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

June 15, 2011

MEMORANDUM TO: ACRS Members
US-APWR Subcommittee

FROM: Ilka Berrios, Staff Engineer ***/RA/***
Technical Support Branch, ACRS

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE ON THE U.S. ADVANCED PRESSURIZED WATER REACTOR, APRIL 22, 2011

The minutes for the subject meeting were certified on June 14, 2011. Along with the transcripts and presentation materials, this is the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc w/o Attachment: E. Hackett
C. Santos
Y. Diaz

cc w/ Attachment: ACRS Members

UNITED STATES
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June 15, 2011

MEMORANDUM TO: Ilka Berrios, Staff Engineer
Reactor Safety Branch B - ACRS

FROM: J. Stetkar, Chairman
U.S. Advanced Pressurized Water Reactor Subcommittee

SUBJECT: MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON THE U.S. ADVANCED PRESSURIZED WATER REACTOR ON APRIL 22, 2011, IN ROCKVILLE, MD

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting are an accurate record of the proceedings for that meeting.

/RA/ ***6-14-2011***
J. Stetkar Date

Chairman of ACRS Subcommittee on the
U.S. Advanced Pressurized Water Reactor

Certified on: June 14, 2011
Certified by: John Stetkar

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
US-APWR SUBCOMMITTEE
APRIL 22, 011
ROCKVILLE, MD

Introduction

The ACRS Subcommittee on the United States Advanced Pressurized Water Reactor (US-APWR) met on April 22, 2011at NRC headquarters in Rockville, MD. John Stetkar, Chairman, presided. The Subcommittee met with NRC staff members and members of the public. The purpose of this meeting was for the Subcommittee members to hear briefings by NRC staff members and representatives of Mitsubishi Heavy Industries (MHI) related to Chapters 11 and 12 of the US-APWR Design Certification Application and the staff's Draft Safety Evaluation Report. The Subcommittee also heard presentations regarding the Gas Turbine Generators for the US-APWR design certification and Interim Staff Guidance DC/COL-ISG–021.

Friday April 22, 2011, Conference Room T-2B1, Two White Flint North

Item	Topic	Presenter(s)	Time
1	Opening Remarks and Objectives	Dr. John Stetkar, ACRS	8:30 – 8:35 a.m.
2	Staff introduction	Jeff Ciocco, NRO	8:35 – 8:40 a.m.
3	Discussion of US-APWR DCD Chapter 11, "Radioactive Waste Management"	MHI	8:40 – 9:45 a.m.
	Break		9:45 – 10:00 a.m.
4	Discussion of the SER related to US-APWR DCD Chapter 11, "Radioactive Waste Management"	NRC Staff	10:00 – 11:00 a.m.
5	Discussion of US-APWR DCD Chapter 12, "Radiation Protection"	MHI	11:00 a.m. – 12:00 p.m.
	Lunch		12:00 - 1:00 p.m.
6	Discussion of the SER related to US-APWR DCD Chapter 12, "Radiation Protection"	NRC Staff	1:00 – 2:00 p.m.
7	Discussion of the Interim Staff Guidance – 021, "Review of Nuclear Power Plant Designs using a Gas Turbine Driven Standby Emergency Alternating Current Power System"	NRC Staff	2:00 – 2:30 p.m.
	Break		2:30 – 2:45 p.m.

8	Discussion of the Gas Turbine Generator System	MHI	2:45 – 4:15 p.m.
9	Subcommittee Discussion	Dr. John Stetkar, ACRS	4:15 – 4:30 p.m.

