

November 30, 2012

Mr. Ikuo Otake, Quality Assurance Department Manager  
Mitsubishi Heavy Industries, Ltd.  
1-1. Wadasaki-Cho 1-Chome, Hyogo-Ku  
Kobe, 652-8585, Japan

SUBJECT: NUCLEAR REGULATORY COMMISSION INSPECTION REPORT  
NO. 99901030/2012-201, NOTICE OF NONCONFORMANCE

Dear Mr. Otake:

From October 9-17, 2012, the U.S. Nuclear Regulatory Commission (NRC) staff conducted an inspection at the Mitsubishi Heavy Industries, Ltd (MHI) facility in Kobe, Japan. The purpose of this reactive inspection was to assess MHI's compliance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 21, "Reporting of Defects and Noncompliance," and selected portions of Appendix B, "Quality Assurance Program Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

This reactive inspection evaluated MHI's quality assurance activities associated with the mock-up and testing of re-designed anti-vibration bars that may be used as a long-term repair of both Unit 2 and Unit 3 San Onofre Nuclear Generating Station (SONGS) steam generators. The inspection will assist the Nuclear Regulatory Commission (NRC) when and if modifications are installed at SONGS. The design and installation of the modification will require that the NRC conduct an independent review of the modification and possibly approval of the design change. The inspection evaluated if MHI's design, manufacturing, preparation, and testing of the mock-up and testing of re-designed anti-vibration bars meet the applicable requirements of Appendix B to 10 CFR Part 50, 10 CFR Part 21, and American Society of Mechanical Engineers Code Section III, "Rules for Construction of Nuclear Facility Components". The enclosed report presents the results of this inspection. This NRC inspection report does not constitute NRC endorsement of MHI's overall quality assurance (QA) or 10 CFR Part 21 programs.

During this inspection, the NRC inspection team found that the implementation of your quality assurance program failed to meet certain NRC requirements imposed on MHI by its customers or NRC licensees. Specifically, MHI: 1) failed to verify the tube outside diameter straightness, tube bending radius, and total tube length conformed to the requirements identified in the purchase order and purchase specifications to Sumitomo Metal Corporation for the alloy 690 seamless tubes used to construct the steam generator u-tube bundle mock-up; and 2) failed to perform dedication of the commercial calibration services provided by Tokyo Sokki Kenkyujo Co., Ltd. The enclosed Notice of Nonconformance (NON) cites these nonconformances, and the circumstances surrounding them are described in detail in the enclosed inspection report. Even though the NRC inspection team did not identify issues in all areas reviewed, in the response to the enclosed NON, MHI should document the results of the extent of condition and determine if there are any effects on other associated QA activities.

Please provide a written statement or explanation within 30 days from the date of this letter in accordance with the instructions specified in the enclosed NON. We will consider extending the response time if you show good cause for us to do so.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Document Access and Management System, which is accessible from the NRC website at <http://www.nrc.gov/reading-rm/adams.html>.

To the extent possible (and if applicable), your response should not include any personal privacy, proprietary, or Safeguards Information (SGI) so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, please provide a bracketed copy of your response that identifies the information that should be protected, as well as a redacted copy of your response that deletes such information. If you request that such material be withheld from public disclosure, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If SGI is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

Sincerely,

*/RA/*

Edward H. Roach, Chief  
Mechanical Vendor Branch  
Division of Construction Inspection  
Office of New Reactors

Docket No. 99901030

Enclosures:

1. Notice(s) of Nonconformance
2. Inspection Report No. 99901030/2012-201  
and Attachment(s)

Please provide a written statement or explanation within 30 days from the date of this letter in accordance with the instructions specified in the enclosed NON. We will consider extending the response time if you show good cause for us to do so.

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Sincerely,

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Edward H. Roach, Chief  
Mechanical Vendor Branch  
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NRC-001

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DATE	11/30/2012	11/30/2012	11/26/2012	11/30/2012	11/30/2012

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## NOTICE OF NONCONFORMANCE

Mitsubishi Heavy Industries, Ltd  
1-1. Wadasaki-Cho 1-Chome, Hyogo-Ku  
Kobe, 652-8585, Japan

Docket No. 99901030  
Report No. 2012-201

Based on the results of a U.S. Nuclear Regulatory Commission (NRC) inspection conducted at the Mitsubishi Heavy Industries, Ltd (MHI) facility in Kobe, Japan from October 9 through October 17, 2012, it appears that certain activities were not conducted in accordance with NRC requirements that were contractually imposed upon MHI by its customers or by NRC licensees.

- A. Title 10 of *Code of Federal Regulation*, Part 50, Criterion VII, "Control of Purchased Material, Equipment, and Services," states in part, that "Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents."

Requisition Card 8161999-KA-110044, dated May 8, 2012, specified that Sumitomo Metal Industries supply 1187 tubes that conformed to the original replacement steam generator tube manufacturing Specification L5-04FZ041, Revision 4. The original specification had a number of specific visual and dimensional specifications for the tubes including outside diameter straightness, bending radius for the u-bend region, and total length.

Mitsubishi Heavy Industries Document L5-04GA592, "San Onofre Nuclear Generating station, Units 2 & 3 Replacement Steam Generators, Mock-Up Test Plan for Verification of Repair Measures for Tube Vibration Issue," Revision 5, dated October 4, 2012, was identified as "Safety Related." Table 4.3.1, "Extraction of Controlled Dimensions for -up Tube (Single Item)," lists tube outside diameter straightness, tube bending radius, and total tube length as "Necessary" examination items. Tables 2.2.1, 2.2.5, and 2.2.6 list how the previous three items were to be measured and the actual measurement specifications.

Contrary to the above, as of October 17, 2012, MHI failed to ensure that the alloy 690 seamless tubes purchased from Sumitomo Metal Industries and used to construct the steam generator u-tube bundle mock-up, conformed to the procurement requirements identified in the purchase order and purchase specifications. Specifically, MHI did not provide objective evidence that the tube outside diameter straightness, tube bending radius, and total tube length conformed to the requirements Requisition Card 8161999-KA-110044 and Inspection Document L5-04GA592 measurement criteria.

This issue has been identified as Nonconformance 99901030/2012-201-01.

- B. Criterion III, "Design Control," of Appendix B to 10 CFR 50, states, in part, that, "Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems and components."

Contrary to the above, as of October 17, 2012, MHI failed to establish adequate measures for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components for the dedication of commercially procure calibration services. Specifically, MHI did not perform a commercial grade dedication of the calibration services procured commercially from Tokyo Sokki Kenkyujo Co., Ltd. Mitsubishi Heavy Industries did not identify or verify critical characteristics that would ensure that Tokyo Sokki Kenkyujo Co., Ltd. would have the capabilities necessary to perform the calibration of a measurement instrument (resistor box) used as part of the strain gauge contact force measurement in the mock-up test, with additional anti-vibration bars inserted in the steam generator tube bundle.

This issue has been identified as Nonconformance 99901030/2012-201-02.

Please provide a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Chief, Construction Mechanical Vendor Branch, Division of Construction Inspection and Operational Programs, Office of New Reactors, within 30 days of the date of the letter transmitting this Notice of Nonconformance. This reply should be clearly marked as a "Reply to a Notice of Nonconformance" and should include for each noncompliance: (1) the reason for the noncompliance or, if contested, the basis for disputing the noncompliance; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid further noncompliance; and (4) the date when the corrective action will be completed. Where good cause is shown, consideration will be given to extending the response time. Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System, which is accessible from the NRC web site at <http://www.nrc.gov/reading-rm/adams.html>, to the extent possible it should not include any personal privacy, proprietary, or Safeguards Information (SGI) so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request that such material be withheld, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If SGI is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21, "Requirements for the Protection of Safeguards Information."

Dated this 30<sup>th</sup> day of November 2012.

**U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NEW REACTORS  
DIVISION OF CONSTRUCTION INSPECTION AND OPERATIONAL PROGRAMS  
VENDOR INSPECTION REPORT**

Docket No.: 99901030

Report No.: 99901030/2012-201

Vendor: Mitsubishi Heavy Industries, Ltd.  
1-1. Wadasaki-Cho 1-Chome, Hyogo-Ku  
Kobe, 652-8585, Japan

Vendor Contact: Mr. Ikuo Otake, Quality Assurance Department Manager  
Mitsubishi Heavy Industries  
Telephone: 81-78-672-3782  
E-mail: ikuo\_otake@mhi.co.jp

Nuclear Industry Activity: Mitsubishi Heavy Industries (MHI) manufactures safety-related and American Society of Mechanical Engineers Boiler and Pressure Vessel Code items and components. MHI supplies reactor vessels, steam generators, reactor internals, and balance of plant components for the nuclear industry and has provided some of these components to the current U.S. fleet of nuclear reactors as replacement components.

Inspection Dates: October 9 - 17, 2012, (Kobe, Japan)

Inspection Team Leader: Richard McIntyre NRO/DCIP/CMVB

Inspection Team Members: Jonathan Ortega NRO/DCIP/CMVB  
Gregory Werner RGN IV

Accompanied by: Arthur Howell RGN IV

Approved by: Edward H. Roach, Chief  
Mechanical Vendor Branch  
Division of Construction Inspection  
and Operational Programs  
Office of New Reactors

## EXECUTIVE SUMMARY

Mitsubishi Heavy Industries, Ltd.  
99901030/2012-201

The U.S. Nuclear Regulatory Commission (NRC) conducted this inspection to verify that the Mitsubishi Heavy Industries, Ltd. (MHI) implemented a quality assurance (QA) program that complies with the requirements of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities." In addition, the NRC inspection also verified that MHI implemented a program under 10 CFR Part 21, "Reporting of Defects and Noncompliance," that met the NRC's regulatory requirements. The NRC inspection team conducted the inspection at the MHI facility in Kobe, Japan from October 9-17, 2012.

