MITSUBISHI HEAVY INDUSTRIES, LTD.
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May 25, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09260

Subject: MHI's Responses to US-APWR DCD RAI No. 292-2232 Revision 1

Reference: [1] "Request for Additional Information No. 292-2232 Revision 1, SRP Section: 09.01.05 – Overhead Heavy Load Handling Systems - Design Certification and New License Applicants, Application Section: 9.1.5," dated March 26, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 292-2232 Revision 1".

Enclosure 1 is the response to 13 questions that are contained within Reference [1].

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

D081
NRO

Enclosures:

1. Responses to Request for Additional Information No. 292-2232 Revision 1

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-09260
Docket No. 52-021

Responses to Request for Additional Information No. 292-2232 Revision 1

May 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

05/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
SRP SECTION:	**09.01.05 – Overhead Heavy Load Handling System**
APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-01

SRP 9.1.5 indicates OHLHS "Overhead Heavy Load Handling Systems" consists of all components and equipment for moving all heavy loads at the plant site. The DCD "Design Control Document" only provides information on two single-failure proof cranes; spent fuel cask handling and polar cranes. DCD section 9.1.5.2 states that "other OHLHS equipment may include, but are not limited to, monorail type hoists, bridge cranes, and jib cranes." While reviewing the DCD the staff noticed that the essential service water pump pit cranes, listed in item 30 of Table 3.2-2 of the DCD, may be located near equipment important-to-safety, (the essential service water system is safety-related). However, the OHLHS was not discussed in DCD Section 9.1.5, and no information on the design of these cranes was included in the DCD.

Provide a complete list of all cranes of the OHLHS along with design details (i.e. single failure-proof, loads, location, seismic category, etc...) for OHLHS cranes located in areas throughout the plant where load drops could result in damage to SSC important-to-safety. Clearly identify whether or not the cranes are single-failure-proof in accordance with NUREG-0554. Include a list/description of all cranes/hoists in areas where there is nuclear fuel or SSC important-to-safety (i.e. a crane that could handle a critical load). In addition, clearly indicate in the DCD that the conditions of SRP section 9.1.5.III.4 are met for each crane that could handle a critical load. Provide a markup of the affected DCD section in your response.

ANSWER:

The DCD will be revised to add Table 9.1.5-3, "Cranes and Hoists Installed Over Safe Shutdown Equipment". Table 3.2-2 of the DCD will be revised accordingly, and section 3.8.1.1.2 of the DCD will also be revised to correct the description of the containment equipment hatch hoist. As discussed in the DCD and in the response to question RAI 9.1.5-02 of this RAI, the polar crane and spent fuel cask handling crane main hook are designed as single-failure-proof for handling critical loads, and therefore these cranes meet criterion III.4.C of SRP 9.1.5. Based on discussion provided further below, the DCD will be revised to indicate how the conditions of SRP section 9.1.5.III.4 are met for other cranes and hoists in Table 9.1.5-3 that handle heavy loads. Note that cranes and hoists in the A/B and T/B are not included in Table 9.1.5-3 because heavy loads handled in these buildings will not be over fuel assemblies or SSCs providing safe shutdown functions, and therefore will not be critical loads.

The essential service water pump pit cranes associated with the UHSRS are not included in the US-APWR standard plant design or in Table 9.1.5-3. These cranes may be temporary or mobile cranes, and their specific design and use is dependent on the configuration of the plant site and the design and configuration of the site-specific UHSRS. Therefore these cranes will be deleted from item 30 of Table 3.2-2 of the DCD and will be addressed as part of the COL Applicant's heavy load handling program. The COL Applicant's load handling program is further addressed in the response to question RAI 9.1.5-12 of this RAI. During the operating life of the plant, it is anticipated that temporarily installed hoists and mobile cranes will be used for plant maintenance. The heavy load handling program, and its associated administrative control procedures, will include temporary cranes and hoists. The heavy load handling program will adopt a defense-in-depth strategy to enhance safety when handling heavy loads. For instance, the program will restrict lift heights to practical minimums and limit lifting activities as much as practical to plant modes in which load drops have the smallest potential for adverse consequences, particularly when critical loads are being handled.

Except for the polar crane and spent fuel cask handling crane, the cranes and hoists listed in Table 9.1.5-3 are not designed as single-failure-proof. However, they are required to be designed as seismic Category II equipment to prevent unacceptable structural interaction and failure during an SSE event. The non-single-failure proof cranes and hoists in Table 9.1.5-3 satisfy the criteria of SRP 9.1.5.III.4 in the following manner:

- The non-single-failure-proof cranes and hoists in Table 9.1.5-3 are not located over or adjacent to fuel assemblies, with the exception of the containment equipment hatch hoist. The hatch hoist is controlled by heavy load handling procedures, such that the hatch is not handled when a postulated load drop could result in unacceptable consequences. Therefore, a load handling incident involving the non-single-failure-proof cranes and hoists would not impact fuel assemblies.

- The non-single-failure proof cranes and hoists are located over safe shutdown equipment, but the plant configuration provides redundancy by separation of the components to assure that the effects of a single load drop from these cranes and hoists would not jeopardize the ability to achieve or maintain safe shutdown conditions. The hoists associated with the safety injection pumps, CS/RHR pumps, EFW pumps, CCW Pumps, and CCW Heat Exchangers are all located on the basement slab of the R/B at floor elevation -26'-4", and each equipment train has its own room. Similarly, separation for other safe shutdown equipment serviced by non-single-failure proof cranes and hoists is achieved by walls, slabs, and/or adequate physical distance between adjacent equipment trains to assure that redundancy of safe shutdown functions is maintained in the case of a single load drop.

- The cranes and hoists other than the polar crane and spent fuel cask handling crane are dedicated to servicing particular pieces of safe shutdown equipment (such as pumps, valves, heat exchangers, and chillers) or systems that will be out-of-service when the cranes and hoists are used for handling heavy loads over them. The use of these cranes and hoists will be administratively controlled by load handling procedures to prevent overhead load handling that could cause unacceptable damage to the dedicated equipment or systems when in service.

Therefore, load handling incidents involving non-single-failure-proof cranes and hoists listed in Table 9.1.5-3 will not jeopardize safe shutdown functions or cause a significant release of radioactivity, a criticality accident, or inability to cool fuel.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- In the first paragraph of DCD Subsection 9.1.5.2, delete the following sentence:

"~~Other OHLHS equipment may include, but are not limited to, monorail type hoists, bridge cranes, and jib cranes.~~"

- Delete the following redundant statement from Subsection 9.1.5.2 of the DCD:

"~~The OHLHS exists in the R/B, specifically the fuel handling area and the PCCV of the R/B.~~"

- Add the following text at the end of the first paragraph in DCD Subsection 9.1.5.2:

"Other than the single-failure-proof OHLHS, miscellaneous hoists and cranes with heavy load capacities are installed in safety-related areas of the US-APWR plant. Descriptions and data for all cranes and hoists that have heavy load capacities and are installed over safe shutdown equipment are given in Table 9.1.5-3. The safety evaluations for those cranes and hoists are discussed in Subsection 9.1.5.3."

- Modify the first sentence of Subsection 9.1.5.2.1 as follows:

"The areas of the plant in which the spent fuel cask handling crane and polar crane operate are ~~physical arrangement of the heavy load handling system for stored fuel and safe shutdown equipment is~~ shown in Figures 9.1.5-1 through 9.1.5-4."

- Add the following discussion after the third bullet in Subsection 9.1.5.3:

"Except for the OHLHS polar crane and spent fuel cask handling crane, miscellaneous cranes and hoists with heavy load capacities as listed in Table 9.1.5-3 are not designed as single-failure-proof. However, they are designed as seismic category II equipment to prevent unacceptable structural interaction and failure during an SSE event. The non-single-failure proof cranes and hoists in Table 9.1.5-3 satisfy safety criteria for critical load handling evolutions in the following manner:

- The non-single-failure-proof cranes and hoists in Table 9.1.5-3 are not located over or adjacent to fuel assemblies, with the exception of the containment equipment hatch hoist. The hatch hoist is controlled by heavy load handling procedures, such that the hatch is not handled when a postulated load drop could result in unacceptable consequences. Therefore, a load handling incident involving the non-single-failure-proof cranes and hoists would not impact fuel assemblies.

- The non-single-failure proof cranes and hoists are located over safe shutdown equipment, but the plant configuration provides redundancy by separation of the components to assure that the effects of a single load drop from these cranes and hoists would not jeopardize the ability to achieve or maintain safe shutdown conditions. The hoists associated with the safety injection pumps, CS/RHR pumps, EFW pumps, CCW Pumps, and CCW Heat Exchangers are all located on the basement slab of the R/B at floor elevation -26'-4", and each equipment train has its own room. Similarly, separation for other safe shutdown equipment serviced by non-single-failure proof cranes and hoists is achieved by walls, slabs, and/or adequate physical distance between adjacent equipment trains to assure that redundancy of safe shutdown functions is maintained in the case of a single load drop.

- The non-single-failure proof cranes and hoists are dedicated to servicing particular pieces of safe shutdown equipment (such as pumps, valves, heat exchangers, and chillers) or systems that will be out-of-service when the cranes and hoists are used for handling heavy loads over them. The use of these cranes and hoists are administratively controlled by load handling procedures to prevent overhead load handling that could cause unacceptable damage to the dedicated equipment or systems when in service.

Therefore, load handling incidents involving non-single-failure-proof cranes and hoists listed in Table 9.1.5-3 will not jeopardize safe shutdown functions or cause a significant release of radioactivity, a criticality accident, or inability to cool fuel."

See Attachment 3 for a mark-up of changes to be made to DCD Tier 2, Revision 2, Table 3.2-2, to add reference to miscellaneous cranes and hoists discussed in this RAI response. Note that related changes to Table 3.2-2 are also made and discussed in the response to RAI 287-2041 Revision 1, question RAI 03.02.01-6.

See Attachment 6 for Table 9.1.5-3 to be added to Subsection 9.1.5 in Revision 2 of the DCD.

See Attachment 7 for a mark-up of DCD Tier 2, Subsection 3.8.1, Revision 2, changes to be incorporated:

- Revise the second paragraph of subsection 3.8.1.1.2 as follows:

  "A lifting rig with an electrically powered hoist is provided to disengage, raise ~~transport~~, and store the hatch in a secure position above ~~next to~~ the opening during outages. When required to seal the opening, the hatch is lowered ~~transported~~ back by hoist, repositioned, refastened, and pressure tested for leaks."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

05/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
SRP SECTION:	**09.01.05 – Overhead Heavy Load Handling System**
APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-02

DCD, Chapter 1, table 1.9.3-1, "Conformance with Generic Issues" (page 1.9-364) lists CMAA 70 or 74 as applicable to cranes handling critical loads and makes repeated reference to ASME NOG-1 Type 1 cranes. However in the design description of the OHLHS in DCD section 9.1.5 there is no discussion on whether the OHLHS design conforms with the criteria specified in CMAA 70, 2000, "Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes", and chapter 2-1 of ANSI/ASME B30.2-2005, "Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist", as recommended in SRP Section 9.1.5.III.3.F. Furthermore, ASME NOG-1 standard defines cranes classified into three types (I, II or III) depending upon crane location and usage of the crane at a nuclear facility. The DCD does not clearly identify the OHLHS cranes as NOG-1 Type I, II or III.

