendix B to the Claimants' Memorial, are considered. Appendix B consists of a table of generally technical statements, alleged to be representations by the Respondents regarding the work they would perform. Examples of these statements from the Claimants' Appendix B include:

This AVB design has no potential of fluid elastic vibration.²²⁸¹

The solid TSP design provides very accurate dimensional control of the tube hole position and diameter. This ensures a very efficient tube support.²²⁸²

The design and quantity of TSP's will provide sufficient stiffness such that the natural frequency of the tube is sufficiently increased to a point that FIV will not occur under any operating conditions.²²⁸³

Thermal-hydraulic RSG performance is determined using MHI's code which is accurate based on extensive benchmarking efforts using lab and field operating/test data.²²⁸⁴

2426. It is not disputed that the Unit 3 RSGs did not perform as the Parties expected and indeed did suffer from conditions that the Respondents stated would not occur.

2427. The Claimants' Appendix B to its Memorial also provides a number of contractual statements that are at issue, including:

²²⁸¹ Memorial, Appendix B, p. 10.

²²⁸² Memorial, Appendix B, p. 1.

²²⁸³ Memorial, Appendix B, p. 2.

²²⁸⁴ Memorial, Appendix B, p. 5.

Work complies with Applicable Laws, Applicable Standards.²²⁸⁵

The Apparatus shall be free from Defects.²²⁸⁶

There will be no primary-to-secondary leakage.²²⁸⁷

All technical and quality requirements of this Specification shall be met.²²⁸⁸

2428. It is not disputed that there was primary-to-secondary leakage. On account of the Gap Velocity Error alone, not all technical and quality requirements of the Specifications were met. The Tribunal determined that the Apparatus was not free from Defects.²²⁸⁹
2429. These contractual issues have already been addressed by the Tribunal in Issue B. However, these items are now addressed in the context of whether they consist of false contractual representations.
2430. The Claimants' Reply identifies six statements from the Respondents' "technical proposal" dated 7 February 2004, which they have highlighted as particularized misrepresentations. Below, the Tribunal sets out those representations, the Claimants' evidence that these constitute misrepresentations, and the Respondents' counter-submissions.

(1) Representation 1

2431. MHI's technical proposal states that "[t]hermal-hydraulic RSG performance is determined using MHI's code which is accurate based on extensive benchmarking

²²⁸⁵ Memorial, Appendix B, p. 11.

²²⁸⁶ Memorial, Appendix B, p. 12.

²²⁸⁷ Memorial, Appendix B, p. 12.

²²⁸⁸ Memorial, Appendix B, p. 13.

²²⁸⁹ See Section XV.A above.

efforts using lab and field operating / test data.”²²⁹⁰ The Claimants submit that this statement constitutes a misrepresentation as an internal Mitsubishi email of 9 September 2005, by Mr. Wilson, referenced a report, i.e., the CLOTAIRE report, which indicated that under certain T/H calculations, FIT-III provided answers which were “very far away from the data and [that] most other codes came closer.”²²⁹¹

2432. In the expert report submitted by Mr. Blandford, on behalf of the Respondents, he opines that the CLOTAIRE report actually shows that FIT-III conservatively predicts void fraction values measured in the U-bend region.

2433. The Tribunal has rendered its findings surrounding Mr. Wilson’s comments on FIT-III and the CLOTAIRE report in Sections XII.A(b) and XIII.E(iii) above.²²⁹² The Tribunal does not consider that the Respondents made an intentional false representation regarding the accuracy of its codes. Details surrounding the validation of these codes were provided to SCE early in the bidding process. Those documents provide the margins of uncertainty in various codes and also provide details of their testing and validation history.

2434. Accordingly, the Tribunal concludes that MHI did not intentionally misrepresent the accuracy of its codes.

(2) Representation 2

2435. MHI’s technical proposal states that “FIT-III code is verified very well by using model SG test results, therefore, it is considered that the results of FIT-III are valid for evaluation of flow induced vibration in actual SG.”²²⁹³ The Claimants submit that

²²⁹⁰ Exh. JX-293, Section 4.3.5.6.

²²⁹¹ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 415.

²²⁹² See ¶¶ 1176-1185 above.

²²⁹³ Exh. JX-293, Section 4.3.3.

this constitutes a misrepresentation as an undated Mitsubishi document indicates “FIT-III has never been verified for U-shaped tubes in triangular arrangements.”²²⁹⁴

2436. The Respondents submit that their proposal identifies that FIT-III had been tested in a square array. The Respondents also indicate that the document cited by the Claimants provides that FIT-III was verified for triangular arrays in a U-bend air test, and that no industry test existed in 2004 that used a triangular array for validating codes in a two-phase array.
2437. The Respondents submit that no codes had been tested in a triangular array. During the Hearing, Dr. Kytömaa, for the Claimants, was examined in regard to the FRIGG²²⁹⁵ test in which ATHOS was supposedly tested in a triangular array.²²⁹⁶ However, the examination of Dr. Kytömaa demonstrated that ATHOS had not been tested in a triangular array pressurized water reactor with a U-bend, but rather only in a boiling water reactor with just a straight leg section.²²⁹⁷
2438. Accordingly, the Tribunal concludes that there can be no particular reliance on MHI’s statement as no other bidders had codes specifically validated for use in triangular arrays either. MHI’s statement was that the “FIT-III code is verified very well.” The Tribunal is not convinced by the Claimants submission that this constitutes an intentional misrepresentation, with reference to a supposed lack of testing, particularly when FIT-III had a comparable level of testing as other codes.
2439. Further, the Tribunal does not consider that MHI’s statement is false. The FIT-III code was validated in a number of tests and experiments as part of its development. The Claimants’ expert, Exponent, has identified five such validation tests for FIT-

²²⁹⁴ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 67 (citing to Exh. JX-1301).

²²⁹⁵ The FRIGG test was a simulated boiling water reactor in Sweden.

²²⁹⁶ Transcript, pp. 333-339.

²²⁹⁷ Transcript, p. 338 (Mr. Kytömaa).

III.²²⁹⁸ While the Claimants, through their expert Exponent, have submitted that other codes, such as ATHOS, have had more such tests, the Tribunal is convinced that the Claimants' submission is imprecise as some of those additional tests for ATHOS related to functions that FIT-III does not perform, such as the calculation of circulation ratios which was calculated by MHI's SSPC.²²⁹⁹ Further, the Claimants were not justified in relying on upon the Respondents' general statement that "FIT-III was verified very well" as the Respondents provided the Claimants with the actual validation background of FIT-III in their technical proposal.²³⁰⁰

2440. Accordingly, the Tribunal does not consider the Respondents to have made a false representation.

(3) Representation 3

2441. MHI's technical proposal states that "the MHI FIT-III thermal-hydraulic code is an extremely accurate computer program for determination of SG secondary side conditions."²³⁰¹ The Claimants submit that this constitutes a misrepresentation as an internal Mitsubishi email of 24 February 2016, sent by Mr. Wilson to Mr. Langford, at the time consultants of MHI, states, "I have my doubts about the accuracy of FIT-III, ATHOS, and PORTHOS - but in spite of this, I endorse using these tools whenever possible."²³⁰²

2442. The Respondents submit that the consultant in question had doubts regarding both FIT-III and ATHOS.

²²⁹⁸ Exponent Rebuttal, ¶ 70.

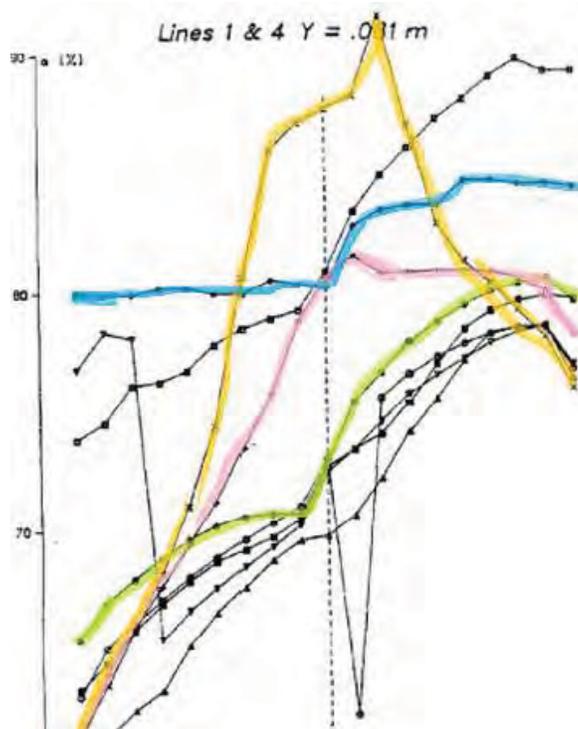
²²⁹⁹ Transcript, p. 321 (Mr. Kytömaa).

²³⁰⁰ Exh. JX-293.

²³⁰¹ Exh. JX-293, Section 4.3.3.1.5.

²³⁰² Exh. JX-567.

2443. The Tribunal considers that the accuracy of FIT-III must be considered within the context of the other codes, as submitted by the Respondents.²³⁰³ In this, the results from the CLOTAIRE program are illustrative:²³⁰⁴



²³⁰³ Transcript, pp. 59-60 (Respondents' Opening).

²³⁰⁴ Exh. JX-98, p. 123 (Color added by Tribunal).

2444. The measured results from the CLOTAIRE test are provided in green. As was discussed previously by the Tribunal, there is measurement uncertainty with regard to void fractions measured through the use of bi-optical probes.²³⁰⁵ The FIT-III results are conservative, generally over predicting void fraction by a factor of a few percent. ATHOS results are, at times, more conservative and, at times, less conservative, i.e., under-predicting void fraction. A number of other codes appear to follow the CLOTAIRE data more closely, although they under-predict what that data is, which constitutes an obvious concern in steam generator design.
2445. When looked at in this holistic context, the Tribunal does not consider MHI's representation, that FIT-III is an "extremely accurate computer program" to be false.

(4) Representation 4

2446. MHI's technical proposal states that "the RSG tube vibration behavior as analyzed by FIT-III and FIVATS will provide sufficient margin against fluid elastic vibration."²³⁰⁶ The Claimants submit that this constitutes a misrepresentation as an internal Mitsubishi email of 9 September 2005 provides that "MHI needs to show that they add some 'margin' to the FIT-III results in whatever direction is needed for the phenomena being evaluated. If it is void fraction and fluid damping – assume FIT-III underpredicts it (...) For tube vibration, assume FIT-III under predicts the velocity and fluid density."²³⁰⁷
2447. The Respondents submit that this email is the opinion of a Mitsubishi consultant, not Mitsubishi, and that it is made over a year following the date of the technical proposal.

²³⁰⁵ See ¶¶ 1423 - 1426 above.

²³⁰⁶ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 415 (citing to Exh. JX-293, Section 7.3.4).

²³⁰⁷ Exh. JX-480.

2448. The Tribunal has determined that classic out-of-plane FEI did not occur at SONGS.²³⁰⁸ Accordingly, there was sufficient margin against out-of-plane FEI at SONGS such that there is no misrepresentation. While there was in-plane FEI on Unit 3, this was a first-of-a-kind unexpected occurrence.
2449. There is accordingly no basis for considering that MHI intentionally misrepresented that its design would preclude in-plane FEI.

(5) Representation 5

2450. MHI's technical proposal states that "the analytical capability of the FIVATS code in combination with the MHI test and verification data is sufficient to eliminate any vibration mechanism concerns for both the TSP and AVB designs offered by MHI."²³⁰⁹ The Claimants submit that this constitutes a misrepresentation as an internal Mitsubishi document indicates that "there is a need to discover the predictive accuracy of codes in plants where FIV is predicted to become tougher, such as SONGS."²³¹⁰
2451. The Respondents submit that the Claimants' own post-Incident investigations indicate that FEI was not at issue regarding the TSP and AVB vibration wear and that the document in question is a study that post-dates the technical proposal.²³¹¹
2452. The Tribunal does not consider that the statement that "the analytical capability of the FIVATS code in combination with the MHI test and verification data is sufficient

²³⁰⁸ See Section XIII.D(c)(iii) above.

²³⁰⁹ Claimants' Reply to Counter-Memorial and Counterclaims, ¶ 415 (citing to Exh. JX-293, Section 7.3.4).

²³¹⁰ Exh. JX-684.

²³¹¹ Respondents Rejoinder, ¶ 373.

to eliminate any vibration mechanism concerns for both the TSP and AVB designs offered by MHI” is an intentional misrepresentation.

2453. It was not unlikely that some form of random vibration was to be expected at SONGS, despite design efforts to the contrary on account of normal random vibrations. The Respondents’ statement at issue was that “concerns” from vibration would be eliminated, not any vibration at all. Further, the Tribunal accepts that the generation of wear-challenged large RSGs, such as SONGS and St. Lucie 2 also experienced unexpected wear despite the industry designing to the contrary.²³¹² Given this industry experience, the Tribunal does not find that MHI’s statement amounts to an intentional misrepresentation. MHI expected its design approach to eliminate vibration concerns. Further, the Tribunal does not consider that the Claimants’ reliance upon an MHI internal 2007 proposal for MHI to further study its codes in a large steam generator such as SONGS does not imply that the representations in question were misrepresentations.²³¹³
2454. Accordingly, the Tribunal does not consider that the representations in question were intentional misrepresentations or constituted fraud or fraudulent inducement.

(6) Representation 6

2455. MHI’s technical proposal indicates that “the combination of Mitsubishi R&D, design, manufacturing, installation, and operating experience provides conclusive results that the AVB’s will provide adequate support to the tubes to preclude FIV and corrosion, while at the same time minimizing negative thermal-hydraulic effects. This applies for the operating life of the RSGs.”²³¹⁴ The Claimants submit that this

²³¹² See e.g. Transcript, pp. 4303-4304 (Dr. Begley).

²³¹³ Exh. JX-684.

²³¹⁴ Claimants’ Reply to Counter-Memorial and Counterclaims, ¶ 415 (citing to Exh. JX-293, Section 4.3.2.5.7).

constitutes a misrepresentation, as an internal Mitsubishi email notes that “we feel large difficulty to design and assembling of AVB in order to keep the minimum gap between AVB and Tube.”²³¹⁵

2456. The Respondents submit that they designed and manufactured tubes with a more precise minimum gap, and that it was this achievement that caused FEI in Unit 3.²³¹⁶

2457. As the Tribunal determined, the AVBs did prevent classical out-of-plane FEI.²³¹⁷ That in-plane FEI occurred was an unexpected phenomenon and cannot be considered an intentional false misrepresentation. Moreover, the representation in question when made in Mitsubishi’s technical proposal related to past experience which was not proven to be false.

(7) Conclusion

2458. Accordingly, the Tribunal answers Issue D.1(a) in the negative, MHI did not procure the RSG Contract through false misrepresentations.

(b) **Have Claimants established each of the elements of fraud under Cal. Civ. Code § 1572? (Issue D.1(b))**

(i) **If so, have Claimants proven that, at the time Mitsubishi made any alleged misstatements, Mitsubishi did not intend to honor its contractual promises?**

(ii) **As a matter of California law, are Claimants required to prove that Respondents did not intend to honor their promises?**

2459. The Tribunal considers whether the Claimants have established each of the elements for a finding of fraud under California law.

²³¹⁵ Exh. JX-366, p. 5.

²³¹⁶ Respondents’ Rejoinder, ¶ 374.

²³¹⁷ See Section XIII.D(c)(iii) above.

(i) The Claimants' Position

2460. In their Responses to Joint List of Issues, the Claimants submit that they “have established the elements of fraud under Cal. Civ. Code § 1572, which states that actual fraud “consists in any of the following acts, committed by a party to the contract, or with his connivance, with intent to deceive another party thereto, or to induce him to enter into the contract: (1) The suggestion, as a fact, of that which is not true, by one who does not believe it to be true; (2) The positive assertion, in a manner not warranted by the information of the person making it, of that which is not true, though he believes it to be true; (3) The suppression of that which is true, by one having knowledge or belief of the fact; (4) A promise made without any intention of performing it; or, (5) Any other act fitted to deceive.” Furthermore, “the requisite intent in a cause of fraud is an intent to induce action and not a specific intent to deceive.”²³¹⁸

2461. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Although Respondents argue in their Response to the List of Issues that “[f]raud is an intentional tort, which means Claimants must show Mitsubishi’s intent to deceive,” Respondents disregard California law, which clearly holds that “the requisite intent in a cause of fraud is an intent to induce action and not a specific intent to deceive.” Respondents’ argument is surprising—given that they cite this standard in their own briefing.

Thus, the procurement of a contract through untrue or unwarranted assertions constitutes “[a]ctual fraud,” regardless of whether the party making the false statements believes them to be true. As long as a statement is made “in a manner not warranted by the information of the person making it,” and reasonably relied upon by the party to which it is directed, even a negligently made statement is actionable as fraud. In addition, fraud may occur when a

²³¹⁸ Claimants’ Responses to Joint List of Issues, ¶ B.15(b).

party makes a statement of fact with a reckless disregard for the truth or falsity of that statement.

As discussed below, Claimants have established that Respondents either made unwarranted assertions, regardless of whether Respondents believed them to be true, made representations with reckless disregard for their truth, or suppressed certain facts and knowledge from Claimants with the intent to induce Claimants to enter the RSG Contract.²³¹⁹

2462. Further, with respect to the Issue D.1(b)(i) i.e., if Claimants have established each of the elements of fraud under Section 1572 of the California Civil Code, have Claimants proven that, at the time Mitsubishi made any alleged misstatements, Mitsubishi did not intend to honor its contractual promises? In their Responses to the List of Issues, the Claimants contend that they “need not prove that “Mitsubishi did not intend to honor its contractual promises,” as it is not a required act of fraud under California law.”²³²⁰
2463. In response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend that the “Respondents repeatedly and incorrectly rely upon language from a single case for the proposition that fraudulent inducement requires Claimants to demonstrate that Respondents “did not intend to honor [their] contractual promises when they were made.” Respondents are wrong and misrepresent California law on this issue.”²³²¹
2464. With respect to the Issue D.1(b)(ii), i.e., that as a matter of California law, are Claimants required to prove that Respondents did not intend to honor their promises, the Claimants, in their Responses to List of Issues, contend that “[u]nder Cal. Civ. Code § 1572, a claim for fraud may be based on a number of acts, one of which is a “promise made without any intention of performing it.” However, fraudulent

²³¹⁹ Claimants’ RPHM, ¶¶ 430-432.

²³²⁰ Claimants’ Responses to Joint List of Issues, ¶ B.15(b)(i).

²³²¹ Claimants’ RPHM, ¶ 433.

inducement based upon false promises, or promissory fraud, is not the only form of fraud under § 1572. Actions for fraud or deceit may also be based on “the positive assertion, in a manner not warranted by the information of the person making it, of that which is not true, though he believes it to be true.” Fraud may also consist of the “suppression of that which is true, by one having knowledge or belief of the fact.”²³²²

(ii) *The Respondents’ Position*

2465. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants assert that Mitsubishi fraudulently induced the RSG Contract under California Civil Code Section 1572(2), which provides that “[t]he positive assertion, in a manner not warranted by the information of the person making it, of that which is not true, though he believes it to be true” constitutes fraudulent inducement. Claimants also argue that Section 1572(2) makes no inquiry into a party’s intent (or lack thereof) to keep its promises and recognizes that fraudulent inducement can arise from both intentional and negligent misrepresentations, even where a party believes its own misrepresentations.

This interpretation is untenable. Fraud is an intentional tort, which means Claimants must show Mitsubishi’s intent to deceive. Furthermore, although not expressly stated as an element of Cal. Civ. Code § 1572, under California law, fraudulent inducement is a specific, intentional tort where “one must show that the defendant did not intend to honor its contractual promises when they were made.”

Claimants have failed to establish each of the elements of fraud under Cal. Civ. Code § 1572(2). As shown above, Claimants have not proven that any of Mitsubishi’s proposal statements were not true. Nor have Claimants put forth any evidence to show that Mitsubishi’s proposal statements were made “in a manner not warranted” by Mitsubishi. Accordingly, Claimants have failed to establish the requisite elements of Cal. Civ. Code § 1572.²³²³

²³²² Claimants’ Responses to Joint List of Issues, ¶ B.15(b)(ii).

²³²³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 354-356.

2466. In addition, with respect to the alternate Issue numbered (i), i.e., “if so, have Claimants proven that, at the time Mitsubishi made any alleged misstatements, Mitsubishi did not intend to honor its contractual promises?,” the Respondents contend that the “Claimants have not even alleged – much less provided any evidence – that Mitsubishi did not intend to honor its promises when it entered into the RSG Contract. Accordingly, Claimants’ claim that the Contract was procured by fraud must be rejected.”

2467. Further, with respect to the alternate Issue numbered (ii), i.e., “as a matter of California law, are Claimants required to prove that Respondents did not intend to honor their promises?,” the Respondents, relying on a case,²³²⁴ submit that “[a]lthough not expressly stated in Cal. Civ. Code § 1572, under California law fraudulent inducement is a specific, intentional tort where “one must show that the defendant did not intend to honor its contractual promises when they were made.”²³²⁵

(iii) The Tribunal’s Determination

2468. Section 1572 of the California Civil Code sets out the test for fraud. While the Parties are somewhat disagreed as to the judicial interpretation of this provision and the consequences thereof, the Tribunal does not find that the Claimants have proven a case of fraud under any legal definition.

2469. Section 1572 of the California Civil Code provides that fraud:

consists in any of the following acts, committed by a party to the contract, or with his connivance, with intent to deceive another party thereto, or to induce him to enter into the contract: (1) The suggestion, as a fact, of that which is not true, by one who does not believe it to be true; (2) The positive assertion, in a manner not warranted by the information of the person making it, of that which is not true, though he believes it to be true; (3) The suppression of that which is true, by one having knowledge

²³²⁴ Exh. RL-121 (*Food Safety Net Servs. v. Eco Safe Sys. USA, Inc.*, 209 Cal. App. 4th at 1131).

²³²⁵ Respondents’ Position Statement on the Revised List of Issues, ¶ 358

or belief of the fact; (4) A promise made without any intention of performing it; or, (5) Any other act fitted to deceive.

2470. The Tribunal has not received any convincing evidence that the Respondents intended to defraud the Claimants within the meaning of Section 1572 of the California Civil Code.
2471. The Claimants suggest that an “intention to induce” action is sufficient under California law.²³²⁶ The Respondents submit that “fraudulent inducement is a specific, intentional tort where one must show that the defendant did not intend to honor its contractual promises when they were made.”²³²⁷ On its face, the Parties appear to have submitted that California law has conflicting standards as to the required intention for fraud. The Tribunal does not consider it necessary to resolve the applicable legal test given its factual determinations on these Issues D.1(b), D.1(b)(i) and D.1(b)(ii). The evidence, as further discussed, does not support a finding of fraud under either definition.
2472. The Tribunal recalls that the RSG Contract contains an entire agreement clause which would render inconsequential any pre-contractual statements.²³²⁸ The Claimants have, however, submitted that an entire agreement clause does not preclude reference to statements that constitute fraud. Accordingly, the Tribunal considers the significance of the Respondents pre-contractual statements.
2473. The Tribunal does not find, based on the evidence presented, that the Respondents made statements in their contract or pre-contractual negotiations which were false. The mere fact that following the provision of services, a contractual breach is alleged on account of a defect in a good or service does not imply that the contract was

²³²⁶ Exh. CL-090 (*Ford v. Cournale*, 36 Cal App. 3d 172, 183 (1973)).

²³²⁷ Exh. RL-121 (*Food Safety Net Servs. v. Eco Safe Sys. USA, Inc.*, 209 Cal. App. 4th at 1131).

²³²⁸ RSG Contract, Section 1.37.

procured by fraud. To hold otherwise would elevate every contractual breach into a cause of action for fraud.

2474. Neither does the Tribunal find that the Respondents made assertions not warranted by the evidence presented in this Arbitration. The Respondents held themselves out on their successful prior record of steam generator design and the qualities of the design as proposed. That record was not proven to be false. The fact that errors in design or manufacturing occurred does not necessarily translate those errors into a cause of action for fraud.
2475. The Tribunal does not find there to be any convincing evidence on the record to show that the Respondents suppressed information from the Claimants. To the extent that not all design discussions were provided to the Claimants during the design era, such omission is irrelevant to whether there was fraud in the inducement of the RSG Contract.
2476. The Claimants have not established that the Respondents entered into the RSG Contract absent an intention to meet their contractual obligations to design and manufacture RSGs in accordance with the terms of the agreement.
2477. In light of the above findings and based on the entirety of evidence presented, the Tribunal declines to find that there was convincing evidence of any general “act fitted to deceive” required under Section 1572 of the California Civil Code.
2478. Accordingly, the Tribunal answers Issues D.1(b), D.1(b)(i), and D.1(b)(ii) in the negative. There is no basis for the Claimants’ claim of fraud under Section 1572 of the California Civil Code.

B. DO CLAIMANTS HAVE A SEPARATE CLAIM FOR NEGLIGENT MISREPRESENTATION? (ISSUE D.2)

2479. In this Issue D.2, the Claimants rely on the same evidence as presented for their claims of fraudulent inducement in Issue D.1 above, to submit that the Respondents' statements and representations amount to a negligent misrepresentation.

(a) Introduction

(i) The Claimants' Position

2480. In their Responses to Joint List of Issues, the Claimants submit that the "evidence supporting [their] claim for fraud also support a separate claim for negligent misrepresentation."²³²⁹

(ii) The Respondents' Position

2481. The Respondents make no submissions concerning this Issue, D.2, and make all their submissions in the sub-Issues, below.

(iii) The Tribunal's Determination

2482. The Tribunal considers that while the Claimants have advanced a separate claim for negligent misrepresentation, it is based on the same evidence supporting their claim for fraud.

2483. Whether or not this evidence satisfied the elements of a claim of negligent representation is determined by the Tribunal in Issue D.2(a) below.

²³²⁹ Claimants' Responses to Joint List of Issues, ¶ B.16.

- (b) If Claimants have a separate claim for negligent misrepresentation, have they established the elements of that claim? (Issue D.2(a))**
- (i) Have Claimants proven that Mitsubishi made false statements without a reasonable basis for believing such statements to be true at the time they were made?**
- (ii) Have Claimants proven that they justifiably relied on Mitsubishi's misrepresentations in entering into the RSG Contract?**

2484. In these Issues D.2(a), D.2(a)(i), and D.2(a)(ii), the Tribunal considers whether, if the Claimants have a separate claim for negligent misrepresentation, they have established the elements of that claim.

(i) The Claimants' Position

2485. In their Responses to Joint List of Issues, the Claimants submit that they “have established that Respondents made “(1) the misrepresentation of a past or existing material fact, (2) without reasonable ground for believing it to be true, (3) with intent to induce another’s reliance on the fact misrepresented, (4) justifiable reliance on the misrepresentation, and (5) resulting damage.” In cases involving expert professionals – or those who hold themselves out as such – “expressions of professional opinion are treated as representations of fact” and “deliberate affirmations of fact based on special knowledge or expertise.” This is especially so in the case of “engineers, [who] by virtue of their training and expertise, may have special relationships of confidence and trust with their clients,” and through those relationships, a duty “to speak with care.””²³³⁰

2486. In addition, the Claimants, in their C-RPHM, contend the following:

²³³⁰ Claimants’ Responses to Joint List of Issues, ¶ B.16(a).

As the *CalPERS* court noted:

[W]hen a party possesses or holds itself out as possessing superior knowledge or special information or expertise regarding the subject matter and a plaintiff is so situated that it may reasonably rely on such supposed knowledge, information, or expertise, the defendant's representation may be treated as one of material fact.

Under California law, parties who hold themselves out as experts and render professional opinions are expressing "affirmations of fact" (...)

In holding themselves out as experts on steam generator design and manufacture, the representations that Respondents made to Edison during the bid process became "actionable expressions of professional opinion rather than nonactionable predictions regarding future events." Respondents' unequivocal assertions, for example, regarding the accuracy and verification of their proprietary thermal-hydraulic code FIT-III are actionable as "deliberate affirmations" of an "existing" material fact, and not mere "casual statements of belief."

Moreover, the procurement of a contract through an untrue or unwarranted assertion constitutes "[a]ctual fraud," regardless of whether the party making the false statements believes them to be true. As long as the statement is made "in a manner not warranted by the information of the person making it," and reasonably relied upon by the party to which it is directed, any untrue statement (including one negligently made) is actionable as fraud.²³³¹

2487. Further, with respect to Issue D.2(a)(i), i.e., "have Claimants proven that Mitsubishi made false statements without a reasonable basis for believing such statements to be true at the time they were made?," the Claimants, in their Response to the Joint List of Issues, contend the following:

Although Mitsubishi told Edison that FIT-III and FIVATS were "extremely accurate" and that the data "is sufficient to eliminate any vibration mechanism concerns" and could provide "conclusive results" to "preclude FIV" and "minimize[] negative thermal-hydraulic effects," its own internal documents revealed Mitsubishi's "doubts about the accuracy of FIT-III." Moreover, while Mitsubishi confirmed to Edison that its "design provides a high margin against

²³³¹ Claimants' RPHM, ¶¶ 436-439.

flow-induced vibration,” Mitsubishi instead modified FIT-III to make it less conservative after internally questioning whether FIT-III was “too focused on safety.”

Mitsubishi’s own consultants expressed doubts and warned Mitsubishi about the inaccuracies present in FIT-III, even describing the modeling code as “very far away from the data.” Mitsubishi’s consultants cautioned Mitsubishi about the need to include substantial margin when evaluating the FIT-III results. Both Messrs. Wilson and Langford testified that the warnings they raised related to the 2.3x Gap Velocity Error and they told Mitsubishi that void fractions would approach 100%. In spite of this, Mitsubishi chose to ignore those warnings and took the exact opposite approach – repeatedly making non-conservative decisions, using unsupportable assumptions, and failing to design the RSGs with sufficient margin, while telling Edison the opposite.

Furthermore, Mitsubishi failed from the beginning to reveal to Edison a very significant qualification on its claim that FIT-III was accurate – namely, that FIT-III was only proven valid for void fractions up to █████. According to the Challenge Board, FIT-III had only been validated up to a void fractions of █████ though Mitsubishi predicted ...[or sic] void fractions at SONGS of █████ which was itself an erroneous under-prediction. Moreover, while Mitsubishi has claimed that FIT-III was validated up to █████ Mitsubishi’s expert █████ candidly admitted that validation for “[e]verything above █████ is extrapolation.”

Mitsubishi’s self-doubts were never conveyed to Edison – on the contrary, Mitsubishi’s bid for the RSG Contract made numerous and unequivocal representations regarding its abilities to control destructive vibrational phenomena and accurately measure the RSGs’ thermal-hydraulic conditions. As Mr. Wharton testified at the Hearing, Mitsubishi’s bid represented that its stability ratios and circulation ratios would be acceptable and would not need to be altered.

Mitsubishi’s representations about its ability to design effective supports were also false. In 2004, Mitsubishi touted its “extensive capabilities” in modeling thermal-hydraulics and designing tube supports, which were sufficient to “preclude FIV” and ensure that “detrimental FIV amplitudes will not occur.” Yet Mitsubishi’s own internal emails expressed doubts over its ability to design such a large RSG, explaining: “[w]e have our own analysis tools but we have no experience large S[team] G[enerator] design.” █████ later told Mr. Langford that he could not “figure out how to evaluate large scale bundle interaction effects.” Moreover, numerous witnesses at the Hearing admitted that Mitsubishi lacked experience in designing and manufacturing steam generators similar in size and proportion to the SONGS RSGs. As just one

example, ██████ admitted that when he joined the SONGS RSG team, he was not an expert in structural strength, materials, or maintenance, and had not been responsible for the design of an AVB assembly structure for any Mitsubishi steam generator prior to being placed in charge of design for the AVB assembly structure for SONGS in 2005. ██████ also admitted that prior to assuming responsibility for the SONGS AVB design, and despite being in charge of the stability ratio analysis, he had never personally run FIT-III, IVHET, or FIVATS, and did not have experience in analyzing stability ratios.

Mitsubishi itself recognized the danger of relying on its past design experience with smaller RSGs to self-validate its design codes and the SONGS RSG design. After the RSGs failed, Mitsubishi admitted that it lacked sufficient processes to properly evaluate the cumulative impact of its design decisions when building a larger RSG for which it had no experience.

In addition to expressly promising that it would “preclude” damaging FIV and “provide sufficient margin against fluid elastic vibration,” Mitsubishi declared that its “tube support plate design for SONGS ha[d] enough strength both for in-plane and out-of-plane forces.” Yet at the Hearing, Mitsubishi admitted that it never evaluated for in-plane FEI, and more shockingly, as ██████ affirmed, “FIVATS operators artificially restrained the modeled tube’s vibration response in the in-plane direction such that the code would output only out-of-plane natural frequencies.”

Mitsubishi had no reasonable basis for the bold statements it made in its bid for the RSG Contract, much less for believing them to be true. Mitsubishi’s statements were not “warranted by the information” it had at the time the statements were made and Mitsubishi had access to the underlying information that formed the basis of its misrepresentations, such as the source codes and validation studies for its proprietary design software.²³³²

2488. In addition, the Claimants, in their C-RPHM, supplement the above submissions by contending the following:

Indeed, Respondents’ Hearing testimony regarding the “margin of error” and “uncertainties” contained in FIT-III—for example, that maximum void fractions at SONGS could be anywhere from ██████ to 100% ██████ and that maximum velocities could have been ██████ times higher than predicted—

²³³² Claimants’ Responses to Joint List of Issues, ¶ B.16(a)(i).

cannot be reconciled with the unambiguous statements made by Respondents during the bid and design phases regarding the “extreme accuracy” of their design codes. At a minimum, this evidence establishes that Respondents lacked the ability accurately to predict the thermal-hydraulic conditions within the RSGs and, therefore, had no basis for making statements regarding their ability successfully to prevent extreme thermal-hydraulic conditions and tube wear.

(...)

Respondents continued to mislead Edison by making similar false representations after Rev. 1 of the RSG Contract was signed. During the RSG design phase, Respondents reaffirmed earlier misrepresentations about their technical capabilities, including their ability accurately to predict thermal-hydraulic conditions and to design effective supports for steam generators of comparable size. In addition, Respondents negligently or intentionally misrepresented their analysis of the RSG design and the design’s ability to preclude excessive and dangerous vibration and tube wear. Edison justifiably relied upon Respondents’ subsequent misrepresentations in continuing to work with Respondents and executing subsequent versions of the RSG Contract.

While Respondents now claim they always knew that void fractions could range from ■■■ to 100%, given the margin of uncertainty in FIT-III’s predictive accuracy, Respondents admitted at the Hearing that before shipping the RSGs to California, they did not tell Edison that the maximum void fraction would be or even could be 99.6%. Respondents also admitted in 2012 that they had used FIT-III beyond its validated range and had grossly underestimated the thermal-hydraulic conditions in the RSGs, as the maximum flow velocities at SONGS were more than ■ times higher than Respondents predicted.

Throughout the design process, Edison repeatedly asked Respondents if the tube supports, including the AVBs and TSPs, would be sufficient to prevent FEI, excessive random vibration, and detrimental tube wear. Respondents repeatedly and consistently told Edison that they knew FIV was a serious problem in the industry and that Respondents had the experience and expertise to design adequate tube supports. Respondents continually promised Edison that they knew how to avoid FEI and to provide sufficient margin to account for uncertainty and risk. Respondents unequivocally stated that their RSG design had no potential to experience FEI. As admitted by Respondents in 2012, each of these representations made during the design phase was false—and as the Tribunal is now aware, Respondents had no basis to make any of them.

As discussed above in detail, Claimants have presented substantial evidence demonstrating that Respondents' statements were false and unwarranted—contrary to Respondents' unsupported assertion that “Claimants' purported evidence . . . consists of five documents and a single witness.”²³³³

2489. Further, with respect to Issue D.2(a)(ii), i.e., “have Claimants proven that they justifiably relied on Mitsubishi's misrepresentations in entering into the RSG Contract,” the Claimants, in their Responses to Joint List of Issues, submit the following:

Through Mitsubishi's misrepresentations, Claimants were convinced that Mitsubishi had developed the necessary tools and expertise to model the critical thermal-hydraulic conditions in the RSGs in a way that would prevent dangerous tube vibration and wear. Claimants also relied on Mitsubishi's representations that it had sufficient expert knowledge and engineering skill to design effective tube support structures, including structures with “enough strength both for in-plane and out-of-plane forces.”

Mr. Wharton testified that Edison became comfortable with Mitsubishi's ability to design the RSGs based on its proposal, which contained considerable detail and information that indicated that Mitsubishi “understood what the issues were that the industry was facing” and “indicated that they knew how to address” those issues. At no point did Mitsubishi express to Edison any concerns that it would not be able to design the RSGs. Nor did Mitsubishi ever suggest to Edison that complying with the specification or RSG Contract would create safety concerns, compromise the operation of the RSGs, or otherwise lead to extensive tube damage or a tube leak.

With respect to the inherent risks in creating new and larger steam generators, Mitsubishi “spoke with authority” at the initial proposal stage as to how it would address issues such as wear and corrosion and “spoke to the models that they had developed, the testing that they had done to validate the information they had.” These unequivocal representations made by Mitsubishi during the bid process “were very important to [SCE's] consideration of Mitsubishi as a

²³³³ Claimants' RPHM, ¶¶ 443, 448-451.

potential RSG supplier, and [SCE] relied upon them in ultimately selecting Mitsubishi to design and build the SONGS RSGs.”²³³⁴

2490. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents participated in a competitive bidding process for the RSG Contract and were selected over qualified bidders on the basis of several key representations about its capabilities as a designer. Relying on Respondents’ misrepresentations, Edison was convinced that Respondents had developed the necessary tools and expertise to model the critical RSG thermal-hydraulic conditions in a way that would prevent dangerous tube vibration and wear. Edison also relied on Respondents’ representations that they had sufficient expert knowledge and engineering skill to design effective tube support structures, including structures with “enough strength both for in-plane and out-of-plane forces.”

(...)

Respondents’ arguments that Edison did not rely on Respondents’ statements because Claimants “conducted their own independent analysis” and understood “the various difficulties and risks . . . at the time it entered into the RSG Contract” are unsupported and irrelevant. Neither argument contradicts the evidence presented that Edison relied upon Respondents’ misrepresentations in awarding Respondents the RSG Contract (including its “repair or replace . . . with dispatch” remedy). Respondents’ argument that Claimants somehow understood all the “various difficulties and risks inherent in the RSG project . . . at the time it entered into the RSG Contract with Mitsubishi” is particularly illogical and belied by the evidence establishing that neither side contemplated the total failure of all four RSGs after one cycle or less.

Moreover, Respondents’ criticism that Mr. Wharton could not identify the specific statements in Respondents’ proposal that Edison relied upon is irrelevant to the legal standard for reliance. Reliance is assumed where the misrepresentations or omissions are material, that is, where a reasonable person “would attach importance to its existence or nonexistence in determining his choice of action in the transaction.” There can be no question that

²³³⁴ Claimants’ Responses to Joint List of Issues, ¶ B.16(a)(ii).

representations and omissions regarding Respondents' tools and capabilities were material to Edison's decision to award Respondents the RSG Contract.²³³⁵

(ii) *The Respondents' Position*

2491. In their Position Statement on the Revised List of Issues, the Respondents contend that “[a]lthough Claimants have alleged a separate claim for negligent misrepresentation, Claimants have failed to establish the elements of that claim. To show negligent misrepresentation, Claimants must show (1) the misrepresentation of a past or existing material fact, (2) without reasonable ground for believing it to be true, (3) with intent to induce another’s reliance on the fact misrepresented, (4) ignorance of the truth and justifiable reliance on the misrepresentation, and (5) resulting damage.”²³³⁶
2492. Further, with respect to Issue D.2(a)(i), i.e., “have Claimants proven that Mitsubishi made false statements without a reasonable basis for believing such statements to be true at the time they were made,” the Respondents contend that the “Claimants have not proven that Mitsubishi made any false statements, as shown above and detailed in Mitsubishi’s Rejoinder Memorial.”²³³⁷
2493. In addition, with respect to Issue D.2(a)(ii), i.e., “have Claimants proven that they justifiably relied on Mitsubishi’s misrepresentations in entering into the RSG Contract,” the Respondents contend the following:

Claimants have not proven that they justifiably relied on Mitsubishi’s statements in entering into the RSG Contract. Edison’s only evidence of reliance was one sentence from Mr. Wharton’s witness statement stating that Edison relied on Mitsubishi’s pre-contractual statements in selecting Mitsubishi. The testimony in Mr. Wharton’s witness statement was not credible

²³³⁵ Claimants’ RPHM, ¶¶ 452, 455-456.

²³³⁶ Respondents’ Position Statement on the Revised List of Issues, ¶ 359.

²³³⁷ Respondents’ Position Statement on the Revised List of Issues, ¶ 360.

as he admitted at the hearing that he had no personal knowledge of which statements in Mitsubishi's proposal Edison relied upon in choosing Mitsubishi.

In contrast, Mitsubishi put forth evidence showing that Claimants did not rely on Mitsubishi's statements – but rather conducted their own independent analysis. Also, the comprehensive results of Claimants' five-month evaluation of bidders makes no mention of the accuracy of modelling codes that Claimants now allege was the basis of their decision to select Mitsubishi.

Respondents introduced a letter written by Dwight Nunn on November 30, 2004, which Mr. Wharton helped draft. Mr. Nunn's letter details the various difficulties and risks inherent in the RSG project and Mr. Wharton testified that those difficulties and risks were known to Edison at the time it entered into the RSG Contract with Mitsubishi.²³³⁸

(iii) Tribunal's Determination

2494. The Parties are in agreement²³³⁹ concerning the elements to be satisfied in order to establish a claim for negligent misrepresentation; that is, (i) the misrepresentation of a past or existing material fact; (ii) without reasonable ground for believing it to be true; (iii) with intent to induce another's reliance on the fact misrepresented; (iv) justifiable reliance on the misrepresentation; and (v) resulting in damage. Further, the Claimants have relied on the same evidence for making its claim in Issue D.2(a) that they presented in support of their claim for fraudulent inducement in relation to Issue D.1, above. The Parties are also in agreement that the elements to satisfy the requirements of a claim for negligent misrepresentation have to be fulfilled cumulatively.²³⁴⁰
2495. Of these five elements, the Tribunal has already considered the first one in Issue D.1(a), above, having determined that the Respondents' statements and statements did not amount to a misrepresentation of any fact, be it in the past or in existence

²³³⁸ Respondents' Position Statement on the Revised List of Issues, ¶¶ 361-363.

²³³⁹ See Section XVI.B(b)(i) and XVI.B(b)(ii) above.

²³⁴⁰ See Section XVI.B(b)(i) and XVI.B(b)(ii) above.

during the time in question.²³⁴¹ Given that the Tribunal has determined that one of the required elements for negligent misrepresentation is not satisfied, this renders any determination of the other four conditions immaterial. Even so, the fact that the FEI that did occur at SONGS was then unprecedented in the nuclear power industry shows that the Respondents had reasonable grounds for believing that their representations to the Claimants regarding the expected performance of the RSGs were true. Therefore, on account of the reasons laid down in relation to Issue D.1(a), above,²³⁴² the Tribunal considers that the Claimants have not persuasively established a negligent misrepresentation of a past or existing fact.

2496. Accordingly, the Tribunal answers the Issues D.2(a) in the negative. The Claimants have not established the elements of a claim for negligent misrepresentation.

2497. In light of this determination, the Tribunal considers that Issues D.2(a)(i) and D.2(a)(ii), which pertain to the second and the fourth conditions of a claim for negligent misrepresentation, to have been rendered moot.

**C. DO CLAIMANTS HAVE A SEPARATE CLAIM FOR INTENTIONAL FRAUD?
(ISSUE D.3)**

- (a) Have Claimants established each of the elements of intentional fraud? (Issue D.3(a))**
 - (i) Have Claimants proven that Mitsubishi's statements were false and that Mitsubishi knew they were false at the time they were made?**
 - (ii) Have Claimants proven that Mitsubishi intended to deceive Claimants with its statements?**

²³⁴¹ See ¶ 2458 above.

²³⁴² See generally XVI.A(a)(iii) above.

(iii) Have Claimants proven that Claimants justifiably relied on Mitsubishi's statements in entering into the RSG Contract?

(i) The Claimants' Position

2498. In these Issues D.3 and D.3(a), the Claimants refer to their arguments made with respect to Section 1572 of the California Civil Code in Issue D.1(b)²³⁴³ above, to support their separate claim for intentional fraud.
2499. With respect to Issues D.3(a)(i), (ii) and (iii), the Claimants rely on their submissions concerning Issues D.2(a)(i) and (ii) above, to argue that there is sufficient evidence showing that the Respondents' statements are false, were intended to deceive the Claimants, and justifiably relied upon by the Claimants.²³⁴⁴

(ii) The Respondents' Position

2500. With respect to Issue D.3(a), the Respondents, in their Position Statement on the Revised List of Issues, submit that the "Claimants have not established the requisite elements for an intentional misrepresentation claim. Intentional misrepresentation (fraud) carries a higher burden than negligent misrepresentation."²³⁴⁵
2501. With respect to Issues D.3(a)(i), the Respondents rely on their above submissions concerning Issues D.1 and D.2 to submit that the "Claimants have not proven the falsity of any specific statement, let alone whether Mitsubishi had knowledge of any alleged false statement."²³⁴⁶

²³⁴³ Claimants' RPHM, ¶ 457.

²³⁴⁴ Claimants' RPHM, ¶¶ 461-463.

²³⁴⁵ Respondents' Position Statement on the Revised List of Issues, ¶ 364.

²³⁴⁶ Respondents' Position Statement on the Revised List of Issues, ¶ 365.

2502. With respect to Issue D.3(a)(ii), the Respondents submit that the “Claimants have not proven that Mitsubishi intended to deceive Claimants with its statements. In fact, Claimants have not introduced any evidence of Mitsubishi’s intent. Instead, Claimants rely on their untenable position that negligent misrepresentations and intentional representations are interchangeable and that they do not need to prove intent in order to prove fraud. Since Claimants have not proven that Mitsubishi intended to deceive Claimants, their claim for intentional fraud fails.”²³⁴⁷
2503. With respect to Issue D.3(a)(iii), the Respondents rely on their submissions concerning Issue D.2(a)(ii), to submit that the “Claimants have not proven that they justifiably relied on Mitsubishi’s statements in entering into the RSG Contract.”²³⁴⁸

(iii) The Tribunal’s Determination

2504. Having already determined that the Claimants have not made out a case on fraud, the Tribunal considers that the Claimants cannot be considered to have made out a case on intentional fraud. It is apparent that the Claimants reiterate the same arguments in Issues D.3 and D.3(a) that were already considered and rejected by the Tribunal in Issues D.1(b) above.²³⁴⁹ Consequently, the Tribunal answers Issue D.3 and D.3(a) in the negative. The Claimants have not made out a separate claim for intentional fraud under Issues D.3(a)(i), (ii) and (iii), nor have they satisfied its elements.
2505. Similarly, having answered Issue D.2(a) above in the negative,²³⁵⁰ and having determined Issues D.2(a)(i) and (ii) above to have been rendered moot, the Tribunal considers that Issues D.3(a)(i), (ii) and (iii) do not require the Tribunal’s consideration. When the Claimants’ claims for fraud and negligent misrepresentation

²³⁴⁷ Respondents’ Position Statement on the Revised List of Issues, ¶ 366.

²³⁴⁸ Respondents’ Position Statement on the Revised List of Issues, ¶ 367.

²³⁴⁹ Section XVI.A(b)(iii) above.

²³⁵⁰ See ¶¶ 2496-2497 above.

have been rejected by the Tribunal, the same evidence and submissions cannot satisfy the elements of a claim of intentional fraud. Therefore, Issues D.3(a)(i), (ii) and (iii) have also not been established by the Claimants.

D. ARE CLAIMANTS' TORT CLAIMS BARRED BY THE ECONOMIC LOSS RULE UNDER CALIFORNIA LAW? (ISSUE D.4)

2506. The Tribunal considers whether the Claimants torts are barred by the economic loss rule under California law.

(i) The Claimants' Position

2507. In their Responses to Joint List of Issues, the Claimants submit that “California law allows parties to seek redress in tort for conduct “separate from the breach [of contract] itself,” such as fraudulent inducement: “a tort independent of the breach” and antecedent to the parties’ contractual obligations. This is especially true where, as here, Mitsubishi’s misrepresentations caused Claimants to purchase a product that, because of its significant failures, “exposed [Claimants] ... to disciplinary action by” the NRC – the governmental regulator that is charged with assuring the “safe performance” and “safe operation” of nuclear steam generators, as well as to liability for personal damages independent of the plaintiff’s economic loss.”²³⁵¹

2508. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents assert that the economic loss rule “prohibits parties from recovering under a tort theory for breaches of duties that arose in a contract.” This argument misses the point: as detailed above, the intentional and negligent misrepresentations Respondents made in order to procure the RSG Contract are actionable independent of Respondents’ breaches of contract. In *Robinson Helicopter Co. v. Dana Corp.*, the California Supreme Court recognized this

²³⁵¹ Claimants’ Responses to Joint List of Issues, ¶ D.18.

point expressly: affirmative misrepresentations constitute “a tort independent of the breach,” which is not barred by the economic loss rule.

In *Robinson Helicopter*, the contract was breached by the supply of nonconforming parts, whereas the “tort independent of the breach” was in the defendant’s delivery of false certificates claiming that the parts conformed. Because the plaintiff had relied on the false certificates, and because the plaintiff’s lack of knowledge of the nonconformity had led to economic loss and exposed it to liability in the event that any of the affected helicopters failed and caused physical injury, the California Supreme Court found that the fraud was independent of the contractual breach.

Respondents’ interpretation improperly cabins *Robinson Helicopter* into a “very narrow” case that only allows recovery of “personal damages independent of the plaintiff’s economic loss.” Respondents’ argument is indistinguishable from the opinion written by the dissenting Justice in *Robinson Helicopter*, which the court rejected. California law provides a complete remedy for misrepresentations “which expose a plaintiff to liability for personal damages,” even if such damages do not actually materialize. Thus, the *Robinson Helicopter* court awarded the plaintiff its economic losses because the defective product in that case could have caused “personal damages if a helicopter crashed.”

The serious safety concerns and risks of “disciplinary action” by the regulator are even more compelling here than in *Robinson Helicopter*. As the California Supreme Court has explained, it is impossible for parties to account for such risks in the bargaining process when a contract is procured through false representations. Under such circumstances, there is no basis to limit damages by excluding economic losses.

Realizing that the authorities they cited in their Counter-Memorial were inapposite, Respondents now attempt to argue that the circumstances in *Food Safety Net* are analogous to those presented here and support Respondents’ argument that the controlling law of *Robinson Helicopter* should not be applied.

First, *Food Safety Net* is an appellate court decision that does not overrule the California Supreme Court’s decision in *Robinson Helicopter*, nor does it purport even to distinguish *Robinson Helicopter*. Rather, the court in *Food Safety Net* followed the holding in *Robinson Helicopter*, but concluded that there was no evidence of fraudulent inducement of the contract, unlike the case here.