The purpose of this inspection was to observe the mock-up testing of re-designed anti-vibration bars that may be used as a long-term repair of both Unit 2 and Unit 3 of San Onofre Nuclear Generating Station (SONGS) steam generators. The inspection results may assist the NRC when and if modifications are installed at SONGS. The design and installation of the modification will require that the NRC conduct an independent review of the design modification and possibly approval of the design change.

This reactive inspection evaluated MHI's quality assurance activities related to the design, manufacturing, preparation, and testing associated with the SONGS steam generators mock-up and re-designed anti-vibration bars, through interviews with MHI personnel, and review of applicable quality assurance (QA) manual sections, implementing procedures, work instructions, and other pertinent QA records associated with the specific inspection areas. The inspection was performed to determine if these quality activities met the applicable requirements of Appendix B to 10 CFR Part 50, 10 CFR Part 21, and American Society of Mechanical Engineers (ASME) Code Section III, "Rules for Construction of Nuclear Facility Components".

The NRC inspection team specifically observed various activities associated with the mock-up testing of a portion of the upper tube bundle. The activities being performed by MHI were conducted to determine if a design modification to repair the SONGS steam generators was feasible. The design modification testing consisted of anti-vibration bar insertion tests using three different designs. The three different anti-vibration bar designs were:

- Thicker – inserted between and parallel to existing anti-vibration bars
- 30 Degree – inserted at a 30 degree angle to existing anti-vibration bars, forming intersections with existing anti-vibration bars
- Comb – shaped like a comb and will be inserted into the bundle on every other row and then rotated 90 degrees, locking tubes into place between the "teeth" of the comb.

In discussions with MHI personnel, they indicated that the thicker anti-vibration bar will likely be the least difficult to insert and the comb anti-vibration bar the most difficult to insert due to slight differences in the gaps and arrangement of the tubes.

Some of the specific activities observed by the NRC inspection team included:

- LG-04GA592, "Mock-up Test Plan for Verification of Repair Measures for Tube Vibration Issue," Revision 5
- Thicker anti-vibration bar insertion test in accordance with Procedure SON-SG-FM-33, "Instruction for Thicker AVBs Insertion Test," Revision 2
- 30 degree anti-vibration bar insertion test in accordance with Procedure SON-SG-FM-43, "Instruction for 30 Degree AVB Insertability Test, Additional Partial Tube Bundle Test," Revision 0
- Eddy current testing in accordance with Procedure UGS-20120526, "ECT Measurement Procedures for Heat Transfer Tube -up of Simulated U-Bend Region," Revision 7

In addition to these activities, the NRC inspection team observed other actions related to the activities described above, including:

- Measurement of anti-vibration bar flatness and warpage
- Use of tube alignment expansion tool
- 3-D measurement of displacement of mock-up jig
- Calibration of the eddy current test equipment

For each of the activities, the NRC inspection team reviewed the procedures and observed the testing to ensure MHI personnel were properly qualified, followed the procedural steps, properly recorded information, and verified that test equipment being used had current calibration.

The NRC inspection team implemented Inspection Procedure (IP) 43003, "Reactive Inspections of Nuclear Vendors," IP 43004, "Inspection of Commercial-Grade Dedication Programs," and as supplemented by IP 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance," during the conduct of this inspection."

The NRC conducted its last inspection at MHI's facility in Kobe, Japan, in May 2008, and documented the results of the inspection in Inspection Report 99901030/2008-201, dated July 18, 2008. No violations or nonconformances were identified during this inspection.

With the exception of the nonconformances described below, the NRC inspection team concluded that MHI's QA policies and procedures comply with the applicable requirements of 10 CFR Part 21 and Appendix B to 10 CFR Part 50, and that MHI personnel are implementing these policies and procedures effectively. The results of this inspection are summarized below.

#### 10 CFR Part 21 Program

The NRC inspection team concluded that MHI appropriately translated the requirements contained in 10 CFR Part 21 into implementing procedures and, for those activities reviewed by the NRC inspection team, implemented them as required by the MHI procedures. No findings of significance were identified.

#### Training and Qualification of Personnel

The NRC inspection team concluded that MHI is implementing its training and qualification program consistent with the regulatory requirements of Criterion II, "Quality Assurance



Program,” of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that MHI is effectively implementing its policies and procedures associated with the training and qualification program. No findings of significance were identified.

### Design Control

The NRC inspection team concluded that MHI is implementing its design control policies and procedures consistent with the regulatory requirements of Criterion III, “Design Control,” of Appendix B to 10 CFR Part 50 and the requirements of the ASME Boiler and Pressure Vessel Code, Section III, “Rules For Construction Of Nuclear Power Plant Components,” Subsection NB, “Class 1 Components.”

As part of the review of design control activities to support mock-up test activities, the team reviewed the procurement and fabrication of the tube bundle mock-up and identified Nonconformance 99901030/2012-201-01 that was associated with Criterion VII, “Control of Purchased Material, Equipment, and Services.” MHI failed to ensure that the alloy 690 steam generator tubes purchased from Sumitomo Metal Industries and used to construct the steam generator u-tube bundle mock-up, conformed to the procurement requirements. Specifically, MHI could not provide documentary evidence that the tube outside diameter straightness, tube bending radius, and total tube length conformed to the requirements of Purchase Specification L5-04JA433 or the Inspection Document L5-04GA592 measurement criteria.

### Commercial-Grade Dedication

The NRC inspection team issued Nonconformance 99901030/2012-201-02 associated with MHI’s failure to implement the regulatory requirements of Criterion III, “Design Control,” of Appendix B to 10 CFR Part 50. MHI failed to review the suitability of application for the commercial calibration services provided by Tokyo Sokki Kenkyujo Co., Ltd. Specifically, MHI did not perform a commercial grade dedication of the commercial calibration services provided by Tokyo Sokki Kenkyujo Co., Ltd., for the strain measurement resistor box.

### Test Control

The NRC inspection team concluded that MHI’s process for control of the testing program is consistent with the regulatory requirements of Criterion XI, “Test Control,” of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team concluded that the MHI quality assurance manual (QAM) and associated test control procedures and activities were adequate and being effectively implemented by qualified personnel, using qualified equipment and processes. No findings of significance were identified.

### Control of Measuring and Test Equipment

The NRC inspection team concluded that MHI’s measuring and test equipment program requirements are consistent with the regulatory requirements of Criterion XII, “Control of Measuring and Test Equipment,” of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team concluded that MHI established appropriate and effective means to control measuring and test equipment. No findings of significance were identified.

### Nonconforming Materials, Parts, or Components

Based on the sample of nonconformances reviewed, the NRC inspection team concluded that MHI's process for the control of nonconforming materials, parts, or components is consistent with the regulatory requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," of Appendix B to 10 CFR Part 50. The NRC inspection team concluded that MHI effectively implemented its QA policies and implementing procedures that govern the control of nonconformances. No findings of significance were identified.

### Corrective Action

Based on the sample of corrective action reports reviewed, the NRC inspection team concluded that the implementation of MHI's program for corrective actions was consistent with the regulatory requirements of Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50. The NRC inspection team concluded that MHI's corrective action system was adequately described in the MHI procedures. No findings of significance were identified.

## **REPORT DETAILS**

The U.S. Nuclear Regulatory Commission (NRC) inspection team observed various activities associated with the mock-up tests of a portion of the upper tube bundle. The activities being done by Mitsubishi Heavy Industries, Ltd. (MHI) were conducted to determine if a design modification to repair the San Onofre Nuclear Generating Station (SONGS) steam generators was feasible. The design modification testing consisted of anti-vibration bar insertion tests using three different designs. The three different anti-vibration bar designs were:

- Thicker – inserted between and parallel to existing anti-vibration bars
- 30 Degree – inserted at a 30 degree angle to existing anti-vibration bars, forming intersections with existing anti-vibration bars
- Comb – shaped like a comb and will be inserted into the bundle on every other row and then rotated 90 degrees, locking tubes into place between the “teeth” of the comb.

In discussions with MHI personnel, they indicated that the thicker anti-vibration bar will likely be the least difficult to insert and the comb anti-vibration bar the most difficult to insert due to slight differences in the gaps and arrangement of the tubes.

MHI conducted the testing at their steam generator manufacturing facility in Kobe, Japan.

Some of the specific activities observed by the NRC inspection team included:

- Thicker anti-vibration bar insertion test in accordance with Procedure SON-SG-FM-33, “Instruction for Thicker AVBs Insertion Test,” Revision 2
- 30 degree anti-vibration bar insertion test in accordance with Procedure SON-SG-FM-43, “Instruction for 30 Degree AVB Insertability Test, Additional Partial Tube Bundle Test,” Revision 0
- Eddy current testing in accordance with Procedure UGS-20120526, “ECT Measurement Procedures for Heat Transfer Tube -up of Simulated U-Bend Region,” Revision 7

In addition to these activities, the NRC inspection team observed other actions related to the activities described above, including:

- Measurement of anti-vibration bar flatness and warpage
- Use of tube alignment expansion tool
- Measurement of displacement of mock-up jig

For each of the activities, the NRC inspection team reviewed the procedures and observed the testing to ensure MHI personnel were properly qualified, followed the procedural steps, properly recorded information, and verified that test equipment being used had current calibration.

## 1. 10 CFR Part 21 Program

### a. Inspection Scope

The NRC inspection team reviewed MHI's policies and implementing procedures that govern the programs and activities used to establish and verify compliance with the requirements of Title 10 of the *Code of Federal Regulation* (10 CFR) Part 21. The NRC inspection team reviewed four 10 CFR Part 21 evaluations performed by MHI, including two that resulted in notifications to the NRC, to verify that the evaluations are in compliance with the requirements of 10 CFR 21.21, "Notification of Failure To Comply or Existence of a Defect and Its Evaluation." In addition, the NRC inspection team observed Part 21 postings for compliance with the requirements of 10 CFR 21.6, "Posting Requirements." The NRC inspection team also reviewed MHI's procedures that govern the control and correction of nonconforming items and conditions adverse to quality to verify an adequate link to the Part 21 process.