In addition, the DCD does not identify classification type for "Suspension Crane" on the spent fuel handling crane. In accordance with ASME NOG-1, section 6320(c), auxiliary hoists on a Type I crane shall meet the performance requirements of hoist for type II cranes. Confirm that the auxiliary cranes meet this requirement.

Confirm that OHLHS cranes will be designed to the criteria specified in CMAA-70-2000, "Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes" and Chapter 2-1 of ASME B30.2-2005, "Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist" as recommended in SRP Section 9.1.5.III.3.F. In addition, provide the ASME NOG-1 Type I, II, or III classification for all OHLHS cranes. Include this information in the DCD, identify which revision of the DCD it will be in, and provide a markup in your response.

ANSWER:

It is confirmed that the OHLHS cranes are designed to the criteria specified in CMAA-70-2000 and Chapter 2-1 of ASME B30.2-2005. CMAA-70-2000 will be discussed in Subsection 9.1.5 of the DCD and added as a reference to the DCD. The reference to CMAA-70-04 in Table 1.9.3-1 of the DCD will be changed to CMAA-70-00 to be consistent. A correction will also be made in the discussion of New Generic Issue #186 in Table 1.9.3-1 of the DCD to change the name of "Auxiliary Building Crane" to "Spent Fuel Cask Handling Crane".

The PCCV polar crane and the spent fuel cask handling crane main hook are designed as single-failure-proof in accordance with NUREG-0554 supplemented by ASME NOG-1 for a Type I crane.

The auxiliary hoist on the PCCV polar crane and the suspension hoist and auxiliary hoist on the spent fuel cask handling crane will not handle critical loads and single-failure-proof design is not required. However, they will meet the electrical performance requirements of Type II cranes in accordance with ASME NOG-1, section 6320 (c). Administrative control procedures will be used to assure that the auxiliary hoists of these cranes do not handle heavy loads that could have adverse consequences for nuclear safety. For example, administrative control procedures may prevent the polar crane auxiliary hoist from being used to handle a reactor coolant pump motor unless the containment is defueled, or other measures are taken assure there is no potential for jeopardizing nuclear safety in the case of a load drop.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- The second paragraph of Subsection 9.1.5.1 will revised as follows:

  "The OHLHS cranes are designed to the criteria specified in CMAA-70, 2000, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes (Ref. 9.1.7-25) and Chapter 2-1 of ASME B30.2-2005, Overhead and Gantry Cranes (Ref. 9.1.7-22). The ~~OHLHS is~~ PCCV polar crane and the spent fuel cask handling crane are also designed as ~~with~~ single-failure-proof ASME NOG-1 Type I cranes in accordance with NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, (Ref. 9.1.7-19) ~~using~~ and ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder) (Ref. 9.1.7-20), to handle the maximum critical loads for ~~based on~~ the areas in which these cranes operate ~~it is operating~~. Note that the suspension hoist of the spent fuel cask handling crane and auxiliary hoists on these cranes will not handle critical loads and are not designed as single-failure-proof. However, they meet the electrical performance requirements of Type II cranes as required by Section 6320 (c) of ASME NOG-1."

- Add the following after the last sentence in the third bullet of Subsection 9.1.5.3:

  "Administrative control procedures are also required to be used to assure that the auxiliary hoists of these cranes do not handle heavy loads that could have adverse consequences for nuclear safety. For example, administrative control procedures may prevent the polar crane auxiliary hoist from being used to handle a reactor coolant pump motor unless the containment is defueled, or other measures are taken to assure there is no potential for jeopardizing nuclear safety in the case of a load drop."

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.7, Revision 2, changes to be incorporated:

- Add the following reference:

  "9.1.7-25 Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes. CMAA Specification No. 70, 2000, Crane Manufacturers Association of America, Inc."

See Attachment 2 for a mark-up of DCD Tier 2, Subsection 1.9.3, Revision 2, changes to be incorporated:

- For New Generic Issue #186 in Table 1.9.3-1, change the "Status/Discussion" column in two places to reference CMAA-70-2000 as follows:

"Cranes that may be used to handle critical loads over SC-I SSCs, are classified as Type I cranes as defined per ASME NOG-1-2004, and will conform to the applicable requirements of that standard as well as the Crane Manufacturers Association of America (CMAA) Specification No. 70-00."

"Cranes that handle critical loads as well as non-critical loads will conform to the applicable requirements of ASME NOG-1-2004, and CMAA Specification No. 70-00 or CMAA Specification No. 74-04, for their applicable lifts."

Note that ASME NOG-1-2004 is cited in the above text as addressed in the response to question RAI 9.1.5-07 of this RAI.

- For New Generic Issue #186 in Table 1.9.3-1, change the first two sentences of the fourth bullet of the "Status/Discussion column to:

  "Spent Fuel Cask Handling Crane - The spent fuel cask handling crane is an overhead traveling crane designed to safely and securely transfer the fresh fuel transport container, spent fuel transport packaging, and fresh fuel. The spent fuel cask handling crane is also designed so that it never falls, including during the earthquake event."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

05/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
SRP SECTION:	**09.01.05 – Overhead Heavy Load Handling System**
APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-03

Section 2.5 of NUREG-0554 specifies that single failure proof cranes are to be designed to retain control of and hold the load during an SSE. DCD Section 9.1.5.2 indicates the OHLHS is designed to seismic category II and thus meet the guidelines of Regulatory Position C.2.of RG 1.29. Although DCD states that the OHLHS are seismic category II, the DCD does not address the OHLHS designs compliance with Section 2.5 of NUREG-0554. Discuss capability of all OHLHS cranes (including non-single failure-proof) to continue to hold their maximum load during an SSE. Include this information in the DCD, identify which revision of the DCD it will be in, and provide a markup in your response.

ANSWER:

The polar crane in the PCCV and the spent fuel cask handling crane in the fuel handling area are designed in accordance with NUREG-0554 and ASME NOG-1 for a Type I single-failure-proof crane. Therefore these single-failure-proof cranes are designed to continue to hold their maximum load during an SSE. DCD Revision 2 will be revised to add this clarification. Section 2.5 of NUREG-0554 applies to single-failure proof cranes that handle critical loads. Note that the auxiliary hoist on the PCCV polar crane and the suspension hoist and auxiliary hoist on the spent fuel cask handling crane will not handle critical loads and single-failure-proof design is not required for those hoists - see also the response to question RAI 9.1.5-02 for related discussion. Considerations for other cranes and hoists that are not single-failure proof are addressed in response to RAI 9.1.5-01.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- The following sentenced will be added as the second and third sentences in the first paragraph of subsection 9.1.5.2:

  "The spent fuel cask handling crane and the polar crane are designed in accordance with the provisions of NUREG-0554 and ASME NOG-1 as Type I single-failure-proof cranes. Therefore these cranes are designed to retain control of and continue to hold their maximum loads during an SSE."

See Attachment 3 for a mark-up of DCD Tier 2, Subsection 3.2, Revision 2, changes to be incorporated:

- For item 30 of Table 3.2-2, add the following note for the PCCV polar crane and the spent fuel cask handling crane in the "Notes" column:

  "These single-failure-proof cranes are designed in accordance with NUREG-0554 to maintain their position and hold their loads during an SSE."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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QUESTION NO. : RAI 9.1.5-04

DCD Section 9.1.5.3 "Safety Evaluation" outlines the evaluation process for the OHLHS "Overhead Heavy Load Handling Systems" as to its ability to prevent damaging or uncovering fuel, compromising sub-criticality, or impeding essential safe-shutdown functions. The DCD described the travel of the spent fuel cask handling machine as being limited "to the areas shown in Figure 9.1.5-4." Since figure 9.1.5-4 provides the traveling route of a heavy load inside containment, the table number appears to be in error. Explain and resolve the apparent discrepancy and make the appropriate revision to the DCD.

ANSWER:

Figure number should be Figures 9.1.5-1 through 9.1.5-3 instead of Figure 9.1.5-4. This will be revised in Revision 2 of DCD.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- Change "Figure 9.1.5-4" to "Figures 9.1.5-1 through 9.1.5-3" in the first bullet of subsection 9.1.5.3.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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QUESTION NO. : RAI 9.1.5-05

The applicant stated in Section 9.1.5.1, "On occasion, the OHLHS may be used to handle non-critical loads of greater weight than the maximum critical load. For those occasions, the maximum non-critical load is the design rated load. The design rated load does not have the safety factor limits of a single-failure-proof crane required by NUREG-0554. The design rated load utilizes standard commercial practice safety factor limits."

Provide examples of non-critical loads and explain the methodology that will be used to determine that the loads are non-critical.

ANSWER:

One example is the special lifting of heavy loads during construction or plant shutdown conditions. Prior to the lifting of non-critical loads after initial fuel loading, it would be demonstrated that the potential load drops due to inadvertent operations or equipment malfunctions, separately or in combination, would not jeopardize safe shutdown functions, cause a significant release of radioactivity, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool.

Impact on DCD

There is no impact on DCD

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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QUESTION NO. : RAI 9.1.5-06

DCD section 9.1.5.3 "Safety Evaluation" indicates that slings for use with the single failure proof cranes (i.e. fuel cask handling and polar crane) are designed to ANSI/ASME B30.9. SRP section 9.1.5.III.4.C.ii(2) indicates that for single-failure cranes the slings are to be constructed of a metallic material and also designed for twice the load or have dual/redundant configuration.

While reviewing the DCD, the staff was not able to locate how this sling criterion is met. Provide details on how the US-APWR will address this criterion for slings used on single failure proof OHLHS cranes.

ANSWER:

The slings used for the single-failure-proof cranes will be of metallic material and have dual/redundant load paths or be capable of supporting a load twice the weight of the handled load. This criterion will be added to subsection 9.1.5.3 in DCD Revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- At the ends of first and second bullets of subsection 9.1.5.3, the following sentence will be added:

  "The slings are of metallic material and have dual/redundant load paths or be capable of supporting a load twice the weight of the handled load."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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QUESTION NO. : RAI 9.1.5-07

DCD contains inconsistencies in code revision of ASME NOG-1 applied to the OHLHS throughout the DCD. The DCD references in question are:

- Table 1.9.3-1 page 1.9-361 "Conformance with Generic Issues" uses reference to NOG-1 2002,
- Section 9.1.5 references NOG-1 2004.
- Section 3.7, "reference 3.7-22" specifies use of 1995 revision of NOG-1.

Justify why the application does not specify the most current revision to ASME NOG-1 standard throughout the application.

ANSWER:

ASME NOG-1 2004 will be used throughout the application. This will be clarified in DCD Revision 2.

Impact on DCD

See Attachment 2 for a mark-up of DCD Tier 2, Subsection 1.9.3, Revision 2, changes to be incorporated:

- For New Generic Issue #186 in Table 1.9.3-1, the reference to NOG-1 2002 will be replaced by NOG-1 2004 in the "Status/Discussion" column on pages 1.9-361, -362 and -364 at a total of 4 locations.

