



Via E-mail Attachment and Post
February 25, 2013

Arthur T. Howell III
Team Manager SONGS Special Project
Nuclear Regulatory Commission, Region IV
1600 East Lamar Blvd
Arlington, TX76011-4511


Subject: Submission of Mitsubishi Root Cause Analysis and Supplemental Technical Evaluation Report

Dear Mr. Howell:

This letter responds to your letter of February 14, 2013, requesting that Mitsubishi Heavy Industries, Ltd. (MHI) provide to the U.S. Nuclear Regulatory Commission (NRC) the MHI document "Root Cause Analysis Report for Tube Wear Identified in the Unit 2 and Unit 3 Steam Generators of San Onofre Generating Station (SONGS)," along with a redacted version of the report complying with the requirements of 10 C.F.R. 2.390 if it contains proprietary information. On February 15, 2013, I responded that MHI would act expeditiously and respond to your request as soon as reasonably possible.

MHI has completed its review of your request and has decided voluntarily to submit the Root Cause Analysis Report (RCA), along with the "Supplemental Technical Evaluation Report" (STER). The STER summarizes the information and conclusions contained in the numerous technical reports prepared by MHI and others in the course of investigating and evaluating the unexpected tube wear at the SONGS replacement steam generators. The STER provides a technical roadmap of the causes of the unexpected wear as well as an overview of the design process for the SONGS replacement steam generators. The STER also provides important context for the technical issues and corrective actions identified in the RCA.

As noted in my February 15 letter, the RCA is MHI's organizational and programmatic root cause analysis, which is a sensitive, internal document of the type that MHI and others in the industry do not make public because its purpose is to set forth a critical, candid self-appraisal, with the *benefit of what is known in hindsight*, of an event to avoid any problems involved in the event from reoccurring in the future. Your request creates an expectation that this type of document could be made public, which in turn could discourage the preparation of other truly candid, reliable root cause evaluations that address internal organizational and programmatic performance. Root cause evaluations are often made available to the NRC for its inspection and indeed MHI had previously made both the RCA and STER available to the NRC for its inspection, but there is no requirement for a vendor such as MHI to formally submit such internal documents to the NRC.

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Add: Brian Benney
Arthur T. Howell to ERJOS



Nevertheless MHI is voluntarily submitting the RCA as requested by the NRC along with the STER. MHI is providing the full proprietary and confidential versions of both reports as well as a redacted version of both reports in which the proprietary and internal confidential information is redacted. MHI has endeavored to minimize the redactions to both documents in order that the public will have the benefit of the information they contain. The supporting 10 C.F.R. 2.390 affidavits supporting the redactions are provided along with this letter and the redacted and un-redacted reports.

The STER provides a discussion of how the design of the SONGS replacement steam generators was developed. As explained in the STER, minimizing tube wear resulting from vibration was a high priority in the design of the SONGS replacement steam generators. As part of the design process, Southern California Edison (SCE) and MHI formed a special AVB Design Team to develop an effective anti-vibration design, focusing on the design of the anti-vibration bars (AVBs) that provide support for the tubes in the U-bend region of the replacement steam generators. The AVB Design Team conducted numerous technical meetings and included third-party experts in the design and construction of large U-bend steam generators. The AVB Design Team used AVBs that had proven successful in previous steam generator designs, including large steam generators similar to the SONGS replacement steam generators. Conservatively, the SONGS replacement steam generator design used more AVBs than other large steam generators of similar design. Because of this feature and other conservative aspects of the SONGS design, the proposed SONGS replacement steam generator design was judged by the AVB Design Team to have a lower potential for vibration wear than that for other large steam generator designs.

Specifically, the AVB Design Team focused on preventing out-of-plane fluid elastic instability (FEI). The understanding of the industry at that time was that out-of-plane FEI will occur before in-plane FEI (never before experienced in operating U-bend steam generators) because tube U-bend natural frequency in the in-plane direction is higher than in the out-of-plane direction. Accordingly, extreme care was taken in the design and fabrication of the SONGS replacement steam generators to prevent out-of-plane FEI (which, in fact, did not occur at SONGS). The STER and the RCA elaborate on the special steps and precautions that MHI took to design and fabricate the SONGS replacement steam generators to prevent tube wear.