ATTENDEES

ACRS Members/Staff
John Stetkar, Chairman
Dennis Bley
Joy Rempe
Michael Ryan
Charles Brown
William Shack
Harold Ray
Sanjoy Banerjee
J. Sam Armijo
Ilka Berrios (DFO)

NRC Staff
Jeffrey Ciocco
Hossein Hamzehee
Edward Roach
Ron La Vera
Zachary Gran
Stephen Monarque
Ann Hodgdon
William Ward
Ngola Otto

MHI
Motoki Konno
Mikihiro Nakata
Masaki Omura
Atsushi Kumaki
Yves Barles

MNES
Scott Kiffer
Keith Pulson
Goro Imada
Ryan Sprengel
Shinji kinchi
Hidelci Tanalca
Shinji Kawanago

URS
Sara Amitrani
Irving Tsang

The presentation slides used by presenters are attached to the transcript of this meeting at the following website: http://www.nrc.gov/reading-rm/doc-collections/acrs/tr/subcommittee/. The presentations to the Subcommittee are summarized below. There were no requests by members of the public to make written or oral statements.

Opening Remarks By Chairman Stetkar

Chairman Stetkar brought the meeting to order and announced the ACRS members in attendance and the Designated Federal Official (DFO) for this meeting. He stated that the purpose of the meeting is for the Subcommittee to review Chapter 11, "Radioactive Waste Management Systems" and Chapter 12, "Radiation Protection" of the NRC Safety Evaluation with Open Items associated with the US-APWR Design Control Document, as well as technical reports related to the Gas Turbine Generators for the US-APWR design certification. During this meeting the Subcommittee gathered information, analyzed relevant issues and facts, and formulated proposed positions and actions for the full Committee to deliberate.

The rules for participation were announced in the notice of this meeting previously published in The Federal Register. The ACRS staff did not receive additional written comments or requests

for time to make oral statements from members of the public. The staff did not receive requests for people to participate via a bridge phone line. A transcript is available.

US-APWR DCD, Chapter 11, "Radioactive Waste Management Systems"

Mitsubishi Heavy Industries, Ltd. (MHI or the applicant) discussed an overview of what is included in Chapter 11 of their design control document (DCD). They first discussed the source term basis and the source term applications. The applicant stated that two source term models were used to calculate the radionuclide concentration in the reactor coolant and secondary coolant. They also explained the design basis and the realistic basis of the application.

The applicant discussed the liquid waste management system (LWMS). The objective of the LWMS is to collect, store, and process radioactive liquid to meet release specifications for discharge. This is a non safety related system and is located in the auxiliary building (A/B). The applicant showed and discussed a flow diagram for the LWMS, which can be found in the transcripts for this meeting. They also stated that the LWMS meets the regulations.

The applicant discussed the gaseous waste management system (GWMS). The objective of the GWMS is to monitor, control, collect, store, handle, and process gaseous radioactive waste to release specifications for discharge. This is a non safety related system and is located in the A/B. The applicant showed and discussed a flow diagram for the GWMS, which can be found in the transcripts for this meeting. They also stated that the GWMS meets the regulations.

The applicant discussed the solid waste management system (SWMS). The objective of the SWMS is to collect, process, package, store, and transport solid radioactive waste for off-site disposal. This is a non safety related system and is located in the A/B. The applicant showed and discussed a flow diagram for the SWMS, which can be found in the transcripts for this meeting. They also stated that the SWMS meets the regulations.

The applicant discussed the process effluent radiation monitoring and sampling systems (PERMS). The objective of the PERMS is to sample, measure, control, and record the radioactivity levels of selected process streams within the plant and effluent streams released into the environment. This is a non safety related system. Monitoring instruments are associated with the process systems, such as the LWMS discharge monitor located in the A/B, while sampling stations are distributed in low radiation areas in the A/B, the reactor building (R/B), and the access building (Ac/B).