See Attachment 4 for a mark-up of DCD Tier 2, Subsection 3.7.6, Revision 2, changes to be incorporated:

- Reference 3.7-22, ASME-NOG-1, 1995 will be replaced by ASME NOG-1, 2004.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-08

The DCD section 9.1.7 "References" seems to indicate an incorrect title and is missing revision date for NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plant" (reference 9.1.7-19). Revise DCD to correct reference.

ANSWER:

The title of Reference 9.1.7-19 will be corrected and its date added in the DCD Revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- The title of Reference 9.1.7-19 will be corrected and date added as follows:

  "Single-Failure-Proof Cranes for Nuclear Power Plants. NUREG-0554, U.S. Nuclear Regulatory Commission, Washington, DC, May 1979."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

05/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
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APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-09

DCD table 9.1.5-1, "Specification of the Spent Fuel Cask Handling Crane" and Table 9.1.5-2, "Specification of the Polar Crane" provide reference to a Figure 9.1.5-5 for "Hook Coverage" dimension (Item 9). Staff is unable to locate figure 9.1.5-5 in the DCD. Provide figure 9.1.5-5 in DCD or revise reference to the correct figure.

ANSWER:

DCD Table 9.1.5-1 should refer to Figure 9.1.5-1 and Figure 9.1.5-2 for "Hook Coverage" and Table 9.1.5-2 should refer to Figure 9.1.5.-4. This will be corrected in DCD Revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- Revise Table 9.1.5-1, item 9 as follows:

  Change "Figure 9.1.5-5" to "Figure 9.1.5-1 and Figure 9.1.5-2"

- Revise Table 9.1.5-2, item 9 as follows:

  Change "Figure 9.1.5-5" to "Figure 9.1.5-4"

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

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QUESTION NO. : RAI 9.1.5-10

DCD, Tier 1, Section 2.7.6.5.1 (subpart "Numeric Performance Values") provides the statement, "The safety analysis states that because the spent fuel cask handling crane is prohibited from traveling directly over the spent fuel, a spent fuel cask drop accident is an implausible event and is not required to be analyzed in the safety analysis."

Staff has the following concerns with this Tier 1 statement above:

- Staff is unable to locate the safety analysis referenced in the statement. Also, details of this analysis do not seem to be provided in Tier 1 or Tier 2 of DCD. Provide location of safety analysis and details.
- DCD, Tier 2, section 9.1.5.1 appears to indicate use of a single-failure proof crane precludes the need for a load drop evaluation to meet highly reliable handling system requirement of SRP 9.1.5.III.4 and NUREG-0612. However, Tier 1 statement above seems to use load path and mechanical stops to meet SRP and NUREG-0612 requirements to preclude need for a safety analysis. Resolve Tier 1 and Tier 2 inconsistency.
- As stated in Tier 1 statement above, spent fuel cask drop accident is not required since crane is prohibited from traveling over spent fuel. Prohibiting travel over spent fuel adequately addresses cask drop accident over the spent fuel, but fails to address a potential load drop accident that could cause damage to equipment essential to achieve or maintain safe showdown. Justify why a safety analysis is not needed for drop accident over equipment essential to achieve or maintain safe showdown.
- DCD, Tier 1, Section 2.7.6.5.1 (subpart "Numeric Performance Values") provides justification for not requiring a load drop analysis for the spent fuel cask handling crane. Staff is unable to locate similar justifications for the polar and other cranes that will handle critical load. Provide similar details for all OHLHS cranes. Staff requests applicant to address concerns listed above.

ANSWER:

For handling of heavy loads, the PCCV polar crane and the spent fuel cask handling crane main hooks are designed as single-failure-proof in accordance with NUREG-0554 to prevent the uncontrolled lowering of heavy loads. In addition, special lifting devices and slings associated with the polar crane and spent fuel cask crane critical load handling operations have dual load paths or double safety factors. Therefore, no load drop analysis is required. As discussed in Subsection

9.1.5.1, crane axle failure may result in limited slip of the lifted load, causing impact on the floor, which has been accounted for in the structural design. The discussion in DCD Tier 1 Section 2.7.6.5.1 (subpart "Numeric Performance Values") will be revised accordingly to provide this clarification.

As stated in response to RAI 9.5.1-1, administrative controls will be imposed on the use of heavy load handling cranes, including those cranes that are not single-failure proof. These controls include restrictions on use based on plant operating mode, and maintaining heavy loads on safe load paths. Because of their reliance on administrative controls and application-specific evaluation, non-single-failure-proof cranes are not well suited for treatment in DCD Tier 1. Assurance of their acceptable operation is provided by the measures described in response to questions RAI 9.1.5-1 and RAI 9.1.5-12 in this RAI.

Impact on DCD

See Attachment 5 for a mark-up of DCD Tier 1, Subsection 2.7.6.5, Revision 2, changes to be incorporated:

- The paragraph under Section 2.7.6.5.1 (subpart "Key Design Features") will be revised to include the following bullet.

  - The main hooks of the PCCV polar crane and the spent fuel cask handling crane are designed as single-failure-proof cranes. Special lifting devices and slings used for critical load handling operations in conjunction with these cranes have dual load paths or double safety factors.

- The paragraph under Section 2.7.6.5.1 (subpart "Numeric Performance Values") will be replaced by the following paragraph:

  The PCCV polar crane and the spent fuel cask handling crane are designed as single-failure-proof to prevent uncontrolled lowering of heavy loads. Therefore, no load drop accident analysis is required. Crane axle failure may result in limited slip of the lifted load, causing impact on the floor, which has been accounted for in the structural design.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
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APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-11

DCD Tier 2, section 9.1.5.1 clearly defines Polar and spent fuel cask cranes as single-failure-proof cranes, by stating, "The OHLHS is designed with single-failure proof cranes in accordance with NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, (Ref 9.1.7-19) using ASME NOG-1, Rules for Construction of Overload and Gantry Cranes (Top Running Bridge, Multiple Girder) (Ref 9.1.7-20, to handle the maximum critical load based on the area in which it is operating."

The US-APWR DCD, Tier 1, Section 2.7.6.5 does not list "single-failure-proof" as certified design information with an ITAAC for either the polar crane or the spent fuel cask handling crane. The staff believes that "single-failure-proof" design criteria for the above listed cranes should be listed in Tier 1. Special lifting devices should also be verified to be in accordance with ANSI N14.6 as an ITAAC.

One design criteria, among several design criteria for Tier 1 information, is that it should include features and functions which could have a significant effect on the safety of a nuclear plant or are important in preventing or mitigating accidents. A drop of the reactor vessel head assembly and the upper and lower reactor internals, a spent fuel cask, Rector Coolant Pump Motors and other similar sized equipment could affect plant safety. Therefore, design features that reduce the risk and/or analyses that provide assurance of safety after a dropped load are important-to-safety. The staff considers "single-failure-proof" design criteria for the OHLHS handling cranes as Tier 1 safety-significant design criteria.

Provide justification for not including "Single-Failure-proof" design criteria and an ITAAC in Tier 1 of DCD, which are safety-significant for OHLHS cranes. In addition, provide justification for not including verification of NASI N14.6 special lifting device as an ITAAC.

ANSWER:

In response to RAI 9.1.5-10, MHI is adding the single-failure-proof design of the PCCV polar crane and the spent fuel cask handling crane main hook to DCD Tier 1 Subsection 2.7.6.5.1, as a key design feature of OHLHS. The single-failure-proof design feature for OHLHS will be added in Table 2.7.6.5-1 of DCD Tier 1 as an ITAAC item.

As stated in DCD Tier 2 Subsection 9.1.5.3, special lifting devices used in conjunction with the spent fuel cask and polar crane, are designed and fabricated in accordance with ANSI N14.6, with the exception of slings supplied in accordance with ANSI/ASME B30.9. As noted in the response to question RAI 9.1.5-10, special lifting devices and slings used in conjunction with the polar crane and spent fuel cask crane during critical load handling operations, are designed with dual load paths or double safety factors, and will therefore be addressed by ITAAC as shown below. MHI considers details of conformance to ANSI 14.6 and ASME B30.9 to be below the level of detail for Tier 1. MHI will revise DCD Tier 2 Subsection 9.1.5.4, *Inspection and Testing Requirements,* to specifically address special lifting devices and slings

Impact on DCD

See the DCD Tier 1 changes in the response to RAI 9.1.5-10 for the inclusion of the single-failure-proof crane design as a key design feature of OHLHS.

See Attachment 5 for a mark-up of DCD Tier 1, Subsection 2.7.6.5, Revision 2, changes to be incorporated:

- ITAAC Item 2.c in DCD Tier 1 Table 2.7.6.5-1 will be added to address OHLHS single-failure proof design. Related changes, provided in MHI's response to RAI 184, question 14.03.07-31, are included below for completeness. An editorial change to the acceptance criteria of ITAAC Item 2.a, to delete reference to LLHS Table 2.7.6.4-1, is also included as shown below:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the OHLHS is as described in Subsection 2.7.6.5.1 Design Description.	1. An inspection of the as-built OHLHS will be performed.	1. The as-built OHLHS conforms to the functional arrangement described in the Design Description of this Subsection 2.7.6.5.1.
2.a The seismic Category II OHLHS is designed so that the SSE could not cause unacceptable structural interaction or failure with seismic category I SSCs.	2.a A combination of inspection, tests and/or analyses will be performed on the as-built seismic Category II OHLHS.	2.a A report exists and concludes that the as-built seismic Category II OHLHS equipment ~~identified in Table 2.7.6.4-1~~ are designed so that the SSE could not cause unacceptable structural interaction or failure with seismic category I SSCs.
2.bThe polar crane has a seismic restraint system which precludes derailment of either the hoist trolley or the main bridge box girders during a seismic event.	2.b A combination of inspection, tests and/or analyses will be performed on the as-built polar crane seismic restraint system.	2.b A report exists and concludes that the as-built polar crane seismic restraint system precludes derailment of either the hoist trolley or the main bridge box girders during a seismic event.
2.c.i The PCCV polar crane and the spent fuel cask handling crane main hook are designed as single-failure-proof cranes.	2.c.i A combination of inspection, tests and/or analyses will be performed on the as-built OHLHS.	2.c.i A report exists and concludes that the as-built PCCV polar crane and the spent fuel cask handling crane main hook are single-failure proof.
2.c.ii Special lifting devices and slings used in conjunction with the PCCV polar crane and the spent fuel cask	2.c.ii A combination of inspection, tests and/or analyses will be performed on the as-built OHLHS.	2.c.ii A report exists and concludes that the as-built special lifting devices and slings used in conjunction

handling crane main hook during critical load handling operations have dual load paths or double safety factors.		with the PCCV polar crane and the spent fuel cask handling crane main hook during critical load handling operations have dual load paths or double safety factors.

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5, Revision 2, changes to be incorporated:

- The following text will be added after the fourth paragraph of DCD Tier 2 Subsection 9.1.5.4:

  "Inspection and testing of special lifting devices and slings used in conjunction with the polar crane and spent fuel cask handling crane, are performed in accordance with ANSI N14.6 (Ref. 9.1.7-23) and ASME B30.9 (Ref. 9.1.7-24), respectively."

