UNITED STATES
**NUCLEAR REGULATORY COMMISSION**
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

November 5, 2010

Mr. Michael J. Pacilio
Senior Vice President, Exelon Generation Company, LLC
President and Chief Nuclear Officer (CNO), Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNITS 1 AND 2; REACTIVE TEAM INSPECTION INVOLVING INDEPENDENT SPENT FUEL STORAGE INSTALLATION OPERATIONS; INSPECTION REPORT NOS. 05000454/2010007; 05000455/2010007; AND 07200068/2010002

Dear Mr. Pacilio:

On September 17, 2010, the U.S. Nuclear Regulatory Commission (NRC) completed a reactive inspection at your Byron Station, Units 1 and 2. The inspection was initiated to review the circumstances involving the problems encountered during the initial dry fuel canister loading. The enclosed inspection report documents the inspection results, which were discussed on September 17, 2010, with Mr. B. Adams and other members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel. The inspection was established to follow up on the events that occurred on August 28 and 29, 2010, involving the initial loading of a dry fuel canister. Several problems occurred when the canister was left unattended overnight and the canister cooling system was shut off. Additionally, the inspection reviewed work control, management oversight, and human performance aspects as they contributed to the event and your staff's failure to initially recognize the significance.

The report documents one NRC identified violation of the NRC requirements of very low safety significance (Severity Level IV). However, because of the very low safety significance and because it was entered into your corrective action program, the NRC is treating the violation as a Non-Cited Violation (NCV) consistent with Section 3.1.1 of the NRC Enforcement Manual. If you contest the subject or severity of this NCV, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Regional Administrator, U.S. Nuclear Regulatory Commission - Region III, 2443 Warrenville Road, Suite 210, Lisle, IL 60532-4352; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the Resident Inspector Office at the Byron Station.

The NRC expects licensee management to provide appropriate oversight of licensed activities and to ensure compliance with NRC requirements. In this case, due to the fact that this was a first of a kind evolution, involving spent nuclear fuel, a higher level of oversight would be expected. In addition, the inspectors observed that the operational sensitivity of independent spent fuel storage installation (ISFSI) operations was not analogous to that of normal plant operations. The inspectors observed that the problems encountered during the initial dry fuel canister loading revealed weaknesses in conservative decision making, communications between departments, control of evaluations, and planning for contingencies.

In accordance with Title 10 of the Code of Federal Regulations (10 CFR) 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

***/RA/***

Steven A. Reynolds, Director
Division of Nuclear Materials Safety

Docket Nos. 50-454; 50-455; 72-068
License Nos. NPF-37; NPF-66

Enclosure:
Inspection Report Nos. 05000454/2010007,
05000455/2010007, 07200068/2010002

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REGION III

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| Docket Nos: | 50-454; 50-455; 72-068 |
| License Nos: | NPF-37; NPF-66 |
| Report Nos: | 05000454/2010007, 05000455/2010007, 07200068/2010002 |
| Licensee: | Exelon Generation Company, LLC |
| Facility: | Byron Station, Units 1 and 2 |
| Location: | Byron, IL |
| Dates: | September 1, 2010, through September 17, 2010 |
| Inspectors: | Matthew Learn, Reactor Inspector, Region III<br>John Robbins, Byron Resident Inspector, Region III<br>John Nicholson, Licensing Branch, Division of Spent Fuel Storage and Transportation (SFST), NMSS<br>Jorge Solis, Senior Thermal Engineer, Thermal and Containment Branch, SFST, NMSS<br>Earl Love, Safety Inspector, SFST, NMSS |
| Approved by: | Christine A. Lipa, Acting Deputy Director<br>Division of Nuclear Materials Safety, Region III |

Enclosure

SUMMARY OF FINDINGS

IR 05000454/2010007, 05000454/2010007, and 07200068/2010002; 09/01/10 – 09/17/10; Byron Station, Units 1 & 2; Reactive Inspection, Inspection Procedures (IP) 60855, “Operation of an Independent Spent Fuel Storage Installation (ISFSI),” and IP 60855.1, “Operation of an ISFSI at Operating Plants.”