Furthermore, the NRC inspection team discussed the 10 CFR Part 21 program with MHI management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

### b. Observations and Findings

#### b.1 10 CFR Part 21 Policies and Procedures

The NRC inspection verified that MHI had effectively implemented the requirements in 10 CFR 21.21(a)(1) for evaluating deviations and failures to comply associated with substantial safety hazards and that MHI's procedures incorporated the appropriate timelines for evaluation and reporting identified in 10 CFR Part 21. In addition, the NRC inspection team verified that (1) MHI's nonconformance and corrective action procedures provided a link to the 10 CFR Part 21 program, and (2) MHI's 10 CFR Part 21 procedures implemented the requirements in 10 CFR 21.21(d) in regard to directors or responsible officers notifying the NRC of identified defects or failures to comply associated with substantial safety hazards.

The NRC inspection team verified that the MHI procedures provide the guidance and organizational structure necessary to implement the requirements of 10 CFR Part 21 and other related regulations associated with timely identification, evaluation, and reporting of defects and failures to comply which could create a substantial safety hazard. The NRC inspection team also verified that the procedures define applicable terms consistent with the terminology defined in 10 CFR 21.3, provided the necessary guidance to assess deviations and failures to comply in an effective and timely manner in accordance with 10 CFR 21.21(a)(1), (a)(3), (b), and (d), and provided appropriate guidance for interim reports in accordance with 10 CFR 21.21(a)(2).

In addition, the NRC inspection team reviewed numerous corrective action and nonconformance reports to verify that each of the programs which can be used to identify deviations, defects, and failures to comply were being implemented consistent with the requirements of 10 CFR Part 21 and the MHI procedures.

#### b.2 10 CFR Part 21 Evaluations

The NRC inspection team reviewed the 10 CFR Part 21 reports submitted to the NRC and determined that they complied with the requirements of 10 CFR 21.21. During the review of MHI Part 21 procedure the NRC inspection team observed that MHI's procedure

UES-69-020008, "Identification and Reporting of Conditions Adverse to Safety Reporting of Defects and Noncompliance (10 CFR Part 21)", Revision 16, dated April 18, 2012, did not document the actual process implemented by MHI to evaluate deviations and failure to comply to identify potential defects that could create a substantial safety hazard. After conversations with several QA Engineers and the QA Manager, MHI provided objective evidence of the indoctrination material related to 10 CFR Part 21 which explains how to evaluate defect and failures to comply. The NRC inspection team evaluated four "Evaluation Report for 10 CFR 21," related to the mock-up and testing of re-designed anti-vibration bars and concluded that the evaluations complied with the requirements of 10 CFR 21.21.

During the inspection, MHI generated corrective action report CAR-12-075 to address and document the NRC inspection team observation. Also, the NRC inspection team reviewed the MHI implementing procedures for the corrective action and nonconformance processes and verified that each of these programs provided adequate instructions to identify any deviations that would require evaluation to determine if defects or failures to comply could create a substantial safety hazard. No findings of significance were identified.

### b.3 10 CFR Part 21 Postings

The NRC inspection team reviewed the content of the MHI Part 21 postings as well as the location of each posting at the facility. The NRC inspection team verified that the information required by 10 CFR 21.6 was included on each of the postings distributed in conspicuous locations throughout the facility. During the review of the postings the NRC inspection team observed that the phone number provided in the postings was different from the phone number identified in MHI's procedure UES-69-020008. The phone number provided by UES-69-020008 was correct in accordance with 10 CFR 21.21(d)(3)(i). MHI took immediate corrective action and generated CAR-12-075 to address this issue. No findings of significance were identified.

### c. Conclusion

The NRC inspection team concluded that MHI appropriately translated the requirements contained in 10 CFR Part 21 into implementing procedures and, for those activities reviewed by the NRC inspection team, implemented them as required by the MHI procedures and in accordance with the regulatory requirements. The NRC inspection team identified no findings of significance.

## 2. Training and Qualification of Personnel

### a. Inspection Scope

The NRC inspection team reviewed the MHI's policies and implementing procedures that govern the implementation of MHI's training and qualification of personnel to verify compliance with the regulatory requirements of Criterion II, "Quality Assurance Program," of Appendix B to 10 CFR Part 50. In addition, the NRC inspection team discussed the personnel training and qualification process with MHI management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

## b. Observations and Findings

### b.1 Personnel Indoctrination and Training

The NRC inspection team verified that MHI had established and implemented a training and qualification program for all personnel involved in safety-related activities. MHI's procedures 5ZD94-51, "Procedure for Qualification of Inspection and Test Personnel," Revision 2 and 5ZD94-52, "Qualification and Certification Procedure of Nondestructive Examination (NDE) Personnel," Revision 0, described the responsibilities and authority for establishing training and qualification requirements for MHI personnel, including the maintenance of training records. The QAM provided for the extent of indoctrination and training to be commensurate with the scope, complexity, and importance of the activity and the education, experience, and proficiency of the person, and required that personnel be indoctrinated and trained prior to assuming full, unsupervised responsibility for their job functions.

The NRC inspection team reviewed a sample of training and qualification records, verified that the training requirements of several employees had been met, and also verified that the training records of several NDE, inspection, and test personnel were correct and up to date (including eye exams as necessary).

### b.2 Qualification and Training of Inspection and Test Personnel

The NRC inspection team reviewed MHI's QAM and associated procedures to verify that MHI had established and implemented a training and qualification program for the training, qualification, and certification of inspection and test personnel. The QAM required that personnel selected to perform inspection and test activities have the experience and training commensurate with the scope, complexity, or special nature of the activities to be performed. The indoctrination and training consisted of on-the-job training with emphasis on firsthand experience gained through actual performance of inspections and tests. The qualification of inspection and test personnel was certified by a Level III Examiner through the evaluation of performance by the examination and successfully meeting the acceptance criteria as stated in procedure 5ZD94-51. Successful completion of the certification process was documented on the Personal Qualification Status Record.

The NRC inspection team reviewed training and qualification records of four members of the MHI staff assigned to activities related to the SONGS mock-up anti-vibration bar testing activities, along with the qualification and certification of the responsible Level III personnel that approve their certification and qualification. The records reviewed included education, experience, classroom, and on-the job training information, initial capability demonstration results, and triennial performance evaluations reviewed and approved by the Level III Examiner. The NRC inspection team also reviewed eye examination records, which were found to be current and in conformance with procedural requirements. The NRC inspection team confirmed that the qualification records of the inspection and test personnel were complete, current, and in accordance with the MHI procedural requirements.

### b.3 Qualification and Training of Nondestructive Examination (NDE) Testing Personnel

MHI QAM established the control procedure for qualification and certification of personnel to perform nondestructive examination (NDE) in accordance with the MHI written practice that satisfied the requirements of the American Society of Mechanical Engineers (ASME) Section III Code and the American Society for nondestructive testing recommended practice for

nondestructive testing personnel qualification and certification (SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing," 1992 edition). MHI's QAM as supplemented by procedure 5ZD91-52 described the administration, education, training, examination, and certification requirements for MHI nondestructive testing (NDT) personnel associated with the ASME Section III Code as well as the specifications of SNT-TC-1A.

The NRC inspection team reviewed the training and qualification records for two NDT personnel. The qualification records included on-the-job minimum hours, written examination results, and annual eye examination records. The records reviewed were accurate, complete, current, and met the requirements of the ASME Section III Code, as well as SNT-TC-1A. The eye examination records of NDT personnel were current and conformed with the requirements of the MHI implementing procedures.

### c. Conclusion

The NRC inspection team concluded that MHI was implementing its training and qualification program consistent with the regulatory requirements of Criterion II, "Quality Assurance Program," of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team also determined that MHI was effectively implementing its policies and procedures associated with the training and qualification program. No findings of significance were identified.

## 3. Design Control

### a. Inspection Scope

The NRC inspection team reviewed MHI's policies and implementing procedures that governed design control. Specifically, the NRC inspection team verified that mock-up test configuration control activities were being implemented in accordance with the requirements of Criterion III, "Design Control," of Appendix B to 10 CFR Part 50, as well as the applicable MHI processes and procedures.

The NRC inspection team performed a review of MHI's design and preparation of the mock-up and additional anti-vibration bars including instructions, procedures and drawings; verified that design activities and any related design changes were accomplished in accordance with the approved procedures; verified that design inputs were correctly translated into specifications, drawings, procedures, or instructions; and, performed a comparison of the actual design of the replacement steam generator tube bundle to the mock-up tube bundle. The NRC inspection team also interviewed MHI personnel associated with design and configuration control activities for both the replacement steam generators and the mock-up tube bundle. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

### b. Observations and Findings

The NRC inspection team verified that the tube bundle mock-up was of similar design and construction as the SONGS replacement steam generator tube bundles. The mock-up was for only a portion of the tube bundle starting from the 7<sup>th</sup> tube support plate consisting of columns 77 to 101 (25 columns) and rows 48 to 142 (95 rows). The tube bundle was instrumented with a large number of strain gauges (approximately 500) to measure the forces placed on the tubes during the insertion of the additional anti-vibration bars as well as forces attributed to the additional anti-vibration bars. The mock-up tube bundle was constructed using essentially the

same design and fabrication requirements and treated as safety-related in order to take credit for it being equivalent to the actual replacement steam generator tube bundles.