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 292-2232 REVISION 1**
SRP SECTION:	**09.01.05 – Overhead Heavy Load Handling System**
APPLICATION SECTION:	**09.01.05**
DATE OF RAI ISSUE:	**03/26/09**

QUESTION NO. : RAI 9.1.5-12

COL items 9.1(3) through 9.1(8) in chapter 9.1.6 were deleted in Revision 1 of DCD. DCD revision 1 provides reason for deletion in description of change list (located in "Rev1_Change_List" page 18 of 75) which states, "Editorial: This COL item is programmatic, and as a part of plant procedures and administrative procedures those has been defined in Subsection 13.5. Since these procedures has already been identified as COL item in Subsection 13.5, the item described in Section 9.1 was deleted to avoid duplicate description in the DCD."

Staff also noticed DCD Tier 2, Chapter 1 table 1.9.3-1, "Conformance with Generic Issues (page 1.9-365, sheet 19 of 30)" provides discussion of the minimum amount of details needed for heavy load handling procedures. SRP 9.1.5 and NUREG-0612 provides guidance for applicants to develop a heavy load handling program for design, operation, testing, maintenance and inspection of heavy load handling systems.

A COL action item should be added to DCD to provide direction for COL applicant to develop such a heavy load handling program.

ANSWER:

MHI agrees to add a COL action item to address the heavy load handling program in DCD revision 2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Subsection 9.1.5 and 9.1.6, Revision 2, changes to be incorporated:

- Change the second bullet of Subsection 9.1.5.2.3 to:

  "For the heavy loads, polar crane movement is limited to exclude the area bounded by the reactor cavity by way of administrative control procedures."

- Change the second to last paragraph in Subsection 9.1.5.1 to:

"The operation, testing, maintenance, and inspection of OHLHS are controlled through the use of safe load paths as defined in Figures 9.1.5-1 through 9.1.5-4 and administrative control procedures."

- Change the last sentence in the second paragraph of Subsection 9.1.5.5 to:

"This resetting is performed remotely from the system controls and is governed by the OHLHS administrative control procedures."

- Change the last sentence in the third paragraph of Subsection 9.1.5.5 to:

"The manual interlocks are controlled by administrative control procedures."

- Add the following text at the end of Subsection 9.1.5.3:

"To assure proper handling of heavy loads during the plant life, the COL Applicant is to establish a heavy load handling program, including associated procedural and administrative controls, that satisfies commitments made in Subsection 9.1.5 of the DCD, and that meets the guidance of ANSI/ASME B30.2, ANSI/ASME B30.9, ANSI N14.6, ASME NOG-1, CMAA Specification 70-2000, NUREG-0554, NUREG-0612, and NUREG-0800, Section 9.1.5. During the operating life of the plant, it is anticipated that temporarily installed hoists and mobile cranes will also be used for plant maintenance. The heavy load handling program will include temporary cranes and hoists. The heavy load handling program will adopt a defense-in-depth strategy to enhance safety when handling heavy loads. For instance, the program will restrict lift heights to practical minimums and limit lifting activities as much as practical to plant modes in which load drops have the smallest potential for adverse consequences, particularly when critical loads are being handled. Further, prior to the lifting of heavy loads after initial fuel loading, the program will institute any additional reviews as necessary to assure that potential drops of these loads due to inadvertent operations or equipment malfunctions, separately or in combination, will not jeopardize safe shutdown functions, cause a significant release of radioactivity, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool."

- Add the following COL item to Subsection 9.1.6:

"*COL 9.1(6)* To assure proper handling of heavy loads during the plant life, the COL Applicant is to establish a heavy load handling program, including associated procedural and administrative controls, that satisfies commitments made in Subsection 9.1.5 of the DCD, and that meets the guidance of ANSI/ASME B30.2, ANSI/ASME B30.9, ANSI N14.6, ASME NOG-1, CMAA Specification 70-2000, NUREG-0554, NUREG-0612, and NUREG-0800, Section 9.1.5. During the operating life of the plant, it is anticipated that temporarily installed hoists and mobile cranes will also be used for plant maintenance. The heavy load handling program will include temporary cranes and hoists. The heavy load handling program will adopt a defense-in-depth strategy to enhance safety when handling heavy loads. For instance, the program will restrict lift heights to practical minimums and limit lifting activities as much as practical to plant modes in which load drops have the smallest potential for adverse consequences, particularly when critical loads are being handled. Further, prior to the lifting of heavy loads after initial fuel loading, the program will institute any additional reviews necessary to assure that potential drops of these loads due to inadvertent operations or equipment malfunctions, separately or in combination, will not jeopardize safe shutdown functions, cause a significant release of radioactivity, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool."

Impact on COLA

The COLA shall be updated to address changes to the DCD for COL item 9.1(6).

Impact on PRA

There is no impact on PRA.

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Mitsubishi Heavy Industries
Docket No. 52-021

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QUESTION NO. : RAI 9.1.5-13

DCD Tier 2, Chapter 1, Table 1.9.3-1, "Conformance with Generic Issues" (page 1.9-365) states, "However, all specific loads and load paths cannot be defined prior to the operations. For these cases, it is anticipated that safe load path considerations will be based on comparison with analyzed cases, previously defined safe movement areas, and previously defined restricted areas and reviewed by the COL Applicant's plant review board." Staff is unable to locate any COL item in DCD to provide closure of this item. Provide justification as to why this COL item was omitted and whether an additional COL item should be added.

ANSWER:

The response to Question No. RAI 9.1.5-12 establishes a COL item to address a heavy loads program to assure proper administrative and procedural control and review of heavy loads handling. Table 1.9.3-1 will be revised in Revision 2 of the DCD to provide a reference to Section 9.1.5 of the DCD.

Impact on DCD

See Attachment 2 for a mark-up of DCD Tier 2, Subsection 1.9.3, Revision 2, changes to be incorporated:

- Add the following Section number in "Addressed in DCD Chapter/Sec." column of Table 1.9.3-1, Page 1.9-365:

  "9.1.5"

See also the response to Question No. RAI 9.1.5-12 for a detailed description of the COL item to be added to DCD revision 2.

Impact on COLA

See the response to Question No. RAI 9.1.5-12 for the impact on COLA.

Impact on PRA

There is no impact on PRA.

9.1.5 Overhead Heavy Load Handling System

The overhead heavy load handling system (OHLHS) consists of devices used for critical load handling evolutions. A critical load handling evolution is defined as the handling of a heavy load where inadvertent operations or equipment malfunctions, separately or in combination, could:

- Cause a significant release of radioactivity
- Cause a loss of margin to criticality
- Uncover irradiated fuel in the reactor vessel or spent fuel pool
- Damage equipment essential to achieve or maintain safe shutdown

Heavy loads are defined as a load weighing more than one fuel assembly and its handling device. For the US-APWR, a fuel assembly weighs approximately 2,000 lbs with a handling tool weighing approximately 450 lbs. Therefore, for the US-APWR, a heavy load is defined as any load greater than the combined weight of approximately 2,450 lbs. This definition is established as a threshold for invoking the use of the OHLHS. The OHLHS is not used for the handling of new and spent fuel assemblies. New and spent fuel assemblies are handled using the light load handling system (light load handling system) defined in Section 9.1.4

9.1.5.1 Design Bases

The load that, if dropped, that would cause the greatest damage is a function of the area in which the OHLHS is operating. In the containment, this is defined as the integrated reactor head package/internals being lifted and transported to the lay down area. In the fuel handling area, this is defined as a full spent fuel cask being lifted and transported through the fuel handling area. In the area between the PCCV and the fuel handling area, this would be a reactor coolant pump motor.

The OHLHS cranes are designed to the criteria specified in CMAA-70, 2000, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes (Ref. 9.1.7-25) and Chapter 2-1 of ASME B30.2-2005, Overhead and Gantry Cranes (Ref. 9.1.7-22). The ~~OHLHS is~~ PCCV polar crane and the spent fuel cask handling crane are also designed as ~~with~~ single-failure-proof ASME NOG-1 Type I cranes in accordance with NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, (Ref. 9.1.7-19) ~~using~~ and ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder) (Ref. 9.1.7-20), to handle the maximum critical loads for ~~based on~~ the areas in which these cranes operate ~~it is operating~~. Note that the suspension hoist of the spent fuel cask handling crane and the auxiliary hoists on these cranes will not handle critical loads and are not designed as single-failure-proof. However, they meet the electrical performance requirements of Type II cranes as required by Section 6320 (c) of ASME NOG-1.

The use of the single failure proof crane precludes the need to perform load drop evaluations with the one exception. Single-failure proof cranes are designed so that any credible failure of a single component will not result in the loss of capability to stop and hold a critical load. However, ASME NOG-1 allows a drop of 1 inch for axle failure. It further defines the acceptable stopping distance as not exceeding 5 inches while lowering the maximum critical load at its maximum speed unless specified otherwise by the purchaser. These distances, 1 inch to 5 inch, represent a case where a critical load be lowered to the floor could impose an impact load on the floor and associated structural features, should a failure event occur within this range.

On occasion, the OHLHS may be used to handle non-critical loads of greater weight than the maximum critical load. For those occasions, the maximum non-critical load is the design rated load. The design rated load does not have the safety factor limits of a single-failure-proof crane required by NUREG-0554. The design rated load utilizes standard commercial practice safety factor limits.

The areas of the plant in which the OHLHS is operated are shown in Figures 9.1.5-1 through 9.1.5-4. These figures represent the Fuel Handling Area and the interior of the PCCV. The OHLHS is designed to meet requirements of 10 CFR 50, Appendix A, specifically, GDC 1, 2, 4, and 5.

The operation, testing, maintenance, and inspection of OHLHS are controlled through the use of safe load paths as defined in Figures 9.1.5-1 through 9.1.5-4 and administrative control procedures ~~defined in Subsection 13.5.1~~.

The administrative control procedures govern the operation, testing, maintenance, and inspection of overhead heavy load handling system. These procedures incorporate the requirements of and follow the recommendations and/or guidelines of the following documents:

Scope	Reference	Reference Title
General requirements	Chapter 5, Section 5.1.1, NUREG-0612	Control of Heavy Loads at Nuclear Power Plants (Ref. 9.1.7-21)
Crane Operators (Training, qualifications, and conduct.)	Chapter 2-3, ANSI/ASME B30.2	Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist (Ref. 9.1.7-22)
Inspection, testing, and maintenance.	Chapter 2-2, ANSI/ASME B30.2	Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist (Ref. 9.1.7-22)

9.1.5.2 System Description

The primary pieces of equipment used in the OHLHS are the spent fuel cask handling crane in the fuel handling area and the polar crane in the PCCV. The spent fuel cask handling crane and the polar crane are designed in accordance with the provisions of NUREG-0554 and ASME NOG-1 as Type I single-failure-proof cranes. Therefore these cranes are designed to retain control of and continue to hold their maximum loads during an SSE. Other OHLHS equipment may include, but are not limited to, monorail type hoists, bridge cranes, and jib cranes. The OHLHS is seismic category II and Equipment Class 5, as described in Section 3.2.

The OHLHS exists in the R/B, specifically the fuel handling area and the PCCV of the R/B.