The applicant discussed the following 5 open items related to Chapter 11:

- Provide liquid effluent and dose calculation package
- Provide reference to MUAP-10019P/NP Rev 0, in DCD and provide information on new approach to RATAF code input/output files for liquid tank failure analysis
- Submit calculation packages for the gaseous effluent releases and doses, and for the waste gas tank and charcoal bed leak analyses
- Revise the DCD to address charcoal bed combustion and ITAAC to address explosive monitoring

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- Identify compliance with IE Bulletin 80-10 in the PERMS design and state compliance in DCD Tier 2, Section 11.5

At the end of the presentation, the applicant provided a summary of the key features of the US-APWR radwaste system. The systems are designed to operate during all normal plant operating modes and after anticipated operational occurrences. The system designs include instrumentation to monitor and control releases of radioactive effluents. The systems are designed to meet liquid and gaseous discharge limits as well as dose rate limits.

Safety Evaluation Report with Open Items for Chapter 11, "Radioactive Waste Management Systems"

The NRC staff discussed an overview of the safety evaluation report (SER) with open items related to Chapter 11 of the US-APWR DCD.

The staff discussed Section 11.1, "Source Terms" of the SER with open items indicating that this section has no open items. The staff stated that the applicant followed the respective Standard Review Plan (SRP, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition") and Regulatory Guide (RG) 1.112. This section contains no combined license (COL) information items.

The staff discussed Section 11.2, "Liquid Waste Management System" of the SER with open items. The staff stated that the applicant complies with the respective regulations in 10 CFR Part 20, Part 50 and 10 CFR 20.1406. The applicant also conforms to RG 4.21 and 1.54. This section includes the following COL information items:

- Description of mobile and temporary radwaste processing equipment and interconnections to plant systems
- Release points, effluent temperature, shape of flow orifice, etc.
- Hydrological data and analysis that groundwater or surface water contamination comply with effluent concentration limits (ECLs) in 10 CFR Part 20, Appendix B, Table 2 for liquid tank failure
- Offsite liquid effluent doses comply with 10 CFR Part 20; 40 CFR Part 190 under 10 CFR 20.1301(e); and 10 CFR Part 50, Appendix I
- Implementation milestones for epoxy coatings program
- Cost-benefit analysis (CBA)
- Piping and instrumentation diagrams (P&IDs)

The staff discussed the following 2 open items in Section 11.2:

- Open Item 11.02-1: Provide calculation packages of liquid effluent releases (both normal and maximum releases) using the MHI PWR-GALE code and comparisons to the ECLs in 10 CFR Part 20, Appendix B, Table 2, Column 1; and liquid effluent doses using the LADTAP II code
- Open Item 11.02-2: Provide updated RATAF code files on the new approach for the liquid tank failure analysis described in MHI Technical Report MUAP-10019P/NP (R0)

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The staff discussed Section 11.3, “Gaseous Waste Management System” of the SER with open items. The staff stated that the applicant complies with the respective regulations in 10 CFR Part 20, Part 50 and 10 CFR 20.1406. This section includes the following COL information items:

- Onsite vent stack design parameters and release point characteristics
- Release points, effluent temperature, shape of flow orifice, etc.
- Offsite gaseous effluent doses comply with 10 CFR Part 20; 40 CFR Part 190 under 10 CFR 20.1301(e); and 10 CFR Part 50, Appendix I
- CBA
- P&IDs

The staff discussed the following 2 open items in Section 11.3:

- Open Item 11.03-1: Provide calculation packages of gaseous effluent releases (normal and maximum releases) using the MHI PWR-GALE code and ECL comparisons of 10 CFR Part 20, Appendix B, Table 2, Column 1; gaseous effluent doses using the GASPAR II code; waste gas surge tank leak; and charcoal bed analysis.
- Open Item 11.03-2: Provide ITAAC to address explosive monitoring in the GWMS design.