Second, *Food Safety Net* is simply irrelevant to the issue presented—that case did not involve the serious safety concerns, risks of disciplinary action by the regulator, or exposure to enormous liability from a defective product that were present in *Robinson Helicopter*—and here. In fact, the food disinfection equipment at issue in *Food Safety Net* was not even used in any of the subject restaurants, and the court found “the record . . . devoid of evidence that Carl’s Jr. intended to buy or lease Eco Safe’s equipment upon completion of a defect-free study.” *Food Safety Net* is simply inapplicable. The economic loss rule does not bar Claimants’ tort claims.²³⁵²

(ii) *The Respondents’ Position*

2509. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants’ tort claims are all derivative of Claimants’ breach of contract claims. and California law is clear that a party may not sue in tort for alleged breaches of contract provisions. California “courts will generally enforce the breach of a contractual promise through contract law” when the tort allegations are of “conduct amounting to a breach of contract.”

The economic loss rule respects the allocations of risk chosen by the contracting parties and ensures that conduct related to the contract is governed by the contract.

Claimants argue for an exception to the economic loss rule as established in *Robinson Helicopter*. But Claimants ignore that the exception carved out in *Robinson Helicopter* was in very narrow circumstances, which do not apply here. Specifically, the *Robinson Helicopter* exception to the economic loss rule applies when “the duty that gives rise to tort liability is either **completely independent of the contract or arises from conduct which is both intentional and intended to harm.**”

Claimants tort claims are not independent of the contract, nor have claimants shown any of the alleged torts was based on conduct which is both intentional and intended to harm. The *Robinson Helicopter* court emphasized that its holding was “narrow in scope and limited to a defendant’s **affirmative misrepresentations.**”

²³⁵² Claimants’ RPHM, ¶¶ 465-471.

The facts here are more analogous to those in *Food Safety Net*. There, the court refused to apply the exception in *Robinson Helicopter* and instead concluded that allegations with respect to pre-contractual statements “suggest[] no misrepresentation ‘beyond a broken contractual promise to perform.’” In that case, a testing company induced the contract by making pre-contract representations that it had sufficient expertise to perform certain tests, and then failed to properly perform those tests. Because the evidence focused on the agency’s mistakes in performing the tests and there was no evidence the agency entered the contract with the intent to not perform, the court held the fraudulent inducement claims were not “conceptually distinct from the contract” and thus barred by the economic loss rule.

In this case, Claimants made the same argument the court rejected in *Food Safety Net*. Claimants point to the tube wear in the RSGs as evidence that Mitsubishi’s pre-contract statements were misrepresentations because they were “unwarranted.” But like in *Food Safety Net*, Claimants have not shown any intentional conduct by Mitsubishi. Thus, Claimants’ tort claims, which are based on allegations of misrepresentation by Mitsubishi, are barred by the economic loss rule.²³⁵³

(iii) *Tribunal’s Determination*

2510. The Claimants’ tort claims are a recasting of their breach of contract claims under Issue B.
2511. The RSG Contract expressly allows for a lifting of the contractually agreed limitation of liability provision in situations of the Respondents’ “gross negligence, fraud, willful misconduct or illegal or unlawful acts.”²³⁵⁴
2512. The RSG Contract, as such, expressly allows for a claim on these tort-like specific issues.
2513. In effect, the RSG Contract expressly carves out from the economic loss rule the same protections as the California Supreme Court found in *Robinson Helicopter Co.*

²³⁵³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 368-373.

²³⁵⁴ RSG Contract, Section 1.21.2.

*v. Dana Corp.*²³⁵⁵ In *Robinson*, the Court found that there was an exception to the economic loss rule, which otherwise bars fraud claims in tort for a breach of contract.

2514. To the extent that the Claimants otherwise attempt to recast contractual breaches pled in Issue B as distinct torts, outside of the exception found in *Robinson Helicopter Co. v. Dana Corp.*, the Tribunal finds those claims are barred by the economic loss rule.

2515. For further certainty, the Tribunal concludes that having found that the Claimants have not successfully demonstrated a number of their breach of contract claims under Issue B, the conclusion follows that the same facts at issue would not serve the Claimants successfully for a claim in tort.

2516. Accordingly, the Tribunal answers Issue D.4 in the affirmative. The Claimants' tort claims are barred by the economic loss rule under California law except as permitted by the RSG Contract, which essentially incorporates the rule in *Robinson*.

E. WHAT ARE THE CONSEQUENCES OF ANY FINDING REGARDING CLAIMANTS' ALLEGED MISREPRESENTATION, FRAUD AND TORT CLAIMS? (ISSUE D.5)

2517. Given that the Tribunal has rejected each of the Claimants' claims of alleged fraudulent inducement, misrepresentation (negligent or otherwise), intentional fraud and tortious liability in its determinations of Issues D.1, D.2, D.3 and D.4 above, with respect to this Issue D.5 it suffices to mention that each of these claims is without any basis, and thus there are no consequences to be considered.

²³⁵⁵ Exh. CL-132; Exh. RL-150 (34 Cal. 4th 979 (2004)).

F. IN CONNECTION WITH ISSUE E ABOVE, ARE THE FOLLOWING SUB-ISSUES RELEVANT, AS CONTENDED BY RESPONDENTS, BUT DENIED BY CLAIMANTS, AND IF SO, WHAT ARE THE ANSWERS AND THE CONSEQUENCES, IF ANY: (ISSUE D.6)

- (a) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, intentional fraud, or fraudulent inducement, was such conduct the cause of damages Claimants allege? (Issue D.6(a))**
- (b) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, have Claimants proven that negligent misrepresentation is equivalent to fraud for the purposes of setting aside the liability cap? (Issue D.6(b))**
- (c) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, have Claimants proven that negligent misrepresentation is equivalent to fraudulent inducement? (Issue D.6(c))**

2518. This Issue D.6, is contingent upon the Tribunal having determined that the Respondents' conduct constituted negligent misrepresentations, intentional fraud or fraudulent inducement. It is only in that eventuality that the Tribunal is required to address Issues D.6(a), (b) and (c).

2519. Given that the Tribunal has not found the Respondents' conduct to constitute negligent misrepresentations, intentional fraud or fraudulent inducement, the Issues D.6, D.6(a), D.6(b) and D.6(c) are rendered moot.

XVII. REMEDY (ISSUE E)

2520. In Issue E, the Tribunal considers the available remedies for the alleged breaches as alleged by the Claimants, as considered in Issues, B, C, and D.

A. IF IT IS DETERMINED THAT MITSUBISHI BREACHED THE RSG CONTRACT (SEE ISSUES B-C ABOVE), ARE CLAIMANTS' REMEDIES LIMITED BY SECTION 1.17 (GOVERNING CONTRACTUAL WARRANTIES), SECTION 1.21 (GOVERNING CONSEQUENTIAL DAMAGES AND LIMITATION OF LIABILITY), AND SECTION 1.29 (GOVERNING LIQUIDATED DAMAGES) OF THE RSG CONTRACT? (ISSUE E.1)

2521. In this Issue E.1, the Tribunal determines whether the Claimants' remedies are limited by the contractual stipulations in Sections 1.17, 1.21 and 1.29 of the RSG Contract, or should those limitations be expunged from the Contract, as contended by the Claimants.

(i) The Claimants' Position

2522. In their C-RPHM, the Claimants submit the following:

The parties agree that the RSG Contract limits the remedies for a breach of Warranty. The remedy for a breach of the Defect Warranty is provided in Section 1.17.1.3. The remedies for a breach of the Performance Warranty (Section 1.17.2) are provided in Section 1.29. If Respondents had satisfied their Warranty obligations—which they did not—any damages or amount spent in pursuit of those Warranty obligations would be limited by Section 1.21.

However, as detailed in Section C, Respondents failed to satisfy their Warranty obligations—namely the limited remedy in Section 1.17.1.3 guaranteeing Edison a repair with due diligence and dispatch. Those Warranty obligations were the *quid pro quo* for the damages limitations in the RSG Contract. In addition, the failure of the limited remedy was total and fundamental; Claimants were denied even a minimum adequate remedy. In such circumstances, the California Commercial Code, as further interpreted by consistent and clearly binding precedent, requires that the limited liability provisions of Section 1.21 be expunged from the contract.²³⁵⁶

²³⁵⁶ Claimants' RPHM, ¶¶ 480-481.

(ii) The Respondents' Position

2523. In their Position Statement on the Revised List of Issues, the Respondents contend that “the RSG Contract Sections cited provide Claimants all the remedies to which they are entitled under the RSG Contract or the law.”²³⁵⁷

(iii) Tribunal's Determination

2524. In Issue B.7, the Tribunal concluded that the Respondents breached their obligations under the RSG Contract with regard to the non-payment of SCE's costs incurred to repair SONGS.²³⁵⁸

2525. In Issue B.6(c), the Tribunal concluded that the Respondents breached their obligations under the RSG Contract to provide adequate tube support.²³⁵⁹ The Respondents' failure to do so resulted in a requirement that tubes be plugged. Tube plugging also triggers, under the RSG Contract, the payment of liquidated damages. The Respondents' failure triggered the Respondents' warranty obligations, as addressed under Issue C.

2526. In Issue B.6(e), the Tribunal concluded that the Respondents breached their obligation under the RSG Contract to provide RSGs that did not experience any primary-to-secondary leakage.²³⁶⁰ This failure does not constitute a Defect to the extent that the Respondents pay liquidated damages.

2527. In Issue F, the Tribunal has determined that the Claimants have not met their burden of demonstrating that the limitation of liability provision, i.e., Section 1.21 of the RSG Contract, should be set aside under the California Commercial Code.²³⁶¹

²³⁵⁷ Respondents' Position Statement on the Revised List of Issues, ¶ 379.

²³⁵⁸ Section XIII.G above.

²³⁵⁹ Section XIII.F(d) (¶ 1634) above.

²³⁶⁰ Section XIII.F(f) (¶ 1651) above.

²³⁶¹ See generally Section XVIII below.

Furthermore, the Claimants have not demonstrated under Issue D, that on account of alleged misrepresentations or fraud, the limitation of liability provisions are waived under the terms of the RSG Contract itself.²³⁶² Similarly, the Claimants have not demonstrated that the Respondents' alleged errors²³⁶³ amount to gross negligence.²³⁶⁴ The errors by the Respondents that the Tribunal did conclude were made, such as regarding SSPC and the Gap Velocity Error do not amount to gross negligence.

2528. In consequence, the Tribunal finds that the Claimants' remedies are limited to those provided under the warranty, Section 1.17 of the RSG Contract, and to liquidated damages as per Section 1.29 of the RSG Contract.
2529. As determined in Issue C, addressed in Sections XIV and XV above, the Tribunal concludes that the Respondents did act with due diligence and dispatch in attempting to repair (or replace) the RSGs. Those efforts were necessarily halted following the unexpected ASLB decision that led to the shutdown of SONGS.²³⁶⁵
2530. The Tribunal concludes that the Respondents failed to pay the Claimants' corresponding expenses for the repair under the RSG Contract, such that damages are due. In addition, damages are due to the Claimants in accordance with the agreed liquidated damages provisions of the RSG Contract.
2531. In light of the above, the Tribunal answers Issue E.1 in the affirmative. Accordingly, the Claimants' remedies are limited to those specified in Sections 1.17 and 1.29 of the RSG Contract and are subject to the limitations imposed under Section 1.21 of the RSG Contract regarding consequential damages and the limitation of liability.

²³⁶² See generally Section XVI above.

²³⁶³ For the alleged errors, see Sections XI and XII.

²³⁶⁴ See ¶¶ 2672-2673, 2686 below.

²³⁶⁵ See *inter alia* ¶¶ 2023-2026 above.

(a) **Are the provisions of Section 1.29 (governing liquidated damages) and Section 1.17.2 (the “Performance Warranty”) of the RSG Contract in lieu of, or in addition to, the limited remedies set forth in Section 1.17.1.3 (the “Defect Warranty”)? (Issue E.1(a))**

2532. In this Issue E.1(a), the Tribunal determines the Claimants’ submission that the remedy of Defect Warranty is complementary to, and not in lieu of the remedies of Performance Warranty and liquidated damages.

(i) *The Claimants’ Position*

2533. In their Responses to Joint List of Issues, the Claimants submit the following:

These provisions are complementary, not mutually exclusive.

First, under the Defect Warranty (RSG Contract Section 1.17.1.3), Claimants were entitled to receive RSGs that were free from defined Defects, which were broadly defined to include, among other things, work that “does not conform to the requirements of the Purchase Order” and anything that “would adversely affect . . . the performance of the [RSGs].” In contrast, under the Performance Warranty (RSG Contract Section 1.17.2), Respondents warranted that the RSGs would meet certain, narrowly defined performance standards, including a warranty that the RSGs would not have “primary-to-secondary leakage.” Nothing in the Performance Warranty suggests that Respondents would be relieved from their broader obligation under the Defect Warranty to repair or replace with due diligence and dispatch any Defect underlying that caused the primary to secondary leakage.

The liquidated damages provisions (RSG Contract Section 1.29) further demonstrates that the Defect Warranty and Performance Warranty were complementary. The liquidated damages provisions include, among other things, specific liquidated damages for breaches of the narrow performance standards set in the Performance Warranty (RSG Contract Section 1.29.2), including the “performance liquidated damages” for primary-to-secondary leakage and “tubes requiring plugging due to degradation.” These liquidated damages are meant to cover the cost to stop the leak or plug a tube. The liquidated damages provisions do not limit [the Claimants’ entitlement to] other remedies [designed] to resolve underlying Defect(s) that caused or were related to the tube leak or degradation [in the first instance]. In fact, the section governing liquidated damages (RSG Contract Section 1.29.4) expressly states

that it does not limit Edison from “seeking any other remedies available to [Edison] for other events or consequences of a default that are not addressed by these liquidated damages.”

Second, Respondents’ argument that the liquidated damages clause precludes any other remedy is belied by the broad definition of Defect in the RSG Contract and the extensive work Respondents performed in attempting to satisfy their obligations under the Defect Warranty. If the liquidated damages provision were intended to be the exclusive remedy for all damages arising from primary to secondary leakage, Respondents would have had no reason to do any warranty work on the SONGS outage, because all of that work arose from the primary-to-secondary leak in Unit 3.

Alternatively, Respondents’ witness ██████████ testified that Claimants could elect either to pursue the liquidated damages remedy or Defect Warranty remedy. Respondents now concede that an award of liquidated damages does not preclude the repair or replace remedy.²³⁶⁶

2534. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents have previously argued that because liquidated damages were available, those remedies are in lieu of the remedy requiring them to “repair or replace with due diligence and dispatch”—thus warranting inclusion in the List of Issues. In their post-Hearing submissions—for the first time—Respondents have abandoned that argument and conceded that the Liquidated Damages provided in Section 1.29 are “in addition to the remedies set forth in Section 1.17.1.3.” Claimants agree that these remedies are separate and additive—and that they address different circumstances. The “repair or replace” remedy is the sole remedy provided under the RSG Contract for Respondents’ breach of the Defect Warranty; Liquidated Damages are available for Respondents’ breach of the Performance Warranty. Moreover, Respondents’ abandonment of their original argument shows the bankruptcy of their claim that Edison was “required” to “step through” other contractual remedies in order to secure the benefits of the “repair or replace” remedy.

As is clear from the face of the contract, the Performance Warranty (and associated Liquidated Damages) and the Defect Warranty (with its repair and replace remedy) are complementary, not mutually exclusive. Under the Defect

²³⁶⁶ Claimants’ Responses to Joint List of Issues, ¶ C.1(a), pp. 66-67.

Warranty (RSG Contract Section 1.17.1.3), Claimants were entitled to receive RSGs that were free from Defects, which were broadly defined to include, among other things, work that “does not conform to the requirements of the Purchase Order,” and anything that “would adversely affect . . . the performance of the [RSGs].” In contrast, under the Performance Warranty (RSG Contract Section 1.17.2), Respondents warranted that the RSGs would meet certain, narrowly defined performance standards, including that the RSGs would not have “primary-to-secondary leakage.” Nothing in the Performance Warranty suggests that Respondents would be relieved from their broader obligation under the Defect Warranty to repair or replace with due diligence and dispatch any Defect that caused the primary-to-secondary leakage.

The Liquidated Damages provision itself demonstrates the difference between the Defect Warranty and Performance Warranty, and demonstrates that Liquidated Damages are available in addition to the repair or replace remedy (...)

Put simply, the Performance Warranty and Liquidated Damages provision does not affect Edison’s rights or Respondents’ obligations under the Defect Warranty—and under no circumstances allows Respondents to escape their obligation to “repair or replace” with due diligence and dispatch.²³⁶⁷

(ii) The Respondents’ Position

2535. In their Position Statement on the Revised List of Issues, the Respondents contend that “Section 1.29 and Section 1.17.2 are in addition to the remedies set forth in Section 1.17.1.3. Section 1.29 is referenced in Section 1.17.2.2 and 1.17.2.4 as providing remedies for the failure to satisfy the requirements of 1.17.2.2 and 1.17.2.3.”²³⁶⁸

(iii) Tribunal’s Determination

2536. Considering that the Parties are agreed on this Issue, E.1(a), the Tribunal answers Issue E.1(a) in the affirmative. Thus, the provisions of Section 1.29 (governing liquidated damages) and Section 1.17.2 (the “Performance Warranty”) of the RSG

²³⁶⁷ Claimants’ RPHM, ¶¶ 482-485.

²³⁶⁸ Respondents’ Position Statement on the Revised List of Issues, ¶ 380.

Contract are in addition to the limited remedies set forth in Section 1.17.1.3 (the “Defect Warranty”).

B. WHAT ARE THE CONSEQUENCES OF SUCH FINDINGS FOR THE PARTIES’ POSITIONS REGARDING THE ENFORCEABILITY OF THE LIMITATIONS OF LIABILITY (SECTION 1.21.2) AND WAIVER OF CONSEQUENTIAL DAMAGES (SECTION 1.21.1) PROVISIONS OF THE RSG CONTRACT? (ISSUE E.2)

2537. In this Issue E.2, the Tribunal determines the consequences of its determinations on Issue E.1 on the enforceability of the limitations of liability, and waiver of consequential damages provisions of the RSG Contract.

(i) The Claimants’ Position

2538. In their Responses to Joint List of Issues, the Claimants submit that “[u]nless the Tribunal concludes that the liquidated damages exclude all other remedies, the analysis below (Section F) must be applied to determine whether California law requires that the limitations of liability at Section 1.21 be expunged from the RSG Contract. Where, as here, a limited remedy fails of its essential purpose, limitations of liability must give way to the broader damages provisions of the Commercial Code.”²³⁶⁹

2539. In addition, in their C-RPHM, the Claimants contend that “[t]he failure of essential purpose analysis below (Issue F) must be applied in determining whether California law requires that the limitations of liability contained in Section 1.21 be expunged from the RSG Contract. The fact that, as Respondents concede, Liquidated Damages are not a contractual remedy for a breach of the Defect Warranty eliminates any argument that Claimants were required to pursue Liquidated Damages. Rather, where—as here—a limited remedy for Respondents’ breach of the Defect Warranty

²³⁶⁹ Claimants’ Responses to Joint List of Issues, ¶ C.2, p. 67.

fails of its essential purpose, the limitations of liability must give way to the broader damages provisions of the Commercial Code.”²³⁷⁰

(ii) The Respondents’ Position

2540. In their Position Statement on the Revised List of Issues, the Respondents contend that “[i]f the Tribunal finds that Mitsubishi breached the RSG Contract or breached its warranty obligations thereunder, the Liability Cap (Section 1.21.2) and the Mutual Waiver of Consequential Damages (Section 1.21.1) limit any damages that Claimants may be entitled to on their breach of contract and/or breach of warranty claims. Claimants’ argument that they should be able to avoid these limitations of liability provisions through the failure of essential purpose or rescission doctrines, or a contractual exclusion such as gross negligence or fraud, fail as described in Sections F and G below.”²³⁷¹

(iii) Tribunal’s Determination

2541. As set forth in Issues F and G below, the Tribunal does not find that the limitation of liability provision is expunged²³⁷² or that there are grounds for rescission of the RSG Contract.²³⁷³

2542. Accordingly, Issue E.2 is determined such that the consequences of the Respondents’ breach of the RSG Contract are as specified by the RSG Contract.

XVIII. LIMITATION OF LIABILITY (ISSUE F)

2543. The Claimants submit that the failure of the RSGs should result in the limitation of liability provision, agreed to in Section 1.21.2 of the RSG Contract, being null either

²³⁷⁰ Claimants’ RPHM, ¶ 486.

²³⁷¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 381.

²³⁷² See generally Section XVIII below.

²³⁷³ See generally Section XIX below.

under its own terms or by operation of California law. Section 1.21.2 of the RSG Contract reads:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that such limitation of liability shall not apply to: (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks.

A. DOES CAL. COMM. CODE § 2719 APPLY TO THE RSG CONTRACT IN THIS CASE? (ISSUE F.1)

2544. Section 2719 of the California Commercial Code (“**Commercial Code**”) provides as follows:

§ 2719. Contractual modification or limitation of remedy

(1) Subject to the provisions of subdivisions (2) and (3) of this section and of the preceding section on liquidation and limitation of damages,

(a) The agreement may provide for remedies in addition to or in substitution for those provided in this division and may limit or alter the measure of damages recoverable under this division, as by limiting the buyer's remedies to return of the goods and repayment of the price or to repair and replacement of nonconforming goods or parts; and

(b) Resort to a remedy as provided is optional unless the remedy is expressly agreed to be exclusive, in which case it is the sole remedy.

(2) Where circumstances cause an exclusive or limited remedy to fail of its essential purpose, remedy may be had as provided in this code.

(3) Consequential damages may be limited or excluded unless the limitation or exclusion is unconscionable. Limitation of consequential damages for injury to the person in the case of consumer goods is invalid unless it is proved that the limitation is not unconscionable. Limitation of consequential damages where the loss is commercial is valid unless it is proved that the limitation is unconscionable.

2545. The Parties disagree as to whether or not the Commercial Code is applicable to the dispute. The Claimants submit that the question of whether the Commercial Code is applicable is answered by reference to a four part predominant purpose test:

Courts consider four factors in determining whether the sale of goods or services predominates: (1) the title and language of the contract; (2) the amount of the contract price dedicated to goods versus services; (3) the payment timing structure (i.e., whether payment depends on delivery of the goods or completion of the design); and (4) whether the product being exchanged fits the definition of a good under the Code.²³⁷⁴

2546. The Respondents submit that the question is rather whether the “essence” of the RSG Contract is for goods or services or alternatively, if the RSG Contract is a mixed contract for goods and services, which is generally not at Issue in this dispute, whether the Commercial Code is only applicable to the goods portion of the agreement.²³⁷⁵

2547. If the Claimants’ submissions are adopted, the Tribunal would proceed to consider whether under Section 2719 of the Commercial Code the limitation of liability and consequential damages waiver provisions of the RSG Contract should be rendered null and void by operation of California law.²³⁷⁶ Under the Respondents’

²³⁷⁴ Claimants’ RPHM, ¶ 490.

²³⁷⁵ Respondents’ Response to the List of Issues, ¶¶ 382-390.

²³⁷⁶ Claimants’ RPHM, ¶ 504ff.

submissions, if the RSG Contract is not a contract for the sale of goods, then under Section 2 of the Commercial Code, the Commercial Code is not applicable and no further analysis is required.²³⁷⁷

2548. On account of the central significance of this question to the dispute at hand, and on account of the general agreement of the Parties concerning the applicability of the Commercial Code to the goods portion of the RSG Contract, the Tribunal considers it necessary to undertake a complete analysis under Section 2719 of the Commercial Code, regardless of the threshold question of the Commercial Code's applicability.
2549. Accordingly, the Tribunal proceeds to determine Issue F.2, assuming the applicability of the Commercial Code, and without specifically determining Issue F.1, including its various Sub-Issues, F.1(a) and F.1(b).

B. REGARDING THE APPLICATION OF THE CALIFORNIA COMMERCIAL CODE TO THE RSG CONTRACT IN THE PRESENT CASE (ISSUE F.2)

2550. As mentioned in Issue F.1 above, the Tribunal considers it necessary to address a central Issue in the arbitration, whether Section 2719 of the Commercial Code operates to render null the limitation of liability and consequential damages waiver in the RSG Contract.

(a) Should Cal. Com. Code Section 2719's analysis be applied as Claimants contend, namely by answering the following (Issue F.2(a))

2551. The Tribunal provides its determinations on Section 2719 of the Commercial Code below.

²³⁷⁷ Respondents' Response to the List of Issues, ¶¶ 382-390.

(i) The Claimants' Position

2552. In their Responses to Joint List of Issues, the Claimants submit that “[t]he analysis Claimants have consistently applied follows four key Ninth Circuit cases, including two cases applying California’s Commercial Code.”²³⁷⁸
2553. In addition, the Claimants supplement these submissions, in their C-RPHM, in the following manner:

Respondents’ argument that the Ninth Circuit case law does not support this analysis can be debunked by a simple review of those cases.

There are four key Ninth Circuit cases analyzing the application of California Commercial Code Section 2719(2). There is no reasonable dispute that these cases apply here. All four concerned contracts for custom-designed goods, which contained a limited remedy of “repair or replacement.” The cases articulate a two-prong test to determine if a seller may rely on limitations of liability:

- Did the limited remedy—repair or replacement—fail its essential purpose? If so, then the cap on damages is unenforceable and must give way to the general remedy provision of the Commercial Code.
- Is the failure of the limited remedy total and fundamental (i.e., has the waiver of consequential damages become oppressive by change of circumstances)? If so, the waiver of consequential damages must be expunged from the contract.

In all four cases, the Ninth Circuit concluded that the repair or replace remedy failed of its essential purpose when the seller was unwilling or unable to make the goods conform to the contract within a reasonable period of time. In three of the four cases, the Ninth Circuit also found that the seller’s default was so “total and fundamental” that a contractual waiver of consequential damages was unenforceable. Contrary to the analysis advocated by Respondents, the Ninth Circuit expressly eschewed any consideration of unconscionability under Section 2719(2).

²³⁷⁸ Claimants’ Responses to Joint List of Issues, ¶ D.2, p. 68.

The Tribunal should follow this clear Ninth Circuit precedent. A repair or replace remedy fails of its essential purpose within the meaning of Section 2719 if the breaching manufacturer or seller is unwilling or unable to make the repairs within a reasonable time. Respondents concede as much. What constitutes a reasonable time depends on the circumstances. For example, in *Milgard*, the contractual limitations of liability became “oppressive by change of circumstances” because the seller’s “inability to effect repair despite 2.5 years of intense, albeit injudicious, effort caused [buyer] losses not part of the bargained-for allocation of risk.” In *RRX*, the court found total and fundamental failure where the seller unsuccessfully attempted to repair for 15 months.

Next, the Ninth Circuit cases provide the standard for determining whether a failure of a limited remedy is “total and fundamental”—such that a waiver of consequential damages must be expunged. In *RRX*, *Milgard*, and *Fiorito Bros.*, the Ninth Circuit held that where there was no repair at all within a reasonable time, the failure of the limited remedy was total and fundamental. By contrast, the Ninth Circuit’s decision in *S.M. Wilson* illustrates when the waiver of consequential damages remains enforceable—i.e. when the seller’s default is not total and fundamental. There, the Ninth Circuit’s reasoning relied on several factors—none of which are present here. Most critically, the defendant in *S.M. Wilson* was able to perform a minimally adequate repair so that the machine at issue still worked, albeit not as quickly as the contract required. Therefore, the court found that the circumstances “were not enough to require that the seller absorb losses the buyer plainly agreed to bear.” Importantly, the holding was “not intended to establish that a consequential damage bar always survives a failure of the limited repair remedy to serve its essential purpose.” Rather, “[e]ach case must stand on its own facts.”

Respondents’ only arguments that engage these cases misstate the courts’ reasoning and the facts pertinent to the decisions in an attempt to evade the import of this analysis. As discussed more fully below, each case applies a “case-by-case” approach, which requires the court to consider the contract terms and facts at issue and apply the failure of essential purpose analysis.²³⁷⁹

(ii) *The Respondents’ Position*

2554. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

²³⁷⁹ Claimants’ RPHM, ¶¶ 504-509.

Even if the Commercial Code applies in this case, Section 2719 should not be applied as Claimants contend. First, the threshold question must be whether the Warranty failed of its essential purpose. As discussed in Section F.2(a)(ii), Claimants cannot credibly argue that the Warranty failed of its essential purpose where Mitsubishi did not ignore or repudiate its warranty obligations, but rather pursued those efforts with due diligence and dispatch; Mitsubishi offered a viable repair, which was rejected, and then formally recommended replacement under the Warranty but Claimants refused. Even if the repair or replacement options are found to have individually failed, Claimants had other remedies under the Warranty, including the ability to recover a refund up to the Purchase Price, which is minimally adequate as a matter of law.

If the Warranty did fail of its essential purpose, to determine the impact on the limitations of liability, a California court would follow the modern and majority independent analysis approach (explained in Sections F.2(b) and F.2(b)(iii)-(v)) to evaluate the impact on the Liability Cap and Mutual Waiver. However, even if the Tribunal chose to apply the analysis set forth by the Ninth Circuit case law cited by Claimants, such analysis should not proceed as Claimants suggest. Instead, the case law cited by Claimants confirms the analysis is based on the totality of the circumstances, and a limitation of liability is *upheld* where sophisticated parties allocated risk for a complex piece of equipment, and where a seller attempted to perform under the warranty, even if a repair was ultimately unsuccessful. [emphasis in original]

The four Ninth Circuit cases repeatedly relied on by Claimants articulate this case-by-case approach and result in upholding the limitation of liability provisions in circumstances such as those in this case. The first of the four cases cited by Claimants, upon which Claimants' other three cases each rely for the applicable test, is *S.M. Wilson v. Smith International, Inc. S.M. Wilson*, applying California law, determined a limited repair remedy failed of its essential purpose, but concluded that the contractual waiver of consequential damages survived that failure. The Court held that “[e]ach case must stand on its own facts” and it explained:

“The issue remains whether the failure of the limited repair remedy to serve its purpose requires permitting the recovery of consequential damages as sections 2714(3) and 2715 permit. We hold it does not. In reaching this conclusion we are influenced heavily by the characteristics of the contract Parties of relatively equal bargaining power negotiated an allocation of their risks of loss. Consequential damages were assigned to the buyer, Wilson. The machine was a complex piece of equipment designed

for the buyer's purposes. The seller Smith did not ignore his obligation to repair; he simply was unable to perform it. This is not enough to require that the seller absorb losses the buyer plainly agreed to bear.”

The other three Ninth Circuit cases cited by Claimants expressly adopt *S.M. Wilson's* case-by-case analysis and therefore also do not support the oversimplified decision tree Claimants presented throughout the hearing. However, even if Claimants' other three cases did support such an analysis, each is distinguishable and not applicable to the facts of this case. Those distinctions are summarized as follows:

- *RRX Industries, Inc. v. Lab-Con, Inc.*, attempted to apply California law, but it is distinguishable in a number of ways. For example, *RRX* involved a computer software contract where the contract obligated the seller to repair any “bugs” in the system but limited the seller’s liability to the contract price. Notably, the warranty remedy consisted only of the repair option, and did not provide any other warranty options for the buyer (such as the ability to declare default and recover up to the purchase price). Further, unlike the case here, those two provisions – the repair warranty and the liability cap – were part of the same paragraph in the contract. Also, contrary to Claimants’ suggested approach, the Court separately evaluated the liability cap as a limited remedy that was subject to Section 2719(2), and citing almost no analysis, affirmed the trial court’s finding that both the repair remedy and the liability cap remedy failed of their essential purposes. Without elaboration, the Court concluded “[t]he facts here justify the result” and expunged the single provision.
- In *Fiorito Bros., Inc. v. Fruehauf Corp.*, the Ninth Circuit attempted to apply Washington law, and the facts were materially different. Again, and importantly, the warranty consisted only of “repair or replacement at Seller’s option” and did not provide any alternative options for the buyer under the warranty. The warranty and waiver of consequential damages were located on the back of a sales order. And when the buyer began experiencing problems with the purchased goods (dump trucks) and notified the defendant seller of the problems, the seller either refused to respond or denied there was any warranty coverage. In fact, the court noted that the seller ““arbitrarily decline[d] to made [sic] necessary repairs”” and ““the facts show nothing but a callous disregard by [seller] for the purposes for which the exclusive repair-or-

replacement remedy was designed.” Importantly, the *Fiorito* Court pointed out that the *S.M. Wilson* Court enforced the waiver of consequential damages despite the failure of the limited remedy there because “the court found that the parties had expressly bargained for both clauses and that the seller ‘did not ignore his obligation to repair; he was simply unable to perform it.’” The *Fiorito* Court did not enforce the limitation of liability, specifically noting “[n]either factor is present here.” It is undisputed that both of these factors are present in this case.

- In *Milgard Tempering, Inc. v. Selas Corp.*, the Ninth Circuit was also attempting to apply Washington law, and again, the circumstances were different. The limited warranty provision only provided for repair or replacement of the purchased furnace; as in *Fiorito*, no other options were provided for the buyer. The waiver of consequential damages was also a part of the same contract provision as the limited warranty. Also, unlike at SONGS, when the buyer started to experience problems with the furnace, the seller had several opportunities to work on the furnace, and even had an opportunity to take over operation of the furnace for 60 days to attempt to get the furnace to perform properly. The court concluded that an “unreasonable delay and ultimate failure in repair made the repair remedy ineffective; thus, the remedy [which again only provided for repair or replacement] failed of its essential purpose.” The court found that the seller’s “inability to effect repair” led to the conclusion that the limit on consequential damages, which was part of the same contract provision, was also not enforceable. The court also noted that although not dispositive, the seller “did not make a completely open and honest effort to bring the furnace into compliance with the contract requirements.”

Of Claimants’ four cited Ninth Circuit cases, only *S.M. Wilson* addresses a similar situation as here, where the parties were of relatively equal bargaining strength, the machine was a complex piece of equipment, and Mitsubishi did not ignore its obligation to repair or replace, it was simply unable to fully perform it (due to Claimants’ conduct and choices). Applying *S.M. Wilson*’s case-by-case analysis, and with its noted California support in mind (*see* discussion, including footnotes, *supra*), it is clear that the limitations of liability should also be enforced in this case.

Claimants’ proposed “Issues” as set forth within this subsection as follows are not reflective of the actual case-by-case analysis adopted by *S.M. Wilson* and

the subsequent three cases discussed above. Even if they were, however, Claimants cannot prove the limitations of liability should be disregarded.²³⁸⁰

(iii) *Tribunal's Determination*

2555. To recall, in relation to Issue C above, the Tribunal has previously determined that MHI did not deny, ignore or repudiate its warranty obligations.²³⁸¹ Further, the Tribunal considers that MHI offered a viable repair, which was rejected as unsatisfactory by SCE.²³⁸² In addition, the Tribunal found that MHI formally recommended replacement under the Warranty, but the Claimants also effectively declined that option by virtue of the shut-down decision.²³⁸³ Moreover, the Tribunal determined that both the repair and replacement proposals were pursued by MHI with “due diligence and dispatch” within the context of the RSG Contract and the circumstances presented by the Incident.²³⁸⁴

2556. Even if it is assumed that the Warranty did fail of its essential purpose, the Tribunal finds that a California Court would likely follow the case-by-case or an independent analysis approach, based on the totality of the relevant circumstances, to evaluate the impact on the liability cap and mutual waiver. Indeed, the case law relied on by both Parties is consistent with the Respondents’ position that the proper analysis should be based on the totality of the circumstances or a case-by-case basis. The Respondents’ position is also supported by the case law that provides that a limitation of liability is generally upheld where sophisticated parties carefully and thoughtfully allocated risk for a complex piece of equipment, especially where a seller offered viable remedies under the warranty, even if a repair was ultimately unsuccessful.²³⁸⁵

²³⁸⁰ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 391-396.

²³⁸¹ See generally Section XV above.

²³⁸² See Section XIV.B (¶¶ 1914-1915) above.

²³⁸³ Section XV.D (¶¶ 2324-2325; 2356-2357) above.

²³⁸⁴ Section XV (*inter alia* ¶¶ 2023-2026) above.

²³⁸⁵ Section XVIII.B(a)(ii) above.

2557. The Ninth Circuit cases relied upon by the Claimants also approve of the case-by-case approach and, in the opinion of the Tribunal, do not inhibit upholding the limitation of liability provisions in circumstances such as those in this case. The first of the four cases cited by the Claimants, upon which the Claimants' other three cases each rely for the applicable test, is *S.M. Wilson v. Smith International, Inc.*,²³⁸⁶ which determined that a limited repair remedy failed of its essential purpose, but concluded that the contractual waiver of consequential damages, the only limitation of liability provision in that contract, survived that failure.
2558. Of the Claimants' four cited Ninth Circuit cases, only *S.M. Wilson* addresses a similar situation as here, where the parties were of relatively equal bargaining strength, and the machine was a complex piece of equipment. Further, as in *S.M. Wilson*, MHI did not ignore its obligation to repair or replace. Rather, MHI was unable to repair or replace the RSGs due to Claimants' conduct and choices.²³⁸⁷ Notably, as determined above, the Claimants rejected a Type 1 repair that the Claimants could have considered as an interim repair in favor of a longer term replacement option and stronger negotiating/litigation position.²³⁸⁸ This strategic choice proved untenable following the decision of the ASLB, which led to the shutdown decision.²³⁸⁹
2559. Similarly, the Tribunal considers that a permissible period of time to effectuate a repair or replacement is to be determined in consideration of the type of repair or replacement being undertaken.²³⁹⁰ If *S.M. Wilson's* case-by-case analysis is accepted, as it is by the Tribunal, it is clear that the limitations of liability should also be

²³⁸⁶ Exh. CL-136 (587 F.2d 1363 (1978)).

²³⁸⁷ See Exh. CL-136 (587 F.2d 1363, 1375 (1978)).

²³⁸⁸ See Section XIV.A(a) above.

²³⁸⁹ See Section VII.G(n)(i) above.

²³⁹⁰ See Section XIV.D above.

enforced in this case. Similarly, the other three Ninth Circuit case, cited by the Claimants²³⁹¹ expressly or implicitly adopt *S.M. Wilson's* case-by-case analysis.

(b) Are the Warranty (Section 1.17), Waiver of Consequential Damages and Limitation of Liability provisions (Sections 1.21.1 and 1.21.2) a “unitary package of risk-allocation” as Claimants contend? (Issue F.2(a)(i))

2560. In this Issue F.2(a), the Tribunal considers whether the Claimants’ argument that the limitation of liability provisions failed of its essential purpose voids only the limitation of liability provision in Section 1.21.2 of the RSG Contract or also the limitation on the recovery of consequential damages in Section 1.21.1.

(i) The Claimants’ Position

2561. In their Responses to Joint List of Issues, the Claimants submit that “[t]he parties’ witnesses agreed that the limited remedies and limitations of liability were a bargained-for exchange of interdependent promises. And, the initial proposed contract contained the crux of this bargain—the Warranty Remedy in exchange for waiver of consequential damages.”²³⁹²

2562. In addition, in their C-RPHM, the Claimants submit the following:

It is clear on the face of the Contract and under California law that the “repair or replace” remedy and the damages limitations work together to allocate risk between the parties. That is all that is required to apply Section 2719(2).

The determination of whether there is a “unitary package of risk allocation” is not complex—despite Respondents’ attempts to make it so. Before determining whether the limited remedy failed of its essential purpose such that the associated damages limitation is unenforceable (as described in Issue

²³⁹¹ Exh. CL-232 (*Milgard Tempering, Inc. v. Selas Corp. of America*, 902 F.2d 703 (9th Cir. 1990)); Exh. CL-134 (*RRX Industries v. Lab-Con, Inc.*, 772 F.2d 543 (9th Cir. 1985)); Exh. CL-086 (*Fiorito Bros., Inc. v. Fruehauf Corp.*, 747 F.2d 1309 (9th Cir. 1984) (applying State of Washington law)).

²³⁹² Claimants’ Responses to Joint List of Issues, ¶ D.1(a)(i), page 69.

F.2(a)(ii)-(iii) below), courts simply ensure that the limited remedy and limitation of liability represent a “unitary package of risk allocation”—that is, whether the provisions work together to protect the interests of both buyer and seller. If so, then it is appropriate to apply the failure of essential purpose analysis in Section 2719(2) to determine whether the failure of the limited remedy should result in the expungement of an associated damages limitation.

Here, it is clear on the face of the RSG Contract that the Warranty (RSG Contract Section 1.17) and Limitations of Liability (Section 1.12) provisions work together to allocate the risk of potential problems between the parties. In the case of a Defect, the Warranty protects Edison by ensuring that Respondents will repair or replace any part or portion of the RSGs with due diligence and dispatch, thus limiting Edison’s potential damages by minimizing “down time and other such consequential harms that follow from defective conditions.” At the same time, the Limitations of Liability protect Respondents from incurring extensive liability, provided they fulfill their Warranty obligations with due diligence and dispatch.

Respondents’ witnesses confirmed that the limited remedies and limitations of liability worked together as a “unitary package of risk allocation.” As Respondents’ expert, Mr. Denton, concluded: “one of the elements of risk allocation in the contract [is] that, if the steam generators failed, Mitsubishi would repair or replace them with due diligence and dispatch.” Similarly, ██████ the lead negotiator for Respondents, described the bargain as follows: “the customer, on the one hand, receives assurances that the product can be repaired or replaced; and the vendor, on the other hand, receives some assurance about its potential liability.” Mr. Ellis, who negotiated the Contract for Edison, had the same understanding: Edison was “willing to agree to certain limitations in exchange for other promises under the RSG Contract, particularly Mitsubishi’s promises to repair or replace any aspects of the RSGs that turned out to be defective with due diligence and dispatch.” Thus, the limited remedies and limitations of liability reflect a bargained-for exchange of interdependent promises.

The Ninth Circuit has considered this type of bargain and recognized that it “serves two main purposes. First, it serves to shield the seller from liability during her attempt to make the goods conform. Second, it ensures that the buyer will receive goods conforming to the contract specifications within a reasonable period of time.” As the Court further reasoned, “it does not make sense to view the exclusive-remedy and consequential-damage provisions independently. The purpose of the parties in agreeing to this exclusive-remedy provision was to insure that the Plaintiff would not suffer from down time and

other such consequential harms that follow from defective conditions in the [product].” Thus, contrary to Respondents’ bald representations, the Ninth Circuit consistently has determined that when contractual provisions work together as they do in the RSG Contract, they are a “unitary package of risk allocation.”

Respondents’ argument that a severability clause in Section 1.34 defeats the notion of a unitary package of risk allocation is nonsensical. Respondents point to no authority for this argument. Nor could they. The severability clause in RSG Contract Section 1.34 itself embraces the simple, undisputed (and often boilerplate) proposition that courts may find provisions of the contract unenforceable while allowing the rest of the contract to survive. Section 2719(2) applies here to the question of whether the damages limitations are enforceable. Further, a court determines separately whether each damages limitation—here, the liability cap and waiver of consequential damages—is enforceable, using two different standards. The severability clause has no bearing on a court’s ability to find a damage limitation void or unenforceable.

Respondents’ other attempts to distinguish the RSG Contracts from the four Ninth Circuit cases fall similarly flat. First, the fact that the remedy and damages limitations are stated in separate sections of the contract does nothing to change the fact that they work together to allocate risk. Respondents point to no authority for allowing such a formalistic distinction to override the substance of those provisions or to undermine the contrary testimony of its own witnesses. Regardless of where the provisions are located in the RSG Contract, the only relevant question is whether they were intended to work together to allocate risk amongst the parties.

Second, Respondents’ arguments regarding the “unitary package of risk allocation” are internally inconsistent. There is no dispute that the limitation of liability and warranty provisions were negotiated together. Respondents’ repeated argument that the parties agreed the limitation of liability would cover the Warranty is itself a concession that the provisions work together to allocate risk. Respondents ignore the provisions of the RSG Contract that remained unchanged from Edison’s Request for Proposal—namely the Warranty obligation to repair or replace and the waiver of consequential damages. The fact that those provisions were not heavily negotiated does not change the fact that they worked together to allocate risk between the parties. Further, Respondents’ arguments that there “were other factors at play with regard to the parties’ risk allocation efforts” do nothing to undermine the Tribunal’s determination that both damages limitations and limited remedies—the

provisions with which Section 2719(2) is concerned—reflect a unitary package of risk allocation.

In sum, it is clear from the face of the RSG Contract and the course of negotiations that Respondents’ promise to repair or replace any RSG Defects with due diligence and dispatch was the *quid pro quo* for the damages limitations. Put simply, it would make no sense for Edison to waive its legal right to recover the full measure of its damages unless it also had a guarantee from Respondents that any problems could and would be resolved with “dispatch.” Respondents failed to uphold their end of the bargain and that failure has clear consequences under California law: the limitations of liability are not enforceable here.²³⁹³

(ii) *The Respondents’ Position*

2563. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants’ argument that the Warranty, Liability Cap, and Mutual Waiver together constitute a “unified package of risk allocation” that stand or fall as one is not supported by the Ninth Circuit case law, discussed in Section F.2(a) above, and is also without support under the facts. Here, as explained in detail below, the RSG Contract dictated that each provision be treated separately, each provision was separately negotiated and stated in the RSG Contract, and there were other elements of risk allocation involved, including Claimants’ desire to obtain a lower purchase price.

Initially, Claimants’ argument fails based on RSG Contract Section 1.34, which provides, “If any section, provision or portion of the Purchase Order is held to be invalid, illegal, void or unenforceable ... the remainder of the Purchase Order shall nevertheless subsist and continue in full force....” This RSG Contract provision defeats Claimants’ “unitary package of risk-allocation” theory.

If the Tribunal decides, however, that Section 1.34 of the RSG Contract is not dispositive, the three provisions should still not be considered a “unitary package of risk-allocation,” nor is the analysis or outcome suggested by Claimants supported under the case law, for a number of reasons.

²³⁹³ Claimants’ RPHM, ¶¶ 510-518.

First, although these three cited provisions were all a part of the parties' negotiations and a single final contract, they were separately stated in the RSG Contract. They therefore cannot be said to be a "unitary package" in the same way as was the case in *RRX* or *Milgard* where the limited warranty and limitation on liability were part of the same contract provision.

Second, Claimants' assertion that only these three provisions were part of a "unitary package" ignores that there were other factors at play with regard to the parties' risk allocation efforts. Most importantly, the parties' agreement on the particular purchase price of the RSG Contract was also a key element of risk allocation and reflected Claimants' willingness to bear more of the risk in exchange for a lower purchase price. For example, ██████████ explained that the limitations of liability worked to "make the price of the product reasonable for the customer to purchase it." Mr. Denton also testified that "A day's outage can run up to a million dollars, for instance. And that a vendor could not take on that kind of – that allocation of risk shifted to the vendor would cause the vendor to raise their prices substantially." Notably, after extended negotiations about the warranty and limitations of liability provisions, "Edison accepted a cap on all of Mitsubishi's liability, including warranty claims, equal to the purchase price (approximately \$137 million). Edison chose not to pay an extra \$6 million to carve warranty claims out of the limitation of liability." Claimants ignore these additional, important aspects of the risk allocation balance.

Because the Warranty, the Liability Cap, and the Mutual Waiver were each separate provisions (with the Warranty being even a separate section) in the RSG Contract, and given the other elements of risk allocation that were heavily negotiated in this complex contract (e.g., the purchase price), it cannot be said that the three provisions at issue were a "unitary package of risk allocation."

However, even if they were a "package" and even if the Warranty failed of its essential purpose, the limitations of liability should still be enforced under the analysis in *S.M. Wilson*.²³⁹⁴

(iii) *Tribunal's Determination*

2564. The Claimants' argument that the warranty, liability cap, and mutual waiver together constitute a "unified package of risk allocation" that stand or fall as one, is not an accurate representation of the Ninth Circuit case law, as discussed in the Tribunal's

²³⁹⁴ Respondents' Position Statement on the Revised List of Issues, ¶¶ 397-403.

determination of Issue F.2(a) above.²³⁹⁵ Nor is “unification” or single packaging of these remedies mandated by the circumstances leading up to the execution of the RSG Contract, especially that the limitation of damages sections were separately negotiated on terms balancing the Claimants’ desire for a lower purchase price against Mitsubishi’s insistence on an “all risks” limitation of liability.

2565. The Tribunal also considers it relevant that the limitation of liability and waiver of consequential damages are separately stated in different sections of the RSG Contract and that the lead in clause to the limitation of liability in section 1.21.2 states, “Notwithstanding anything to the contrary stated in the Purchase Order”. These facts alone underscore the intent of the Parties that the liability cap and waiver address all undertakings of MHI under the RSG Contract, including the limited warranty obligations. Consequently, the provisions in question cannot be said to be a “unitary package” in the same way as was the case in the *RRX* or *Milgard* cases, where the limited warranty and limitation on liability were part of the same contract provision.
2566. While it is certainly true that the limited warranty provisions were negotiated at or about the same time as were the limitation of damages and consequential damages waiver, the Claimants have offered no credible and persuasive evidence that the Parties mutually agreed that the limitations on recoverable damages were conditioned upon a successful warranty repair or replacement. In fact, the persuasive evidence is to the contrary, in that the damages limitations were intended to cover “all risks,” with no exclusion for a good faith failure of warranty remedies.
2567. For example, the Parties’ ultimate agreement on the Purchase Price of the RSG Contract was in the context of a careful risk allocation and reflected the Claimants’ willingness to bear more of the risk in exchange for a lower Purchase Price. This

²³⁹⁵ See Section XVIII.B(a)(iii) above.

willingness to accept greater risk was evidenced by the testimony of ██████████ for the Respondents, who explained that the limitation of liability made it possible to negotiate a lower Purchase Price,²³⁹⁶ and the testimony of Mr. Denton, for the Claimants, who confirmed that a vendor of nuclear powered steam generators cannot take on the risk of a plant’s shutdown, where “a day’s outage can be up to a million dollars” in losses.²³⁹⁷ Indeed, the evidence is not disputed that SCE chose not to pay an extra \$6 million to extend the warranty period.²³⁹⁸

2568. In summary, the Tribunal finds that the limited warranty obligations, the liability cap, and the mutual waiver were not a “unitary package of risk allocation.”

(c) **Have the warranty remedies (Section 1.17) failed their essential purpose? (Issue F.2(a)(ii))**

2569. The Tribunal determines below whether the warranty remedies in Section 1.17 of the RSG Contract failed their essential purpose.

(i) *The Claimants’ Position*

2570. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi was unwilling or unable to provide RSGs that conformed to the terms of the RSG Contract within a reasonable period of time. After more than 16 months of attempting to find a repair, there was still no viable proposal for a repair. Even if there was a viable proposal, as discussed above, it could not have been implemented to render the RSGs operational within a reasonable period of time. Under Ninth Circuit law, the repair or replace remedy therefore failed its essential purpose.”²³⁹⁹

²³⁹⁶ Transcript, pp. 2436-2437.