The reactive inspection was conducted by a five person NRC team, comprised of an ISFSI inspector, resident inspector, and staff from the Division of Spent Fuel Storage and Transportation (SFST). The inspection team identified one Severity Level IV Non-Cited Violation (NCV) associated with the licensee’s failure to have procedures in place to ensure that the design basis peak fuel cladding limit would not be exceeded during vacuum drying operations. The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, “Significance Determination Process” (SDP). Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. The NRC’s program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, “Reactor Oversight Process,” Revision 4, dated December 2006.

A. **NRC-Identified Violations**

- Severity Level IV. The inspectors identified a Severity Level IV NCV of 10 CFR 72.150, "Instructions, Procedures, and Drawings." Specifically, the licensee failed to have procedures in place to ensure that the design basis peak fuel cladding temperature limit would not be exceeded during vacuum drying operations. The licensee entered this issue into its corrective action program and revised the procedure to provide monitoring criteria.

  The violation was determined to be of more than minor significance because, if left uncorrected, it could lead to a more safety significant event. Although the violation contributed to the likelihood of peak fuel cladding temperatures exceeding the safety limit, subsequent analysis by the licensee and the NRC determined that fuel cladding temperature limits were not exceeded during this event; therefore, the violation screened as having very low safety significance. (Section 4OA5.2)

B. **Licensee-Identified Violations**

No violations of significance were identified.

## REPORT DETAILS

Background and Description of Event

This event is associated with the process of moving spent fuel from the spent fuel pool into an alloy multi-purpose canister (MPC) that, when the process is complete, is placed on a concrete pad outside the reactor complex in a concrete and metal storage cask (HI-STORM). The spent fuel pool is located in the Fuel Handling Building. During operations in the Fuel Handling Building, the MPC is contained within a transfer cask (HI-TRAC), which is used to move the MPC and provide additional radiation shielding.

The following is a simplified description of the process: The HI-TRAC and MPC are placed in a location adjacent to the spent fuel pool. This facilitates fuel transfers from the spent fuel pool to the MPC. The MPC is resting inside the HI-TRAC during this operation. When fuel loading is complete, a lid is placed on the MPC and then the HI-TRAC and MPC are moved to an area for conditioning the atmosphere within the MPC. This conditioning process removes water from inside the MPC and replaces it with an inert gas. A vacuum pump is connected to the MPC to facilitate the final drying process. During the vacuum drying process, fuel temperatures are elevated due to the reduction in convection cooling. Depending on the actual heat load of the selected fuel, a cooling mechanism may be required to maintain the temperature within the design limits. Once the drying process is complete, the canister is connected to a manifold that allows an inert gas to be placed in the MPC; this part of the process is frequently referred to as the "backfill" process. Once the atmospheric conditioning is complete, the MPC is removed from the HI-TRAC and placed in the HI-STORM. The MPC and HI-STORM are then moved to the storage pad.

On Saturday, August 28, 2010, during Byron Station's initial ISFSI campaign, a MPC containing spent nuclear fuel was left unmonitored at the end of shift operations. The MPC had been undergoing vacuum drying throughout the day and at the end of shift was under vacuum. While the canister was under vacuum, convective cooling of the fuel was significantly reduced, and subsequently fuel temperatures were elevated. The licensee's safety analysis for the spent fuel cask system required that the MPC shell temperature be maintained below 125 degrees Fahrenheit (°F) while the MPC is under vacuum. A MPC shell temperature of 125°F corresponds to a design basis limit of 1040°F for fuel cladding temperature as discussed in the Holtec HI-STORM 100 Final Safety Analysis Report (FSAR), Revision 5. When required, cooling of the water contained within the HI-TRAC annulus, the area between the MPC and the HI-TRAC, is provided by a chiller unit. The method selected by the licensee to provide cooling was a chiller; other methods are possible and allowed by the license. For the fuel selected, annulus cooling would be required to maintain the MPC shell temperature below 125$^{o}$F. Prior to the end of shift on August 28, 2010, the inspectors asked of the licensee what plans were in place for monitoring the MPC overnight. The inspectors were informed that various options were being considered for monitoring the MPC overnight and that a final decision on exact method and specific staffing had not been determined. Later that evening, the licensee discussed the importance of the chiller with technical experts and determined that, due to the heat loads selected for this canister, heat rates were not high enough to exceed fuel temperature limits even in the event of a chiller shut off. Therefore, the licensee concluded that no monitoring was necessary overnight. No specific analysis was performed to support this determination.