The NRC inspection team met with a number of MHI engineers to review the mock-up to the actual replacement steam generator bundle criteria by comparing the requirements of the mock-up as specified in:

- Document L5-04GA592, "Mock-up Test Plan for Verification of Repair Measures for Tube Vibration Issue," Revision 5;
- Document L5-04JA433, "AVB Detailed Drawing 1/2 for Mock-up", Revision 1; and,
- Document L5-04JA411, "Tube Support Plate Detailed Drawing for Mock-up," Revision 0

These documents were then compared to the following specifications used to manufacture the replacement steam generator components as specified in:

- Document L5-04FZ041, "Purchase Specification for SONGS Unit 2 and 3 RSG [Replacement Steam Generator] Tubing," Revision 4;
- Document L5-04FW-111, Fabrication Drawing Detail of AVB 1/5 (Center Narrow AVB), Revision 6, and Document L5-04FW036, "Fabrication Drawing Tube Support Plate 4/4," Revision 4.

The NRC inspection team selected a sample of 13 different items to review between the mock-up and the replacement steam generators including: six dimensional inspection requirements for the tubing, four dimensional inspection requirements for the anti-vibration bars, and three dimensional inspection requirements for the tube support plate. Of the 13 dimensional inspection requirements selected, the NRC inspection team determined that MHI could not provide object evidence for 3 of them. The three inspection requirements were associated with the alloy 690 tubes: 1) outside diameter for straight region of the tube, 2) bending radius for the u-bend region, and 3) total tube length. MHI supplied a Certified Material Test Report (CMTR), dated July 4, 2012, as evidence that the required dimensional checks were completed. The CMTR contained attachments for only three of the six dimensional inspections; however, MHI indicated that they believed that all of the measurements specified in the replacement steam generator Specification L5-04FZ041, Revision 4, were satisfied based on the following CMTR statement: "Visual & Dimensional Examination After Final Cutting: Acceptable. This certification affirms that these tubes were manufactured in accordance with L5-04FZ041 Revision 4 for SONGS-3RSG mock-up test and satisfies the requirements of SONGS-3RSG leakage mock-up test." For the 'outside diameter for straight region,' Sumitomo Metals Industries (the supplier of the tubes) did not use the specified laser to measure the full length of each tube; instead they used an outside micrometer and sampled points along the length of each tube.

This change to the measurement criteria was not approved by MHI. MHI did not provide objective evidence that Sumitomo performed the tube measurements as specified in the purchase specification. The NRC inspection team identified Nonconformance 99901030/2012-201-01 for MHI's failure to ensure that the steam generator tubes for the test mock-up purchased from Sumitomo Metal Industries, conformed to all of the procurement requirements. Specifically, MHI did not provide objective evidence that the tube outside diameter straightness, tube bending radius, and total tube length conformed to the requirements of Purchase Specification L5-04JA433 or Inspection Document L5-04GA592 measurement



criteria. MHI took immediate corrective action and generated CAR-12-076 to address this issue. No other discrepancies with the manufacturing and construction of the mock-up were identified.

The NRC inspection team reviewed the replacement steam generator documentation and verified that three inspection requirements discussed above had inspection verification sheets showing how these specific measurements were taken and marked as satisfactory.

Based on the results of the testing done on the mock-up, MHI was in the planning stages of potentially developing additional testing at another facility, to perform actual flow testing on the final selected additional anti-vibration bar design. This additional testing had not been finalized at the completion of this inspection.

#### c. Conclusion

The NRC inspection team concluded that, with the exception of Nonconformance 99901412/2012-201-01 for MHI's failure to ensure that the alloy 690 seamless tubes purchased from Sumitomo Metal Industries and used to construct the steam generator u-tube bundle mock-up, conformed to the procurement requirements identified in the purchase order and purchase specifications, that MHI is implementing its design control policies and procedures consistent with the regulatory requirements of Criterion III, "Design Control," of Appendix B to 10 CFR Part 50.

#### 4. Commercial-Grade Dedication

##### a. Inspection Scope

The NRC inspection team reviewed MHI's policies and implementing procedures that govern the dedication of commercial-grade items (CGI) for use in safety-related applications, to verify compliance with applicable regulatory requirements applications to verify compliance with Criterion III, "Design Control," of Appendix B to 10 CFR Part 50. Specifically, the NRC inspectors reviewed the following procedure established by MHI:

- "TA" QMS91-N08, Takasago Research and Development Center (Takasago), "Nuclear Energy Research and Development Center Commercial Grade Dedication (CGD) Procedure," Revision 1, dated December 28, 2010

The NRC inspection also reviewed a sample of mock-up test specific dedication packages, including Commercial Grade Dedication (CGD) procedures, CGD dedication plans, various CGD evaluation and test reports, the criteria for the selection of critical characteristics, the basis for sampling plan testing selection, and the selection of verification methods to verify effective implementation of the MHI CGI dedication process. The NRC inspection team reviewed the dedication of mock-up test strain gauges and calibration services for the eddy current data acquisition system performed by MHI Takasago staff. The NRC inspection also reviewed the commercial grade surveys performed by Takasago for the vendor who supplied the strain gauges and the supplier of the commercial calibration services for the eddy current data acquisition unit. The NRC inspection team discussed the CGD program with MHI's Kobe and Takasago management and technical staff. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

## b. Observations and Findings

The NRC inspection team noted that “TA” QMS91-N08, provided adequate controls for dedication activities, including CGI evaluation criteria for safety function, procurement controls, acceptance and rejection criteria consistent with safety function, material traceability controls, and controls for receipt inspection and test activities. The NRC inspection team confirmed that MHI implemented the methods contained in the Electric Power Research Institute (EPRI) 5652, “Guideline for the Utilization of Commercial Grade Items in Nuclear Safety-Related Applications,” issued June 1988, for dedication activities. EPRI 5652 provides four methods of accepting a CGI for use in safety-related applications: Method 1, “Special Tests and Inspection;” Method 2, “Commercial Grade Survey of Supplier;” Method 3, “Source Verification;” and Method 4, “Acceptable Supplier/Item Performance Record.” MHI implemented Methods 1, 2, and 3 for the verification of critical characteristics during the dedication process. The NRC inspection team performed a sample review of dedication packages to verify adequate implementation of MHI’s dedication process. The NRC inspection team reviewed the following dedication packages:

### b.1 Mock-up Test Strain Gauges

The NRC inspection team reviewed the CGD package and related documents for strain gauges procured as commercial grade items and dedicated for use on the SONGS mock-up test rig. The inspectors reviewed the purchase orders to Tokyo Sokki Kenkyujo for 600 (catalog item) strain gauges. These strain gauges were used on the mock-up for evaluation of forces to be applied on the steam generator tubes affected by the AVBs. The MHI dedication package consisted of

- WQS35058, CGD Dedication Procedure for Strain Gauges, Revision 0, dated September 26, 2012
- WQS35138, CGD Survey Plan and Source Verification Plan, Revision 1, dated October 7, 2012
- Commercial Grade Item Survey Checklist, Revision 1, dated October 7, 2012
- WQS35152, CGD Evaluation Report, Revision 1, dated October 7, 2012
- Procurement documents, F05Q01206114, F05Q01206046, F05Q01206030 for type FLA-1-11-3LJBC, lot #A15121A, to Tokyo Sokki Kenkyujo for 600 strain gauges and calibration services.
- WQS35073, Strain Gauge Measurement Procedure, Revision 4, dated October 9, 2012

The MHI dedication consisted of a combination of EPRI Methods 2 and 3 for the strain gauges. During review of the commercial grade survey, the inspectors verified that MHI commercial grade survey check list addressed the appropriate areas at Tokyo Sokki Kenkyujo; such as verification methods for the identified critical characteristics, calibration of the measuring and test equipment (M&TE) for the measuring gauge factors, standards were traceable to national or international standards, items were provided with appropriate lot traceability, and that documented procedures existed for the commercial grade quality control processes that were being implemented for the specific areas reviewed.

During the observation and discussions of dedication activities with MHI Kobe and Takasago staff, the NRC inspection team noted that MHI appropriately identified and verified the critical characteristics in accordance with written instructions, procedures, and drawings. The NRC

inspection team also noted that qualified personnel performed these activities using calibrated equipment. The NRC inspection team did not identify any issues with MHI's activities related to the CGD dedication and the verification of critical characteristics.

During the review of CAR-12-064 as discussed in Section 9 b.2 of this inspection report, the NRC inspection team noted that MHI generated the CAR because Takasago had not informed MHI Kobe when previous NCR 14-2012 was issued as required by MHI policies and procedures. As part of the review, the NRC inspection team evaluated the content of nonconformance report NCR 14-2012. NCR-14-2012 was issued by Takasago as a result of an extent of condition performed due to a nonconformance that was identified during a previous NRC inspection performed at Takasago in July of 2011 (NRC Inspection Report No. 05200021/2011-202 and Notice of Violation, dated September 1, 2011).

Takasago procured the calibration services from Tokyo Sokki Kenkyujo Co., Ltd. The NRC inspection team interviewed the engineer responsible for performing the evaluation of Tokyo Sokki Kenkyujo Co., Ltd. and during the conversation the engineer explained that an audit was performed on the services to be procured. The NRC inspection team noted that the Takasago engineer performed an Audit/Survey on the Calibration Supplier and during the Audit/Survey; they verified that the Tokyo Sokki Kenkyujo Co., Ltd. had quality controls in place based on ISO 9000. In addition, the engineer did not verify that Tokyo Sokki Kenkyujo Co., Ltd. had a 10 CFR Part 21 program or a procedure that meets the requirements of 10 CFR Part 21. The engineer from Takasago qualified Tokyo Sokki Kenkyujo Co., Ltd. calibration services based only on the supplier's perceived understanding of the regulations (10 CFR50 Appendix B and 10 CFR Part 21) and having a program to report out of calibration instrument.

Ultimately, the inspectors determined that Tokyo Sokki Kenkyujo Co., Ltd. is a commercial supplier that was being used by MHI to perform safety-related calibration services for the measurement instrument (Resistor Box) used as part of the strain measurement in the mock-up test with additional AVBs inserted. MHI did not verify and validate the strain gauge data as part of a commercial-grade dedication for strain gauge measurement. The NRC inspection team identified Nonconformance 99901030/2012-201-02 for MHI's failure to review the suitability of the application of commercially calibrated M&TE for use in activities affecting quality as part of a commercial-grade item dedication. Specifically, MHI did not perform a commercial grade dedication of the commercial calibration services provided by Tokyo Sokki Kenkyujo Co., Ltd. MHI took immediate corrective action and generated CAR 21-2012 to address this issue.

