ENTERGY NUCLEAR OPERATIONS

DOCKET NO. 50-003

INDIAN POINT GENERATING UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 53
License No. DPR-5

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Entergy Nuclear Operations, Inc., (Entergy, the licensee), dated February 27, 2007, as supplemented October 3, 2007, and February 27, 2008, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I;

   B. The facility will be maintained in conformity with the application, as amended, the provisions of the Act, and the applicable rules and regulations of the Commission;

   C. There is reasonable assurance: 1) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public; and 2) that such activities will be conducted in compliance with applicable portions of the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 53, the license is amended to authorize revision to the Final Safety Analysis Report (FSAR), as set forth in the application for amendment by Entergy dated February 27, 2007, as supplemented by letters dated October 3, 2007, and February 27, 2008. Entergy shall update the FSAR by the next periodic update, to reflect the revisions authorized by this amendment in accordance with 10 CFR 50.71(e).

3. The license amendment is effective as of its date of issuance, with the implementation to begin immediately and completed by the next periodic update to the FSAR in accordance with 10 CFR 50.71(e). Implementation of the amendment is the incorporation into the FSAR the revisions described in the amendment application of February 27, 2007, as supplemented by letters dated October 3, 2007, and February 27, 2008, and evaluated in the NRC staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Keith I. McConnell, Deputy Director
Decommissioning and Uranium Recovery
Licensing Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials and
Environmental Management Programs

Date of Issuance: May 9, 2008

SAFETY EVALUATION BY OFFICE OF FEDERAL AND STATE MATERIALS

AND ENVIRONMENTAL MANAGEMENT PROGRAMS

RELATED TO AMENDMENT NO. 53 TO FACILITY OPERATING LICENSE NO. DPR-5

ENTERGY NUCLEAR OPERATIONS, INC.

INDIAN POINT ENERGY CENTER, UNIT 1

DOCKET NO. 50-003

1.0 INTRODUCTION

By application dated February 27, 2007, (Agencywide Document and Access Management System (ADAMS) Accession No. ML070740552), as supplemented by letters dated October 3, 2007, (ADAMS Accession No. ML073050247), and February 27, 2008, (ADAMS Accession No. ML080630507), Entergy Nuclear Operations, Inc. (Entergy, the licensee) requested changes to the Final Safety Analysis Report (FSAR) for the Indian Point Energy Center, Unit 1 (IP-1). The supplements dated October 3, and February 27, 2008, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on June 19, 2007 (72 FR 33779).

The amendment would enable the licensee to make changes to the FSAR to reflect the use of the non-single-failure-proof Fuel Handling Building (FHB) crane main hoist for dry spent fuel cask component lifting and handling operations. Specifically, the FHB crane main hoist will be used for the lifting and handling of the spent fuel canister, canister lid, and transfer cask, as needed. This amendment would change the IP-1 FSAR to reflect this proposed use of the FHB crane main hoist. The licensee has stated that the FSAR will be revised to include a summary of the activities in support of dry spent fuel storage that take place in the IP-1 FHB, and to add a discussion related to the spent fuel storage cask component drops.

2.0 BACKGROUND

IP-1 was permanently shut down in October 1974, and is currently in safe storage condition (SAFSTOR). SAFSTOR is the decommissioning method in which a nuclear facility is placed and maintained in a condition that allows the safe storage of radioactive components of the nuclear plant and subsequent decontamination to levels that permit license termination. A Decommissioning Plan (DP) was approved in January 1996. Subsequent to the 1997 decommissioning rule, the licensee converted its DP into its FSAR.

NRC Bulletin 96-02, “Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor, or Over Safety-Related Equipment” requested licensees to review and report their plans and capabilities for handling heavy loads in accordance with existing regulatory guidelines and within their licensing basis as previously analyzed in their FSAR. In response, IP-1 committed to submit a License Amendment Request (LAR) should spent fuel cask handling operations be resumed in the IP-1 Fuel Handling Building, and if a cask was to be lifted over the spent fuel pool or in a manner otherwise outside the licensing basis.

The licensee, in its letter dated February 27, 2007, provided the background as summarized in the following subsections.

2.1 Fuel Handling Building 75-ton Crane Design and Licensing Considerations

The IP-1 FHB 75-ton crane was designed and procured in 1958 and installed in the FHB for plant startup in 1962. It is a non-safety-related, commercial-grade crane originally designed and licensed to lift and handle a spent fuel shipping cask. The crane was used to load and transport 124 Core A fuel assemblies and 120 Core B fuel assemblies from IP-1 to an off-site fuel reprocessing facility. The loading and transport, which utilized two casks and was completed without incident, required several hundred lifts of the 30-ton shipping casks. The crane was also used to lift and move individual spent fuel assemblies within the spent fuel pool and between the spent fuel pool and the cask loading pool.

The FHB 75-ton crane is a bridge-and-trolley design that is not single-failure-proof as defined in NUREG-0612, "Control of Heavy Loads at Power Plants," Resolution of Generic Technical Activity A-36, issued July 1980 (NUREG-0612) and its design pre-dates publication of that document. However, many of the criteria contained in NUREG-0612 pertaining to crane design, maintenance, and inspection, as well as operator training, safe load paths, and design of lifting devices associated with cask handling are, or will be met, as part of the dry cask storage project at IP-1. The FHB 75-ton crane main hoist has a rated load of 75 tons and the auxiliary hoists have a rated load of 15 tons and 3 tons respectively. Only the main hoist is used to lift the transfer casks.

A review of the crane design, maintenance, and operational history was performed. This review concluded that with additional analysis, inspections, and load testing, the 75-ton HI-TRAC 100D-Version IP1™ transfer cask loaded with spent fuel can be handled by the 75-ton crane main hoist with a load drop being a highly unlikely event. An analysis was performed to demonstrate the crane can handle the rated load under the limiting loading conditions including a seismic event concurrent with a loaded cask suspended from the main hook. Inspections of welds, bolting, and structural steel were performed to provide reasonable assurance that the crane was installed according to the design drawings and specifications. However, consistent with the guidance in NUREG-0612, because the crane is not single failure proof, several hypothetical drops of heavy loads associated with cask loading have been analyzed to ensure their consequences were acceptable.

The HI-TRAC 100D-Version IP1™ transfer cask and the Multiple Purpose Canister (MPC) must be lifted and moved several times during fuel loading operations in the FHB. At various points in the operation, the empty transfer cask with the empty MPC, the MPC lid, and the fuel-loaded transfer cask and MPC must be lifted and handled by the FHB 75-ton crane. Five lifts out of the cask load pool of a fuel-loaded transfer cask and MPC, approaching the 75-ton design rating of the crane, are planned to be performed to place the transfer cask and MPC at the cask preparation work station.

Five additional lifts of the fuel-loaded transfer cask and seal welded MPC are planned to place the transfer cask and sealed MPC on the air transporter pad for movement out of the FHB. These five additional lifts are a few inches in height, over the FHB truck bay floor.

The locations where drops are postulated and evaluated comply with the applicable Part 50 licensing requirements, and are consistent with the guidance in NUREG-0612, NRC Bulletin 96-02, and Regulatory Issues Summary RIS-2005-25.

To mitigate the consequences of two of the postulated transfer cask drops, namely, the vertical cask drop into the cask load pool and a tilted transfer cask drop also into the cask load pool, an impact limiter will be employed on the floor of the cask load pool to limit the g forces to which the transfer cask, MPC, and fuel in the loaded MPC would be exposed. The impact limiter serves no Part 50 design function since (1) the transfer cask and MPC will not be lifted over or near (within 15 ft) the spent fuel pool, (2) there is no safety related or essential-to-operation equipment in the FHB, and (3) the entire travel path of the load is exclusively over concrete floors founded directly on bed rock or engineered fill.

FHB Loading Operations Summary

The HI-STORM 100S Version B, Type 185 System™ will be used for dry cask storage of IP-1 spent fuel at the IPEC Independent Spent Fuel Storage Installation (ISFSI). This IP-1 custom-designed dry spent fuel storage system is currently under NRC review as a proposed amendment to the Holtec HI-STORM 100 System 10 CFR 72 Certificate of Compliance (CoC). The ISFSI will serve as the temporary storage facility for spent fuel from IPEC Units 1, 2, and 3 until such time as the fuel is removed from the site and sent to a federal repository. Five of the storage systems will contain all of the fuel from the "SAFESTOR" Unit 1, and the remaining storage systems will contain fuel from operating Units 2 and 3.