On the morning of August 29, 2010, the licensee identified that the chiller had unexpectedly shut off overnight; however, the licensee failed to recognize that the annulus water temperature corresponded to a safety limit for fuel cladding temperature as discussed in the FSAR. A back-up chiller was placed in service promptly; however, the licensee did not recognize the importance of determining the current water temperature to ensure that no safety limits were exceeded. The inspectors notified the licensee of the design basis annulus water temperature limit of 125$^{o}$F, which was specified in the FSAR. The inspectors estimated that the 125$^{o}$F limit was likely exceeded by several degrees.

The licensee began a prompt evaluation to determine if any fuel cladding safety limits were exceeded. Working with the licensee's vendor, Holtec, the prompt evaluation concluded that no fuel cladding safety limits were exceeded.

Inspection Scope

Since this was the licensee's first spent fuel loading campaign, the NRC Region III Office had maintained one or more ISFSI inspectors on-site for ISFSI operations since the start of the campaign on August 23, 2010. In response to the circumstances of August 28 and 29, 2010, the NRC increased the oversight of the ISFSI project at Byron Station and began a reactive inspection on September 1, 2010. Subsequently, a preliminary notification was issued under PN-III-10-015, "Initiation of Reactive Inspection in response to a failure of the Mechanism that Cools Water Surrounding a Canister Containing Spent Fuel."

This reactive inspection was chartered to assess the circumstances surrounding the loss of cooling to the annulus water of the MPC and HI-TRAC on August 28, 2010, corrective actions taken, and the licensee's readiness to safely resume the ISFSI campaign. This reactive inspection was performed in accordance with IMC 2690, "Inspection Program for Dry Storage of Spent Reactor Fuel at Independent Spent Fuel Storage Installations and for Title 10 Code of Federal Regulation Part 71 Transportation Packagings," and IMC 2515, "Light-Water Reactor Inspection Program – Operations Phase." This reactive inspection was chartered to include, but not be limited to, the items listed below.

1. Develop a sequence of events.

2. Review certain portions of the licensee's ISFSI program as applicable to the events on August 28, 2010.

    - Licensee's procedures related to ISFSI vacuum drying and helium backfill operations;
    - Owner's acceptance criteria for non-licensee calculations, procedures, etc.; and
    - ISFSI program management oversight.

3. Review the licensee's response to the event on August 28, 2010 through review of records, personal statements, and interviews of those involved.

    - Assess the licensee's decision-making and communications that contributed to the event;
    - Evaluate the licensee's response to the event;

- Independently review plant and ISFSI cask documents and records to confirm the adequacy of the licensee's assessment; and
- Review the licensee's planned corrective actions.

4. Verify with SFST staff that FSAR safety limits were not exceeded and review licensee and licensee contractor documents as needed to understand margins to safety.

**4OA5 Other Activities**

.1 Sequence of events

a. Inspection Scope

The inspectors identified the events that occurred at the Byron Station and documented the specific events in chronological order. In order to develop this sequence of events, the inspectors interviewed several licensee staff members and reviewed licensee documentation in order to validate and establish the sequence of events documented in this report. All of the times below are approximated.

b. Findings and Observations

Saturday, August 28, 2010

08:30 The licensee completed a final nitrogen blowdown of the MPC loaded with spent nuclear fuel to remove excess bulk water using procedure Byron Fuel Handling Procedure (BFP) FH-71, "MPC Processing," Revision 5.

09:00 The licensee completed setup of the HI-TRAC annulus and water jacket cooling using procedure BFP FH-71.

12:00 The licensee completed setup of the vacuum drying system using procedure BFP FH-78, "Vacuum Drying System Operation," Revision 2.

12:20 The licensee initiated the vacuum drying process to remove excess water from the MPC using BFP FH-71.

13:30 Realizing that vacuum drying would not be completed during the shift, the licensee decided that at the end of the shift that vacuum drying would be secured, the annulus chiller pump would be left in operation, and the annulus submersible pump would be shutoff. The Control Room was notified that the annulus chiller would remain running; however; no formal monitoring of the equipment was requested to ensure the chiller remained functional. Additionally, no monitoring of the annulus water temperatures was requested.

16:10 The licensee began to secure the MPC and shutdown the vacuum drying system. Vacuum drying was secured by isolating the canister using two air operated valves mounted on the canister.

16:45 The HI-TRAC annulus cooling submersible pump was shut off. The MPC pressure was stable at 9 Torr. The annulus chiller was left running unmonitored.