²³⁹⁷ Transcript, p. 2948.

²³⁹⁸ Transcript, pp. 2435-2436 ██████████; Witness Statement of ██████████ ¶ 25; Transcript, p. 2948 (Denton); see also Witness Statement of Mr. Denton, ¶¶ 11-14.

²³⁹⁹ Claimants’ Responses to Joint List of Issues, ¶ D.2(a)(ii).

2571. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

It is undisputed that the failure of essential purpose doctrine applies when "a party is deprived of its contractual remedy" or where "enforcement of the limited remedy would essentially leave plaintiff with no remedy at all." Here, Respondents' inability to even present—let alone execute—a viable repair after 16 months left Edison without the contractual remedy it bargained for.

None of Respondents' arguments change the fact that Edison was left without any remedy. In a transparent attempt to avoid the consequences of their failure to provide a remedy, Respondents repeatedly mischaracterize the governing case law in suggesting that Claimants were required to wait indefinitely for Respondents to repair the steam generators, or were required to invoke remedies that were not applicable given the circumstances. Knowing that these claims lack legal or logical substance, Respondents advance a new theory, which suggests that the repair or replace remedy cannot fail of its essential purpose because Claimants "rejected" Respondents' recommendation to redesign and replace all four RSGs.

➤ ***Mitsubishi Did Not Repair The RSGs Within A Reasonable Amount Of Time***

As discussed above in Section F.1, under California law, a repair or replace remedy fails of its essential purpose within the meaning of Section 2719 if the breaching manufacturer or seller is unwilling or unable to make the repairs within a reasonable time. The determination of a "reasonable time" is based upon the particular facts of the case—including, here, the RSG Contract's requirement that all repairs be completed with due diligence and dispatch.

The evidence here shows that Respondents were "either unwilling or unable to provide a system that work[ed] as represented" within a reasonable time, let alone with dispatch. After 16 months, and substantial support from Edison (which was not legally required under the RSG Contract), Respondents were unwilling or unable to offer a viable repair proposal, let alone complete an actual repair. The April 2013 U-Bend Repair Report lacked engineering support sufficient to allow Edison to accept the repair and determine whether the proposal would be licensable or implementable. Throughout those 16 months, Respondents refused to perform critical testing that Edison—on the advice of its NRC consultants—repeatedly requested to demonstrate that the Type 1 repair would work even if the thermal-hydraulic conditions inside the RSGs remain unchanged. As discussed above, Respondents were bound to

perform such testing and simply refused to do so. Respondents resumed their attempts to develop and prove a viable repair after this arbitration commenced, yet have been unable to do so despite an additional 2.5 years of trying.

Respondents also repeatedly concealed or flatly lied about the details of their repair proposal. During the Hearing, Respondents' story on what they did—and when—varied from day to day and witness to witness. Seemingly all of their actions in 2012 and 2013 were in anticipation of litigation—not in pursuit of a repair. For example, after testifying that Edison had not “shown any interest” or “asked a single question about” the repair, Respondents were forced to concede that Edison had provided 60-plus questions and concerns on the U-Bend Repair Report. Yet when Edison provided these comments, Respondents sent their draft responses only to its lawyers—not to Edison. Even now, after more than three years of working on its repair proposal, Respondents still cannot demonstrate that their Type 1 repair proposal would fix the root causes of the RSG failures without causing harmful secondary effects, nor have Respondents demonstrated that they could provide “a system that works as represented.” Mr. Leeds, the individual at the NRC who would have made the final decision about whether to allow SONGS to return to service after the repair, testified clearly and credibly that he would never have allowed SONGS to operate even if a Type 1 repair was implemented. This testimony should be dispositive. The Defect Warranty failed its essential purpose.

Respondents' claim that Edison “ignored and discouraged” the Type 1 Repair is not supported by this evidence. As discussed in detail in Section C, Edison acted in good faith when considering Respondents' Type 1 Repair proposal. Edison's requests for support for the Type 1 repair were both consistent with its contractual rights and industry standards and reflected a safety-conscious, responsible utility. Edison sought and never received the adequate repair it bargained for.

➤ ***Edison Was Not Required To Permit Multiple Repair Attempts***

Respondents mischaracterize numerous cases in an effort to suggest that Edison was required to permit them multiple repair attempts to repair. No case has ever held that a buyer is required to permit a seller multiple repair attempts, much less over an indefinite period. Rather, courts applying California law—including those cited by Respondents—uniformly hold that a repair or replace remedy fails of its essential purpose when there is no repair within a reasonable amount of time.

The quotes Respondents cherry picked from *In re MyFord Touch Consumer Litigation* and *S.M. Wilson* do nothing to bolster Respondents claims that

Edison was required to give them multiple repair attempts here, or that so long as a repair was attempted the remedy did not fail of its essential purpose. In *MyFord Touch*, the buyer did not bring his car to the dealership or otherwise provide the dealer with any opportunity to repair it. There, the court commented that the cases “uniformly require the plaintiff to give the defendant a chance to perform warranty service before the defendant can be held liable”—a proposition no one disputes. Similarly, the fact that the seller attempted a repair in *S.M. Wilson* did not mean the remedy did not fail of its essential purpose. There, the court held: “In any event, the inability to cure substantial defects does indicate that the repair remedy so failed [of its essential purpose].”

Neither of these decisions focuses on the seller’s attempts to repair. The focus is rather whether or not the *buyer received* a repair within a reasonable time. Indeed, it would be absurd to require a buyer to permit a seller multiple repair attempts, without regard to the passage of time or the seller’s ability to demonstrate efficacy. It would be equally absurd to ignore the failure of the limited remedy so long as the seller *tried* to repair. Either approach advocated by Respondents would defeat the very purpose of section 2719(2)—to provide the buyer a minimally adequate remedy.

More to the point, Respondents had ample opportunity to repair. Under the circumstances, Edison was within its contractual rights and industry safety requirements to insist that the repair be proven safe, effective, and licensable. It would have been pointless to implement a repair that could not be approved by the NRC. Respondents cannot complain that they did not have the “opportunity” to try a repair, when it was their inability to demonstrate the repair’s viability that deprived them of that “opportunity.” And, as several Edison witnesses testified, they would have accepted any repair if Respondents had sufficiently shown that they solved the problems, would not cause new problems and would be licensable by the NRC.

If Respondents could have repaired the RSGs within a reasonable period of time and with dispatch—which they did not—then Claimants likely would have received an “adequate remedy.” But Claimants were not required to wait indefinitely for a viable repair, without regard to ongoing harm stemming from the outage. Such a requirement would defeat their right to receive a “minimally adequate” remedy.

➤ ***No Other Remedies Were Available Or Adequate***

Respondents next argue that “the remedies available to Claimants here extended beyond the repair option and included a replacement option, a

backcharge option, and the ability to recover, for example, a refund up to the Purchase Price under a default option.” Respondents would impose a requirement that Claimants “step-through” other remedies in the contract—regardless of whether they were available under the contract, whether they even addressed the Defect Warranty implicated by Respondents’ failures, or whether they were minimally adequate. These arguments are just one more attempt by Respondents to escape their Warranty obligations, and are not supported by law, fact, or common sense. Respondents continue to ignore the fact that the RSG Contract does not permit, let alone require, Edison to pursue remedies that are not applicable to the Defects at issue. Nor have Respondents made any attempt to show that these remedies are minimally adequate.

Respondents’ “step-through” theory is legally unsound and rife with internal inconsistencies. In their pre-Hearing Memorials, Respondents cited *Marr Enterprises v. Lewis Refrigeration* for the proposition that “[w]here the contract specifies other remedies, a party must step through each of the remedies available under the contract.” At the Hearing, Respondents went further, arguing that “Edison had the obligation to pursue all of the remedies in this matter.” When pressed by the Tribunal, however, Respondents backtracked and admitted that “[w]hether [Edison] has to step through every single one could be subject of debate.” Under further questioning, Respondents ultimately conceded that “[t]he concept you have to step through every single remedy is not in Marr.” Now, Respondents have wholly abandoned Marr—yet persist in making the argument without any authority. The case they now cite—*Natural Rural Telecommunications Cooperative v. DirecTV*—does not support their “step-through” argument either. It simply confirms that one must pursue available remedies that are minimally adequate. Respondents conveniently ignore that in *DirecTV*, there was an applicable refund remedy, the buyer did not even ask for that remedy, and the court found that remedy was a minimally adequate remedy for the breach at issue. Here, the “sole remedy” available to Claimants under the RSG Contract was repair or replacement.

Respondents attempt to marginalize the Ninth Circuit’s focus on the limited remedies of repair or replacement by arguing that there were no other remedies available in the contracts at issue in those cases. That assertion is not supported by the cases. None of the cases discuss other possible contractual remedies. Rather, those decisions focused on repair or replacement because it was the contractual remedy for breach of Warranty— which is the same “sole remedy” provided for breach of the Defect Warranty in the RSG Contract.

There is simply no requirement in the case law (and Respondents point to none) which supports the proposition that, in order to argue that a remedy has failed

of its essential purpose, a buyer must pursue other remedies listed in the contract, regardless of whether those alleged remedies provided a minimally adequate remedy for—or even related to—breach of warranty.

Respondents make no attempt to show that the contractual remedies they point to are either applicable under the circumstances or minimally adequate. Edison bargained for, and was entitled to, repair or replacement with due diligence and dispatch of any Defect —i.e., any nonconformity with the contractual Specification, including those that adversely affected the RSGs' performance. Not one of the remedies Respondents point to achieves that end.

The structure and language of the Warranty confirms that the provisions Respondents point to were meant to reinforce the repair-or-replacement remedy for Edison's benefit—not to undermine Edison's interests with less-than-adequate alternative “remedies.” The “backcharge” and “default” remedies referenced by Respondents are subsections of the Warranty remedy. The language used confirms that these remedies were at Edison's option, triggered if Respondents failed to act with due diligence and dispatch. These remedies were available to Edison if Respondents “fail[ed] to take action to correct any Defect within two (2) days after upon notification . . . or fail[ed] to diligently continue performing such correction to completion thereafter” Then, and only then, could Edison seek a repair elsewhere, but it was not required to do so: Edison “may perform or . . . have performed such necessary warranty work and backcharge [Mitsubishi] for such direct costs for repair or replacement and/or declare [Mitsubishi] to be in default pursuant to Section 1.24.” In any event, Respondents consistently have asserted that they acted diligently at all times, so under their own theory, Edison's option to hire another vendor was never triggered because there was no “fail[ure] to diligently continue performing” Respondents' obligations.

Furthermore, interpreting the RSG Contract as requiring Edison to seek out other vendors or perform the repair itself cannot be reconciled with Respondents' express obligation to repair or replace with diligence and dispatch—and, if adopted as Respondents urge, would strip that critical contract provision of all meaning. If the “backcharge” provision were a requirement, Respondents would be encouraged to “throw in the towel” on an impossible repair and insist that Edison retain another vendor to perform it—while maintaining their right to argue that the other vendor did not act reasonably in attempting to repair the Defect, and therefore, that Respondents have no further obligations. That is, under Respondents' theory, Respondents could reject their “limited remedy” obligations while maintaining the benefits of its “limitation of liability.” As the record reflects, these provisions were part

of the unitary allocation of risk for which the parties bargained, and cannot be severed as Respondents now suggest. Respondents alone had the required knowledge concerning their proprietary design, and were in the best position to fix their defective product. Edison was not required to switch vendors in June 2013 or any other time, and start the repair process over, while spending millions of dollars a day just to keep the plant in a state of suspended animation.

Furthermore, Respondents' theory that Edison was required to declare Respondents in default is circular—and without substance. If Edison declared default under Section 1.24, it could elect among a number of remedies. One of those remedies would be to “pursue any of its other rights and remedies under the contract”—including its right to have Respondents repair or replace the defective RSGs with due diligence and dispatch. Thus, any pursuit of Default would allow Claimants to demand the remedy provided in the Defect Warranty, which is repair or replacement of the RSGs with due diligence and dispatch. Any declaration of Default would not relieve Respondents of their Warranty obligations.

Putting aside the fact that Respondents point to no legal or contractual support for this argument, their theory that Edison was required to “step-through” other remedies makes no practical sense. Respondents do not and cannot claim that if Claimants had pursued any of these other remedies, they would have received the functional RSGs they bargained for with dispatch. Indeed, Respondents have never even attempted to make such a showing. Therefore, these other remedies are not minimally adequate remedies for Respondents' breach of the Defect Warranty.

➤ ***Replacement Was Not A Minimally Adequate Remedy***

In an about-face from their previous statements and theory of the case, Respondents now claim that the Warranty remedy has not failed of its essential purpose because Claimants rejected replacement. As discussed above in Issue C.4, this newly formed litigation theory is supported by neither the facts nor Respondents' previous assertions.

Claimants never rejected replacement of the RSGs. In reality, Respondents only proposed replacement after being pressed by Claimants for a recommendation on the best path to restore SONGS to service. When Mr. Dietrich informed Respondents of Claimants' view that a replacement of all four RSGs while SONGS was left idle for an extended period did not satisfy Respondents' obligations to repair or replace any Defects at their sole expense with due diligence and dispatch—and therefore, that Respondents would be required to make Claimants whole for the losses suffered during the period of

time they were forced to wait for these “replacements”—Respondents abandoned the proposal. Indeed, they immediately reverted to their prior recommendation of a Type 1 Repair. This is consistent with Respondents’ internal discussions (then unknown to Claimants) that total replacement was “beyond the scope” of the Warranty obligation. Moreover, throughout this arbitration, Respondents have repeatedly conceded—indeed, affirmatively argued—that replacement of the RSGs was not technically, politically, or commercially feasible.

In any case, the parties now disagree whether the RSG Contract contemplated total replacement of all four RSGs. The actual Warranty provision describing Respondents’ obligation to remedy any Defects refers only to “repairing or replacing . . . any defective part or other portion of the Work affected by such Defect” and does not make reference to replacement of an entire RSG. Respondents, however, point to a later sub-subpart of the Warranty concerning their obligation to conduct a root cause analysis when Defects occur, which references Respondents’ “obligat[ion] to repair or replace the Apparatus.” Relying on the definition of Apparatus, Respondents assert this proves the parties contemplated a total replacement of all four RSGs (presumably all at the same time and to the point all Units would spend years offline). Their overreaching argument misrepresents the emphasis of the clause in question and ignores Respondents’ own witness’s conflicting testimony that the parties did not consider replacement of all four RSGs. A better reading is that the clause cited is that it is merely a shorthand reference to any situation in which Respondents are required to provide a warranty remedy.

Even if the Tribunal credits Respondents’ reading, the Warranty is drafted with internally inconsistent language that creates a latent ambiguity as to the extent of the replacement obligation. It is a well-established principle of California law that, even where a contract includes an integration clause, a party is entitled to introduce extrinsic evidence to show a latent ambiguity and to clarify the parties’ actual intent in contracting.

Witness testimony confirms Claimants’ position: The parties never contemplated a scenario in which the entire plant would have to be shut down for an extended outage while Respondents attempted a complete re-design and re-manufacture of the RSGs. As Mr. Ellis testified, the parties’ contemplation of risk was necessarily “based on industry experience” and the complete failure of the SONGS steam generators was an unprecedented event in the history of nuclear power. Therefore, Edison “never contemplated a scenario where all four . . . generators would be defective to the point that they would all four have to be repaired or replaced.” ██████████ agreed, testifying that the parties never

discussed or considered a scenario in which a total re-design of all four RSGs would be necessary.

Mr. Ellis further testified that the parties contemplated at most total replacement of one RSG. As he explained, the parties believed that the replacement remedy would only be implicated if a unit had a manufacturing defect or was damaged by a foreign object inside the RSG. That “replacement” would not have required time to re-design the RSGs or a years long outage of both SONGS Units. Mr. Ellis’s testimony is made all the more credible in light of Respondents’ obligation to complete the replacement “at [their] sole expense” because four RSGs could not be designed, manufactured, shipped, installed, and tested within the limits of Respondents’ liability.

██████████ added that, in his understanding of industry experience, the design and manufacture of replacement steam generators always takes place while the plant is fully operational and “will not prevent the plant from running.” Consistent with this industry standard, the RSG Contract required not only repairs with “due diligence and dispatch” but that the warranty Work be performed “at the jobsite to minimize the downtime of the Apparatus.” The testimony of these witnesses is not consistent with Respondents’ reading of the Warranty that contemplates replacement of all four RSGs in one instance. Thus, there is a potential latent ambiguity in the text and the Tribunal must consider extrinsic evidence to identify and give effect to the parties’ intent.

Even if, as Respondents erroneously claim, the Tribunal cannot credit these witnesses’ testimony because the RSG Contract includes an integration clause—an objection which is not only legally unfounded but entirely waived because it was not raised when the testimony was offered—the Panel need look no further than Respondents’ own post-contractual statements and actions to understand what the parties really thought about the replacement remedy. There can be no doubt that thus evidence is admissible: California law is clear that the terms set forth in an integrated writing “may be explained or supplemented by course of dealing or usage of trade or by course of performance.” Prior to the introduction of their replacement theory for the purposes of this litigation, Respondents repeatedly asserted that a replacement requiring 5-7 years to complete was not contemplated by the RSG Contract. In an email dated August 23, 2012 between ██████████ and ██████████ ██████████ stated in unequivocal terms “MHI will never agree to bundle replacement. It is beyond the scope of our agreement.” In depositions, Respondents’ own counsel explained that replacement was simply “not practical because you couldn’t let the plant sit there for five years.” And

Respondents' own expert confirmed that "replacement of the steam generators w[as] neither technically practical nor economically viable."

Ultimately, Respondents' argument defies common sense. It requires the parties to have considered and agreed to a scenario in which Respondents failed at their design duties and delivered defective goods in the first instance, requiring a total re-design and re-manufacture of all four RSGs over an extended period of many years—essentially a "re-replacement" of the "replacement" steam generators—at Claimants' expense. At the very least, this scenario is at odds with the contractual language requiring that any remedy be carried out with "dispatch" and at Respondents' sole expense. But Respondents' argument goes even further: it asserts that Claimants also agreed to accept the risk that Respondents would additionally fail to carry out their warranty duties. There is no reading of the RSG Contract, evidence, or logic that would support Respondents' position here. Put simply, it is absurd to think Claimants would agree that Respondents could provide Defective RSGs and fail to meet their Warranty obligations to repair or replace with due diligence and dispatch, and yet still stand on the limitations of liability. That is not the deal to which the parties agreed.²⁴⁰⁰

(ii) *The Respondents' Position*

2572. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants' attempt to avoid the RSG Contract through an argument that the Warranty failed of its essential purpose cannot succeed under the facts of the case. Therefore, Claimants cannot succeed on what they concede is a key initial hurdle in the Commercial Code Section 2719 analysis.

As discussed in detail below, Section 2719(2), which is the source of the failure of essential purpose doctrine, "becomes operative when a party is deprived of its contractual remedy. ... 'A limited remedy fails its essential purpose when the circumstances existing at the time of the agreement have changed so that enforcement of the limited remedy would essentially leave plaintiff with no remedy at all.'" Here, Claimants were not deprived of their contractual remedies; unlike many cases where a warranty is found to have failed, the remedies available for Claimants here extended beyond the repair option and included a replacement option, a backcharge option, and the ability to recover,

²⁴⁰⁰ Claimants' RPHM, ¶¶ 519-547.

for example, a refund up to the Purchase Price under a default option. As a matter of law, the Warranty cannot have failed of its essential purpose.

The Warranty provision that Claimants say failed – RSG Contract Section 1.17.1.3 – includes multiple components: Section 1.17.1.3 provides for both the repair or replace options that the parties frequently refer to, as well as options for Claimants to “perform[] such necessary warranty work and backcharge the Supplier ... and/or declare Supplier to be in default pursuant to Section 1.24.” Claimants’ rights under the default option included terminating the Purchase Order and seeking a refund of up to the Liability Cap, which equals the RSG Contract Purchase Price.

As discussed in detail below, Mitsubishi acted with due diligence and dispatch in meeting its repair and replacement obligations until Claimants decided to close the plant. Mitsubishi proposed a viable thicker-AVB repair method that Claimants unreasonably ignored and rejected, instead pushing Mitsubishi toward replacement. Then, when Mitsubishi recommended replacement, Claimants declared Mitsubishi in breach. Claimants never attempted to pursue the alternative options under Section 1.17.1.3, which included the backcharge and default provisions. Claimants were not deprived of the multiple Warranty remedies in Section 1.17.1.3; they simply chose not to avail themselves of those options. Under these circumstances, as a matter of law the Warranty cannot be said to have failed of its essential purpose.

First, even if the Type 1 Repair were the only consideration (which it is not, due to the other options under the Warranty), the Warranty cannot be found to have failed of its essential purpose where Claimants ignored and discouraged the Type 1 Repair until such time as they closed SONGS.

As set forth above, Mitsubishi developed and proposed a technically viable repair that could have been implemented in a reasonable amount of time and could have been licensed. Mr. Robert Denton, the former President and CEO of Constellation Nuclear, confirmed that based on his review of the facts, Mitsubishi “did as much as they possibly could do to move forward with that repair.”

Unfortunately, as a result of Claimants’ intense focus on restart efforts, and insistence on improving the T/H conditions, Claimants largely ignored or discouraged the Type 1 Repair option. As ██████████ explained, Claimants “showed no interest in a plan for moving ahead with Mitsubishi on a repair.” In fact, Claimants rejected Mitsubishi’s attempts to present on the Type 1 Repair in at least two different meetings. At a meeting on November 1, 2012, ██████████ recalled, “Mitsubishi began to again explain the status of our repair

efforts, as planned. Mr. Avella, however, immediately stopped our presentation. He explained that he thought repair would be very difficult, and asked us why we were still working on it.” Mitsubishi again tried to present its analysis of the Type 1 Repair at a December 14, 2012 meeting, but as ██████████ testified, “[a]gain, we were interrupted by Mr. Avella, and before discussion was completed we were told that SCE had rejected the Type 1 repair, and we ended at that step.”

A limited warranty remedy cannot be said to have failed of its essential purpose unless a seller actually has had an opportunity to attempt a repair. The cases Claimants rely upon where a warranty was found to have failed of its essential purpose all involved situations where the seller was actually allowed to attempt a repair at least once, and in some cases, multiple times.

Further, Claimants’ suggestion that pursuing the repair would have been futile due to viability or licensing questions has been expressly rejected in a recent case in the Northern District of California, which confirmed that a buyer is required to give the seller the opportunity to repair before contending a warranty for repair failed of its essential purpose. In *In re MyFord Touch Consumer Litigation*, the Court was confronted with a breach of warranty claim, and failure of essential purpose argument, involving Ford vehicles, where certain plaintiffs had not actually brought their cars in for a repair. The plaintiffs argued it would have been futile to bring the cars in for a repair under the circumstances alleged in the case, but the Court rejected that argument and instead confirmed that the case law requires “a plaintiff claiming breach of an express warranty to give the seller the opportunity to repair or replace the product ‘before the exclusive repair and replace remedy is considered to have failed of its essential purpose.’”

Here, Claimants failed to give Mitsubishi the necessary support or approval to continue to pursue or implement the Type 1 Repair; that support and approval was necessary because of the “in a mutually agreeable manner” requirement in Section 1.17.1.3. The Type 1 Repair, and therefore the Warranty, cannot be said to have failed of its essential purpose under these circumstances.

Second, regardless of the Tribunal’s conclusions regarding the Type 1 Repair, the Warranty cannot fail of its essential purpose given the option of, Mitsubishi’s recommendation of, and Claimants’ rejection of, replacement.

While Claimants now argue that, during contract negotiations, total replacement was never actually contemplated, the RSG Contract and evidence prove otherwise. Jeff Ellis, Edison’s Contracts Manager, testified that in negotiating the Contract, the parties specifically discussed that replacement

might involve the entire Apparatus under Section 1.17.1.3. Ellis was asked, “[I]f I have to remove the apparatus and reinstall it, and that’s the entire steam generator, that’s a significant repair that’s going to require a significant outage, isn’t it?” Ellis responded, “I don’t think that it makes a distinction – the language makes a distinction between a major or significant repair versus a minor one.”

██████████ also confirmed that the parties discussed that the term “Apparatus” as used in the Warranty provision was expressly intended to include the whole component. Importantly, ██████████ confirmed that he made clear to Claimants that if replacement of the entire RSGs was required, Mitsubishi would be obligated under the Warranty to replace the RSGs up to the Purchase Price (under the Liability Cap).

Consistent with these negotiations, the final Warranty provision in Section 1.17.1.3 included the assumption that replacement might be of the entire “Apparatus,” and “Apparatus” is defined in the RSG Contract as including the “RSG Units.” Notably, the definition of “RSG Unit” states, “when both of the RSG Units are being referred to at the same time, the term RSG Units is used.” Therefore, in addition to the testimony of Mr. Ellis and ██████████ the RSG Contract itself makes clear that the parties expressly contemplated that the Warranty included the option of total replacement.

The “Entire Agreement” provision in Section 1.37 precludes Claimants from arguing the understanding of the parties was otherwise. That provision provides, in relevant part, “The Purchase Order contains the entire agreement and understanding between the Parties and merges and *supersedes all prior representations and discussions* pertaining to the Purchase Order.” This is consistent with California law:

California recognizes the objective theory of contracts. It is the objective intent, as evidenced by the words of the contract, rather than the subjective intent of one of the parties, that controls interpretation. Thus, evidence of the undisclosed subjective intent of the parties is irrelevant to determining the meaning of contractual language. Rather, it is the outward manifestation or expression of assent that is controlling.

Claimants also recognized and focused on replacement as an option under the Warranty throughout the parties’ efforts to determine the path forward after the leak in January 2012. As soon as the SGRT team, led by Mr. Avella, was put in place, Mr. Avella made it clear that Claimants preferred replacement as the

only option that could materially improve the T/H conditions. For example, ██████ explained that, given Mr. Avella's focus on decreasing the void fractions and improving T/H conditions, "[t]he impression that I got was that there was a strong preference for replacement." ██████ further explained, "[O]n November 1, 2012, the SGRT asked Mitsubishi for daily updates on replacement activities. They never asked for such updates on our repair efforts. These actions made it clear to me that the SGRT preferred replacement to any repair option."

Eventually, at the meeting on December 14, 2012, ██████ explained that Mr. Avella interrupted a presentation on the thicker-AVB repair, "expressly rejecting the thicker-AVB repair. Mr. Avella clearly wanted Mitsubishi to recommend a replacement option instead of one that involved a repair." Shortly thereafter, on December 19, 2012, Mr. Avella sent a letter to ██████ demanding a single, final long term recommendation.

Mitsubishi recognized Claimants' ongoing disapproval of the repair option. Accordingly, on December 21, 2012, ██████ responded to Mr. Avella's letter in a letter stating,

"Based on the MHI technical assessment alone of the various proposed options, our understanding of SCE's evaluation criteria and considering the need for the parties to act expeditiously towards an acceptable remedy, MHI recommends Option #3 [replacement of the tube bundles] as the technical basis for a mutually agreeable remedy in accordance with the Purchase Order and subject to negotiation and agreement of acceptable terms and conditions."

Moreover, "Terms set forth in a writing intended by the parties as a final expression of their agreement with respect to the terms included therein may not be contradicted by evidence of a prior agreement or of a contemporaneous oral agreement."

Despite Claimants' previous and obvious emphasis on replacement, Mr. Dietrich responded to Mitsubishi's proposal on January 8, 2013 by arguing the proposal would breach the RSG Contract's requirement "that Mitsubishi actually repair or replace the RSGs with dispatch." Due to the time it could take to implement the replacement, Mr. Dietrich declared that "we believe it clear that any contractual limitations on liability are no longer applicable. We will therefore be looking to Mitsubishi to make SCE and its customers whole for all resulting damages."

Claimants have offered no evidence about what would have constituted “due diligence and dispatch” with regard to the replacement option. In fact, despite acknowledging a “commercially reasonable timeframe of 5-7 years” Claimants’ counsel refused to take a position when asked by Mr. Hinchey at the hearing how long Claimants expected replacement would have taken. Given Claimants’ unfounded rejection of the replacement option, the Warranty cannot have failed of its essential purpose.

Third, Section 1.17.1.3 provided that if Claimants believed Mitsubishi was not performing its warranty obligations with sufficient dispatch, Claimants could have “performed such warranty work and backcharge[d] the Supplier for direct costs for repair or replacement... .” Edison’s Jeff Ellis testified that Claimants include this backcharge option in their contracts for exactly the situation they say they were in with Mitsubishi: “And the reason we have that there is that if a supplier is -- is unwilling or unable or is very slow in implementing a warranty repair, we want – Edison wants the ability to go in and either make the repairs or have the repairs made to be able to get our plant back online as soon as possible. So we -- we always preserve that right.” It is undisputed that Claimants did not pursue this aspect of the Warranty.

Similarly, Section 1.17.1.3(b) also included the option for Claimants to “declare Supplier to be in default pursuant to Section 1.24.” Sections 1.24.2 and 1.24.3 of the RSG Contract provided Claimants with a number of additional options, including the options to terminate the Purchase Order in whole or in part and seek a refund up to the Purchase Price, seek equitable relief, or cure the default and obtain reimbursement from Mitsubishi for reasonable costs and expenses. As discussed *infra* at Section F.2(b)(ii), the ability to recover damages up to the amount of the Purchase Price alone constitutes a minimum adequate remedy for Claimants as a matter of law.

Again, Claimants may not have been required to pursue each of the options under the Warranty, but as a matter of law they cannot say the Warranty failed of its essential purpose where they chose not to avail themselves of the Warranty remedies.

➤ ***The Warranty cannot have failed of its essential purpose as a matter of law under these facts***

A claimant must attempt to avail itself of a limited remedy before it can assert that remedy failed of its essential purpose. “[A] limited repair or replacement remedy would not fail of its essential purpose if the aggrieved buyer never requested the seller to provide the limited remedy or precluded the seller from providing the limited remedy.”

The Central District of California, applying California law, explained and applied this concept. In *National Rural Telecommunications Cooperative v DIRECTV, Inc.*, the plaintiff NRTC argued that the limited remedy in its contract with DIRECTV failed of its essential purpose. The court, however, explained that under California law “[Section 2719(2)] becomes operative when a party is deprived of its contractual remedy. ... Moreover, an aggrieved party ‘[o]rdinarily ... must provide [the other] a reasonable opportunity to carry out the exclusive or limited remedy before ... successfully [arguing] failure of essential purpose.’”

The *NRTC* Court concluded that NRTC’s failure of essential purpose argument failed as a matter of law where the limited remedy at issue included options NRTC never pursued:

“In this case, NRTC has a remedy, namely, the partial refund of its Committed Member Payments. Additionally, NRTC never gave DIRECTV an opportunity to effect NRTC’s remedies under Section 11 of the Agreement. NRTC never sent a notice to cure; NRTC never terminated the Agreement; and NRTC never requested a refund of its Committed Member Payments.”

Here, Claimants were not deprived of the remedies under the Warranty. With an understanding of the risks and uncertainties inherent in their circumstances, the parties negotiated the Warranty under Section 1.17.1.3 to include the options of repair, replacement (which included replacement of the total Apparatus), or the backcharge or default options. After the leak occurred, Mitsubishi diligently tried to pursue repair and replacement options, but Claimants discouraged the Type 1 Repair efforts. Mitsubishi eventually recommended replacement, but Claimants responded immediately to inform Mitsubishi it was in breach of its contractual obligation because replacement would take too long. And Claimants never even attempted to utilize the other aspects of the Warranty, the backcharge and/or default options. Accordingly, Claimants cannot say the Warranty failed of its essential purpose.²⁴⁰¹

(iii) *The Tribunal’s Determination*

2573. The Tribunal has previously determined that MHI did not ignore or repudiate its warranty obligations.²⁴⁰² The Tribunal found that MHI offered a viable repair, which

²⁴⁰¹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 404-430.

²⁴⁰² See generally Section XV above.

was rejected as insufficient by SCE. Further, the Tribunal determined that MHI formally recommended replacement under the Warranty, but that the Claimants effectively declined that option by a decision to shutdown SONGS following the ASLB decision.²⁴⁰³ Also the Tribunal considered that both the repair and replacement proposals were pursued by MHI with “due diligence and dispatch” within the context of the RSG Contract and the circumstances presented by the Incident.²⁴⁰⁴ Notwithstanding those findings, the Tribunal will proceed to address the specific issues raised by the Parties with respect to Issue F.2(a)(ii) with reference to Section 2719 of the Commercial Code.

2574. Section 2719(2) of the Commercial Code, by its terms, becomes operative when a party is deprived of its contractual remedy. As previously determined by the Tribunal, the Claimants were not deprived of the repair or replacement Warranty remedy, nor did they lack other contractual remedies. The remedies available to the Claimants under the RSG Contract extended beyond the repair or replacement options, and included a back charge option and the ability to recover a refund up to the Purchase Price under a default option. Consequently, the Warranty cannot be considered to have failed its essential purpose under the applicable California law.
2575. The Warranty provision as stipulated in Section 1.17 of the RSG Contract, includes multiple components. Section 1.17.1.3 provides for the much debated repair or replacement options subject to the agreement of the Claimants and, in addition, the option for the Claimants to “perform[] such necessary warranty work and back charge the Supplier (...) and/or declare Supplier to be in default pursuant to Section 1.24.” Beyond that, the Claimants also had the right to terminate the Purchase Order

²⁴⁰³ See Section XIV.A(a) above; See also Sections VII.G(n)(i) and VII.G(o) above.

²⁴⁰⁴ See *inter alia* ¶¶ 2023-2026 above.

under Section 1.23 of the RSG Contract, and the right to seek a refund of up to the Liability Cap, i.e., the equivalent of the RSG Contract Purchase Price.

2576. It is undisputed that the Claimants never attempted to pursue the alternative options under Section 1.17.1.3, which included the back charge and default provisions. In other words, the Claimants were not deprived of the multiple Warranty remedies in Section 1.17.1.3, but rather elected not to avail themselves of those options. While the Claimants did solicit and review repair proposals from other vendors, including AREVA, Westinghouse, and B&W, these alternative options were not pursued by the Claimants.²⁴⁰⁵ Given these circumstances, the Warranty cannot be said to have failed of its essential purpose.
2577. The Claimants' characterization of the alternative options under the Warranty and the RSG Contract as requiring a "step-through" process misses the point, which is that Claimants were not restricted to a single remedy or even a severely limited number of remedies. Nor were the Claimants obligated to successively pursue or "step through" any one or all of the available remedies. These optional remedies were provided as additional and alternative remedies by the RSG Contract and were readily available to Claimants if they had chosen to exercise them. When it is recognized, first, that the RSG Contract included several Warranty remedies, all of which were at Claimants' option, second, that the Warranty remedies included repair or complete replacement of both RSG Units, also at Claimants' option, and third, that these remedies were freely negotiated and accepted by both Parties at the time the RSG Contract was executed, it cannot be credibly argued that the freely bargained for Warranty remedies failed their essential purpose or that the Claimants were deprived of their remedies.

²⁴⁰⁵ See Section VII.G(b) above.

2578. As the Tribunal found above, MHI developed and proposed a technically viable repair which, based on the weight of the evidence, could have been implemented within a reasonable amount of time and could likely have been licensed, had MHI been authorized to proceed.²⁴⁰⁶
2579. A limited warranty remedy cannot be said to have failed its essential purpose unless a seller actually has had a fair and reasonable opportunity to attempt a repair. The cases that the Claimants rely on, in which a warranty was found to have failed of its essential purpose, all involved situations where the seller was actually allowed to attempt a repair at least once, and in some cases, multiple times. For example, in *Chatlos Sys., Inc. v. Nat'l Cash Register Corp.*,²⁴⁰⁷ the Court applied New Jersey law, holding that the test is whether the seller is unable or unwilling to repair or replace. Also, the Court's rationale in determining whether a repair or replacement is unreasonable or untimely depends on the circumstances of the case in question, and in this case the seller had attempted a repair on several occasions.²⁴⁰⁸
2580. Similarly, in *Fiorito Bros. v. Fruehauf Corp.*,²⁴⁰⁹ the Ninth Circuit, applying the law of the State of Washington, noted that the sole remedy was repair or replacement. The seller refused to attempt a repair/replacement option and ignored its warranty obligations under the contract.

²⁴⁰⁶ See Section XIV.A(a) above.

²⁴⁰⁷ Exh. RL-112 (635 F.2d 1081, 1085 (3d Cir. 1980)).

²⁴⁰⁸ Similarly, in Exh. CL-232 (*Milgard Tempering, Inc. v. Selas Corp. of America*, 902 F.2d 703, 709 (9th Cir. 1990)); Exh. CL-134 (*RRX Industries v. Lab-Con, Inc.*, 772 F.2d 543, 548 (9th Cir. 1985)); Exh. RL-36 (*American Electric Power v. Westinghouse Electrical Corp.*, 418 F. Supp. 435, 460 (S.D.N.Y. 1976)), the seller in each instance was permitted a reasonable opportunity to repair or replace the defect in question.

²⁴⁰⁹ Exh. CL-086 (747 F.2d 1309, 1313 (9th Cir. 1984)).

2581. Hence, the actual or implicit holding in each of the cases cited by the Parties is to the effect that a finding that a warranty failed of its essential purpose requires an independent analysis in each case.
2582. In *S.M. Wilson*,²⁴¹⁰ the Court applied a case-by-case analysis, finding that the sales contract was limited to a repair or replacement remedy, without regard to a buyer's choice of the alternative remedies, as was the case with the SONGS RSGs. The *Wilson* Court also noted an alternative remedy in law, the "entitlement to recover the difference between the value of what [the buyer] should have received and the value of what [the buyer] got," which the buyer declined to assert on account of allegedly only suffering consequential damages.²⁴¹¹ *Wilson* is also distinguishable in that the seller was permitted to attempt repair, but the repair nonetheless failed. In the case at hand, SCE never agreed to permit the proposed repair.
2583. In this present dispute, the Claimants refused or failed to give MHI the necessary approval to continue to pursue or implement the Type 1 Repair, as the Claimants had the right to do because of the "in a mutually agreeable manner" requirement in Section 1.17.1.3.²⁴¹² This fact alone distinguishes this case from the cases relied on by Claimants. Accordingly, The Type 1 Repair, and therefore the Warranty, cannot be said to have failed of its essential purpose under these circumstances.
2584. The Tribunal also finds that the Warranty did not fail of its essential purpose, considering MHI's recommendation, and Claimants' rejection of, the replacement option. As the Tribunal discussed in Sections XIV.D and XV.D above, the Warranty provision in Section 1.17.1.3 of the RSG Contract expressly anticipates that replacement might be of the entire "Apparatus," which term is defined in the RSG

²⁴¹⁰ See Exh. CL-136 (587 F.2d 1363, 1375 (1978)).

²⁴¹¹ See Exh. CL-136 (587 F.2d 1363, 1375 (1978)).

²⁴¹² See Section XIV.A(a) above.

Contract as including both “RSG Units.” Consequently, the explicit terms of the RSG Contract itself make clear that the Claimants should have appreciated that the Warranty includes the option of a total replacement of both Units 2 and 3 within a normal time frame of 3 to 5 years.²⁴¹³

2585. The Claimants reference the deposition testimony of Mr. Ellis, who was involved with the negotiations of the RSG Contract for Edison.²⁴¹⁴ Mr. Ellis testified that the Parties did not contemplate the need for a replacement of all four Units, but only a major failure in one Unit.²⁴¹⁵ The Claimants further submit that only failure on account of a manufacturing issue, not design was contemplated.²⁴¹⁶ According to Mr. Ellis, a failure of all four Units was not contemplated as such an occurrence had not occurred in the industry. The Tribunal recalls that to operate a Unit, both steam generators in that Unit must be operational. If only one steam generator was offline, as per a scenario envisioned by the negotiators, this results in the entire Unit being out of service. The Tribunal therefore, does consider, a situation where an entire Unit would be offline was contemplated by the Parties. Further, the Tribunal takes note of the entire agreement clause in Section 1.37 of the RSG Contract:

The Purchase Order contains the entire agreement and understanding between the Parties and merges and supersedes all prior representations and discussions pertaining to the Purchase Order, including Supplier's proposal. Any changes, exceptions or different terms and conditions proposed by the Supplier, or contained in Supplier's acknowledgment of the Purchase Order, packaging, shipment documents, or invoice are hereby rejected unless expressly stated in the Purchase Order or incorporated therein by a Change Order.

²⁴¹³ RSG Contract, Sections 1.2.43 (RSG Unit); 1.2.4 (Apparatus); 1.17.1.3 (Warranty).

²⁴¹⁴ Claimants' and Respondents' Joint Deposition Designations of Mr. Ellis, p. 72.

²⁴¹⁵ Claimants' and Respondents' Joint Deposition Designations of Mr. Ellis, p. 72.

²⁴¹⁶ Claimants' RPHM, ¶ 544.

2586. The Claimants submit that there is a latent ambiguity in the RSG Contract when it comes to the interpretation of the replacement provision of Section 1.17.1.3:

Supplier shall be responsible for all costs and expenses associated with such repair or replacement, including but not limited to (i) any necessary adjustments, modifications, change of design, removal, repair, replacement or installation of the Apparatus. (...)

2587. The Tribunal finds no ambiguity in Section 1.17.1.3 of the RSG Contract. The provision clearly specifies that “change of design” is contemplated. Replacement of an entire steam generator is also contemplated, with provisions made for both the “removal” of a steam generator and the “installation” of a replacement. The “Apparatus” is also defined in Section 1.24 as “The RSG Units (...)” defined as:

RSG Unit: either the first two RSGs fabricated under the Purchase Order (which may be referred to more specifically as the "First RSG Unit") or the second pair of RSGs fabricated under the Purchase Order (which may be referred to more specifically as the "Second RSG Unit"); the Second RSG Unit is expected to be delivered soon after delivery of the First RSG Unit and **when both of the RSG Units are being referred to at the same time, the term RSG Units is used.** [emphasis added].²⁴¹⁷

2588. Accordingly, the Tribunal is not convinced by the Claimants’ submissions that the plain and explicit wording of Section 1.17.1.3 of the RSG Contract should be displaced.

2589. The Tribunal also took note of the lack of evidence offered by the Claimants about what length of time would have constituted “due diligence and dispatch” with regard to the replacement option. Given the absence of a reasonable time standard for replacement, coupled with the Claimants’ rejection of the replacement option, the Warranty cannot be said to have failed its essential purpose. It is noteworthy that not

²⁴¹⁷ RSG Contract, Section 1.2.43.

one of the other vendors retained by the Claimants offered evidence that a replacement of the RSGs could have occurred in substantially less time than estimated by MHI.

2590. The Tribunal further finds it significant that Section 1.17.1.3 of the RSG Contract provides that if the Claimants believed MHI was not performing its warranty obligations with sufficient dispatch, the Claimants could have “performed such warranty work and back charge[d] the Supplier for direct costs for repair or replacement (...).” It is undisputed that the Claimants did not pursue this aspect of the Warranty.
2591. Similarly, Section 1.17.1.3(b) of the RSG Contract includes the option for the Claimants to “declare Supplier to be in default pursuant to Section 1.24.” Additionally, Sections 1.24.2 and 1.24.3 of the RSG Contract provides the Claimants with a number of additional options, including the options to terminate the Purchase Order in whole or in part and seek a refund up to the Purchase Price, to seek equitable relief or to cure the default and obtain reimbursement from MHI for reasonable costs and expenses. The Claimants had no obligation to pursue each of the options under the Warranty, but, as a matter of law, they cannot say that the Warranty failed its essential purpose or that they were deprived of remedies, when they specifically chose not to avail themselves of these additional Warranty remedies.
2592. The case law in California recognizes that a claimant must attempt to avail itself of a limited remedy before it can assert that the remedy failed its essential purpose. As referenced by the Respondents, the Central District Court of California, applying California law, explained and applied this concept in *National Rural Telecommunications Cooperative v DIRECTV, Inc.*, where the plaintiff NRTC argued that the limited remedy in its contract with DIRECTV failed of its essential purpose. The court, however, explained that under California law “[Section 2719(2)]

becomes operative when a party is deprived of its contractual remedy (...) Moreover, an aggrieved party ‘[o]rdinarily ... must provide [the other] a reasonable opportunity to carry out the exclusive or limited remedy before (...) successfully [arguing] failure of essential purpose.’”²⁴¹⁸

2593. Thus, the Central District Court of California, in *NRTC*, concluded that NRTC had a remedy, namely, the partial refund of its Committed Member Payments. Additionally, NRTC never gave DIRECTV an opportunity to effect NRTC’s remedies under Section 11 of the applicable agreement. Similarly, NRTC never sent a notice to cure; never terminated the agreement; and never requested a refund of its Committed Member Payments.²⁴¹⁹ Thus, the Court decided that NRTC was not deprived of the Warranty remedies, which had not failed their purpose.

2594. Taking lessons from the *NRTC* decision, the Tribunal considers that the Claimants, in this case, were not deprived of the bargained-for Warranty remedies. Given the risks and uncertainties inherent in the design and installation of the RSGs, the Parties negotiated the Warranty under Section 1.17.1.3 of the RSG Contract to include SCE’s options of repair or replacement (which includes replacement of all Units) and the back charge or default options. After the leak occurred, MHI acted diligently to pursue repair and replacement options, but SCE discouraged these efforts and placed unreasonable requirements on MHI’s Type 1 Repair efforts.²⁴²⁰ MHI eventually recommended a replacement, but SCE responded immediately to inform MHI that it was in breach of its contractual obligation because the proposed replacement would take too long. The Claimants never even attempted to utilize the other aspects of the Warranty, the back charge and/or the default options.

²⁴¹⁸ Exh. RL-141 (319 F. Supp. 2d 1040, 1055).

²⁴¹⁹ Exh. RL-141 (319 F. Supp. 2d 1040, 1055).

²⁴²⁰ See Section XIV.A(a) above.

2595. Accordingly, the Tribunal concludes that the freely bargained-for Warranty remedies under Section 1.17 of the RSG Contract did not fail their essential purpose under Section 2719(2) of the Commercial Code; but rather the Claimants for their own economic reasons declined to pursue those remedies.

(iv) Considerations on Concurring and Dissenting Opinion

2596. In the foregoing analysis, the Majority has carefully taken into account the comments made in the Concurring and Dissenting Opinion concerning the limitation of liability.

2597. The Majority considers it pertinent to specifically address the view, set forth in the Concurring and Dissenting Opinion, that the Award's determination in this regard amounts to a violation of California public policy.

2598. The Tribunal recalls its mandate, under the ICC Rules, which require that the Tribunal "shall make every effort to make sure that the award is enforceable at law."²⁴²¹

2599. The Concurring and Dissenting Opinion provides that the failure to find for the Claimants is a violation of California public policy.

2600. The Concurring and Dissenting Opinion, however, provides no authority for the view that the Majority's determination, on what the Majority understands is Issue F.2(a)(ii), is a violation of California public policy. The opinions on public policy in the Concurring and Dissenting Opinion are set forth below:

Edison argues in response that California law and public policy do not permit Mitsubishi to enforce these limitations against Edison due to the nature of Mitsubishi's breach of its contractual obligations.²⁴²²

²⁴²¹ ICC Rules, Article 41.

²⁴²² Concurring and Dissenting Opinion, ¶ 4.

It is the public policy of the state of California that a sales contract must contain remedies sufficient to provide the buyer with the “substantial value of the bargain.”²⁴²³ This policy is implemented through section 2-719(2) of the California Commercial Code, which renders a limitation on the buyer’s remedy to repair or replacement invalid if it “fails of its essential purpose,” which is to provide the buyer with the product that meets the contract’s requirements within a reasonable period of time.²⁴²⁴

While I have the utmost respect for the Tribunal, in my view the Tribunal’s determination that the RSG Contract’s limitation of remedy and liability cap are enforceable is predicated on misinterpretations of the RSG Contract and California law and is inconsistent with California public policy.²⁴²⁵

California law and public policy require the Tribunal to determine whether Mitsubishi’s default caused Edison to suffer losses that were not within the parties’ bargained-for allocation of risk.²⁴²⁶

The public policy underlying this limitation is the recognition that, when the buyer agrees to limit his remedy to repair or replacement, the agreement is based on the buyer’s assumption that, in the event of breach, repair or replacement of the product will be sufficient to provide the buyer with the “substantial value of the bargain.” In other words, the buyer does not give up its right to receive the value of its bargain—the reason why parties sign contracts in the first place—just because the

²⁴²³ Concurring and Dissenting Opinion, ¶ 8. Citing to Official Comments to Cal. Comm. Code § 2-179 [RL-21].

²⁴²⁴ Concurring and Dissenting Opinion, ¶8; citing to Cal. Comm. Code § 2-719(2); *Milgard Tempering, Inc. v. Selas Corp. of Am.*, 902 F.2d 703 (9th Cir. 1990); *S.M. Wilson & Co. v. Smith Int’l, Inc.*, 587 F.2d 1363, 1375 (9th Cir. 1978) (citing Jonathan A. Eddy, On the ‘Essential’ Purposes of Limited Remedies: The Metaphysics of UCC Section 2-719(2), 65 Cal. L. Rev. 28, 63 (1977)). See, e.g., *Milgard*, 703 F.3d at 708-09; *RRX Indus., Inc. v. Lab-Con, Inc.*, 772 F.2d 543, 547 (9th Cir. 1985).

²⁴²⁵ Concurring and Dissenting Opinion, ¶ 16.

²⁴²⁶ Concurring and Dissenting Opinion, ¶ 17. Citing to *E.g., Milgard*, 902 F.2d at 708-09; *RRX*, 772 F.3d at 547 [CL-42].

buyer agrees to limit the remedy to which it is entitled to repair or replacement.²⁴²⁷

This public policy is reflected in section 2-719(2) of the California Commercial Code, which provides that where a limited remedy “fails of its essential purpose, remedies may be had as provided in this Code.”²⁴²⁸

Rather, the concept of unconscionability that underpins section 2-719(2) of the California Commercial Code is the recognition that a limitation on the buyer’s remedy, an “apparently fair and reasonable clause” at the time the contract was signed, may, because of changed circumstances, operate to deprive the buyer of the “substantial value of the bargain,” and become unconscionable. That is because it is against the public policy of the state of California to enforce a limitation on the seller’s liability if it permits the seller to default without an adequate remedy at law for the buyer.²⁴²⁹

I disagree with the Tribunal’s reasoning as inconsistent with California law and public policy.²⁴³⁰

The Tribunal’s reasoning is inconsistent with the RSG Contract and the public policy of California, which requires that the adequacy of a remedy be evaluated by determining whether it provides the buyer with the “substantial value” of its bargain.²⁴³¹

Second, to the extent the [Award’s] findings rely on the liquidated damages available under the Performance Warranty (§ 1.17.2), the [Award’s] findings also contravene California law and public policy.²⁴³²

²⁴²⁷ Concurring and Dissenting Opinion, ¶ 134, Citing to Official Comments to Cal. Comm. Code 2-719 [RL-21]; see *S.M. Wilson*, 587 F.2d at 1374-75 [CL-53].

²⁴²⁸ Concurring and Dissenting Opinion, ¶ 135. Quoting the Commercial Code.