The HI-STORM 100S Version B, Type 185 System™ consists of a multi-purpose canister (MPC-32) which is capable of holding 32 IP-1 fuel assemblies; a Transfer Cask (HI-TRAC 100D-Version IP1™), which contains the MPC during loading, unloading, and transfer operations; and a storage overpack (HI-STORM 100S Version B, Type-185™), which provides shielding, heat removal capability, and structural protection for the MPC during storage operations at the ISFSI. IP-1 fuel is stainless steel clad and the fuel rods are shrouded in a protective sheath. The assemblies are nominally 137 in. long. Because of the unique configuration of the IP-1 fuel, the five HI-STORM 100S, Version B, Type185™ systems are specifically designed for IP-1 and are not interchangeable with Units 2 and 3 or any other pressurized water reactor (PWR).

The 75-ton crane is required to lift and handle the HI-TRAC transfer cask and MPC (both empty and loaded with spent fuel) and the MPC lid in support of dry cask loading. The combined maximum lift weight, including rigging and lift yoke will not exceed 75 tons, which is the design rated load of the IP-1 FHB 75-ton crane.

All the IP-1 fuel is stored in the west fuel pool. The east fuel pool is currently not used for fuel storage. IP-1 also has disassembly and cask loading pools.

During each of the five cask loading evolutions, spent fuel assemblies are moved one at a time, from the spent fuel racks in the west pool, through a gate slot into the disassembly pool, through a second gate slot into the cask load pool and into the MPC. The cask load pool and the disassembly pool will have been previously flooded to the same level as the west spent fuel pool and the intermediate gates will have been removed. Once the MPC is loaded with 32 fuel assemblies, the MPC lid is installed under water, and the transfer cask with the loaded MPC inside is lifted by the 75-ton crane and placed on the 70 ft 6 in. floor to the east of the cask load pool. The horizontal cask trolley movement totals approximately 22 ft from the cask load pool position to the cask preparation work station in the adjacent area to the east.

At the 70 ft 6 in. location, the MPC is seal welded and the canister is drained, dried, and backfilled with helium and leak tested in accordance with the 10 CFR 72 Certificate of Compliance (CoC) and cask FSAR. The transfer cask containing the sealed MPC is lifted a few inches and placed on an air castor and moved northward out of the FHB. A Vertical Cask Transporter (VCT) will move the transfer cask to the Unit 2 FHB where it is placed on top of an empty storage overpack using the Unit 2 single-failure-proof gantry crane. The Unit 2 gantry crane is disengaged from the transfer cask lifting trunions and rigged to lift the MPC, which is inside the transfer cask. The MPC is lifted to take its weight off the transfer cask pool lid, which is then removed, and the MPC is lowered through the transfer cask into the overpack. After the overpack lid is installed, the HI-STORM overpack is transported to the ISFSI using the VCT.

The evolutions performed in the Unit 2 FHB with the gantry crane are essentially identical to the operations associated with the Unit 2 fuel handling operations reviewed and approved by the NRC on November 21, 2006 (ADAMS Accession No. ML053000051), except for the IP-1 MPC and transfer cask being shorter and lighter than the corresponding Unit 2 components.

3.0 REGULATORY EVALUATION

The regulatory requirements and regulatory guidance on which the U.S. Nuclear Regulatory Commission (NRC) staff based its review are discussed below:

NUREG-0612 provides guidelines and recommendations to assure safe handling of heavy loads by prohibiting, to the extent practicable, heavy load travel over stored spent fuel assemblies, fuel in reactor core, safety-related equipment, and equipment needed for decay heat removal.

NUREG-0612 provides the basis for review of the licensee-proposed handling of heavy loads during the dry spent fuel cask loading operation. NUREG-0612 endorses a “defense-in-depth” approach for handling of heavy loads near spent fuel and safe shutdown systems to minimize load handling accidents and their consequences. General guidelines for overhead handling systems that are used to handle heavy loads in the area of the reactor vessel and spent fuel pool are given in Section 5.1.1 of NUREG-0612. They are as follows: (1) definition of safe load paths; (2) development of procedures for load handling operations; (3) training and qualification of crane operators in accordance with Chapter 2-3 of American National Standards Institute (ANSI) B30.2-1976; (4) use of special lifting devices that meet guidelines in ANSI N14.6-1978; (5) installation and use of non-custom lifting devices in accordance with ANSI B30.9-1971; (6) inspection, testing, and maintenance of cranes in accordance with Chapter 2-2 of ANSI B30.2-1976; and (7) design of crane in accordance with Chapter 2-1 of ANSI B30.2-1976 and Cranes Manufacture of America (CMMA) Standard 70 (CMMA-70), "Overhead and Gantry Cranes (1967)."

NUREG-1864, “*A Pilot Probabilistic Risk Assessment Of a Dry Cask Storage System At a Nuclear Power Plant*”, Issued March 2007 (NUREG-1864), develops and assesses a comprehensive list of initiating events, including dropping the cask during handling and external events during onsite storage (such as earthquakes, floods, high winds, lightning strikes, accidental aircraft crashes, and pipeline explosions), and models potential cask failures from mechanical and thermal loads.

4.0 TECHNICAL EVALUATION

The technical evaluations of the proposed amendment considered welding and nondestructive examinations of the crane, structural adequacy of the crane, load drop analysis of the spent fuel cask and components, and load drop analyses of the spent fuel.

4.1 Welding and Nondestructive Examination of the Crane

Materials and Fabrication

Section 4.3 (Crane Structural Steel) of Attachment 1 to the licensee's license amendment request dated February 27, 2007 (ML070740552), stated that an engineering review of the crane's past inspection and maintenance history was performed. As a result of this review and in preparation for the planned dry cask loading effort, critical structural areas were identified and inspected. In its supplemental letter dated October 3, 2007 (ML073050247), the licensee stated that the critical components were identified based on (1) analysis results of the integrated crane and building model showing locations of high loading (e.g., bridge girder bolting to end trucks); (2) locations of significance from a primary load path standpoint (e.g., main hook); (3) locations of significance from a basic structural mechanics/strength of materials standpoint (e.g., bridge girder welds at mid-span cross-section extremes); and (4) locations of significance based on structural engineering experience (e.g., end truck bolting securing wheel bearing housing). The nondestructive examinations (NDE) comprised of performing visual testing (VT), ultrasonic testing (UT) and magnetic particle testing (MT) at the identified inspection locations. The inspections were performed using Entergy procedures by Level 2 inspectors. This inspection confirmed that all of the selected critical welds were in acceptable condition. However, the inspection identified cracking in some bridge rail tie-down bolting which were made of copper alloy 655 material (currently alloy UNS (Unified Numbering System) C65500). All such bolting was replaced with ASTM (American Society for Testing and Materials) A-307 bolting. The staff finds that the results of this review and inspection will provide reasonable assurance that the crane structural steel components will perform as designed.

Section 4.3 also stated that, as a result of the seismic qualification effort, the trolley-to-end truck bolting was replaced to assure the adequacy of the bolting to resist the calculated seismic stresses. In its supplemental letter dated October 3, 2007, the licensee stated that the reason for the replacement is due to the finding that the crane drawings do not identify the bolt material. Based on a search of available materials during the period of crane assembly, it was determined that the bolts could be made by either ASTM A-7 or ASTM A-325 material. ASTM A-7 material was found to not satisfy the design requirements of supporting the maximum load lift during a seismic event. Since the available NDE is not capable of confirming the material of the bolts, the licensee replaced all such bolts with ASTM A-325 bolts.

Section 4.4 (Crane Inspections and Tests) stated that the IP-1 FHB 75-ton crane received pre-use inspections, quarterly exercise and operational inspections and an annual inspection by Whitey Services based upon 29 CFR 1910, Section 179, "Overhead and Gantry Cranes" and the original manufacturer's specifications. In its supplemental letter dated October 3, 2007, the licensee stated that the most recent inspections were performed prior to and following the proof test. Whiting Services, Inc. performed the pre- and post proof load test inspection of the crane on March 2, 2007 and March 14, 2007, respectively. The proof test was performed on March 6,

2007. The lift load test block used was 125.6% of the 150,000 lbs (75 tons) rated crane load. NDE comprising of VT, MT or UT was performed to verify the condition of the critical structural components. The licensee stated that the following critical structural components were inspected by NDE after the proof test: main hook, east/west end girder and truck welds, east/west end trolley and girder bolting, east/west end truck and locator bolting, east/west end truck tie welds, bridge girder welds and end truck wheel bolting. All of the post-proof test inspections were acceptable. NRC staff finds that the results of the proof test and the post-proof test inspections will provide reasonable assurance that the structural integrity of the critical crane components will be maintained when lifting the load as designed.