Sunday, August 29, 2010

06:00 A crew brief was held by the licensee on resuming vacuum drying using procedure BFP FH-71.

07:00 The licensee entered the Fuel Handling Building and discovered the chiller shut off.

09:30 The license replaced the shutoff chiller with a functional replacement and restarted annulus cooling. No temperature measurements of the annulus region were taken prior to restart. Water was not visibly boiling.

10:00 The licensee resumed vacuum drying operations.

10:30 An NRC inspector entered the Fuel Handling Building. The inspector questioned whether the licensee had taken any temperature readings of the HI-TRAC annulus region, which would indicate MPC shell temperature prior to restarting chiller, or whether the licensee had any plans to monitor temperature in the future. The inspector discussed FSAR requirements for MPC shell temperature. The inspector requested the licensee take an annulus temperature reading for reporting purposes.

11:00 Temperature monitoring of the annulus region began. Annulus temperature was approximately 115$^{o}$F.

11:30 Annulus temperature was approximately 107$^{o}$F.

12:00 Annulus temperature was approximately 104$^{o}$F.

.2 Review of Licensee Procedures Related to ISFSI Vacuum Drying and Helium Backfill Operations

a. Inspection Scope

The inspectors reviewed licensee procedures related to ISFSI vacuum drying and helium backfilling. The inspectors compared the procedures to the Holtec Certificate of Compliance (CoC), 1014 Amendment 3, Technical Specifications (TS) and FSAR. The inspectors consulted Division of Spent Fuel Storage and Transportation (SFST) Interim Staff Guidance (ISG) documents during review.

b. Findings and Observations

MPC vacuum drying is a process that removes excess moisture contained in the MPC prior to MPC backfilling with inert gas and final closure welding. The MPC is connected to a vacuum pump and pressure in the MPC is slowly decreased from atmospheric pressure to less than 3 Torr. A perfect vacuum is 0 Torr and atmospheric pressure is 760 Torr. The MPC is then isolated from the vacuum pump for thirty minutes. After thirty minutes, if the MPC pressure has remained below 3 Torr, the MPC is considered dry and may be backfilled with helium. While the MPC is under vacuum, convective heat transfer from the spent fuel to the MPC shell wall is lessened. Depending on the heat load of the selected fuel, additional cooling of the MPC shell may be required. The method selected by the licensee to provide this additional cooling utilized an annulus chiller, heat exchanger, and submersible pump.

The licensee procedures did not clearly define the necessary actions needed for planned and unplanned work stoppages during the vacuum drying process. Procedure BFP FH-71 did contain procedural steps for loss of vacuum, loss of Fuel Handling Building ventilation, and elevated airborne activity. In these instances, the workers were instructed to “secure vacuum drying.” However, the procedure failed to provide sufficient information to establish a specific configuration that represented “vacuum drying secured.” The inspectors identified that procedure BFP FH-78 did contain a section related to securing vacuum drying; however, this section was specifically related to securing the vacuum drying process after the MPC was considered dry, rather than planned or unplanned work stoppages. The procedure did not address what state the annulus chiller, heat exchanger, and submersible pump shall be in during planned or unplanned work stoppages, or what actions were appropriate for monitoring of these system components.

The process of vacuum drying has historically varied in duration dependent upon the MPC heat load. Heat load refers to the amount of heat that is continually generated by the spent nuclear fuel. Lower canister heat loads have taken as much as 150 hours to complete vacuum drying while higher canister heat loads have taken as little as 4 hours. The licensee was loading a canister with a relatively high heat load and therefore expected vacuum drying to finish in a short amount of time. Even though the licensee believed that vacuum drying would not take a long time, the operational experience associated with the vacuum drying process indicated that the process could last for several hours and would not necessarily be completed within one shift. Therefore, it would have been appropriate for procedures to include a predefined configuration for planned/expected work stoppages. Additionally, vacuum drying was performed in the Fuel Handling Building. Under certain radiological conditions, the Fuel Handling Building may need to be evacuated. The procedures should have identified the desired configuration for the vacuum drying and annulus cooling equipment prior to an evacuation, in the event one was needed.

The procedures also allowed the configuration and reconfiguration of equipment at the discretion of the supervisor. Configuration control on-site is routinely managed with more rigor. The procedures should have identified decision points, criteria for selecting an appropriate configuration, and steps for achieving the desired configuration.

