

2.206 PRESENTATION
San Onofre Units 2 and 3
Replacement Steam Generators

MEETING WITH PETITIONER FRIENDS OF THE EARTH, REQUESTING
ENFORCEMENT ACTION AGAINST SOUTHERN CALIFORNIA
EDISON UNDER 10 CFR 2.206

January 16, 2013

Presented For Friends of the Earth
By Fairewinds Associates Inc, Burlington VT

Based Upon Non-Proprietary Information

Sequence of Presentation

SECTION 1: Chronology of Events

SECTION 2: Magnitude of Design Changes

SECTION 3: Conclusions



SECTION 1

CHRONOLOGY OF EVENTS

Prior To Analysis And Design Of RSGs, Edison Applied To CPUC For RSG Permits

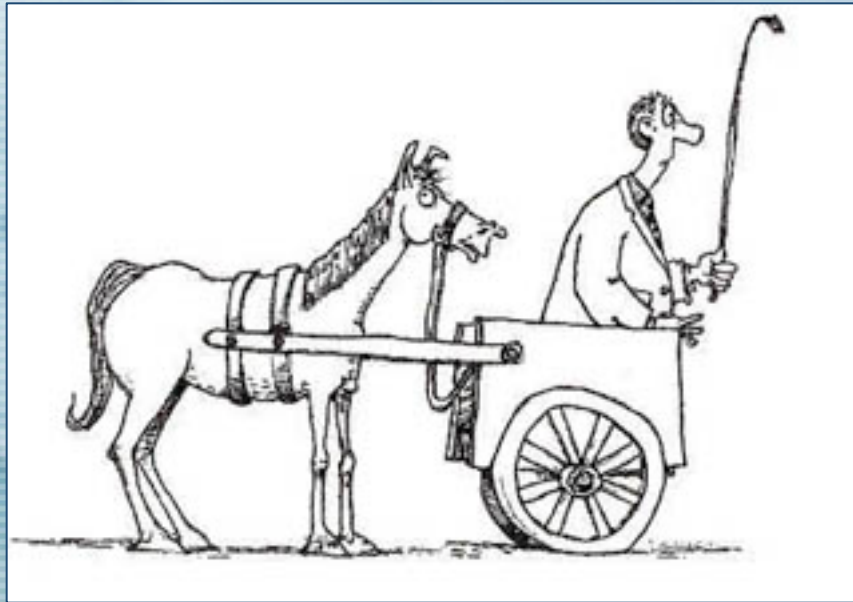
According to Southern California Edison's 2004 Annual Report, its application for its Unit 2 and 3 Replacement Steam Generators was filed with the State of California's PUC on February 27, 2004, which was prior to the contract with MHI on September 30, 2004.

In 2004 Edison Contract Language Directed MHI That CFR§50.59 Would Not Apply

An Edison Whistleblower released the San Onofre Design Specification for RSG. This specification required that CFR§50.59 would not apply to the San Onofre RSG's even though an analysis had not yet been completed.

EXCERPTS FROM SONGS Replacement Steam Generator Design & Performance Specifications SO23-617-1

Originator – James Chan
IRE – Jun Gaor
FLS – David Calhoun
SLS – Craig Herberts
PE Tom Pierno
NO& A Bill Kotekkaskos



San Onofre

Design Specification For RSG #1

3.6.1.1

“Edison intends to replace the steam generators under the 10 CFR 50.59 rule.”

3.6.1.2

“...the Supplier shall guarantee in writing that the RSG design is licensable and provide all support necessary to achieve that end.”

3.6.1.3

“Any deviations from these requirements shall require Edison’s approval.”

San Onofre

Design Specification For RSG #2

3.6.2 Licensing Topical Report:

“The Supplier shall prepare and submit for Edison’s approval a Licensing Topical Report demonstrating compliance of the RSG design with all SONGS licensing requirements. The report shall include an engineering evaluation, including all necessary analyses and evaluations, justifying that the RSGs can be replaced under the provisions of 10 CFR 50.59 (without prior NRC approval). ...The 10 CFR 50.59 evaluation shall be performed by Edison.”