The OHLHS also includes equipment accessories (e.g., slings, and hooks, etc.) instrumentation, physical stops and/or electrical interlocks, and associated administrative controls.

The applicable Codes and Standards are identified in Section 9.1.5.1.

Other than the single-failure proof OHLHS cranes, miscellaneous hoists and cranes with heavy load capacities are installed in safety-related areas of the US-APWR plant. Descriptions and data for all cranes and hoists that have heavy load capacities and are installed over safe shutdown equipment are given in Table 9.1.5-3. The safety evaluations for those cranes and hoists are discussed in Subsection 9.1.5.3.

9.1.5.2.1 Physical Arrangement

The areas of the plant in which the spent fuel cask handling crane and polar crane operate are physical arrangement of the heavy load handling system for stored fuel and safe shutdown equipment is shown in Figures 9.1.5-1 through 9.1.5-4. The specifications for the spent fuel cask handling crane and the polar crane are given in Table 9.1.5-1 and 9.1.5-2. As shown, the spent fuel handling crane has three load handling hooks, the main, the auxiliary, and the suspension crane. The suspension crane is only used for new fuel assembly handling between a new fuel container to the new fuel storage area or between the new fuel storage rack and the basket on the new fuel elevator. Because of this limitation, the suspension crane is considered part of the light load handling system. Its operation and control is detailed in Section 9.1.4.

9.1.5.2.2 Spent Fuel Cask Handling Crane

A spent fuel cask filled with spent fuel assemblies is lifted and transferred using the main hoist of the spent fuel cask handling crane and the spent fuel cask lift rig. The cask's path is from the cask loading pit to the truck access area on the ground floor as shown on Figure 9.1.5-1.

Neutron source containers and Irradiation sample containers are transferred using the auxiliary hoist through the path shown on Figure 9.1.5-2.

A reactor coolant pump (RCP) motor is transferred from the PCCV into the fuel handling area. In the fuel handling area, once the RCP motor is in position, it is lifted by the main hook of the spent fuel handling crane and transferred to the truck access area using the path shown on Figure 9.1.5-3.

Miscellaneous equipment is transferred from the PCCV using the same path as the RCP motors. The spent fuel cask handling crane movement and storage is handled as follows:

- The spent fuel handling cask crane range of movement is limited; in general, to the fuel handling area defined by the hook coverage ranges shown in Figure 9.1.5-1. The limitation is controlled by the configuration of the spent fuel handling cask crane and by permanent rail stops installed on the crane rails.
- For the RCP motors and miscellaneous equipment, movement is design limited to exclude the new fuel storage, cask, and fuel inspection pits. The movement of the spent fuel handling crane is limited by removable rail stops.
- The crane is stored on the truck access hatch side of the fuel handling area when not in service.

9.1.5.2.3 Polar Crane

During refueling, the integrated reactor vessel head assembly and the reactor core upper and lower internals are transferred using the main hook and a lifting rig. These components are transferred from the reactor vessel to their respective lay down area as shown on Figure 9.1.5-4.

The RCP motors and other similar sized equipment are transferred using the auxiliary hook from their installed location to the PCCV equipment hatch area where they are loaded onto a transporter for transfer to the fuel handling area or other designated areas. The transporter is not covered in this section because it does not operate overhead and it is not a critical load handling component

The polar crane movement and storage is handled as follows:

- The polar crane range of movement is limited, in general, area defined by the hook coverage ranges shown in Figures 9.1.5-4. The limitation is controlled by the configuration of the polar crane and by the fact, travel is limited by the circumferential rail on which the polar crane travels.
- For the heavy loads, polar crane movement is limited to exclude the area bounded by the reactor cavity by way of ~~the~~ administrative control procedures ~~defined in Subsection 13.5.1~~.
- The polar crane has a seismic restraint system which precludes derailment of the either the hoist trolley or the main bridge box girders during a seismic event.

The polar crane is stored in the parked position during plant operation. The parked position for the polar crane is parallel to the centerline of the C/V running between azimuth 0° and azimuth 180° with the hoist trolley located over the roof of the pressurizer room.

The polar crane is designed to be used as a structural component during steam generator (SG) replacement. The driven components are not used during SG replacement.

9.1.5.3 Safety Evaluation

The OHLHS is evaluated as to its ability to, assure there is no unacceptable release of radiation through mechanical damage to fuel, prevent damage that could compromise ability to maintain adequate degree of sub criticality, uncovering of fuel in the reactor vessel or spent fuel pool, and to prevent damage that could result in loss of essential safe-shutdown functions. This is accomplished by the following:

- Limiting the travel of the spent fuel cask handling machine to the areas shown in ~~Figure 9.1.5-4~~ Figures 9.1.5-1 through 9.1.5-3 through the use of physical stops on the travel rails of the machine and the hoist carriage. The machine is fabricated and erected in accordance with the requirements of NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, and (Ref. 9.1.7-19). This is accomplished by procuring the machine in conformance with ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder), (Ref. 9.1.7-20). All lifting devices used for the spent fuel cask are designed and fabricated in accordance with ANSI N14.6, American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More for Nuclear Materials, (Ref. 9.1.7-23) with the exception of slings which are supplied in accordance with ANSI/ASME B30.9, Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings – Slings, (Ref. 9.1.7-24). The slings are of metallic material and have dual/redundant load paths or be capable of supporting a load twice the weight of the handled load.

- Fabricating and erecting a polar crane that complies with the requirements of NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, (Ref. 9.1.7-19). This is accomplished by designing the crane in conformance with ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder), (Ref. 9.1.7-20). All lifting devices are designed and fabricated in accordance with ANSI N14.6, American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More for Nuclear Materials, (Ref. 9.1.7-23) with the exception of slings which are supplied in accordance with ANSI/ASME B30.9, Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings – Slings, (Ref. 9.1.7-24). The slings are of metallic material and have dual/redundant load paths or be capable of supporting a load twice the weight of the handled load.

- Administrative control procedures to govern operator training, load handling instructions, and equipment inspection. The administrative control procedures are developed in accordance with ANSI/ASME B30.2, Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist, (Ref. 9.1.7-22). Administrative control procedures are also required to be used to assure that the auxiliary hoists of the spent fuel cask handling crane and polar crane do not handle heavy loads that could have adverse consequences for nuclear safety. For example, administrative control procedures may prevent the polar crane auxiliary hoist from being used to handle a reactor coolant pump motor unless the containment is defueled, or other measures are taken to assure there is no potential for jeopardizing nuclear safety in the case of a load drop.

Except for the OHLHS polar crane and spent fuel cask handling crane, miscellaneous cranes and hoists with heavy load capacities as listed in Table 9.1.5-3 are not designed as single-failure-proof. However, they are designed as seismic category II equipment to prevent unacceptable structural interaction and failure during an SSE event. The non-single-failure proof cranes and hoists in Table 9.1.5-3 satisfy safety criteria for critical load handling evolutions in the following manner:

- The non-single-failure-proof cranes and hoists in Table 9.1.5-3 are not located over or adjacent to spent fuel assemblies, with the exception of the containment equipment hatch hoist. The hatch hoist is controlled by heavy load handling procedures, such that the hatch is not handled when a postulated load drop could result in unacceptable consequences. Therefore, a load handling incident involving the non-single-failure-proof cranes and hoists would not impact fuel assemblies.

- The non-single-failure proof cranes and hoists are located over safe shutdown equipment, but the plant configuration provides redundancy by separation of the components to assure that the effects of a single load drop from these cranes and hoists would not jeopardize the ability to achieve or maintain safe shutdown conditions. The hoists associated with the safety injection pumps, CS/RHR pumps, EFW pumps, CCW Pumps, and CCW Heat Exchangers are all located on the basement slab of the R/B at floor elevation -26'-4", and each equipment train has its own room. Similarly, separation for other safe shutdown equipment serviced by non-single-failure proof cranes and hoists is achieved by walls, slabs, and/or adequate physical distance between adjacent equipment trains to assure that redundancy of safe shutdown functions is maintained in the case of a single load drop.

- The non-single-failure proof cranes and hoists are dedicated to servicing particular pieces of safe shutdown equipment (such as pumps, valves, heat exchangers, and chillers) or systems that will be out-of-service when the cranes and hoists are used for handling heavy loads over them. The use of these cranes and hoists are administratively controlled by load handling procedures to prevent overhead load handling that could cause unacceptable damage to the dedicated equipment or systems when in service.

Therefore, load handling incidents involving non-single-failure-proof cranes and hoists listed in Table 9.1.5-3 will not jeopardize safe shutdown functions or cause a significant release of radioactivity, a criticality accident, or inability to cool fuel.

To assure proper handling of heavy loads during the plant life, the COL Applicant is to establish a heavy load handling program, including associated procedural and administrative controls, that satisfies commitments made in Subsection 9.1.5 of the DCD, and that meets the guidance of ANSI/ASME B30.2, ANSI/ASME B30.9, ANSI N14.6, ASME NOG-1, CMAA Specification 70-2000, NUREG-0554, NUREG-0612, and NUREG-0800, Section 9.1.5. During the operating life of the plant, it is anticipated that temporarily installed hoists and mobile cranes will also be used for plant maintenance. The heavy load handling program will include temporary cranes and hoists. The heavy load handling program will adopt a defense-in-depth strategy to enhance safety when handling heavy loads. For instance, the program will restrict lift heights to practical minimums and limit lifting activities as much as practical to plant modes in which load drops have the smallest potential for adverse consequences, particularly when critical loads are being handled. Further, prior to the lifting of heavy loads after initial fuel loading, the program will institute any additional reviews as necessary to assure that potential drops of these loads due to inadvertent operations or equipment malfunctions, separately or in combination, will not jeopardize safe shutdown functions, cause a significant release of radioactivity, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool.

9.1.5.4 Inspection and Testing Requirements

The OHLHS components are subjected to various tests and inspections prior to being placed in service and are the subject of an inspection, tests, analyses, and acceptance criteria (ITAAC) program, which is detailed in Chapter 14, Section 14.3.

During fabrication, the quality assurance program of the Manufacturer satisfies the requirements of ASME NQA-1. The manufacturer's inspection and testing program conforms to Sections 7100 and 7200 of ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder, (Ref. 9.1.7-20).

Prior to operation, the OHLHS is received, stored, and installed in accordance with Sections 7100, 7300, and 7400 of ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder, (Ref. 9.1. 7-20). Qualification of the assembled OHLHS is performed in accordance with Section 7500 of ASME NOG-1.

Periodic tests and inspections of the OHLHS are performed in accordance with Chapter 2-2 of ANSI/ASME B30.2, Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist, (Ref. 9.1.7-22).

Inspection and testing of special lifting devices and slings used in conjunction with the polar crane and spent fuel cask handling crane, are performed in accordance with ANSI N14.6 (Ref. 9.1.7-23) and ASME B30.9 (Ref. 9.1.7-24), respectively.

9.1.5.5 Instrumentation Requirements

The OHLHS is equipped with mechanical and electrical limit devices to disengage power to the motors as the load hook approaches its travel limits or to prevent damage to other components when continued operation would potentially damage the OHLHS as required by NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, (Ref. 9.1.7-19).