The inspectors concluded that these procedural weaknesses contributed to this event.

(1) <u>Inadequate Procedures for Implementing FSAR Required Annulus Cooling</u>

<u>Introduction</u>

The inspectors identified a Severity Level IV NCV of very low safety significance of 10 CFR 72.150, "Instruction, Procedures, and Drawings." Specifically, the licensee failed to have procedures in place to ensure that the design basis peak fuel cladding limit would not be exceeded during vacuum drying operations.

<u>Description</u>

Holtec CoC 1014, Amendment 3, TS 3.1.1, Surveillance Requirement (SR) 3.1.1.1, states that the licensee shall verify that the MPC cavity has been dried in accordance with the applicable limits in TS Table 3-1. TS Table 3-1 states that for assemblies having a fuel burn-up of less than 45,000 mega watt days per metric tons of uranium (MWD/MTU) an appropriate method of removal is vacuum drying.

The TS Bases for SR 3.1.1.1 states that:

> "Table 3-1 of Appendix A to the CoC provides the appropriate requirements for drying the MPC cavity based on the burn-up class of the fuel (moderate or high) and the applicable short term temperature limit. The temperature limits and associated cladding hoop stress calculation requirements are consistent with the guidance in NRC Interim Staff Guidance (ISG) Document 11."

The Holtec FSAR, Revision 5, Chapter 4 discusses how the temperature limits and associated cladding hoop stress calculation requirements are consistent with the guidance in SFST ISG-11 during vacuum drying operations. Specifically, the Holtec FSAR, Revision 5, Section 4.5.1.1.4.1, "Vacuum Drying" states, in part:

> "The initial loading of Spent Nuclear Fuel (SNF) in the MPC requires that the water within the MPC be drained and replaced with helium. For MPCs containing moderate burn-up fuel assemblies only, this operation may be carried out using the conventional vacuum drying approach. In this method, removal of the last traces of residual moisture from the MPC cavity is accomplished by evacuating the MPC for a short time after draining the MPC.
>
> Prior to the start of the MPC draining operation, both the HI-TRAC annulus and the MPC are full of water. The presence of water in the MPC ensures that the fuel cladding temperatures are lower than design basis limits by large margins. As the active fuel length is uncovered during the draining operation, the fuel and basket mass will undergo a gradual heat up from the initially cold conditions when the heated surfaces were submerged under water. Basket periphery-to-MPC shell heat transfer occurs through conduction and radiation.
>
> For any decay heat load in an MPC-32, vacuum drying of the MPC is performed with the annular gap between the MPC and the HI-TRAC continuously flushed with water. The water movement in this annular gap will maintain the MPC shell temperature at about the temperature of flowing water. Thus, the thermal analysis of the MPC during vacuum drying for these conditions is performed with cooling of the MPC shell with water at a bounding maximum temperature of 125$^{o}$F.
>
> To avoid excessive conservatism in the computed FLUENT® solution, partial recognition for higher axial heat dissipation is adopted in the peak cladding calculations. The boundary conditions applied to this evaluation are: ii. The

entire outer surface of the MPC shell is postulated to be at a bounding maximum temperature of 125°F."

The Holtec FSAR, Revision 5, Section 4.5.2.2, "Maximum MPC Basket Temperature Under Vacuum Conditions" further states:

> As stated in Subsection 4.5.1.1.4, above, an axis symmetric FLUENT® thermal model of the MPC is developed for the vacuum condition. Each MPC [three different models exist] is analyzed at its respective design maximum heat load. The steady-state peak cladding results, with partial recognition for higher axial heat dissipation where included and are summarized in Table 4.5.9. The peak fuel clad temperatures for moderate burn-up fuel during short-term vacuum drying operations with design basis maximum heat loads are calculated to be less than 1058ºF for all MPC baskets by a significant margin.

Table 4.5.9 further clarifies that if the licensee uses a MPC-32 while vacuum drying with a MPC canister shell temperature at 125ºF, the analyzed peak fuel cladding temperature is 1040ºF.

The inspectors reviewed procedures BFP FH-71 and BFP FH-78. The procedures did not contain steps that would ensure that the annulus temperature would be maintained below 125°F in accordance with the Holtec FSAR, Revision 5. As discussed earlier, this annulus temperature design limit was selected to ensure peak fuel cladding temperatures are maintained below SFST ISG-11 safety limits. Specifically, the licensee procedures failed to monitor annulus water temperature and provide quantitative acceptance criteria such that peak cladding temperatures would remain within the design basis.