²⁴²⁹ Concurring and Dissenting Opinion, ¶ 136. Citing to Official Comments to Cal. Comm. Code § 2-719(2) [RL-21]; *RRX Indus*, 772 F.2d at 547 [CL-52].

²⁴³⁰ Concurring and Dissenting Opinion, ¶ 150.

²⁴³¹ Concurring and Dissenting Opinion, ¶ 153.

²⁴³² Concurring and Dissenting Opinion, ¶ 155. See RSG Contract Sections 1.17.2, 1.29.2.1.

In my view, the Tribunal’s reasoning is inconsistent with California law and public policy.²⁴³³

As explained above, the public policy underlying section 2-719(2) of the California Commercial Code is the assurance of “minimum adequate remedies” to the buyer such that, in the event that the seller defaults on its obligations, the buyer is entitled to recover the “substantial value” of the bargain.²⁴³⁴

The Ninth Circuit has recognized the meaning of this comment in relation to the public policy underlying section 2-719(2). As the Court held in *RRX Industries*, “[n]either bad faith nor procedural unconscionability is necessary under California Commercial Code § 2719(2). It provides an independent limit when circumstances render a damages limitation clause oppressive and invalid.”²⁴³⁵

The public policy underlying the decisions that have considered the issue of the validity of damages limitations in the context of the seller’s default is similar to the public policy underlying the “failure of essential purpose” doctrine in the context of limitations of the buyer’s remedy to repair or replacement.²⁴³⁶

In my view, California public policy, as interpreted by the Court of Appeals for the Ninth Circuit, requires Mitsubishi, not Edison, to bear these losses, as they arose from the materialization of a risk Edison did not agree to bear in the RSG Contract.²⁴³⁷

2601. The Claimants do not submit, contrary to what is mentioned in the Concurring and Dissenting Opinion,²⁴³⁸ as cited above, that the contractually negotiated limitations of liability are a violation of California public policy. The Concurring and Dissenting

²⁴³³ Concurring and Dissenting Opinion, ¶ 161.

²⁴³⁴ Concurring and Dissenting Opinion, ¶ 162. Citing to Official Comments to Cal. Comm. Code § 2-719 [RL-21]; see *RRX Indus.*, 772 F.2d at 547 [CL-52].

²⁴³⁵ Concurring and Dissenting Opinion, ¶ 163. Citing to *RRX Indus.*, 772 F.2d at 547 [CL-52]; see *Fiorito Bros. v. Freuhauf Corp.*, 747 F.2d 1309, 1314-15 (9th Cir. 1984) [CI-31].

²⁴³⁶ Concurring and Dissenting Opinion, ¶ 168.

²⁴³⁷ Concurring and Dissenting Opinion, ¶ 180. Referencing *Milgard* [CL-46].

²⁴³⁸ Concurring and Dissenting Opinion, ¶ 4.

Opinion provides no supporting reference to the Claimants' submissions in this regard.²⁴³⁹

2602. The Concurring and Dissenting Opinion relies upon the authorities of *Milgard*, *RRX Industries*, *S.M. Wilson*, and *Fiorito Bros*. None of those authorities, which have been considered in this Award,²⁴⁴⁰ make any mention of California public policy in regard to Section 2719 of the Commercial Code.
2603. Nor is it reasonable that they would.
2604. Section 2719 of the Commercial Code provides the statutory conditions upon which a buyer may exert remedies against a seller in conditions which supplant a negotiated sales contract. Section 2719, as such, ensures that a buyer has adequate remedies from a seller's purported breach of a sales contract.
2605. It cannot be the case that where, on the facts, an arbitral tribunal finds that the contractually negotiated remedies are sufficient, or where there is no unconscionability, this determination results in a breach of California public policy. It is not the case that either the buyer wins or an award is null for violation of public policy.
2606. California law, as applied in this case, requires that the Tribunal weigh the facts at hand. As the above authorities provide, determinations under Section 2719 of the Commercial Code are heavily dependent upon the specific facts of every case, i.e., whether the particular contractual remedies available to a particular buyer are adequate under California law. California public policy does not dictate the particular outcome of such a factual determination. This is especially true as in this case, when

²⁴³⁹ Concurring and Dissenting Opinion, ¶ 4.

²⁴⁴⁰ For *Milgard*, see ¶¶ 2559, 2579 and 2613; *RRX Industries*, ¶¶ 2559, and 2579, *S.M. Wilson*, ¶¶ 2557, 2558, 2559, 2613, 2614, and 2616; and *Fiorito Bros* ¶¶ 2559 and 2580.

the contractual remedies explicitly address the circumstances that actually occurred, i.e., the potential for repair or replacement of the entire Apparatus.

2607. The Majority considers that it has met its obligations in this regard. Assuming that the Parties had made submissions regarding California public policy, the Majority finds that no aspect of California public policy, or California law for that matter, has been violated by the determination of Issue F.2(a)(ii) or any other determination in this Award.

(d) **If so, was that failure so total and fundamental that the exclusion of consequential damages must be expunged from the RSG Contract, as alleged by Claimants? Alternatively, has enforcement of the consequential damages waiver become oppressive by change of circumstances, such that it must be expunged from the RSG Contract? (Issue F.2(a)(iii))**

2608. This Sub-Issue arises only (i) in the event that the Tribunal has determined the warranty remedies to have failed, and requires the Tribunal to determine whether such failure was so total and fundamental that the exclusion of consequential damages must be expunged from the RSG Contract, or if (ii) the enforcement of such exclusion of consequential damages became oppressive by change of circumstances. As the limited warranties did not fail, the Tribunal only considers the question of whether a change of circumstances should result in the expunging of the consequential damages waiver of the RSG Contract.

(i) *The Claimants' Position*

2609. In their Responses to Joint List of Issues, the Claimants submit that "Mitsubishi's default was total and fundamental because it could not provide any repair or replacement that would enable the RSGs to operate within any reasonable period of time. The damages suffered by Claimants are approximately 50 times more than the \$138 million limitation of liability. Under any metric, enforcing the waiver of consequential damages is oppressive. When the parties signed the RSG Contract no

one anticipated that all four RSGs would fail, would need replacement, and there would be no beneficial repair within a reasonable amount of time. The limited remedies and damage limitations did not allocate risk for those circumstances. These facts satisfy either articulation of the Ninth Circuit’s test for expunging waivers of consequential damages—either that the failure to repair or replace was total and fundamental or the waiver of consequential damages oppressive by chance of (i.e. unforeseen) circumstances.”²⁴⁴¹

2610. In addition, in their C-RPHM, the Claimants contend the following:

Respondents’ default was total and fundamental because they could not provide any repair or replacement that would enable the RSGs to operate within any reasonable period of time.

The parties agree that there is nothing “magical about the phrase ‘total and fundamental default’ in relation to [Section 2719(2)].” Instead, courts undertake a case-by-case analysis to determine whether “the default caused a loss which was not part of the bargained-for allocation of risk.” That analysis has been equated to the alternative determination of whether an exclusion of consequential damages has become “oppressive by change of circumstances.”

As demonstrated by *S.M. Wilson*, the total and fundamental failure of a remedy is a matter of degree. There, the Ninth Circuit held that a seller’s inability to repair the machine meant the remedy failed of its essential purpose, but that failure was not a total and fundamental failure (or oppressive by a change of circumstances) because the machine still worked—albeit more slowly than bargained for. Therefore, the buyer was not wholly deprived of the good purchased and losses outside the bargained-for risk allocation did not rise to the level of “oppressive by a change of circumstances.”

➤ ***The Failure Of The Limited Remedy Was Total And Fundamental***

The record is clear that the failure of the limited remedy was total and fundamental. The Warranty makes clear the importance of prompt repairs, minimizing any steam generator downtime. The Warranty requires Respondents to repair “with due diligence and dispatch,” to begin repairs

²⁴⁴¹ Claimants’ Responses to Joint List of Issues, ¶ D.2(a)(iii), pp. 69-70.

“within two days,” to continue performing repairs diligently, and to perform Warranty repairs “at the Jobsite to minimize the down time of the Apparatus.” The RSG Contract also granted Edison the right to continue to operate the RSGs, “or any part thereof, which may require warranty correction or repair until such time as EMS or Edison elects to remove such Apparatus, or part thereof from service.” The testimony from Respondents’ own witnesses demonstrates that the parties contemplated weeks or perhaps months for a repair when they were negotiating the RSG Contract—not multiple years.

There was no fix for the RSGs that could restore them to service within a reasonable time period, let alone with “dispatch.” Even if Respondents’ Type 1 repair proposal could have been presented to the NRC in June 2013, which it could not have been, and even if the Type 1 repair proposal would have been approved, which it would not have been, the repair still would have taken another 46-65 months to implement. Thus, any Type 1 repair of the RSGs would have taken five to seven years to complete. As Respondents admitted in 2012, a repair or replacement requiring that amount of time was “beyond the scope of [the parties’] agreement.” Respondents clearly stated that they would never agree to undertake a replacement—implicitly conceding that a replacement could not be completed with “due diligence and dispatch.”

There is no dispute that SONGS was a baseload plant (i.e., a plant in virtually full-time operation, providing stability to the power grid). The plant powered approximately two million homes. It would be wholly inequitable and inconsistent with California law to require Edison to continue spending millions of dollars a day for years while it waited for Respondents to develop, test, and present a viable, comprehensive, supported, and licensable repair plan—to say nothing of the additional years required to secure regulatory approval and implement a repair, in the poisoned regulatory environment created by Respondents’ conduct.

And it would be beyond folly to force Edison to wait past the point where the potential benefits of any such repair were outweighed by the costs of keeping SONGS operable. Under such circumstances, forcing Edison to wait 16 months for a viable repair plan (which never came) was not reasonable—and forcing Edison to wait 65 months for the design, testing, manufacture, approval, and installation of the Type 1 repair proposal (assuming all those things would even happen and assuming it would be licensable) went well beyond either dispatch or reason. No matter which of Respondents’ hypothetical scenarios the Tribunal considers, the failure of the repair or replace remedy was total and fundamental.

The evidence demonstrates that after 16 months of analysis, responses to RFIs, testing at Chalk River, and multiple OAs, Edison could not even turn the less damaged SONGS Unit back on at 70% power for 5 months. That reality is a product of just how deeply defective these RSGs were: After more than a year of inspection, reflection, and discussion, the NRC would not allow Edison to turn the virtually brand-new “good” unit back on even for a quarter of a normal cycle and even at much-reduced power. The ASLB’s holding that even this limited restart was an “experiment” requiring a license amendment meant that Edison could not turn Unit 2 back on at any power level for any period of time before the benefits of doing so were completely eviscerated. And Unit 3 was so crippled that no one seriously suggested restarting it during the SONGS outage.

In the face of these record facts, Respondents continually refuse to engage with the consequences of their conduct. Instead, their only responses are to assert generally that the waiver of consequential damages cannot become oppressive because it works in Respondents’ favor or because of the magnitude of the damages sought. Simply put, that is not and has never been recognized by the governing cases as a basis for upholding limitations of liability in the circumstances presented here.

➤ ***The Waiver Of Consequential Damages Is Oppressive By Change Of Circumstances***

Similarly, the record demonstrates that the waiver of consequential damages is “oppressive by a change of circumstances” where Respondents’ inability to perform their Warranty obligations caused damages that were outside the bargained-for risk allocation. As both parties agree, no one contemplated a scenario where all four RSGs were so totally and fundamentally defective that they could not be repaired with diligence and dispatch and would need to be taken offline at the same time for a complete re-design. Certainly, Edison did not contract for the delivery of RSGs that were so riddled with errors and bad design choices that they exhibited thermal-hydraulic conditions never before experienced by the industry and suffered extreme and unprecedented tube wear leading to the permanent shutdown of SONGS within one cycle of their operation. Respondents’ RSGs were supposed to have a 40 year operating life, yet they failed after 11 months (for Unit 3) and 22 months (for Unit 2). The magnitude of those damages confirms that they were not part of the bargained-for risk allocation—Edison never agreed to bear the risk of damages 50 times more than the price of the RSG Contract. By any measure or reasonable

consideration, enforcing the waiver of consequential damages in these circumstances would be oppressive.²⁴⁴²

(ii) *The Respondents' Position*

2611. In their Position Statement on the Revised List of Issues, the Respondents, while referring to their submissions concerning Issues F.2(a) and F.2(a)(ii) above and Issue F.2(a)(iv) below, contend the following:

[T]he Warranty did not fail of its essential purpose, but even if it had, as explained in Sections F.2(a) and F.2(a)(iv), neither of Claimants' proposed questions addresses the Liability Cap or articulates the proper analysis for determining the enforceability of the Mutual Waiver. Even if these questions were relevant or applicable, however, Claimants cannot prove either a "total and fundamental" failure or that the Mutual Waiver is "oppressive by change of circumstances."

Claimants' own cited Ninth Circuit case law states that there is "nothing magical about the phrase 'total and fundamental' default in relation to U.C.C. 2-719(2)." Instead, the court's focus is on "the characteristics of the contract" and, as the court concluded in *S.M. Wilson*, where "[p]arties of relatively equal bargaining power negotiated an allocation of their risks of loss" and "[the seller] did not ignore his obligation to repair; he simply was unable to perform it," the Mutual Waiver remains enforceable.

To the extent "total and fundamental" has meaning, *S.M. Wilson* concluded that, because the parties were of equal bargaining power and the seller did not ignore his obligation to repair, the "default of the seller is not so total and fundamental." The same conclusion applies here where again the parties were of equal bargaining power and Mitsubishi did not ignore its warranty obligations, as discussed above in Section F.2(a)(ii), and therefore any failure by Mitsubishi was not "total and fundamental."

Further, it cannot be said that any failure of the Warranty was "total and fundamental" given Claimants' disregard of the Type 1 Repair, their rejection of Mitsubishi's recommendation of replacement, and their refusal to pursue in any way the default or backcharge options in the Warranty, as discussed above in Section F.2(a)(ii).

²⁴⁴² Claimants' RPHM, ¶¶ 548-557.

The disparity between the damages Claimants have asserted for the purpose of this arbitration and the amount Claimants bargained to recover under the RSG Contract also cannot support a finding regarding any alleged failure of the Warranty. Claimants' own cited case law – *S.M. Wilson* – specifically stated that the alleged magnitude of the consequential damages was not a factor in determining the failure of the limited repair remedy.

The Mutual Waiver also has not become “oppressive” by change of circumstances. As admitted by Edison’s Jeff Ellis, Claimants themselves included the Mutual Waiver as one of their own standard terms, aimed at protecting Claimants from “the types of consequential damages Edison would want to avoid, would want to have waived by the supplier.” Given the parties’ extensive negotiations on the proper allocation of risk with respect to the Purchase Price of the RSG Contract, the extent of Mitsubishi’s actions to perform under the Warranty, and Claimants’ own actions and decisions related to Mitsubishi’s ability to perform under the Contract, the Mutual Waiver does not become oppressive simply because it would work in Mitsubishi’s favor, rather than Claimants’.²⁴⁴³

(iii) *Tribunal’s Determination*

2612. For completeness, the Tribunal briefly addresses the question of what is meant by “total and fundamental” as raised in this Issue F.2(a)(iii) before turning to the question of change of circumstances.
2613. It is true that case law in California recognizes that there is “nothing magical about the phrase ‘total and fundamental’ default in relation to UCC. 2-719(2).”²⁴⁴⁴ Instead, the California Courts’ focus is on “the characteristics of the contract” and, as the Court concluded in *S.M. Wilson*, where “[p]arties of relatively equal bargaining power negotiated an allocation of their risks of loss” and “[the seller] did not ignore

²⁴⁴³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 431-436.

²⁴⁴⁴ Exh. CL-232 (*Milgard Tempering, Inc. v. Selas Corp. of America*, 902 F.2d 703, 709 (9th Cir. 1990))

his obligation to repair; he simply was unable to perform it,” the mutual waiver of consequential damages remains enforceable.²⁴⁴⁵

2614. Applying the interpretation of “total and fundamental” in *S.M. Wilson*, where the Court concluded that because the parties were of equal bargaining power and the seller did not ignore his obligation to repair, the “default of the seller is not so total and fundamental.”²⁴⁴⁶ The same conclusion applies here where no one disputes that the Parties were of equal bargaining power.
2615. As considered in relation to Issue F.2(a)(ii) above,²⁴⁴⁷ the Claimants unilaterally placed unreasonable limitations on MHI’s proposed Type 1 Repair, then later refused to pursue the replacement option suggested by MHI, and further elected not to pursue in any way the default or back charge options in the Warranty.²⁴⁴⁸ It cannot, therefore, be credibly contended that any failure of the Warranty was “total and fundamental” within the meaning of California law.
2616. The Claimants emphasize the disparity between the damages they have asserted for the purpose of this Arbitration and the damages they would be entitled pursuant to the limitation imposed by the liability cap and the waiver of consequential damages they bargained for under the RSG Contract. In this regard, it must be noted that the Court in *S.M. Wilson* specifically stated that the alleged magnitude of the consequential damages was not a factor in determining the failure of the limited repair remedy.²⁴⁴⁹

²⁴⁴⁵ Exh. CL-136 (*S.M. Wilson v. Smith International, Inc.*, 587 F.2d 1363, 1375 (1978)).

²⁴⁴⁶ Exh. CL-136 (*S.M. Wilson v. Smith International, Inc.*, 587 F.2d 1363, 1375 (1978)) (“Risk shifting is socially expensive and should not be undertaken in the absence of a good reason. An even better reason is required when to so shift is contrary to a contract freely negotiated.”).

²⁴⁴⁷ Section XVIII.B(c) above.

²⁴⁴⁸ See Section XIV.A(a) above.

²⁴⁴⁹ Exh. CL-136 (*S.M. Wilson v. Smith International, Inc.*, 587 F.2d 1363, 1375 (1978)) (“We do not weigh the alleged magnitude of consequential damages in determining whether the limited repair

2617. Further, the Claimants have not convincingly established that the mutual waiver has become “oppressive by change of circumstances” based on the facts and circumstances of this case.²⁴⁵⁰ In fact, the “change of circumstances” was the Claimants’ placing unreasonable requirements on the Type 1 repair option and refusal to pursue replacement of the RSGs. Moreover, the Claimants themselves included the mutual waiver as one of their own standard terms, so as to protect themselves from consequential damages SCE would want to avoid if claimed by a supplier.²⁴⁵¹ Indeed, the potential of extraordinarily large exposures to unexpected losses are one of the main reasons for inserting waivers of consequential damages in commercial contracts.
2618. Given the Parties’ extensive negotiations on the proper allocation of risk with respect to the Purchase Price of the RSG Contract, MHI’s extensive efforts to perform under the Warranty, and the Claimants’ own actions and decisions related to MHI’s ability to perform under the Contract, the Tribunal concludes that the mutual waiver did not become oppressive simply because it would work in MHI’s favor.

(e) **Does Section 2719(2) of the California Commercial Code require a showing of unconscionability in order to support a finding that the exclusion of consequential damages is unenforceable? (Issue F.2(a)(iv))**

2619. With respect to Issue F.2.(a)(iv), the Tribunal determines whether Section 2719(2) of the Commercial Code requires a showing of unconscionability in order for the waiver of consequential damages to be rendered unenforceable.

remedy failed of its essential purpose, because of the presence of the contractual exclusion of any liability for consequential damages.”).

²⁴⁵⁰ Note that the Tribunal’s findings that the Warranty remedies did not become oppressive as a matter of fact in this case should be distinguished from the Dissent’s positions that the California Commercial Code, Official Comment to §2719 recognizes that warranties may fail of their essential purpose or become oppressive due to post-contract change of circumstances.

²⁴⁵¹ Claimants’ and Respondents’ Joint Deposition Designations of Mr. Ellis, pp. 35-36.

(i) The Claimants' Position

2620. In their Responses to Joint List of Issues, the Claimants submit that “[u]nconscionability relates to Subsection (3) of Section 2719, which is an independent and alternative means of overturning a waiver of consequential damages from Subsection (2). Under Subsection (2), the Ninth Circuit has held that “[u]nconscionability is irrelevant.”²⁴⁵²
2621. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

California law is clear that unconscionability is not required to determine that an exclusion of consequential damages is unenforceable under Section 2719(2)—i.e. where a limited remedy totally and fundamentally failed its essential purpose.

Respondents claim that only Section 2719(3)—and not Section 2719(2)—can invalidate a contractual waiver of consequential damages. Thus, Respondents assert that Claimants must demonstrate that the waiver of consequential damages is both procedurally and substantively unconscionable. They term this approach to the statute the “independent approach.”

The Ninth Circuit has expressly considered and rejected this argument, regardless of the nomenclature employed. That court has held that “[n]either bad faith nor procedural unconscionability is necessary under California Commercial Code § 2719(2) [which] provides an independent limit when circumstances render a [waiver of consequential damages] oppressive and invalid.” In short, where Subsection (2) applies, “[u]nconscionability is irrelevant.” Indeed, in *RRX Industries, Milgard*, and *Fiorito Bros*, the Ninth Circuit held that waivers of consequential damages were unenforceable because a limited remedy failed of its essential purpose totally and fundamentally, without any finding of unconscionability.

Under California Law, a waiver of consequential damages may be invalidated for two independent reasons: (1) under Section 2719(2), when it is linked to a remedy that fails of its essential purpose and that failure is “total and fundamental” (an ex post determination); and (2) under Section 2719(3), where

²⁴⁵² Claimants’ Responses to Joint List of Issues, ¶ D.2(a)(iv).

it is unconscionable at the time of contract (an *ex ante* determination). When seeking to invalidate an exclusion of consequential damages under Section 2719(3), plaintiffs need not show that any limited remedy failed of its essential purpose. Conversely, there is no requirement under Section 2719(2) (and no California court has ever held) that a plaintiff seeking to demonstrate “failure of essential purpose” must also meet the unconscionability requirement of Section 2719(3). Respondents have presented no logical reason for applying the strictures of Section 2719(3) to Section 2719(2). It is a separate part of the statute, subject to separate analysis.

Understanding that California law could not be more clear and dispositive, Respondents instead ask the Tribunal to disregard the law governing this dispute and instead apply law from outside the jurisdiction. Unlike California, Illinois law holds that “[u]nconscionability can be either ‘procedural’ or ‘substantive’ or a combination of both.” Respondents ignore this distinguishing feature of Illinois law, and instead seek to substitute into their gerrymandered standard California’s more stringent unconscionability standard, which requires a showing of *both* procedural and substantive unconscionability. Thus, in an analytical jumble, Respondents have transposed the strict California unconscionability standard onto the narrow Illinois framework, to create a hybrid standard that has never been applied in either jurisdiction. The Tribunal should reject Respondents’ self-serving and unprincipled mixing and matching of legal standards and apply the prevailing Ninth Circuit analysis of California law.

Respondents’ reliance on these out-of-state cases is nothing more than a request to change California law (and for that matter, Illinois law). Even those cases recognize that different states take different approaches to applying their own states’ version of Section 2719(2). As the court in *Razor v. Hyundai Motor America* conceded, there are “two main schools of thought.” California has adopted one of those schools of thought—which was the majority approach at that time. The fact that other states—applying their own law, which varies from California—have subsequently taken a different course does not compel the Tribunal to abandon California authority, nor would it be appropriate to do so given that California is the governing law of the RSG Contract.

In an attempt to mask their reliance on other states’ laws, Respondents overreach and assert that two California cases follow the “independent approach.” This is wrong. Neither California case cited by Respondents—*Nat’l Rural Telecomms. Coop.* or *Nunes Turfgrass*—adopts the “independent approach,” and instead stand for the unremarkable and undisputed proposition that Subsection 2719(3) requires a showing of unconscionability in order to

find unenforceable an exclusion of consequential damages. Neither case mentions Subsection 2719(2), let alone contradicts the Ninth Circuit law interpreting that Subsection.

Nor does Respondents' argument that "California courts seek to interpret and apply UCC provisions consistent with the majority approach" make any sense—or come with support. This is not an issue of first impression in California. There is clear precedent on point, which Respondents are simply unable to distinguish and which governs this issue. Those cases should be followed.

In sum, Respondents' attempt—again—to evade the strictures of Section 2719(2) by imposing an unconscionability requirement finds no support in California law and should be rejected.²⁴⁵³

(ii) *The Respondents' Position*

2622. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants' proposed Issue F.1(a)(iv) misleadingly focuses only on Subsection 2719(2). Although Subsection 2719(2) itself does not directly address the unconscionability analysis, Section 2719 overall does require a showing of unconscionability to invalidate the Mutual Waiver because of the existence of Subsection 2719(3). Subsection 2719(3) was specifically included in Section 2719 to govern the analysis of limitations or exclusions of consequential damages provisions. As discussed below in Section F.2(b), the California Court of Appeal in *Nunes Turfgrass* stated that Section 2719(3) "expressly allows the limitation or exclusion of consequential damages for commercial loss unless the limitation or exclusion is unconscionable."

Further, *Razor v. Hyundai Motor America*, explained: "The two provisions—limitation of remedy and exclusion of consequential damages—can be visualized as two concentric layers of protection for a seller. . . . This repair or replacement remedy is an outer wall, a first defense. If that wall is breached, because the limited remedy has failed of its essential purpose, the seller still would prefer at least not to be liable for potentially unlimited consequential damages, and so he builds a second inner rampart as a fallback position. That

²⁴⁵³ Claimants' RPHM, ¶¶ 558-566.

inner wall is higher, and more difficult to scale—it falls only if unconscionable.”

The Indiana Supreme Court also recently explained that “[T]he drafters of the UCC inserted distinct legal standards into each provision. A limited remedy will be struck when it fails of its essential purpose; an exclusion of consequential damages fails when it is unconscionable. . . . These facial distinctions between §§ 2-719(2) and (3) suggest a legislative intent that the provisions should function independently of one another.”

Claimants’ narrow and misleading reliance on a statement in *RRX Industries, Inc. v. Lab-Con, Inc.*, 772 F.2d 543 (9th Cir. 1985) regarding the absence of unconscionability analysis within Subsection 2719(2) should be rejected for the reasons set forth in Section F.2(a), which distinguishes *RRX* generally, and because of *RRX*’s misunderstanding or misapplication of Section 2719(3) as being only an *ex ante* consideration, explained in Section F.2(b)(iv).

However, even if Claimants succeed in arguing only Subsection 2719(2) applies, which itself does not rest on an unconscionability determination, both the Liability Cap and Mutual Waiver are still enforceable as directly held by Claimants’ cited case law, *S.M. Wilson* (discussed in Section F.2(a) above).²⁴⁵⁴

(iii) *The Tribunal’s Determination*

2623. As a preliminary matter, the Tribunal considers that while Section 2719(2) of the Commercial Code, by its own terms, does not directly address the unconscionability analysis, Section 2719(3) of the Commercial Code requires a showing of unconscionability to invalidate the mutual waiver. Section 2719(2) was specifically included in Section 2719 to govern the analysis of limitations or exclusions of consequential damages provisions. The California Court of Appeal in *Nunes Turfgrass* stated that Section 2719(3) “expressly allows the limitation or exclusion of consequential damages for commercial loss unless the limitation or exclusion is unconscionable.”²⁴⁵⁵

²⁴⁵⁴ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 437-441.

²⁴⁵⁵ Exh. CL-318 (*Nunes Turfgrass, Inc. v. Vaughan-Jacklin Seed Co.*, 200 Cal. App. 3d 1518, 1539 (1988)).

2624. The rationale of Section 2719(3) of the Commercial Code in the context of Section 2719 as a whole was appropriately explained in *Razor v. Hyundai Motor America*, as follows: “The two provisions - limitation of remedy and exclusion of consequential damages - can be visualized as two concentric layers of protection for a seller (....) This repair or replacement remedy is an outer wall, a first defense. If that wall is breached, because the limited remedy has failed of its essential purpose, the seller still would prefer at least not to be liable for potentially unlimited consequential damages, and so he builds a second inner rampart as a fallback position. That inner wall is higher, and more difficult to scale - it falls only if unconscionable.”²⁴⁵⁶
2625. Even if the Claimants are correct in arguing that under California law, a waiver of consequential damages may be invalidated under Section 2719(2), when it is linked to a remedy that fails its essential purpose and that failure is “total and fundamental,” the Tribunal has previously found²⁴⁵⁷ that the Warranty remedies did not fail their essential purpose, nor was there a “total and fundamental” failure of the Warranty options.²⁴⁵⁸ For clarity, the Tribunal’s findings that the Warranty remedies did not fail of their essential purposes or become oppressive as a matter of fact in this case should be distinguished from the perspective that the California Commercial Code, Official Comment to §2719 recognizes that warranties *may* fail of their essential purpose or become oppressive due to post-contract change of circumstances.
2626. Consequently, the Tribunal determines Issue F.2(a)(iv) in the affirmative. Section 2719(2) of the California Commercial Code, properly interpreted in the context of Section 2719 in its entirety, means that the mutual waiver of the consequential

²⁴⁵⁶ Exh. CL-127 (*Razor v. Hyundai Motor America*, 222 Ill.2d 75 (2006) 854 N.E.2d 607, 619); see also *Rheem Mfg. Co. v. Phelps Heating & Air Conditioning, Inc.*, 746 N.E.2d 941, 948 (Ind. 2001) (adding that “[t]he independent view is also the modern trend.”).

²⁴⁵⁷ Section XVIII.B(c)(iii) above.

²⁴⁵⁸ Section XVIII.B(d)(iii) above.

damages provision is governed by Section 2719(3), meaning that it is invalid only if the Claimants can demonstrate that it was unconscionable at the time of entering into the RSG Contract (an *ex ante* determination).

(f) **If so, is the waiver of consequential damages (Section 1.21) both procedurally and substantively unconscionable? (Issue F.2(a)(iv)(a))**

2627. The Tribunal determines below whether the contractual provision containing a waiver of consequential damages was procedurally and substantively unconscionable in this case.

(i) *The Claimants' Position*

2628. In their Responses to Joint List of Issues, the Claimants submit that “[t]his (...) analysis is not applicable, as it conflates California’s unconscionability standard with Illinois’s Section 2719 analysis to create a hybrid test that applies in neither jurisdiction.”²⁴⁵⁹

2629. In addition, in their C-RPHM, the Claimants contend that they “do not need to show—and therefore have never argued—that the exclusion of consequential damages was unconscionable. Claimants do assert, however, that in the circumstances presented, enforcing the consequential damages waiver would be “oppressive by change of circumstances,” as recognized by California law governing the “failure of essential purpose” doctrine under Section 2719(2).”²⁴⁶⁰

(ii) *The Respondents' Position*

2630. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

²⁴⁵⁹ Claimants’ Responses to Joint List of Issues, ¶ D.2(iv)(a).

²⁴⁶⁰ Claimants’ RPHM, ¶ 567.

The Mutual Waiver is not unconscionable. Although the Commercial Code does not separately define unconscionability, it “has generally been recognized to include an absence of meaningful choice on the part of one of the parties together with contract terms which are unreasonably favorable to the other party. Unconscionability has both a ‘procedural’ and a ‘substantive’ element.”

In *National Rural Telecommunication Cooperative v. DIRECTV, Inc.*, the court also evaluated the unconscionability of a limitation of liability provision. The Court, applying California law, noted that the provisions were clearly labelled, and “[b]oth parties were sophisticated, represented by counsel, and negotiated the Agreement at arm's length.” “Moreover, [defendant] is equally bound by the limitation of liability provisions at issue. . . . “Where two equal bargainers ... agree as to the appropriate remedy ... they should be held to the terms of their bargain.”” The court found the limitation of liability was not unconscionable, as a matter of law.

Claimants have not attempted to, nor could they, demonstrate that the Mutual Waiver was unconscionable *ex ante*, given the undisputed evidence in this case. According to SCE’s Jeff Ellis, the Mutual Waiver was included by Claimants as one of their own standard terms, aimed at protecting Claimants from “the types of consequential damages Edison would want to avoid, would want to have waived by the supplier. Such a provision, benefitting both parties and agreed upon after extensive contractual negotiations between sophisticated parties, cannot be found to be unconscionable.

Claimants’ statement in their closing argument slides that “Respondents’ argument, if accepted, would mean that no ‘sophisticated party’ could ever overcome a waiver of consequential damages in California” is largely accurate, but does not lead to the result Claimants seek. In fact, a leading treatise has confirmed this conclusion: “Findings of unconscionability should be and are rare in commercial settings.” As Professors White, Summers and Hillman explain, “nearly all cases between sophisticated parties in which remedies were fully negotiated impose a heavy burden of proof and persuasion on the parties seeking to invalidate the agreement. A general survey of the cases shows that the party seeking to invalidate the agreement in such cases typically loses.” The Mutual Waiver is not unconscionable.²⁴⁶¹

²⁴⁶¹ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 442-445.

(iii) Tribunal's Determination

2631. Regardless of whether the doctrine of unconscionability is “procedural” or “substantive” in nature, the Tribunal concludes that the mutual waiver is not unconscionable for the following reasons.
2632. Although “unconscionable” is not defined in the California Commercial Code, the term has generally been recognized, by case law, to mean an absence of meaningful choice on the part of one of the parties, together with contract terms that are unfairly favorable to the other part, in particular, this has been highlighted in the *Nunes Turfgrass* decision.²⁴⁶²
2633. In *NRTC v. DIRECTV, Inc.*,²⁴⁶³ the District Court, applying California law, noted that the waiver provisions were clearly labeled, and “[b]oth parties were sophisticated, represented by counsel, and negotiated the Agreement at arm’s length (....) Moreover, [defendant] is equally bound by the limitation of liability provisions at issue (....) “Where two equal bargainers (....) agree as to the appropriate remedy (....) they should be held to the terms of their bargain.”²⁴⁶⁴ Accordingly, the Court, in the *Nunes* case found the limitation of liability was not unconscionable as a matter of law.
2634. The Tribunal finds that the mutual waiver was neither procedurally nor substantially unconscionable in this case, given the undisputed evidence that (i) the mutual waiver

²⁴⁶² Exh. CL-318 (*Nunes Turfgrass, Inc. v. Vaughan-Jacklin Seed Co.*, 200 Cal. App. 3d 1518, 1534 (1988)) (Cases that have discussed substantive unconscionability discuss “‘overly harsh’ or ‘one-sided’ results” (Exh. CL-318, p. 1535). The *Nunes Turfgrass* Court concluded the limitations of liability in its case were not unconscionable, based on the following facts: “[T]he plaintiff was familiar with and read and understood, and even had similar restrictions on its products. Certainly it was a part of the agreement between the parties, the Plaintiff knew the Defendant would not sell the seed at this price without [sic] all the limitations and the Court finds that the limitation under all of the circumstances is not unconscionable in this case” (Exh. CL-318, p. 1539).

²⁴⁶³ Exh. RL-141 (*Nat’l Rural Telecomms. Coop.*, 319 F. Supp. 2d 1040 (C.D. Cal. 2003) (applying California law)).

²⁴⁶⁴ Exh. RL-141 (319 F. Supp. 2d 1040, 1054-1055).

was included by Claimants as one of their own standard terms; and (ii) the fact that neither Party could be said to be in an unequal bargaining position at the time of contracting. Such a provision, benefitting both parties and agreed upon after extensive contractual negotiations between sophisticated parties, cannot be found to be unconscionable.

2635. Accordingly, the mutual waiver, having been negotiated by two willing and sophisticated parties, and having been mutually accepted as fair at the time of contracting, should be enforced.

(g) **Should Cal. Com. Code 2719's analysis be applied as Respondents contend, namely by answering the following: (Issue F.2(b))**

(i) *The Tribunal's Determination*

2636. The Tribunal addresses in this Issue all the associated Sub-Issues, F.2(b)(i) through F.2(b)(vi).

Have the warranty remedies (Section 1.17) failed of their essential purpose under Cal. Com. Code Section 2719(2)? (Issue F.2(b)(i))

Are the warranty remedy (Section 1.17), the exclusion of consequential damages (Section 1.21.1) and the liability cap (Section 1.21.2) subject to independent analysis? (Issue F.2(b)(ii))

Has the liability cap of the RSG Contract failed its essential purpose? (Issue F.2(b)(iii))

Is the exclusion of consequential damages (Section 1.21.1) governed by Cal. Com. Code Section 2719(3)? (Issue F.2(b)(iv))

Have Claimants met their burden to prove the exclusion of consequential damages (Section 1.21.1) is both procedurally and substantively unconscionable? (Issue F.2(b)(v))

Even if the warranty remedy (Section 1.17), the exclusion of consequential damages (Section 1.21.1) and the liability cap (Section 1.21.2) are a “unitary package of risk-allocation,” as Claimants contend, do all three provisions automatically fail if one provision fails of its essential purpose, or do the liability cap and/or the exclusion of consequential damages still survive under the case-by-case approach set forth in Claimants’ Ninth Circuit case law? (Issue F.2(b)(vi))

2637. In Issue F.2(a), and its sub-Issues, the Tribunal analyzed each of the aforesaid questions raised under Issue F.2(b).
2638. Specifically, the Tribunal’s determination of Issue F.2(a)(ii) addresses the question raised in Issue F.2(b)(i) and determined that the warranties in the RSG Contract had not failed of their essential purpose.²⁴⁶⁵
2639. Further, the Tribunal’s finding that the warranty provisions in the RSG Contract did not fail to meet their essential purpose also serves to render Issue F.2(b)(iii) moot, which concerns the question of whether the liability cap of the RSG Contract failed its essential purpose. These questions arise only in the event that the warranty remedies have been determined to fail of their essential purpose, and when the liability cap is determined to fall along with the warranty provisions on the premise that they are part of a unitary package.²⁴⁶⁶ Given the Tribunal’s determination that the warranty remedies have not failed of their essential purpose, and that the liability cap does not attach itself to the warranty remedies as part of a unitary package, Issue F.2(b)(iii) is rendered moot.
2640. The Tribunal’s determination of Issue F.2(a)(i) on unitary risk allocation²⁴⁶⁷ also addresses the question in Issue F.2(b)(ii) regarding whether the exclusion of

²⁴⁶⁵ See ¶ 2594 above.

²⁴⁶⁶ Claimants’ Responses to Joint List of Issues, ¶ D.2(b)(iii), pp. 71-72; C-RPHM, ¶ 574.

²⁴⁶⁷ See ¶ 2568 above.

consequential damages is to be analyzed independently of the issues regarding the enforceability of the liability cap.

2641. Similarly, the Tribunal's determination of Issue F.2(a)(iv)²⁴⁶⁸ answers Issue F.2(b)(iv).
2642. Likewise, the determination of Issue F.2(a)(iv)(a), concerning the unconscionability of the waiver of the consequential damages, answers Issue F.2(b)(v),²⁴⁶⁹ regarding whether the exclusion of consequential damages is both procedurally and substantively unconscionable.
2643. Lastly, with respect to Issue F.2(b)(vi), whether a unitary package of risk-allocation or a case-by-case approach should be adopted, the Tribunal, in its determination of Issue F.2(a), considered the Ninth Circuit case law relied upon by the Claimants, and determined that the common thread ensuing from these cases is that California law prescribes a case-by-case analysis. On a case-by-case analysis, the Tribunal determined, in Issues F.2(a) and F.2(a)(iv)(a), that the liability cap and the waiver of consequential damages continue to be enforceable. Thus, Issue F.2(b)(vi) is also rendered moot.

C. DOES SECTION 1668 OF THE CALIFORNIA CIVIL CODE INVALIDATE THE EXCLUSION OF CONSEQUENTIAL DAMAGES (SECTION 1.21.1) AND LIABILITY CAP (SECTION 1.21.2), AS ALLEGED BY CLAIMANTS? (ISSUE F.3)

2644. Section 1668 of the Civil Code provides:

All contracts which have for their object, directly or indirectly, to exempt anyone from responsibility for his own fraud, or willful injury to the

²⁴⁶⁸ See ¶ 2626 above.

²⁴⁶⁹ See ¶ 2635 above.

person or property of another, or violation of law, whether willful or negligent, are against the policy of the law.

2645. The Claimants submit that Section 1668 of the Civil Code invalidates the exclusion of consequential damages provision and liability cap in Section 1.21 of the RSG Contract. The Respondents challenge this submission.

(i) The Claimants' Position

2646. In their Responses to Joint List of Issues, the Claimants submit the following:

First, Section 1668 of the California Civil Code invalidates contractual provisions “that purport to exempt an individual or entity from liability for . . . gross negligence.” In the alternative, Section 1668 applies to invalidate any contract which “exempt(s) anyone from responsibility for his own fraud . . . whether willful or negligent.” Under either application, Section 1668 would therefore apply to invalidate both the liability cap and exclusion of consequential damages.”²⁴⁷⁰

2647. In addition, in their C-RPHM, the Claimants, referring to their submissions concerning Issue D.2(a), above, submit that “the evidence shows that Respondents were grossly negligent in designing, manufacturing and ultimately delivering Defective RSGs to be used in a nuclear setting (...) [T]he evidence also shows that Respondents engaged in fraudulent conduct.”²⁴⁷¹

2648. Further, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend the following:

Respondents argue that Section 1668 is not applicable here because the limitation of liability and consequential damages waiver are not exculpatory clauses that exempt a party from all liability. Yet Section 1668 has been used in California to invalidate limitations of liability that are not “complete

²⁴⁷⁰ Claimants' Responses to Joint List of Issues, ¶ D.3.

²⁴⁷¹ Claimants' RPHM, ¶ 580.

exemptions,” particularly where there is evidence of intentional fraud or negligent misrepresentation.

Respondents’ position that Section 2719 of the Commercial Code supplants the application of Civil Code Section 1668 is similarly flawed. There is no case holding that Section 2719 supersedes Section 1668. Neither is there any language in the Commercial Code indicating that it repeals Civil Code Section 1668. California courts have recognized this fact, noting that the Commercial Code “neither expressly nor impliedly repeals” Civil Code Section 1668. Instead, Section 1668 is the “policy of law” in this state.

Absent express repeal of Section 1668, which does not exist, in order to show that Section 2719 supersedes Section 1668, Respondents must show that Section 2719 of the Commercial Code and Section 1668 are clearly, actually, and irreconcilably inconsistent. Respondents have not done so here. Instead, Respondents rely on *Nunes Turfgrass*, a case arising from a dispute over the sale of grain seed, which the court carefully notes is “unique because seed is a unique chattel,” requiring particular reliance on a line of cases addressing seed sales. *Nunes* did not hold that Section 2719 supplanted the application of Section 1668 in all commercial cases. At most, *Nunes* stands for the narrow proposition that Section 1668 does not invalidate exculpatory clauses in contracts for the sale of goods that limit liability for negligent violations of the law. Notably, *Nunes* has not been relied upon by any court for the proposition that Section 1668 is not applicable to contracts governed by the Commercial Code. Moreover, there was no fraud (intentional or negligent), willful injury, or intentional violation of the law at issue in the case – all conduct that is at issue here.²⁴⁷²

(ii) *The Respondents’ Position*

2649. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

California Civil Code Section 1668 (“Section 1668”) does not invalidate either the Liability Cap or Mutual Waiver. The Liability Cap itself excludes fraud, gross negligence, and willful violations of law from its application. Moreover, California case law demonstrates that Section 1668 applies to exemptions from *all liability*, and not to limitations of liability that simply limit economic harm. Specifically, *CAZA Drilling (California), Inc. v. TEG Oil & Gas U.S.A., Inc.*, held that certain limitations of liability (including a mutual waiver of

²⁴⁷² Claimants’ RPHM, ¶¶ 581-583.

consequential damages) did not violate Section 1668 because the provision did not provide a complete exemption, but rather limited liability for economic harm. Similarly here, the Liability Cap and Mutual Waiver do not attempt to provide complete exemptions from liability, but rather limit the economic damages Claimants may recover.

There is also California case law that concluded that the more specific provision of California Commercial Code Section 2719(3), which authorizes limitations on damages for commercial loss unless that limitation is unconscionable, prevails over the more general provision in Civil Code Section 1668. In *Nunes Turfgrass*, the Court stated that “[i]t is also settled law that when a special and a general statute are in conflict, the former controls” and it concluded that even if the disclaimer at issue violated Section 1668, the limitations of liability were enforceable under the more specific provision of Section 2719(3), which expressly allows an exclusion of consequential damages for commercial loss unless the exclusion is unconscionable.²⁴⁷³

(iii) The Tribunal’s Determination

2650. The Tribunal agrees with the Respondents that Section 1668 of the California Civil Code does not invalidate either the liability cap or mutual waiver for the following reasons. Section 1668 provides that “all contracts which have for their object, directly or indirectly, to exempt any one from responsibility for his own fraud, or willful injury to the person or property of another, or violation of law, whether willful or negligent, are against the policy of the law.”
2651. Section 1.21.1 of the RSG Contract does not exempt the Respondents from the consequences of gross negligence or fraud, because the Liability Cap itself excludes fraud, gross negligence and willful violations of law from its application. It reads as follows:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that **such limitation of liability shall not apply to:** (i) Supplier's indemnification obligations

²⁴⁷³ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 463-464.

hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, **fraud, willful misconduct or illegal or unlawful acts**; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks. (emphasis added)²⁴⁷⁴

2652. Further, a plain reading of the liability cap and mutual waiver shows that these contract provisions do not attempt to provide complete exemptions from liability, but rather operate to limit the economic damages that the Claimants may recover.
2653. This approach is supported by at least two relevant decisions applying California law, both of which have held that certain limitations of liability (including a mutual waiver of consequential damages) did not violate Section 1668 of the Civil Code. These California cases are based on the rationale that the provisions in question did not provide a complete exemption, but rather only served to limit the liability for economic harm.²⁴⁷⁵
2654. On the facts of this case, the Tribunal has found that the Claimants have not made out a case of fraud, willful injury or violation of law, as addressed in Issues D²⁴⁷⁶ and F.2.²⁴⁷⁷

²⁴⁷⁴ RSG Contract, Section 1.21.1.

²⁴⁷⁵ Exh. RL-172 (*CAZA Drilling (California), Inc. v. TEG Oil & Gas U.S.A., Inc.*, 142 Cal. App. 4th 453, 475 (2006)); see also Exh. CL-234 (*Peregrine Pharms., Inc. v. Clinical Supplies Mgmt., Inc.*, No. SACV 12-1608 JGB ANX, 2014 WL 3791567, at *1 (C.D. Cal. July 31, 2014) (“[T]he LOD clauses do not ‘exempt’ CSM from responsibility for any of the causes of action in this litigation. They merely limit the amounts and types of damages available to Peregrine for these violations.”)).

²⁴⁷⁶ Section XVI above.

²⁴⁷⁷ Section XVIII.D above.

2655. Accordingly, the Tribunal finds that Section 1668 of the California Civil Code does not invalidate the exclusion of consequential damages (Section 1.21.1) and liability cap (Section 1.21.2) of the RSG Contract.

D. REGARDING THE EXCLUSIONS TO THE LIABILITY CAP SET FORTH IN SECTION 1.21.2 OF THE RSG CONTRACT: (ISSUE F.4)

(a) Have Claimants met their burden of proving gross negligence under California law? (Issue F.4(i))

2656. As specified in Issue F.3, above, the RSG Contract provides for the condition under which the limitation of liability cap is excluded:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that **such limitation of liability shall not apply to:** (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) **any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts;** or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks. (emphasis added)²⁴⁷⁸

2657. The Parties dispute whether the Claimants have met their burden of proving gross negligence under California law.

(i) The Claimants' Position

2658. In their Responses to Joint List of Issues, the Claimants submit that “[a]mong other gross errors and omissions, Respondents breached dozens of provisions of the RSG

²⁴⁷⁸ RSG Contract, Section 1.21.1.

Contract in addition to the Performance and Defect Warranties, designed and delivered fundamentally defective RSGs, failed to conduct an adequate quality assurance program when safety is a critical concern in the nuclear industry, and deliberately prevented their codes from calculating key in-plane vibration modes.”²⁴⁷⁹

(ii) The Respondents’ Position

2659. In their Position Statement on the Revised List of Issues, the Respondents contend that the “Claimants have not met their burden of proving gross negligence under California law.”²⁴⁸⁰

(iii) Tribunal’s Determination

2660. The Tribunal defers and joins the determination of this Issue until subsequent to its determination in Issues F.4(i)(a) and F.4(i)(b) below, regarding the Claimants’ gross negligence allegations.

(b) Have Claimants proven that Mitsubishi’s conduct was an extreme departure from the standard of care required? (Issue F.4(i)(a))

2661. While negligence requires a breach of the standard of care owed, gross negligence requires that the allegedly breaching behavior consists of an “extreme departure” from the standard of care required. The Parties dispute whether the Respondents’ actions meet this standard.

(i) The Claimants’ Position

2662. In their Responses to Joint List of Issues, the Claimants submit that “[i]n addition to the myriad errors and omissions discovered by Claimants’ experts, Claimants proved that Respondents ignored the warnings of their consultants that the design-era

²⁴⁷⁹ Claimants’ Responses to Joint List of Issues, ¶ D.4(i).

²⁴⁸⁰ Respondents’ Position Statement on the Revised List of Issues, ¶ 465.

thermal-hydraulic and velocity calculations seemed low, including Mr. Langford's direct identification of the Gap Velocity Error. Had that error been corrected, Respondents would have known that stability ratios exceeded 1.0. Moreover, witnesses for both parties testified that Mitsubishi did not follow industry practice with regard to in-plane modes. Claimants also proved that Mitsubishi's quality assurance program was disastrous and did not meet even the standards set by its own "experts" in quality assurance. Thus, Claimants proved that Respondents missed clear opportunities to identify the exact problems that led to the failure at SONGS."²⁴⁸¹

2663. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that the "Respondents' attempt to shield themselves from liability by pointing to a lack of industry practice regarding in-plane FEI fails, as California law is clear that compliance with industry standard is not a defense to a negligence claim: "The standard is always due care. The presence or absence of custom does not alter that standard."²⁴⁸²

(ii) The Respondents' Position

2664. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

To prove gross negligence, Claimants must not only establish the traditional elements of ordinary negligence, they must also prove that Mitsubishi acted with the "want of even scant care" or displayed an "extreme departure from the ordinary standard of conduct." To show ordinary negligence, Claimants must proffer expert testimony proving the standard of care from which Mitsubishi allegedly departed.

Mitsubishi demonstrated that it followed existing design standards with respect to in-plane FEI. Claimants provided scant evidence that there was a standard

²⁴⁸¹ Claimants' Responses to Joint List of Issues, ¶ D.4(i)(a).

²⁴⁸² Claimants' RPHM, ¶ 585.

for designing to prevent in-plane FEI. But even if Claimants had introduced such evidence, they have not shown that Mitsubishi grossly departed from it.

The parties' experts disagreed about whether out-of-plane FEI occurred. The record remains unclear, however, as to whether Claimants' experts were testifying about classic FEI or gap-limited FEI, which even Claimants' experts agree have vastly different consequences. Regardless of the distinction, Claimants failed to establish an industry standard against which to judge Mitsubishi's conduct.