In addition to the limit devices, the control system is designed to include safety devices, which will assure the OHLHS returns to and/or maintains a secure holding position of critical loads in the event of a system fault. These safety devices are in addition to and separate from the control devices used for normal operation of the OHLHS. Emergency stop buttons are strategically placed at various locations to de-energize the OHLHS independent of the system controls. The overload sensing system is designed to be reset when switching the OHLHS between maximum critical load operations and design rate load operations. This resetting is performed remotely from the system controls and is governed by the OHLHS administrative control procedures ~~defined in Subsection 13.5.1~~.

The OHLHS driver control systems are designed using a combination of electrical and mechanical components. The control systems take into account the hoisting (raising and lowering) of the complete range of loads from the load hook itself up to and including the rated load in conjunction with the inertia of moving components, such as the motor armature, shafting and coupling, gear reducer, drum, etc. In general, the OHLHS is not contemplated to be used to lift individual spent fuel elements. The control system has been designed to be adaptable to include manual interlocks, which will preclude trolley and/or bridge movement while a spent fuel assembly is being hoisted free of the reactor vessel or a storage rack. The manual interlocks are controlled by ~~the~~ administrative control procedures ~~defined in Subsection 13.5.1~~.

Instrumentation is installed within the motor control circuits to detect and react to malfunctions such as excessive electric current, excessive motor temperature, overspeed, overload, and overtravel. Control devices are installed to absorb the kinetic energy of the rotating components and arrest the hoisting movement should the load line or one of the dual revving systems fail, or should an overload and/or overspeed condition occur.

The drives are designed to conform to ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder), (Ref. 9.1.7-20) with respect to hoist speed, specifically Section 5331 of ASME NOG-1.

The complete operating control system, along with emergency control features is located in the cab on the OHLHS. Additional wireless remote control stations are also provided for remote operations of the OHLHS. The wireless remote control stations have the same control, including emergency, features as the cab mounted controls. The configuration of the controls stations are in accordance with Section 2-1.13 of ANSI/ASME B30.2, Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist, (Ref. 9.1.7-22). The individual control stations are interlocked to permit only one station to be operable at a time.

9.1.6 Combined License Information

COL 9.1(1) *The COL Applicant is to provide a program for monitoring the effectiveness of neutron poison present in the neutron absorbing panel.*

COL 9.1(2) *Deleted*

COL 9.1(3) *Deleted*

COL 9.1(4) *Deleted*

COL 9.1(5) *Deleted*

COL 9.1(6) ~~*Deleted*~~ To assure proper handling of heavy loads during the plant life, the COL Applicant is to establish a heavy load handling program, including associated procedural and administrative controls, that satisfies commitments made in Subsection 9.1.5 of the DCD, and that meets the guidance of ANSI/ASME B30.2, ANSI/ASME B30.9, ANSI N14.6, ASME NOG-1, CMAA Specification 70-2000, NUREG-0554, NUREG-0612, and NUREG-0800, Section 9.1.5. During the operating life of the plant, it is anticipated that temporarily installed hoists and mobile cranes will also be used for plant maintenance. The heavy load handling program will include temporary cranes and hoists. The heavy load handling program will adopt a defense-in-depth strategy to enhance safety when handling heavy loads. For instance, the program will restrict lift heights to practical minimums and limit lifting activities as much as practical to plant modes in which load drops have the smallest potential for adverse consequences, particularly when critical loads are being handled. Further, prior to the lifting of heavy loads after initial fuel loading, the program will institute any additional review as necessary to assure that potential drops of these loads due to inadvertent operations or equipment malfunctions, separately or in combination, will not jeopardize safe shutdown functions, cause a significant release of radioactivity, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool.

COL 9.1(7) *Deleted*

COL 9.1(8) *Deleted*

9.1.7 References

9.1.7-1 Prevention of Criticality in Fuel Storage and Handling, 'General Design Criteria for Nuclear Power Plants,' "Domestic Licensing of Production and Utilization Facilities," . NRC Regulations Title 10, Code of Federal Regulations, 10 CFR Part 50, Appendix A, Criterion 62.

9.1.7-2 'Criticality Accident Requirements,' "Domestic Licensing of Production and Utilization Facilities," Energy. NRC Regulations Title 10, Code of Federal Regulations, 10 CFR Part 50.68.

9.1.7-3 Kopp, L. Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants. U.S. Nuclear Regulatory Commission, February 1998.

9.1.7-4 Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors. ANSI/ANS-8.17-2004, American National Standards Institute/American Nuclear Society.

9.1.7-5 Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors. ANSI/ANS-8.1-1998 (2007), American National Standards Institute/American Nuclear Society.

9.1.7-6 Criticality Analysis for US-APWR new and spent fuel racks, MUAP-07032, February, 2008.

9.1.7-7 Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants. ANS 57.2-1983, American Nuclear Society.

9.1.7-8 Mechanical Analysis for US-APWR new and spent fuel racks, MUAP-07033, March, 2009.

9.1.7-9 Design Requirements for New Fuel Storage Facilities at Light Water Reactor Plants. ANS 57.3-1983, American Nuclear Society.

9.1.7-10 Rules for Construction of Nuclear Components, ASME Boiler and Pressure Vessel Code, Division 1, Section III, 2007.

9.1.7-11 EPRI Primary Water Chemistry Guidelines: Revision 4, 2003

9.1.7-12 Spent Fuel Storage Facility Design Basis. Regulatory Guide 1.13, Rev. 2, U.S. Nuclear Regulatory Commission.

9.1.7-13 Design Requirements For Light Water Reactor Fuel Handling Systems. ANSI/ANS57.1-1992, American National Standards Institute/American Nuclear Society.

9.1.7-14 "Occupational Safety and Health Standards," Labor. Title 29 Code of Federal Regulations; Part 1910, U.S. Nuclear Regulatory Commission,.

9.1.7-15 "Standards for Protection against Radiation," Energy. Title 10, Code of Federal Regulations, Part 20, U.S. Nuclear Regulatory Commission,

9.1.7-16 "Rules for Construction of Nuclear Facility Components," Boiler and Pressure Vessel Code Section III, American Society of Mechanical Engineers, 2001 Edition through the 2003 Addenda.

9.1.7-17 "Shippers – General Requirements for Shipments and Packagings," Transportation. Title 49, Code of Federal Regulations, Part 173, U.S. Nuclear Regulatory Commission, Washington, DC.

9.1.7-18 "Packaging and Transportation of Radioactive Material," Energy. Title 10, Code of Federal Regulations, Part 71, U.S. Nuclear Regulatory Commission, Washington, DC.

9.1.7-19 NRC Collection of Abbreviations Single-Failure-Proof Cranes for Nuclear Power Plants. NUREG-0554, U.S. Nuclear Regulatory Commission, Washington, DC, May 1979.

9.1.7-20 Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder). ASME NOG-1, 2004, American Society of Mechanical Engineers.

9.1.7-21 Control of Heavy Loads at Nuclear Power Plants. NUREG-0612, U.S. Nuclear Regulatory Commission, Washington, DC, July 1980.

9.1.7-22 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist). ANSI/ASME B30.2-2005, American Society of Mechanical Engineers.

9.1.7-23 American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials. American National Standards Institute, ANSI N14.6-1993, American Nuclear Society, IL.

9.1.7-24 Slings. ANSI/ASME B30.9-2003, American Society of Mechanical Engineers.

9.1.7-25 Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes. CMAA Specification No. 70, 2000, Crane Manufacturers Association of America, Inc.

Table 9.1.5-1 Specification of the Spent Fuel Cask Handling Crane

1. Type		Overhead bridge crane		
2. Operating device		Radio remote control unit and cab on crane		
3. Component supplied electric power		Trolley		
4. Electric power supply		Power	: 460V ac, 60 Hz, 3 Phase	
		Space Heater	: 230V ac, 60 Hz, Single Phase	
5. Bridge Span		47'-3"		
6. Top level of the rail		Elevation 125'-8"		
		Main Hook	Auxiliary Hook	Suspension Hoist
7. Capacity	Metric ton	135	20	2
8. Lift	ft-in (m)	124'-9" (38.003 m)	124'-9" (38.003 m)	69'-3" (21.0886 m)
9. Hook Coverage	ft-in (m)	Refer to Figure ~~9.1.5-5~~9.1.5-1 and Figure 9.1.5-2		
10. Hoisting Speed	m/min	0.12, 0.6, 1.2	0.45, 1.8, 4.5	2.1, 6.3
11. Traveling Speed	m/min	Bridge: 0.6, 1.5, 6.0		Suspension Crane: 3.0, 9.0
		Trolley: 0.6, 1.5, 6.0		Hoist: 3.0, 9.0
12. Wire Material		Stainless Steel (ATSM A 492 Type 304)		

Table 9.1.5-2 Specification of the Polar Crane

1. Type		Overhead bridge crane	
2. Operating device		Portable wireless control box on operating floor, Cab on crane	
3. Component supplied electric power		Trolley	
4. Electric power supply		Power	: 460V ac, 60 Hz, 3 Phase
		Space Heater	: 230V ac, 60 Hz, Single Phase
5. Bridge Span		142'-1"	
6. Top level of the rail		Elevation 145'-6"	
		Main Hook	Auxiliary Hook
7. Capacity	Metric ton	250	50
8. Lift	ft-in (m)	67'-9" (20.650 m)	119'-1" (36.296 m)
9. Hook Coverage	ft-in (m)	Refer to Figure ~~9.1.5-5~~9.1.5-4	
10. Hoisting Speed	m/min	0.12, 0.6, 1.2	1.2, 6.0, 12.0
11. Traveling Speed	m/min	Bridge: 0.9, 1.8, 18.0	
		Trolley: 0.6, 3.42, 12.0	
12. Wire Material		Carbon Steel	

