## EDO Principal Correspondence Control

FROM: DUE: 10/27/11 EDO CONTROL: G20110705
DOC DT: 09/22/11
FINAL REPLY:

Said Abdel-Khalik, ACRS

TO:

Borchardt, EDO

FOR SIGNATURE OF : ** GRN ** CRC NO:

Borchardt, EDO

DESC:

Chapters 2, 5, 8, 10, 11, 12, 13 and 16 of the Safety Evaluation Report with Open Items for Certification of othe US-APWR Design (EDATS: OEDO-2011-0649)

ROUTING:

Borchardt
Weber
Virgilio
Ash
Mamish
OGC/GC
Burns, OGC
Frazier, OEDO

DATE: 09/26/11

ASSIGNED TO: NRO

CONTACT: Johnson

SPECIAL INSTRUCTIONS OR REMARKS:

Please prepare response to ACRS for the signature of the EDO. Add the Commission and SECY as cc's. Also, include RidsAcrsAcnw_MailCTR to your distribution on the concurrence page. USE SUBJECT LINE IN RESPONSE.

Template: EDO-001

E-RIDS: EDO-01

# EDATS

Electronic Document and Action Tracking System

**EDATS Number:** OEDO-2011-0649

**Source:** OEDO

## General Information

**Assigned To:** NRO

**OEDO Due Date:** 10/27/2011 11:00 PM

**Other Assignees:**

**SECY Due Date:** NONE

**Subject:** Chapters 2, 5, 8, 10, 11, 12, 13 and 16 of the Safety Evaluation Report with Open Items for Certification of the US-APWR Design

**Description:**

**CC Routing:** OGC

**ADAMS Accession Numbers - Incoming:** NONE

**Response/Package:** NONE

## Other Information

**Cross Reference Number:** G20110705

**Staff Initiated:** NO

**Related Task:**

**Recurring Item:** NO

**File Routing:** EDATS

**Agency Lesson Learned:** NO

**OEDO Monthly Report Item:** NO

## Process Information

**Action Type:** Letter

**Priority:** Medium

**Sensitivity:** None

**Signature Level:** EDO

**Urgency:** NO

**Approval Level:** No Approval Required

**OEDO Concurrence:** NO

**OCM Concurrence:** NO

**OCA Concurrence:** NO

**Special Instructions:** Please prepare response to ACRS for the signature of the EDO. Add the Commission and SECY as cc's. Also, include RidsAcrsAcnw_MailCTR to your distribution on the concurrence page. USE SUBJECT LINE IN RESPONSE.

## Document Information

**Originator Name:** Said Abdel-Khalik

**Date of Incoming:** 9/22/2011

**Originating Organization:** ACRS

**Document Received by OEDO Date:** 9/26/2011

**Addressee:** R. W. Borchardt, EDO

**Date Response Requested by Originator:** NONE

**Incoming Task Received:** Letter

**UNITED STATES**
**NUCLEAR REGULATORY COMMISSION**
**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS**
**WASHINGTON, DC 20555 - 0001**

September 22, 2011

Mr. R. W. Borchardt
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: CHAPTERS 2, 5, 8, 10, 11, 12, 13, AND 16 OF THE SAFETY EVALUATION REPORT WITH OPEN ITEMS FOR CERTIFICATION OF THE US-APWR DESIGN

Dear Mr. Borchardt:

During the 586th meeting of the Advisory Committee on Reactor Safeguards, September 8-10, 2011, we met with representatives of the NRC staff and Mitsubishi Heavy Industries, Ltd. (MHI) to review the following chapters of the Safety Evaluation Report (SER) with Open Items associated with the United States Advanced Pressurized Water Reactor (US-APWR) design certification application:

- Chapter 2, "Site Characteristics"
- Chapter 5, "Reactor Coolant and Connecting Systems"
- Chapter 8, "Electric Power"
- Chapter 10, "Steam and Power Conversion System"
- Chapter 11, "Radioactive Waste Management"
- Chapter 12, "Radiation Protection"
- Chapter 13, "Conduct of Operations"
- Chapter 16, "Technical Specifications"

Our US-APWR Subcommittee also reviewed these chapters during meetings on June 7, 2010; November 29, 2010; April 22, 2011; May 27, 2011; and August 17, 2011. Technical aspects of the US-APWR design as well as the open items identified in each of these SER chapters were discussed at those meetings. We also had the benefit of the documents referenced.

## CONCLUSIONS AND RECOMMENDATIONS

1. Except for the current SER open items and the issues that are highlighted in Recommendation 2, our review of chapters 2, 5, 8, 10, 11, 12, 13, and 16 did not identify any other issues with potentially significant safety implications that merit special attention at this interim stage of the review.