In its supplemental letter dated October 3, 2007, the licensee stated that the original crane specification (MP-5830, dated July 11, 1958) required fabrication welding to be in conformance with the latest applicable ASTM specifications. No significant structural modifications have been made on the crane since original fabrication. However, weld records or information beyond the original purchase specification requirements could not be found. The licensee also stated that any minor post-installation welding on the crane structure has been done in accordance with Indian point site procedures referencing AWS (American Welding Society) Welding Code D1.1 (Structural Welding code-Steel). The NRC staff finds that the fabricated welds at the subject crane are acceptable because they are fabricated in accordance with the applicable ASTM specifications or AWS Welding Code D1.1 and that the quality of the fabricated welds was successfully demonstrated by the results of NDE inspection and the 125% proof test.

Based upon its review of the information submitted by the licensee, the NRC staff finds that the critical structural components associated with the IP1 FHB 75-ton crane are of acceptable quality and thus reasonable assurance of adequate structural integrity and safety exists to ensure the subject crane will perform as designed.

4.2 Structural Adequacy of the Crane

4.2.1 Background of the IP-1 FHB 75-ton Crane and Proposed Cask Handling Operations

The licensee provided the background of the FHB crane in Section 3.1 of the LAR. The licensee stated that the IP-1 FHB 75-ton crane was designed and procured in 1958 (without seismic considerations) and installed inside the non-safety-related FHB for plant startup in 1962. The crane is a commercial-grade bridge-and-trolley design that is non-safety-related and non-single-failure-proof as defined in NUREG-0612. The crane was originally designed, licensed and used to lift and handle the 30-ton GE IF-200 spent fuel shipping casks.

The licensee stated that the crane design and procurement process predated the issuance of 10 CFR 50 Appendix B, NUREG-0612, and associated Generic Letters and Regulatory Guides. As part of the IP-1 Dry Cask Storage project, a comprehensive evaluation was undertaken to review the FHB crane original design, maintenance and operational history details and compare them to what is recommended by NUREG-0612 and current standard practice, design, and operational guidance. From this review and the results of additional calculations (including seismic qualification), inspections, and testing, the licensee concluded that the crane and superstructure are suitable for use in IP-1 dry storage cask loading operations.

The licensee stated that many of the criteria contained in NUREG-0612 pertaining to crane design, maintenance, and inspection, as well as operator training, safe load paths, and design of lifting devices associated with cask handling are, or will be met, as part of the dry cask storage project at IP-1. The licensee provided a matrix comparing the IP-1 cask handling operation to NUREG-0612 criteria in Table 4 of the LAR. In Attachment Three of the LAR, the licensee made commitments that included implementation of the General Guidelines of NUREG-0612 with regard to the FHB 75-ton crane.

By letter of September 7, 2007 (ML072480497), NRC staff requested the licensee to provide information on the preventive measures/controls that it would have in place to ensure that the auxiliary hoists (rated loads of 15 tons and 3 tons) are not used inadvertently in the transfer cask handling operations. In its response dated October 3, 2007 (ML073050247), the licensee stated that the Unit 1 cask loading operations will be controlled by specific cask loading procedures which will clearly require the use of the main hoist for the transfer cask and cask lid lifts. The licensee's response also indicated that the Holtec designed and fabricated special lifting device has been specifically designed to mate with the main hoist sister hook. The subject lifting device is not compatible with the smaller auxiliary hoists.

The licensee's response to NRC staff questions indicates that the procedures and the mating design of the special lifting device for the cask lifts ensure that only the main hoist can be used for the cask lifts. The staff finds the response acceptable since it adequately addressed the staff's concern.

In Table 4 of Attachment 1 of the LAR, the licensee provided an evaluation of the FHB crane design in comparison to design requirements in Section 5.1.1(7). The licensee stated that the IP-1 FHB bridge crane was fabricated in 1958 in accordance with specification requirements that required the crane to be designed in accordance with safety standard provisions of New York State or any other codes applying to this type of equipment that meet the intent of the New York codes. Codes in effect at that time included American National Standards Institute (ANSI) B30.2-1943 and Crane Manufacturers Association of America (CMAA) standards (in effect in 1955). The crane has since been evaluated to the requirements of (American Society of Mechanical Engineers) ASME NOG-1, which utilizes similar design requirements to that of Chapter 2-2 of ANSI B30.2 and CMAA-70. Supplemental testing and inspections have been or will be performed to offset the material design requirements of ANSI B30.2 and CMAA-70, including a full load proof test at minimum operating temperature and NDE inspection of critical welds post proof test.

The licensee provided a summary description of the fuel building loading operations and cask handling sequence in Section 3.2 and Table 3, respectively, of the LAR. The load path in the FHB for the 75-ton crane is illustrated in Figures 1, 2 and 3 of the LAR. The 75-ton FHB crane is required to lift and handle the HI-TRAC transfer cask and MPC (both empty and loaded with spent fuel) and the MPC lid in support of dry cask loading. The combined maximum lift weight, including rigging and lift yoke will not exceed 75 tons, which is the design rated load of the IP-1 FHB 75-ton Crane.

Since the cask lift load is expected to approach the rated load of the crane, NRC staff requested additional information, by letter dated September 7, 2007 (ML072480497), with regard to the actual lift weight expected to be lifted for the proposed cask handling operations at IP-1.

The licensee responded to NRC staff by letter dated October 3, 2007. The licensee confirmed that the manufacturer's 75-ton rated load for the FHB crane is exclusive of the 7,294 pound weight of the lower hook block assembly. The licensee provided a breakdown (HI-TRAC transfer cask, MPC canister, fuel, and lifting yoke) of the maximum expected calculated lift load for the IP-1 cask handling operations for two controlling lifts: (i) the lift out of the cask pool, and (ii) lift onto the air pad outside the pool. The lift out of the cask pool governed with a maximum lift weight of 67.2 tons.

The licensee stated that these lift weights were calculated bounding weight estimates. The calculated weight provides over 10 percent margin to the rated load. The licensee noted that for the heaviest item (the transfer cask body), the actual delivered weight (58,240 lbs) was less than the calculated weight (62,636 lbs) by over 2 tons and using this actual weight would increase the margin to the rated load to over 13 percent.

The licensee further emphasized that an upper bound lift weight of 75 tons (equal to the rated load) was used in the structural and seismic analyses of the FHB crane. Also, a 125 percent proof test was successfully completed, in March 2007, on the FHB crane using stamped test weights totaling 188,495 lbs (94.25 tons). Since the proof test was conducted using actual known test weights (as opposed to calculated), it indicates that the 75-ton rated load of the crane has a margin of safety of at least 25 percent.

The staff finds that the margins listed above to the rated load are conservative and adequate to accommodate reasonable variations in actual load from the calculated maximum lift load. Further, the available safety margin (based on the 125 percent proof-test and considering an upper bound lift weight equal to the rated load) provides reasonable assurance that the crane capacity is adequate to perform the required lifts. Therefore, the licensee’s response is acceptable.

4.2.2 <u>FHB 75-ton Crane Refurbishment, Inspections and Tests</u>

In Section 4.2 of the LAR, the licensee stated that based upon a thorough review and inspection of the existing electrical system and controls, it decided to undertake an electrical refurbishment of the crane in early 2007. This refurbishment was performed and functionally tested, included replacement of the motors and related controls and installation of a new pendant with auxiliary switches for start/stop and bridge zone control. Operation in the “Safe” mode will now restrict bridge travel to the area north of the west spent fuel pool, thus assuring that the bridge cannot travel near the spent fuel pool during dry cask handling operations.

In Section 4.3 “Crane Structural Steel” of the LAR, the licensee stated that it completed an engineering review of the cranes past inspection and maintenance history in preparation for the planned dry cask loading effort. Critical structural areas were identified and inspected using Entergy NDE procedures and the acceptance criteria of the applicable ASME, ANSI, and AWS codes and standards, referenced in ASME NOG-1, “Rules for Construction of Overhead Cranes.” The NDE inspections (VT, UT and MT) confirmed that all of the selected critical welds were in acceptable condition. The inspection of certain bridge rail tie-down bolted connections raised concern with potential bolt cracking. All the subject bolting has been replaced. As a result of the seismic qualification effort (discussed further below), the trolley-to-end truck bolting was replaced to assure the adequacy of the bolting material to resist the calculated seismic stresses.