Edison Official Notification To NRC June 2006

Edison Notified NRC of 50.59 Decision in June 2006

“A meeting was held on Wednesday, June 7, 2006, between the Nuclear Regulatory Commission (NRC) staff and the SCE, the licensee for SONGS 2 and 3. The meeting was held at the request of the licensee to provide to the NRC staff an overview of the various aspects of its steam generator (SG) replacement project.”

(ML061670140)

JUNE 2006 Edison Presentation to NRC

Licensing



- Will Be Implemented Under 10CFR 50.59
- No Power Uprate
- Associated Technical Specification Changes
 - Identification 2007



2006 NRC Informed of “Improvements”

Some Key Design Improvements



- Larger Surface Area
- Alloy 690 Thermally Treated Tubing
- Improved AVB Design
- Integral Steam Nozzle
- Improved Material for Tube Supports
- Forged Shell



**S/G 3A Lower and Middle Shell
S/G 2A Balance Ring, Extension
Ring, & Tubesheet**



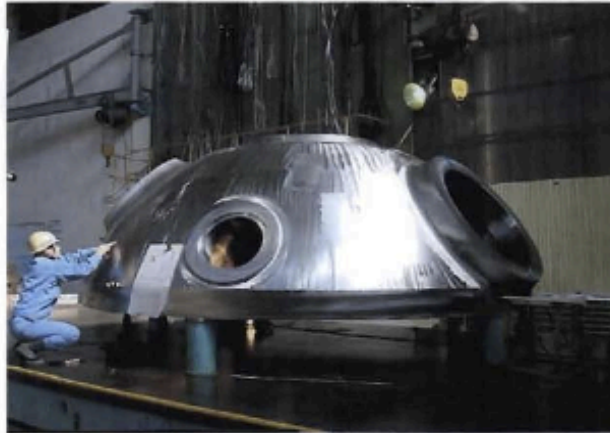
2006 Edison Accepts Responsibility

Oversight



- Design Reviews
- Technical Meetings (SONGS, Kobe)
- SCE Resident Personnel @ Kobe
- Special Engineering Visits
- Readiness Reviews
- Independent Inspections
- Audits

SONGS 2B Channel Head



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Mitsubishi Heavy Industries Was Constrained By The Contract

Between the contract award in 2004 and NRC kickoff meeting in 2006, Mitsubishi Heavy Industries had to force fit the RSG analysis and design in order to support Edison's earlier decision determining that 10CFR§50.59 did not apply.

The 10CFR§50.59 Process

In its January 9, 2013 Response to the NRC, Edison said

"As discussed in Section 1.3 of NEI 96-07, changes are evaluated under 10 CFR 50.59 using a multi-step process. First, a licensee must determine that a proposed change is safe and effective through appropriate engineering and technical evaluations." *Page 5*

- **Fairewinds agrees with Edison that this is the correct approach, and it should have been implemented.**
- **However, this approach was not applied during the RSG Project. Rather this "multistep process" was thwarted by Edison.**
- **No "appropriate engineering and technical evaluation" was performed by Edison when the contractual decision was made that 10CFR§50.59 would not apply.**

Standard Technical Specifications License Amendment

2009: During the San Onofre Standard Technical Specification License Amendment, Edison identified many areas where the San Onofre Replacement Steam Generator was dramatically different than the Original Steam Generator.

San Onofre RSG's Were Not *Like-For-Like*

Modification	Design Parameter Ratio RSG / OSG*	Percent Difference
Steam Generator (SG) Volume	23,100 / 22,803	1% Increase
Secondary Volume to Cover Tubes in One SG	3825 / 3349	14% Increase
Flow Restrictor Area	2.8 / 7.87	65% Decrease
Total SG Mass	1,334,393 / 1,242,369	7% Heavier: Increase of 100,000 pounds
Cold Pipe Coolant Mass	68,235 / 60,073	13 % Increase
SG Tube Active Volume	2,898 / 2,523	14% Increase
Hot Plenum Volume	2,998 / 3,055	2% Decrease
Cold Plenum Volume	3,701 / 3,974	7% Decrease
Tube Mass Specific Heat	48,512 / 50,182	3% Decrease

*Note: RSG (Replacement Steam Generator) to OSG (Original Steam Generator)

Edison Identified Numerous San Onofre Design Changes

2011 Edison and MHI Report tout all the design changes implemented in the San Onofre RSG:

- Remove Stay Cylinder
- Add 377 Tubes
- Change Tube Support Structure
- Add New Anti-Vibration Bars
- Dozens More Changes...