The staff discussed Section 11.4, “Solid Waste Management System” of the SER with open items indicating that this section has no open items. The staff stated that the applicant complies with 10 CFR 61.55, 61.56 and 20.1406. The DCD adopts the Nuclear Energy Institute (NEI) process control program (PCP) template 07-10A until a plant-specific PCP is developed to support plant operation. The staff also stated that the applicant conforms to RGs 1.54 and 4.21. This section includes the following COL information items:

- Onsite radioactive waste storage
- PCP and implementation milestones
- Mobile/portable SWMS connections and other non-radioactive systems that may become contaminated and related operational procedures
- Offsite laundry services or mobile compaction unit subsystem
- CBA (addressed in DCD Sections 11.2 and 11.3)
- Contract services or compaction equipment for solid waste
- P&IDs
- Mobile and temporary solid radioactive waste processing and interconnection to plant systems comply with 10 CFR 50.34a; 10 CFR 20.1406; and RG 1.143

The staff discussed Section 11.5, “Process Effluent Radiation Monitoring and Sampling Systems” of the SER with open items. The staff stated that the applicant complies with the respective regulations in 10 CFR Part 20, Part 50 and 10 CFR 20.1406. The DCD adopts NEI Offsite Dose Calculation Manual (ODCM) template 07-09A until a plant and site-specific ODCM is developed to support plant operation. The staff also stated that the applicant conforms to RG

1.45 and ANSI N42.18-2004, and primary-to-secondary leakage detection conforms to NEI 97-06 for technical specifications basis. This section includes the following COL information items:

- Site-specific aspects of PERMS beyond the standard design in accordance with RG 1.12, RG 1.33, and RG 1.45; and comply with 10 CFR Part 50, Appendix I for offsite doses from liquid and gaseous effluent streams
- ODCM with description of methods and parameters for radiation monitor setpoints and follow NEI ODCM template 07-09A
- Develop radiological environmental monitoring program (REMP) and follow NUREG-1301, NUREG-0133, NEI ODCM template 07-09A
- Procedures related to radiation monitoring instruments
- Analytical procedures and sensitivity for radioanalytical methods and sampling media type
- CBA (addressed in DCD Sections 11.2 and 11.3)

The staff discussed the following open item in Section 11.5:

- Open Item 11.05-1: Provide supporting information to describe the provisions to avoid unmonitored releases and uncontrolled radioactive releases to the environment.

At the end of their presentation, the staff stated that resolution of the open items is expected in Phase 4 of DCD review.

Subcommittee Questions on DCD Chapter 11

Subcommittee Members raised the following questions that will be addressed by the applicant or the staff during future meetings on related topics.

- What is the typical volume of spent resin disposal from operating plants that use only demineralizers for all liquid waste processing streams?
- What are the connections from the pressurizer vent and reactor vessel head vent lines to the gaseous waste processing system (i.e., for RCS degassing)?
- Does the certified design provide an integrated process sampling data management program that includes online sampling, manual sampling, trending, decisions, etc.?

US-APWR DCD Chapter 12, “Radiation Protection”

MHI discussed an overview of what is included in Chapter 12 of their DCD.

The applicant discussed DCD Section 12.1, “Ensuring that Occupational Radiation Exposures are as Low as Reasonably Achievable (ALARA).” They stated that the equipment shielding and facility layout are designed with consideration of ALARA criteria to reduce radiation levels and to minimize personnel exposure.

The applicant discussed DCD Section 12.2, “Radiation Sources.” They stated that for the contained sources, Nitrogen-16 (N-16) is the predominant activity in the reactor coolant system (RCS) and the very short half-life is included in the evaluation of N-16 activity in each

component. The airborne sources are primarily from the RCS, spent fuel pit, and refueling cavity water based on assumed constant leakage/evaporation. The applicant identified the following COL items: identification of additional sources not already listed, radiation protection for additional radwaste storage, and refueling water storage auxiliary tank (RWSAT) and primary makeup water tanks (PMWTs) dose rates compliance and radioactivity concentration controls.