## b.2 Commercial Calibration Services for the Eddy Current Data Acquisition Unit

The NRC inspection team reviewed the CGD package and related documents for commercial calibration services associated with calibration services for eddy current data acquisition unit MIZ-85iD. The acquisition unit, MIZ-85iD, was procured as commercial grade and dedicated to be used as part of the system on the strain gauges that measure the AVB contact force on the SONG steam generator mock-up tubes. The acquisition unit will be utilized for measurements of the gaps between the AVBs and the heat transfer tubes. The calibration services were procured from E-Techno, Ltd. The subject data acquisition unit, MIZ-85iD, serial number 519940, was manufactured by Zetec, Inc. The MHI dedication package consisted of

- CGD Commercial Grade (Service) Dedication Plan associated with calibration services for eddy current data acquisition unit, MIZ-85iD, UGS-20120714, Revision 2, dated October 3, 20120,

- Commercial Grade Survey Checklist, UGS-20120714, Revision 2, dated October 3, 2012
- CGD Commercial Grade (Service) Dedication Evaluation Report associated with calibration services for eddy current data acquisition unit, MIZ-85iD, UGS-20120921, Revision 0, dated October 3, 20120
- E-Techno Calibration Certificate, for the MIZ-85iD eddy current data acquisition unit, serial number 519940, dated September 12, 2012

The MHI dedication consisted of an EPRI Method 2, "Commercial Grade Survey of Supplier." During review of the commercial grade survey, the NRC inspection team verified that the MHI commercial grade item survey check list and its implementation addressed the appropriate areas at the supplier's (E-Techno) facility; such as verification methods for the identified critical characteristics, calibration activities for accuracy of each voltage and frequency of the eddy current test data acquisition unit, standards used by E-techno were traceable to national or international standards, and that documented procedures existed for commercial grade quality control processes that were being implemented for the specific areas reviewed. The NRC inspection team also observed that the survey verified appropriate item traceability for the data acquisition unit being calibrated and reviewed that the E-Techno calibration certificate, including the appropriate measurements and parameters.

During the observation and discussion with MHI Kobe and Takasago staff of dedication activities, the NRC inspection team noted that MHI appropriately identified and verified the critical characteristics in accordance with written instructions, procedures, and drawings. The NRC inspection team also noted that qualified personnel performed these activities using calibrated equipment. The NRC inspection team did not identify any issues with MHI's activities related to the CGD dedication and the verification of critical characteristics.

### c. Conclusion

The NRC inspection team concluded, with the exception of the below finding, that the MHI commercial-grade dedication program and implementation was consistent with the applicable regulatory requirements of 10 CFR Part 21, Criterion III, "Design Control," and Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team concluded that MHI's Kobe and Takasago's implementation of its policies and procedures provided an effective commercial-grade dedication program.

The inspection team identified Nonconformance 99901030/2012-201-02 for MHI's failure to review the suitability of the application of commercially calibrated measuring and test equipment for use in activities affecting quality, as part of a commercial-grade item dedication. Specifically, MHI did not perform a commercial grade dedication of the commercial calibration services provided by Tokyo Sokki Kenkyujo Co., Ltd., for the strain measurement resistor box in the mock-up test with additional AVBs inserted.

## 6. Test Control

### a. Inspection Scope

The NRC inspection team reviewed the MHI policies and implementing procedures that governed the test control program to verify compliance with the requirements of Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50. Specifically, the NRC inspection team

reviewed a sample of MHI test control activities related to the SONGS mock-up anti-vibration bar testing activities. As part of the test control activities, the team completed a range of tasks including the following items:

- Reviewed the adequacy of the test procedures
- Verified instrumentation and components used for testing specified in test procedures
- Sampled test instruments used on the mock-up test rig for calibration, results, and acceptability of readings
- Reviewed qualifications and training of personnel involved with using the test equipment

The NRC inspection team conducted interviews with responsible MHI personnel and reviewed testing documents to determine if MHI performed activities in accordance with the applicable design, quality, and technical requirements imposed in the MHI POs and industry standard requirements. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

## b. Observations and Findings

### b.1 Test Plan

The NRC inspection team reviewed a number of various documents related to mock-up testing, including Document L5-04GA592, "San Onofre Nuclear Generating Station Unit 2 & 3 Replacement Steam Generators, Mock-up Test Plan for Verification of Repair Measures for Tube Vibration Issue," Revision 5. This was the overarching plan to address the tube vibration wall thinning issues at SONGS Unit 2 & 3. This covered the testing of the various options for additional anti-vibration bars (thicker, 30 degree, and comb type). The verification tests for the thicker anti-vibration bars were designated as safety-related and implemented the requirements of 10 CFR Appendix B, 10 CFR Part 21, and the Mitsubishi Quality Assurance Manual. The 30 degree and the comb type anti-vibration bars were listed as options and were treated as non-safety related. Mitsubishi indicated that the thicker type anti-vibration bars were chosen to be the most practical based on a number factors, including ease of installation and requiring the least amount of deconstruction of the replacement steam generators.

### b.2 Test Procedures

The NRC inspection team reviewed, verified, and if available observed MHI personnel use of the following procedures during mock-up testing:

- Drawing Number SO-KAS-TW-012, "Mock-up Test Manual for Alignment of Expansion Tool," Revision 3, which described the usage of the "alignment expansion tool" for spreading the tube gap to allow insertion of additional anti-vibration bars.
- Procedure SON-SG-FM-43, "Instruction for 30 Degree AVB Insertability Test – Additional Partial Tube Bundle Test," Revision 0, which described 30 degree anti-vibration bar insertion steps.
- Procedure SON-SG-FM-33, "Instruction for Thicker AVBs Insertion Test (Type 1 to 8)," Revision 2, which described the thicker anti-vibration bar insertion test.

The NRC inspection team verified that the MHI test procedures adequately included the technical, quality and regulatory requirements identified in the purchase order. The NRC

inspection team also verified that the MHI test procedures provided an adequate description of the test objectives, test sequences, test instructions, test parameters, measuring and test equipment usage, acceptance criteria, and post-test activities.

### b.3 Test Program Implementation

As part of the testing program, MHI installed approximately 500 strain gauges to measure forces exerted on the tubes during the actual expansion of the tubes using a balloon type expansion tool that spread the tubes apart to allow insertion of the additional anti-vibration bars, as well as the contact forces exerted by the additional anti-vibration bars themselves. The lack of sufficient contact forces between the anti-vibration bars and the tubes was one of the suspected root causes for the tube-to-tube wear associated with in-plane vibration.

Other testing completed as part of the test program included:

- Safety-related Procedure UGS-20120528, "Procedure for Measurement of Displacement on the Fall-Down Preventive Jigs by 3D Measurement," Revision 2, was done to check for displacement of the tube bundle associated with insertion of the thicker anti-vibration bars.
- Safety-related Procedure UGS-20120526, "ECT Measurement Procedures for Heat Transfer Tube Mock-up of Simulated U-Bend Region," Revision 7 described measurement procedures using eddy current testing using both "Intelligent" and "Rotating" eddy current technology to identify anti-vibration bar position and tube dents, using the two different technologies, respectively.
- Document WQS35073, "Procedure for Strain Measurement in a Test with Additional AVBs Inserted," Revision 2, provided instructions on taking measurements of the forces applied to the tubes with additional anti-vibration bars installed. This information was being used in their structural analysis model for the modified tube bundle with additional anti-vibration bars.

The NRC inspection team confirmed that the following testing elements were satisfied, verified, and recorded, as appropriate: (a) test parameters and initial conditions, (b) test acceptance criteria, (c) test prerequisites, (d) test instrument range, accuracy, and uncertainty appropriate for the test, (e) current calibration, and (f) proper procedure sequence followed and any deviations documented and evaluated.

The team verified that MHI personnel appropriately referenced the procedures during their use and used proper communication and verification techniques of location, air pressure, and insertion force as specified in the procedures.

### b.4 Test Results and Data Evaluation

The NRC inspection team verified that test result data was being collected in accordance with the procedural requirements and verified that the equipment used, including a number of data acquisition systems were calibrated. Personnel gathering the data were qualified in accordance with the testing plan and/or procedural requirements and in particular, Procedure 5ZD94-51, "Procedure for Qualification of Inspection and Test Personnel," Revision 3. If they were performing as eddy current (ET) examiners and analysts, they were qualified as ET Level II or better in accordance with JIS Z 2305:2001.

During the NRC inspection, MHI was still collecting data and had not started on the data analysis at that time. Therefore, the inspection team was not able to complete a review of the MHI's data analysis and evaluation.

The NRC inspection team verified that MHI implemented suitable requirements for recording data during testing and had established a process with functional responsibilities for effective evaluation of test results. The NRC inspection team reviewed MHI's controls applicable to test log documentation and data acquisition software to assess the completeness of the requirements with regard to traceable and verifiable data, and documenting the accuracy of instruments used to collect data.

c. Conclusion

The NRC inspection team concluded that MHI's process for control of the testing program was consistent with the regulatory requirements of Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team concluded that the MHI QA Manual and associated test control procedures and activities were adequate and being effectively implemented by qualified personnel, using qualified equipment and processes. No findings of significance were identified.