SECTION 2

MAGNITUDE OF DESIGN CHANGES

**In and of themselves,
Edison's design changes to the
Replacement Steam Generators
should have triggered
the 10CFR§50.59 process.**

- The San Onofre tubes and tube sheets are part of the containment boundary and are safety related.
- San Onofre claimed to the NRC that new improved **anti-vibration bars** would reduce wear on these important components and would not adversely impact their design function.

Table 1
Steam Generator Design Changes Identified By Fairewinds
Compared With The NRC's Like-For-Like Criteria

50:59 Criteria (A)	(B) Remove stay cylinder	Change tube sheet	Tube alloy change	Add tubes	Change tube support	Add flow restrictor	Additional water volume	Feed water distribution ring
i – Accident Frequency Increase	Yes (1)	Yes (1)	No	Yes (3,4)	Yes (3,4,8)	No	No	No
ii – Increase in SSC Malfunction occurrence	Yes (1)	Yes (1)	No	Yes (3,4)	Yes (3,4,8)	No	No	No
iii - Accident consequent increase	Yes (1)	Yes (1)	No	Yes (3,4)	Yes (3,4,8)	Yes (2)	Yes (2,5,6)	No
iv - Increase in SSC consequence of malfunction	Yes (1)	Yes (1)	No	Yes (3,4)	Yes (3,4,8)	Yes (2)	Yes (2,5,6)	No
v - Create unanalysed accident	Yes (1)	Yes (1)	No	No	No	Yes (2)	Yes (2,5,6)	Yes (3,7,8)
vi – Create new malfunction	Yes (1)	Yes (1)	No	No	Yes (3,8)	Yes (2)	No	Yes (3,7,8)
vii – Alter fission product barrier	Yes (1)	Yes (1)	No	Yes (3)	No	No	No	No
viii – Change design basis evaluation method	Yes (2)	Yes (2)	No	Yes (2)	Yes (2,8)	Yes (2)	Yes (2,5,6)	No

Mitsubishi Heavy Industries Should Not Be The Scapegoat

“If the RSGs had been designed and manufactured in accordance with the procurement specification, the leak and tube wear would never had occurred.” Page 12, 1/9/13 Edison Letter to NRC

- The replacement steam generator design developed by Mitsubishi ... in accordance with the licensee's design specification was translated into the same set of design and fabrication drawings. AIT Report, Page 27
- **No matter who fabricated the RSG's for San Onofre, the tube damage would have occurred. The root cause of this problem was the design, not the fabrication.**