In designing the SONGS replacement steam generators, the AVB Design Team evaluated the circulation ratio as well as the thermal-hydraulic conditions of the SONGS replacement steam generator design. For SONGS, MHI looked at other large steam generator designs and selected as a reference plant a successful design about which MHI had the best information. MHI compared the relevant design parameters of the reference plant and confirmed that those parameters of the SONGS replacement steam generators compared favorably. The design went through an extensive design review process which included the participation of third-party experts. MHI and SCE recognized that the thermal-hydraulic conditions were high compared to previous steam generator designs. In particular, the higher steam quality was seen as increasing the potential for steam generator tube "dry out" (potentially increasing concentration of impurities on the tubes and increasing the risk of corrosion) and decreasing damping conditions for out-of-plane vibration. With that understanding, different potential changes to the replacement steam generator design were evaluated to increase the circulation ratio, which would serve to decrease certain thermal-hydraulic conditions such as steam quality, while meeting other design requirements. The evaluated changes included different AVB configurations, a larger downcomer, larger tube support plate flow area, and removing one tube

support plate. Because the physical size and number of tubes of the replacement steam generators had already been established in accordance with the requirements of the SCE design specification, including the requirement that the replacement steam generators be designed to criteria consistent with the application of 10 C.F.R. 50.59, the evaluated design changes, while significant in scope, had minimal impact on the circulation ratio. As explained in the RCA and the STER, while some changes with small beneficial effect on thermal hydraulic conditions were adopted, other alternatives under consideration did not have a large enough effect on the maximum thermal-hydraulic conditions to justify the significant change to the design. The reference in the RCA to “unacceptable consequences” reflects the fact that those potential alternatives that were not implemented, in addition to being largely ineffective in increasing the circulation ratio, had negative safety impacts on other aspects of the design (e.g., reducing tube bundle structural integrity and reducing tube support plate structural margin). Consequently, MHI and SCE concluded that the trade-offs associated with these evaluated changes did not justify changing the design in light of the minimal benefit in reducing thermal-hydraulic conditions.

Thus, at the time of design of the replacement steam generators, SCE and MHI had concluded that the replacement steam generator design was optimized for the SONGS application and that the replacement steam generators had greater margin against U-bend tube vibration and wear than other similar steam generators. The forced outage of Unit 3 and the subsequent discovery of significant U-bend tube wear was a wholly unexpected occurrence as reflected in the recent briefing of the NRC Commissioners by the NRC Staff and various experts from the nuclear industry, including MHI’s competitors. In-plane FEI had never been observed in operating U-bend steam generators and its occurrence at SONGS was the first evidence that in-plane FEI conditions could be achieved in such steam generators.

The STER sets forth the technical explanation of how this occurrence came about. FEI was caused by insufficient contact forces between the tubes and the AVBs to restrain movement of the tubes in the in-plane direction under high localized thermal hydraulic conditions. Thermal hydraulic conditions by themselves are not controlling as evidenced by the fact that, even though the thermal hydraulic conditions of Unit 2 and Unit 3 are the same, tube-to-tube wear in Unit 2 due to in-plane FEI was negligible or nonexistent. The reason for this difference between Unit 2 and Unit 3 is that the Unit 3 tube-to-AVB contact forces on the tubes are approximately half of those in Unit 2 due to the more precise U-bend fabrication and assembly used for Unit 3.

The RCA also refers to tube wear due to vibration of certain retainer bars. This wear is isolated and is limited to some tubes adjacent to the retainer bars at the periphery of the bundle. All tubes potentially affected by retainer bar vibration at SONGS have been plugged and taken out-of-service by SCE.

Your letter states that the NRC intends to provide copies of both the redacted and the un-redacted versions of the RCA report to the U.S. Senate Environment and Public Works Committee. We understand that the NRC has a process established to place water marks stating “Not for Public Disclosure” on each page of all non-public documents provided to the Committee. We further understand that the cover letter with documents submitted to the Committee will expressly request that the Committee (1) not publicly disclose information marked as “Not for Public Disclosure” and (2) limit internal dissemination of such information to the Committee’s Members and solely those Committee staffers who have a need-to-know.



In closing, I want to reemphasize, as pointed out in my February 15 letter, that MHI has been cooperating fully with the NRC's inspection activities regarding the SONGS replacement steam generators and has made and is making available internal MHI documents to the NRC for its review as they are requested. MHI is committed to fully supporting the NRC in its inspection activities.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Edmund Baumgartner", is written over the typed name.

Edmund Baumgartner
Corporate Counsel
Mitsubishi Nuclear Energy Systems, Inc.

cc: Karla Fuller, Esq. (by hand delivery)
Margaret Doane, Esq.
Trip Rothschild, Esq.
John H. O'Neill, Esq.