7. Control of Measuring and Test Equipment

a. Inspection Scope

The NRC inspection team reviewed the MHI policies and implementing procedures that govern the M&TE program to verify compliance with the requirements of Criterion XII, "Control of Measuring and Test Equipment," of Appendix B to 10 CFR Part 50. The NRC inspection team sampled a variety of M&TE associated with the testing performed on the mock-up assembly before, during, and after the insertion of additional anti-vibration bars. During the inspection, the NRC inspection team verified that MHI had established and implemented adequate controls for the calibration of equipment; reviewed the measuring and testing equipment for current calibration certificate; reviewed the application of the equipment for appropriate instrument range and accuracy; and reviewed calibration history, including calibration intervals, calibration standards, and if applicable purchase orders associated with vendor calibrated instruments. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

Section 12, "Calibration of Measurement and Test Equipment," of MHI's B91U-N001 QAM, Revision 27 established requirements and assigns responsibilities for the control of M&TE. The program ensures that tools, gauges, instruments, and other M&TE and devices used in activities affecting quality are of the proper range, type, and accuracy to verify conformance to established requirements.

The NRC inspection team selected a sample of M&TE including: pressure gauge, outside caliper, height gauge, depth gauge, digital micrometer, eddy current rotating probes, eddy current data acquisition system, and laser tracker/IFM by reviewed their calibration records for consistency and completeness. The NRC inspection team found that the calibration records for all of the equipment were complete, with a minor exception. The laser tracker/IFM was not calibrated by MHI. The team reviewed the Calibration Test 002303-12, dated June 15, 2012,

performed by the manufacturer, Automated Precision, Incorporated. The calibration test document included the following statement, "The user must reinstall the software provided with the product in order to have accuracy and reliability as specified. Old parameter files are not valid." When questioned, the MHI engineers were not aware of this requirement. Procedure 5ZDF92-12, "Control Procedure for Non-Contact 3D Measurement Equipment," Revision 1, required calibration every 3 years, but did not provide any requirements for updating the software after calibration. After further investigation MHI personnel were able to find objective evidence to demonstrate, using the API Work Completion Report, dated June 29, 2012, that the software had been updated as specified with the calibration test.

c. Conclusion

The NRC inspection team concluded that MHI's measuring and test equipment program requirements were consistent with the regulatory requirements of Criterion XII, "Control of Measuring and Test Equipment," of Appendix B to 10 CFR Part 50. Based on the limited sample of documents reviewed, the NRC inspection team concluded that MHI established appropriate and effective means to control measuring and test equipment. No findings of significance were identified.

8. Control of Nonconforming Materials, Parts, or Components

a. Inspection Scope

The NRC inspection team reviewed the MHI policies and implementing procedures that governed the control of nonconformances to verify compliance with the requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," of Appendix B to 10 CFR Part 50. Specifically, the NRC inspection team reviewed a sample of Nonconformance Reports and verified that the disposition and control of nonconformances was in accordance with the MHI procedural guidelines.

The Nonconformance Reports reviewed were associated with the activities and testing of the SONGS Mock-up to verify compliance with program requirements and adequate implementation of those requirements. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

b. Observations and Findings

b.1 Policies and Procedures for the Control of Nonconformances

Section 16, "Control of Nonconforming Items and Activities," Revision 30, of the MHI QAM, established the control procedure for nonconforming items and activities. The MHI QAM described the process for identifying, documenting, segregating, evaluating, and handling nonconformances, as well as for notifying affected organizations and customers. Procedure 5ZD91-54(2), "Guideline for implementation on NCR/CAR," Revision 2, dated December 2, 2011, described the process for identifying, evaluating, reporting, and correcting nonconformances. This procedure contains process flow diagrams and sample reporting forms that further describe and govern the nonconformance process. The NRC inspection team also verified that:



- The applicable MHI procedures provided reference to instructions or procedures for repair and rework activities (where required), re-inspection of repaired and reworked items, and notification to affected organizations of nonconforming conditions.
- The applicable procedures appropriately identified the responsibility and authority for review and disposition of nonconforming items, and control further processing, delivery, and installation of nonconforming items until disposition is completed.
- The nonconformance process provided an effective interface to MHI's 10 CFR Part 21 program and procedure.

#### b.2 Review of Nonconformance Reports

Upon evaluation of the nine NCRs initiated for issues associated with the activities and testing of the mock-up, the NRC inspection team noted that each NCR contained a detailed description of the concern and at least one proposed corrective action associated with the identified deficiency. The NRC inspectors verified that the NCRs included the appropriate review and signoff and, when applicable, verified that each corrective action was assigned to a lead organization responsible for its completion. Also, the NRC inspection team verified that the MHI QAM and procedures implement an adequate program to assess and control nonconforming items, including the identification, documentation, segregation, evaluation, and disposition of these items. This process also properly applied the principles of acceptable, reject, repair, scrap, or use-as-is, and provided for the applicable technical justifications to be adequately supported and properly documented, including the need for additional design control measures as necessary, commensurate with those applied to the original design.

The NRC inspection team reviewed nonconformance report UENR-SON3-MOCK-001(0), "Strain gauges of commercial grade item which were used in mock-up test, were purchased without Dedication," dated September 20, 2012. The MHI Takasago dedication of the strain gauges is discussed in Section 4 b.1 of this report. MHI identified that they used a commercial grade item without performing a commercial grade dedication in a safety-related application. As a result of the nonconformance MHI generated CAR-12-063, "Strain gauges of commercial grade items which were used in mock-up test were purchased without dedication," dated September 24, 2012, in accordance with Procedure 5ZD91-54(2) to evaluate and correct the issue. MHI evaluated the problem identified that as a result of lack of understanding, MHI staff was not aware that the strain gauges needed to be dedicated before they were installed in the mock-up. As part of MHI evaluation they corrected the deficiency, provided training to the MHI staff involved in the activities and testing of the Full-Scale Mock-up, and performed a commercial-grade dedication of the strain gauges as documented in Section 4 b.1 of this report. The NRC inspection team evaluated MHI corrective actions and the disposition of the nonconformance reports and found them adequate.

#### c. Conclusion

Based on the sample of nonconformances reviewed, the NRC inspection team concluded that MHI's process for the control of nonconforming materials, parts, or components was consistent with the regulatory requirements of Criterion XV, "Nonconforming Materials, Parts, or Components," of Appendix B to 10 CFR Part 50. The NRC inspection team concluded that MHI effectively implemented its QA policies and implementing procedures that govern the control of nonconformances. No findings of significance were identified.

## 9. Corrective Actions

### a. Inspection Scope

The NRC inspection team reviewed the current status of the corrective actions implemented in response to the activities and testing of the SONGS mock-up. The NRC inspection team also reviewed the MHI policies and implementing procedures that govern the corrective action program to verify compliance with the requirements of Criterion XVI, "Corrective Actions," of Appendix B to 10 CFR Part 50. Specifically, the NRC inspection team reviewed a sample of corrective action reports (CAR) and verified that the CAR disposition and control provide adequate documentation and description of conditions adverse to quality, as well as specifying the cause of these conditions and the corrective actions taken to prevent recurrence. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

The NRC inspection team evaluated a sample of CAR associated with the activities and testing of the SONGS Mock-up to verify compliance with program requirements and adequate implementation of those requirements. The attachment to this inspection report lists the documents reviewed by the NRC inspection team.

### b. Observations and Findings

#### b.1 Policies and Procedures for the Corrective Action Program

Section 16, "Corrective Action, Preventive Action and Lessons Learned," Revision 24, of the MHI's QAM and Procedure 5ZD91-54 to ensure that MHI has measures in place to provide assurance that conditions adverse to quality were promptly identified, documented, and corrected or otherwise handled in accordance with the MHI policies and practices. The procedure also ensured that the causes of the conditions adverse to quality were identified and that corrective or preventive action was taken to preclude recurrence.

The NRC inspection team verified that MHI's staff associated to activities and testing of the Full-Scale mock-up must submit nonconformance reports and proposed corrective actions for approval before implementing corrective actions, and MHI adequately assesses deficiencies identified or reported by its staff and enters them into the nonconformance or corrective action programs. The NRC inspection team also verified that the corrective action process provides an effective interface to MHI's 10 CFR Part 21 program and procedure, and that a management system has been established for the overview of trends for conditions adverse to quality. No findings of significance were identified.

#### b.2 Implementation of the Corrective Action Program

The NRC inspectors noted that MHI procedure 5ZD91-54 adequately identified sources of quality and product safety-related problems that result in the generation of a CAR. The NRC inspectors verified that MHI procedure 5ZD91-54 provided adequate guidance for the review of corrective actions to determine if they were effective in precluding the recurrence of the deficiencies.

The NRC inspection team reviewed a sample of 16 CARs related to activities and testing of the SONGS mock-up. The NRC inspection team verified that the CARs provided (1) adequate documentation and description of conditions adverse to quality; (2) an appropriate analysis of the cause of these conditions and the corrective actions taken to prevent recurrence;

(3) direction for review and approval by the responsible authority; (4) a description of the current status of the corrective actions; and, (5) the follow-up actions taken to verify timely and effective implementation of the corrective actions.

During the review of CAR-12-064, "Takasago Research and Development Center the NRC inspection team noted that Takasago issued NCR 14-2012 on August 20, 2012, and the CAR did not make any reference of the content of the NCR. NCR-14-2012 was issued on September 24, 2012, by Takasago as a result of an extent of condition performed by MHI for a nonconformance identified at during a previous NRC inspection. During the review of CAR-12-064 the NRC inspection team noted that MHI focused on the programmatic aspect of the issue and did not evaluate the technical content of the NCR. The MHI proposed corrective action to CAR-12-064 was to indoctrinate MHI staff on the process that needs to be followed when dealing with the issuance and disposition of NCRs as required by the policies and procedures of the MHI Nonconformance Program. NCR-14-2012 was issued to address the inadequate commercial grade dedication of commercial grade calibration services used in safety related applications. The disposition of NCR-14-2012 was not adequate. Takasago used a commercial grade calibration service to calibrate a safety-related item without performing a commercial grade dedication as required by MHI policies and procedures. This deficiency is discussed in Section 4 b.2 of this inspection report and documented under Nonconformance 99901030/2012-201-02. The NRC inspection team determined that the MHI's QAM and associated corrective action procedure were being effectively implemented. No findings of significance were identified.