The applicant discussed DCD Section 12.3, "Radiation Protection Design Features." MHI discussed the following design features: the RCS components are designed for remote inspection and easy replacement to reduce maintenance time; radioactive components are in cubicles with sufficient wall thicknesses to reduce radiation level in surrounding areas; and features built into the design comply with RG 4.21. They also discussed the shielding and ventilation designs. For the shielding design, the applicant stated that the reactor system design includes primary and secondary shields, the shielding is designed assuming maximum postulated radiation levels, and the design considers the use of removable sections of block shield walls for equipment maintenance. For the ventilation design, they stated that the air flows from low to higher contamination areas, containment ventilation flows through high-efficiency particulate air filters for contamination removal, and the control room is designed to minimize uncontrolled in-leakage in the event of an accident. The area radiation and airborne radioactivity monitoring instrumentation design provides indication of plant radiological conditions to ensure radiation exposure is ALARA, complies with RGs 1.21, 1.97, 8.2, 8.8 and conforms with ANSI/ANS HPSSC-6.8.1. The applicant identified the following COL items: portable instrumentation for airborne iodine concentrations during accidents, site-specific radiation zones, administrative and access controls for fuel transfer tube areas, radiological considerations for mobile LWMS installation, boric acid evaporator room controls to prevent very high radiation area, and site-specific RG 4.21 compliance issues.

The applicant discussed DCD Section 12.4, "Dose Assessment." MHI stated that the dose assessments are calculated based on RG 8.19 and the total annual station exposure is about 71 person-rem, which is less than the 100 person-rem value provided in NUREG-0713. The dose assessment values can be found in DCD Section 12.4 tables.

The applicant discussed DCD Section 12.5, "Operational Radiation Protection Program." MHI stated that this program is for ensuring that occupational radiation exposures are ALARA and is identified as a COL Item.

The applicant discussed the following open items related to Chapter 12 with their respective proposed response:

- Open Item 12.02-1: MHI revised Section 9.3.4.1.2.3 to indicate that the CVCS can provide purification rates up to 400 gpm when using the RHRS for letdown cooling during shutdown without explaining how the 110-180 gpm design for the CVCS demineralizers can accommodate the 400 gpm flow rate.
    - Proposed response: During shutdown purification operation, the CVCS filters and demineralizers are aligned as two parallel trains to accommodate the higher flow. The filters and demineralizers are designed with sufficient margins and are capable of handling the higher flow. It is anticipated that the higher flow condition is short term (about two days).

- Open Item 12.02-2: The DCD should include the design features of the Tank House enclosure for the PMWT and RWSAT, including the ventilation controls and effluent monitoring for the area.
    - Proposed response: MHI responded in September, 2010, but additional information may be required in the DCD.
- Open Item 12.03-12.04-1: Insufficient data and description of mission pathways on radiation exposure associated with repair, recalibration, and replacement of qualified instruments following an accident.
    - Proposed response: MHI provided the additional data in the response including a revision to DCD Table 3D-2, Table 12.3-10 (Mission Doses for Access Areas and Access Route: 1 Week after an Accident) and Figure 12.3-11 (Post Accident Radiation Map: 1 Week after an Accident), and these revisions are included in DCD Revision 3.
- Open Item 12.03-12.04-2: Insufficient data on doses during transferring spent fuel in the event of a postulated rapid refueling cavity drain, and the justification for continued use of Fuel Drop Accident Analysis method.
    - MHI action: MHI amended the response and will discuss with NRC staff
- Open Items 12.03-12.04-3 &12.03-12.04-4: Insufficient description of design features provided to demonstrate compliance with 10 CFR 20.1406
    - MHI action: Amended response is currently in final review cycle for submittal. The amended response includes the information outlined in this presentation earlier.

MHI provided an overview of the confirmatory items in this chapter. The confirmatory items are responses for which the staff has preliminarily accepted MHI's proposed closure of the issue identified in the RAI, subject to confirmation of inclusion in a future revision of the US-APWR DCD. The applicant confirmed that the RAI response information has been included in DCD Revision 3 issued at the end of March 2011.