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Table 1.9.3-1 Co[...]es (sheet 15 of 30)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/Sec.
New Generic Issue #186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants NRC priority: CONTINUE	This issue was identified when the concern was raised that licensees operating within the regulatory guidelines of GL 85-11 may not have taken adequate measures to assess and mitigate the consequences of dropped heavy loads. n April 1996, NRC Bulletin 96-02 was issued to alert licensees of potential high consequences that could result from a cask drop and to remind them of complying with existing regulatory guidelines on the control and handling of heavy loads. In nuclear plant operation, maintenance, and refueling activities, heavy loads may be handled in several plant areas. If these loads were to drop because of human error or crane failure, they could impact on stored spent fuel, fuel in the core, or on equipment that may be required to achieve safe shutdown or permit continued decay heat removal. In some instances, load drops at specific times, locations, and weights could potentially lead to offsite doses that exceed 10CFRPart 100 limits. If a licensee elected to use long-term dry storage casks to store excess spent fuel, the large, heavy casks would have to be hoisted and transported to and from the spent fuel pool while the plant is at full power operation. A comprehensive analysis of U.S. nuclear industry crane operating experience from 1968 through 2002 was conducted by the NRC and documented in NUREG-1774. Some of the NRC's findings and observations were: 1) The human error rate for crane operating events increased significantly; 2) Load drop events between the period 1993-2002 increased over the period 1981-1992; 3) The number of below-the-hook crane events (mainly rigging deficiencies or failures) increased greatly; 4) Calculational methodologies, assumptions, and predicted consequences varied greatly from licensee to licensee for very similar accident scenarios; 5) The number of mobile crane events declined slightly; and 6) There were few load slips or drops involving very heavy loads. 7) Criteria for declaring a crane as single-failure-proof were applied inconsistently	The concern of this generic issue is regarding load drops that have occurred in recent years and the possibility that such an event could someday result in the load being dropped onto a source of radioactive inventory, such as stored spent fuel, fuel in the core, equipment that is performing a decay heat removal function, or equipment that would be required for safe shutdown. Per the language of the generic issue, some of the events that have occurred could have been prevented by single failure proof crane design (i.e., load drops or hook and block assembly drops). Many of these "below the hook" events, however, were rigging errors that were strictly the result of manual operator faults, and would not have been prevented by single failure proof crane design. NRC adopted 4 recommendations for development of follow-up guidance. Two of the recommendations involve evaluation and endorsement of cranes and rigging equipment that would result in fewer mishaps. The other two recommendations involve NRC developing guidance on good practices for crane operations, load movements, and load drop calculations. For the US-APWR, design (and later, by the COL Applicant, operational procedures) for the containment polar and refueling cranes, spent fuel pit crane, and auxiliary building crane preclude the dropping of heavy loads. A critical load is defined in ASME NOG-1-200~~2~~4 and referred to in this DCD as any lifted load whose uncontrolled movement or release could adversely affect a nuclear safety-related (SC-1) SSC in terms of its ability to perform a required safety function, or when uncontrolled movement or release could result in potential offsite exposure in excess of 10CFRlimits.	3.5 (design of SSCs - cranes), 9.1.1 through 9.1.5 (descriptions of new and spent fuel handling and storage), chapter 13 (conduct of operations), 15.7.4 (fuel handling accident) 15.7.5 (spent fuel cask drop accident) 18.2 (human factors - operations organization), 18.4 (human factors - task analysis and hazards evaluation), 18.9 (human factors - procedural development)

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Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/Sec.
New Generic Issue #186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants NRC priority: CONTINUE (continued)	8) Among events occurring during the period 1968 through 2002 involving cranes suitable for an upgrade to a single-failure-proof design, most load drop events were the result of poor program implementation or human performance errors that led to hoist wire rope or below-the-hook failures. All three very heavy load drops were the result of rigging failures, not crane failures. Consequently, there were no very heavy load drop events that could have been prevented had only a single-failure-proof crane been employed in the lift. However, there were load or hook and block assembly drops that could have been prevented with the use of single-failure-proof cranes and lifting devices. The screening and technical assessments of the issue were documented in NUREG-1774. At the completion of the technical assessment, four recommendations were made for follow-up guidance development by the NRC staff: 1) Evaluate the capability of various rigging components and materials to withstand rigging errors and issue necessary guidelines for rigging applications. 2) Endorse ASME NOG-1 for Type I cranes as an acceptable method of qualifying new or upgraded cranes as single-failure-proof and issue guidance endorsing the standard, as appropriate. 3) Reemphasize the need to follow Phase I guidelines involving good practices for crane operations and load movements and continue to assess licensee implementation of heavy load controls in safety-significant applications. 4) Request the appropriate industry Code Committees to evaluate the need to standardize load drop calculational methodologies for nuclear power plants.	Cranes that may be used to handle critical loads over SC-I SSCs, are classified as Type I cranes as defined per ASME NOG-1-2002 4, and will conform to the applicable requirements of that standard as well as the Crane Manufacturers Association of America (CMAA) Specification No. 70-004. Type I cranes are designed to remain in place and support the critical load during and after, a seismic event, and are equipped with single failure-proof features in conformance with the requirements of ASME NOG-1-2002 4, to prevent load drops. • Polar Crane - The Reactor Containment is designed to have a reactor cavity of reinforced concrete construction with stainless steel lining, and is equipped with a refueling crane and a polar crane that will enable refueling operation to be carried out on the main operating Floor. The polar crane girder is directly fixed to the cylindrical portion of the containment vessel. When in use, the polar crane is under administrative controls. During hot standby and hot shutdown, it is anticipated that the polar crane will be used to minimize critical path outage times for cold shutdowns and refueling, and to assist with maintenance that can be performed in a hot plant condition. Planned usage includes activities such as crane inspections, operability checks, and movement of tools and equipment required for the cold shutdown/refueling outage. The anticipated loads would not be required to be lifted in the vicinity of the reactor vessel.	

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Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/Sec.
New Generic Issue #186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants NRC priority: CONTINUE (continued)		• Refueling Crane - The refueling crane is a bridge crane consisting of a frame and transfer carriage that move horizontally on the rail installed on the canals inside the reactor cavity and inside the reactor containment vessel. On the transfer carriage are a control platform and a mast tube assembly, including the gripper tube to grip the fuel assemblies. Contained in the mast tube, a fuel assembly can be moved to an appropriate position in the canals inside the reactor cavity and inside the reactor containment vessel. The gripper located in the lower part of the gripper tube is pneumatically operated, and is provided with a device that prevents the fuel assembly from being dropped by the gripper. If there is no air pressure, the fuel is held and cannot be removed from the gripper. Furthermore, the crane is provided with a load indicator and interlocks that prevent a lifting operation if the preset load is exceeded, thereby preventing an assembly from being dropped due to excessive load. Interlocks are also provided to assure safe and secure operation of the frame and transfer carriage, as well as safe and secure ascending and descending of the gripper tube. The refueling crane is designed with a device that secures the traveling portion to the rail so that it never falls, including during the earthquake event. • Spent Fuel Pit Crane - The spent fuel pit crane is a bridge crane running above the spent fuel pit and moves the spent fuel by a hoist, to which are attached a special frame and handling tools. The spent fuel pit crane is designed to "fail as is" with a loss of driving power, and a mechanical interlock for the handling tools is	

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Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/Sec.
New Generic Issue #186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants NRC priority: CONTINUE (continued)		provided so that the fuel assembly will not drop during fuel handling. The spent fuel pit crane is designed with a device that secures the traveling portion to the rail so that it never falls, including during the earthquake event. • ~~Auxiliary Building~~ Spent Fuel Cask Handling Crane - The ~~A/B~~ spent fuel cask handling crane is an overhead traveling crane designed to safely and securely transfer the fresh fuel transport container, spent fuel transport packaging, and fresh fuel. The ~~A/B~~ spent fuel cask handling crane is also designed so that it never falls, including during the earthquake event. US-APWR cranes that will not handle critical loads over SC-I SSCs are not required to have single failure-proof features, however any such cranes that may travel over SC-I SSCs will be designed to remain in place during a seismic event. Cranes that handle critical loads as well as non-critical loads will conform to the applicable requirements of ASME NOG-1-200~~2~~4, and CMAA Specification No. 70-004 or CMAA Specification No. 74-04, for their applicable lifts. Further, cranes are designed according to the crane structural standard and so structured as to prevent diversion and derailment. Also, in the measures against earthquake, drop prevention design is employed based on earthquake design criteria. Therefore, load drops and derailment of cranes do not represent credible sources of missiles that would jeopardize safety-related SSCs, and load drop missiles are not postulated. The significance of crane operation and restricted	

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Table 1.9.3-1 Co ues (sheet 19 of 30)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/Sec.
New Generic Issue #186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants NRC priority: CONTINUE (continued)		load movement around the reactor vessel will be stressed to those involved with heavy load lifts. Anticipated heavy load movements will be analyzed as required by NUREG 0612 and safe load paths defined. However, all specific loads and load paths cannot be defined prior to the operations. For these cases, it is anticipated that safe load path considerations will be based on comparison with analyzed cases, previously defined safe movement areas, and previously defined restricted areas and reviewed by the COL Applicant's plant review board. Load Handling Procedures - Movements of heavy loads will be controlled to protect safety-related SSCs. Load handling operations for heavy loads that are or could be handled over or in proximity to irradiated fuel or safe shutdown equipment will be controlled by written procedures. As a minimum, procedures will be used for handling loads with spent fuel cask bridge crane and polar crane, and for those loads listed in table 3-1 of NUREG 0612. It is anticipated that each procedure will address: • Specific equipment required to handle load (e.g., special lifting device, slings, shackles, turnbuckles, clevises, load cell, etc.). • Requirements for crane operator and riggers qualification • Requirements for inspection prior to load movement and acceptance criteria for inspection • Defined safe load path and provisions to provide visual reference to the crane operator and/or signal person of the safe load path envelope • Specific steps and proper sequence to be followed for handling load	<u>9.1.5</u>

Table 3.2-2 Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 41 of 53)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards[(3)]	Seismic Category	Notes
30. Miscellaneous Plant Equipment							
PCCV polar crane	5	PCCV	N/A	N/A	5	II	These single-failure-proof cranes are designed in accordance with NUREG-0554 to maintain their position and hold their loads during an SSE.
Spent fuel cask handling crane	5	R/B	N/A	N/A	5	II	
~~Essential service water pump pit crane~~	~~5~~	~~UHSRS~~	~~N/A~~	~~N/A~~	~~5~~	~~II~~	
Miscellaneous ~~C~~ cranes and hoists in reactor building	5	R/B	N/A	N/A[(4)]	5	II	
Miscellaneous hoists in power source buildings	5	PS/B	N/A	N/A[(4)]	5	II	
Crane for SWDS in auxiliary building	5	A/B	N/A	N/A	5	II	
31. Containment Purge System							
Containment high volume purge air handling unit	5	R/B	N/A	N/A	5	NS	
Containment high volume purge air handling unit fan	5	R/B	N/A	N/A	5	NS	
Containment high volume purge air handling unit cooling coil	4	R/B	D	N/A	5	NS	
Containment high volume purge air handling unit electric heating coil	5	R/B	N/A	N/A	5	NS	
Containment high volume purge exhaust filtration unit	5	A/B	N/A	N/A	5	NS	
Containment high volume purge exhaust filtration unit fan	5	A/B	N/A	N/A	5	NS	
Containment high volume purge exhaust filtration unit high-efficiency particulate air filter	5	A/B	N/A	N/A	5	NS	
Containment low volume purge air handling units	5	R/B	N/A	N/A	5	NS	

3.7-12 United States Nuclear Regulatory Commission Staff Requirement Memorandum SECY-93-087, Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, James M. Taylor, Executive Director of Operations, April 2, 1993.

3.7-13 IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, IEEE Std 344-2004, Appendix D, Institute of Electrical and Electronic Engineers Power Engineering Society, New York, New York, June 2005.

3.7-14 McGuire, R.K., Silva, W.J., and Costantino, C.J. Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines, NUREG/CR-6728, U.S. Nuclear Regulatory Commission, Washington, DC, October 2001.

3.7-15 Damping Values for Seismic Design of Nuclear Power Plants, Regulatory Guide 1.61, Rev.1, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3.7-16 Seismic System Analysis, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, SRP 3.7.2, Rev.3, United States Nuclear Regulatory Commission, March 2007.

3.7-17 An Advanced Computational Software for 3D Dynamic Analysis Including Soil-Structure Interaction, ACS SASSI PREP User's Guide, Revision 2, for ACS SASSI, Version 2.2, Ghiocel Predictive Technologies, Inc. Pittsford, NY.