By letter dated September 7, 2007 (ML072480497), NRC staff requested additional information regarding inspections of the crane structural steel. In particular, NRC staff asked how age-related degradation effects were considered and evaluated for the crane structural steel. NRC staff requested a list of the welds that were selected as critical and subjected to NDE inspection, and specific confirmation of following as critical welds: (i) the welds of the truck structure that supports and aligns the crane bridge and trolley wheels on their respective runway rails; and (ii) the welds that align the wheel trucks relative to the bridge girders and (iii) welds in the bridge girders and trolley load girder.

In its above response to the NRC staff request, the licensee stated in an October 22, 2007 letter (ML073050247), that the crane has always been in a controlled indoor environment and subjected to loading conditions that rarely exceeded 40 percent of the rated load, which minimized any age-related degradation and fatigue effects. The response also indicates that the licensee performed NDE inspections on all critical welds and bolting on the accessible crane structural steel using a qualified inspector and approved site procedures. These inspections of welds, bolting, and structural steel yielded acceptable results and provide reasonable assurance that the crane was installed according to the design drawings and specifications. The NRC staff finds that the response fully addressed the staff's concerns and is therefore acceptable.

By letter dated September 7, 2007 (ML072480497), NRC staff requested additional information with regard to the Quality Assurance (QA) program that was used in the electrical refurbishment and bolt replacement activities.

The licensee's October 22, 2007 (ML073050247), response to NRC staff indicates that the electrical refurbishment and bolt replacement efforts on the non-safety-related FHB crane were performed under controlled site programs that provide a reasonable assurance of quality. Therefore, staff finds the response acceptable.

The licensee described the "Crane Inspections and Tests" in Section 4.4 of the LAR. The licensee stated that the IP-1 FHB 75-ton crane receives pre-use inspections, quarterly exercise and operational inspections and an annual inspection by Whitey Services based upon 29 CFR 1910, Section 179, "Overhead and Gantry Cranes" and the original manufacturer's specifications. The use of the 75-ton crane to move and prepare low level radioactive waste for shipment to off site disposal facilities drives the inspection and maintenance requirements. An annual inspection was completed in August 2006 as part of the effort to evaluate and document the condition of the crane. The ongoing inspections and the 2007 electrical refurbishments and testing will ensure the ability of the crane to safely carry its 75 ton critical load.

By letter dated September 7, 2007 (ML072480497), NRC staff requested additional information with regard to the full load proof test of the crane. Staff requested the licensee to discuss the procedure and/or standard that will be used for performing the full load proof test of the crane, since the FHB 75-ton crane is an older vintage, (designed and procured in 1958 and installed in 1962) partly refurbished crane, and the limiting dry spent fuel cask load that will be handled is at or close to the design rated load of 75 tons. Additionally, NRC staff requested the licensee to discuss the basis for concluding that use of 100% of the design rated load of 75 tons as the proof test load for the crane provides a proper verification of the structural adequacy of the crane for dry spent fuel cask handling operations.

In response to NRC staff by letter dated October 3, 2007 (ML073050247), the licensee clarified that the actual proof load test was successfully conducted in March 6, 2007, at a load equal to 125.6% of the rated load, and not at 100% of the expected lift load. The test load consisted of 188,495 lbs of stamped (known) steel test weights. The higher 125% proof testing exceeds that required by more recent editions of ANSI B30.2 and is in agreement with the testing specified in NUREG-0612. The trolley was in a position that mimicked the position when lifting the dry casks from the cask load pool. The test load was lifted and held in position for five minutes with no indication of drift or distress. The temperatures of the crane steel and columns recorded during the test will be the lower bound temperatures permitted during the cask lifts. The test was conducted in a manner that is consistent with industry standards and meets the intent of NUREG-0612. Therefore, the staff finds that the licensee's response is acceptable.

4.2.3 FHB 75-ton Crane Seismic Qualification

The licensee's LAR states that, as part of the Dry Cask Storage Project's assessment of the crane, an analysis was performed which confirmed that the crane system and its supporting structure are qualified to hold the maximum critical load during a seismic Safe Shutdown Earthquake (SSE) event. Since there exist no specific IP-1 design seismic response spectra, the analysis utilized the 0.15 g ground response spectra specified for the adjacent Unit 2 and is consistent with previous seismic analyses performed for various IP-1 structures.

By letter dated September 7, 2007 (ML072480497), NRC staff requested the following additional information with regard to the determination of seismic response in the crane seismic qualification:

- Describe the methodology used for seismic qualification of the crane including the use of computer codes and models, and the limiting loads considered.

- Define the boundary of the crane system, and any crane configuration assumptions considered in the analysis and provide an explanation why the crane load has no impact outside of this boundary.

- Discuss the response spectra used, and its appropriateness as input for the crane seismic evaluation

- Indicate the approach used (time domain, frequency domain) for applying the seismic load to the crane structural model.

- Explain the treatment of the load on the hook in the seismic analysis for both horizontal and vertical seismic excitation effects.

- Explain how were seismically induced pendulum and swinging effects of the load considered in the analysis and design evaluation of the crane.

- Provide justification for any seismic effects not considered.

In an October 3, 2007 (ML073050247), response to NRC staff questions, the licensee stated that the seismic analysis of the crane system was performed by the response spectra method using the computer program SAP2000 Version 7.4. The licensee provided an appropriate rationale for use of the Unit 2 SSE response spectra for the analysis. The licensee provided a comprehensive description of the extent of the computer model, boundary conditions, components included, the governing trolley/hook positions, damping and the loads and load combinations considered in the seismic evaluation. The licensee also appropriately explained the rationale for considering only the vertical participation of the load on the hook to the seismic response. The licensee also justified that predicted response from the higher than actual stiffness modeled for the cable system is conservative. The staff finds that the approach and model used by the licensee for determining and evaluating the seismic response of the crane is reasonable, adequate and conservative. Therefore, the licensee's response is acceptable.

The licensee further stated, in Section 4.5 of the LAR, that the crane was evaluated in accordance with guidelines in NUREG-0612 and the design acceptance criteria as applicable with IPEC Unit 2 FSAR Section 1.11 for SSE loads. The crane and supporting structure were determined to remain below material yield when subject to the maximum 75 ton load lift combined with the SSE. Standards and guides which have been used for determining allowable stress limits and other acceptance criteria, are consistent with industry practice for similar applications. These include the American Institute of Steel Construction (AISC) Manual, 9th Edition, the American Concrete Institute (ACI) 318-02, Building Code Requirements for Reinforced Concrete and the American Society of Mechanical Engineers (ASME) NOG-1, "Rules for Construction of Overhead Cranes."

The second paragraph of Section 4.5 "Crane Seismic Qualification" of Attachment 1 of the LAR, states that "The crane and supporting structure were determined to remain below yield when subject to the maximum load lift combined with the SSE ...". NRC staff notes that, although this criterion is acceptable for structural steel members when buckling limit states do not govern, the criterion is not appropriate for the structural steel members for which buckling considerations govern the design. Therefore, by letter dated September 7, 2007 (ML072480497), the NRC staff requested additional information regarding the acceptance criteria and maximum force/stress levels in the crane seismic qualification as follows:

- Clarify the acceptance criteria used for structural steel members of the crane, the wire ropes and other important load carrying components of the FHB crane system considering the governing failure limit states.

- List the maximum force/stress levels in the important members/components of the crane and its supporting structure under the critical load combination with seismic SSE loading, and the corresponding acceptance criteria with basis, and the factors of safety.

- Describe the factor of safety provided in the design/selection of lifting devices attached to the load block.

The licensee summarized the stress levels, for the applicable load combinations, in all important crane components: wire rope, trolley, bridge girders, girder bolts, end trucks, rail clamps and bolting, building columns and the column footings. The maximum ratio of actual stress to the allowable for any component was 0.96, which occurred in the crane bridge girders.

In an October 3, 2007, response letter (ML073050247), the licensee stated that the acceptance criteria for the various crane elements and building structure were based on ASME NOG-1, Section NOG-4300 or AISC. The acceptance criteria for the hoisting wire ropes were based on

CMAA-70 and the fabricated lift yoke was designed and tested to meet the requirements of ANSI N14.6-1993. The licensee presented a summary of results of stress evaluation of all the crane components. The ratios of the actual stress/force to the allowable were in all cases less than 1.0 with a reasonable margin. The staff finds that the acceptance criteria and standards used by the licensee for evaluation of the crane are consistent with standard industry practice and meets the intent of NUREG-0612. Therefore, the response is acceptable.