At the end of their presentation, MHI provided a summary indicating that for Chapter 12, policy considerations, design considerations, radiation sources, and radiation protection design features ensure that occupational exposures are ALARA; radiation protection design complies with 10 CFR Parts 20 and 50 for normal operation/shutdown and design basis post-accident actions; and dose assessment for occupational exposures and design basis post-accident actions meet NRC's general requirements and/or 10 CFR 50.34.

Safety Evaluation Report with Open Items for Chapter 12, "Radiation Protection"

The NRC staff discussed an overview of the SER with open items related to Chapter 12 of the US-APWR DCD.

The staff discussed Section 12.1, "Ensuring that Occupational Exposures are ALARA" of the SER with open items indicating that this section has no open items. The staff reviewed the ALARA considerations, including training on ALARA processes, lessons learned and regulatory guidance. In order to comply with the requirements of 10 CFR Part 20, the COL information

items require the COL applicant to conform to the operational radiation protection and ALARA regulatory guides. This Section specified that these programs are to be designed, developed, implemented and maintained as described in NEI templates NEI 07-03A (radiation protection program) and NEI 07-08A (ALARA).

The staff discussed Section 12.2, "Radiation Sources." In this section, the staff indicated that they reviewed the contained and airborne radioactivity sources that were used as inputs for the shielding and ventilation designs. The staff requested information on source strengths for the RCS, spent fuel, the boron recycle system and the in-core instrument system. As a result of the staff's questions about the potential effects of concentrating activity in the water from the RCS on component dose rates, the applicant added a COL item to require a surveillance to prevent the boric acid evaporators from becoming a very high radiation area (VHRA) near the end of core life. The staff asked the applicant about assumed purification system flow rates that appear to exceed the design capacity of some of the chemical and volume control system components. The staff is working with the applicant to clarify the appropriate flow rates for the stated purification flow paths, and is tracking this as Open Item 12.02-1. This section also describes airborne sources.

The staff discussed Section 12.3-4, "Radiation Protection Design Features." The staff stated that the use of low-cobalt materials and other design features that prevent buildup of radioactive materials is an effective method for reducing personnel exposures. The staff performed calculations confirming that the expected cobalt introduction rates from major system components were consistent with current industry guidance. The staff also stated that the applicant performed a shielding analysis using one percent fuel cladding defects as a basis to determine the radiation zones in the plant and to ensure adequate shielding. The staff performed independent shielding calculations for various areas, including spent resin storage tank, spent fuel transfer tube to gate valve reach rod, and the boric acid evaporators. As a result of the staff's questions, the applicant added the following COL items: 1) to verify shielding design for mobile liquid waste processing system, and 2) to limit activity concentration in the boric acid evaporators.

Regarding the refueling cavity, the staff asked the applicant to describe the potential sources of radiation located in the refueling cavity, safe storage locations for fuel bundles outside the reactor vessel when the refueling cavity water level is at the minimum possible level, and the resultant potential dose rates. This is being tracked as Open Item 12.03-04-2.

Regarding the area radiation monitors (ARMs) the staff asked the applicant to provide additional information about some areas of the plant without installed ARMs, which are subject to potentially significant changes in dose rates due to operational, transient or maintenance activities. The applicant stated that the location of one ARM would be changed, and that the use of portable ARM equipment would be required in some areas like the cask handling area and the refueling platform. They also stated that the setpoint determination methodology described in DCD Section 7.2.2.7 would be used to establish installed radiation monitor calibration intervals and setpoints.

The staff stated that they reviewed the application for compliance with 10 CFR 20.1406, which requires the description of design features and program elements provided to minimize contamination of the facility environment and to facilitate eventual decommissioning. The staff

is continuing to work with the applicant to resolve Open Items 12.03-12.04-3 and 12.03-12.04-4 involving design features for the condensate system, the steam generator blowdown system, and the auxiliary steam system.