#### c. Conclusion

Based on the sample of corrective action reports reviewed, the NRC inspection team concluded that the implementation of MHI's program for corrective actions was consistent with the regulatory requirements of Criterion XVI, "Corrective Action," of Appendix B to 10 CFR Part 50. The NRC inspection team concluded that MHI's corrective action system was adequately described in the MHI procedures. No findings of significance were identified.

#### 10. Entrance and Exit Meetings

On October 9, 2012, the NRC inspection team discussed the scope of the inspection with Mr. Ei. Kadokami, Senior Vice President and Head of Kobe Shipyard & Machinery Works and other members of the MHI management and staff. On October 17, 2012, the NRC inspection team presented the inspection results and observations during an exit meeting with Mr. Fumiki Kono, General Manager Nuclear Energy Systems and other MHI staff. The attachment to this report lists the entrance and exit meeting attendees, as well as those individuals interviewed by the NRC inspection team.

## ATTACHMENT

### 1. ENTRANCE / EXIT MEETING ATTENDEES AND PERSONS CONTACTED

Name	Title	Affiliation	Entrance	Exit	Interviewed
Yoshihiro Asada	Deputy Director, Nuclear Energy Systems Safety and Quality Management Department	MHI		X	X
Kengo Shimamura	Manager, Steam Generator Designing Section	MHI		X	X
Hidehito Mimaki	Deputy General Manager, Nuclear Plant Component Designing Department	MHI	X	X	X
Masaaki Katayama	Engineering Manager, Steam Generator Designing Section	MHI	X	X	X
Tomonori Shichida	Deputy Manager, Component Quality Control Section	MHI		X	X
Takashi Hasebe	Quality Assurance Engineer, Component Quality Control Section	MHI	X	X	X
Nobuki Tamai	Deputy Manager, Component Quality Control Section	MHI	X		X
Naoki Kawai	Quality Assurance Engineer, Component Quality Control Section	MHI	X	X	X
Hiroshi Matsuyama	Deputy Manager, Nuclear Plant Quality Assurance	MHI			X
Tsubasa Osato	Quality Assurance Engineer, Nuclear Plant Quality Assurance	MHI			X
Ren Imoto	Quality Assurance Engineer, Nuclear Plant Quality Assurance	MHI			X
Yasunobu Harada	Acting Manager Nuclear Plant Quality Assurance Section Quality Assurance Department Nuclear Energy Systems	MHI	X	X	X
Ikuo Otake	Chief Engineer, Manager Quality Assurance Department Nuclear Energy Systems	MHI	X	X	X
Takayoshi Tsuruta	Manager UT/ET/RT Level III EPRI PDI Piping & DM Quality Assurance Department Lead NDE Level III Nuclear Energy Systems	MHI			X
Masayoshi Suzuki	Engineer Manager, Quality Project Team Nuclear Plant Quality Assurance Section	MHI	X	X	X

	Quality Assurance Department Nuclear Energy Systems				
Setsuko Morimoto	Interpreter	G-Media NHK	X	X	
Asami Mori	Interpreter	G-Media NHK	X	X	
Chieko Okado	Interpreter	Interpretation & Translation Services		X	
Hirohide Nakamura	Technical Official, Ministry of the Environmental for BWR	Nuclear Regulatory Authority			
Ken Yoshizaki	Technical Official, Ministry of the Environmental for PWR	Nuclear Regulatory Authority			
Katsuhiko Hirakawa	Director Quality Assurance Department Nuclear Energy Systems	MHI		X	
Takashi Fukuda	Deputy Manager Nuclear Plant Quality Assurance Section Quality Assurance Department Nuclear Energy Systems	MHI	X	X	
Takanori Murakami	Deputy General Manager Quality Assurance Department Nuclear Energy Systems	MHI	X	X	
Ei Kadokami	Senior Vice President Head of Kobe Shipyard & Machinery Works	MHI	X		
Fumiki Kono	General Manager Nuclear Energy Systems Senior General manager Nuclear Plant Production Division	MHI	X	X	
Tadashi Murakami	Engineer Manager Nuclear Energy Systems	MHI	X		
Keita Kobayashi	PQES Manager Nuclear Energy Systems	MHI	X		
Takanori Muratami	Quality Assurance Department Nuclear Energy Systems	MHI	X		
Yoshiaki Shimokusu	NPMD Director Manufacturing Department Nuclear Energy Systems	MHI	X	X	
Hisashi Nishiki	SGS Deputy Manager Nuclear Energy Systems	MHI	X	X	
Toshiyuki Mizutan	Overseas Project Nuclear Energy Systems	MHI	X	X	
Masahiko Morino	NSMOG, Senior Engineer Nuclear Energy Systems	MHI	X	X	
Takashi Kanabushi	SGDS Nuclear Energy Systems	MHI	X	X	

Akifumi Takahashi	NPQAS, Engineer Manager Nuclear Energy Systems	MHI	X	X	
Fumiki Kono	General Manager Nuclear Energy Systems	MHI	X		
Jinichi Miyaguchi	NPCDD, Director Nuclear Energy Systems	MHI	X	X	
Takafumi Hiro	SGDS, Deputy Manager Nuclear Energy Systems	MHI	X	X	
Shinya Maeda	Manufacturing Engineer Nuclear Energy Systems	MHI	X	X	
Yoichi Ishigami	SGS, Manager Nuclear Energy Systems	MHI	X	X	
Takeshi Hanaoka	CQCS, Manager Nuclear Energy Systems	MHI	X	X	
Yoshinobu Yoshikawa	NPPD, General Manager Nuclear Energy Systems	MHI	X	X	
Kenji Nishida	SGDS, Senior Design Engineer Nuclear Energy Systems	MHI	X	X	
J. Nawba	Interpreter		X		
Masaharu. Tabiraki	Interpreter		X	X	
Takashi Veno	Senior Manager of Takasago R&D Center	MHI	X		X
Vann Mitchell	General Manager Quality Assurance Division	MNES	X	X	
Frank Gillespie	Senior Vice President	MNES	X	X	
John Manso	Engineer Manager SGR Team SCE	SCE	X	X	
Ryan Treadway	Regulatory Affairs Manager SCE SGR Team	SCE	X	X	
Jeff Julien	SCE Liaison	SCE	X		
Takahiro Nakata	PQCS, Engineer Manager Nuclear Energy Systems	MHI		X	
Takeshi Matsuda	Quality Assurance Takasago R&D Center	MHI		X	
Yutaka Tanaka	Manager Takasago R&D Center	MHI		X	
Kiichi Tokuhisa	NPQAS, Engineer Manager Nuclear Energy Systems	MHI		X	

## 2. INSPECTION PROCEDURES USED

Inspection Procedure 43003, "Reactive Inspection of Nuclear Vendors," dated April 25, 2011.

Inspection Procedure 43004, "Inspection of Commercial-Grade Dedication Programs, dated October 3, 2007

Inspection Procedure 36100, "Inspection of 10 CFR Part 21 and Programs for Reporting Defects and Noncompliance," dated February 13, 2012.

### 3. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

<u>Item Number</u>	<u>Status</u>	<u>Type</u>	<u>Description</u>
99901030/2012-201-01	Open	NON	Criterion VII
99901030/2012-201-02	Open	NON	Criterion III

### 4. DOCUMENTS REVIEWED

#### Quality Assurance Manual

- B91U-N001, "Quality Assurance Manual (NUCLEAR)," Revision 43 dated May 15, 2012

#### 10 CFR Part 21 Documents

- UES-69-020008, "Identification and Reporting of Conditions Adverse to Safety <Reporting of Defects and Noncompliance (10CFR Part21)>", Revision 16 dated April 18, 2012
- UEQ-20120668, "Understanding of US Regulation, Indoctrination of 10 CFR Part 21," July 3, 2012
- UEQ-20071005(5), "10 CFR Part 21," Training Material: Broad Understanding of the Regulation, Relation to App B and how or What is Needed to Perform Dedication"
- U21-18-E(0), "Evaluation Report for 10 CFR 21 – Steam Generator tube wear adjacent to retainer bar" dated August 31, 2012
- U21-19(0), "Evaluation Report for 10 CFR 21 – Steam Generator tube to tube wear," dated August 31, 2012
- U21-20-E(0), "Evaluation Report for 10 CFR 21 – Inappropriate input of flow velocity in the evaluation of flow-induced vibration tubes for SONGS Unit 2/3 Steam Generators," dated July 6, 2012
- U21-21-E(0), "Evaluation Report for 10 CFR 21 – Unclear description on user's manual for analysis code (FIT III)," dated August 31, 2012
- UET-20120105, "Interim Report of Evaluation of a Deviation Pursuant to 10 CFR 21.21(a)(2)," Revision 1 dated June 1, 2012
- UET-20120217, "Notification of the written report pursuant to 10 CFR 21.21(d)(4) (Title: Steam Generator tube wear adjacent to retainer bars)," Revision 0 dated October 5, 2012
- UET-20120218. "Notification of the written report pursuant to 10 CFR 21.21(d)(4) (Title: Steam Generator tube to tube wear)," Revision 0 dated October 5, 2012

#### Corrective Action Request generated from NRC inspection

- CAR 21-2012, "Takasago R&D Center did not perform CGD for calibration services of a strain calibrator," dated October 16, 2012
- CAR-12-075(0), "Not adequate and insufficient description were detected on control procedure for 10 CFR Part 21," dated October 12, 2012
- CAR-12-076(0), "No documentation was found to demonstrate that the tube outside diameter straightness, tube bending radius, and total tube length conformed to the requirements of Purchase Specification L5-04JA433 or Inspection Document L5-04GA592 measurement acceptance criteria."