4.2.4 Tornado Wind and Severe Weather Evaluations

In Section 4.6 of the LAR, the licensee addressed tornado wind and severe weather issues during cask loading operations using the FHB crane. The Unit 1 FHB 75-ton crane is totally contained within the IP-1 FHB. The stack up of the transfer cask and MPC on the HI-STORM overpack will be accomplished using the Unit 2 gantry crane inside the IP-2 FHB. The licensee stated that it currently has administrative controls in place that prohibit IP-2 fuel handling and the FHB doors from being opened if severe weather is imminent. If fuel handling is in progress, current procedures require fuel handling and radioactive material transport to cease except as required to move material to a safe location. The licensee stated that IP-1 cask loading procedures will be verified to contain similar severe weather restrictions.

By letter dated September 7, 2007 (ML072480497), the NRC staff requested additional information with regard to actions taken for severe weather conditions during cask handling operations using the IP-1 FHB crane as follows:

- Describe procedures and administrative controls to be followed prior to commencement of each cask loading operations in the IP-1 FHB building to ensure that fuel handling is stopped and the FHB doors are closed in the event of imminent severe weather.

- Describe what actions will be taken if severe weather becomes imminent after a cask loading operation using the crane has commenced.

The licensee's October 3, 2007, response (ML073050247) described the site specific cask loading procedures that will instruct cask loading personnel to contact the Control Room prior to initiating cask movement activities to verify that severe weather is not imminent. Their response also indicated the transfer cask is moved into the FHB on air pads and the exterior door will be closed prior to any crane-related lifting activities, and that if severe weather becomes imminent after a cask lift has commenced, the load will be placed in a safe condition either back on the cask load pool floor slab or on the FHB elevation 70 ft slab.

NRC staff finds that the licensee has site specific procedures that would direct actions to verify severe weather is not imminent prior to commencing cask movement activities and a plan of action to place the load in a safe condition if severe weather becomes imminent after a cask lift has commenced. Therefore, the response is acceptable.

4.2.5 Conclusion on the Structural Adequacy of the Crane

Based on its review of the licensee's submittal and detailed RAI responses, the staff finds that the licensee performed a comprehensive structural design evaluation (including seismic qualification), inspections of crane structural steel, functional and 125% proof-load testing, and severe weather evaluations of the IP-1 FHB 75-ton crane in support of its use for the proposed spent fuel cask loading operations. The licensee performed an analysis that demonstrated that the crane is structurally adequate to handle the rated load under the limiting loading conditions including a seismic SSE event concurrent with a loaded cask suspended from the main hook. These analyses/evaluations, inspections and tests were properly performed using methods that are consistent with industry standards and standard practices and yielded acceptable results that meet the intent of NUREG-0612. The IP-1 FHB 75-ton crane is thus adequately designed and appropriately maintained, inspected, and tested to provide reasonable assurance that the cask operation loads can be safely handled without a load drop. Therefore, the staff finds that the use of the FHB 75-ton crane for the proposed spent fuel dry cask handling operations at IP-1 is acceptable.

4.3 Load Drop Analysis of the Spent Fuel Cask and Components

The staff has reviewed the licensee’s technical and regulatory analyses in support of the proposed license amendment, which are described in Sections 4.0 and 5.0, respectively, of the applicants LAR that was submitted as Attachment 1 to its February 22, 2007, letter. The cask loading operation proposed by the licensee involves the considerations regarding NUREG-0612. Specifically, the cask loading operation involves handling and control of heavy loads inside the FHB. As such, considerations are given to the design and operation of the FHB crane, the proposed movement of the transfer cask, the use of procedures for loading and handling, and analyses of potential load drops. A matrix showing the degree of compliance with the guidelines prescribed in NUREG-0612 was provided as Table 4 of the licensee’s February 22, 2007, letter. The license amendment proposes to change the plant’s FSAR/Decommissioning Plan to reflect the use of the FHB crane for dry spent fuel cask component lifting and handling operations.

4.3.1 Fuel Handling Building Crane/Loading Operations

The HI-STORM 100S Version B, Type 185 system will be used for dry cask storage for nuclear fuel at the IP-1 ISFSI. The FHB crane will be used to lift and handle the HI-TRAC 100D Version IP1 transfer cask and MPC-32, a 32-assembly PWR fuel storage MPC. The combined lift weight, including rigging and lift yoke, to be handled during cask loading operations will not exceed 75-tons.

During the cask loading evolution, individual spent fuel assemblies are moved from the spent fuel racks in the west pool, through a gate into the disassembly pool, through a second gate into the cask load pool and loaded into the MPC, which is inside the HI-TRAC transfer cask in the cask load pool. Once the 32 pre-designated fuel assemblies have been loaded into the MPC, the MPC lid is installed underwater and the transfer cask is lifted by the FHB crane and placed on the truck bay floor in the cask preparation work station area. In this area, the canister is welded, drained, dried, and backfilled with helium. The transfer cask containing the sealed MPC is lifted a few inches by the FHB crane and placed on an air castor to be moved northward out of the FHB. This concludes the lifting operations by the Indian Point Unit 1 FHB crane in support of dry spent fuel storage. Lifting evolutions performed by cranes other than the Indian Point Unit 1 FHB crane have not been reviewed or approved by the NRC in this safety evaluation report.

4.3.2 NUREG-0612 General Guidelines

In Table 4 of its February 22, 2007, letter (ML070740552), the licensee provided a matrix comparing the FHB crane design with the applicable regulatory guidelines in NUREG-0612.

Included in the evaluation column of this matrix is a discussion on how the objectives and general guidelines of Section 5.1.1 of NUREG-0612 will be met with regards to: (1) use of defined safe load paths, (2) specific procedure development, (3) training and qualification of crane operators, (4) use of special lifting devices, (5) installation and use of non-custom lifting devices (6) inspection, testing, and maintenance of cranes, and (7) application of codes and standards to crane design.

With regard to NUREG-0612 Section 5.1.1(1), safe load paths, the licensee states that safe load paths for heavy load movements will be defined within a specific cask lifting procedure for Indian Point Unit 1 and that the transfer cask is prevented from traveling over the reactor vessel and the spent fuel pool due to the pool configuration. The licensee also states that the safe load path does not result in any lifts above or near any safe shutdown equipment. In Attachment 3, the licensee has committed to defining the safe load path in specific cask loading procedures and clearly marking it on the floor prior to the first lift of the loaded transfer cask.

NUREG-0612 Section 5.1.1(2) gives guidance relating to procedural development to cover load-handling operations for heavy loads that are or could be handled over or in proximity to irradiated fuel. The licensee states that it will prepare specific crane operating procedures covering the areas discussed in NUREG-0612 Section 5.1.1(2). These include: identification of required equipment, inspections and acceptance criteria required before load movement, the steps and proper sequence to be followed in handling the load, defining the safe load path, and other special precautions. The licensee also states that additional details for controlling movement during transfer cask handling operations will be provided in a specific cask loading and handling procedure. A commitment regarding these procedural developments has been made in Attachment 3.

To satisfy the guidelines of NUREG-0612 Section 5.1.1(3), the licensee indicated that crane operators are trained in the area of material handling and hoisting and equipment control and that the training includes Chapter 2-3 American National Standards Institute (ANSI) B30.2-1976, "Overhead And Gentry Cranes." This has been committed to in Attachment 3.

Guidance on the use of special lifting devices is provided in NUREG-0612 Section 5.1.1(4). The licensee states that the only device required to meet the guidelines for use of special lifting devices provided in NUREG-0612 Section 5.1.1(4) is the Holtec HI-TRAC lifting yoke. According to the licensee, the lifting yoke complies with the guidelines of ANSI-N14.6-1993, "Special Lifting Devices For Shipping Containers Weighing 10,000 Pounds Or More For Radioactive Material," and the additional guidelines of NUREG-0612 Section 5.1.6(1)(a). The licensee also states that the lifting trunions of the HI-TRAC cask have a design safety factor that is greater than 10 times the maximum combined static and dynamic load.