Edison 2003 Annual Report: San Onofre Identical To Palo Verde

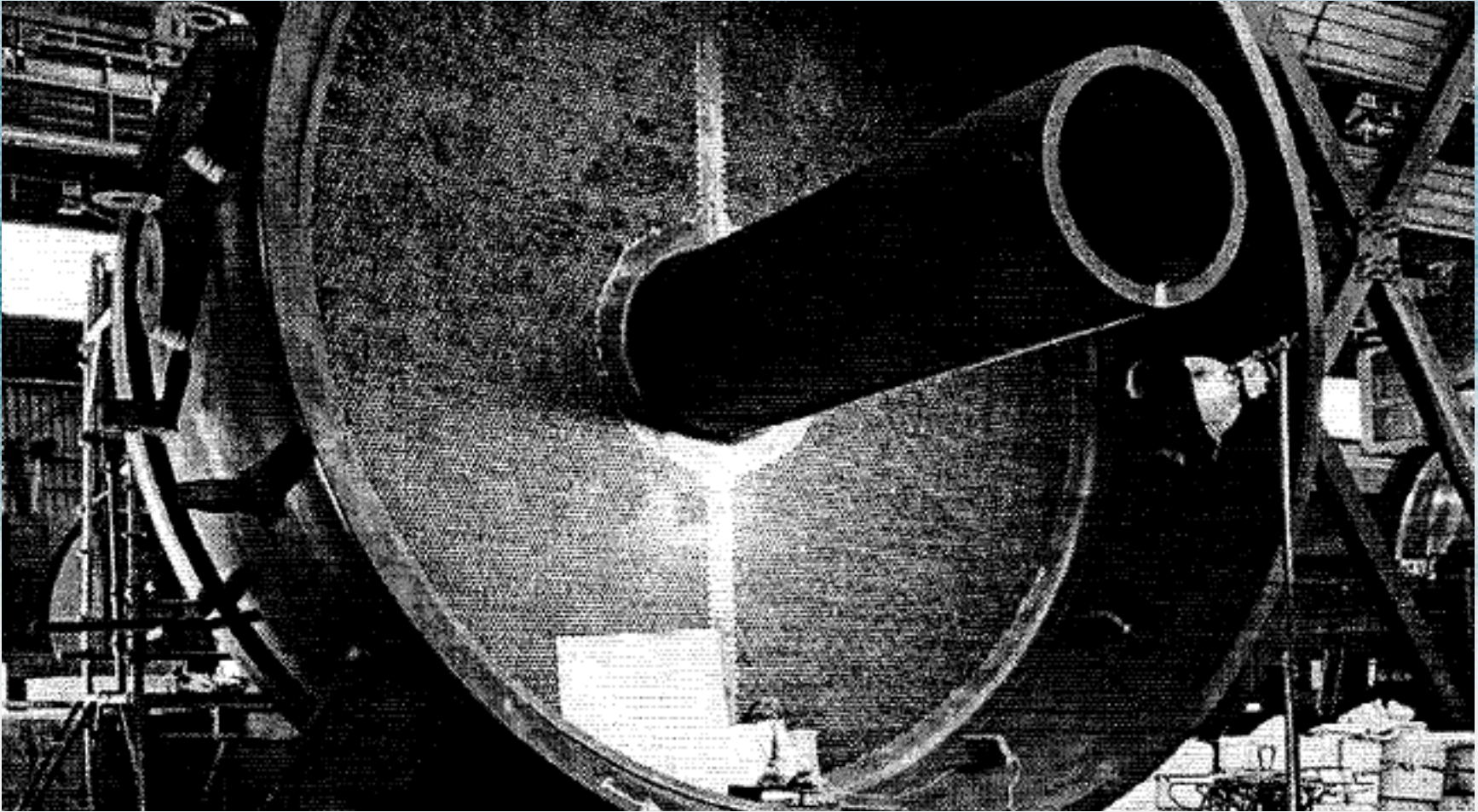
Palo Verde Steam Generators

“The steam generators at the Palo Verde Nuclear Generating Station (Palo Verde), in which SCE owns a 15.8% interest, have the same design and material properties as the San Onofre units. During 2003, the Palo Verde Unit 2 steam generators were replaced.”

