REQUEST FOR ADDITIONAL INFORMATION 524-4020 REVISION 1

1/26/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 12.03-12.04 - Radiation Protection Design Features
Application Section: 12.3

QUESTIONS for Health Physics Branch (CHPB)

12.03-12.04-33

RAI 428-2910, Question 12.03-12.04-22 (a supplemental question derived from RAI 171-1858, Question 12.03-12.04-9 and RAI 172-1864, Question 12.03-12.04-10), requested additional information about the radiation protection features associated with the additional penetrations in shield walls located in some of the piping areas depicted in Figure 12.3-1 included in the response to RAI 172-1864. In their response, the applicant noted that some resin transfer lines ran through areas that were contiguous with areas containing valves. The piping rooms were assigned Radiation Zone IX $\leq$ 500 rad/h. However, confirmatory calculations performed by the NRC staff using some of the isotopic concentrations provided in FSAR Tier 2 Table 12.2-17 indicate that dose rates could exceed 500 rad/h at one meter from a 2" pipe 90 degree elbow containing resin, even after a year of decay in the mixed bed vessel. The NRC staff requires additional information to be able to confirm the applicant's conclusion that dose rates in the piping areas will remain $\leq$ 500 rad/h during resin transfers.

The applicant should provide information regarding the analytical code used to evaluate the dose rates in areas traversed by resin lines, the assumptions and input parameters used to determine the area dose rates due to pipes containing resin described in the response to RAI 428-2910.

12.03-12.04-34

RAI 428-2910, Question 12.02-24 (a supplemental question derived from RAI 147-1850, Questions 12.03-12.04-4), requested additional information about specifications for allowable cobalt impurity levels. The applicant's response to this question indicated that the MHI specifications are compliant with the recommendations in industry guidance documents (EPRI TR-1003390 "Radiation Field Control Manual"). However, while EPRI TR-1003390 notes that cobalt impurity levels should be less than 500 ppm in stainless steels and less that 200 ppm in Inconels, Table 12.3-7 contains the following cobalt content limits which exceed these values:

- Inconel and stainless steel components in fuel assemblies 0.05 w% (500 ppm) vs. 200 ppm for Inconels
- Upper core plate, Upper/lower core support plate, lower core barrel 0.10 w% (1000 ppm)
- Main Coolant Piping, casings and internals of Rector Coolant Pumps and Reactor Internals other than listed above 0.20 w% (2000 ppm)

The applicant should revise and update the USAPWR DCD Tier 2 Sections 12.2 to provide cobalt content limits consistent with industry recommendations, or provide the specific alternative approaches used and the associated justification.

12.03-12.04-35

RAI 262-1972, Question 12.03-12.03-17, Item 8816-Q6 requested additional information about the radiation protection features associated with an inadvertent rapid drain down of the refueling cavity.

In the response to Item 8816-Q6, the applicant indicated that:

- There are a number of fill and drain lines in the refueling cavity administratively locked closed prior to fuel movement. However, a review of US-APWR FSAR Tier 2 Chapters 5, 9 and 16, failed to show any requirement to have fill/drain lines for the refueling cavity locked shut, or any requirement to have two barriers preventing inadvertent drain down through these flow paths.
- A water level alarm would detect a decrease in the refueling cavity water level. However, US-APWR FSAR Tier 2 Chapters 5, 7 and 9 do not mention a Refueling Cavity Level alarm. This implies a reliance on the SFP level alarm. Since there are no physical constraints preventing closing the SFP weir gate, the SFP level alarm may not be able to monitor the Refueling Cavity level under all conditions where fuel is out of the reactor vessel in the refueling cavity. In addition, there are no requirements in Technical Specifications 3.7.12 “Fuel Storage Pit Water Level” or 3.9.7 “Refueling Operations Water Level” to have the SFP Weir Gate open while fuel is out of the reactor vessel in the refueling cavity, or for the SFP Level alarm to be operable.
- If a drain down event were to occur, then water would be added to the RC system to maintain level. However, insufficient information is available to demonstrate that sufficient water would be available for shielding and cooling during a rapid cavity drain down event.

Background

GDC 61 requires that the fuel storage and transfer system be designed to ensure adequate safety and shielding, as well as be designed to prevent the release of radioactive material during normal and accident conditions.