NUREG-0612 Section 5.1.1(5), installation and use of non-custom lifting devices, does not apply since the licensee states that transfer cask lift and transfer to the loading floor does not utilize any lifting devices that are not specifically designed.

To ensure the guidelines of NUREG-0612 Section 5.1.1(6), inspection, testing, and maintenance of cranes, are met, the licensee confirms that the FHB crane is inspected, tested, and maintained in accordance with Chapter 2-2 of ANSI B30.2-1976 and the additional guidance contained in NUREG-0612. The licensee has completed a full-load proof test on the crane

The FHB crane conformed to ANSI B30.2 and Crane Manufacturers Association of America (CMAA) standards in place at the time of fabrication. Testing and inspections, including a full-load proof test at minimum operating temperature and nondestructive examination of critical welds after the proof test will be performed to offset the material design requirements of the current ANSI B30.2 and CMAA-70, “Specifications For Overhead Traveling Cranes,” guidelines. This satisfies the guidance on application of codes and standards to crane design given in NUREG-0612 Section 5.1.1(7).

Based on the staff review of the information provide by the licensee in its submittal and in the NUREG-0612 comparison matrix for the Indian Point Unit 1 FHB crane, the staff finds that the licensee satisfies the general guidelines given in Section 5.1.1 of NUREG-0612.

4.3.3 NUREG-0612 Spent Fuel Pool Area Guidelines

To provide assurance that the evaluation criteria of Section 5.1 of NUREG-0612 are met for load handling operations in the spent fuel pool area, in addition to satisfying the general guidelines of Section 5.1.1 of NUREG-0612, one of four sets of additional guidelines must be met. These guidelines are provided in Section 5.1.2 of NUREG-0612. Table 4 of the February 22, 2007, letter gives the licensee’s evaluation and compliance with these additional guidelines. Specifically, the licensee conforms with items 2 and 4 of Section 5.1.2 of NUREG-0612.

Item 2 of Section 5.1.2 of NUREG-0612 has 5 sub-guidelines to mitigate the potential damage caused by a load drop event by a non-single-failure-proof crane. Item 2 includes limiting movement of the overhead crane through mechanical and electrical interlocks and limits on lifting height. In regards to NUREG-0612 Section 5.1.2(2)(a), the licensee states that mechanical stops or electrical interlocks will be provided that prevent movement of the overhead crane load block over or within 15 feet (horizontal) of the spent fuel pool. These mechanical stops or electrical interlocks will be controlled by administrative controls. A commitment to this effect has been made in the licensee’s submittal. To satisfy NUREG-0612 Section 5.1.2(2)(b), the licensee states that an electrical interlock will be provided to prevent the bridge from traveling toward the fuel pool when it is moving the transfer cask or its components. Analysis has been performed by the licensee and they have concluded that a dropped cask in the cask load pool will not result in leakage from the spent fuel pool that could uncover the fuel. Guidance in NUREG-0612 Section 5.1.2(2)(c) is given to preclude a dropped cask from rolling. The licensee states that the transfer cask will not be carried more than six inches above the FHB operating floor, which satisfies this guideline. NUREG-0612 Section 5.1.2(2)(d) is met because there is no safety-related or safe shutdown equipment in the vicinity, although mechanical stops or electrical interlocks will be provided to prevent transfer cask movement over the fuel pool. To satisfy NUREG-0612 Section 5.1.2(2)(e), the licensee confirms that cask drop consequence analysis have been performed in accordance with the guidelines of Appendix A of NUREG-0612.

Item 4 of NUREG-0612 Section 5.1.2 requires that the effects of drops of heavy loads be analyzed and shown to satisfy the evaluation criteria of Section 5.1 of NUREG-0612 and conform to the guidelines in Appendix A or NUREG-0612. The licensee states that cask drop analyses have been performed that conform to the guidelines of Appendix A of NUREG-0612.

Based on review of the information provide by the licensee in its submittal and in the NUREG-0612 comparison matrix for the IP-1 FHB crane, the staff finds that the licensee satisfies the additional guidelines given in Section 5.1.2 of NUREG-0612.

4.3.4 Load Drop Considerations

Because the FHB crane is not single-failure-proof crane, the licensee has identified a requirement to perform additional load drop analysis due to a difference in the design of the proposed transfer cask from the existing licensing basis. The regulatory difference is that the transfer cask to be used to support the dry fuel storage initiative (HI-TRAC 100D Version IP1) is not certified to the standards of 10 CFR 71 as was the previous shipping cask (GE IF-200). Certain drops of the transfer cask, MPC, and MPC lid were postulated. The locations of where the drops were postulated and evaluated were chosen to comply with applicable parts of Part 50 licensing requirements, NUREG-0612, and NRC Bulletin 96-02.

To mitigate the consequences of two of the postulated drops, the licensee will use an impact limiter in the cask load pool where the transfer cask will be moved in the vertical direction. In attachment three of the February 22, 2007, letter, the licensee has committed to installing the properly designed impact limiter in the cask loading pool prior to the first lift of the transfer cask loaded with fuel. Although NUREG-0612 states that energy absorbing devices must be attached to the cask during load handling operations for credit to be taken, it is generally accepted that the impact limiter can be separate from the cask if the load path prevents lifts over anything except the impact limiter in the spent fuel pool.

The analyses submitted by the licensee confirmed that the postulated load drops of the 75-ton transfer cask in the cask load pool or on the elevation 70 ft 6 in. concrete floor would not result in significant damage to any safety related structures, systems, or components (SSC) and the cask would experience a deceleration less than the allowable limit for the fuel. The postulated drops of the MPC lid resulted in four MPC-32 IP1 basket cells being damaged, although major relocation of fuel is not expected.

Based on the staff's review of the drop analyses provided by licensee in 4.7.2 of its LAR submittal, the staff finds that the licensee has included the considerations and assumptions stated in NUREG-0612, Appendix A, and conforms to the guidelines.

4.3.5 Conclusion on Load Drop Analysis of the Spent Fuel Cask and Components

Based on the review of the licensees submitted information on the handling of heavy loads associated with this amendment request, the staff finds the licensee has provided adequate assurance that their planned actions for the handling of heavy loads associated with dry cask storage loading operations are consistent with the "defense-in-depth" approach to safety described in NUREG-0612. Therefore, the staff finds the amendment request acceptable for the handling of heavy loads.

4.4 Load Drop Analyses of the Spent Fuel

Because the FHB is not a single-failure-proof crane, certain drops of the transfer cask, MPC, and MPC lid were postulated and evaluated. The drop locations were chosen to comply with applicable portions of 10 CFR Part 50 licensing requirements, and guidance of NUREG-0612

Appendix A, and NRC Bulletin 96-02. The licensee has reviewed the required fuel building cask handling operations and has evaluated drops at various locations along the load path in order to be in compliance with the applicable regulatory requirements and additional guidelines in NUREG-0612.

The HI-STORM 100 storage cask system at IP-1 consists of an MPC, which holds up to 32 PWR fuel assemblies, a HI-TRAC 100D-Version IP1 transfer cask, which contains the MPC during loading, unloading, and transfer operations, and a HI-STAR storage overpack, which provides shielding, heat removal, and structural protection for the MPC deployed at the ISFSI. Attachment 1 to the licensee's February 22, 2007, letter (ML070740552) presents the cask handling operational sequence, summarizes cask loading operations and corresponding load drop scenarios. Additional information is presented in the licensee's October 3, 2007 (ML073050247), and February 27, 2008 (ML080630507), responses. The following subsections provide a discussion of the structural performance of the cask system for withstanding the six most bounding load drops to ensure that the cask system is capable of maintaining its shielding, confinement, and criticality safety functions after the postulated cask drop events.

4.4.1 <u>Loaded Vertical Transfer Cask Drop into the Cask Load Pool</u>

This event is postulated to occur by crane failure at upper limit of lift resulting in drop through air and a continued drop in water onto the impact limiter.

A HI-TRAC transfer cask containing a MPC loaded with 32 fuel assemblies is lifted from the floor of the cask loading pool (Elevation 31 ft 4 in.) to above the cask handling elevation (Elevation 70 ft 6 in.). The cask is dropped vertically and lands upright on the impact limiter installed on the floor of the cask load pool.