The gap velocity error—which Mitsubishi discovered and disclosed—caused it to under-predict stability ratios. But when that error was corrected, the predicted stability ratios were all still well below 1.0 (assuming all supports effective). At most, Claimants can argue that Mitsubishi failed to meet its own stability ratio criteria as a result of the gap error. But Claimants did not prove that Mitsubishi actually established a stability ratio design criteria. While evidence was introduced about discussions and presentations concerning the stability ratio analyses and what criteria *might* be used, the design documents contain no acceptance standard for stability ratios. And even if Mitsubishi had established criteria that might serve as a standard for gross negligence, there was no evidence presented that it willfully or recklessly departed from any such criteria. Mitsubishi believed that it correctly applied its design process, but was mistaken as a result of human error in the gap conversion; this error had no impact on the prediction of FEI. This was not gross negligence; Claimants produced no evidence supporting a finding of reckless or wanton disregard of an established standard.

And even if the gap conversion error led to *gap-limited* FEI, as discussed above, Claimants failed to prove that gap-limited-FEI would prevent the safe operation of the plant or was the cause of in-plane FEI leading to the tube-leak.²⁴⁸³

²⁴⁸³ Respondents' Position Statement on the Revised List of Issues, ¶¶ 466-470.

(iii) The Tribunal's Determination

2665. To meet their burden to prove gross negligence under California law, the Claimants must establish that MHI acted with “want of even scant care” or displayed an “extreme departure from the ordinary standard of conduct.”²⁴⁸⁴
2666. The Tribunal has determined that the weight of the evidence establishes that MHI followed contemporaneous design standards with respect to preventing in-plane FEI.²⁴⁸⁵ The Tribunal’s analysis on in-plane FEI also considered that, regardless of industry practice, in-plane FEI only occurred once a tube was lacking six consecutive support points and that it was not apparent that a steam generator designer undertaking in-plane FEI calculations would assess such a scenario.²⁴⁸⁶
2667. While the Tribunal accepts that gap limited out-of-plane FEI occurred at SONGS, the Claimants have not convincingly demonstrated that this is a type of wear that is excluded under the RSG Contract, as rather, gap limited out-of-plane FEI appears to be a unavoidable occurrence in steam generators.²⁴⁸⁷ As Mr. Langford, the Claimants’ witness, testified, sometimes this results in a “polishing” of the tube over the life of the steam generator.²⁴⁸⁸
2668. The Tribunal does not consider that the Claimants have persuasively demonstrated that the nine alleged design errors²⁴⁸⁹ or the Claimants’ other alleged design errors²⁴⁹⁰ were material to the RSG design or to the occurrence of the Incident, or to the extent

²⁴⁸⁴ Exh. RL-232 (*Rosencrans v. Dover Images, Ltd.*, 192 Cal. App. 4th 1072, 1073 (2011)); Exh. CL-173 (*City of Santa Barbara v. Super. Ct.*, 41 Cal. 4th 747, 754 (2007)).

²⁴⁸⁵ See ¶¶ 1468 - 1473 above.

²⁴⁸⁶ See ¶¶ 1473 - 1476 above.

²⁴⁸⁷ Section XIII.D(c)(iii) above.

²⁴⁸⁸ See ¶ 1445 above.

²⁴⁸⁹ See generally Section XI above.

²⁴⁹⁰ See generally Section XII above.

that they were material, such as with the SSPC Errors and the Gap Velocity Error, they constitute gross negligence.

2669. The most that the Claimants' evidence established was that because of MHI's admitted Gap Velocity Error, it under-predicted stability ratios. However, while this evidence may have resulted in an under-prediction of the stability ratio to SCE, it does not establish an industry standard nor does it demonstrate a violation of such a standard, if it did exist. Even when the Gap Velocity Error was discovered and corrected, the predicted stability ratios were all still below 1.0 (assuming all supports effective). Such demonstrates that there was no classic out-of-plane FEI.
2670. Further, the Tribunal does not consider that the Respondents ignored the advice of its consultants. Rather, the Respondents investigated these concerns and took actions to address them.²⁴⁹¹ This does not constitute ignoring concerns, let alone demonstrating a "want of even scant care."
2671. The Claimants have also not demonstrated that the Respondents' quality assurance program amounts to a departure from the standard of care.²⁴⁹² In this regard, the Claimants' submissions were premised on the existence of the nine alleged design errors and other alleged design errors that the Tribunal has not accepted to be material to the RSG design.
2672. While evidence was introduced about discussions and presentations concerning the stability ratio analyses and what criteria might be used,²⁴⁹³ the design documents contain no acceptance standard for stability ratios. To the contrary, it appears that steam generator designers have discretion in the selection of these criteria. Moreover,

²⁴⁹¹ See Sections VII.D(e)(ii) and VII.D(e)(iii) above.

²⁴⁹² See Section XIII.D(f)(iii) above.

²⁴⁹³ See Section XII.C(a) above.

even if it could be argued that MHI did establish criteria by its predictions, there was no convincing evidence presented that it willfully or recklessly departed from any such criteria.

2673. Accordingly, the Respondents were not grossly negligent under California law and the Claimants have not established the basis for a finding of reckless or wanton disregard of an established standard. Therefore, the Tribunal answers Issue F.4(i)(a) in the negative.

2674. In addition, the Tribunal also then determines that the Claimants have not met their burden of proof in Issues F.4(i) above.²⁴⁹⁴

(c) **Have Claimants proven the other elements of negligence, as required for a finding of gross negligence? (Issue F.4(i)(b))**

2675. The other requirements for a finding of gross negligence are the existence of a duty of care, the breach of that duty, and harm suffered on account of that breach. In this Sub-Issue, the Tribunal addresses these other elements of gross negligence, to the extent necessary.

(i) *The Claimants' Position*

2676. In their Responses to Joint List of Issues, the Claimants submit that they “showed that Respondents owed both a contractual and a regulatory (NRC, ASME N-Stamp) duty of care in designing the RSGs. Claimants proved that the duty was breached and that the breach caused extensive harm.”²⁴⁹⁵

²⁴⁹⁴ See ¶ 2660 above.

²⁴⁹⁵ Claimants' Responses to Joint List of Issues, ¶ D.4(i)(b).

(ii) The Respondents' Position

2677. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

In order to state a claim for gross negligence, Claimants must first prove that they have met the traditional elements of negligence, “duty, breach, causation, and damages.” Claimants have not met nor even tried to meet this burden.

(...)

Claimants have failed to offer any evidence that would establish the standard of care against which Mitsubishi’s conduct is to be judged. Claimants have further failed to demonstrate that any breach of any contractual duty by Mitsubishi was the cause of their damages.²⁴⁹⁶

(iii) Tribunal’s Determination

2678. In order to state a claim for gross negligence under California law, the Claimants must first prove that they have met the traditional elements of negligence, “duty, breach, causation, and damages.”²⁴⁹⁷

2679. The Tribunal has previously determined that the Claimants have demonstrated the following design errors:

SSPC Downcomer Friction Error;²⁴⁹⁸

SSPC Downcomer Contractions Error;²⁴⁹⁹

SSPC Downcomer Turn Error;²⁵⁰⁰ and

²⁴⁹⁶ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 471-472.

²⁴⁹⁷ Exh. RL-113 (*Chavez v. 24 Hour Fitness USA, Inc.*, 238 Cal. App. 4th 632, 640 (2015) (citing Exh. RL-232 (*Rosencrans v. Dover Images, Ltd.* 192 Cal. App. 4th 1072, 1082 (2011)))).

²⁴⁹⁸ Section XI.A(a) above.

²⁴⁹⁹ Section XI.A(b) above.

²⁵⁰⁰ Section XI.A(c) above.

The Respondents' admitted Gap Velocity Error.²⁵⁰¹

2680. Nevertheless, there is no convincing evidence of any particular connection between these three SSPC errors and any harm suffered by the Claimants or that if these errors had not occurred, a different design would have been adopted.²⁵⁰²
2681. With regard to the admitted Gap Velocity Error, i.e., the FIT-III Post-Processor conversion error, the Tribunal is not convinced that this error resulted in the Incident at SONGS. As set out above, the Claimants have calculated that, assuming one support point to be inactive, accounting for the Gap Velocity Error results in Stability Ratios that exceed 1.0, indicating instability. The Respondents have submitted that calculating under this assumption is not improper, as the AVBs are physically present in the RSGs as built. The Tribunal accepts the Respondents' submission.²⁵⁰³
2682. Even accepting the Claimants' submission that the stability ratios should be evaluated with one support point inactive, such that there is calculated instability when accounting for the Gap Velocity Error, the Claimants' have not convincingly established that there was in-plane instability at SONGS on account of the Gap Velocity Error. That is, even assuming that one should evaluate out-of-plane FEI assuming one ineffective support, and that on account of the Gap Velocity Error and this assumption, out-of-plane stability ratios exceed 1.0, this does not imply that in-plane FEI, and the harm at SONGS, occurred, for those reasons. The Claimants have failed to demonstrate a required causal connection between the alleged error and harm, which is required for a finding of gross negligence.
2683. Nonetheless, the Claimants have sought to prove that there was out-of-plane FEI. The Parties and their experts have provided various opinions to the Tribunal as to

²⁵⁰¹ Section XI.C(a) above.

²⁵⁰² See ¶ 1250 above.

²⁵⁰³ See ¶ 1448 above.

whether out-of-plane FEI occurred and if so whether it amounts to classic out-of-plane FEI or gap-limited FEI, i.e., tube to AVB wear. The Respondents' have persuasively shown that in designing the RSGs, the requirement is to avoid classic FEI in which there is rapid tube-to-tube wear (TTW), which quickly degrades the tubes. The T/H forces that cause Gap-limited FEI are always present in an operating RSG and, accordingly, gap-limited FEI is a tube-to-AVB wear consideration, not an instability concern.²⁵⁰⁴

2684. Further, there is evidence that out of the approximately 19,000 tubes in Unit 2, two tubes experienced out-of-plane TTW.²⁵⁰⁵ The investigations into those tubes concluded that one possible explanation was out-of-plane FEI.²⁵⁰⁶ Another explanation was that those two tubes were poorly manufactured or assembled such that they were in close proximity.²⁵⁰⁷ Despite the TTW in these two tubes, the Claimants found that Unit 2 was safe to restart and petitioned that the NRC authorize a restart.²⁵⁰⁸ Given the severe consequences of FEI on tube wear, the Tribunal interprets the Claimants' intention to restart Unit 2 as indicative of those two tubes not having suffered from classic out-of-plane FEI.

2685. In light of the above, the Claimants have established only that MHI is responsible for certain errors in the RSG design. However, they have not established that these errors were the cause of the Incident, nor have they established that the errors were the source of the claimed damages by the Claimants.

²⁵⁰⁴ See ¶ 1436.ii above.

²⁵⁰⁵ See ¶ 1436.vii above.

²⁵⁰⁶ See ¶ 1436.vii above.

²⁵⁰⁷ Exh. JX-1322, p. 135.

²⁵⁰⁸ See ¶ 612 above.

2686. Accordingly, the Tribunal answers Issue F.4(i)(b) in the negative. The Claimants have not met their burden of establishing the required elements of gross negligence.

(d) **Have Claimants met their burden of proving fraud? (Issue F.4(ii))**

2687. Section 1.21.2 of the RSG Contract also incorporates an exception to the limitation of liability for fraud. Section 1.21.2 of the RSG Contract provides:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that such limitation of liability shall not apply to: (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks.

(i) *The Claimants' Position*

2688. The Claimants make no submission on this Sub-Issue, and refer to their submissions concerning Issues A.1(g) and D above.²⁵⁰⁹

(ii) *The Respondents' Position*

2689. In their Position Statement on the Revised List of Issues, the Respondents make a reference to their submissions concerning Issue D above, and contend that the "Claimants have not met their burden of proving fraud."²⁵¹⁰

²⁵⁰⁹ Claimants' Responses to Joint List of Issues, ¶ D.4(ii).

²⁵¹⁰ Respondents' Position Statement on the Revised List of Issues, ¶ 473.

(iii) The Tribunal's Determination

2690. Above, when determining Issue D.1 the Tribunal determined that the Claimants have not met their burden of proving fraud in the inducement as a separate tort.²⁵¹¹
2691. Accordingly, the Tribunal answers Issue F.4(ii) in the negative. There is insufficient proof of fraud as an exception to the liability cap.

(e) Have Claimants met their burden of proving Mitsubishi acted with willful misconduct? (Issue F.4(iii))

2692. Section 1.21.2 of the RSG Contract, as cited above, also incorporates an exception to the limitation of liability for willful misconduct. Section 1.21.2 of the RSG Contract provides:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that such limitation of liability shall not apply to: (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks.

(i) The Claimants' Position

2693. In their Responses to Joint List of Issues, the Claimants make a reference to their submissions concerning Issue B.5 and D.3 above and submit that “[w]illful

²⁵¹¹ Section XVI.A (¶¶ 2470-2478) above.

misconduct includes Mitsubishi's knowledge of its design errors and intentional fraud."²⁵¹²

(ii) The Respondents' Position

2694. In their Position Statement on the Revised List of Issues, the Respondents contend that the "Claimants have not met their burden of proving Mitsubishi acted with willful misconduct. Claimants largely failed to even plead, let alone prove, willful misconduct. Indeed, in their Opening Memorial under the section heading "Because Of Mitsubishi's Fraudulent Misrepresentations, Gross Negligence, And Illegal And Unlawful Acts, The Damages Cap Does Not Apply" (omitting "Willful Misconduct"), Claimants write: "By its own terms, the limitation on liability set forth in Section 1.21.2 of the Contract does not apply to "any loss or damage arising out of or connected with [Respondents'] gross negligence, fraud ... or illegal or unlawful acts[.]" Claimants themselves used ellipses to omit the term "willful misconduct." Mitsubishi pointed out that "Claimants do not...allege that Mitsubishi engaged in willful misconduct." Claimants did [not] respond to Mitsubishi's point by putting forth any evidence at the hearing to substantiate a claim that Mitsubishi acted with willful misconduct."²⁵¹³

(iii) Tribunal's Determination

2695. The Claimants failed to (i) meet their burden of proving the legal parameters of "willful misconduct"; and (ii) introduce credible and persuasive evidence which would prove such a claim. The Tribunal recalls that it has previously rejected the Claimants' submissions regarding the Respondents' alleged knowledge of the design

²⁵¹² Claimants' Responses to Joint List of Issues, ¶ D.4(iii).

²⁵¹³ Respondents' Position Statement on the Revised List of Issues, ¶ 474.

errors alleged by the Claimants²⁵¹⁴ and the Claimants' intentional fraud allegations.²⁵¹⁵

2696. Accordingly, the Tribunal answers Issue F.4(iii) in the negative. The Claimants have not established "willful misconduct" as a ground for avoiding the liability cap.

(f) **Have Claimants met their burden of proving Mitsubishi committed illegal or unlawful acts? (Issue F.4(iv))**

2697. Section 1.21.2 of the RSG Contract also incorporates an exception to the limitation of liability for illegal or unlawful acts. Section 1.21.2 of the RSG Contract provides:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price; provided, however, that such limitation of liability shall not apply to: (i) Supplier's indemnification obligations hereunder; (ii) Supplier's obligations under Section 1.18; (iii) costs incurred by Supplier (and in the case of default hereunder, costs incurred by EMS or Edison) in achieving Acceptance of all of the Work; (iv) any loss or damage arising out of or connected with Supplier's gross negligence, fraud, willful misconduct or illegal or unlawful acts; or (v) risks insured through insurance required under the Purchase Order, it being the Parties' specific intent that the limitation of liability shall not relieve the insurers' or guarantors' obligations for such insured risks.

(i) *The Claimants' Position*

2698. In their Responses to Joint List of Issues, the Claimants make a reference to their submissions concerning Issue B.6(d) and D.3 above and submit that "[i]llegal and unlawful acts include Respondents failure to comply with ASME code (...) and/or intentional fraud."²⁵¹⁶

²⁵¹⁴ See ¶ 1575 above.

²⁵¹⁵ Section XVI.A (¶¶ 2470-2478) above.

²⁵¹⁶ Claimants' Responses to Joint List of Issues, ¶ D.4(iv).

(ii) The Respondents' Position

2699. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have not met their burden of proving Mitsubishi committed illegal or unlawful acts. Claimants' arguments concerning illegal or unlawful acts are rooted in the idea that violating a federal regulation represents an illegal or unlawful act. Claimants argued that "federal regulations 'have the force of law'" and also used Oxford dictionary definitions of "illegal" and "unlawful." The Oxford dictionary defines unlawful as "not conforming to, permitted by, or recognized by law or rules." Claimants asserted this definition includes acts not conforming to regulations, including Appendix B to 10 C.F.R. Part 50.

But Claimants mistake both what the Notice of Non-Conformance represents and how it is applied. First, a Non-Conformance is a departure from the regulatory commitments of that party, but "not a violation of the law." Second, the NRC Enforcement Manual makes clear that a Notice of Non-Conformance is an administrative action, which is "processed as a non-escalated enforcement action." Finally, under California law, an alleged violation of law does not automatically invalidate an exculpatory clause.

Furthermore, Claimants cannot meet their burden by simply alleging a violation of law and then claiming the Liability Cap is invalidated. Rather, Claimants must show that their claim is "predicated" on the violation and that the violation is a "proximate cause" of their loss. Here, Claimants have shown neither.

Claimants did not introduce any evidence at the hearing showing that Mitsubishi committed illegal or unlawful acts. Not a single witness for Claimants even used the terms "illegal" or "unlawful." Conversely, during Respondents' case, Mr. Johnson testified that a Notice of Non-Conformance was not "evidence of illegal or unlawful conduct."

Because Claimants did not show that (1) a Notice of Non-Conformance proves an "illegal" or "unlawful" act, especially in light of the NRC's Enforcement Manual's language, or (2) that actions that triggered the Notice of Non-Conformance were the same actions that harmed Edison, Claimants have failed to carry their burden of proof.²⁵¹⁷

²⁵¹⁷ Respondents' Position Statement on the Revised List of Issues, ¶¶ 475-479.

(iii) The Tribunal's Determination

2700. The Claimants' arguments concerning illegal or unlawful acts are essentially based on the propositions that (i) MHI was found by the NRC to be in "non-conformance" under a federal regulation; (ii) federal regulations have the force of law; and (ii) such violation represents an illegal or unlawful act.
2701. However, neither the authorities nor the evidence presented by the Claimants established that conduct constituting non-conformance of a federal regulation amounts to a "a violation of the law."²⁵¹⁸ The NRC Enforcement Manual makes clear that a Notice of Non-Conformance is an administrative action which is "processed as a non-escalated enforcement action."²⁵¹⁹ In this respect, the Respondents' expert, Mr. Johnson, testified that a Notice of Non-Conformance was not "evidence of illegal or unlawful conduct."²⁵²⁰
2702. Further, under California law, an alleged violation of law does not automatically invalidate an exculpatory clause.²⁵²¹
2703. The Tribunal also accepted the Claimants' submission that not all provisions of the ASME code were complied with by the Respondents, for example provisions in regard to retention of prior versions of documents and inadequate FIT-III documentation regarding the need to convert from square pitch to triangular pitch arrays.²⁵²² Nevertheless, the Claimants have not convincingly demonstrated that failure to comply with portions of the ASME code amounts to an unlawful or illegal act under Section 1.21.1 of the RSG Contract.

²⁵¹⁸ Expert Witness Statement of Mr. Johnson, ¶¶ 57-59.

²⁵¹⁹ Exh. JX-1865, pp. 0206-0207.

²⁵²⁰ Transcript, p. 4811 (Johnson).

²⁵²¹ See Exh. CL-28 (*Delta Air Lines, Inc. v. McDonnell Douglas Corp.*, 503 F.2d 239 (5th Cir. 1974)).

²⁵²² See Section XIII.F(e)(iii) above.

2704. Therefore, the Claimants have failed to show: (i) that non-compliance with the NRC's Enforcement Manual or the ASME code proves an "illegal" or "unlawful" act, especially in light of the NRC's Enforcement Manual's language; or (ii) that the ASME omission and actions that triggered the Notice of Non-Conformance were the same actions that harmed SCE.
2705. Accordingly, the Tribunal answers Issue F.4 (iv) in the negative. The Claimants have failed to carry their burden of proof to establish that MHI is guilty of unlawful acts, such as would invalidate the liability cap.

XIX. RESCISSION (ISSUE G)

A. IN THE ALTERNATIVE, ARE CLAIMANTS ENTITLED TO RESCIND THE RSG CONTRACT (ISSUE G.1)

2706. In Issue G.1 and its Sub-Issues, the Tribunal determines the Claimants' alternate challenge to MHI's limitation of liability defenses addressed in Issue F, i.e., concerning the rescission of the RSG Contract.

(i) The Claimants' Position

2707. The Claimants make no submissions on this general Issue G.1, and instead make all their submissions under the Sub-Issues below.

(ii) The Respondents' Position

2708. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants are not entitled to rescind the RSG Contract because: (1) California law does not permit rescission when the parties expressly contracted for the risk at issue in the case; (2) Claimants failed to meet the statutory requirements of fraud in the inducement or failure of consideration, the only two grounds for rescission they have advanced; (3) Claimants failed to meet the additional statutory and equitable requirements for rescission; and (4) Mitsubishi has substantially performed its obligations under the Contract and was excused

from any further performance by Claimants' unilateral decision to shutter SONGS instead of pursuing their substantial warranty rights.

With respect to the first issue, California law does not permit parties to obtain rescission in order to escape damage limitations and allocations of risk agreed to in a contract. Both California law and the Restatement are clear that parties' contractual expectations are not to be lightly disturbed. Rescission in California does not provide a means by which sophisticated contracting parties can avoid contractual terms they agreed to because they later discover such terms to have been improvident. Claimants' rescission claim is nothing more than an opportunistic attempt to avoid the RSG Contract's limitations on liability, which were heavily and knowingly negotiated -- indeed, certain of which Claimants proposed. Through rescission, Claimants ask the Tribunal to award them far greater benefits than they originally bargained for and a greater recovery than they would have under the RSG Contract. They also ask the Tribunal to ignore the legitimate contractual expectations upon which Mitsubishi relied, forcing Mitsubishi to bear not only its own costs, but Claimants' costs as well.

With respect to the second issue, Claimants have argued only two statutory grounds for rescission: fraud in the inducement, and failure of consideration. As discussed below, the evidence does not support either theory.

Claimants have provided no evidence that any court – in California or elsewhere – has ever granted rescission where, as here, (a) the contracting parties expressly allocated the risk of failure of a highly technical component part and negotiated limits on liability in the event of a product defect or issue, and (b) the contract included a robust warranty for repair or replacement and the complaining party refused to allow repair or replacement. Even the more complex rescission cases upon which Claimants rely do not involve contracts approaching the comprehensiveness of the RSG Contract, including particularly its multifaceted balancing of risks and benefits. The lack of precedent permitting rescission in circumstances such as these is instructive: contractual risk allocations confirm the parties' reasoned understanding that a loss may occur, and that, in that event, one party will bear a greater proportion of that loss. To rescind such a contract after a risk materializes would be directly contrary to the parties' intentions.²⁵²³

²⁵²³ Respondents' Position Statement on the Revised List of Issues, ¶¶ 480-483.

(iii) Tribunal's Determination

2709. The Tribunal considers the substance of this Issue under the particularized Sub-Issues addressed below.

(a) Have Claimants proven a ground for rescission on the basis of failure of consideration? (Issue G.1(a))

2710. The Tribunal considers whether the Claimants have proven a ground for rescission on the basis of an alleged failure of consideration.

(i) The Claimants' Position

2711. The Claimants make no submissions on this Issue G.1(a), and make all their submissions in the Sub-Issues below.

(ii) The Respondents' Position

2712. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have not proven a ground for rescission on the basis of failure of consideration. Claimants' failure of consideration argument rests upon an inaccurate and incomplete characterization of the consideration underlying the Parties' bargain; considering the full extent of the negotiations, it is clear that the consideration for which Edison bargained did not fail. Additionally, Claimants cannot seek rescission because Mitsubishi substantially performed its contractual obligations.

Claimants have argued that Mitsubishi's alleged breach of contract was so complete that it amounts to a failure of consideration sufficient to rescind the RSG Contract. Rescission for material breach of contract, however, is subject to "restrictive requirements because of its potential to destabilize the contractual exchange, imposing what may be an effective forfeiture as a penalty for breach." Thus, California Civil Code section 1689(b)(2) permits rescission on the ground of failure of consideration only if a breach relates to a "material" aspect of the contract "so dominant or pervasive as in any real or substantial measure to frustrate the purpose of the undertaking." Rescission for failure of consideration is available where, for example, a party refuses to perform or otherwise repudiates its contractual obligations. Conversely, rescission is not available where a party "was aware of the nature of the

[substance of the transaction] and knowingly bought a risk,” because the risk itself “is then assumed as one of the elements of the bargain.” Likewise, a breach cannot justify rescission unless it is “tantamount to a repudiation,” and rescission is unavailable where the non-rescinding party demonstrates that it has “substantially perform[ed]” its contractual obligations.

Claimants did not, and indeed, could not, demonstrate that the RSG tube wear “frustrated the purpose of the undertaking.” The parties’ bargain never included a promise that the RSGs would function perfectly. On the contrary, the inherent risks in the RSG Project, specifically that the RSGs’ large size presented high risks for tube wear and that the industry had yet to develop AVB support mechanisms for steam generators as large as the RSGs, were openly discussed. As the RSG Contract makes clear, the parties thus contemplated the possibility that even if Mitsubishi fully complied with its obligations, a performance problem could potentially require replacement of the entire “Apparatus,” a term that included the entire RSGs.

Accordingly, the centerpiece of the exchange Claimants bargained for was a robust and multi-faceted warranty, complemented by limitations on Mitsubishi’s potential liability. These provisions memorialized the parties’ agreement regarding the extent to which Mitsubishi would be obligated to provide further performance should the risks of a performance problem materialize, and provided Claimants a number of alternatives in the event of any loss, as well as a lower price on the Contract in exchange for Claimants’ acceptance of the risk of a performance problem above a certain dollar amount. Specifically, the RSG Contract provided that should repair or replacement become necessary for *any* reason after the RSGs were put into service, Mitsubishi would pay liquidated damages (if warranted) and perform its obligations under the warranty by repairing or replacing the RSGs or pay for Edison to have another vendor do so (up to the Liability Cap). The parties also provided Edison substantial warranty rights in the Contract.

The RSGs’ performance problem did not invalidate the consideration Edison bargained for or in any way “frustrate the purpose of the undertaking.” The Parties had assumed the risk that the RSGs might not perform as intended, even to the point where total replacement could be necessary. Where, as here, a party knowingly accepts a risk, however remote, the fact that the risk materializes cannot amount to a failure of consideration. Thus, the failure of the RSGs did not invalidate the consideration Edison bargained for or in any way “frustrate the purpose of the undertaking.” Rather, the failure of the RSGs activated Edison’s substantial warranty rights and triggered Mitsubishi’s continuing obligations to provide further performance under the Contract.

Claimants focused on “restart at partial power” strategy that ultimately backfired, chose not to avail themselves of the various contractual options available to them following discovery of the leak, despite the fact that Mitsubishi worked immediately and diligently for more than a year to meet all of its contractual obligations (*i.e.*, to perform as required under the various options available to Edison upon discovery of the problem). Edison, for its own reasons, unilaterally and strategically elected not to utilize its rights under the Contract’s warranty provisions, but that does not in any way prove that the consideration it bargained for failed. When Claimants decided to close the plant without pursuing a repair or replacement option, they elected, on their own, to forego the consideration for which they had bargained.

In addition, and independently, Claimants are not entitled to rescission based on any alleged breach, both because there was no breach, much less one that was material, and because even had Claimants proven any breach, Mitsubishi substantially performed under the RSG Contract. As set forth extensively in Mitsubishi’s response to Issue C, above, that performance is indisputable. To overlook the extensive, years-long work Mitsubishi undertook in good faith reliance upon the Contract would be plainly inequitable.

In their closing argument, the only California case Claimants offered to support rescission for failure of consideration concerning defective goods was *Hot-N-Kold Corp. v. Todd*. That case, however, is wholly distinguishable from this case. *Hot-N-Kold* involved a refrigeration unit – a common, commercial product – that did not meet the specifications for temperature range. The customer was an individual proprietor who did not negotiate a comprehensive risk allocation in the event the refrigerator failed. Here, the customer is a sophisticated, regulated utility that understood the RSGs might experience a performance problem and accounted for that in the ultimate RSG Contract. The *Hot-N-Kold* contract’s guarantee was therefore much more simplistic than that provided in Section 1.17 of the RSG Contract. In addition, the refrigeration unit could be returned to the vendor.

There are additional material distinctions between the *Hot-N-Kold* case and this case. Before finding a failure of consideration, the vendor in *Hot-N-Kold* had been permitted to attempt a repair multiple times, including changing the motor in the refrigerator. Despite the purchaser’s willingness to provide “ample opportunity [for the vendor] to adjust in some manner the equipment,” the vendor proved unable to make the machine work properly. Here, in contrast, Edison prevented Mitsubishi from even attempting a repair, despite Mitsubishi’s readiness and willingness to do so.

Critically, the warranty in *Hot-N-Kold* apparently contemplated only an obligation to ensure that the refrigeration unit provided to the purchaser operated properly. Thus, where the vendor proved unable to fulfill its contractual obligation, there was a failure of consideration sufficient to justify rescission. Here, however, the Contract's warranty provision obligated Mitsubishi to potentially provide a replacement option, which Mitsubishi stood ready and willing to do. Thus, *Hot-N-Kold* in fact supports Mitsubishi's position because it establishes that there cannot be a failure of consideration absent a vendor's demonstrated inability or disavowal of its obligation to fulfill its contractual obligations. The evidence in this case cannot support such a finding against Mitsubishi.²⁵²⁴

(iii) *Tribunal's Determination*

2713. As the Tribunal has outlined in chronological detail above, when the Incident occurred, Mitsubishi was prepared, and took prompt action, to honor its Warranty obligations.²⁵²⁵ Accordingly, the consideration for which Edison bargained did not fail. As will be shown below, the Claimants cannot seek rescission because Mitsubishi substantially performed or was prepared to perform its contractual obligations.
2714. Section 1689(b)(2) of the California Civil Code permits rescission on the ground of failure of consideration only if a breach relates to a "material" aspect of the contract, which is "so dominant or pervasive as in any real or substantial measure to frustrate the purpose of the undertaking."²⁵²⁶ The classic remedy of rescission is normally only available where, for example, a party refuses to perform or otherwise repudiates its contractual obligations.²⁵²⁷ In this case, Mitsubishi neither refused to perform nor repudiated its contractual obligations. The Parties in this case explicitly contracted for various Warranty and other specific remedies, which were triggered in the event of defects in the RSGs that were contrary to the contractual design specifications in

²⁵²⁴ Respondents' Position Statement on the Revised List of Issues, ¶¶ 484-493.

²⁵²⁵ See Sections VII.F and VII.G above.

²⁵²⁶ Exh. CL-083 (*Fantasy, Inc. v. Fogerty*, 984 F.2d 1524, 1530 (9th Cir. 1993)).

²⁵²⁷ See generally Restatement (Third) of Restitution and Unjust Enrichment, § 54, Com. (c).

the RSG Contract, all of which the evidence demonstrated that Mitsubishi was prepared to honor.

2715. The RSG Contract specifically and purposefully allocates the risk of potentially unsuccessful Warranty remedies, as evidenced by the limitation of liability and mutual waiver of consequential damages, which allocations were the subject of substantial attention and negotiation between the Parties. In its decision on the limitation of liability claim, Issue F above, the Tribunal determined that these damage limitations were valid and enforceable.²⁵²⁸ Consequently, the boundaries of Mitsubishi's undertakings in the RSG Contract are expressly stated and narrowly contained.
2716. As the RSG Contract provides, the Parties specifically contracted for the possibility that a performance problem could potentially require replacement of the entire "Apparatus," a term which, the Tribunal determined,²⁵²⁹ includes both RSG Units.²⁵³⁰
2717. The RSG Contract explicitly memorializes the Parties' agreement regarding the extent to which MHI would be obligated to provide further performance, should the risks of a performance or even a Warranty problem materialize, and further provides the Claimants with a number of alternative remedies in the event of any loss. For example, the RSG Contract provided that should repair or complete replacement of the RSGs become necessary, for any reason, after the RSGs were put into service, MHI would either (i) pay specified liquidated damages; (ii) perform its obligations

²⁵²⁸ See Section XVII above.

²⁵²⁹ Section XIV.D (¶ 1980) above.

²⁵³⁰ See RSG Contract, Section 1.2.4 (defining "Apparatus" as "the RSG Units"); Section 1.17.1.3 (contemplating Supplier's obligation to potentially repair or replacement of the Apparatus); see also Supplementary Fact Witness Statement of [REDACTED] ¶ 4.

under the Warranty by repairing or replacing the RSGs; or (iii) pay for Edison to either by itself or have another vendor do so, up to the liability cap.²⁵³¹

2718. By having executed the RSG Contract with the Warranty replacement option, coupled with the limitation of liability and mutual waiver of consequential damages, Edison should have appreciated and taken into account the risk that the RSGs might not perform as intended, even to the point where total replacement of the entire “Apparatus” might be necessary.

2719. Logically, if a party explicitly and knowingly accepts a contractual risk, however remote, the fact that the risk materializes cannot amount to a contractual failure of consideration. The failure of the RSGs did not invalidate the consideration Edison bargained for or in any way “frustrate the purpose of the undertaking.” Rather, the defects in and failure of the RSGs simply triggered Edison’s substantial Warranty rights. They also triggered Mitsubishi’s continuing Warranty obligations to provide further performance under the specific remedial and limitation provisions of the RSG Contract.

2720. As the Tribunal has determined above, the Claimants, by their actions, frustrated the fulfillment of the various contractual remedies available to them, following discovery of the causes of the Incident.²⁵³² When the Claimants decided to shut down the plant without pursuing the proposed Type 1 repair or a replacement option,²⁵³³ they must be deemed to have elected, on their own, to forego the consideration for which they had bargained.

²⁵³¹ RSG Contract, Section 1.17.

²⁵³² See Section XIV.A above.

²⁵³³ See Section VII.G(o) above.

2721. The California case law relied upon by the Claimants to support their rescission claim for failure of consideration is not applicable to the circumstances presented by this case, based on the following analysis.
2722. The *Hot-N-Kold Corp. v. Todd* decision,²⁵³⁴ relied on by the Claimants, is distinguishable from this case, inasmuch as the purchaser of the refrigeration unit in that case was an individual proprietor who did not negotiate an alternative performance in the event the refrigerator failed. In contrast, SCE was a sophisticated, regulated utility that contractually contemplated, by virtue of the explicit and detailed Warranty terms and conditions, that the RSGs might not perform or even totally fail.
2723. Moreover, the vendor in the *Hot-N-Kold* case was permitted to attempt a repair multiple times, including changing the motor in the refrigerator, but was unable to make the machine work properly. By contrast, SCE, for its own legitimate strategic and economic reasons, elected to shut down SONGS, rather than pursue the available options, including the repair or replacement Warranty options.
2724. In light of the RSG Contract's multi-faceted Warranty provisions, including the repair or complete replacement option, and considering that MHI stood ready and willing to honor those commitments, and considering that SCE either declined or refused to permit MHI a reasonable opportunity to pursue either Warranty remedy, and further taking into account that California law does not authorize a finding of failure of consideration without a vendor's demonstrated inability or disavowal of its obligation to fulfill its contractual obligations,²⁵³⁵ the Tribunal determines that the

²⁵³⁴ Exh. CL-098 (*Hot-N-Kold Corp. v. Todd*, 105 Cal. App. 718 (1930)).

²⁵³⁵ Exh. CL-098 (*Hot-N-Kold Corp. v. Todd*, 105 Cal. App. 718, 723 (1930)); see also Exh. CL-30 (*Federal Deposit Insurance Corporation, as a receiver of United States National Bank v. Air Florida System, Inc.*, 822 F.2d 833, 840).

Claimants have not established that there was a failure of consideration in this case sufficient to justify the remedy of rescission.

(b) Was there a failure of consideration, in whole or in part, as alleged by Claimants? (Issue G.1(a)(i))

2725. In this Sub-Issue G.1(a)(i), the Tribunal shall determine the Claimants' contention that Mitsubishi's breach of the expressly stipulated warranty obligation constituted a material breach sufficient to justify rescission.

(i) The Claimants' Position

2726. In their Responses to Joint List of Issues, the Claimants submit that "California law holds that a party may rescind a contract whenever there is a material breach of contract. As discussed in Section B of this Issues List, Mitsubishi committed numerous material breaches of the RSG Contract. In addition, Section G discusses Mitsubishi's breaches of the Warranty provisions of the RSG Contract, and California law holds that, for purposes of rescission, a breach of an express warranty is *per se* a material breach of contract sufficient to justify rescission."²⁵³⁶

2727. In addition, in response to the Respondents' submissions concerning Issue G.1, and Issue G.1(a), the Claimants, in their C-RPHM, contend the following:

Respondents have conceded that "[r]escission is available when the breaching party has ... 'committed a material breach[.]'" In their Response to the List of Issues, Respondents repeat this concession, but add a new twist—Respondents now claim that a breach justifying rescission need not merely be material, it must also be "tantamount to a repudiation." This is false, and the source Respondents cite for this proposition states clearly that rescission is available disjunctively, for *either* "material breach *or* repudiation." Respondents' suggestion that "repudiation" is a necessary condition for rescissory relief is thus unsupported by law, and the consequence of Respondents' argument would be to import a requirement of "willful breach" into the law of

²⁵³⁶ Claimants' Responses to Joint List of Issues, ¶ E.1(a)(i), p. 76.

rescission—which is unheard of and uncountenanced in California or any other jurisdiction of which Claimants are aware.

Under California law, any breach of an express warranty is by definition a material failure of consideration sufficient to invoke the remedy of rescission: “if there was a breach of the warranty, that is, if in any respect the machine was not what it was warranted to be,” a party has “the right . . . to rescind the sale.” The reason for this rule is that a warranty is “an essential part” of the “inducement for the payment,” such that an agreement “would not have been executed” without it. The evidence shows that the parties here viewed the repair warranty as just such an essential inducement. As ██████████ testified, “[r]epairing or replacing a product that does not work is necessary to serve the original purpose of the purchase.” And as discussed in Issue C above, Respondents breached their warranty obligations by failing to supply RSGs “free from Defects,” or to repair the RSGs “at [their] sole expense with due diligence and dispatch.”

Consistent with these principles, at least two California cases have allowed the rescission of a contract for a defective product that could not be repaired. In *Leaf v. Phil Rauch, Inc.* (cited in Respondents’ Rejoinder Memorial), the supplier sold a car that was covered by a repair warranty from the Chrysler Corporation. After the sale, the car suffered three major transmission failures and experienced other defects and malfunctions. The Court reasoned that since Chrysler “materially breached its warranty by failing to correct the defects,” the contract between the buyer and the supplier should be rescinded.

Similarly, *Hot-N-Kold Corp. v. Todd* (cited in Respondents’ Reply Memorial) involved the sale of commercial refrigeration equipment that, for the buyer’s business purposes, was required to maintain temperatures within a certain range—but failed to do so. The supplier attempted repairs, replaced parts, and modified the equipment’s mechanism, all without success. The buyer “put up with the inconvenience for a considerable time, giving [the supplier] ample opportunity to adjust in some manner the equipment so that proper refrigeration might be had,” but to no avail. Subsequently, the court concluded that the contract should be rescinded, despite the supplier’s protests that “only minor repairs were necessary.”

The facts of this case are in line with *Hot-N-Kold*. A buyer in possession of a defective product need not wait interminably for the supplier to perform needed repairs; after a “considerable time” and “ample opportunity” to correct the defect, the contract may be rescinded. Respondents attempt to distinguish *Hot-N-Kold* by asserting (without support) that “Edison prevented Mitsubishi from even attempting a repair.” As discussed in Section C.5 above, this claim is

unsupported and runs directly counter to the record evidence of this case. Claimants refused nothing; as Mr. Dietrich testified, Claimants “were willing to consider anything that Mitsubishi brought forward.” Even Respondents’ expert on implementation admitted that Claimants posed no obstacle to Respondents’ study of the Type 1 repair concept—which was not completed until after this arbitration commenced. Respondents’ other experts admitted that Edison could not conduct a technical review based on the limited information Respondents provided and that Respondents should have (but did not) provide Edison with additional technical proof of their proposed repair. Respondents cannot point to a single request they made that Edison denied (or any action that Edison could have taken) that would have made a difference in the development of the Type 1 repair concept, which Respondents had the obligation to validate.

None of the authorities cited by Respondents argue against rescission of the RSG Contract. Respondents place primary reliance not on California law, but on a treatise that Respondents quote for the proposition that “[r]escission for material breach of contract ... is subject to ‘restrictive requirements because of its potential to destabilize the contractual exchange[.]’” Respondents fail to note that the language they quote is followed immediately by an instruction to “See Comment e,” which lists examples of such “destabilizing” circumstances that have no relevance here, such as the need “to protect the stability of land titles,” or improperly “giv[ing] the claimant a form of security for which the claimant should properly have bargained.” None of these circumstances are present in this case, but even if they were, Respondents have not cited any controlling California law (or law from any jurisdiction) to suggest that these issues are relevant—because they are not. The extraordinary weakness of Respondents’ argument that failure of consideration must meet certain “restrictive requirements” is illustrated by Respondents’ need to rely on irrelevant and selectively quoted passages of a treatise rather than citing to controlling statutory or decisional authority.

In their post-Hearing submissions, Respondents make a new argument on the basis of yet another treatise, asserting that “where the parties know that there is doubt in regard to a certain matter and contract on that assumption,” the risk associated with that doubt becomes “one of the elements of the bargain” and cannot serve as the basis for rescission. But the parties in this case struck a bargain pursuant to which Claimants agreed to limited remedies, provided that Respondents met their warranty obligation to repair or replace Defects with due diligence and dispatch—Respondents’ failure to meet that obligation was thus not a risk that Claimants assumed. Respondents now attempt to water down their contractual obligation (effectively rewriting “shall be repaired” as

“might be repaired”) through the use of what can only be described as classic parol evidence: a self-serving statement made by Respondents during pre-contract negotiations that the parties expressly rejected and did not include in their final written agreement.

Relying only on a single document—a set of answers drafted by Respondents to a questionnaire during pre-contract negotiations—Respondents assert that the contractual liability cap should apply “to all potential risks under the Purchase Order,” and that Claimants accepted the “risk” that Respondents would fail to repair or replace the RSGs with due diligence and dispatch. Respondents’ argument would leverage a one-sided piece of negotiating evidence to effectively read the RSG Contract’s repair warranty provisions out of existence, in violation of the parol evidence rule. Standard rules of contractual interpretation derive the same conclusion: Respondents cannot use such words “to negate or limit” the effect of its repair obligations[—especially where, as here, the parties agree that “[r]epairing or replacing a product that does not work is necessary to serve the original purpose of the purchase.”

That Respondents would repair or replace the RSGs with due diligence and dispatch was a fundamental provision of the parties’ agreement, not a “risk” that Claimants considered and assumed. At the Hearing, Respondents’ lead negotiator of the RSG Contract confirmed this point, admitting that, far from being a risk that was “expressly contracted for,” the parties never even considered—much less negotiated and contracted for—the possibility that the RSGs would fail during their first cycle of operation, or that repair efforts would require the entire plant to be offline for 16 months (or, for that matter, for several years), or that the RSGs’ defects would be so fundamental and pervasive as to require Edison to permanently retire the plant. This sworn testimony, from Respondents’ own witness, aligns with the common sense point that it would have made no sense for Claimants to bear the risk that the RSGs could not be repaired with due diligence and dispatch to be borne by Edison instead of Respondents, the N-Stamp holder and designer and manufacturer of the RSGs, who promised to repair or replace RSG Defects with diligence and dispatch in return for the limited remedies they now seek to enforce. And, of course, it was not a risk that Edison actually bears under the Contract; if Respondents are unable to meet their Warranty obligations, then the full remedies of the California Commercial Code become available.

Respondents’ unique and exclusive control over all issues relating to the design (and potential repair) of the RSGs distinguishes this case from *Reliance Finance Corp. v. Miller*, which Respondents cite for the first time in their Response to the List of Issues. Reliance is inapplicable here. In that case, a

purchaser attempted to rescind the agreement by which it had acquired a collections agency. Prior to the acquisition, the collections agency received a “substantial portion” of its business from a single client, but shortly after the sale, that client announced that it was shrinking its operations drastically, reducing the collections agency’s revenues by 80%. Noting the seller’s testimony that during negotiations he “insisted that he could not guarantee the continuity of client business”—and that the contract itself contained “a provision to this effect”—the court found that the loss in revenue, while drastic, was a normal market-based risk of which both parties were aware and over which neither party had control. There was therefore no basis to declare a failure of consideration based on “the fault of the [non-rescinding] party.” In this case, by contrast, Respondents were responsible for the design, manufacture, and repair of the RSGs—using the special expertise and proprietary tools that they advertised in order to be awarded the RSG Contract in the first place—and consistently promised Edison that they would prevent the very problems that came to pass, while concealing from Edison the risks that they themselves were discussing internally. Accordingly, Respondents’ last, desperate attempt to find a case challenging Claimants’ request for rescission fails.²⁵³⁷

(ii) The Respondents’ Position

2728. The Respondents make no submissions on this sub-Issue, and make a reference to their arguments advanced on the Issues “immediately above,” to contend that “there was no failure of consideration in this case.”²⁵³⁸

(iii) The Tribunal’s Determination

2729. As previously determined by the Tribunal, of the nine alleged design errors alleged by the Claimants,²⁵³⁹ the Claimants have proven only three SSPC errors²⁵⁴⁰ in addition to the Respondents’ admission of the Gap Velocity Error.²⁵⁴¹ The Claimants have not proven the remaining five alleged errors in FIT-III and the FIT-III post-

²⁵³⁷ Claimants’ RPHM, ¶¶ 593-602.

²⁵³⁸ Respondents’ Position Statement on the Revised List of Issues, ¶ 494.

²⁵³⁹ See Section XI above.

²⁵⁴⁰ See Section XI.A(d) above.

²⁵⁴¹ See Section XI.C above.

processor.²⁵⁴² Nor have the Claimants proven their other alleged design errors or that those errors were significant.²⁵⁴³

2730. With respect to the three proven SSPC errors, the Tribunal determined that there is no convincing evidence of any particular connection between these SSPC errors and any harm suffered by the Claimants or that if these errors had not occurred, a different design would have been adopted.²⁵⁴⁴
2731. With regard to the Gap Velocity Error, as considered above, the Tribunal is not convinced that this error resulted in the Incident at SONGS. While the Gap Velocity Error did increase stability ratio calculations, the Tribunal is not convinced as to any connection between this error and the Incident, nor is it convinced that this error resulted in an out-of-plane FEI at SONGS.²⁵⁴⁵
2732. Therefore, the Claimants failed to establish a requisite causal link between the proven design errors and the alleged damages sustained as a result of the Incident and subsequent shutdown of SONGS.
2733. However, even if the proven design errors did result in the Incident and shutdown of SONGS, the RSG Contract provides MHI with the opportunity to offer a repair or replacement of the RSGs.²⁵⁴⁶ Thus, the proven design errors were effectively superseded or subsumed in the warranty provisions of the Contract. The Tribunal has considered the Issues concerning the Warranty in Issue C above.²⁵⁴⁷

²⁵⁴² See Section XI.D above.

²⁵⁴³ See Section XII above.

²⁵⁴⁴ See ¶¶ 1141 and 1250 above.

²⁵⁴⁵ See Section XI.C(a) above; see also ¶¶ 1389-1391 above.

²⁵⁴⁶ RSG Contract, Section 1.17.1.3.

²⁵⁴⁷ See Section XV above.

2734. With respect to the warranty repair option presented by the Respondents, the Tribunal previously determined that the Claimants developed unreasonable and unnecessary criteria for the Respondents' repair - requiring the Respondents to either markedly improve T/H conditions to some unspecified value, which SCE knew was not possible absent a replacement design, or prove that the repair would function in the same operating conditions as SONGS, which was equally not possible, absent a SONGS RSG replica of sufficient scale to replicate the T/H conditions.²⁵⁴⁸ These choices, coupled with the time constraints imposed by the Claimants on the repair options, appear to have left the Respondents with no choice but to transition to a replacement recommendation.
2735. With respect to the warranty replacement option, the evidence established that a replacement would take approximately five years at a cost of several hundred million dollars, exceeding the liability cap set at the purchase price of the RSGs. The Tribunal recognized, as submitted by the Claimants that, an outage spanning a period of five years would not under typical and normal conditions constitute a repair with dispatch.²⁵⁴⁹ However, the Tribunal also determined that, as a matter of law, a repair of the RSG Units in a nuclear powered generation facility "with due diligence and dispatch" is to be interpreted relative to the task being undertaken.²⁵⁵⁰
2736. As the RSG Contract provides for the replacement of the entire "Apparatus" (defined to include all RSGs), whether that replacement is done with dispatch must be weighed as a relative, not objective matter; and the Claimants failed to establish that Mitsubishi either failed or refused to proceed to replace the RSGs, subject to the

²⁵⁴⁸ See Sections XIV.A(a) and XV.C(i)(iii) above.

²⁵⁴⁹ See ¶ 1982 above.

²⁵⁵⁰ See ¶ 1982 above.

express limitation of liability and mutual waiver, both of which the Tribunal has determined to be valid and effective contractual stipulations.²⁵⁵¹

2737. Thus, the Tribunal finds that Mitsubishi neither breached nor willfully repudiated its warranty obligations to repair or replace the RSGs. Consequently, the Tribunal determines that in relation to Issue G.1(a)(i), there was no failure of consideration, either in whole or in part, as alleged by the Claimants.

B. OTHER RESCISSION ISSUES

2738. Having determined that the Claimants have not proven a failure of consideration, and that, accordingly, rescission is not an available remedy to the Claimants, the Tribunal considers that a majority of the remaining Issues and Sub-Issues, in particular, the Issues concerning the appropriateness of the remedy of rescission (Issue G.1(b)), the Claimants' satisfaction of the burden of proof regarding other requirements of a claim for rescissions (Issue G.1(d)), the provision of the notice of rescission (Issue G.2), and the Claimants' obligation to restore Mitsubishi everything of value that it received under the RSG Contract (Issue G.3), are rendered moot. Issues G.1(a)(ii), G.4(a), G.5, and G.6 are also rendered moot on account of the Tribunal's determinations of the remaining aspects of Issue G in favor of the Respondents and are therefore not addressed.

2739. However, the Tribunal briefly addresses two Issues that warrant the Tribunal's consideration, despite the aforesaid determinations, namely Issue G.1(c)(i), and Issue G.4.