2. The following items should be addressed:

- Evidence to (a) justify why no leakage will occur through the reactor coolant pump (RCP) seals within one hour after loss of all seal cooling, (b) estimate when leakage will begin during a prolonged loss of all seal cooling at hot standby temperatures and pressures, and (c) quantify the amount of seal leakage, based on the US-APWR RCP seal design and materials.

- Confirmation that published reliability estimates for the gas turbine generator (GTG) emergency power supplies account for all relevant ancillary and support equipment that is included in comparable reliability data for emergency diesel generators (DGs).

- Evidence to (a) justify stable operation of the turbine-driven emergency feedwater (TDEFW) pumps for at least one hour without active room cooling and (b) estimate when turbine control failures are expected to occur if the room heatup continues for longer than one hour.

3. We plan to review the staff's resolution of the open items in SER chapters 2, 5, 8, 10, 11, 12, 13, and 16 and the issues in Recommendation 2 during future meetings.

4. Systems described in these chapters interact with other systems that are discussed in SER chapters that we have not yet reviewed. We will comment on potential safety implications of any system interactions in future interim letters and in our final report.

## BACKGROUND

The US-APWR is a four-loop pressurized water reactor with a large dry containment. The design includes a combination of active and passive safety systems, arranged in four divisions. Reactor protection, safeguards actuation, and other instrumentation and control functions are developed through integrated digital platforms. Notable design features include advanced passive accumulators, elimination of low pressure injection pumps, a refueling water storage pit inside the containment, a core debris spreading area below the reactor vessel, and gas turbine generator emergency power supplies.

MHI submitted a Design Control Document (DCD) with its application for the US-APWR design certification on December 31, 2007. Revision 1 of the DCD was submitted on August 29, 2008; Revision 2 on October 27, 2009; and Revision 3 on March 31, 2011. We have agreed to review the SER on a chapter-by-chapter basis to identify technical issues that may merit further consideration. This process aids effective resolution of any early concerns and facilitates timely completion of the US-APWR design certification review. Accordingly, the staff has provided SER chapters 2, 5, 8, 10, 11, 12, 13, and 16 with open items for our review. The staff's SER and our review of these chapters address DCD Revision 2. As a result of MHI's responses to the staff's review questions and evolution of the design documentation, some issues that are identified in these SER chapters may not account for the current status of specific design information in DCD Revision 3.

## DISCUSSION

The current open items from these SER chapters identify several technical issues that must be resolved during the staff's final review. As part of our reviews, we have requested additional information about specific details of the US-APWR design. Based on our experience to date, we expect that these issues will be resolved to our satisfaction before all open items are closed. For this interim report, we note the following observations on selected elements of the design addressed in these chapters. We did not identify any other issues that merit special attention at this time.

### Chapter 5: Reactor Coolant and Connecting Systems

The US-APWR RCP cooling systems design is similar to that for many currently operating U.S. pressurized water reactors. The component cooling water (CCW) system provides cooling for the RCP bearing oil coolers, motor coolers, and thermal barrier coolers. The CCW system also cools the charging pumps, which supply normal RCP seal water injection flow.

The US-APWR station blackout coping analysis indicates that the RCP seals will retain their integrity for at least one hour without cooling. The staff should request that MHI provide evidence that there is no leakage through the seals during this one-hour coping time. Based on the US-APWR RCP seal design and materials, the staff should also request an estimate when leakage will begin during a prolonged loss of all seal cooling at hot standby temperatures and pressures, and the corresponding amount of that leakage.

### Chapter 8: Electric Power

Safety-related emergency AC power for the US-APWR is supplied by four GTGs. The design includes two additional smaller non-safety GTGs that can be started and aligned manually as alternate AC (AAC) power supplies if offsite power fails, and power is not available from the safety-related GTGs. The safety-related GTGs are designed to start and be ready to accept load within 100 seconds after loss of power at their respective buses. Due to the gas turbine design and operation requirements, this starting time is longer than that for a comparably rated DG. The advanced accumulators provide passive coolant injection during the GTG starting and loading interval for all design basis loss of coolant accident (LOCA) conditions.

There has been considerable discussion about the use of GTGs as safety-related emergency power supplies. This is a unique feature of the US-APWR, compared with currently operating U.S. nuclear power plants and other proposed new reactor designs. We have not yet reviewed the safety analyses that justify the GTG starting and loading times for the full spectrum of design basis transients and LOCAs. However, we have not identified any inherent features of the GTG design or operating characteristics that would preclude their use as safety-related emergency power supplies.

There has also been considerable discussion about GTG reliability, compared with the historically demonstrated reliability of emergency DGs. Based on the information that we have reviewed in the DCD and supporting technical reports, we conclude that GTG reliability is neither generically much better nor much worse than DG reliability. The available Japanese operating experience for similar GTGs and preliminary test results for the US-APWR GTG design indicate that the generic GTG and DG reliabilities are likely comparable, within the expected range of data uncertainties; unit-to-unit variability; and plant-specific operating, maintenance, and testing practices. The published GTG reliability data do not cover the same scope of ancillary and support equipment as the U.S. data for emergency DGs (e.g., including external starting signals, the generator output circuit breaker, etc.). The staff should request that MHI confirm that the scope of the GTG operating experience data and test results account consistently for contributions of these items to the published GTG reliability estimates.