The February 22, 2007 (ML070740552), LAR indicates that the simulations were carried out for different impact limiter resistances. The 80% and 120% of nominal strength simulations provide bounding results for standard impact limiter material tolerances. The analysis results demonstrate that the proposed impact limiter configuration successfully maintains an acceptable deceleration level in the transfer cask, MPC, and the contained fuel. The maximum calculated cask deceleration was 35.9 g which is below the 64.8 g limit for the fuel. The maximum impact limiter "crush" was determined to be 13.8 in. The maximum impact force was used to check the bearing capacities of the cask load pool slab and its underlying rock. The minimum safety factor is calculated as 1.78 for the concrete slab. No significant increase in pool leakage is anticipated to result from this drop event since the concrete base slab of the cask load pool remains well within code allowable stress levels. In addition, a permanent weir in each of the connecting gate slots extends to an elevation of 41 ft 3-11/16 in. This weir retains sufficient water shielding in the spent fuel pool to cover the active portion of the fuel while stored in the racks in the event make-up water needed to be added to restore level.

In a September 7, 2007 letter (ML072480497), NRC staff questioned the 64.8 g deceleration limit for fuel based on recent NRC staff evaluations. NRC staff requested the licensee provide additional analysis to demonstrate the IP-1 stainless steel clad fuel will not be damaged in the postulated loaded vertical transfer cask load drop scenario.

The licensee's October 3, 2007 response (ML073050247), provided an analysis to demonstrate that IP-1 fuel is bounded by the spent fuel already considered by NRC staff in NUREG-1864.

The metrics provided in the licensee's submittal indicate that results for the NUREG-1864 Reference fuel will bound results for the IP-1 Analysis Basis fuel (i.e., the IP-1 fuel has lower burnup, has fuel rods of lower total weight, has a larger critical buckling load, and requires a smaller lateral movement before contact with the fixed wall of the storage cell). Therefore, structural integrity of the Analysis Basis IP-1 fuel rods can be directly asserted by comparison with the results from analyses performed in NUREG-1864 using reference fuel it is concluded that:

1. The 4-in. drop on the concrete slab condition is enveloped by the 20-ft drop condition by a large margin.

2. The 40-ft drop on the impact limiter in water will certainly result in more than 10% reduction in strain from the 40-ft drop onto concrete, considering that: (i) the IP-1 fuel will have less than half the kinetic energy, and has less lateral movement space because of the fuel channel around it; and (ii) the impact limiter is sized to absorb virtually all of the kinetic energy.

Therefore, drop scenarios for IP-1 fuel are considered enveloped by those mentioned above in NUREG-1864.

By letter of January 31, 2008 (ML080290311), NRC staff requested the licensee to provide the basis for the 1% failure strain limit for stainless steel cladding for IP-1 spent fuel. In its February 27, 2008 response (ML080630507), the licensee provided a comparison of test results for stainless steel clad fuel which indicates a minimum total elongation of about 5% for fuel with similar operating history to IP-1 spent fuel. Based on this information, NRC staff agrees that the 1% assumption is conservative.

On the basis of the bounded condition of IP-1 fuel by NUREG-1864 reference fuel, the NRC staff finds that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.2 <u>Inclined Loaded Vertical Transfer Cask Drop into the Cask Load Pool</u>

A HI-TRAC transfer cask containing an MPC loaded with 32 fuel assemblies is lifted from the floor of the cask load pool (Elevation 31 ft 4 in.) to above the cask handling elevation (Elevation 70 ft 6 in.). The transfer cask is dropped and the edge of the transfer cask strikes the impact limiter installed on the floor of the cask load pool.

The simulations were once again carried out for different impact limiter resistances. The 80% and 120% of nominal strength simulations provide bounding results for standard impact limiter material tolerances. The analysis results demonstrate that the proposed impact limiter configuration successfully maintains an acceptable deceleration level in the transfer cask, MPC, and the contained fuel. The maximum calculated cask deceleration was 41.3 g which is below the 64.8 g allowable limit for the fuel. The maximum impact limiter "crush" was determined to be 14.1 in. The maximum impact force was once again used to check the bearing capacities of the cask load pool slab and its underlying rock. The minimum safety factor is calculated as 1.69 for the concrete slab.

In a September 7, 2007 letter (ML072480497), NRC staff questioned the 64.8 g deceleration limit for fuel based on recent NRC staff evaluations. NRC staff requested the licensee provide additional analysis to demonstrate the IP-1 stainless steel clad fuel will not be damaged in the postulated inclined loaded vertical transfer cask load drop scenario.

The licensee's October 3, 2007 response (ML073050247) provided an analysis to demonstrate that IP-1 fuel is bounded by the spent fuel already considered by NRC staff in NUREG-1864. The metrics provided in the licensee's submittal indicate that results for the NUREG-1864 Reference fuel will bound results for the IP-1 Analysis Basis fuel (i.e., the IP-1 fuel has lower burnup, has fuel rods of lower total weight, has a larger critical buckling load, and requires a smaller lateral movement before contact with the fixed wall of the storage cell.) As demonstrated above, the structural integrity of the Analysis Basis IP-1 fuel rods can be assessed by comparison with the results from analyses performed in NUREG-1864 using reference fuel. As in the vertical drop discussed above, it is concluded that drop scenarios for IP-1 fuel are enveloped by those in NUREG-1864.

This finding is further reinforced by the fact that the austenitic stainless steel irradiated to a low fluence in the low flux IP-1 reactor is considerably more ductile than higher burnup Zircaloy fuel.

On the basis of the bounded condition of IP-1 fuel by NUREG-1864 reference fuel, the NRC staff finds that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.3 Loaded Transfer Cask Tips into the Cask Load Pool.

A HI-TRAC transfer cask containing an MPC loaded with 32 fuel assemblies is lifted out of the cask load pool and begins to traverse horizontally to the east with the cask bottom slightly above elevation 70 ft 6 in. The cask drops just as it begins to travel over the cask load pool east wall and the bottom of the cask strikes the edge of the pool. The cask tilts to the west and rotates with its side contacting the west wall of the cask load pool. The LS-DYNA model consists of the cask initially positioned 18 in. above the east wall curb. Two cases (denoted "Center" and "Edge") are considered with the only difference being the initial position of the cask relative to the edge of the east wall when the cask impacts. The "Center" case positions the cask pool lid center right over the curb edge to the load pool; while in the "Edge" case the cask has only 1 in. overlap with the east wall edge.

The results of drop simulations of the cask onto the cask load pool east wall top edge with a subsequent rotation of the cask and impact with the cask load pool west wall top edge produces acceptable cask decelerations and only local damage to the wall. Table 1 summarizes the results from simulations of impact with the cask load pool walls. The calculated decelerations are less than the 64.8 g limit for the fuel and are, therefore, acceptable. The 4-ft thick concrete wall only suffers local damage at the impacted region. No significant increase in pool leakage is anticipated as a result of the localized structural damage which could occur as a result of this drop event. Normal pool make-up capability, which can be backed up by emergency make-up from the fire water and city water systems, ensure that no significant loss of shielding will occur for any spent fuel stored in the west spent fuel pool. The design of the interconnecting gates are such that the spent fuel being stored in the west storage pool cannot become uncovered due to a cask drop in the cask load pool. Due to the age of the spent fuel, water inventory is only required for shielding in the vicinity of the fuel pools.

In a September 7, 2007 letter (ML072480497), NRC staff questioned the 64.8 g deceleration limit for fuel based on recent NRC staff evaluations. NRC staff requested the licensee provide additional analysis to demonstrate the IP-1 stainless steel clad fuel will not be damaged in the postulated load drop scenarios.

The licensee's October 3, 2007 response (ML073050247) provided an analysis to demonstrate that IP-1 fuel is bounded by the spent fuel already considered by NRC staff in NUREG-1864. The metrics provided in the licensee's submittal indicate that results for the NUREG-1864 Reference fuel will bound results for the IP-1 Analysis Basis fuel (i.e., the IP-1 fuel has lower burnup, has fuel rods of lower total weight, has a larger critical buckling load, and requires a smaller lateral movement before contact with the fixed wall of the storage cell). Therefore, structural integrity of the Analysis Basis IP-1 fuel rods can be assessed by comparison with the results from analyses performed in NUREG-1864 using the Reference fuel. The staff finds that:

1. The 4-in. drop on the concrete slab condition is enveloped by the 20-ft drop condition by a large margin.

2. The 40-ft drop on the impact limiter in water would certainly result in more than 10% reduction in strain from the 40-ft drop onto concrete, considering that: (i) the IP-1 fuel will have less than half the kinetic energy, and has less lateral movement space because of the fuel channel around it; and (ii) the impact limiter is sized to absorb virtually all of the kinetic energy.