2740. Issue G.1(c)(i) concerns the question of whether the Claimants have an alternative basis for their rescission claim based upon the allegations of fraudulent inducement, as determined in Issue D.1 above. Given the Tribunal's determination on Issue D.1,

²⁵⁵¹ See general Section XVII above.

that the RSG Contract was not procured by fraudulent inducement, there is no basis for considering whether this ground gives rise to rescission.²⁵⁵²

2741. Issue G.4 concerns the question of whether the Claimants other than EMS may make a claim for rescission, despite not being signatories to the RSG Contract.
2742. While this Issue is moot in light of the findings that a claim of rescission is not made out, the Tribunal considers that SCE is a named beneficiary under the RSG Contract and may pursue a rescission claim.²⁵⁵³ While it is not necessarily apparent that SDG&E or Riverside may invoke a claim of rescission under a principle/agent theory, for present purposes, the Tribunal considers that they may pursue such a claim under that theory. Nonetheless, their claims fail for the same reasons as those set out in relation to Edison.
2743. Accordingly, as explained above in greater detail in the Tribunal's determination concerning SDG&E's claims in Issue J, below, both SDG&E and Riverside are Parties to this arbitration, have adopted the submissions of Edison as their own, and are deemed to succeed or fail in their respective case on those same grounds.

XX. DAMAGES (ISSUE H)

A. DAMAGES IN GENERAL

2744. The Tribunal's analysis in this Award has generally followed the determination of the List of Issues as agreed by the Parties.
2745. The Parties' submissions on damages address the entirety of the damages as claimed by the Claimants. On account of the Tribunal's determination on the breach of

²⁵⁵² See Section XVI.A above.

²⁵⁵³ RSG Contract, Section 1.1.2.

contract allegations (Issue B),²⁵⁵⁴ breach of warranty (Issue C)²⁵⁵⁵ and fraud and misrepresentation (Issue D),²⁵⁵⁶ it is not necessary to consider the majority of the Claimants' damage claims.

2746. The Claimants' damages are limited to their costs incurred in the repair of SONGS, as determined in Issue B.7.²⁵⁵⁷ In particular, this determination is based upon Section 1.17.1.3 of the RSG Contract which provides:

Any Defect discovered during the Warranty Period, and damage to any other part of the Apparatus or other property resulting directly from such Defect, shall be repaired or replaced, in a mutually agreeable manner, by the Supplier at its sole expense with due diligence and dispatch by repairing or replacing (as appropriate) any defective part and other portion of the Work affected by such Defect. Supplier shall be responsible for all costs and expenses associated with such repair or replacement (...)

2747. Thus, under Section 1.17.1.3 of the RSG Contract, repair and replacement costs are to be borne by the Supplier, i.e., MHI.

2748. The Claimants demonstrated that they incurred substantial costs in their efforts to repair SONGS. In particular, Claimants allege \$181,352,160 in damages, adjusted to a present value of some \$227 million.²⁵⁵⁸

2749. Issue H.1 inquires as to whether the Claimants are "entitled to damages, and if so, in what amount." The Tribunal concludes that the Claimants are entitled to the damages

²⁵⁵⁴ See Section XIII above.

²⁵⁵⁵ See Section XV above.

²⁵⁵⁶ See Section XVI above.

²⁵⁵⁷ See ¶¶ 1689, 1746 above.

²⁵⁵⁸ See Claimants' PHM, ¶ 392

they incurred in attempting to repair the RSGs, but not exceeding the liability cap stated in Section 1.21.2:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price (...)

2750. Issue H.1(a) inquires as to whether the Claimants have “proven all of their alleged damages were caused by a breach or other conduct for which Mitsubishi has been found liable.” The Claimants’ expenses in attempting to repair the RSG Contract are caused by the Defects in the RSGs, for which MHI is liable.
2751. As addressed in Issue B.7 above,²⁵⁵⁹ the Respondents raised concerns regarding the adequacy of the supporting documentation for the Claimants’ expenses. The Claimants provided approximately 18,000 pages of supporting materials documenting their expenses.²⁵⁶⁰ While the Respondents may be correct that certain of the Claimants’ costs could be better justified, it is clear that these costs also far surpass the liability cap, which is \$137,453,131. The Tribunal has no doubt that these costs were incurred and connected to the Claimants’ repair efforts.
2752. Further, as has been explained in greater detail in the Tribunal’s determinations on the Respondents’ Counterclaim, i.e., Issue I below, this liability cap is reduced by \$7,459,765, in light of the adjustments made to the Purchase Order Price, and \$45,361,816.94, which is the amount of SGIR costs that were admittedly paid by the Respondents on 26 December 2012 towards the first invoice issued by the Claimants, i.e., RSG-001. After these deductions from \$137,453,131, the liability cap stands at \$84,243,723.06.

²⁵⁵⁹ See ¶¶ 1740-1746 above.

²⁵⁶⁰ Exh. JX-2035.

2753. The Claimants submit an additional \$32,721,995 of alleged repair costs for the first time in this arbitration. The Respondents submit that the Claimants have provided insufficient justification for these expenses. Considering that the additional claimed amount exceeds the liability cap, this added claim is of no consequence to the damages that the Claimants can be awarded.
2754. In their submissions, the Claimants attempt to render inoperative the limitation of liability provision, either through allegations of the Respondents' gross negligence (Issue F)²⁵⁶¹ and/or fraud and misrepresentation (Issue D).²⁵⁶² The Tribunal concluded that the Respondents were not grossly negligent, nor did they procure the RSG Contract by fraud or misrepresentation. The Claimants, additionally, attempt to demonstrate that the limitation of liability provision is inoperative pursuant to the California Commercial Code. However, in considering Issue F,²⁵⁶³ the Tribunal determined that the Claimants did not successfully demonstrate that the limitation of liability provision should be set aside.
2755. Accordingly, the contractually agreed limitation of liability provision in Section 1.21.2 of the RSG Contract stands, as reduced by the adjustments determined above. The Claimants may recover the damages that they have proven up to the adjusted liability cap of \$84,243,723.06.
2756. The Claimants' submitted expenses in repairing SONGS exceed the limitation of liability cap. Expenses up to the limitation of liability are recoverable as damages to the extent that they are not excluded by the waiver of consequential damages at Section 1.21.1 of the RSG Contract:

²⁵⁶¹ See Section XVIII.D above.

²⁵⁶² See Section XVI above.

²⁵⁶³ Section XVIII (¶ 2655) above.

Neither EMS nor Edison, on the one hand, nor the Supplier on the other hand (including its Subcontractors and EMS's and Edison's subcontractors of any tier) shall be liable to the other Party for any special, indirect, incidental or consequential damages whatsoever whether in contract, tort (including negligence) or strict liability including, but not limited to, loss of use of or under-utilization of labor or facilities, loss of revenue or anticipated profits, cost of replacement power or claims from customers, resulting from a Party's performance or nonperformance of its obligations under the Purchase Order, or in the event of suspension of the Work or termination of the Purchase Order; (...)

2757. Damages incurred to repair the RSGs are direct damages under California law as submitted by the Parties.²⁵⁶⁴ The Respondents admit that costs to repair the RSGs incurred by the Claimants are direct costs.²⁵⁶⁵
2758. For greater certainty, the Tribunal does not consider that the damages claimed for repair expenses are of the type that are excluded from recovery either by operation of California law or the RSG Contract. Indeed, the Respondents do not appear to submit otherwise.
2759. Considering the above, the Tribunal answers Issues H and H.1(a) to conclude that the Claimants are entitled to damages, as a consequence of the Respondents' breach of non-payment of the invoiced SGIR costs, in an amount up to the liability cap, i.e., \$137,453,131, as reduced by \$7,459,765, i.e., the adjustments made to the Purchase Order Price, and \$45,361,816.94, i.e., the amount of SGIR costs that were admittedly paid by the Respondents on 26 December 2012 towards the first invoice issued by the Claimants, i.e., RSG-001, after which adjustments the total sum amounts to \$84,243,723.06. Further, with respect to Issue H.1(b), the Tribunal considers that the

²⁵⁶⁴ Claimants' RPHM, ¶ 640-644; Respondents' Position Statement on the Revised List of Issues, ¶ 528.

²⁵⁶⁵ Respondents' Position Statement on the Revised List of Issues, ¶ 533.

Claimants have proven these damages with reasonable certainty as to their occurrence.

2760. In light of the above determinations, the Tribunal considers it immaterial to address the Parties' remaining submissions, in Issues H.1(a), H.1(b), H.1(c) and their various submissions, concerning the other categories of claimed damages. Further, as determined in Issue G above,²⁵⁶⁶ the Tribunal has not accepted the Claimants' rescission argument, which determination renders Issue H.2 wholly moot such that rescission damages are not available.
2761. Exceptionally, the Tribunal addresses Issues H.1(d) and H.1(e) concerning the Claimants' recovery from its insurer and from the CPUC, respectively. In this connection, the Tribunal does not consider any offset on this account as necessary. Those payments are insufficiently tied to the Claimants' repair expenses such that there is no risk of double recovery on this matter.
2762. Consequently, the Tribunal awards damages to the Claimants in an amount up to the limitation of liability as adjusted above, in the sum total of \$84,243,723.06.

B. PRE-AWARD INTEREST

2763. Section 1.22.2.6 of the RSG Contract, in its relevant part, provides that an "arbitral award (...) shall include an award for pre-award (pre-judgment) interest." Aside from this provision, the Contract does not provide an indication as to the rate or the manner of calculation of interest.
2764. In this connection, the California Civil Code provides guidance in the following provisions:

²⁵⁶⁶ See Section XIX above.

Section 3287

(a) A person who is entitled to recover damages certain, or capable of being made certain by calculation, and the right to recover which is vested in the person upon a particular day, is entitled also to recover interest thereon from that day, except when the debtor is prevented by law, or by the act of the creditor from paying the debt. This section is applicable to recovery of damages and interest from any debtor, including the state or any county, city, city and county, municipal corporation, public district, public agency, or any political subdivision of the state.

Section 3289

(a) Any legal rate of interest stipulated by a contract remains chargeable after a breach thereof, as before, until the contract is superseded by a verdict or other new obligation.

(b) If a contract entered into after January 1, 1986, does not stipulate a legal rate of interest, the obligation shall bear interest at a rate of 10 percent per annum after a breach.

2765. In light of the aforesaid provisions, it becomes apparent that any party entitled to receive damages is entitled to recover interest thereon. The default statutory rate for such interest is 10 percent per annum, in the event that the contract is silent. In their Request for Arbitration, the Claimants have sought interest at this default rate:

pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;²⁵⁶⁷

2766. Furthermore, in the absence of any other indication, the 10% interest per annum is simple interest.

2767. Interest starts running from the date of the breach. In the present case, the Tribunal considers that the Respondents' breach concerning the non-payment of SGIR costs arose at different points in time for the different invoices, since each of the invoices

²⁵⁶⁷ RfA, ¶ 147(h).

was issued on a different date. While interest starts running on separate dates for each invoice, for all of them it runs up to the date on which this Award is rendered, which is 10 March 2017.

2768. Further, for each invoice, in order to calculate the date of breach, Section 1.9.4 of the RSG Contract provides: “the Supplier shall pay invoices from EMS for backcharges, pursuant to Section 1.17.1.3(b) within thirty (30) days after receipt of such invoice.” Taking into account this provision of the Contract, the date of breach of non-payment of each of the invoices is represented in the following table in which the interest is calculated:

Invoice	Amount²⁵⁶⁸	Date of Invoice	Date of Breach	Interest (at 10%)
RSG-002	\$8,187,324	05.12.2012	05.01.2013	\$3,420,731.26
RSG-003	\$52,343,892	07.02.2013	09.03.2013	\$20,966,238.38
RSG-004	\$20,386,928	25.03.2013	24.04.2013	\$7,909,010.97
RSG-005	\$12,442,730	10.04.2013	10.05.2013	\$4,772,553.97
RSG-006	\$6,873,967	08.05.2013	07.06.2013	\$2,583,858.28
RSG-007	\$3,033,548	21.06.2013	21.07.2013	\$1,103,712.81
Sub-Total				\$40,756,105.68
Principal				\$84,243,723.06
Total				\$124,999,828.74

2769. Accordingly, the pre-award simple interest, at the rate of 10 percent per annum, on the principal amounts of each invoice, shall be payable from the aforementioned dates of breach, by the Respondents to the Claimants in the proportion set forth in the table at ¶ 2915 below.

²⁵⁶⁸ Exh. JX-2179.

XXI. COUNTERCLAIM (ISSUE I)**A. SHOULD CLAIMANTS' DAMAGES, IF ANY, BE REDUCED BY (I) THE AMOUNT ADVANCED BY MITSUBISHI AGAINST EDISON'S CLAIM FOR REIMBURSEMENT OF STEAM GENERATOR INSPECTION AND REPAIR COSTS, (II) THE AMOUNT OF LIQUIDATED DAMAGES AMOUNTS ALREADY PAID TO EDISON BY MITSUBISHI, IF ANY, AND/OR (III) THE AMOUNT EXPENDED BY MITSUBISHI IN FULFILLING ITS WARRANTY OBLIGATIONS? (ISSUE I.1)**

2770. The Tribunal considers whether the Respondents have proven that they should be awarded damages for some or all of their counterclaims: (i) the amount advanced by MHI against SCE's claim for reimbursement of the RSG inspection and repair costs; (ii) the amount of liquidated damages already paid to SCE by MHI; and (iii) the amount expended by MHI in fulfilling its warranty obligations.

(i) The Respondents' Position

2771. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

As to (i) (the \$45.4 million advanced by Mitsubishi against Edison's first invoice for reimbursement of Steam Generator Inspection and Repair ("SGIR") Costs), this payment was made pursuant to a Memorandum of Understanding that provided that "[t]he \$45,361,816.94 payment will be credited towards Mitsubishi's limitation of liability under the Contract." Since the \$45.4 million payment was expressly made to reimburse Edison for the costs included in its first invoice, Claimants should have applied it as a credit to reduce their claim for such costs. Having failed to do so, the Tribunal must credit this amount to reduce any award of damages to Claimants.

As to (ii) (the \$7,458,765 in liquidated damages already paid to Edison by Mitsubishi), these liquidated damages payments are relevant only as an amount that should also be credited against Mitsubishi's Liability Cap amount of \$137.4 million. Since these liquidated damages (a) were due under the terms of the Contract, and (b) were not included in Claimants' damages computations, they should not be applied to reduce any damages otherwise awarded to Claimants.

As to (iii) (the \$27,408,647 expended by Mitsubishi in fulfilling its warranty obligations), again, this amount should be credited toward Mitsubishi's Liability Cap amount under the contract. However, outside of that context, any recovery by Claimants should not be reduced by a credit for the amount expended by Mitsubishi in satisfying its warranty obligations.²⁵⁶⁹

(ii) The Claimants' Position

2772. In their Responses to Joint List of Issues, the Claimants refer to their submissions "below" with respect to Mitsubishi's counterclaims for SGIR costs, and to their submissions concerning Issue E, above, with respect to liquidated damages and warranty-related expenditures.²⁵⁷⁰

2773. In addition, in response to the Respondents' submissions, the Claimants, in their C-RPHM, contend that the Respondents agree that "liquidated damages . . . should not be applied to reduce any damages otherwise awarded to Claimants" nor should "any recovery by Claimants . . . be reduced by a credit for the amount expended by Mitsubishi in satisfying its warranty obligations."²⁵⁷¹

(iii) The Tribunal's Determination

2774. Section 1.21.2 of the RSG Contract limits the liability of SCE and MHI to the purchase price:

Notwithstanding anything to the contrary stated in the Purchase Order, Supplier's liability to EMS and Edison under the Purchase Order shall be limited to an amount equal to one hundred (100%) percent of the Purchase Order Price;

²⁵⁶⁹ Respondents' Position Statement on the Revised List of Issues, ¶¶ 668-670.

²⁵⁷⁰ Claimants' Responses to Joint List of Issues, ¶ G.1.

²⁵⁷¹ Claimants' RPHM, ¶ 787.

2775. The original Purchase Order, dated 30 September 2004 set the price for the RSGs at \$136,990,000.²⁵⁷²
2776. As of 21 February 2008, the Purchase Price had been adjusted to \$137,065,305.²⁵⁷³
2777. The actual Purchase Price paid by SCE was lowered on account of both late delivery of the RSGs (an amount of \$6,856,065) and on account of “dings” in the RSGs (an amount of \$631,000, reduced to \$603,700) for a total combined amount of \$7,459,765.²⁵⁷⁴
2778. Section 1.24 of the RSG Contract specifies the definition of the Purchase Order Price:
- Purchase Order Price: The total amount to be paid to Supplier under the Purchase Order, which amount shall only be subject to adjustment in accordance with the terms hereof.
2779. Accordingly, the Tribunal determines that the Purchase Order Price, under the terms of the RSG Contract, may be adjusted from that as originally stated in the Purchase Order(s). Notably, the Purchase Order Price represents the amount paid under the RSG Contract.
2780. The Tribunal next addresses the particular adjustments claimed by the Respondents.
2781. Addressing first the Respondents’ position on the liquidated damages paid at the time of delivery, the Tribunal considers that the Purchase Price is to be adjusted by the amount of the liquidated damages awarded, such that the Purchase Price under the limitation of liability, Section 1.21.2 of the RSG Contract, equals the price actually paid:

²⁵⁷² Exh. JX-321, pp. 1, 4, and 8.

²⁵⁷³ Exh. JX-752, p. 11.

²⁵⁷⁴ Counter-Memorial, ¶ 553 (citing to Exh. JX-924 and Exh. JX-1151).

Original Purchase Price:	\$137,065,305
Liquidated Damages:	<u>- \$7,459,765</u>
Adjusted Purchase Price	\$129,605,540

2782. Accordingly, the limitation of liability cap is adjusted downwards from \$137,065,305 to \$129,605,540.
2783. The Respondents' further submission concerns the payment of \$45,361,816.94 already undertaken by the Respondents to SCE in compensation of the Claimants' costs incurred to repair the RSGS.²⁵⁷⁵
2784. The Tribunal considers that this is an amount directly related to the Claimants' claims, under Issue B.7 above regarding its unpaid invoices for the repair costs.
2785. Accordingly, damages awarded by the Tribunal in satisfaction of this claim must account for any payments the Respondents have already made. This position is reflected in the MoU between SCE and MHI, which expressly provides that "the \$45,361,816.94 payment will be credited towards MHI's limitation of liability under the contract."²⁵⁷⁶
2786. Thus, the Tribunal has reduced the total payment that could be awarded of \$129,605,540 downwards by \$45,361,816.94 to an amount of \$84,243,723.06.
2787. The Respondents' third contention is that damages should be reduced on account of the Respondents' costs in pursuing a repair and replacement of the RSGs in the amount of \$27,408,647. The Tribunal is not convinced by this submission. The Tribunal takes into account the particular wording of the RSG Contract that would

²⁵⁷⁵ Exh. JX-1583; Exh. JX-1572.

²⁵⁷⁶ Exh. JX-1574, p. 2; Exh. JX-1572, p. 2.

otherwise allow the Respondents' to reduce the limitation of liability cap by their repair expenses:

1.17.11.2 After completion of the warranty work, Supplier shall promptly submit documentation to demonstrate the amount of actual and reasonable costs that were incurred to perform the warranty work and an explanation of any costs that are in excess of the estimate provided under Section 1.17.11.1. Only actual and reasonable costs shall be considered as subject to the limitation of liability cap in Section 1.21.

2788. The Respondents never completed the warranty work. While completion was impossible, given the Claimants' shutdown of the RSGs, it remains the case that the contractual conditions for this deduction was not met. Further, the Respondents did not submit their expenses to the Claimants for a determination as to their reasonableness, as required by the above cited Section 1.17.11.2 of the RSG Contract.
2789. Accordingly, the Tribunal rejects the Respondents' submission that damages should be further reduced by \$27,408,647.
2790. Considering the above, the Tribunal answers Issue I.1 by reducing the damages that can be awarded to the Claimants under the limitation of liability provision to an amount of \$84,243,723.06.

B. IS MITSUBISHI ENTITLED TO A REFUND OF ANY OF ITS \$45 MILLION ADVANCE AGAINST EDISON'S CLAIMED STEAM GENERATOR INSPECTION AND REPAIR COST DUE TO EDISON'S FAILURE TO SUBSTANTIATE ITS EXPENDITURES? IF SO, HOW MUCH OF A REFUND IS MITSUBISHI DUE? (ISSUE I.2)

2791. The Tribunal considers whether MHI is entitled to a refund of any of its \$45 million advance against SCE's claimed steam generator inspection and repair cost due to SCE's failure to substantiate its expenditures and, if so, how much of a refund MHI is due.

(i) *The Respondents' Position*

2792. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants have asserted that they incurred approximately \$181 million in costs in connection with Edison's Steam Generator Inspection and Repair ("SGIR") efforts. This amount is comprised of \$148.6 million that was invoiced to Mitsubishi in seven invoices between September 2012 and June 2013, and an additional \$32.7 million which was never invoiced to Mitsubishi, but first appeared in the July 27, 2015 expert report materials submitted by Claimants' expert, Kenneth Metcalfe. As stated above, Mitsubishi paid Edison \$45.4 million (the full amount of the first invoice) pursuant to a Memorandum of Understanding that permitted Mitsubishi to make such a provisional payment without waiving or otherwise prejudicing its right to contest undocumented amounts in the future.

Claimants, of course, bear the burden of proving to a reasonable degree of certainty that the damages they claim were reasonably incurred, and were compensable under the terms of the parties' contract. Respondents aver that, with respect to all but approximately \$32.8 million of the \$181 million claimed, Claimants have fallen well short of meeting this burden of proof.

Two independent experts have examined this issue for Respondents. First, Mitsubishi retained forensic accounting consultant Paul Ficca to review Edison's supporting documentation and to interface directly with Edison in attempting to gather supporting documentation. Mr. Ficca met with both Mitsubishi and Edison personnel, and reviewed all backup documentation provided by Edison. As detailed in his expert report, he and Mitsubishi went to great lengths in attempting to obtain proper supporting documentation from Edison, with little success. For example, despite repeated requests for backup documentation and the execution of a Non-Disclosure Agreement between AREVA and Mr. Ficca's firm, Edison passed on a \$10.5 million invoice, an \$8.3 million invoice, and six \$1+ million invoices—all from AREVA—with nothing more than a one page coversheet as support, despite the fact that AREVA's purchase order required it to maintain detailed records for all time, material and equipment supplied and to provide such documentation with each invoice. Edison similarly failed to provide documentation for other vendors as well. For example, Edison Material Supply, Black Diamond Services, and Choice Workforce Solutions comprise almost 40% of the non-AREVA vendor amount claimed, yet Claimants have not produced *any* invoices to support the combined \$11,522,831 it claimed to have paid them for work allegedly

chargeable to Respondents. In addition, the \$4,978,521 of Westinghouse invoices are supported by only single-page coversheets that omit details of the costs incurred or work performed. More surprisingly, Edison Material Supply, a party to this proceeding, submitted over \$5 million in invoices to Edison which Edison, in turn, includes in its claim against Mitsubishi, yet Mr. Ficca could not locate any EMS billing notices or other documentation to support these charges. As detailed in his expert report, Mr. Ficca determined, from a forensic accounting point of view, that at least \$132.8 million of the \$181 million claimed either lacked documentary support, double-counted certain labor amounts, or was otherwise unsupported.

However, the lack of forensic accounting documentation tells only part of the story, as the parties' contract identifies certain inspection and repair costs which are typically incurred in connection with warranty work that were to be borne by Edison, not Mitsubishi. In addition, other costs were agreed to be covered by liquidated damages amounts, not actual costs. In order to assess whether Edison (a) was billing Mitsubishi for charges it had agreed to bear under the RSG Contract, and (b) was providing Mitsubishi with the cost records it routinely requires from its vendors, Mitsubishi retained J. Michael Wade (who also testified as part of the "Would-have-been Timeline Panel" and who served for 21 years as the Resident Site Manager at SONGS for Westinghouse and its predecessor company) to review the invoices and backup provided to Mitsubishi. Mr. Wade's task was to make a determination whether the charges (a) could be understood based on the information provided by Edison, (b) if understandable, were costs for which Mitsubishi was responsible under the terms of the RSG Contract, and (c) if understandable and covered by the terms of the RSG Contract, were reasonable, given the exigencies of the situation.

As detailed in his Statement, Mr. Wade reviewed the RSG Contract and identified the provisions that informed his analysis of whether Edison or Mitsubishi was responsible for the costs invoiced by Edison for which documentation existed and explained what was being done. Those provisions were: (a) § 1.17.1.3 which governed specific warranty-related charges and markups; (b) § 1.17.2.2 which, together with § 1.29.2, stated that the cost of tube plugging was covered by liquidated damages of \$3,000 per tube; (c) § 1.17.2.3-4 which, together with § 1.29.2.1, assessed liquidated damages of \$1.4 million for costs associated with primary-to-secondary leakage; (d) § 1.17.7.4 which allocates responsibility for costs of scaffolding, opening of access hatches, installation of nozzle dams, Edison personnel and personnel hired by Edison to assist with warranty work; and (e) § 1.21 which provides for a mutual waiver of consequential damages. Mr. Wade then analyzed all of the backup documentation made available to Mitsubishi to determine whether

each vendor invoice was adequately documented and chargeable under the contract.

Mr. Wade was surprised at the lack of documentation made available to Mitsubishi, and testified that:

Based on my experience working with SONGS personnel for 21 years, I am confident that SCE has substantial additional invoicing information from its vendors that it has chosen not to share with Mitsubishi.

No witness of Claimants has contradicted this statement.

As to the \$148.6 million of charges actually invoiced to Mitsubishi, Mr. Wade detailed his analysis in a 54-page spreadsheet that categorized each vendor invoice by whether the work was considered to be actual warranty work, whether it should be excluded due to the contract issues discussed above, and whether it was properly documented. It also detailed how much of each vendor invoice was approved as chargeable, estimated as properly chargeable although not fully supported or non-chargeable pursuant to various identified provisions of the contract. Mr. Wade further detailed his analysis in a 23-page “Invoice Reasoning Table” in which he verbally explained his rationale for approving or rejecting vendor invoices. As summarized in the table below, he concluded that, despite invoicing Mitsubishi over \$148 million, Claimants had properly supported only \$27,284,786 in invoices, and that he had sufficient information to estimate that Edison had incurred another \$3,205,868 in properly chargeable amounts, for a total of \$30,490,654.

Inv. No.	Approved	Estimate of Properly Chargeable Amount	Rejected	Rejected as covered by LDs	Rejected Pending Receipt of Further Support	Total
1	\$23,229,197		\$15,283,215	\$866,181	\$5,983,223	\$45,361,816
2	\$932,754		\$4,870,093		\$2,384,478	\$8,187,325
3	\$3,010,135	\$3,205,868	\$18,543,216	\$3,761,118	\$23,823,555	\$52,343,892
4	\$112,700		\$11,067,835	\$(252,882)	\$9,459,276	\$20,386,929

Inv. No.	Approved	Estimate of Properly Chargeable Amount	Rejected	Rejected as covered by LDs	Rejected Pending Receipt of Further Support	Total
5			\$12,442,729			\$12,442,729
6			\$6,428,439		\$445,528	\$6,873,967
7			\$2,825,293		\$208,255	\$3,033,548
Total	\$27,284,786	\$3,205,868	\$71,460,820	\$4,374,417	\$42,304,315	\$148,630,206

Summary of Wade Analysis

Although Mr. Wade rejected some of the costs invoiced by Edison as being covered by the liquidated damages provisions of the contract dealing with tube plugging and primary-to-secondary leaks, he did not account for those liquidated damages in his analysis. Edison was entitled to assess \$2,357,000 in liquidated damages for those issues, such that the amount properly credited against the \$45.4 million payment by Mitsubishi is \$32,847,654.

As noted in the first paragraph of this section, in addition to the \$148.6 million of alleged SGIR costs invoiced to Mitsubishi, Claimants have included another \$32.7 million in the July 27, 2015 expert report materials submitted by Kenneth Metcalfe. Claimants have not provided *any* backup for these charges and Mr. Metcalfe's analysis ignores the fact that these amounts were never part of the Edison invoices. Based on the lack of documentary evidence alone, the Tribunal should reject this \$32.7 million as not proven with reasonable certainty as a matter of law.

Mr. Metcalfe, who had access to materials not available to Respondents, classified all of the vendor invoices totaling \$181 million into five distinct categories:

- Category 1: Steam Generator Inspection, Repair, and Support
- Category 2: Steam Generator Recovery Team Effort

- Category 3: Steam Generator Recovery Plant Support Effort
- Category 4: Long-Term Plant Equipment Preservation
- Category 5: Required New or Refurbished Equipment

Mr. Ficca examined Mr. Wade's treatment of the vendor invoices which comprised the \$148.6 million, and saw that the invoices either approved outright by Mr. Wade or for which he provided an estimate of the properly chargeable amount fell overwhelmingly in Category 1. However, the \$32.7 million in claims added through the Metcalfe Report were overwhelmingly categorized by Mr. Metcalfe in one of the other categories. Thus, the conclusions to be drawn are that (a) these charges were not included in Edison's invoices because they were determined at the time not to be chargeable to Mitsubishi, and (b) had Claimants provided Respondents with the backup for these charges, thus allowing Mr. Wade to review them, they would have been overwhelmingly rejected in that analysis.

Most importantly, however, both Mr. Ficca and Mr. Wade agree that the complete lack of supporting documentation for the \$32.7 million of purported SGIR costs introduced into this case by Mr. Metcalfe mandates the Tribunal's rejection of this part of the claim.

If the Tribunal adopts Mr. Wade's in-depth analysis of Claimants' invoices, then Claimants have proven, at most, \$30.5 million in SGIR expenses, and are entitled to the \$2.357 million liquidated damages figure discussed above. Depending on the Tribunal's other findings regarding damages and their offsets, Respondents are entitled to a refund of \$12,514,163, the remainder of their \$45.4 million payment.²⁵⁷⁷

(ii) The Claimants' Position

2793. In their Responses to Joint List of Issues, the Claimants submit that "Mitsubishi has submitted only scant evidence in support of its counterclaim for reimbursement of SGIR costs. Their expert, Mr. Ficca, admitted that "it is likely that SCE incurred" these costs. Mr. Wade, who was the only one of Mitsubishi's witnesses to attempt to address the relationship between the SGIR costs and the RSG repair efforts,

²⁵⁷⁷ Respondents' Position Statement on the Revised List of Issues, ¶¶ 671-683.

identified only \$57.6 thousand (out of \$181 million in nominal dollars) in costs that, in his view, were not caused by the tube leak. Mitsubishi has not submitted any evidence to support a counterclaim for more than that amount. In stark contrast, Claimants supported the amounts invoiced to Mitsubishi with more than 10,000 pages of supporting documentation and the testimony of Michael Wharton, who, along with his team of experienced nuclear engineers, verified that all of the invoiced costs were incurred solely due to the failure of the RSGs. Although Mr. Wharton was a key resource for Mr. Metcalfe's analysis of the SGIR costs – which Mitsubishi knew – Mitsubishi failed to ask him a single question on this subject in either his deposition or at the Hearing.”²⁵⁷⁸

2794. In addition, in response to the Respondents' submissions, the Claimants contend that the “Respondents' position on this issue is best characterized as willful blindness to Claimants' evidence mixed with speculation about unspecified documents that may or may not exist. For example, Respondents continue to assert that “Edison passed on a \$10.5 million invoice [to Mitsubishi] . . . with nothing more than a one page coversheet as support,” but ignore that those costs were billed against a detailed purchase order and recorded to a specific Work Order that was generated for “development and installation costs for the unique split stabilizer, a method of controlling tube vibration after the tube is plugged and removed [from] service.” Rather than respond to that evidence, Respondents rely on the testimony of their expert, Mr. Wade, who stated that he was “confident that SCE has substantial additional invoicing information from its vendors that it has chosen not to share with Mitsubishi.” Mr. Wade did not specify what additional information he would have expected Edison to possess, nor how that information would have been superior to the mountain of documentation that Claimants produced and that he allegedly reviewed. Based on the evidence before the Tribunal, Respondents should not be

²⁵⁷⁸ Claimants' Responses to Joint List of Issues, ¶ G.2.

permitted to escape their contractual commitment to reimburse Claimants for all costs incurred in attempting to return Respondents' failed RSGs to service."²⁵⁷⁹

(iii) Tribunal's Determination

2795. The Tribunal is not convinced that the Claimants are required to reimburse part of the Respondents initial payment of the Claimants' repair expenses for the following reasons.
2796. The Tribunal considers that the MOU is the requisite evidence to take into account for determining Issue I.2.
2797. The MoU did require that SCE provide adequate accounting records justifying its repair expenses to restore SONGS to service.²⁵⁸⁰ Significant accounting records were exchanged. While the evidence shows that the Respondents' experts and staff maintain concerns as to the adequacy of the supporting documentation, the Tribunal is convinced that the Claimants did incur the significant costs claimed in returning the RSGs to service.
2798. Accordingly, the Tribunal answers Issue I.2 in the negative. The Respondents are not entitled to a reimbursement of the advance provided under the MOU.

C. IS MITSUBISHI ENTITLED TO THE FINAL MILESTONE PAYMENT OWED BY EDISON UNDER THE SEPARATE RRVH CONTRACT IN THE AMOUNT OF \$1,971,647? (ISSUE I.3)

2799. The Tribunal considers whether MHI is entitled to a final milestone payment allegedly owed by SCE under the separate replacement reactor vessel head contract in the amount of \$1,971,647.

²⁵⁷⁹ Claimants' RPHM, ¶ 789.

²⁵⁸⁰ Exh. JX-1572; Exh. JX-1574.

(i) The Respondents' Position

2800. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

Claimants assert that their liability to Respondents for this \$1.97 million payment was excused by the doctrine of commercial frustration—that Respondents denied Claimants of the value of the RRVH Contract “by providing defective and unrepairable RSGs.” However the RSGs were not “unrepairable,” and Claimants’ unilateral commercial decision to decommission SONGS in the wake of the ASLB’s decision that thwarted Claimants’ strategy to return Unit 2 to service and Claimants’ unwarranted insistence on a repair that “restored” thermal hydraulic conditions in the RSGs to some never-identified level of void fraction neither nullifies nor discharges Edison’s obligations under the RRVH Contract. Claimants have never identified an event of default under the RRVH Contract which might have excused this payment under Section 1.16.5 of that contract. As a result, Respondents are entitled to payment of the \$1.97 million, or a corresponding credit against the Liability Cap amount.²⁵⁸¹

(ii) The Claimants' Position

2801. In their Responses to Joint List of Issues, the Claimants submit that “Mitsubishi did not make any argument in support of this claim either in its Rejoinder Memorial or during the Hearing. As set forth in prior Memorials, the conditions necessary to trigger the final milestone payment never occurred, and in any event the frustration of purpose doctrine relieves Edison of any further obligations under the RRVH Contract. The RRVH Contract provides that Respondents are not entitled to the final milestone payment until the RRVHs “have been installed;” “initial start-up . . . has been achieved;” and the RRVHs “have been in operation for sixty (60) days.” It is undisputed that these conditions were not met: neither RRVH had been completely installed when the Unit 3 tube leak occurred, let alone started up or operated for 60 days. Additionally, California law excuses Claimants from making any further payment. When “the reason the parties entered the agreement has been frustrated . .

²⁵⁸¹ Respondents’ Position Statement on the Revised List of Issues, ¶ 684.

. . . such that the value of performance . . . is substantially destroyed, the doctrine of commercial frustration applies to excuse performance.” Both Mitsubishi’s and Edison’s witnesses (██████████ and Bauder) agree that the value of the RRVHs was “substantially destroyed” once the RSGs failed and could not be returned to service.”²⁵⁸²

2802. In addition, in response to the Respondents’ submissions, the Claimants, in their C-RPHM, contend the following:

Respondents did not make any argument in support of this claim either in their Rejoinder Memorial or during the Hearing. As set forth in prior Memorials, the conditions necessary to trigger the final milestone payment never occurred, and in any event, the frustration of purpose doctrine relieves Edison of any further obligations under the RRVH Contract. The RRVH Contract provides that Respondents are not entitled to the final milestone payment until the RRVHs “have been installed;” “initial start-up . . . has been achieved;” and the RRVHs “have been in operation for sixty (60) days.” It is undisputed that these conditions were not met: neither RRVH had been completely installed when the Unit 3 tube leak occurred, let alone started up or operated for 60 days.

Additionally, California law excuses Claimants from making any further payment. When “the reason the parties entered the agreement has been frustrated . . . such that the value of performance . . . is substantially destroyed, the doctrine of commercial frustration applies to excuse performance.” Both Respondents’ and Claimants’ witnesses agree that the value of the RRVHs was “substantially destroyed” once the RSGs failed and could not be returned to service. ██████████ admitted that replacing the reactor vessel heads is not necessary if a plant is not operating. Mr. Bauder explained during the Hearing that Claimants and Respondents never would have entered into the RRVH Contract had they known that the RSGs were defective and would cause SONGS to shut down by 2013.

Respondents’ response to this issue concedes that none of the conditions precedent discussed in the preceding paragraph ever occurred. Instead, Respondents assert that Claimants’ decision to shut down SONGS—after Respondents wasted sixteen months on ill-conceived repair concepts that failed to correct the root cause of the RSG failures—eliminated commercial

²⁵⁸² Claimants’ Responses to Joint List of Issues, ¶ G.3.

frustration. Respondents fail to cite any legal authority to support this position, or to distinguish their own witness's admission that the RRVHs were not necessary once the RSGs failed and could not be returned to service. In reality, the failure of the RSGs and Respondents' inability to repair them constitute a textbook example of an unanticipated supervening circumstance that eliminated all of the value of the RRVH Contract for Claimants. Respondents are not entitled to any additional payments under the RRVH Contract.²⁵⁸³

(iii) Tribunal's Determination

2803. The Tribunal considers that the Respondents have insufficiently justified this claim on the grounds that the specified conditions for payments in the RRVH Contract were never achieved.

2804. Thus, the Tribunal declines to award the Respondents this requested amount.

D. WHAT ARE THE CONSEQUENCES OF ANY FINDING REGARDING THE COUNTERCLAIM? (ISSUE I.4)

2805. The Tribunal considers the consequences of any finding regarding the counterclaim.

(i) The Respondents' Position

2806. In their Position Statement on the Revised List of Issues, the Respondents contend the following:

In addition to the counterclaim amounts discussed above, and as detailed in the Fact Witness Statement of ██████████ pursuant to Section 1.5.3 of the Contract, Mitsubishi was liable for liquidated damages for any delay in delivering the RSGs to Edison. Unit 3 was delivered late, and, as a result, Edison reduced its payments to Mitsubishi under the Contract by \$6,856,065. In addition, pursuant to Section 1.29.1.2 of the Contract Mitsubishi was assessed an additional \$603,700 in liquidated damages for "ding signals" in RSG tubes which were discovered during the pre-service eddy current inspections performed after delivery of the RSGs. Since these amounts (totalling \$7,458,765) are liabilities Respondents paid Edison under the terms of the Contract, and do not fall within the scope of one of the express

²⁵⁸³ Claimants' RPHM, ¶¶ 790-792.

exceptions to the Limitation of Liability clause, they should be credited against the Liability Cap amount.

➤ ***Summary of Respondents' counterclaim position***

The counterclaim amounts operate as a credit of \$47,333,464 for Mitsubishi against any amount awarded to Claimants. If the Tribunal awards Claimants zero damages, the entirety of the counterclaim amounts must be awarded to Mitsubishi.

If the Tribunal awards Claimants damages, and enforces the heavily negotiated Limitation of Liability clause as it must, then the \$45.4 million provisional payment, the \$7.5 million in liquidated damages already paid (and discussed above), and the \$27.4 million in SGIR expenses incurred by Respondents should all reduce that Liability Cap amount from \$137,453,131 to \$57,222,902. Claimants could only recover that \$57 million if they proved damages up to that amount, which they have failed to do. If the Tribunal does not enforce the Liability Cap, then the counterclaim amount of \$47.3 million should still be applied to reduce any award of damages otherwise found to be due Claimants.

If the Tribunal enforces the Mutual Waiver of Consequential damages as it must, then only direct, justified costs can be recovered. These costs total \$46.8 million. If those damages are awarded and not offset by Claimants' other recoveries, the counterclaim credits result in a net award of \$485,810 to Mitsubishi. If the Tribunal does not enforce the Mutual Waiver of Consequential Damages, the \$1.97 million from the RRVH contract and the \$45.4 million payment must still reduce any award of damages otherwise found to be due Claimants.²⁵⁸⁴

(ii) *The Claimants' Position*

2807. In their Responses to Joint List of Issues, the Claimants submit that “[f]inding in Claimants’ favor on Mitsubishi’s counterclaims means that Claimants’ damages should not be reduced under either a benefit-of-the-bargain or rescission theory.”²⁵⁸⁵

²⁵⁸⁴ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 685-688.

²⁵⁸⁵ Claimants’ Responses to Joint List of Issues, ¶ G.4.

(iii) Tribunal's Determination

2808. As determined in Issue I.1 above, the Tribunal reduces the limitation of liability cap on account of the liquidate damages payment adjustment to the Purchase Price.²⁵⁸⁶ Further on account of the Parties' agreement under the MOU, MHI's prior payment of \$45,361,816.94 should be deducted from any damages awarded under the RSG Contract:

Original Purchase Price	\$136,990,000.00
Updated Purchase Price	\$137,065,305.00
Updated Purchase Price:	\$137,065,305.00
Liquidated Damages:	<u>-\$7,459,765.00</u>
Adjusted Purchase Price	\$129,605,540.00
MOU Payment	<u>-\$45,361,816.94</u>
Allowable Damages	\$84,243,726.06

2809. Consequently, the Tribunal answers Issue I.4 by reducing the damages that may be awarded to the Claimants under the limitation of liability provision to an amount of \$84,243,723.06.

XXII. SDG&E CLAIM (ISSUE J)

2810. SDG&E owns approximately 20% of the shares of SCE, and has accordingly sought corresponding damages for approximately 20% of the total damages of the Claimants.

2811. For a majority of its claims, SDG&E has generally adopted the submissions of the other Claimants, by "join[ing] in the evidence and argument of Edison."²⁵⁸⁷ Further, the Claimants' primary argument has been that "EMS entered into the RSG Contract as the agent of SCE, and SCE, in turn, is the agent of SDG&E. As principal, SDG&E

²⁵⁸⁶ See ¶ 2790 above.

²⁵⁸⁷ SDG&E Memorial, ¶¶ 19, 24, 26, 28.

is a party to the RSG Contract.”²⁵⁸⁸ Alternatively, SDG&E claims its entitlement as a third-party-beneficiary to the RSG Contract.

2812. Additionally, SDG&E has raised a number of distinct claims, separate from the Claimants’ submissions. Broadly, these distinct claims, which are the subject of this Issue J, consist of a breach of contract claim based on its entitlement as a third-party-beneficiary, claims for rescission, indemnity and alternatively tortious liability.
2813. The Tribunal considers that each of SDG&E’s distinct claims is contingent upon affirmative findings in favor of the Claimants for the preceding Issues. Given that this is not the case, with the exception of Issue B.7, for this Issue, J, the Tribunal considers it sufficient to determine SDG&E’s claims summarily, without adhering to the order of the List of Issues.
2814. As a preliminary matter, the Tribunal clarifies, for greater certainty, that its findings concerning all the preceding Issues in this Award are applicable equally to SDG&E. This is in light of SDG&E’s adoption of the Claimants’ submissions, and of the Claimants’ assertions concerning SDG&E being a party to the RSG Contract or a third-party-beneficiary thereof.
2815. Accordingly, the Tribunal’s determination on Issue B regarding the Claimants’ breach of contract claims limit recovery to damages to those claimed under Issue B.7 regarding SCE’s unpaid repair expenses.²⁵⁸⁹ The Tribunal’s determination on Issue C equally limits any potential recovery for SDG&E on alleged failures of the Respondents to meet their warranty obligations.

²⁵⁸⁸ Claimants’ Responses to Joint List of Issues, ¶ H.2.

²⁵⁸⁹ See ¶ 1689 above.

2816. The Tribunal's determination on Issue D²⁵⁹⁰ regarding fraud and misrepresentation is equally determinative of SDG&E's claims. The Tribunal does not consider that the factual record is indicative of the Respondents having engaged in fraud or misrepresentations in order to procure the RSG Contract.
2817. The Tribunal's determination on Issue F²⁵⁹¹ regarding the limitation of liability and consequential damages is such that none of the Claimants may recover for losses exceeding the adjusted actual Purchase Price of the RSGs.
2818. Similarly, the Tribunal's determination on Issue G²⁵⁹² regarding the inapplicability for a claim of rescission, is equally applicable to SDG&E.
2819. Therefore, given the fate of each of the aforesaid Claimants' claims, it no longer falls upon this Tribunal to determine whether or not SDG&E is a party to the RSG Contract or whether or not SDG&E is a third-party-beneficiary. Since the Claimants have not satisfactorily proven their claims of breach of contract, except the claim concerning the non-payment of SGIR costs (Issue B.7), it is immaterial if SDG&E is a Party to the RSG Contract (Issue J.2), or a third-party-beneficiary (Issue J.3). Similarly, its entitlement to bring a claim for breach of contract as a third party beneficiary is not relevant (Issue J.4).
2820. Furthermore, inasmuch as the Tribunal determined Issue D to find that the Claimants have failed to prove a case of fraud of misrepresentation, any determination of SDG&E's claims of fraud, negligent misrepresentation, intentional misrepresentation and/or concealment is no longer warranted (Issue J.5). As submitted by the Respondents, SDG&E's claims are duplicative of the factual issues

²⁵⁹⁰ Section XVI above.

²⁵⁹¹ Section XVIII above.

²⁵⁹² Section XIX above.

reviewed under Issue D. Therefore, the Tribunal considers that Issues J.1 to J.5 are rendered moot.

2821. On a similar note, SDG&E's separate claims for damages on account of contractual indemnity (Issues J.6 to J.8) are also rendered moot, in light of the Tribunal's determination on Issue H above, concerning damages, and Issue F, above, concerning the limitation of liability. In these Issues, the Tribunal awarded damages in favor of the Claimants, up to the adjusted actual Purchase Price, in accordance with the limitation of liability provision of the RSG Contract.
2822. SDG&E's claims of contractual indemnity may not result in an award of damages against the Respondents greater than the agreed limitation of liability provision. Accordingly, the Tribunal considers that it is no longer necessary to determine whether or not SDG&E has made out a claim for contractual indemnity.
2823. With respect to SDG&E's alternative tort claims for equitable indemnity and negligent interference with prospective economic advantage (Issue J.9), the Claimants admit that "if the Tribunal determines that SDG&E is a party to, or third party beneficiary of, the RSG Contract, these alternative claims are moot."²⁵⁹³ Further, the Respondents do not contest that SDG&E is a third-party-beneficiary of the RSG Contract.²⁵⁹⁴
2824. In light of the Parties' admissions, the Tribunal considers it unnecessary to determine the merits behind SDG&E's claims concerning the principal-agency relationship between SCE and SDG&E, and, in turn, its argument of being a party to the RSG Contract. Notwithstanding the merits behind this submission, which if upheld shall

²⁵⁹³ Claimants' RPHM, ¶ 838.

²⁵⁹⁴ Respondents' Position Statement on the Revised List of Issues, ¶ 708.

render the alternative tort claims moot, the Parties' joint position to the effect that SDG&E is a third-party-beneficiary renders the alternative tort claims moot.

2825. With respect to SDG&E's claim concerning payments made to Southern California ratepayers or other third parties because of Mitsubishi's negligence (Issue J.10), the Tribunal considers this Issue to also have been rendered moot on two grounds – firstly, the mootness of Issue J.9, concerning the alternative tort claim of negligence, and secondly, the Tribunal's findings concerning Issue F – the latter of which is discussed below.
2826. In Issue F, the Tribunal determined that the Claimants have not demonstrated that the consequential damages waiver should be rendered inoperative.²⁵⁹⁵ The consequential damages waiver prevents recovery for damages on account of claims for “cost of replacement power or claims from customers, resulting from a Party's performance or nonperformance of its obligations under the Purchase Order.”²⁵⁹⁶ Accordingly, SDG&E's claim for damages for payments made to ratepayers or other third parties, is expressly excluded from recovery by Section 1.21.1 of the RSG Contract, which precludes damage claims for consequential damages. Therefore, the Tribunal considers that Issue, J.10, is rendered moot.
2827. Consequently, since SDG&E has not persuasively established any of its separate and distinct claims from that of the other Claimants, the Tribunal considers that there are no consequences that ensue from its determinations on Issue J (Issue J.11).

²⁵⁹⁵ See ¶¶ 2626, 2635 above.

²⁵⁹⁶ RSG Contract, Section 1.21.1.

XXIII. COSTS (ISSUE K)

2828. In this Issue K, the Tribunal shall determine the costs of arbitration that are payable to the prevailing Parties in this arbitration pursuant to Section 1.22.2.6 of the RSG Contract and Article 37 of the ICC Rules.

2829. Section 1.22.2.6 of the RSG Contract provides:

If the prevailing Party makes a claim during the arbitration proceeding, the arbitral award in favor of such Party shall include an award for pre-award (pre-judgment) interest and costs for legal representation and assistance.

2830. Article 37 of the ICC Rules, in its relevant part, provides:

(1) The costs of the arbitration shall include the fees and expenses of the arbitrators and the ICC administrative expenses fixed by the Court, in accordance with the scale in force at the time of the commencement of the arbitration, as well as the fees and expenses of any experts appointed by the arbitral tribunal and the reasonable legal and other costs incurred by the parties for the arbitration.

(...)

(3) At any time during the arbitral proceedings, the arbitral tribunal may make decisions on costs, other than those to be fixed by the Court, and order payment.

(4) The final award shall fix the costs of the arbitration and decide which of the parties shall bear them or in what proportion they shall be borne by the parties.

(5) In making decisions as to costs, the arbitral tribunal may take into account such circumstances as it considers relevant, including the extent to which each party has conducted the arbitration in an expeditious and cost-effective manner.

2831. As a matter of terminology,

- (i) the description of “costs of the arbitration” in Article 37(1) of the ICC Rules includes “reasonable legal and other costs incurred by the parties for the arbitration,” which definition the Tribunal determines to cover the “cost for legal representation and assistance” mentioned in Section 1.22.2.6 of the RSG Contract;
- (ii) part of the “costs of the arbitration” in Article 37(1) of the ICC Rules are “the fees and expenses of the arbitrators and the ICC administrative expenses;” the Tribunal will refer to them as the “ICC Costs of the Arbitration;” and
- (iii) the totality of the costs of arbitration referred to in Article 37(1) of the ICC Rules (which, as mentioned, also comprise the costs for legal representation and assistance referred to in Section 1.22.2.6 of the RSG Contract) shall be referred to as “**Costs.**”

2832. In accordance with the aforesaid provisions, the Tribunal considers that the Costs , are to be awarded to the “prevailing Party” in this arbitration.

2833. In light of the fact that there are multiple Claimants and Respondents in this case, the Tribunal, instead of using the singular term that is mentioned in the Contract, i.e., “prevailing Party,” shall use its plural form, i.e., “prevailing Parties.” However, any reference to the term “prevailing Parties” shall constitute a reference either to the Claimants, or to the Respondents. At no point shall the term be used as a cumulative reference to Parties on both sides of this arbitration, i.e., the Claimants and the Respondents.