In this section, the applicant documented the results of a dose assessment that projected a total annual plant-level exposure of about 71 person-rem. This assessment was based on current reactor operating experience and the US-APWR's ALARA design considerations. The staff stated that NUREG-0713 contains an annual compilation of exposures from power plants of all types across the US. This document provides the average and the median collective radiation exposures. For the year that was compared (2005), the average collective dose for PWRs was 79 person-rem, and the median collective dose was 64 person-rem.

The staff also discussed Open item 12.03-04-1. This item is tracking information provided in the US-APWR DCD Section 3.11, "Equipment Qualification," which indicates the need for additional post accident personnel missions not described in Section 12.4 and adjustment of projected doses.

At the end, the staff discussed Section 12.5, "Operational Radiation." This section has no open items. In the Section, the applicant provided a list of program features that will be required from the COL applicant. They include the use of NEI 07-03A and NEI 07-08A, the radiation protection and ALARA program templates, which are approved by the NRC.

Subcommittee Questions on DCD Chapter 12

Subcommittee Members raised the following questions that will be addressed by the applicant or the staff during future meetings on related topics.

- Do features of the design support possible future revisions to US worker dose standards to be more consistent with internationally applied limits?
- Does the certified design explicitly include zinc injection?
- What is the operating experience for worker doses at operating PWRs that use zinc injection, vs. PWRs that do not?
- Does the certified design have specific limitations on the use of cobalt?
- How is the plant-level collective dose of approximately 71 Rem per year apportioned among individual workers who receive that dose (i.e., what is the average annual individual worker dose)?
- What COLA information is contained in the DCD regarding specific design features of the liquid waste effluent discharge piping (in particular, protection against leaks, dection and collection of leakage, etc.)?

Gas Turbine Generators Interim Staff Guidance DC/COL-ISG-021

This topic was included in this meeting to complete the Subcommittee's review of issues pertaining to the gas turbine generator (GTG) test programs and reliability estimates, which were not covered during the Subcommittee's review of DCD Chapter 8.

The staff provided an overview of the Interim Staff Guidance DC/COL-ISG-021, "Review of Nuclear Power Plant Designs using a Gas Turbine Driven Standby Emergency Alternating Current Power System." The US-APWR design certification uses gas turbine generators (GTG) as emergency power sources. The staff developed this guidance in parallel with the US-APWR review, since the most current regulatory guidance applies specifically to emergency diesel generators (EDGs). The most current guidance includes the SRP and RG 1.9, "Application and Testing of Safety-related Diesel Generators in Nuclear Power Plants." This interim guidance does not change the existing regulatory guidance; it supplements these documents to provide guidance on GTG.

DC/COL-ISG–021 contains the following 8 articles. The staff stated that the following articles will be incorporated into the next revision of the RG and the SRP update:

- Article 1: Introduction
- Article 2: Application and Testing of GTG (RG 1.9)
- Article 3: AC Power Systems (SRP 8.3.1)
- Article 4: Fuel Oil Storage and Transfer (SRP 9.5.4)
- Article 5: GTG Cooling Water (SRP 9.5.5)
- Article 6: GTG Start System (SRP 9.5.6)
- Article 7: GTG Lubrication System (SRP 9.5.7)
- Article 8: GTG Air Intake and Exhaust (SRP 9.5.8)

The staff stated that during the public comments period, they received 30 comments from the public regarding this guidance. Most of the comments were incorporated in the final version, with the exception of applicability of some of the standards, freeze/ice protection, vibration, and air receiver capacity for successive starts.

The staff concluded that since DC/COL-ISG-21 is guidance, the applicants can meet regulations using other design features as justified.

Gas Turbine Generator Qualification

The applicant discussed the result of the qualification of the gas turbine generator and the result of the seismic test. They stated that this gas turbine generator is a conventional gas turbine that has been modified.