Therefore, drop scenarios for IP-1 fuel are considered enveloped by those mentioned above in NUREG-1864.

On the basis of the bounded condition of IP-1 fuel by NUREG-1864 reference fuel, the NRC staff finds that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.4 <u>MPC Lid Drop onto the MPC</u>

After the spent fuel is loaded into the MPC, the MPC lid is installed using the FHB 75-ton crane. The rigging, attached to four symmetrically located lift points in the lid, ensures that the lid is held in the horizontal position during lowering to assure fit up onto the MPC. If the lid is dropped from a significant height, the column of water below the falling lid will eventually cause the lid to drift laterally and not physically be able to enter the open MPC. This analysis assumes the lid is 3 ft above the MPC and perfectly positioned for insertion when the postulated failure occurs, allowing the lid to drop straight down into the MPC fuel cavity in the horizontal orientation. The lid will accelerate as it falls and impart an impact load on the four lift lugs welded to the inside of the MPC shell. The lift lugs are designed to support the dead weight of the lid until the lid is welded to the canister shell. The analysis evaluates the ability of the lift lugs to withstand the impact load of the lid drop using manual structural mechanics computational techniques. The acceptance criterion for this analysis is no damage to the spent fuel assemblies in the MPC.

The results of the analysis show that the lift lugs would withstand the impact force and prevent the lid from coming into contact with the fuel basket or the fuel.

In a September 7, 2007 letter (ML072480497), NRC staff requested the licensee to provide the basis for the simplifying assumption that the water's change in density is proportional to the lid velocity, and to provide an analysis of how this assumption affects the analysis. The licensee's October 3, 2007 response (ML073050247) provided an analysis demonstrating how water compressibility was conservatively modeled in this postulated event. Additionally, language of the key assumption under question was reworded to clarify the relationship between water density, fluid velocity and lid velocity.

In consideration of the additional information provided by the licensee in the October 3, 2007 response, and the February 27, 2008 response discussed below, the NRC staff finds that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.5 MPC Lid Drop onto the Transfer Cask Flange

A second lid drop event was analyzed where the MPC lid is assumed to drop vertically from the elevation of 90 in. above the cask loading pool water surface. The lid is slightly offset from the center of the MPC cavity so that the first impact will occur on the top flange of the HI-TRAC transfer cask. Subsequent to the initial impact, the lid may hit the MPC shell, the fuel basket and the stored fuel assemblies before it eventually rests in the MPC cavity. The objective of the analysis performed, using the LS-DYNA finite element code, is to determine whether the postulated offset drop scenario would significantly damage the fuel basket in the MPC resulting in an unacceptable criticality configuration for the stored fuel assemblies.

The results of the analysis conclude that the MPC lid hits the transfer cask top flange at a velocity of 220.0 in/sec. and that a dropped MPC 32 IP-1 lid could damage up to 4 MPC-32 IP1 basket cells. The total of 4 basket cells suffer plastic deformation extending down as much as 6.3 in. below the basket top, which is inside the region covered by the neutron absorber (3.75 in. below the basket top). The cell deformation is limited to an area more than 12 in. above the active fuel region of the stored fuel. Major relocation of fuel material is not expected. The analysis did not credit the IP-1 fuel loading arrangement which places all fuel assemblies in damaged fuel containers. These containers provide additional assurance that relocation of fuel material leading to criticality is precluded.

By letter of January 31, 2008 (ML080290311), NRC staff requested the licensee to provide an analysis and evaluation of consequences for this postulated load drop that conforms to the guidance of NUREG-0612, Appendix A. NUREG-0612 stipulates that the load drop analyses must consider a load drop in the orientation causing the most severe consequences, and must also consider the maximum damage that could result. The submittal considers a lid drop in a near horizontal orientation, versus a vertical orientation. In its February 27, 2008, response (ML080630507), the licensee provided a rationale supporting the near horizontal orientation, based on the relative size of the lid to the drop distance, the stability of the orientation due to large moment of inertia of the axis perpendicular to the lid, and the lid lift yoke and rigging design. The response also indicated that their analysis considered damage to all 32 loaded spent fuel assemblies. A vertically oriented cask lid drop would only be expected to impact 2 rows of spent fuel, or about 12 to 14 assemblies.

Based on the licensee's analyses, the NRC finds that, while the cask lid drop in a nearly horizontal orientation is not the most damaging, the licensee's damage analysis did evaluate the most severe consequences, and therefore the staff agrees that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.6 Loaded Transfer Cask and Vertical Drop onto the Elevation 70 ft 6 in. Concrete Floor**.**

This event would occur after the loaded transfer cask is lifted out of the cask load pool and is traversing to the east to the cask preparation area for canister welding and other activities. This analysis fixes the allowable height above the floor to which the loaded transfer cask can be lifted while being moved. This also bounds placement of the loaded transfer cask on the air transporter pads.

By administratively limiting the carrying height, when the cask is above the spent fuel building floor level, the cask would experience a maximum deceleration below the 64.8 g allowable limit for the fuel.

In a September 7, 2007 letter (ML072480497), NRC staff questioned the 64.8 g deceleration limit for fuel based on recent NRC staff evaluations. NRC staff requested the licensee provide additional analysis to demonstrate the IP-1 stainless steel clad fuel will not be damaged in the postulated load drop scenarios.

The licensee's October 3, 2007 response (ML073050247) provided an analysis to demonstrate that IP-1 fuel is bounded by the spent fuel already considered by NRC staff in NUREG-1864. The metrics provided in the licensee's submittal indicate that results for the NUREG-1864 Reference fuel will bound results for the IP-1 Analysis Basis fuel (i.e., the IP-1 fuel has lower burnup, has fuel rods of lower total weight, has a larger critical buckling load, and requires a smaller lateral movement before contact with the fixed wall of the storage cell). Therefore, structural integrity of the Analysis Basis IP-1 fuel rods can be assessed by comparison with the results from analyses performed in NUREG-1864 using the Reference fuel. The staff finds that:

1. The 4-in. drop on the concrete slab condition is enveloped by the 20-ft drop condition by a large margin.

2. The 40-ft drop on the impact limiter in water will certainly result in more than 10% reduction in strain from the 40-ft drop onto concrete, considering that: (i) the IP-1 fuel will have less than half the kinetic energy, and has less lateral movement space because of the fuel channel around it; and (ii) the impact limiter is sized to absorb virtually all of the kinetic energy.

Therefore, drop scenarios for IP-1 fuel are considered enveloped by those mentioned above in NUREG-1864.

On the basis of the bounded condition of IP-1 fuel by NUREG-1864 reference fuel, the NRC staff finds that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop.

4.4.7 Conclusion of Load Drop Analyses of the Spent Fuel

Based on its review of the licensee's submittal and detailed RAI responses, the staff finds that the licensee performed comprehensive load evaluations for a postulated loaded vertical transfer cask drop into the cask load pool, an inclined loaded vertical transfer cask drop into the cask load pool, a loaded transfer cask tipping into the cask load pool, an MPC lid drop onto the MPC, an MPC lid drop onto the transfer cask flange, and a loaded transfer cask and vertical drop onto the concrete floor. The licensee performed analyses that demonstrated for these scenarios that: (1) the drop event would not cause fuel damage or fuel relocation that would result in an unanalyzed criticality configuration; and (2) the MPC and transfer cask would retain their structural configurations to permit retrieval of the MPC after the drop. These analyses/evaluations, inspections and tests were properly performed using methods that are consistent with industry standards and standard practices and yielded acceptable results that meet the intent of NUREG-0612. Therefore, the staff finds that the use of the FHB 75-ton crane for the proposed spent fuel dry cask handling operations at IP-1 is acceptable.

5.0 SUMMARY

The changes proposed by this LAR will authorize the licensee to allow use of the FHB crane in support of dry storage of spent nuclear fuel at IP-1.

6.0 STATE CONSULTATION

In accordance with the Commission's regulations, the appropriate New York State official was notified of the proposed issuance of the amendment. The State official had no comments.

7.0 ENVIRONMENTAL CONSIDERATION

The amendment allows spent fuel stored in the Indian Point Unit 1 FHB to be moved into dry storage utilizing the 75-ton FHB crane.

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding published on June 19, 2007, (72 FR 33779). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

8.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: 1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner; and 2) such activities will be conducted in compliance with the Commission's regulations, and the issuance of the amendment will not be inimical to the common defense and security nor to the health and safety of the public.

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