2834. Accordingly, the Tribunal shall first determine whether it is the Claimants or the Respondents that are the “prevailing Parties” in this arbitration. Thereafter, the Tribunal, in light of Article 37(1) of the ICC Rules, shall determine the

reasonableness of the costs claimed by the prevailing Parties. Lastly, the Tribunal shall quantify the amount of the Costs that shall be awarded to those Parties.

(i) *The Claimants' Position*

2835. With respect to the Issue of which Parties are the “prevailing Parties” in this arbitration pursuant to Section 1.22.2.6 of the RSG Contract, the Claimants, in their C-RPHM, submit that “[t]he evidence in this proceeding supports designating Claimants the Prevailing Party on all claims.”²⁵⁹⁷ Further, in the Claimants’ submission on costs dated 3 October 2016, they contend the following:

Under California law, “the party prevailing on the contract shall be the party who recovered a greater relief in the action on the contract.” Cal. Civ. Code § 1717(b)(2). The fact that a claimant recovers less than the damages sought does not preclude its being named the prevailing party. *See Sukut-Coulson, Inc. v. Allied Canon Co.*, 85 Cal. App. 3d 648, 656 (Cal. App. 2d Dist. 1978) (finding Defendant’s argument that it was entitled to attorney’s fees because plaintiff’s damages award was less than the amount sought to be “without merit”); *Epstein v. Frank*, 125 Cal. App. 3d 111, 124 (Cal. App. 2d Dist. 1981) (“[T]he party who obtains a favorable judgment is deemed to be the prevailing party, even though he did not successfully obtain all the relief which he sought in the action.”).

Accordingly, if the Tribunal grants Claimants’ relief on any theory – breach of contract or warranty, intentional or negligent misrepresentation, or rescission – Claimants are the prevailing party under California law and the Award should require Respondents to pay all of Claimants’ reasonable costs in pursuing their claims.²⁵⁹⁸

2836. In addition, in the Claimants’ Reply submission on costs dated 2 November 2016, they contend the following:

If Claimants recover damages in excess of any recovery Respondents might obtain on counterclaims (regardless of whether Claimants’

²⁵⁹⁷ Claimants’ RPHM, ¶ 845.

²⁵⁹⁸ Claimants’ Submission on Costs, ¶ A.1, p.1.

recovery is on a contract, tort, and/or rescission theory), Claimants would recover “a greater relief” and should be deemed the prevailing party (...) see also *Frog Creek Partners, LLC v. Vance Brown, Inc.*, 206 Cal. App. 4th 515, 529 (2012) (...); *Hughes Tool Co. v. Max Hinrichs Seed Co.*, 112 Cal. App. 3d 194, 203 (1980).²⁵⁹⁹

2837. Further, in response to the Respondents’ legal submissions concerning the Issue of which party should be considered as prevailing in this arbitration, the Claimants, in their reply submissions on costs, contend that “the sole case cited by Respondents on this Issue [is] *Hsu v. Abarra*, 9 Cal. 4th 863, 865 (1995) (citing Section 1717). Unlike this matter, however, *Hsu* did not involve a claim for monetary damages, so the court turned to the parties’ “litigation objectives” to determine which party obtained the greater relief. There, the plaintiff sought specific performance of a contract, the defendant sought to prove no contract existed, and the trial court agreed with the defendant that no contract had been formed (...) Observing that “the court render[ed] a simple, unqualified decision in favor of the defendant on the only contract claim in the action,” the court concluded that the defendant was the prevailing party as a matter of law.”²⁶⁰⁰
2838. Additionally, the Claimants also dispute the Respondents’ claims for legal fees and expenses incurred in the “Claimants’ interim relief motion and the motions to stay SDG&E’s and Riverside’s court proceedings pending arbitration,” on the ground that, under California law, “[t]here is no merit to Respondents’ argument that the Tribunal should make separate prevailing-party determinations.”²⁶⁰¹

²⁵⁹⁹ Claimants’ Reply Submission on Costs, ¶ I, p. 1.

²⁶⁰⁰ Claimants’ Reply Submission on Costs, ¶ I, p. 2.

²⁶⁰¹ Claimants’ Reply Submission on Costs, ¶ II-II(A), p. 3-4.

2839. Based on their submissions, the Claimants ultimately seek a Costs award in the amount of \$84,031,353.97, including the fees and expenses of the Tribunal and the ICC. This includes:

- i. a combined total of \$44,572,149.20 in attorneys' fees and expenses;²⁶⁰²
- ii. a combined total of \$29,655,136.10 in experts' fees and expenses;²⁶⁰³
- iii. a total of \$9,804,068.60 in other expenses related to the arbitration, including consultants' fees and expenses.²⁶⁰⁴

2840. The Claimants justify the reasonableness of these claimed Costs by contending the following:

In determining the reasonableness of costs, California courts consider the nature, difficulty, and intricacy of the litigation; the damages at stake; the skill and experience of counsel; and the length of the matter (...) These factors all point in favor of a finding that Claimants' costs are reasonable.

The fact that the parties' attorneys' fees and costs were virtually the same (\$44.5 million by Claimants and \$43.9 million by Respondents – a difference of only 1.3%) provides further evidence of their reasonableness.

(...)

Claimants' expert expenses must be considered in the context of the sophisticated technical and economic analysis involved, the vigorously contested nature of the issues, and the resources available to each side. For example, while Claimants' total expenditure for experts and consultants was higher than Respondents', much of the disparity is attributable to the fact that Respondents offered four of their own

²⁶⁰² Claimants' Reply Submission on Costs, ¶ IV(A), p. 18.

²⁶⁰³ Claimants' Reply Submission on Costs, ¶ IV(B), p. 19.

²⁶⁰⁴ Claimants' Reply Submission on Costs, ¶ IV(C), p. 19 [These other expenses include direct costs incurred towards arbitration facilities (hotel), copying and printing, court reporting and transcription, data hosting, documenting reviewing, ICC fees, litigation support services, translation and interpretation, and travel and lodging.].

employees ([REDACTED] [REDACTED] [REDACTED] and [REDACTED]) as “expert” witnesses regarding the RSG design as well as the purported viability of Respondents’ proposed repair concept. Respondents thus avoided paying expert fees for the work performed by existing employees.²⁶⁰⁵

(ii) *The Respondents’ Position*

2841. With respect to the Issue of which party is the “prevailing Party,” the Respondents, in their Position Statement on the Revised List of Issues, submit the following:

In making an award of costs, factors to take into account include the success of a party relative to the relief that party sought. Weighing the relative success of each party’s claims is also contemplated within the language of ICC Article 37(4). Article 37(4) states: “The final Award shall fix the costs of the arbitration and decide which of the parties shall bear them or in what proportion they shall be borne by the parties.” Thus, if damages are granted in a smaller amount than requested, then a proportionate amount of the costs should be borne by the parties. In other words, if not all claims are allowed and the final amount awarded is considerably less than the total amount claimed, it would not be appropriate to assess all costs against the party who had to defend against the disallowed claims. Based on the evidence set forth above, Mitsubishi should be deemed the prevailing party, and be awarded all of its fees and costs incurred for this arbitration.²⁶⁰⁶

2842. In addition, in the Respondents’ fees and costs submission dated 3 October 2016, they contend the following:

Respondents have already prevailed on two issues: (1) their efforts to compel Claimants San Diego Gas & Electric and the City of Riverside to arbitrate their claims against Mitsubishi in lieu of litigating them in a California state court and (2) Claimants’ request for interim relief under Section 1.9.6 of the RSG Contract. As the prevailing party on these issues Respondents seek recovery of all their reasonable fees and costs (...) For the remaining claims asserted by Claimants, Respondents contend that should Claimants be awarded any amount that is substantially less than

²⁶⁰⁵ Claimants’ Reply Submission on Costs, ¶ III-III(A), pp. 9-10.

²⁶⁰⁶ Respondents’ Position Statement on the Revised List of Issues, ¶¶ 716-717.

the approximately \$7 billion in damages sought by Claimants, then Respondents should be regarded as the prevailing party for the purposes of the Tribunal's assessment of fees and costs.²⁶⁰⁷

(...)

California precedent supports a finding that the extent to which a party may be held to have prevailed may be determined by reference to the amount of relief claimed versus the relief awarded.²⁶⁰⁸

2843. Further, in response to the Claimants' legal submissions regarding Section 1717 of the Californian Civil Code, the Respondents submit that the:

Claimants' discussion of § 1717 ignores the seminal California Supreme Court case interpreting Cal. Civ. Code § 1717, *Hsu v. Abbata*, 9 Cal. 4th 863 (1995). It is well recognized that Hsu is the standard for applying Cal. Civ. Code § 1717. See, e.g., *David S. Karton, A Law Corp. v. Dougherty*, 231 Cal. App. 4th 600, 607-08 (2014) ("On the attorney fee issue, the controlling statute is section 1717, and the controlling case is *Hsu v. Abbata*.")(...) Claimants, conveniently, only cite pre-Hsu § 1717 case law. California courts applying § 1717 post-Hsu demonstrate the flexibility the fact finder has in allocating fees.²⁶⁰⁹

2844. Based on their submissions, the Respondents ultimately seek a Cost award in the amount of \$61,526,758.95.²⁶¹⁰ This includes:

- i. a combined total of \$43,971,832.62 in attorneys' fees and expenses, including:²⁶¹¹

²⁶⁰⁷ Respondents' Fees and Costs Submission, Cover Letter, p. 3.

²⁶⁰⁸ Respondents' Challenge to Claimants' Fees and Costs, Cover Letter, pp. 3-5.

²⁶⁰⁹ Respondents' Challenge to Claimants' Fees and Costs, Cover Letter, p. 3.

²⁶¹⁰ Respondents' Challenge to Claimants' Fees and Costs, Tab 5.

²⁶¹¹ Respondents' Challenge to Claimants' Fees and Costs, Tab 5.

- a. \$162,700.88 for defending court proceedings brought by San Diego Gas & Electric and City of Riverside;²⁶¹²
 - b. \$144,434.28 for the court proceedings initiated by Claimants for interim relief;²⁶¹³ and
 - c. \$1,908,974.05 in connection with the preparation and presentation of the counterclaim;²⁶¹⁴
- ii. a total of \$17,554,926.33 in other fees and expenses related to the arbitration, including experts' and consultants' fees and expenses.²⁶¹⁵

2845. The Respondents justify the reasonableness of these claimed Costs by contending that “[i]n light of the amount in dispute and the complexity of the case, these fees and costs are reasonable.”²⁶¹⁶

(iii) The Tribunal’s Determination

2846. As mentioned above,²⁶¹⁷ the Tribunal shall first determine the allocation of Costs between the Parties, i.e., the Issue of which parties are the “prevailing Parties,” followed by a determination concerning the reasonableness of the legal representation and other expenses claimed by that Party. On this basis and taking into account the ICC Cost of Arbitration, the Tribunal shall determine the quantification of the total Costs payable to the prevailing Party.

²⁶¹² Respondents’ Fees and Costs Submission, Cover Letter, p. 5; Tab 4.

²⁶¹³ Respondents’ Fees and Costs Submission, Cover Letter, p. 6; Tab 5.

²⁶¹⁴ Respondents’ Fees and Costs Submission, Cover Letter, p. 7; Tab 6.

²⁶¹⁵ Respondents’ Challenge to Claimants’ Fees and Costs, Tab 5 [These other fees and costs include fees and disbursements incurred towards experts, consultants, interpreters, court reporting services, document translation services, E-discovery services, document processing and hyperlinking, site visit by the Tribunal, and expenses of the arbitration including arbitration facilities (hotel) and advance payments of costs of arbitration.].

²⁶¹⁶ Respondents’ Fees and Costs Submission, Cover Letter, p. 2.

²⁶¹⁷ See ¶ 2834 above.

2847. Each of these determinations is made on the basis of Section 1717 of the California Civil Code, which the Parties agree is the statutory provision in California law that applies to a determination on the costs of the arbitration.²⁶¹⁸ Section 1717 of the California Civil Code, in its relevant part, provides:

1717. (a) In any action on a contract, where the contract specifically provides that attorney's fees and costs, which are incurred to enforce that contract, shall be awarded either to one of the parties or to the prevailing party, then the party who is determined to be the party prevailing on the contract, whether he or she is the party specified in the contract or not, shall be entitled to reasonable attorney's fees in addition to other costs.

(...)

Reasonable attorney's fees shall be fixed by the court, and shall be an element of the costs of suit (...)

(b) (1) The court, upon notice and motion by a party, shall determine who is the party prevailing on the contract for purposes of this section, whether or not the suit proceeds to final judgment. Except as provided in paragraph (2), the party prevailing on the contract shall be the party who recovered a greater relief in the action on the contract. The court may also determine that there is no party prevailing on the contract for purposes of this section.

2848. This provision applies in conjunction with Section 1.22.2.6 of the RSG Contract, and Article 37 of the ICC Rules, as set out in ¶¶ 2829-2830 above. While the former provides that the arbitral award shall include an award for the expense of legal representation and assistance in favor of the prevailing Parties, the latter authorizes the Tribunal with discretion to make a determination on Costs of the arbitration, and provides an indication of what these costs are comprised of.

²⁶¹⁸ Claimants' Submission on Costs, ¶ A.1, p.1; Respondents' Fees and Costs Submission, Cover Letter, p. 3.

2849. *Prevailing Parties*: A determination concerning which Parties are the “prevailing Parties” in the arbitration must be made in light of Section 1717 of the California Civil Code. Section 1717 uses the term “party prevailing on the contract,” and defines it to mean “the party who recovered a greater relief in the action on the contract.”
2850. The Tribunal considers that the Respondents have convincingly established that the “seminal California Supreme Court”²⁶¹⁹ decision interpreting Section 1717 of the California Civil Code is *Hsu v. Abbara*.²⁶²⁰ As submitted by the Respondents, *Hsu* has been consistently followed as a precedent in California.²⁶²¹
2851. Further, while the Claimants have primarily relied on case law decided before the decision in *Hsu*,²⁶²² the few post-*Hsu* cases cited by the Claimants also either heavily rely on *Hsu*,²⁶²³ thereby reaffirming its authority, or were not decided in the context of Section 1717 of the California Civil Code, and are therefore of less relevance.²⁶²⁴
2852. Moreover, the case law cited by the Claimants, which was decided before the decision in *Hsu*, is less persuasive, since this case law was decided in the context of a differently worded Section 1717 of the California Civil Code, which contained the term “prevailing Party,” as opposed to “party prevailing on the contract,” and defined the former term as “the party in whose favor final judgment is rendered.”²⁶²⁵ Tracing the legislative history of Section 1717 of the California Civil Code, the Californian Supreme Court’s decision in *Hsu*, states that:

²⁶¹⁹ Respondents’ Challenge to Claimants’ Fees and Costs, Cover Letter, p. 3.

²⁶²⁰ *Hsu v. Abbara*, 9 Cal. 4th 863 (1995).

²⁶²¹ See *David S. Karton, A Law Corp. v. Dougherty*, 231 Cal. App. 4th 600, 607-08 (2014).

²⁶²² *Sukut-Coulson, Inc. v. Allied Canon Co.*, 85 Cal. App. 3d 648, 656 (Cal. App. 2d Dist. 1978); *Epstein v. Frank*, 125 Cal. App. 3d 111, 124 (Cal. App. 2d Dist. 1981).

²⁶²³ *Frog Creek Partners, LLC v. Vance Brown, Inc.*, 206 Cal. App. 4th 515, 529 (2012).

²⁶²⁴ *Contractors Labor Pool v. Westway Contractors*, 53 Cal. App. 4th 152, 168 (Cal. App. 1997).

²⁶²⁵ *Hsu v. Abbara*, 9 Cal. 4th 863, 874 (1995).

In 1987, the Legislature amended section 1717 to its current form (...) The Legislature replaced the term “prevailing party” with the term “party prevailing on the contract,” (...) Also, the Legislature deleted the previous definition of “prevailing party” as the party entitled to recover costs, providing instead that “the party prevailing on the contract shall be the party who recovered a greater relief in the action on the contract.”²⁶²⁶

2853. Therefore, the change from the words employed in the provision, i.e., from “prevailing Party” to “party prevailing on the contract,” and more importantly, the amendments to their respective definitions, marked a crucial change from an absolute standard of determining the prevailing Party, under which the prevailing Party was “the party in whose favor final judgment is rendered,” to a relative standard, under which “the party prevailing on the contract shall be the party who recovered a greater relief in the action on the contract.” Consequently, the case law relied upon by the Claimants lost its relevance, with the passage of both time and this statutory amendment to Section 1717 of the California Civil Code.

2854. Thus, under the current Section 1717 of the California Civil Code, the most authoritative explanation of the relative standard of determining the prevailing Party, or the party prevailing on a contract, was prescribed by the Californian Supreme Court in *Hsu*, on which the Respondents rely:

[I]n deciding whether there is a “party prevailing on the contract,” the trial court is to compare the relief awarded on the contract claim or claims with the parties’ demands on those same claims and their litigation objectives as disclosed by the pleadings, trial briefs, opening statements, and similar sources. The prevailing party determination is to be made only upon final resolution of the contract claims and only by “a comparison of the extent to which each party ha[s] succeeded and failed to succeed in its contentions.”²⁶²⁷

²⁶²⁶ *Hsu v. Abbara*, 9 Cal. 4th 863, 874-5 (1995).

²⁶²⁷ *Hsu v. Abbara*, 9 Cal. 4th 863, 877 (1995).

2855. In other words, a Party’s “status as the ‘party prevailing on the contract’ is ascertained (...) by a pragmatic assessment of the parties’ ultimate positions vis-à-vis their litigation objectives as reflected in pleadings, prayers, and arguments.”²⁶²⁸ This relative standard of determining prevailing Parties in a case, comes across even from a 1981 judgment, also cited by the Claimants, in which it was held that “[i]t is not always the case however that the party in whose favor the final judgment is entered will be deemed to be the prevailing party. For example, the party who prevails on all of the issues which were actually litigated at the trial will be deemed the prevailing party even though the judgment may be entered in favor of the opposing party.”²⁶²⁹
2856. Further, while the Claimants attempt to distinguish *Hsu* from the present case, by contending that *Hsu* was “a simple, unqualified decision” that granted non-monetary relief,²⁶³⁰ this argument does not convince the Tribunal. Subsequent precedents have applied *Hsu* it in the context of monetary remedies as well.²⁶³¹ Further, despite it being a decision rendered in a simple, unqualified scenario, the Supreme Court in *Hsu* demarcated a difference between that scenario and one where the results of a dispute are not so simple and unqualified. In this regard, it stated that “section 1717 internally (...) allow[s] those parties whose litigation success is not fairly disputable to claim attorney fees as a matter of right, while reserving for the trial court a measure of discretion (...) when the results of the litigation are mixed.”²⁶³² It is this discretion that warrants the application of the aforesaid standard, articulated in *Hsu* and upheld

²⁶²⁸ *In re Estate of Drummond*, 149 Cal. App. 4th 46, 51 (2007)

²⁶²⁹ *Epstein v. Frank*, 125 Cal. App. 3d 111, 124 (Cal. App. 2d Dist. 1981) ¶ 6.

²⁶³⁰ Claimants’ Reply Submission on Costs, ¶ I, p. 2.

²⁶³¹ *Berkla v Corel Corp.*, 302 F.3d 909 (2002).

²⁶³² *Hsu v. Abbara*, 9 Cal. 4th 863, 877 (1995).

routinely in subsequent cases in California,²⁶³³ for determining the prevailing Party in a case.

2857. Therefore, a determination of which Parties, between the Claimants and the Respondents, are the prevailing Parties in this arbitration requires the Tribunal to compare the ultimate positions of the Claimants and the ultimate positions of the Respondents after the arbitration, with their respective initial litigation objectives and claims. Whichever Parties' ultimate position after the Award is relatively closer to the original claims sought in the arbitration shall be the prevailing Parties.

2858. On the basis of this test, the Tribunal considers that the Respondents have persuasively shown that "should Claimants be awarded any amount that is substantially less than the approximately \$7 billion in damages sought by Claimants, then Respondents should be regarded as the prevailing party for the purposes of the Tribunal's assessment of fees and costs."²⁶³⁴ The Claimants have been awarded \$84,243,723.06 plus interest,²⁶³⁵ which is substantially less compared to the Claimants' claim of damages amounting to approximately \$7 billion. Moreover, the amount awarded to the Claimants arose out of a breach that was in concept accepted, and in amount partially admitted, by the Respondents, insofar as the supported SGIR costs that were invoiced to the Respondents, but remained unpaid, were concerned. The partial success of the Respondents' counter-claims also puts the Respondents in a comparatively better position,²⁶³⁶ regardless of how this success compares to the amounts awarded to the Claimants in absolute terms.

²⁶³³ *Frog Creek Partners, LLC v. Vance Brown, Inc.*, 206 Cal. App. 4th 515, 532 (2012).

²⁶³⁴ Respondents' Challenge to Claimants' Fees and Costs, Cover Letter, p. 3.

²⁶³⁵ See ¶ 2759 above.

²⁶³⁶ See Section XXI (¶¶ 2808-2809) above.

2859. In light of this, comparing the relief awarded to the Claimants vis-à-vis their demands on those same claims and their litigation objectives, and the Respondents' ultimate position vis-à-vis their litigation objectives, the Respondents emerge as the prevailing Parties in this arbitration. Consequently, pursuant to Article 37(4) and Article 37(5) of the ICC Rules, the Tribunal determines the Costs claimed by the Respondents, shall be borne by the Claimants, subject to the following.
2860. In its discretion to proportion the costs of arbitration under Article 37(4) and Article 37(5) of the ICC Rules, the Tribunal considers that it is appropriate to determine that 95% of the ICC Costs of the Arbitration shall be borne by the Claimants and 5% of the ICC Costs of the Arbitration by the Respondents. This allocation is in light of the fact that the Claimants persuasively demonstrated their claim for a breach of the RSG Contract, concerning the non-payment of the claimed SGIR costs, in Issue B.7, above. In so doing, the Claimants managed to successfully rebut the expert evidence provided by two of the Respondents' experts, i.e. FTI Professional Services (Mr. Paul S. Ficca) and Mr. J. Michael Wade. The proportioning under the present paragraph is limited to that part of the Costs that concerns the ICC Costs of the Arbitration.
2861. *Reasonableness of claimed legal fees and expenses:* The Tribunal finds that the legal fees and other expenses claimed by the Respondents, in their fees and costs submission and their Challenge to Claimants' Fees and Costs, are reasonable.
2862. The Parties have agreed that the relevant period for any award on Costs runs from the permanent retirement of SONGS on 7 June 2013 through the filing of the Post-Hearing Replies on 31 August 2016, as well as costs incurred in preparing their cost submissions.²⁶³⁷ As mentioned above, the Respondents' legal fees and expenses

²⁶³⁷ Claimants' Submission on Costs, ¶ 2, p. 2; Respondents' Fees and Costs Submission, Cover Letter, p. 1.

amount to \$61,526,758.95,²⁶³⁸ the largest portion of which is a combined total of \$43,971,832.62 in attorneys' fees and expenses,²⁶³⁹ and the remaining portion of \$17,554,926.33 is constituted by the experts' fees and expenses and other expenses related to the arbitration.²⁶⁴⁰

2863. With respect to the attorneys' fees and expenses, as mentioned in ¶ 2840 above, the Claimants observe that "[t]he fact that the parties' attorneys' fees and costs were virtually the same (\$44.5 million by Claimants and \$43.9 million by Respondents – a difference of only 1.3%) provides (...) evidence of their reasonableness."²⁶⁴¹

2864. With respect to the experts' fees and costs, the Claimants justify their total expenditure for experts by stating that they, as opposed to the Respondents, had to avail the services of "independent outside experts."²⁶⁴² The Tribunal is not convinced by this argument, since each Party is at liberty to retain expert evidence as it sees fit to best establish its own case. The fact that the Respondents used their own personnel as expert witnesses does not attribute any unreasonableness to the experts' fees and expenses claimed by the Respondents.

2865. The reasonableness of the Respondents' experts' fees and expenses, amounting to \$12,889,075.10, is best illustrated when compared to the Claimants' costs in this regard amounting to \$29,655,136.10. A specific, expert-by-expert comparison is contained in the following table, which demonstrates such reasonableness, even more so given that the number of testifying experts was greater for the Respondents:

²⁶³⁸ Respondents' Challenge to Claimants' Fees and Costs, Tab 5.

²⁶³⁹ Respondents' Challenge to Claimants' Fees and Costs, Tab 5.

²⁶⁴⁰ Respondents' Challenge to Claimants' Fees and Costs, Tab 5.

²⁶⁴¹ Claimants' Reply Submission on Costs, ¶ III, pp. 9-10.

²⁶⁴² Claimants' Reply Submission on Costs, ¶III.A, p. 10.

S.No.	CLAIMANTS		RESPONDENTS	
	I. QUANTUM			
	Expert/Corporation	Fees (USD)	Expert/Corporation	Fees (USD)
1	Battle Group (Graves)	9,354,060.80	Concentric Energy Advisors	1,161,394.89
2	The Keinrich Group (Metcalf)	9,430,362.40	FTI Professional Services (Ficca)	1,464,660.16
3	NERA	1,441,938.59	Navigant Consulting (Emmert)	3,976,140.76
	Sub-total	20,226,361.80	Sub-total	6,602,195.81
	II. TECHNICAL (Including Thermal Hydraulics/Physics/Code Analysis/ Industry Practice/Repair/Wear Analysis/Shutdown Decision)			
4	Exponent (Kytömaa, Morse)	4,687,986.99	Arthur Baggett	39,079.59
5	Richard Lahey	637,244.79	Edward Blandford	183,484.30
6	FAE Consulting (Asadi)	175,902.45	Lyle H. Bohn	366,814.31
7	GCE Consulting (Elder)	440,371.99	Thomas Boyd	104,680.63
8	Intertek USA (Egan)	800,890.11	Donald Stewart	218,365.97
9	Michael G. Morris	201,698.51	Takashi Hibiki	555,741.49
10	David Ratcliffe	27,052.54	██████████	31,414.23
			Lettis Consultants Int'l	76,480.00
			Vann Mitchell	99,426.66
			Keith Paulsson	15,623.25
			Preferred Licensing Services (Lagally, Olszewski, Wade)	591,308.89
			RTI (Denton, Au-Yang)	1,048,022.17

			TCA Solution (Begley)	1,026,810.57
			Robert M. Wilson	569,041.45
	Sub-total	6,971,147.38	Sub-total	4,926,293.51
	III. REGULATORY/NRC			
	Talisman International (Leeds, Merschhoff, Strosnider)	2,457,626.96	Arther T. Howell	117,734.17
			William T. Russell	1,018,862.73
			Lightbridge Corporation (Johnson)	223,988.85
	Sub-total	2,457,626.96	Sub-total	1,360,585.75
	Total	29,655,136.1	Total	12,889,075.1

2866. Similarly, with respect to the other expenses incurred by the Respondents, pertaining to disbursements incurred towards consultants, interpreters, court reporting services, document translation services, E-discovery services, document processing and hyperlinking, site visit by the Tribunal, and expenses of the arbitration including arbitration facilities (hotel), the Tribunal considers the same to be reasonable in light of a comparison between these other sundry expenses incurred by both Parties. The other expenses claimed by the Respondents (including its consultants' fees and expenses, but excluding the experts' fees and expenses) amount to \$4,665,851.23, where-as these other expenses claimed by the Claimants amount to \$9,804,068.60. The Tribunal considers that in light of the complexities of the case, and the length of the hearings and the submissions made by both Parties, the other expenses claimed by the Respondents, amounting to \$4,665,851.23, are reasonable.

2867. *Quantification:* With respect to the ICC Costs of Arbitration, the ICC Court, at its session on 23 February 2017, fixed those costs at \$3,500,000 as follows:

COSTS FIXED BY THE COURT ON 23 February 2017		
Administrative expenses		US\$ 113 215
President's fees		US\$ 1 486 750
Co-arbitrators' fees	US\$ 805 325 x 2	US\$ 1 610 650
Expenses incurred		US\$ 289 385
Total		US\$ 3 500 000

2868. The amount of \$3,500,000 shall be borne by the Claimants for 95% and by the Respondents for 5% (see ¶ 2860 above). Thus, the Claimants shall bear \$3,325,000 and the Respondents \$175,000 of the ICC Costs of the Arbitration.

2869. Regarding the advance on costs for covering the ICC Cost of the Arbitration, reference is made to Article 36(2), Article 36(3) and Article 36(5) of the ICC Rules:

Article 36: Advance to Cover the Costs of the Arbitration

(2) As soon as practicable, the Court shall fix the advance on costs in an amount likely to cover the fees and expenses of the arbitrators and the ICC administrative expenses for the claims which have been referred to it by the parties, unless any claims are made under Article 7 or 8 in which case Article 36(4) shall apply. The advance on costs fixed by the Court pursuant to this Article 36(2) shall be payable in equal shares by the claimant and the respondent.

(3) Where counterclaims are submitted by the respondent under Article 5 or otherwise, the Court may fix separate advances on costs for the claims and the counterclaims. When the Court has fixed separate advances on costs, each of the parties shall pay the advance on costs corresponding to its claims.

(5) The amount of any advance on costs fixed by the Court pursuant to this Article 36 may be subject to readjustment at any time during the arbitration. In all cases, any party shall be free to pay any other party's share of any advance on costs should such other party fail to pay its share.

2870. In accordance with these provisions, on 14 January 2016, the ICC Court readjusted the advance on costs to an amount of \$3,500,000, to be advanced by the Parties in proportion to the claims and the counterclaims. After receiving the advance payments from the Claimants of their share of \$3,175,000 and from the Respondents of their share of \$325,000, by letter dated 1 April 2016, the ICC Secretariat confirmed that the advance on costs had been paid in full by the Parties.
2871. Since the Respondents have advanced \$325,000 of the ICC Costs of the Arbitration and are to bear 5% of those costs (i.e., \$175,000), the Claimants are required to compensate the Respondents \$150,000,.
2872. With respect to the reasonable legal and other expenses incurred by the Respondents, the Respondents have claimed an amount of \$61,526,758.95, the entirety of which has been found to be reasonable by the Tribunal in ¶¶ 2862 to 2865 above.
2873. Concerning the legal fees and expenses, from the total claimed attorney fees and expenses, the Tribunal considers that \$162,700.88 should be deducted, for the following reasons. The Claimants dispute the Respondents' entitlement to this portion of the attorneys' fees and expenses claimed by the Respondents, which constitute the costs that were incurred in defending court proceedings brought by San Diego Gas & Electric and City of Riverside,²⁶⁴³ on the ground that California law does not allow piecemeal fee awards of parts of each procedural motion that a Party has prevailed in.²⁶⁴⁴
2874. The Tribunal considers that the attorneys' fees and expenses incurred concerning the court proceedings brought by SDG&E and City of Riverside cannot be awarded to the Respondents because Section 1.22.2.6 of the RSG Contract contemplates an

²⁶⁴³ Respondents' Fees and Costs Submission (3 October 2016), Cover Letter, p. 5; Tab 4.

²⁶⁴⁴ Claimants' Reply Submission on Costs, ¶ II-II(A), pp. 3-4.

award of legal fees and expenses for legal representation only for claims made by the prevailing Party “during the arbitration proceedings.” Since the Respondents’ motion to compel arbitration was made before a Court and not in these arbitration proceedings, these costs cannot be awarded by the Tribunal. Therefore, the total legal costs claimed by the Respondents is reduced by \$162,700.88.

2875. While the Claimants similarly also dispute the Respondents’ entitlement to an additional \$144,434.28, which constitute the expenses that were incurred in defending the application filed by the Claimants for interim relief before the Tribunal,²⁶⁴⁵ the Tribunal considers these costs to be subsumed in the overall costs incurred by the Respondents during the arbitration proceedings. Thus, their entitlement need not be considered by the Tribunal separately from the overall costs of legal representation. In the Claimants’ own words, doing the same “would be an immense undertaking (...) to review more than three years of fees and costs to isolate the portion attributable to each motion or procedural dispute.”²⁶⁴⁶
2876. Further, since only one side, between the Claimants and the Respondents, can emerge to be the prevailing one under California law,²⁶⁴⁷ the Claimants’ additional claim that “[i]f the Tribunal were to select a prevailing party for the interim relief application, or the Motions to Stay, then each of the parties’ procedural motions would have to receive similar treatment,” in a “vast majority” of which the “Claimants prevailed,”²⁶⁴⁸ cannot succeed, since they are not the prevailing Parties in this arbitration.

²⁶⁴⁵ Respondents’ Fees and Costs Submission, Cover Letter, p. 6; Tab 5.

²⁶⁴⁶ Claimants’ Reply Submission on Costs, ¶ II.D, p. 9.

²⁶⁴⁷ *Frog Creek Partners, LLC v. Vance Brown, Inc.*, 206 Cal. App. 4th 515, 532 (2012).

²⁶⁴⁸ Claimants’ Reply Submission on Costs, ¶ II.D, p. 8.

2877. In addition, the Respondents' claim for Costs includes their advance of \$325,000 on account of the ICC Costs of the Arbitration.²⁶⁴⁹ As the Tribunal adjudicated on them separately,²⁶⁵⁰ the amount of \$325,000 is to be deduction from the Respondents' claim for Cost for the purposes of quantifying the legal and other expenses.
2878. Accordingly, taking into account the deductions of \$162,700.88, i.e., the attorneys' fees and expenses incurred concerning the court proceedings brought by SDG&E and City of Riverside, and \$325,000, i.e., the Respondents' advance for the ICC Costs of the Arbitration, the cumulative legal fees and expenses of the Respondents result in an amount of \$61,039,058.07.
2879. As explained in ¶ 2860 above, a reduction of 5% is to be applied to the Respondents' legal fees and expenses. The results in an amount of $(61,039,058.07 - 3,051,952.90 =) \$57,987,105.17$.
2880. In light of the Tribunal's determinations above, the total amount of the Costs (i.e., the ICC Costs of the Arbitration and the legal fees and expenses) to be reimbursed by the Claimants to the Respondents is $(150,000 + 57,987,105.17 =) \$58,137,105.17$.

XXIV. POST-AWARD INTEREST

2881. The Parties have not requested that the Tribunal grant post-Award interest.
2882. The Tribunal notes that Section 1.22.3 of the RSG Contract requires that:

Any award of monetary damages shall bear interest from and including the award date to but excluding the date of payment in full at the lesser of twenty-five percent (25%) per annum or the maximum contractual

²⁶⁴⁹ See n. 2615 above.

²⁶⁵⁰ See ¶¶ 2867-2871 above.

interest rate permissible under the applicable laws of the State of California.

2883. As no relief has been requested by the Parties, the Tribunal makes no determination with regard to post-Award interest.

XXV. CONCLUSION

2884. The Tribunal sets forth below its conclusions on (i) the merits of this arbitration, including the Respondents' counterclaim; and (ii) costs, fees, and expenses.

2885. In setting forth these conclusions, the Tribunal recalls its prior statement that references to the Tribunal include the views of the concurring and dissenting arbitrator, except as otherwise specified in his separate opinion.²⁶⁵¹

A. MERITS

2886. The Parties' relief sought is set-forth in Sections VIII.G, VIII.H, and VIII.I above. Having regard to the analysis and relief sought, as considered above, the Tribunal reaches the following conclusions.

(a) The Claimants

2887. The Claimants' relief sought is set forth in their RfA,²⁶⁵² and affirmed in their Memorial²⁶⁵³ and Reply.²⁶⁵⁴ In particular, the:

144. Claimants seek a declaration that Mitsubishi²⁶⁵⁵ breached both the Contract and the warranties contained therein such that Claimants are

²⁶⁵¹ See ¶ 798 above.

²⁶⁵² See ¶ 780 above.

²⁶⁵³ See ¶ 781 above.

²⁶⁵⁴ See ¶ 782 above.

²⁶⁵⁵ The Claimants' RfA defines "Mitsubishi" as MHIA, MNES, and MHI (see RfA, p. 1). In this Award, as specified in ¶ 30 above, MNES and Mitsubishi Heavy Industries shall be jointly referred to as "MHI," "Mitsubishi," or the "Respondents."

entitled to damages in an amount not less than \$4 billion, to be proven at arbitration.²⁶⁵⁶

2888. In light of the Tribunal's above considerations, as determined in Section XIII.G above addressing Issue B.7,²⁶⁵⁷ the Tribunal grants, in part, the declaration requested in ¶ 144 of the RfA, as quoted in the preceding paragraph. MNES breached Section 1.17.1.3 of the RSG Contract in failing to timely pay invoices for expenses that are the responsibility of MNES.²⁶⁵⁸
2889. In addition, in light of the Tribunal's determinations in Section XIII.H above addressing Issue B.8, the Tribunal declares that the Respondents breached Section 1.9.6 of the RSG Contract in failing to allow access to their documents.²⁶⁵⁹
2890. Further, the Claimants seek a declaration with respect to Section 2719 of the California Commercial Code:

145. Claimants seek a further declaration that the limited remedies set forth in the Contract failed of their essential purpose and are unenforceable in these circumstances under section 2719 of the California Commercial Code. Claimants specifically seek a declaration that Mitsubishi's failures were so total and fundamental that any waiver of consequential or other damages is unenforceable.²⁶⁶⁰

²⁶⁵⁶ See ¶ 780 above, citing to RfA, ¶ 144. Subsequent to the RfA, the Claimants increased the amount of damages to \$7,750,000,000 and thereafter decreased to \$6,918,000,000 and 6,667,000,000, see the Expert Report of Mr. Graves, Rebuttal Expert Report of Mr. Graves, and the Revised Summary of Damages by Mr. Graves.

²⁶⁵⁷ See specifically ¶ 1689 above.

²⁶⁵⁸ The Tribunal considers that as the unpaid invoices are directed to MNES, therefore MNES is the party responsible for their payment. To the extent that MNES does not comply with its payment obligations as ordered in this Award, the Tribunal notes the parent guaranty agreement on behalf of Mitsubishi Heavy Industries Ltd as per appendix H of the RSG Contract

²⁶⁵⁹ See ¶ 1766 above.

²⁶⁶⁰ RfA, ¶ 148.

2891. In Section XVIII above, addressing Issue F, regarding the enforceability of the RSG Contract's limitation of liability, the Tribunal determined that, aside from the question of whether Section 2719 of the Commercial Code applies, on the facts in dispute, Section 2719 of the Commercial Code does not render unenforceable the limited remedies set forth in the RSG Contract for failure of their essential purpose.²⁶⁶¹ Nor did the Tribunal find that the Respondents' alleged failures were so total and fundamental as to render unenforceable the RSG Contract's waiver of consequential (and other) damages.²⁶⁶² Accordingly, the Tribunal rejects the relief sought in ¶ 145 of the RfA.

2892. In their relief sought the Claimants request a declaration of the Tribunal regarding indemnification for future liability and to be held harmless therefrom:

146. Claimants seek a further declaration that Claimants are entitled to be defended, indemnified, and held harmless from and against any and all liability, damages, losses, claims, demands, actions, causes of action, and/or costs (including attorney's fees and expenses), arising from Mitsubishi's defective RSGs. An actual controversy exists between Claimants and Mitsubishi regarding the scope of Mitsubishi's liability under the Contract. Such a declaration is necessary and proper at this time to administer final and complete relief, and to liquidate any chance of subsequent litigation between Claimants and any other individuals or entities.²⁶⁶³

2893. The Claimants did not develop their submissions on this relief sought. Even if they had, the Tribunal considers that the Respondents' liability under the RSG Contract, for matters arising from the Respondents' defective RSGs, is limited to the liability

²⁶⁶¹ See ¶¶ 2595, 2638, 2639 above.

²⁶⁶² See ¶¶ 2612-2618 above.

²⁶⁶³ See ¶ 780 above.

as determined in this present Award.²⁶⁶⁴ Accordingly, the Tribunal rejects the relief sought in ¶ 146 of the RfA.

2894. The Claimants seek damages:

147. Claimants seek the full measure of direct, indirect, consequential, incidental, and special damages to which they may be entitled under the California Commercial Code. As a result of Mitsubishi's breaches of contract and warranty, Claimants have suffered or are reasonably certain to suffer all of the following losses: (...)²⁶⁶⁵

2895. In ¶¶ 147 (a) through (j) of the RfA, the Claimants enumerate twelve heads of damages.²⁶⁶⁶ The Tribunal, as per its determinations above,²⁶⁶⁷ awards damages for two of these requested heads of damages, as set forth immediately below. On account of the Tribunal's determination of Issues B and C, the other heads of damages requested²⁶⁶⁸ are not recoverable by the Claimants. Accordingly, the Tribunal rejects the other heads of damages in the relief sought in ¶ 147 of the RfA.

2896. The breach of Section 1.17.1.3 of the RSG Contract, for unpaid invoices, results in the granting of the relief sought per ¶ 147 of the RfA:

a. [ii]²⁶⁶⁹ costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work; [and]

²⁶⁶⁴ See ¶¶ 2755-2759 above.

²⁶⁶⁵ See ¶ 780 above.

²⁶⁶⁶ See ¶ 780 above.

²⁶⁶⁷ Issue B.7, as quantified in Issue H (See ¶¶ 1689, 2762 above).

²⁶⁶⁸ Those are RfA, ¶ 147 (a), (b), (b)[ii], (c), (d), (e), (f), (g), (i) and (j). The Claimants' RfA has duplicate numbering, containing two paragraphs numbered 147(b). The Tribunal describes the second ¶ 147(b) as ¶ 147(b)[ii].

²⁶⁶⁹ The Claimants' RfA has duplicate numbering. The damages awarded by this Tribunal are per ¶ 147, sub-paragraph second (a), as cited in full. The Tribunal describes the second (a) as "(a)[ii]."

(...)

h. pre-judgment interest and interest on unpaid invoices for repair costs already billed to Mitsubishi at the California statutory rate of 10 percent per annum;²⁶⁷⁰

2897. As a consequence of the Tribunal's determinations concerning the liability of MNES, mentioned above in Section XIII.G above addressing Issue B.7 (unpaid invoices), the Tribunal grants the Claimants' damages as requested in ¶¶ 147 (a)[ii] and 147 (h). Accordingly, the Tribunal awards damages, as quantified in Issue H,²⁶⁷¹ on account of unpaid invoices issued by SCE to MNES.

2898. As stated above,²⁶⁷² the Tribunal also determined that the Respondents breached Section 1.9.6 of the RSG Contract. The RfA does not particularize specific relief for this breach. However, in ¶ 147 (j) of their RfA, the Claimants seek:²⁶⁷³

j. any other direct, indirect, incidental, special, and consequential damages that may be demonstrated following further investigation, or as the arbitration Tribunal deems just.²⁶⁷⁴

2899. The Claimants have not demonstrated any damages from the breach of Section 1.9.6 of the RSG Contract. Accordingly, as no damages are requested nor demonstrated, the Tribunal does not consider that any damages are to be awarded as a consequence of the breach of Section 1.9.6 of the RSG Contract.

²⁶⁷⁰ See also, SDG&E RfA, ¶ 57(l) for SDG&E's identical request. The Tribunal notes that the type of interest is not specified. Accordingly, the Tribunal may only grant simple interest.

²⁶⁷¹ See Section XX above.

²⁶⁷² See ¶ 2889 above.

²⁶⁷³ See also, SDG&E RfA, ¶ 57(l) for SDG&E's identical request.

²⁶⁷⁴ See ¶ 780 above.

2900. Further, the Claimants seek damages for alleged negligence and/or fraudulent misrepresentations:

148. Claimants seek damages for all injuries proximately caused by Mitsubishi's negligent and/or fraudulent misrepresentations, including:
(....)²⁶⁷⁵

2901. In ¶¶ 148 (c) through (m) of the RfA, the Claimants particularize 11 heads of damages.²⁶⁷⁶ In Section XVI above addressing Issue D regarding the Claimants' case for allegations of misrepresentation, fraud and tort claims, the Tribunal rejected the Claimants allegations of negligent and/or fraudulent misrepresentations.²⁶⁷⁷ As a consequence, the Tribunal does not award any damages and the Tribunal rejects these claims. Thus, the Tribunal rejects the relief sought in ¶¶ 148, including (c) through (m) of the RfA.

2902. As an alternative argument, the Claimants request relief in the form of a rescission of the RSG Contract:

149. In the alternative to the relief set forth in Paragraphs 147-48, Claimants seek rescission of the Contract and restitution, including:
(....)²⁶⁷⁸

2903. In ¶¶ 149 (a) through (h), the Claimants particularize eight heads of damages.²⁶⁷⁹ In Section XIX above, addressing Issue G, the Claimants' rescission claim, the Tribunal

²⁶⁷⁵ See ¶ 780 above.

²⁶⁷⁶ The RfA numbering contains an obvious error in beginning its numbering at ¶ 148 (c) and omits ¶¶ 148 (a) and (b).

²⁶⁷⁷ See ¶¶ 2478, 2496, 2516 above.

²⁶⁷⁸ See ¶ 780 above; See also SDG&E Post-Hearing Memorial, ¶ 110 for SDG&E's separate rescission damages.

²⁶⁷⁹ See ¶ 780 above.

rejected the availability of this remedy and, thus, rejects the relief sought in ¶¶ 149, including (a) through (h).

2904. It follows from the foregoing that the Tribunal rejects all claims and requests made by the Claimants, except as specifically granted, i.e., as per ¶¶ 147(a)[ii] and (h) of the RfA.

2905. In the separate SDG&E RfA, SDG&E submits that:

55. On information and belief, SDG&E joins in Edison's²⁶⁸⁰ requests for relief asserted in paragraphs 144 through 149 of Edison's RFA²⁶⁸¹

2906. The determinations and conclusions on ¶¶ 144 through 149 of the Claimants' RfA are set out above.²⁶⁸² Consequently, the Tribunal rejects the relief sought by SDG&E, with the exception of the relief granted in ¶¶ 147 (a)[ii] and 147 (h).

2907. SDG&E also submits that:

56. On information and belief, SDG&E joins in Edison's request for a further declaration that it is entitled to be defended, indemnified, and held harmless from and against any and all liability, damages, losses, claims, demands, actions, causes of action, and/or costs (including attorney's fees and expenses), arising from Mitsubishi's defective RSGs. An actual controversy exists between SDG&E and Mitsubishi regarding the scope of Mitsubishi's liability under the Contract. Such a declaration is necessary and proper at this time to administer final and complete relief, and to liquidate any chance of subsequent litigation between SDG&E and any other individuals or entities. In addition, SDG&E requests all damages arising from Mitsubishi's failure to provide express indemnity,

²⁶⁸⁰ Edison is defined as SCE and MNES, SDG&E RfA, p. 1. In this Award, Edison is also defined as SCE and MNES, see ¶ 23 above.

²⁶⁸¹ See ¶ 786 above.

²⁶⁸² See ¶¶ 2887 - 2903 above.

or in the alternative, SDG&E requests damages pursuant to the theory of equitable indemnity.²⁶⁸³

2908. The Tribunal's conclusion to the identical request by the Claimants, as set forth in ¶ 2893 above, applies equally to SDG&E. Therefore, the Tribunal rejects SDG&E's request as set out in ¶ 56 of the SDG&E RfA.

2909. SDG&E further submits that:

57. SDG&E joins in Edison's request for the full measure of direct, indirect, consequential, incidental, and special damages to which SDG&E may be entitled under California law. As a result of Mitsubishi's breaches of contract and the warranties contained therein, SDG&E has suffered or is reasonably certain to suffer all of the following losses: (...)²⁶⁸⁴

2910. In ¶¶ 57 (a) through (l) of the SDG&E RfA, SDG&E enumerates 12 heads of damages.²⁶⁸⁵ In Sections XIII and XV above, regarding the Claimants' breach of contract (Issue B) and breach of warranty claims (Issue C), the Tribunal determined that the Claimants have not proven such, with the exception of a breach of Sections 1.17.1.3 in Issue B.7 (unpaid invoices) and 1.9.6 in Issue B.8 (access to documents) of the RSG Contract; accordingly, the Tribunal rejects the relief otherwise sought.²⁶⁸⁶ The rejected relief sought is that requested in ¶¶ 57 (a) through (l) of the SDG&E RfA, with the exception of ¶¶ 57(c) and (j) of the SDG&E RfA.

²⁶⁸³ See ¶ 786 above.

²⁶⁸⁴ See ¶ 786 above.

²⁶⁸⁵ See ¶ 786 above.

²⁶⁸⁶ See ¶¶ 1786, 2402 above.

2911. Further, SDG&E seeks damages:

58. SDG&E seeks damages for all injuries proximately caused by Mitsubishi's negligence and negligent interference with prospective economic advantage, including: (...) ²⁶⁸⁷

2912. In ¶¶ 58 (a) through (l) of the SDG&E RfA, SDG&E enumerates 12 heads of damages. ²⁶⁸⁸ As analyzed above, on the assumption that SDG&E is a party to the RSG Contract, the Tribunal addressed the SDG&E claims in Section XXII above, regarding Issue J, SDG&E's separate claims. As elaborated by SDG&E, ²⁶⁸⁹ this relief sought is an alternative grounds in the event the Tribunal determines that SDG&E is not a party to the RSG Contract. As set forth in Section XXII above, SDG&E's claims are either unproven to the extent they rely upon determinations common to all the Claimants and/or exceed the enforceable liability cap of the RSG Contract, and are hence not awarded. Accordingly, the Tribunal rejects the relief sought in ¶¶ 58, including (a) through (l), of the SDG&E RfA.

2913. SDG&E requests that it be compensated for its share of the repair costs for the RSGs. ²⁶⁹⁰ The Tribunal understands that this share is by reference to SDG&E's shareholding in SONGS, which is not contested by the Parties.

2914. In addition, the City of Riverside requests damages of 1.79% of the total damages sought by the Claimants. ²⁶⁹¹ The Tribunal understands that this share is by reference to Riverside's shareholding in SONGS, which is not contested by the Parties.

²⁶⁸⁷ See ¶ 786 above.

²⁶⁸⁸ See ¶ 786 above.

²⁶⁸⁹ SDG&E Memorial, ¶ 60.

²⁶⁹⁰ See ¶ 786 above; SDG&E RfA, ¶¶ 57(c) and (j). See also RfA, as cited above in ¶ 2896 above.

²⁶⁹¹ See ¶ 784 above.

2915. Accordingly, the damages awarded, including pre-award simple interest, are to be paid by MNES in the following proportion (see also table at ¶ 2768 above):

Claimant	Share	Amount (\$)	Interest (\$)	Total (\$)
SCE	78.21%	65,887,015.81	31,875,350.25	97,762,366.05
SDG&E	20.00%	16,848,744.61	8,151,221.14	24,999,965.75
Riverside	1.79%	1,507,962.64	729,534.29	2,237,496.93
EMS	0.00%	0.00	0.00	0.00
Total	100%	84,243,723.06	40,756,105.68	124,999,828.74

2916. Under appendix H of the RSG Contract, a separate parent guaranty agreement, Mitsubishi Heavy Industries Ltd., the second respondent, is the guarantor of MNES.²⁶⁹² The Parties have not disputed Mitsubishi Heavy Industries Ltd.’s responsibility under this guaranty agreement.²⁶⁹³ The guaranty agreement provides that the guarantor, Mitsubishi Heavy Industries Ltd., “irrevocably and unconditionally guarantees, as primary obligor and not merely as surety ... the full and prompt payment and performance of [MNES] of each and every payment and performance obligation of [MNES] arising under the” RSG Contract.²⁶⁹⁴

2917. The Tribunal determines that the damages awarded to the Claimants for the breach of Section 1.17.1.3 of the RSG Contract are payment obligations of MNES arising out of the RSG Contract that are covered by the Mitsubishi Heavy Industries Ltd. guaranty agreement.