Generic Safety Issue 137 (GSI-137) “Refueling Cavity Seal Failure” was initiated to consider a Reactor Cavity Seal Ring failure as an initiating event for a Spent Fuel Pool accident sequence (see NRC Bulletin 84-03). GSI-137 noted the following possible consequences to a reactor cavity seal ring failure;

(1) high radiation levels in the containment due to uncovering of spent fuel in transfer;
(2) radioactive material release in the containment building due to rupture of fuel pins (by self-heating after uncovering);
(3) high radiation levels in the spent fuel building due to uncovering of stored spent fuel; and
(4) radioactive material release outside the containment building due to rupture of fuel pins in the storage pool.

While the installation of permanent seal rings between the reactor vessel and the refueling cavity wall, and the installation of cofferdams between the refueling cavity and the spent fuel pool precluded draining of the SFP, it did not specifically address exposure of fuel bundles in the refueling cavity.

In their response to NRC Bulletin 84-03, "Refueling Cavity Water Seal," a number of licensees indicated that if a large seal leak occurred, the refueling cavity could drain rapidly and therefore, the procedures and makeup capability for refilling the refueling cavity would be insufficient to prevent drainage. In anticipation of such an event, the licensees developed an abnormal procedure for safely storing a fuel assembly were one positioned above the vessel flange level during a loss of the refueling cavity water.

Information Notice No. 92-25 "Potential Weakness in Licensee Procedures for a Loss of the Refueling Cavity Water", noted an event where improper movement of the reactor lower internals package resulted in damage to cavity components. The Information Notice noted that under slightly different circumstances, the event could have resulted in a rapid drainage of the Refueling Cavity. Information Notice 84-93 “Potential Loss of Water from the Refueling Cavity” noted that a variety of events might result in loss of water from the refueling cavity. INPO SOER 85-1 “Reactor Cavity Seal Failure” and NUREG 1449 “Shutdown and Low-Power Operation at Commercial Nuclear Power Plants in the United States” noted a number of events, besides Refueling Cavity (RC) seal failure that can result in cavity drain down events. Industry experience has shown that valve positioning errors, and problems with freeze seals failures have resulted in significant events. Information Notice 87-13 noted that in the event of a rapid refueling cavity drain down event, high dose rates might result from loss of shielding from around irradiated core components, other than fuel, stored in the refueling cavity.

Therefore, in order to adequately address operating experience considerations and in accordance with the requirement specified by 10 CFR 52.47(a)(22), the following additional information is required:

1. Identify any locations in the Refueling Cavity, where more than one fuel bundle, including any in transit, may be out of the reactor vessel in the Refueling Cavity.
2. Provide information on each location in the refueling cavity, where a licensee could safely store a spent fuel assembly should the reactor cavity undergo inadvertent rapid drain down while one or more fuel bundles were out of the reactor vessel in the refueling cavity.
3. For the identified safe storage areas, where the water level at the lowest point following the drain down event is less than 10 feet above the fuel bundles that are out of the reactor vessel, provide the estimated dose rates, and the associated methods, models and assumptions for determining the dose rates.
4. If the volume of water in the safe storage area is less than the amount to needed to ensure complete coverage of the fuel bundle for the time allotted for ensuring containment closure, then justify the continued use of the Fuel Drop Accident Analysis methodology described in RG 1.183 Appendix B.
5. describe and provide the estimated dose rates, from any other irradiated components, that may be exposed during an inadvertent refueling cavity drain down event

12.03-12.04-36

10 CFR 20.1101(b), 10 CFR 20.1406(b) require licensees to describe design feature to maintain Occupational Radiation Exposure(ORE) ALARA, reduce contamination of the facility, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. 10 CFR 52.47 requires applications to include information describing how operating experience has been incorporated into the design. SRP Section 12.3-4 Acceptance Criteria and Regulatory Guides 8.8 and 4.21, provide guidance for meeting the requirements of 10 CFR 20.1001 and 10 CFR 20.1406 while Regulatory Guide 1.206 sections C.I.5.4 and C.I.9.3 note that applicants should discuss system reliability considerations.