Enclosures:

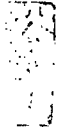
1. Notarized 2.390 Affidavit of K. Hirakawa
2. Notarized 2.390 Affidavit of J. Miyaguchi
3. Root Cause Analysis Report for Tube Wear Identified in the Unit 2 and Unit 3 Steam Generators of San Onofre Generating Station (Proprietary version)
4. Root Cause Analysis Report for Tube Wear Identified in the Unit 2 and Unit 3 Steam Generators of San Onofre Generating Station (Non-Proprietary version)
5. Supplemental Technical Evaluation Report (Proprietary version)
6. Supplemental Technical Evaluation Report (Non-Proprietary version)

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Katsuhiko Hirakawa, state as follows:

1. I am Director, Quality Assurance Department, of Mitsubishi Heavy Industries, Ltd. ("MHI"), and have been delegated the function of reviewing the referenced documentations to determine whether they contain MHI's information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information that is privileged or confidential.
2. In accordance with my responsibilities, I have determined that the Root Cause Analysis Report for Tube Wear Identified in the Unit 2 and Unit 3 Steam Generators of San Onofre Nuclear Generating Station (SONGS) ("RCA") contains MHI proprietary and confidential information that should be withheld from public disclosure. Those pages containing proprietary and confidential information have been bracketed with an open and closed bracket as shown here "[]" / and should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).
3. The information identified as proprietary and confidential in the RCA has in the past been, and will continue to be, held in confidence by MHI. Its disclosure outside the company has been limited to inspection by regulatory bodies, customers and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.
4. The basis for holding the information identified as proprietary and confidential in the RCA is that it describes unique design, manufacturing, experimental and investigative information developed by MHI and not used in the exact form by any of MHI's competitors. This information was developed at significant cost to MHI, since it is the result of an intensive MHI effort. Additionally, the RCA is MHI's organizational and programmatic root cause analysis, which is a sensitive, internal document of the type that MHI and others in the industry do not make public because its purpose is to set forth a critical self-appraisal, with the benefit of what is known in hindsight, of an event to avoid any problems involved in the event from reoccurring in the future. As such it contains information and analyses that are the result of candid assessments performed by MHI and its release could discourage the nuclear industry from preparing truly candid, reliable root cause evaluations that address internal organizational and



programmatic performance.

5. The information identified as proprietary and confidential in the RCA is voluntarily furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.
6. The information identified as proprietary and confidential in the RCA is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.
7. Public disclosure of the information identified as proprietary in the RCA would assist competitors of MHI in their design and manufacture of nuclear plant components without incurring the costs or risks associated with the design and the manufacture of the subject component. Therefore, disclosure of the information contained in the RCA would have the following negative impacts on the competitive position of MHI in the U.S. and world nuclear markets:
 - A. Loss of competitive advantage due to the costs associated with development of technologies relating to the component design, manufacture and examination. Providing public access to such information permits competitors to duplicate or mimic the methodology without incurring the associated costs.
 - B. Loss of competitive advantage of MHI's ability to supply replacement or new heavy components such as steam generators.
8. MHI has provided a redacted version of the RCA to the NRC. The redactions have removed the information identified as proprietary and confidential in the unredacted version and may be made available to the public.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 22 day of Feb., 2013.

Katsuhiko Hirakawa

Katsuhiko Hirakawa,
Director, Quality Assurance Department
Mitsubishi Heavy Industries, LTD

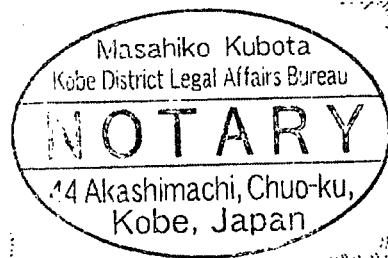
Sworn to and subscribed

Before me this 22 day

of February, 2013

Masahiko Kubota

Notary Public



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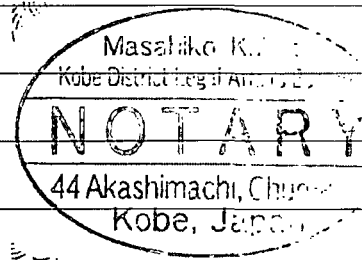
My Commission does NOT expire.