## Corrective and Preventive Action Request/Report

- CAR-UGG-084(7), "Steam Generator Tube Wear Adjacent to Retainer Bars," dated September 7, 2012
- CAR-12-044(1), "Procedure for Controlling of Design Activities," did not require that retainer bars and other steam generator parts subject to flow induced vibration under the high velocity flow conditions be evaluated..., dated October 2, 2012
- CAR-UGG-085(6), "Steam Generator Tube to Tube Wear," dated September 7, 2012
- CAR-12-042(0), "Tube in plane stability shall be described on Design Procedure for SG as well as out-of-plane stability," dated August 3, 2012
- CAR-12-066(0), "Procedure for controlling of the design activities did not require that effective tube to AVB contact force under high localized thermal-hydraulic conditions be addressed in SG design," dated September 28, 2012
- CAR-12-028(3), "SGDS applied velocity which is different from the analysis procedure decided by SGDS," dated May 10, 2012
- CAR-12-045(1), "Proper user documentation for computer code used to calculate Gap Velocity was not provided to the user," dated October 8, 2012
- CAR-12-067(0), "Procedure for tube vibration analysis did not specify to ensure that the program used to calculate GAP Velocity has a user manual to support the use of MHI tube configuration," dated October 2, 2012
- CAR-12-068(0), "Procedure for development and control of computer software did not require the additional comparison to other validation methods in SG design analysis if necessary depending on complexity and/or importance of analysis," dated October 2, 2012
- CAR-12-046, "No guidance for use FIT-III was describe on the procedure," dated August 8, 2012
- CAR-12-048(0), "Gap velocity and validation range," dated August 3, 2012
- CAR-12-027(0), "Foreign Material," dated May 7, 2012
- CAR-12-047, "No procedure was developed for analysis of cumulative effect of design changes during the design phase," dated August 6, 2012
- CAR-12-069(0), "Comprehensive Actions," dated October 2, 2012
- CAR-12-072, "Data acquisition unit was calibrated by organization without QA program in accordance with 10CR Appendix B," dated September 28, 2012
- CAR-12-063, "Strain gauges of commercial grade items which were used in mock-up test were purchase without dedication," dated September 24, 2012
- CAR-12-064, "Takasago Research and Development Center issued NCR 14-2012 on Aug.20, 2012. However, this NCR was not sent to SGDS against SGDS's specifications requirements," dated September 24, 2012

## Nonconformance Report

- UENR-SON3-MOCK-001(0), "Strain gauges of commercial grade item which were used in mock-up test, were purchased without Dedication," dated September 20, 2012
- UENR-SON3-MOCK-002(0), "Data Acquisition Unit calibrated by organization without QA program in accordance with 10CFR Appendix B was used in the mock-up test," dated September 27, 2012
- UENR-SON3-MOCK-003(0), "The corrective coefficient described in the strain measurement procedure (WQS35073r1) is draft value," dated September 28, 2012



- UENR-SON3-MOCK-004(0), "Procedure for strain measurement was revised at 9/20. Although this procedure revision number described in FPS was 0," dated September 10, 2012
- UENR-SON3-MOCK-005(0), "The contact force measured by Takasago R&D did not meet the acceptance criteria," dated September 10, 2012
- UGNR-SON3-MOCK-001(1), "Out of tolerance for tube outside diameter," dated July 25, 2012
- UGNR-SON3-MOCK-003(0), "Out of tolerance for the tick AVB during dimensional inspection," dated September 26, 2012
- NCR-14-2012, Evaluation of Calibration Services," issued September 24, 2012 by Takasago Research and Development Center

### Calibration Records

- Automated Precision, Inc., Test Number 002303-12 (IFM/Laser Tracker)
- SON-UGS-20120413-4 (for outside micrometer ID # 060959)
- SON-UGS-20120413-7 (for dial gauge ID # 106860)
- SON-UGS-20120413-8 (for plug gauge ID # 101260)
- SON-UGS-20120526-1 (for large caliper for tube bundle measurement ID # 114858)

### Procedures

- 5ZDF92-12, "Control Procedure for Non-Contact 3D Measurement Equipment," Revision 1
- 5ZD94-51, "Procedure for Qualification of Inspection and Test Personnel," Revision 2 dated February 21, 2012
- 5ZD91-52, "Qualification and Certification Procedure of Nondestructive Examination (NDE) Personnel," Revision 0 dated May 31, 2012
- 5ZD91-53(1), "RCA (Root Cause Analysis) Procedure," Revision 1 dated February 17, 2012
- 5ZD91-54(2), "Guideline for Implementation on NCR/CAR," Revision 2 dated December 2, 2011
- 5ZDB14-70(2), "Control Procedure of Quality Assurance Record," Revision 2 dated May 18, 2012
- LG-04GA592, "Mock-up Test Plan for Verification of Repair Measures for Tube Vibration Issue," Revisions 4 and 5
- MS5ZDB6-9113, "Calibration Procedure for Height Gauge," Revision 0
- MS5ZDB6-9121, "Calibration Procedure for Outside Micrometer," Revision 1
- MS5ZDB6-9132, "Calibration Procedure for Digital Type Dial Gauge," Revision 0
- SO-KAS-TW-012, "Mock-up Test Manual for Alignment of Expansion Tool," Revision 3
- SO-KAS-TW-013, "Manual for Visual Inspection Tool," Revision 1
- SON-SG-FM-33, "Instruction for Thicker AVBs Insertion Test," Revision 2
- SON-SG-FM-43, "Instruction for 30 Degree AVB Insertability Test, Additional Partial Tube Bundle Test," Revision 0
- "TA" QMS91-N08, Takasago Research and Development Center "Nuclear Energy Research and Development Center Commercial Grade Dedication (CGD) Procedure," revision 1, dated December 28, 2010
- TSN 5071, "Dimensional Examination Procedure for Alloy 690 Steam Generator Tubing," Revision 1

- UES-20120254, "San Onofre Nuclear Generating Station Unit 2 & 3 Replacement Steam Generators Root Cause Analysis Report for tube wear identified in the Unit 2 and Unit 3 Steam Generators of San Onofre Nuclear Generating Station," Revision 0 dated October 12, 2012
- UGS-20120413, "Inspection Procedure for Mock-up of Bended Area," Revision 2 dated July 20, 2012
- UES-20112060, "ASME Code Job Section Standard Control List," Revision 3 dated May 29, 2012
- UGS-20120421, "Inspection Plan for Mock-up," Revision 1
- UGS-20120526, "ECT Measurement Procedures for Heat Transfer Tube Mock-up of Simulated U-Bend Region," Revision 7
- UGS-20120528, "Procedure for Measurement of Displacement of the Fall-Down Prevention Jigs by 3D Measurement," Revision 2
- WQS35073, "Procedure for Strain Measurement in a Test with Additional AVBs Inserted," Revision 1, dated October 9, 2012

#### Miscellaneous Documents

- L5-04FW036, "Fabrication Drawing Tube Support Plate 4/4," Revision 4
- L5-04FW-111, "Fabrication Drawing Detail of AVB 1/5 (Center Narrow AVB)," Revision 6
- L5-04FZ041, "Purchase Specification for SONGS Unit 2 and 3 RSG Tubing," Revision 4
- L5-04GA428, "Design of Anti-Vibration Bars," Revision 5
- L5-04JA411, "Tube Support Plate Detailed Drawing for Mock-up," Revision 0
- L5-04JA433, "AVB Detailed Drawing 1/2 for Mock-up," Revision 1
- L5-04GA561, "San Onofre Nuclear Generating Station Unit 2 & 3 Replacement Steam Generators Retainer Bar Tube Wear Report," Revision 4 dated February 13, 2012
- L5-04GA564, "San Onofre Nuclear Generating Station Unit 2 & 3 Replacement Steam Generators Tube wear of Unit-3 RSG – Technical Evaluation Report," Revision 9 dated March 30, 2012
- L5-04GA567, "San Onofre Nuclear Generating Station Unit 2 & 3 Replacement Steam Generators Tube wear of Unit-3 RSG – Evaluation of Stability Ratios for Return to Service," Revision 6 dated May 14, 2012
- Mock-up Test Schedule
- Nippon Steel and Sumitomo Metal Corporation Letter for SONGS-3RSG Leakage Mock-up Test, dated October 16, 2012
- Sumitomo Metals Certified Material Test Report for SONGS-3RSG Leakage Mock-up Test, Dated July 4, 2012
- TSN 5050, "Control Document Status List for Alloy 690 Steam Generator Tubing," Revision 5
- TSN 5064, "Control Document Status List for Alloy 690 Steam Generator Tubing," Revision 0
- TSN 5071, "Dimensional Examination Procedure for Alloy 690 Steam Generator Tubing," Revision 1
- UDVT-16-072707, Visual and Dimensional Report (After Final Cutting)
- U\*Q-20112011, "ASME Code Job List of Qualified NDE Personnel ASME Section III," Revision 11 dated October 1, 2012
- UGS-20120714, CGD Commercial Grade (Service) Dedication Plan Associated with Calibration services for Eddy Current Data acquisition Unit, MIZ-85iD, Revision 2, dated October 3, 2012,

- UGS-20120714, Commercial Grade Survey Checklist, Revision 2, dated October 3, 2012
- UGS-20120921, CGD Commercial Grade (Service) Dedication Evaluation Report Associated with Calibration services for Eddy Current Data acquisition Unit, MIZ-85iD, Revision 0, dated October 3, 20120
- WQS35058, CGD Dedication Procedure for Strain Gauges, revision 0, dated September 26, 2012
- WQS35138, CGD Survey Plan and Source Verification Plan, revision 1, dated October 7, 2012
- WQS35138, Commercial Grade Item Survey Checklist, revision1, dated October 7, 2012
- WQS35152, CGD Evaluation Report, revision 1, dated October 7, 2012
- F05Q01206114, F05Q01206046, F05Q01206030, Purchase order procurement documents for type FLA-1-11-3LJBC, lot #A15121A, to Tokyo Sokki Kenkyujo for 600 strain gauges and calibration services.
- Requisition Card 8161999-KA-110044, dated May 8, 2012.