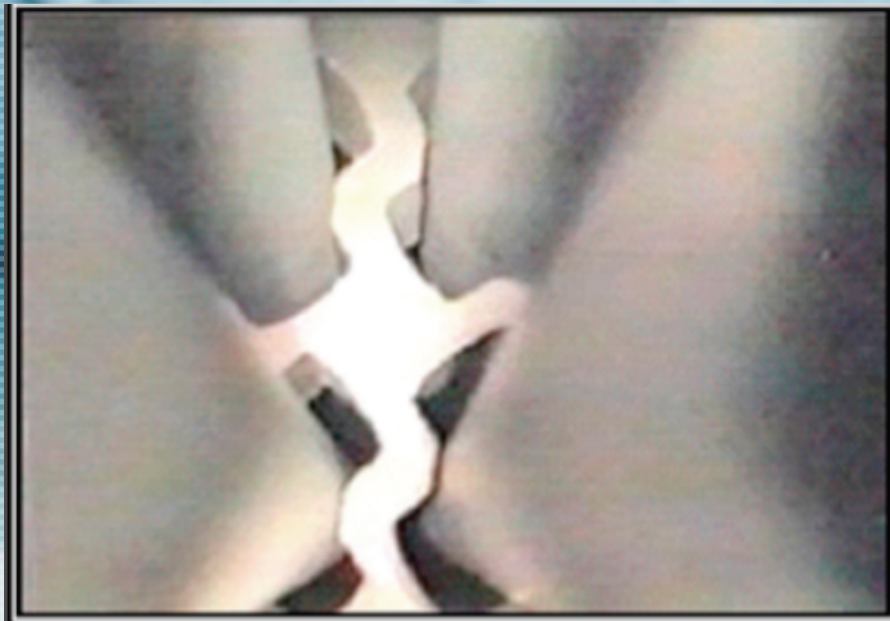
(Edison 2003 Annual Report, Page 21)

http://www.edison.com/images/cms_images/c6452_2003_annual_eix_5543.pdf

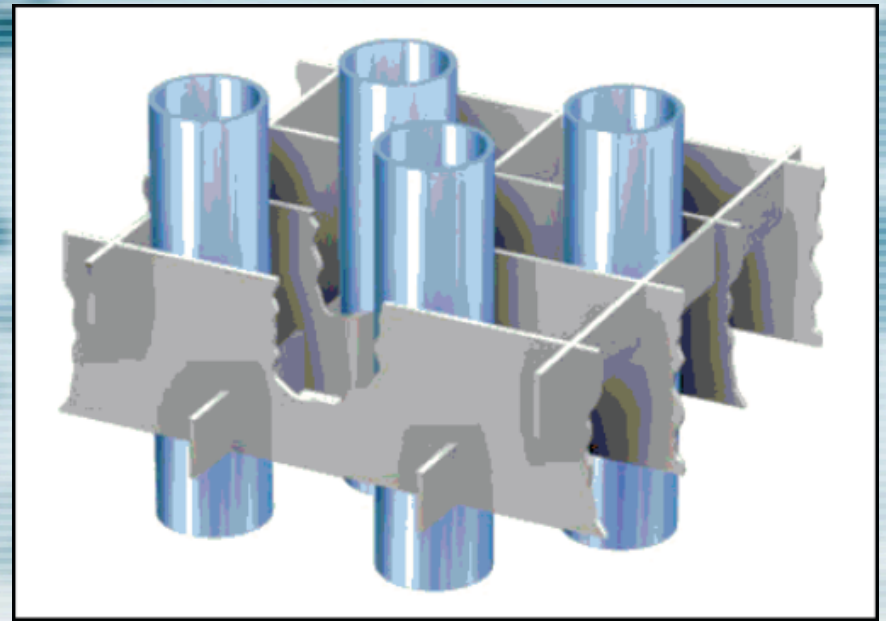
Stay Cylinder: Retained On Palo Verde And Eliminated On San Onofre