FEB. 22 2013

登簿平成25年第 39 号

認 証

囑託人 三菱重工業株式会社 原子力事業本部
品質保証部 部長 平川克彦 は本職の面前で添
付書面に 署名 した。



よって認証する。

平成25年2月22日

本職役場に於て

神戸市中央区明石町44番地

神戸地方法務局所属

公証人

窪田正彦

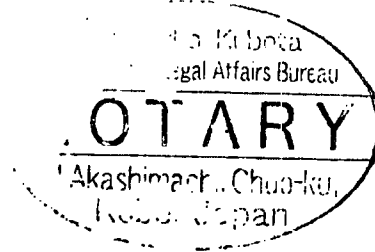
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Registered Number 39

Date FEB. 22. 2013

NOTARIAL CERTIFICATE

This is to certify that KATSUHIKO HIRAKAWA, Director, Quality Assurance Department MITSUBISHI HEAVY INDUSTRIES, LTD has affixed his signature in my very presence to the attached document.



Masahiko Kubota

MASAHIKO KUBOTA

Notary

44 Akashimachi, Chuo-Ku,

Kobe, Japan

Kobe District Legal Affairs Bureau

(面前法2)

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Jinichi Miyaguchi, state as follows:

1. I am Director, Nuclear Plant Component Designing Department, of Mitsubishi Heavy Industries, Ltd. ("MHI"), and have been delegated the function of reviewing the referenced documentations to determine whether they contain MHI's information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information that is privileged or confidential.
2. In accordance with my responsibilities, I have determined that the Supplemental Technical Evaluation Report ("STER") contains MHI proprietary and confidential information that should be withheld from public disclosure. Those pages containing proprietary and confidential information have been bracketed with an open and closed bracket as shown here "[]" / and should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).
3. The information identified as proprietary and confidential in the STER has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.
4. The basis for holding the information identified as proprietary and confidential in the STER is that it describes unique design, manufacturing, experimental and investigative information developed by MHI and not used in the exact form by any of MHI's competitors. This information was developed at significant cost to MHI, since it is the result of an intensive MHI effort.
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information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

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 - B. Loss of competitive advantage of MHI's ability to supply replacement or new heavy components such as steam generators.
8. MHI has provided a redacted version of the STER to the NRC. The redactions have removed the information identified as proprietary and confidential in the unredacted version and may be made available to the public.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 22 day of February, 2013.

Jinichi Miyaguchi

Jinichi Miyaguchi,

Director, Nuclear Plant Component Designing Department

Mitsubishi Heavy Industries, LTD

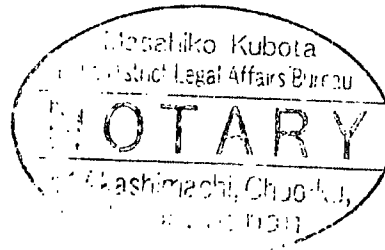
Sworn to and subscribed

Before me this 22 day

of February, 2013

Masahiko Kubota

Notary Public



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FEB. 22. 2013

My Commission does NOT expire.

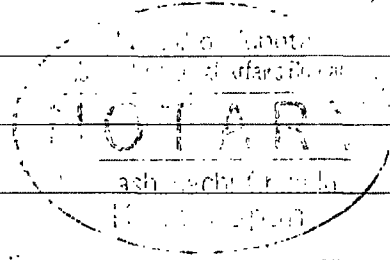
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認 証

嘱託人 三菱重工業株式会社 原子力事業本部

原子力製造総括部 原子力機器設計部 部長 宮

口仁一 は本職の面前で添付書面に 署名 した。



よって認証する。

平成25年2月22日

本職役場に於て

神戸市中央区明石町44番地

神戸地方法務局所属

公証人

窪田正彦

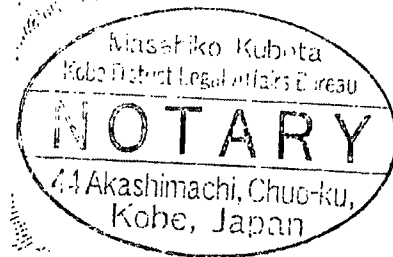
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Registered Number 40

Date FEB. 22. 2013

NOTARIAL CERTIFICATE

This is to certify that JINICHI MIYAGUCHI , Director-Nuclear Plant
Component Designing Department MITSUBISHI HEAVY INDUSTRIES, LTD
has affixed his signature in my very presence to the attached
document.



Masahiko Kubota

MASAHIKO KUBOTA

Notary

44 Akashimachi, Chuo-Ku,

Kobe, Japan

Kobe District Legal Affairs Bureau

(面前法2)