²⁶⁹² Exh. JX-318.

²⁶⁹³ RfA, ¶ 18.

²⁶⁹⁴ Exh. JX-318.

(b) The Respondents

2918. The Respondents' relief sought is as follows:

192. Respondents respectfully request that Claimants' claims for relief be denied in full, that Mitsubishi's Counter-Claims be granted and Claimants fully compensate Respondents for all their party costs and expenses connected with the present arbitral proceedings, including its attorneys' fees and such other costs as Respondents/Counter-Claimants will specify in due course.²⁶⁹⁵

2919. Having regard to the foregoing considerations, the Tribunal grants the Respondents' relief sought with respect to a denial of the Claimant's claims, except for the Tribunal's determinations of Issue B.7 (unpaid invoices) in Section XIII.G above and Issue B.8 (access to documents) in Section XIII.H above.

2920. With respect to the Respondents' counterclaims, the Tribunal rejected such in its determination of Issues I.2 and I.3 in Sections XXI.B and XXI.C above.²⁶⁹⁶

2921. The Tribunal considers that Issue I.1, i.e., the Respondents' requested adjustments to the purchase price and request that its prior invoice payment be counted against its limitation of liability, as determined in Section XXI.A above, is not a counterclaim *per se*, but rather a limitation of the damages recoverable by the Claimants pursuant to the breach by MNES of Section 1.17.1.3 of the RSG Contract, as determined in Issue B.7 (unpaid invoices) and quantified in Issue H (damages).²⁶⁹⁷

2922. It follows from the foregoing that the Tribunal rejects all claims and requests made by the Respondents, except as specifically granted.

²⁶⁹⁵ Respondents' R-PHM, ¶ 192.

²⁶⁹⁶ See ¶¶ 2798, 2803 above.

²⁶⁹⁷ See ¶ 2752 above.

B. COSTS, FEES, AND EXPENSES

2923. The Parties request that the Tribunal allocate the payment of the costs, fees, and expenses of this arbitration.

2924. The Claimants request:

(i) all costs of legal representation and assistance related to the enforcement of the Contract²⁶⁹⁸

2925. The Respondents' relief sought is as follows:

192. Respondents respectfully request that Claimants' claims for relief be denied in full, that Mitsubishi's Counter-Claims be granted and Claimants fully compensate Respondents for all their party costs and expenses connected with the present arbitral proceedings, including its attorneys' fees and such other costs as Respondents/Counter-Claimants will specify in due course.²⁶⁹⁹

2926. As determined in Section XXIII above, regarding the costs of this arbitration (Issue K), the Tribunal determined that the Claimants are to bear 95% of the ICC Costs of the Arbitration and 95% of the Respondents' legal fees and expenses.²⁷⁰⁰ As mentioned, the total amount of the ICC Costs of the Arbitration and the legal fees and expenses to be reimbursed by the Claimants to the Respondents is \$58,137,105.17.

2927. Riverside and SDG&E adopted in full the submissions as put forth by Edison. Accordingly, SDG&E and Riverside are responsible for the costs of this arbitration and the Respondents' fees and expenses in accordance with their percentage of the damages requested. Therefore, the Tribunal determines that the Claimants are to bear

²⁶⁹⁸ See ¶ 780 above; RfA ¶ 147(i).

²⁶⁹⁹ Respondents' R-PHM, ¶ 192.

²⁷⁰⁰ See ¶ 2860 above.

responsibility in the same percentage as their damages requested, i.e., SCE is responsible for 78.21%, SDG&E is responsible for 20%, and Riverside for 1.79%, of 95% of the Respondents' costs, legal fees, and expenses awarded as per the Tribunal's decisions below.

2928. The Respondents did not request a distribution as to costs, fees, and expenses between themselves. The Tribunal considers that the Costs are payable by the Claimants to MNES.
2929. The Parties did not specifically request that damages awarded be set-off against any costs, fees, and expenses awarded.

XXVI. DECISIONS

2930. FOR THE FOREGOING REASONS, the Tribunal renders the following decisions:

- (1) DECLARES that MNES breached Section 1.17.1.3 of the RSG Contract in failing to timely pay invoices for expenses that are the Respondents' responsibility.
- (2) DECLARES that the Respondents breached Section 1.9.6 of the RSG Contract in failing to allow SCE access to their documents.
- (3) DETERMINES that MNES owes to the Claimants in total \$124,999,828.74, which comprises the principal amount plus simple pre-award simple interest at 10% per annum until the date of the Award, as a consequence of its breach of Section 1.17.1.3 of the RSG Contract, referred to in Decision No. (1), for costs associated with the investigation of the causes and extent of damage to the RSGs, the efforts to restore Unit 2 to service at reduced power, and interim and permanent repair work.
- (4) ORDERS MNES to pay SCE, SDG&E, and Riverside the sum mentioned in Decision No. (3) as follows:
 - SCE (78.21%): \$97,762,366.05
 - SDG&E (20%): \$24,999,965.75
 - Riverside (1.79%): \$2,237,496.94
- (5) DETERMINES that the Claimants shall bear 95 percent of the ICC Costs of the Arbitration, which the ICC Court fixed at \$3,500,000 and for which Claimants have advanced \$3,175,000 and the Respondents \$325,000, the entirety of the

Claimants' own legal fees and expenses, and 95 percent of the legal fees and expenses of the Respondents, being in total \$58,137,105.17.

(6) ORDERS the Claimants to pay MNES the sum mentioned in Decision No. (5) as follows:

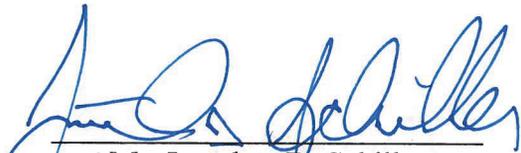
- SCE (78.21%): \$45,469,029.95
- SDG&E (20%): \$11,627,421.03
- Riverside (1.79%): \$1,040,654.18.

(7) REJECTS all other claims and requests.

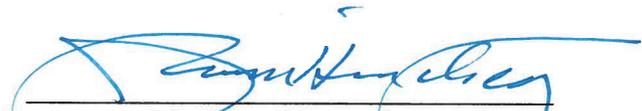
Place of arbitration: San Francisco, State of California, United States of America.

Date: 10 March 2017

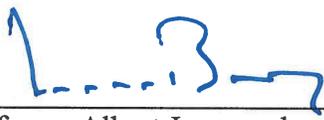
THE ARBITRAL TRIBUNAL



Mr. Jonathan D. Schiller
Arbitrator
(Concurring and Dissenting in Part)



Mr. John W. Hinchey
Arbitrator



Professor Albert Jan van den Berg
President

ANNEX A

DRAMATIS PERSONAE

Individual	Role in Arbitration	Evidence
██████████	Fact witness for Claimants SDG&E	Fact Witness Statement Supplemental Fact Witness Statement
Dr. Asadi, Ghasem	Expert for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Dr. Au-Yang, M.K.	Expert witness for the Respondents	Expert Witness Statement Expert Report Rebuttal Expert Witness Statement Testimony during Hearing
Avella, Edward	Fact witness for the Claimants	Fact Witness Statement Rebuttal Fact Witness Statement Testimony during Hearing
██████████	Fact witness for Claimants SDG&E	Fact Witness Statement Corrected Fact Witness Statement
Baggett, Arthur	Expert Witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Joint Deposition Designations
Bauder, Douglas	Fact Witness for the Claimants	Fact Witness Statement Testimony during Hearing
Dr. Begley, James	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Joint Expert Witness Statement with ██████████ and ██████████ Testimony during Hearing

Individual	Role in Arbitration	Evidence
Dr. Blandford, Edward	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Bohn, Lyle	Fact and Expert witness for the Respondents	Witness Statement Joint Expert Report (with ██████) Thicker-AVB Repair Implementation Report Testimony during Hearing
Boyd, Thomas	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Craver, Theodore	Fact witness for the Claimants	Fact Witness Statement Rebuttal Fact Witness Statement Testimony during Hearing
Denton, Robert	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Dietrich, Peter	Fact witness for the Claimants	Fact Witness Statement Rebuttal Fact Witness Statement Testimony during Hearing
Ditzel, Kenneth and John Reed	Expert Witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Supplemental Expert Witness Statement Testimony during Hearing
Egan, Geoff	Expert witness for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Joint Deposition Designations

Individual	Role in Arbitration	Evidence
Dr. Elder, Gary	Expert for the Claimants	Expert Witness Statement on Repair and Replacement Effort Expert Witness Statement on Design Era Rebuttal Expert Witness Statement on Design Era Rebuttal Expert Witness Statement on Repair and Replacement Effort Testimony during Hearing
Ellis, Jeffery	Fact witness for the Claimants	Fact Witness Statement Joint Deposition Designations
Emmert, Michael	Expert Witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Ficca, Paul	Fact and Expert Witness for the Respondents	Fact Witness Statement Expert Witness Report on SCE's claimed expenses Rebuttal Expert Witness Statement Joint Deposition Designations
Graves, Frank	Expert Witness for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Supplemental Expert Witness Statement Testimony during Hearing
Dr. Harrison, David	Expert Witness for the Claimants	Expert Witness Statement Joint Deposition Designations
Dr. Hibiki, Takashi	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Howell, Arthur (†)	Fact witness for the Respondents	Fact Witness Statement

Individual	Role in Arbitration	Evidence
		<p>Supplemental Fact Witness Statement</p> <p>*On account of the impossibility of examining Mr. Howell, during the Hearing, the Claimants submitted commentary on Mr. Howell's statements, to which the Respondents provided their own commentary.</p>
██████████	Fact witness for the Respondents	<p>Fact Witness Statement</p> <p>Supplemental Fact Witness Statement</p> <p>Joint Deposition Designations</p>
██████████	Fact and Expert witness for the Respondents	<p>Fact Witness Statement</p> <p>Supplemental Fact Witness Statement</p> <p>Expert Witness Statement</p> <p>Joint Expert Statement with Mr. Bohn</p> <p>Testimony during Hearing</p>
Johnson, Jon	Expert witness for the Respondents	<p>Expert Witness Statement</p> <p>Rebuttal Expert Witness Statement</p> <p>Joint Expert Witness Statement with Mr. Mitchell</p> <p>Testimony during Hearing</p>
██████████	Fact witness for the Respondents	<p>Fact Witness Statement</p> <p>Supplemental Fact Witness Statement</p> <p>Testimony during Hearing</p>
██████████	Expert witness for the Respondents	<p>Expert Witness Statement</p> <p>Rebuttal Expert Witness Statement</p> <p>Joint Expert Witness Statement with Dr. Begley and ██████████</p>

Individual	Role in Arbitration	Evidence
		Joint Expert Witness Statement with Mr. Russell and Mr. Wade. Joint Rebuttal Expert Witness Statement with Mr. Russell and Mr. Wade. Testimony during Hearing
	Fact and Expert witness for the Respondents	Fact Witness Statement Supplemental Fact Witness Statement Expert Witness Statement Rebuttal Expert Witness Statement Joint Expert Witness Statement With  Supplemental Rebuttal Expert Witness Statement With Dr. Begley and  Testimony during Hearing
	Fact Witness for the Respondents	Fact Witness Statement Supplemental Fact Witness Statement Joint Deposition Designations
King, Michael	Expert Witness for SDG&E	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
	Fact witness for the Respondents	Fact Witness Statement Supplemental Fact Witness Statement Testimony during Hearing
	Fact witness for the Respondents	Fact Witness Statement Joint Deposition Designations
Dr. Kytömaa, Harri (Exponent)	Expert for the Claimants	Tutorial* Design Review Report*

Individual	Role in Arbitration	Evidence
		Rebuttal Report* Supplemental Rebuttal Report* Testimony during Hearing *joint author with Dr. Timothy Morse
Lagally, Hermann	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Dr. Lahey, Jr, Richard	Expert for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Langford, Paul	Fact witness for the Claimants ²⁷⁰¹	Deposition Transcript of 16 March 2016 Testimony during Hearing
Leeds, Eric	Expert witness for the Claimants	Expert Witness Statement* Rebuttal Expert Witness Statement* Testimony during Hearing *With Mr. Strosnider
Dr. Lettis, William	Expert Witness for the Respondents	Expert Report Joint Deposition Designations
Merschhoff, Ellis	Expert witness for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Metcalf, Kenneth	Expert Witness for the Claimants	Expert Witness Statement Testimony during Hearing

²⁷⁰¹ Mr. Langford appeared in this arbitration following PO 9 in which the Tribunal granted the Claimants' request to subpoena Mr. Langford. Mr. Langford did not submit any written witness statements in this arbitration.

Individual	Role in Arbitration	Evidence
Mitchell, Vann	Fact and Expert witness for the Respondents	Fact Witness Statement Expert Witness Statement Joint Expert Witness Statement with Mr. Johnson Testimony during Hearing
Moran, Michael	Fact witness for the Claimants	Fact Witness Statement Testimony during Hearing
Morris, Michael	Expert Witness for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Dr. Morse, Timothy (Exponent)	Expert for the Claimants	Tutorial* Design Review Report* Rebuttal Report* Supplemental Rebuttal Report* Testimony during Hearing *joint author with Dr. Timothy Morse
	Fact witness for Claimants SDG&E	Fact Witness Statement
Olszewski, James	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Palmisano, Thomas	Fact witness for the Claimants	Fact Witness Statement Reply Fact Witness Statement Testimony during Hearing
Dr. Paulson, Keith	Fact witness for the Respondents	Fact Witness Statement Joint Deposition Designations
Ratcliffe, David	Expert witness for the Claimants	Expert Witness Statement Rebuttal Expert Witness Statement

Individual	Role in Arbitration	Evidence
		Testimony during Hearing
Russell, William	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Expert Report on Licensing Joint Expert Witness Statement with Mr. Russell and Mr. Wade. Joint Rebuttal Expert Witness Statement with Mr. Russell and Mr. Wade. Testimony during Hearing
██████████	Fact witness for the Respondents	Fact Witness Statement Supplemental Fact Witness Statement Testimony during Hearing
Stewart, Donald	Expert witness for the Respondents	Expert Witness Statement Rebuttal Expert Witness Statement Testimony during Hearing
Strosnider, Jack	Expert witness for the Claimants	Expert Witness Statement* Rebuttal Expert Witness Statement* Testimony during Hearing *With Mr. Leeds
Treadway, Ryan	Fact witness for the Claimants	Fact Witness Statement Joint Deposition Designations
██████████	Fact and Expert witness for the Respondents	Fact Witness Statement Expert Witness Statement Rebuttal Expert Witness Statement Joint Expert Witness Statement With ██████████ Testimony during Hearing
Wade, Michael	Expert Witness for the Respondents	Expert Witness Statement

Individual	Role in Arbitration	Evidence
		Joint Expert Statement with Mr. Russell and ██████████ Rebuttal Joint Expert Statement with Mr. Russell and ██████████ Joint Deposition Designations
Wharton, Michael	Fact witness for the Claimants	Fact Witness Statement Reply Fact Witness Statement Testimony during Hearing
Wilson, Robert	Fact Expert witness for the Respondents	Fact Witness Statement Supplemental Fact Witness Statement Expert Witness Statement Expert Report on Circulation Ratio and Gap Velocity Rebuttal Expert Witness Statement Testimony during Hearing

Other Relevant Individuals & Entities

Individual	Role in Case
Bob Olech	A senior MHI engineer who opined that only a replacement RSG would meet all of SCE's repair criteria.
AREVA	AREVA, Previously FRAMATONE, is a French designer and manufacturer of nuclear steam generators. It was the other leading bidder for designing the SONGS RSGs. It (i) submitted a repair proposal for SONGS at the request of SCE; (ii) was hired by SCE to undertake an OA for the Unit 2 restart; and (iii) was hired by SCE to review MHI's final repair proposal.
American Society of Mechanical Engineers (ASME)	The ASME sets various mandatory and non-mandatory standards for the design of nuclear steam generators. The ASME issues an "N-Stamp" certification to license designers of nuclear steam generators, such as MHI.

Individual	Role in Case
Atomic Energy of Canada Limited (AECL)	Atomic Energy of Canada Limited has a facility in Chalk River, Canada, at which testing on T/H conditions could be undertaken.
Atomic Safety and Licensing Board Panel	The ASLB Panel heard the Friends of the Earth Petition and granted a public hearing request after finding that a restart of Unit 2 at 70% power constituted a <i>de facto</i> license amendment.
Babcock and Wilcox / Babcock and Wilcox Canada (B&W)	B&W is a Canadian nuclear steam generator designer. It was also a bidder for the SONGS RSG project. B&W submitted a repair proposal at the request of SCE for Unit 3. B&W were involved in discussions regarding T/H testing at the AECL Chalk River facility.
Bechtel Corporation	Was hired by SCE to install the SONGS RSGs and remove the OSGs.
California Public Utilities Commission (CPUC)	The CPUC determines the rates that SCE can charge customers for its electricity. This rate setting determines whether SCE can recover for capital expenditures.
Chris Kudla	A consultant retained by MHI to assist with the repair/replacement efforts whose services were no longer required.
Demark	A consulting firm that assisted SCE in preparing its RfP for the SONGS replacement project.
Edison International (EIX)	The parent company of SCE.
Electric Power Research Institute (EPRI)	EPRI is the developer of ATHOS.
Friends of the Earth (FoE)	Is a civil society group that opposes nuclear power. It launched the legal actions which resulted in a ASLB Panel decision that found that the Unit 2 restart was a <i>de facto</i> license amendment request and thereby granted a public hearing opportunity.
Intertek	A consulting firm in the nuclear industry that provided SCE with an OA on the restart of Unit 2 of SONGS.

Individual	Role in Case
Nuclear Regulatory Commission (NRC)	The US NRC is the regulator for the US nuclear industry. It issued the Confirmatory Action Letter which set the conditions for the restart of Unit 2 and Unit 3 of SONGS. It sent an Augmented Inspection Team to investigate the SONGS Incident and MHI's manufacturing. It reviewed SCE's Unit 2 restart plan. It referred the Friends of the Earth petition to an Atomic Safety and Licensing Board Panel for determination.
Dr. Pierre Pettigrew	Professor at the École Polytechnique de L'Université de Montréal. Affiliated with Atomic Energy of Canada Limited. Professor Pettigrew's role in the events of this case is as (i) a leading researcher in T/H who published a paper on in-plane FEI; (ii) an independent expert who testified at NRC hearings regarding T/H and the events at SONGS; and (iii) an independent expert retained as part of the SONGS Expert Panel to advise on T/H and the events at SONGS.
US Department of Energy (DoE)	The US Department of Energy provides (or is supposed to provide) safe storage for spent nuclear fuel.
Westinghouse	Is a former designer and manufacturer of nuclear steam generators. The Westinghouse nuclear steam generator design was licensed to MHI and formed the basis of MHI's early design models. Westinghouse continues to provide its expertise to the nuclear industry. In this arbitration, it was hired by SCE to undertake an OA for the Unit 2 restart.

ANNEX B

ICC CASE 19784/AGF/RD

1. SOUTHERN CALIFORNIA EDISON COMPANY (U.S.A.), 2. EDISON MATERIAL SUPPLY LLC (U.S.A.), 3. SAN DIEGO GAS & ELECTRIC COMPANY (U.S.A.), 4. CITY OF RIVERSIDE (U.S.A.)

V.

**1. MITSUBISHI NUCLEAR ENERGY SYSTEMS, INC. (U.S.A.),
2. MITSUBISHI HEAVY INDUSTRIES, LTD. (JAPAN)**

Revised Joint List of Issues²⁷⁰²

A. Burden of Proof

1. Have Southern California Edison Company, Edison Material Supply LLC, San Diego Gas & Electric Company, and City of Riverside (“Claimants”) carried their burden of proof on the following issues:
 - (a) Claimants’ breach of contract claim;
 - (b) Claimants’ breach of warranty claim;
 - (c) That the RSG Contract’s warranty remedy failed of its essential purpose;

²⁷⁰² Pursuant to Procedural Order No. 1, the following abbreviations apply to previous written submissions:

Claimants’ Memorial (“M”)

Respondents’ Counter-Memorial (“CM”)

Claimants’ Reply Memorial (“RyM”)

Respondents’ Rejoinder Memorial (“RjM”)

Claimants’ Rejoinder Memorial on Counterclaim (“RjCM”)

- (d) That the RSG Contract's liability cap should be invalidated;
 - (e) That the RSG Contract's mutual waiver of consequential damages should be invalidated;
 - (f) Claimants' negligent misrepresentation claim;
 - (g) Claimants' intentional fraud claim;
 - (h) Claimants' rescission claim;
 - (i) Claimants' damages.
2. Have Respondents carried their burden of proof on the following issues:
- (a) That Respondents were excused from further performance of the RSG Contract because of Claimants' conduct;
 - (b) That Claimants failed to mitigate their damages;
 - (c) Respondents' entitlement to offsets to Claimants' damages, if any;
 - (d) Respondents' breach of contract counterclaim.
3. Who bears the burden to prove:
- (a) Whether or not the California Commercial Code (adapted from the Uniform Commercial Code ("UCC")) applies;
 - (b) Whether or not the economic loss rule bars Claimants' claims for negligent misrepresentation and intentional fraud.

B. Breach of Contract

1. What documents constitute the RSG Contract?
- (a) At the time of execution of the RSG Contract and its revisions?
 - (b) Subsequent to the execution of the RSG Contract and its revisions?
 - (c) In particular, has the Performance Analysis Report dated October 28, 2008 (JX-813) ("PAR") become part of the RSG Contract so that the

design parameters stated in the PAR have become binding contractual obligations?

- (i) If so, have the documents referenced at page 80 of the PAR also become binding contractual obligations?
2. Are the breaches of contract alleged by Claimants subsumed in, and governed by, the RSG Contract's warranties and remedies, as is contended by Respondents? (CM ¶ 390.) If so, what is the consequence, if any?
 - (a) Or, are there covenants in the RSG Contract that are separate and independent of Respondents' warranty obligations, as Claimants contend? (M ¶¶ 321-30.) If so, what is the consequence, if any?
3. Which party or parties had design responsibility under the RSG Contract? (M ¶ 77-78; RyM ¶¶ 15, 35-47.)
4. If and to the extent that Mitsubishi was responsible for the design, did it commit design errors as alleged by Claimants? (M ¶¶ 321-37; CM ¶¶ 327-332, 390-411; RyM ¶¶ 32-220; RjM ¶¶ 33-113.)
 - (a) Did Mitsubishi fail properly to analyze the key design features of its RSG design?
 - (b) Did Mitsubishi under-predict the thermal-hydraulic conditions, potential for tube vibration, and potential for tube wear in its RSG design?
 - (c) Did Mitsubishi fail properly to analyze for out-of-plane fluid elastic instability?
 - (d) Did Mitsubishi have a sufficient basis for not analyzing in-plane fluid elastic instability, independently or otherwise?
 - (e) Did Mitsubishi fail properly to analyze for wear due to random vibration?
 - (f) Did Mitsubishi fail to execute an effective quality assurance program to catch and correct the alleged design errors, as alleged by Claimants?

- (i) As Respondents contend, can a quality assurance program be effectively implemented and not identify the design errors alleged by Claimants?
 - (g) Did Mitsubishi fail to execute an adequate design review to catch and correct the alleged design errors, as alleged by Claimants?
 - (h) If Claimants have shown the failures in (a), (b), (c), (d), (e), (f) and/or (g), did extreme thermal-hydraulic conditions, vibration, and/or tube wear occur?
 - (i) If Claimants have shown the failures in (a), (b), (c), (d), (e), (f), (g) and/or (h), does such failure or failures, individually or in combination, provide evidence of Claimants' breach of contract claim?
 - (i) If so, what is the consequence, if any?
5. Did Mitsubishi have knowledge of any of the alleged design errors in Paragraph XIII.D above? (RyM ¶¶ 53-89; RjM ¶¶ 107-113.)
- (a) If so, did Mitsubishi improperly withhold such knowledge from Claimants?
 - (b) If Mitsubishi had knowledge of any alleged design errors in Paragraph 3 and improperly withheld that knowledge from Claimants, did Mitsubishi fail to act to correct the alleged design errors?
 - (c) If so, what is the consequence, if any?
6. Did Mitsubishi fail to deliver RSGs that conformed to the RSG Contract? (M ¶¶ 323-345; CM ¶¶390-411; RyM ¶¶ 32-34, 38-195, 199-217; RjM 33-113.).
- (a) Did Mitsubishi fail to supply RSGs that complied with RSG Contract Section 3.7.1.1?
 - (i) In this connection, should the RSGs have a service life of 40 calendar years, as Claimants contend, or have been designed using a 40-year service life, as Respondents contend?

- (b) Did Mitsubishi fail to supply RSGs that did not require parts or components to be replaced for their full service life (RSG Contract Section 3.7.1.2)?
 - (c) Did Mitsubishi fail to supply RSGs equipped with tube supports that adequately supported the tube bundle, minimized tube wear, and precluded tube damage caused by flow-induced and turbulence-induced vibration of the tubes and tube supports (RSG Contract Sections 3.9.3.7, 3.8.2)?
 - (d) Did Mitsubishi fail to comply with the provisions of U.S. legal and professional codes, referenced by the parties, including 10 CFR Part 50 Appendix B and the ASME Boiler and Pressure Vessel Code Section III (RSG Contract Sections 2.0, 2.6.5, 2.8.2, 2.8.5, 3.15, 3.4, 3.5, 3.6, 3.9.6.1)?
 - (e) Did Mitsubishi fail to supply RSGs that experienced no primary-to-secondary leakage under normal operating conditions (RSG Contract Sections 1.16.5.7, 3.20.2.4)?
 - (f) If Claimants have shown the failures in (a), (b), (c), (d) and/or (e), did extreme thermal-hydraulic conditions, vibration, and/or tube wear occur?
 - (g) If Claimants have shown the failures in (a), (b), (c), (d) and/or (e), does such failure or failures, individually or in combination, provide evidence of Claimants' breach of contract claim?
 - (i) If so, what is the consequence, if any?
7. Did Mitsubishi timely pay Edison's invoices back-charging Mitsubishi for expenses that are Mitsubishi's responsibility (RSG Contract Sections 1.17.1.3; 1.9.4; 1.12.2; 1.17.6)?
- (a) If not, was Edison's documentation supporting the charges inadequate, such that Mitsubishi was excused from paying any such invoices due to Edison's inadequate documentation supporting the charges? (M ¶¶ 308-20; CM ¶¶ 539-556; RyM ¶¶ 535-536 RjM ¶¶ 498-505.)

8. Did the RSG Contract (Section 1.9.6) obligate Mitsubishi to allow Claimants to examine relevant documents and records?
 - (a) If so, did Mitsubishi breach that obligation? (CM footnote 899; RyM ¶¶ 218-220.)
 - (b) If so, does that obligation include source codes?
 - (i) If so, did Mitsubishi breach that obligation?
9. Have Claimants established that any or all of the alleged failures, individually or in combination, constitute a material breach of contract through any or all of the provisions of the RSG Contract?

C. Warranty & Repair/Replacement

1. Did Mitsubishi deliver RSGs that were free from Defects, as defined in the RSG Contract (RSG Contract Section 1.17)? (M ¶¶ 346-357; RyM ¶¶ 32-372.)
 - (a) If not, is such failure a breach of the RSG Contract's warranty? (CM ¶¶ 390-428; RyM ¶¶ 221-228; RjM ¶¶ 114-120.)
2. Did Mitsubishi fail to repair or replace the RSGs in a mutually agreeable manner with due diligence and dispatch? (CM ¶¶ 415-418; Ry ¶¶ 229-386; RjM ¶¶ 114-265.)
 - (a) If so, is such failure a breach of the RSG Contract's Warranty?
3. Regarding Mitsubishi's proposed repair:
 - (a) Was Mitsubishi obligated to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the "root cause" of the Defect or alternatively, demonstrate that the problem(s) would not recur, as required in RSG Contract Section 1.17.1.3(c)? (M ¶¶ 131-147, 186; CM ¶¶ 132; 412, RyM ¶¶ 222-224; RjM ¶¶ 115, 120.)
 - (i) If so, did Mitsubishi undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the "root cause" of the Defect or demonstrate that the problem(s) would not recur?

(M ¶¶ 199-221, 270-292; CM ¶¶ 132, 271-280, 412-414; RyM ¶¶ 237-258; RjM ¶¶ 114-116, 130-138.)

- (ii) If Mitsubishi was obligated but failed to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” or demonstrate that the problem(s) would not recur, was Mitsubishi excused from its obligation due to Claimants’ actions?
 - (iii) If Mitsubishi was obligated but failed to undertake a technical analysis of the problem and demonstrate that its proposed repair corrects the “root cause” or demonstrate that the problem(s) would not recur, and Mitsubishi was not excused due to Claimants’ actions, what are the consequences of that failure?
- (b) Did the RSG Contract obligate Mitsubishi to demonstrate that its proposed repair would not cause other modes of failure? (RyM ¶¶ 265-279, 293-308; RjM ¶¶ 211-216.)
- (i) If so, did Mitsubishi demonstrate that its proposed repair would not cause other modes of failure?
 - (ii) If Mitsubishi was obligated but failed to demonstrate that its proposed repair would not cause other modes of failure, was Mitsubishi excused from its obligation due to Claimants’ actions?
 - (iii) If Mitsubishi was obligated but failed to demonstrate that its proposed repair would not cause other modes of failure, and Mitsubishi’s failure was not excused due to Claimants’ actions, what are the consequences of that failure?
- (c) Did the RSG Contract obligate Mitsubishi to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59? (CM ¶¶ 279, 411, 425; RjM ¶¶ 217-246.)
- (i) If so, did Mitsubishi demonstrate its proposed repair would either licensable through a license amendment or implementable under 10 C.F.R. § 50.59?

- (ii) If Mitsubishi was obligated but failed to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59, was Mitsubishi excused from its obligation due to Claimants' actions?
 - (iii) If Mitsubishi was obligated but failed to demonstrate that its proposed repair would be either licensable through a license amendment or implementable under 10 C.F.R. § 50.59, and Mitsubishi was not excused due to Claimants' actions, what are the consequences of that failure?
 - (d) Which party bears the risk, contractually or otherwise, of the length of time it would take to secure any required regulatory approval?
4. Regarding Mitsubishi's proposed replacement:
- (a) Did Mitsubishi raise or preserve the issue of a proposed replacement in its Memorials? (CM ¶¶ 136-139, 195-197, 222, 255-270; RjM ¶¶ 162-91.)
 - (i) Has Mitsubishi raised the issue of replacement in its Counter-Memorial and Rejoinder Memorial?
 - (ii) Did Mitsubishi show that it notified Edison that replacement was a viable option to correct the root cause of the tube-to-tube wear?
 - (iii) If so, was Mitsubishi then excused by virtue of Edison's actions?
 - (iv) If not, has Mitsubishi waived any right to claim that it offered replacement?
 - (b) If Mitsubishi has preserved a replacement claim: (M ¶¶ 131-147, 186; CM ¶¶ 132; 412, RyM ¶¶ 222-224; RjM ¶¶ 115, 120.)
 - (i) Did Mitsubishi offer to replace the RSGs in a manner consistent with Mitsubishi's obligations under RSG Contract Section 1.17.1.3?

- (ii) Did Mitsubishi's proposed replacement of the RSGs correct the "root cause" of the Defect or demonstrate that the problem(s) would not recur as set forth in RSG Contract § 1.17.1.3(c)?
 - (iii) Did Mitsubishi withdraw any offer to replace the RSGs, when Edison stated that Mitsubishi would be obligated to pay the full costs of the RSGs?
 - (iv) Was Mitsubishi excused from pursuing its proposal to replace the RSGs due to Claimants' responses and actions?
5. Regarding whether Mitsubishi was excused from further performance:
- (a) Was Edison obligated to agree to the repair proposed by Mitsubishi, under Section 1.17 of the RSG Contract?
 - (b) Did Edison act in good faith in seeking a mutually agreeable repair or replacement under Section 1.17 of the RSG Contract? (RjM ¶ 119.)
 - (c) As contended by Respondents, was Edison required to refrain from taking any actions that would interfere with Mitsubishi's ability to perform its obligations under Section 1.17 of the RSG Contract? (RjM ¶ 119.)
 - (i) If so, did Edison so refrain?
 - (d) Did Edison provide Mitsubishi with a reasonable opportunity to perform its obligations under the Warranty?
 - (e) Was Edison obligated to hire another vendor to repair or replace any Defect and backcharge Mitsubishi under Section 1.17.1.3(b), as alleged by Respondents?
 - (f) Was Mitsubishi excused from further performance under Section 1.17 because of Edison's conduct in (b) and (c) above? (CM ¶¶ 411-428; RyM ¶¶ 237-390, 457-463; RjM ¶¶ 121-191.)
6. Have Claimants established that any or all of the alleged failures, individually or in combination, constitute a material breach of contract through any or all of the warranty provisions of the RSG Contract?

7. What are the consequences of any finding regarding repair or replacement for Claimants' breach of warranty claim?

D. Misrepresentation, Fraud, and Tort Claims

1. Regarding Claimants' fraudulent inducement claims:
 - (a) Did Mitsubishi procure the RSG Contract through false representations? (M ¶¶ 358-75; CM ¶¶ 432; RyM ¶¶ 406-425; RjM ¶¶ 389-390.)
 - (b) Have Claimants established each of the elements of fraud under Cal. Civ. Code § 1572?
 - (i) If so, have Claimants proven that, at the time Mitsubishi made any alleged misstatements, Mitsubishi did not intend to honor its contractual promises? (RjM ¶¶ 389-390.)
 - (ii) As a matter of California law, are Claimants required to prove that Respondents did not intend to honor their promises?
2. Do Claimants have a separate claim for negligent misrepresentation (M ¶¶ 358-375, RyM ¶¶ 406-425, 479-82; CM ¶¶ 366-376; RjM ¶¶ 363-384)?
 - (a) If Claimants have a separate claim for negligent misrepresentation, have they established the elements of that claim?
 - (i) Have Claimants proven that Mitsubishi made false statements without a reasonable basis for believing such statements to be true at the time they were made? (M ¶¶ 366-72; CM ¶¶ 366-376; RyM ¶¶ 406-425, 479-82, RjM ¶¶ 363-376.)
 - (ii) Have Claimants proven that they justifiably relied on Mitsubishi's misrepresentations in entering into the RSG Contract? (M ¶¶ 373-75; CM ¶¶ 380-382; RjM ¶¶ 381-384.)
3. Do Claimants have a separate claim for intentional fraud?
 - (a) Have Claimants established each of the elements of intentional fraud?

- (i) Have Claimants proven that Mitsubishi's statements were false and that Mitsubishi knew they were false at the time they were made? (CM ¶¶ 387-388 and 510-513; RjM ¶¶ 363-374 and 385-388.)
 - (ii) Have Claimants proven that Mitsubishi intended to deceive Claimants with its statements? (CM ¶¶ 387-388 and 510-513; RjM ¶¶ 385-388.)
 - (iii) Have Claimants proven that Claimants justifiably relied on Mitsubishi's statements in entering into the RSG Contract? (CM ¶¶ 380-382; RjM ¶¶ 381-384.)
4. Are Claimants' tort claims barred by the economic loss rule under California law? (CM ¶¶ 383-384; RyM ¶¶ 409-410; RjM ¶¶ 391-393.)
5. What are the consequences of any finding regarding Claimants' alleged misrepresentation, fraud and tort claims?
6. In connection with Issue XVI.E above, are the following sub-issues relevant, as contended by Respondents, but denied by Claimants, and if so, what are the answers and the consequences, if any:
 - (a) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, intentional fraud, or fraudulent inducement, was such conduct the cause of damages Claimants allege? (RjM ¶¶ 424-436.)
 - (b) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, have Claimants proven that negligent misrepresentation is equivalent to fraud for the purposes of setting aside the liability cap? (CM ¶¶ 510-514; RjM ¶¶ 353-355.)
 - (c) If the Tribunal determines that any of the aforementioned conduct constituted negligent misrepresentations, have Claimants proven that negligent misrepresentation is equivalent to fraudulent inducement? (CM ¶¶ 510-514; RjM ¶¶ 353-355.)

E. Remedy

1. If it is determined that Mitsubishi breached the RSG Contract (see Issues B-C above), are Claimants' remedies limited by Section 1.17 (governing contractual warranties), Section 1.21 (governing consequential damages and limitation of liability), and Section 1.29 (governing liquidated damages) of the RSG Contract?
 - (a) Are the provisions of Section 1.29 (governing liquidated damages) and Section 1.17.2 (the "Performance Warranty") of the RSG Contract in lieu of, or in addition to, the limited remedies set forth in Section 1.17.1.3 (the "Defect Warranty")?
2. What are the consequences of such findings for the parties' positions regarding the enforceability of the limitations of liability (Section 1.21.2) and waiver of consequential damages (Section 1.21.1) provisions of the RSG Contract?

F. Limitation of Liability

1. Does Cal. Comm. Code § 2719 apply to the RSG Contract in this case? (CM ¶¶ 452-472; RyM ¶¶ 429-49; RjM ¶¶ 282-287.)
 - (a) Was the RSG Contract predominantly for the sale of goods, such that California Commercial Code Section 2719(2) applies to the RSG Contract, as alleged by Claimants? (RyM ¶¶ 433-42)
 - (i) Are the design services clearly distinct and separable from the sale of the RSGs such that the California Commercial Code should not apply to breaches of that portion of the RSG Contract? (RyM ¶¶ 446-49)
 - (b) Or, was the essence of the RSG Contract for engineering and design services, such that the California Commercial Code does not apply, as alleged by Respondents? (RyM ¶ 450)
2. Regarding the application of the California Commercial Code to the RSG Contract in the present case:

- (a) Should Cal. Com. Code Section 2719's analysis be applied as Claimants contend, namely by answering the following: (M ¶¶ 387-411; RyM ¶¶ 429-35)
- (i) Are the Warranty (Section 1.17), Waiver of Consequential Damages and Limitation of Liability provisions (Sections 1.21.1 and 1.21.2) a "unitary package of risk-allocation" as Claimants contend? (RyM ¶ 462)
 - (ii) Have the warranty remedies (Section 1.17) failed their essential purpose? (M ¶¶ 383-411; RyM ¶¶ 451-472)
 - (iii) If so, was that failure so total and fundamental that the exclusion of consequential damages must be expunged from the RSG Contract, as alleged by Claimants? Alternatively, has enforcement of the consequential damages waiver become oppressive by change of circumstances, such that it must be expunged from the RSG Contract? (M ¶¶ 397-411; RyM ¶¶ 451-53)
 - (iv) Does Section 2719(2) of the California Commercial Code require a showing of unconscionability in order to support a finding that the exclusion of consequential damages is unenforceable? (M ¶ 389; RyM ¶¶ 27, 451)
 - (a) If so, is the waiver of consequential damages (Section 1.21) both procedurally and substantively unconscionable? (M ¶ 389; RyM ¶¶ 27, 451)
- (b) Should Cal. Com. Code 2719's analysis be applied as Respondents contend, namely by answering the following:
- (i) Have the warranty remedies (Section 1.17) failed of their essential purpose under Cal. Com. Code Section 2719(2)? (CM ¶¶ 476-492; RjM ¶¶ 288-303.)
 - (ii) Are the warranty remedy (Section 1.17), the exclusion of consequential damages (Section 1.21.1) and the liability cap

(Section 1.21.2) subject to independent analysis? (RjM ¶¶ 307-316.)

- (iii) Has the liability cap of the RSG Contract failed its essential purpose? (RjM ¶¶ 317-323.)
 - (iv) Is the exclusion of consequential damages (Section 1.21.1) governed by Cal. Com. Code Section 2719(3)? (RjM ¶¶ 330-340.)
 - (v) Have Claimants met their burden to prove the exclusion of consequential damages (Section 1.21.1) is both procedurally and substantively unconscionable? (RjM ¶¶ 330-340.)
 - (vi) Even if the warranty remedy (Section 1.17), the exclusion of consequential damages (Section 1.21.1) and the liability cap (Section 1.21.2) are a “unitary package of risk-allocation,” as Claimants contend, do all three provisions automatically fail if one provision fails of its essential purpose, or do the liability cap and/or the exclusion of consequential damages still survive under the case-by-case approach set forth in Claimants’ Ninth Circuit case law? (RjM ¶¶ 324-329 (re liability cap), ¶¶ 341-342 (re exclusion of consequential damages).)
3. Does Section 1668 of the California Civil Code invalidate the exclusion of consequential damages (Section 1.21.1) and liability cap (Section 1.21.2), as alleged by Claimants? (M ¶¶ 415, 421-426; 424; CM ¶¶ 524-526; RyM ¶¶ 450, 473-487; RjM ¶¶ 359-362.)
4. Regarding the exclusions to the Liability Cap set forth in Section 1.21.2 of the RSG Contract: (RyM ¶ 251; CM ¶¶ 510-526; RjM ¶¶ 343-358.)
- (i) Have Claimants met their burden of proving gross negligence under California law? (M ¶¶ 422-24; RyM ¶¶ 474-77)
 - (a) Have Claimants proven that Mitsubishi’s conduct was an extreme departure from the standard of care required? (CM ¶¶ 515-526; RjM 344-352.)

- (b) Have Claimants proven the other elements of negligence, as required for a finding of gross negligence?
- (ii) Have Claimants met their burden of proving fraud? (M ¶ 426; RyM ¶¶ 478-82)
- (iii) Have Claimants met their burden of proving Mitsubishi acted with willful misconduct?
- (iv) Have Claimants met their burden of proving Mitsubishi committed illegal or unlawful acts? (M ¶ 425; RyM ¶¶ 483-87)

G. Rescission

1. In the alternative, are Claimants entitled to rescind the RSG Contract (M ¶¶ 418-26; RyM ¶¶ 488-514; RjM ¶¶ 394-420.)
 - (a) Have Claimants proven a ground for rescission on the basis of failure of consideration?
 - (i) Was there a failure of consideration, in whole or in part, as alleged by Claimants? (M ¶¶ 377-381; RjM ¶¶ 398-407; RyM ¶¶ 509-513.)
 - (ii) Are Claimants precluded from claiming a failure of consideration? (RjM ¶ 398-407.)
 - (b) Is rescission inappropriate? (CM ¶¶ 434-436; RjM ¶¶ 398-404.)
 - (c) With respect to fraudulent inducement:
 - (i) As an alternative basis for rescission, have Claimants proven fraudulent inducement as determined in Issue D.1? (M ¶382; RyM ¶¶ 409-10, 514; RjM ¶¶ 389-390.)
 - (d) Have Claimants met their burden to prove the other statutory and equitable requirements, if any, for rescission? (RjM ¶¶ 394-420; RyM ¶¶ 489-508.)

2. Did Claimants give notice of rescission to Mitsubishi promptly upon discovering the facts that entitled Claimants to rescission? (CM ¶¶ 437-438; RyM ¶¶ 494-506 RjM ¶¶ 413-415.)
3. Are Claimants required under California law to restore to Mitsubishi everything of value that Claimants received under the RSG Contract, as alleged by Respondents? (RyM ¶¶ 504-08)
 - (a) If so, have Claimants restored to Mitsubishi everything of value that Claimants received under the RSG Contract? (CM ¶ 429, CM to SDG&E ¶ 11; RyM ¶¶ 504-08; RjM ¶¶ 416-420.)
4. Are Claimants Southern California Edison Co., San Diego Gas & Electric Co., and City of Riverside entitled to rescind the contract and/or to recover rescissory damages under California law? (RyM ¶¶ 490-93; CM ¶ 429, CM to SDG&E ¶ 11; RjM ¶¶ 416-420; SDG&E RyM ¶¶ 17-24.)
 - (a) If not, and if only EMS is entitled to rescind the RSG Contract, what are the consequences for the rescission claim?
5. Does Claimants' alternative claim for rescission extinguish the RSG Contract (other than the arbitration provision), including the limitations on liability? (M ¶¶ 418-20; Ry ¶541; RjM ¶¶ 394-396.)
6. What are the consequences of any finding regarding rescission? (RyM ¶¶ 508-14.)

H. Damages

1. Are Claimants entitled to damages and, if so, in what amount?
 - (a) Have Claimants proven all of their alleged damages were caused by a breach or other conduct for which Mitsubishi has been found liable? (RyM ¶¶ 517-19; RjM ¶¶ 426-436.)
 - (i) To determine if the damages are direct damages:
 - (a) Did the damages result in the ordinary course of events from Mitsubishi's breach of contract? (M ¶¶ 433-34; RyM ¶ 517.)

- (b) Did the damages flow directly and necessarily from a breach for which Mitsubishi has been found liable? (RjM ¶¶ 429-30.)
 - (c) Are those damages barred under RSG Contract § 1.21.1? (RjM ¶ 438.)
- (ii) To determine if the damages are consequential damages:
 - (a) Were those damages foreseen or foreseeable? (RyM ¶¶ 519-22.)
 - (b) Are those damages barred under RSG Contract § 1.21.1?
- (b) Have Claimants proven that the categories of their damages are reasonably certain as to their occurrence? (RyM ¶¶ 517-19.)
 - (i) Are Claimants required to prove that the extent of their damages is reasonably certain, as alleged by Respondents?
 - (ii) If so, have Claimants so proven?
- (c) Have Respondents met their burden of showing that Claimants failed to mitigate their damages?
 - (i) Did Claimants fail to act reasonably to pursue a mutually agreeable repair? (CM ¶¶ 533-535.)
 - (ii) Did Claimants fail to act reasonably in not hiring another vendor to repair or replace the RSGs under the RSG Contract § 1.17.1.3(b)?
 - (iii) Did Claimants fail to act reasonably in permanently retiring SONGS on June 7, 2013? (M ¶ 430; RyM ¶¶ 388-90, 526.)
 - (iv) Did Claimants fail to act reasonably in choosing when and how to decommission the plant? (M ¶ 430; RyM ¶¶ 388-90, 526.); RjM ¶¶ 464-468.)
- (d) Should any damages award to Claimants be offset by the payments Claimants received under an insurance policy compensating them for

the purchase of replacement power during an outage? (RjM ¶¶ 472-474.)

- (e) Should any damages award to Claimants be offset by the settlement of the OII proceeding before the CPUC? (RjM ¶¶ 469-471.)
2. If the Tribunal determines rescission of the RSG Contract is an appropriate remedy:
 - (a) Have Claimants proven that the rescissory damages they seek are appropriate under California law? (M ¶ 440; RyM ¶¶ 527-28; CM ¶¶ 536-538; RjM ¶¶ 475-486.)
 - (b) Should any rescissory damages award to Claimants be offset by amounts Mitsubishi incurred in designing, manufacturing, and delivering the RSGs? (CM ¶ 439; RjM ¶¶ 409-412.)
 3. What are the consequences of any finding regarding damages?

I. Counterclaim

1. Should Claimants' damages, if any, be reduced by (i) the amount advanced by Mitsubishi against Edison's claim for reimbursement of Steam Generator Inspection and Repair costs, (ii) the amount of liquidated damages amounts already paid to Edison by Mitsubishi, if any, and/or (iii) the amount expended by Mitsubishi in fulfilling its warranty obligations? (CM ¶¶ 557-565; RjM ¶¶ 498-511.)
2. Is Mitsubishi entitled to a refund of any of its \$45 million advance against Edison's claimed Steam Generator Inspection and Repair cost due to Edison's failure to substantiate its expenditures? If so, how much of a refund is Mitsubishi due? (CM ¶¶ 558-559; RyM ¶¶ 535-536; RjM ¶¶ 506-507; RjCM ¶¶ 6-8.)
3. Is Mitsubishi entitled to the final milestone payment owed by Edison under the separate RRVH Contract in the amount of \$1,971,647? (CM ¶¶ 560-565; RjM ¶¶ 506-507; RyM ¶¶ 537-39 ; RjCM ¶ 5.)
4. What are the consequences of any finding regarding the counterclaim?

J. SDG&E's Claim²⁷⁰³

1. See also Issue G.4 above.
2. Is it established that SDG&E was a party to the RSG Contract entitled to bring a claim for rescission? (SDG&E RyM ¶¶ 17-24.)
3. If SDG&E is not a party to the RSG Contract, is SDG&E, as a third party beneficiary, entitled to rescind the RSG Contract?
4. If SDG&E is not a party to the RSG Contract, is SDG&E, as a third party beneficiary, entitled to bring claims for breach of contract and breach of warranty?
5. Have all of the elements of SDG&E's fraud claim (negligent misrepresentation, intentional misrepresentation, and/or concealment) been established? (SDG&E RyM ¶¶ 54-78; RjM to SDG&E ¶¶ 13-14.)
6. Has SDG&E proven that any of the alleged conduct at issue resulted in events that would potentially give rise to contractual indemnity, specifically: death or injury to person, damage to property, claims by Governmental Authority for taxes, claims with respect to employer's liability or worker's compensation, liens or encumbrances on the Work, or failure of Mitsubishi to comply with Applicable Laws? (SDG&E RyM ¶¶ 46-53; RjM to SDG&E ¶¶ 15-20.)
7. If the occurrence of an event potentially giving rise to contractual indemnity has been established, did SDG&E's damages arise from that event? (RjM to SDG&E ¶¶ 28-29.)
8. Does the economic loss rule not apply because a special relationship existed between Mitsubishi and SDG&E that would justify recovery for harm to

²⁷⁰³ SDG&E is a "Claimant" with respect to the claims asserted by its Operating Agent, SCE, including breach of contract, breach of warranty, fraud (negligent misrepresentation and intentional fraud), and rescission, and, as set forth above, is seeking recovery in that capacity. In the event that SCE is not entitled to recovery as SDG&E's Operating Agent, SDG&E, in the alternative, has asserted separate claims of its own: breach of contract and warranty under a third party beneficiary theory, fraud, express indemnity, negligence, negligent interference with prospective economic advantage, equitable indemnity, and declaratory relief.

economic interests? (SDG&E M ¶ 59; SDG&E RyM ¶¶ 83-87; CM to SDG&E ¶ 17, RyM of SDG&E ¶ 83.)

9. Are SDG&E's alternative tort claims for equitable indemnity and negligent interference with prospective economic advantage moot because Mitsubishi concedes that SDG&E is a third party beneficiary to the RSG Contract? (SDG&E RyM ¶¶ 111-20; CM to SDG&E ¶¶ 18-20.)
10. Has it been established that SDG&E has been compelled to make payments to Southern California ratepayers or other third parties because of Mitsubishi's negligence? (RyM of SDG&E ¶¶ 8, 118; RjM to SDG&E ¶ 23.)
11. What are the consequences of any finding regarding SDG&E?

K. Costs

1. What are the costs of the arbitration?
 2. Which party shall bear the costs of the arbitration?
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