Egg Crate Design Retained On Palo Verde/ Eliminated On San Onofre



BROACHED TUBE SUPPORT

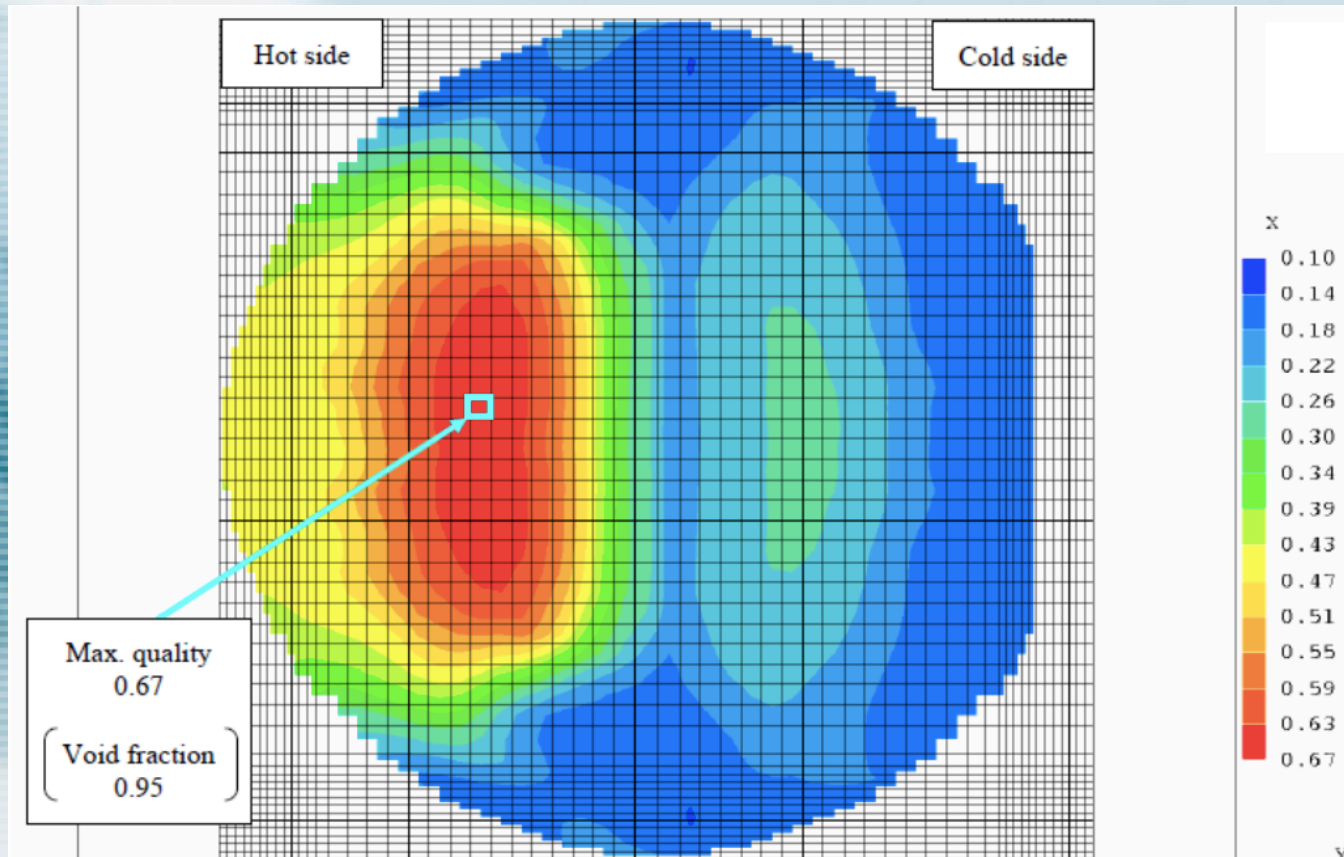


EGG CRATE TUBE SUPPORT

San Onofre Problem Was Foreseeable

- Stay Cylinder removal and Tube addition placed too much heat in the center of San Onofre's Replacement Steam Generators
- San Onofre added 4% more tubes at the center of its RSGs
- Palo Verde added 10% to the periphery and added 2.9% more heat
- Palo Verde has no FEI problems
- Edison's Design destroyed San Onofre's RSGs

Contour Of Steam Quality



Condition Report: 201836127, Revision 0, 5/7/2012, Figure 2: Contour of steam quality at the height of the maximum quality in U-bend region for T-hot = 598°F (Figure 8.1-2 (a) in Reference [2]), Page 74.

What Did The 10CFR§50.59 Review Say? Edison is parsing its words!