3.7-18 Dynamic Analysis of the Coupled RCL-R/B-PCCV-CIS Lumped Mass Stick Model, MHI Technical Report, Later.

3.7-19 Design Guidance For Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants, Regulatory Guide 1.143, Rev.2, U.S. Nuclear Regulatory Commission, Washington, DC, November 2001.

3.7-20 NASTRAN, Femap with NX NASTRAN, Version 9.3.

3.7-21 ANSYS, Advanced Analysis Techniques Guide, Release 11.0, ANSYS, Inc., 2007

3.7-22 Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder), American Society of Mechanical Engineers, ASME-NOG-1 (i.e., Nuclear Overhead Gantry), New York, ~~1995~~ 2004.

3.7-23 Quality Assurance Requirements for Nuclear Facility Applications, The American Society of Mechanicals Engineers, NQA-1-2004, New York, New York, December 2004.

3.7-24 Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers/Structural Engineering Institute, ASCE/SEI 7-05, Reston, VA, 2006.

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2.7.6.5 Overhead Heavy Load Handling System

2.7.6.5.1 Design Description

System Purpose and Functions

The purpose and function of the overhead heavy handling system (OHLHS) is to move heavy loads. For the US-APWR, a heavy load is defined as any load greater than approximately 2450 lbs. The OHLHS is non-safety related.

Location and Functional Arrangement

The OHLHS exists in the reactor building, specifically the fuel storage and handling area, and in the pre-stressed concrete containment vessel (PCCV) of the reactor building. The functional arrangement and design characteristics of the OHLHS are discussed below.

Key Design Features

Key design features of the OHLHS include:

- The primary equipment used in the OHLHS are the spent fuel cask handling crane in the fuel handling area and the polar crane in the PCCV.
- The spent fuel handling crane has three load handling hooks, the main, the auxiliary, and the suspension crane.
- The suspension crane is only used for new fuel assembly handling between a new fuel container to the new fuel storage area or between the new fuel storage rack and the basket on the new fuel elevator. Because of this limitation, the suspension crane is considered part of the Light Load Handing System (LLHS) (Subsection 2.7.6.4).
- The polar crane has a seismic restraint system which precludes derailment of either the hoist trolley or the main bridge box girders during a seismic event.
- The main hooks of the PCCV polar crane and the spent fuel cask handling crane are designed as single-failure-proof cranes. Special lifting devices and slings used for critical load handling operations in conjunction with these cranes have dual load paths or double safety factors.

Seismic and ASME Code Classifications

The OHLHS is seismic Category II.

System Operation

The OHLHS operation includes:

- A spent fuel cask filled with spent fuel assemblies is lifted and transferred using the main hoist of the spent fuel cask handling crane and the spent fuel cask lift rig.
- During refueling, the reactor vessel head assembly and the upper and lower reactor internals are transferred using the polar crane's main hook and a lifting rig.
- Reactor coolant pump motors and other similar sized equipment are transferred using the polar crane's auxiliary hook.

Alarms, Displays, and Controls

There are no main control room alarms, displays, or controls associated with the OHLHS.

Logic

Not applicable.

Interlocks

The OHLHS is equipped with mechanical and electrical limit devices to disengage power to the motors as the load hook approaches its travel limits or to prevent damage to other components when continued operation would potentially damage the OHLHS.

The control system includes safety devices which assure that the OHLHS returns to and/or maintains a secure holding position of critical loads in the event of a system fault.

Class 1E Electrical Power Sources and Divisions

Not applicable.

Equipment to be Qualified for Harsh Environments

Not applicable.

Interface Requirements

here are no safety-related interfaces with systems outside of the certified design.

Numeric Performance Values

~~The safety analysis states that because the spent fuel cask handling crane is prohibited from traveling directly over the spent fuel, a spent fuel cask drop accident is an implausible event and is not required to be analyzed in the safety analysis.~~

The PCCV polar crane and the spent fuel cask handling crane are designed as single-failure-proof to prevent uncontrolled lowering of heavy loads. Therefore, no load drop accident analysis is required. Crane axle failure may result in limited slip of the lifted load, causing impact on the floor, which has been accounted for in the structural design.

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2.7.6.5.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.6.5-1 describes the ITAAC for the OHLHS.

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Table 2.7.6.5-1 Overhead Heavy Load Handling System Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the OHLHS is as described in Subsection 2.7.6.5.1 Design Description.	1. An inspection of the as-built OHLHS will be performed.	1. The as-built OHLHS conforms to the functional arrangement described in the Design Description of this Subsection 2.7.6.5.1.
2.a The seismic Category II OHLHS is designed so that the SSE could not cause unacceptable structural interaction or failure with seismic category I SSCs.	2.a A combination of inspection, tests and/or analyses will be performed on the as-built seismic Category II OHLHS.	2.a A report exists and concludes that the as-built seismic Category II OHLHS equipment ~~identified in Table 2.7.6.4-1~~ are designed so that the SSE could not cause unacceptable structural interaction or failure with seismic category I SSCs.
2.bThe polar crane has a seismic restraint system which precludes derailment of either the hoist trolley or the main bridge box girders during a seismic event.	2.b A combination of inspection, tests and/or analyses will be performed on the as-built polar crane seismic restraint system.	2.b A report exists and concludes that the as-built polar crane seismic restraint system precludes derailment of either the hoist trolley or the main bridge box girders during a seismic event.
2.c.i The PCCV polar crane and the spent fuel cask handling crane main hook are designed as single-failure-proof cranes.	2.c.i A combination of inspection, tests and/or analyses will be performed on the as-built OHLHS.	2.c.i A report exists and concludes that the as-built PCCV polar crane and the spent fuel cask handling crane main hook are single-failure proof.
2.c.ii Special lifting devices and slings used in conjunction with the PCCV polar crane and the spent fuel cask handling crane main hook during critical load handling operations have dual load paths or double safety factors.	2.c.ii A combination of inspection, tests and/or analyses will be performed on the as-built OHLHS.	2.c.ii A report exists and concludes that the as-built special lifting devices and slings used in conjunction with the PCCV polar crane and the spent fuel cask handling crane main hook during critical load handling operations have dual load paths or double safety factors.
3. The OHLHS is equipped with mechanical and electrical limit devices to disengage power to the motors as the load hook approaches its travel limits or to prevent damage to other components when continued operation would potentially damage the OHLHS.	3. Tests of the as-built OHLHS mechanical and electrical limit devices to disengage power to the motors as the load hook approaches its travel limits will be performed.	3. The as-built OHLHS is equipped with mechanical and electrical limit devices to disengage power to the motors as the load hook approaches its travel limits.

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Table 9.1.5-3 Cranes and Hoists Installed Over Safe Shutdown Equipment

Crane and Hoist	Crane/Hoist Type	Location	Maximum Load Rating (metric tons)	ASME NOG-1 Type	Single–Failure-Proof	Seismic Category
Polar Crane	Top-Running Overhead Bridge Crane	PCCV	250	I	Yes	II
Spent Fuel Cask Handling Crane	Top-Running Overhead Bridge Crane	R/B (Fuel handling area)	135	I	Yes	II
MSIV(main steam isolation valve) room crane	Underhung overhead crane	R/B (MS/FW Piping Area hung from roof slab)	10	NA	No	II
PCCV Equipment Hatch Hoist	Base Mounted Drum Hoist	PCCV (above equipment hatch at azimuth 40°)	40	NA	No	II
Safety Injection Pump(SIP) Room Hoist	Monorail Hoist	R/B (SIP Rooms, Floor EL. -26'-4")	5	NA	No	II
CS/RHR Pump Room Hoist	Monorail Hoist	R/B (CS/RHR Pump Rooms, Floor EL. -26'-4")	5	NA	No	II
EFW Pump Room Hoist	Monorail Hoist	R/B (EFW Pump Rooms, Floor EL. -26'-4")	5	NA	No	II
CCW Pump Hoist	Monorail Hoist	R/B (CCW Rooms, Floor EL. -26'-4")	5	NA	No	II
CCW Heat Exchanger Hoist	Monorail Hoist		2	NA	No	II
Essential Chiller Unit Hoist	Monorail Hoist	East and West PS/B (Basement Floor EL. -26'-4")	3	NA	No	II

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oriented in a radial pattern originating at the dome apex. The dome rib plates are stiffened with 5 in. by 3 in. by 1/4 in. angles running horizontally in the hoop direction, spaced approximately at 34 in. maximum. Where acceptable based on the results of the liner anchorage stress and strain design analyses (discussed in Subsection 3.8.1.4), the liner anchors are connected to the liner using discontinuous welds such as stitched fillet welds.

Figure 3.8.1-1 provides the overall dimensions of PCCV and Figure 3.8.1-5 provides GA of prestressing tendons and conventional reinforcement of the PCCV shell. Figure 3.8.1-3 and 4 also show the liner anchorage system arrangement.

3.8.1.1.2 Equipment Hatch

Figure 3.8.1-6 provides the equipment hatch general layout. The hatch is located at centerline elevation 86 ft, 3 in., azimuth 40 degrees, and is a 27 ft, 11 in. diameter spherical dish with a convex profile projecting into the PCCV volume. The containment internal pressure places the hatch head into compression against a double-sealed seat on the frame. The space between the two seals is capable of pressure testing for leakage across either seal.

A lifting rig with an electrically powered hoist is provided to disengage, raise ~~transport~~, and store the hatch in a secure position above ~~next to~~ the opening during outages. When required to seal the opening, the hatch is lowered ~~transported~~ back by hoist, repositioned, refastened, and pressure tested for leaks.

3.8.1.1.3 Personnel Airlocks

Figure 3.8.1-7 provides the general layout for the two personnel airlocks. The lower airlock at centerline elevation 28 ft, 10 in. is located at azimuth 24 degrees, and upper airlock at centerline elevation 80 ft, 2 in. is located at azimuth 120 degrees. The airlock inside diameter is 8 ft, 6-3/8 in.

3.8.1.1.4 Mechanical Penetrations

Several typical PCCV penetrations are shown in Figure 3.8.1-8.

Figure 3.8.1-8, Sheet 12, shows typical details for the main steam penetrations. An anchor flange disc is embedded along the outer surface of the PCCV wall, with 12 triangular gussets at equal spacing connecting the flange disc and a 60 in. Outside Diameter (OD) cylindrical pipe sleeve, which is capped with a flexible boot outside the PCCV. A similar gusset configuration exists at the PCCV inner wall surface connecting the pipe sleeve to the thickened steel liner. The sleeve extends approximately 3 ft, 9-1/4 in. inside containment for Loops A and D, and 4 ft, 3-1/4 in. for Loops B and C as measured along the sleeve centerline, and is closed off by a thickened end cap with a concentric opening for the passage of the steam line. The 32 in. OD main steam pipe passes through the sleeve opening, and a thickened pipe wall is welded to the end cap, but allowed to expand outside the PCCV.

Figure 3.8.1-8, Sheet 13, shows typical details for the startup feedwater penetration. An anchor flange disc is embedded along the outer surface of the PCCV wall, with eight triangular gussets at equal spacing connecting the flange disc and 30 in. OD cylindrical