1. Initial Type Test Program

The applicant stated that the class 1E GTG testing program was based on RG 1.9 (Application and Testing of Safety-related Diesel Generators), IEEE 387-1995 (Standard Criteria for diesel Generator Units Applied as Standby Power Supplies) and DC/COL-ISG-021. The applicant showed a figure, which can be found in the transcripts for this meeting, identifying with a red box the systems that are included in the test. The GTG specifications include a continuous rating of 4500 kW (5625 kVA), a power factor of 0.8, an output of 6900 volts. The start time is less than 100 seconds and the limiting load is a coincident loss of offsite power (LOOP) and a loss of coolant accident (LOCA).

The applicant discussed the GTG initial type tests, all based on IEEE 387. The load capability test demonstrates the capability to carry rated load. The start and load acceptance test establishes the capability to start and accept load within the required time period. The margin test demonstrates the capability to carry the most severe load step + 10%. A schedule for each test was showed by the applicant.

2. Initial Type Test Results

Load Capability Test: The purpose of the test is to demonstrate the capability to carry the continuous rated load and successfully reject a short time rated load without tripping. The scope of the test was to apply continuous rated load until the temperatures stabilize. They then increased the load to 110% of rated conditions and performed a two-hour run at that short time rating, following by a 22-hour run at rated load. Then, they did a short time load rejection. The basic acceptance criteria were to supply the load while maintaining normal operating parameters. The short time load rejection test should be able to reject a short time load without having an overspeed trip. The applicant showed their results stating that the engine lubricant oil temperature remained stable and that the engine exhaust gas temperature (EGT) depends on output power and ambient temperature. Variations in EGT showed the expected pattern. As a conclusion, the applicant stated that the GTG successfully completed 24 hour operation with stable nominal expected engine parameters, and that the GTG successfully rejected the short time rated load without tripping.

Start and Load Acceptance Test: The purpose of the test is to establish the capability of the unit to start and accept load within the period of time necessary to satisfy the plant design requirements. The scope is based on DC/COL-ISG-021 and is to demonstrate 95% confidence of achieving at least 95% reliability. The acceptance criteria are to successfully complete 150 starts without a start failure, to be able to accept load within 100 seconds, and to accept a single step load of $\geq$ 50% of continuous rated power. The applicant showed the test results: 20 successful starts at ambient conditions (cold starts) with an average time to accept load of 26.6 seconds, and 131 successful starts at normal operating conditions (hot starts) with an average time to accept load of 28 seconds. All starts demonstrated a time to accept load of less than 30 seconds, and more than 50% of rated load was applied to each start.

Margin Test: The purpose of this test is to demonstrate the capability to accept the most severe load step +10%. The test is conducted applying a pre-load (a running load prior to the most severe step), then in a single step addition, a margin load is added that is 110% of the most severe load in the duty cycle for the machine. The acceptance criterion is to successfully accept the margin load step and recover to nominal values. The results showed that the voltage returned to normal quickly, the frequency recovered quickly and that the engine did not trip and returned to stable operation. The test successfully accepted the margin load.

Load Transient Test: This test is not required by DC/COL-ISG-21. The purpose of this test is to determine GTG response to large load addition and rejection transients. The scope is to monitor voltage and frequency response to step load additions and load rejections of 25%, 50%, 75%, and 100% of rated load. The results showed that the GTG returned to nominal voltage and frequency quickly and that the voltage and frequency responses were as expected.

CLOSED SESSION – PROPRIETARY INFORMATION

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Subcommittee Questions on GTG Reliability Estimates

Subcommittee Members raised the following questions that will be addressed by the applicant or the staff during future meetings on related topics.

- How do the gas turbine control systems ensure stable load sharing between the two engines in each GTG set and prevent unstable control oscillations?
- The GTG starting reliability estimates do not include failures of the generator output circuit breaker, which are included in the EDG data. How would the estimated GTG starting reliability compare with the EDG data, if failures of the GTG generator output circuit breaker were included?