- “At the time the RSGs were designed, MHI evaluated the flow patterns and determined that fluid elastic instability (FEI) would not occur.” 1/9/13 Edison brief to NRC, page 14
- “MHI provided a thermal-hydraulic analysis as part of the original design of the RSGs that showed there would be no FEI.” page 17
- **Removing the stay cylinder allowed 377 extra tubes into the center void, creating more interior heat**
- **The riser column water void above the tube sheet was also eliminated**
- **There was nothing on the steam side to facilitate and bias the flow direction. The steam side flow patterns were never established.**
- **The 10CFR§50.59 analysis should identify high void fractions and confused in/out-of-plane FEI.**

Friends Of The Earth Consultants Reached A Different 10CFR§50.59 Conclusion

"... design changes may be screened out under 10 CFR 50.59 if the changes do not adversely affect a design function" Page 9, Edison Response, 1/9/13

"The adverse condition that later resulted in the tube leak was a deficiency associated with the design and was not known at the time the 50.59 evaluation was performed." Page 9, Edison Response, 1/9/13

- **Fairewinds agrees with this approach, but it is not the approach used by Edison at San Onofre.**
- **The totality of RSG changes Edison proposed in 2004 created an unacceptable void fraction at the top of the hot side of the tubes that then created the FEI.**
- **Fairewinds and John Large both agree that it should have been foreseeable to Edison in 2004 that this combination of changes would cause FEI to occur.**

Edison's Cause Report Was Wrong

- Former NRC Chairman Gregory Jaczko promised Senator Boxer and the public a complete Root Cause Analysis. This has not been conducted.
- Kepner Tregoe Cause Analysis is severely flawed.
- “If they can get you asking the wrong questions, they don't have to worry about answers.” Thomas Pynchon, *Gravity's Rainbow*
- Statement upon which Edison based its Cause Report: “What is different or has changed when comparing SONGS Replacement SGs to Another US plant's Replacement SG” (page 43, Condition Report)

What Root Cause Question Should Edison Have Asked?

There are no *changes* to compare among Edison's RSG and other RSGs nationwide. It's an apples and oranges comparison.

The *changes* Edison should have analyzed and compared are those between the OSG and the RSG or between San Onofre and Palo Verde, since Edison has acknowledged that Palo Verde's RSG is identical to San Onofre's OSG.

Exclusions From Edison's Kepner Tregoe (KT) Analysis Process

Possible Causes	Reason
Departure from the OSG design in terms of tube U" bend configuration and U" bend support configuration	Changing design from the original SG to the Replacement SG, is not causal factor in itself for tube to tube wear.
Departure from the OSG design in terms of replacing the stay cylinder with the divider plate and separator configuration	Changing design from the original SG to the Replacement SG, is not causal in itself for tube to tube wear.
Departure from the OSG design in terms of tube straight leg support configuration	Changing design from the original SG to the Replacement SG, is not causal in itself for tube to tube wear.

Extracted from the Edison Kepner Tregoe Exclusion Table: *Condition Report: 201836127*, Revision 0, 5/7/2012, Root Cause Evaluation: Unit 3 Steam Generator Tube Leak and Tube-to-Tube Wear, San Onofre Nuclear Generating Station, Page 52



SECTION 3

CONCLUSIONS

THE CHANGES EDISON MADE CREATED FORESEEABLE PROBLEMS

During the past eight years, the NRC had extensive evidence from multiple sources that the replacement steam generators at San Onofre were not the *like-for-like* replacements for the original designs, as Edison committed during the 10CFR50.59 processes. And, as demonstrated by the significant damage in the San Onofre Replacement Steam Generators, the design changes did have a significant impact upon key design functions and in fact degraded the containment boundary.

Edison should have notified the NRC that the significance of all the changes required a 10CFR50.59 license amendment.

San Onofre Was A 'Near Miss'

The tube failures at San Onofre are the worst nuclear equipment failures since the near miss at Davis Bessie in 2002.



San Onofre Technical Specifications

San Onofre Technical Specifications states that the limiting design basis accident is a "double ended rupture of a single tube".

Page 510

Edison's San Onofre: Operating Outside Design Basis

Eight Tubes failed their pressure test, not one!

The evidence shows that San Onofre was operating outside of its design basis and the NRC has done nothing to address this major violation.

“Although in this case the degraded condition of the tubes was manifested as a small primary to secondary leak, it is possible that a full-blown rupture could have been the first indication.” Page 57, NRC AIT Report

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