US-APWR Tier 2 FSAR section 12.3.1.1 “Plant Design Features for As Low As Reasonably Achievable” discusses some design features intended to reduce radiation exposure. In addition, a number of these design features can reduce corrosion, and improve component availability so that system and unit reliability is improved. A number of industry standard documents, notably those provided by the Electric Power Research Institute (EPRI) describe changes to previous design practices shown to be erroneous or which represent improvements over previous practices. A number of the design features described in US-APWR FSAR Tier 2 Sections 5, 9.3 and 12.3.1, intended to improve component reliability or reduce radiation exposure, are inconsistent with current operating experience or are incomplete. Examples include:

- Some of the specifications provided for valves are not consistent with current industry recommendations for valve reliability or leakage reduction and in some cases may be counter productive.
    - § Metallic bellows and diaphragms produce a hermetic seal that results in the lowest achievable leak rates, but they are limited to low-stroke length applications. Industry experience has shown that these bellows will crack and leak when installed on valves subject to frequent movement, such as fine control valves (e.g. Pressurizer spray valves).
    - § Fully engineered packing sets, valve stem material and finish specifications, and the use of Live Load packing on critical valves, and valves subject to thermal tapering, are methods that improve valve reliability and reduce leakage.
    - § Industry documents note that some important design considerations for check valve reliability are:
        - proper sizing to reduce flutter related wear during the most frequent use conditions rather than maximum flow conditions,
        - reducing turbulence prior to the check valve,
        - the proper identification of the severity of the valve duty (i.e. high-pressure drop).
        - More frequent inspections for some types of check valves that are subject to severe conditions.
- Industry experience has shown that some of the specifications provided for pumps are not consistent with current industry recommendations for pump reliability or leakage reduction and in some cases may be counter productive.
    - § Material selection and finishing specifications, such as electropolishing followed by the application of stabilized chrome coating, effectively reduce material deposition and increase pump efficiency.

§ Elimination of cobalt containing Hard Facing alloys in pumps such as Reactor Coolant Pumps have reduced the accumulation of activated corrosion products at some plants.

§ Some plants have improved pump seal reliability by improving pump specifications:

· Specifying the use of seal design features that enhance sealing surface lubrication improves cooling and reduces leaks and failures.

· The use of Seal cartridges, which are pre-assembled mechanical face seal assemblies that contain all of the essential components simplify maintenance and eliminate installation related failures.

· Initial pump specification should include the use of seal cartridge packages, because retrofitting mechanical seal packages into pumps designed to accept conventional packing, limits the fluid circulation around the seal, and results in frequent leaks and seal maintenance.

· Some of the specifications provided for piping are not consistent with current industry recommendations for reducing facility contamination and dose rates.

- Some plants have additional material specifications related to the use of O-ring-type pipe caps and O-ring face seal fittings, which allow easy access by operators and eliminate subsequent leaks. Seals and fittings, that develop a positive seal with minimal effort and are not subject to wear with repeated assembly.

§ A number of plants have installed fitting and connections to facilitate hydrolasing of sections of system piping that are especially prone to radioactive material deposition, like portions of the RHR, CVCS let down, CVCS Spray and Safety Injection.

§ Preconditioning of surfaces by means like electro-polishing and application of stabilized chrome pre-coatings can significantly reduce material deposition in specific sections of piping, such as parts of the PWR spray lines and sections of RCS Letdown lines, that accumulate significant deposits of radioactive material. These design features are particularly cost effective for when used for local applications.

· Industry experience has shown that sludge and the liquid inputs to liquid and solids collection tanks contain chemical impurities that can attack tank welds and wall thickness, which may result in tank failure.

§ The use of isolation valves and flushing points allows for the removal of sludge in pipes and lines, thus reducing the risk of component failure.

§ The use of internal spray or sparging components and the availability for recirculation reduces the accumulation of internal sedimentation

§ Industry experience indicates that some specific valves, like Pressurizer Spray Control valves, Letdown Control valves and RCS loop interface check valves can accumulate significant deposits of radioactive material, if not polished and/or pre-treated.

Please revise the US-APWR Tier 2 Sections 5, 9 and 12, to update the description of the design features provided for improving facility reliability, minimizing facility contamination and reducing personnel exposure to be consistent with current industry experience and practices, or provide the specific approaches used and the associated justification.