Chapter 10: Steam and Power Conversion System

The US-APWR safety-related DC batteries can supply power for a rated duration of two hours without recharging under design basis loading conditions. The emergency feedwater (EFW) system contains two motor-driven pumps and two turbine-driven pumps. Each EFW pump is sized to supply 50% of the feedwater flow required for reactor decay heat removal under design basis accident conditions. The TDEFW pumps do not require AC power for startup, turbine control, or feedwater flow control.

MHI stated that, without active room cooling, elevated temperatures in the TDEFW pump rooms may cause turbine control system malfunctions and loss of stable control after approximately one hour. The TDEFW pump room coolers and their heat removal systems are powered from AC buses. Therefore, sustained stable flow from the TDEFW pumps requires restoration of AC power to the room cooling equipment within approximately one hour after loss of all AC power. The US-APWR station blackout analyses include credit for manual startup, alignment, and loading of the AAC GTGs to supply the TDEFW room cooling equipment within one hour if offsite power fails, and power is not available from the safety-related GTGs. Extended operation of the TDEFW pumps for longer than two hours also requires restoration of AC power to the safety-related battery chargers.

The staff should request that MHI provide room heatup analyses and documentation of the turbine control systems environmental qualifications that justify why the TDEFW pumps will continue to operate stably for at least one hour after loss of all room cooling. The analyses should also estimate when TDEFW control failures are expected to occur if the room heatup continues for longer than one hour.

We plan to review the resolution of the open items identified in SER chapters 2, 5, 8, 10, 11, 12, 13, and 16 and the issues discussed in this report during future meetings. Systems described in these chapters interact with other systems that are discussed in SER chapters that we have not yet reviewed. We will comment on potential safety implications of any system interactions in future interim letters and in our final report.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

**REFERENCES**

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2. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items for Chapter 5, "Reactor Coolant and Connecting Systems," 04/28/2011 (ML111030412)

3. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items for Chapter 8, "Electric Power," 11/18/2010 (ML102850482)

4. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items for Chapter 10, "Steam and Power Conversion System," 07/21/2011 (ML111940429)

5. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items for Chapter 11, "Radioactive Waste Management," 03/17/2011 (ML110660501)

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7. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items Chapter 13, "Conduct of Operations," 09/01/2010 (ML101550468)

8. NRC Memorandum, Subject: Advanced Pressurized Water Reactor Design Certification Application – Safety Evaluation Report with Open Items Chapter 16, "Technical Specifications," 05/18/2010 (ML100840605)

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10. Mitsubishi Heavy Industries, MUAP-DC005, Revision 2, Design Control Document for the US-APWR, Chapter 5, "Reactor Coolant and Connecting Systems," 10/27/2009 (ML093070255)

11. Mitsubishi Heavy Industries, MUAP-DC008, Revision 2, Design Control Document for the US-APWR, Chapter 8, "Electric Power," 10/27/2009 (ML093070258)

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13. Mitsubishi Heavy Industries, MUAP-DC011, Revision 2, Design Control Document for the US-APWR, Chapter 11, "Radioactive Waste Management," 10/27/2009 (ML093070340)

14. Mitsubishi Heavy Industries, MUAP-DC012, Revision 2, Design Control Document for the US-APWR, Chapter 12, "Radiation Protection," 10/27/2009 (ML093070341)

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17. Mitsubishi Heavy Industries, MUAP-07024, Revision 2, "Qualification and Test Plan of Class 1E Gas Turbine Generator System," 10/26/2010 (ML103120130)

18. Mitsubishi Heavy Industries, MUAP-07028, Revision 1, “Probability of Missile Generation from Low Pressure Turbines," 01/18/2011 (ML110260170)

19. Mitsubishi Heavy Industries, MUAP-07029, Revision 2, “Probabilistic Evaluation of Turbine Valve Test Frequency," 01/18/2011 (ML110280165)

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21. Mitsubishi Heavy Industries, MUAP-09016, Revision 1, "Pressure and Temperature Limits Report," 02/01/2010 (ML100470913)

22. Mitsubishi Heavy Industries, MUAP-09017, Revision 0, "Justification for 20 Years Inspection Interval for Reactor Coolant Pump Flywheel," 07/15/2009 (ML091980451)

23. Mitsubishi Heavy Industries, MUAP-09023, Revision 0, "Onsite AC Power System Calculation," 03/29/2010 (ML100950159)

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26. Mitsubishi Heavy Industries, MUAP-10023, Revision 1, "Initial Type Test Result of Class 1E Gas Turbine Generator System," 03/01/2011 (ML110680337)