Analysis

The inspectors determined that the licensee's failure to have an adequate procedure to monitor annulus water temperature and provide quantitative acceptance criteria such that peak cladding temperatures would remain within limits was a licensee performance deficiency of more than minor significance. Consistent with the guidance in Section 2.2 of the NRC Enforcement Policy, independent spent fuel storage installations (ISFSIs) are not subject to the Significance Determination Process and, thus, traditional enforcement will be used for these facilities. The inspectors determined that the violation was of more than minor significance because, if left uncorrected, a failure to properly monitor and maintain annulus temperature within design limits could lead to a more significant safety concern in that fuel damage could occur. Consistent with the guidance in Section 2.6.D of the NRC Enforcement Manual, if a violation does not fit an example in the Enforcement Policy Violation Examples, it should be assigned a severity level: (1) Commensurate with its safety significance; and (2) informed by similar violations addressed in the Violation Examples. The inspectors found no similar violations in the Violation Examples. Subsequent analysis by the licensee and the NRC indicates that fuel cladding temperature safety limits were not exceeded during this event; therefore, the violation was determined to be of very low safety significance (Severity Level IV). The licensee documented the issue in its corrective actions program as IR01107151.

Enforcement

Title 10 CFR 72.150, “Instructions, Procedures, and Drawings,” states, in part, that the licensee shall prescribe activities affecting quality by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall require that these instructions, procedures, and drawings be followed. The instructions, procedures, and drawings must include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

Contrary to the above, on August 28, 2010, procedure BFP FH-71, “MPC Processing,” Revision 5, failed to include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. Specifically, the licensee’s procedures did not include appropriate quantitative and qualitative acceptance criteria to ensure that the HI-TRAC annulus cooling water temperature was maintained at a value less than its design bases. This Severity Level IV Violation will be treated as a NCV consistent with Section 3.1.1 of the NRC Enforcement Manual. **(NCV 05000454/2010007-01; 05000455/2010007-01; 07200068/2010002-0, Inadequate Procedures for Implementing FSAR Required Annulus Cooling.)**

(2) Unresolved Item - Non-Inert Atmosphere May Challenge Fuel Integrity

Introduction

The inspectors identified a URI associated with the licensee’s adherence to Holtec CoC 1014, Amendment 3, Appendix B, Section 3.4.10, during vacuum drying operations. Specifically, Appendix B 3.4.10 states that users shall establish procedural and/or mechanical barriers to ensure that during loading operations and unloading operations, either the fuel cladding is covered by water, or the MPC is filled with an inert gas.

Discussion

SFST ISG-22 discusses that cladding and fuel damage may occur if: a) the fuel has pinhole leaks or hairline cracks; and b) air is introduced into a dry fuel canister while fuel is at an elevated temperature. The Holtec CoC defines intact fuel as fuel assemblies without known or suspected cladding defects greater than pinhole leaks or hairline cracks and which can be handled by normal means. The Holtec FSAR indicates that during vacuum drying operations, fuel cladding temperatures are designed to be less than 1058$^{o}$F, but could be as high as 1040$^{o}$F.

The inspectors observed that while under vacuum, a hose rupture would allow air to flow back into the MPC. The licensee used commercial grade equipment hosing and valves, to complete the vacuum drying process. The licensee had no compensatory measures in place to promptly isolate and/or backfill the canister.

The licensee documented this concern in its corrective action program under IR1116408, “NRC Potential URIs from ISFSI Reactive Inspection.” Currently, the licensee has stated that they have selected fuel with no known pinhole leaks or hairline cracks. This determination was made from a review of fuel sipping and chemistry records. The licensee has added additional contingency procedures to appropriately recognize a hose failure and backfill the canister with an inert gas. This will remain an unresolved issue pending further review of whether a postulated vacuum hose break would result in fuel damage. **(URI 05000454/2010007-02; 05000455/2010007-02; 07200068/2010002-02, Non-Inert Atmosphere May Challenge Fuel Integrity.)**

.3 Review of Owner's Acceptance Criteria for Non-Licensee Calculations and Procedures

a. Inspection Scope

The inspectors reviewed the licensee's owner's acceptance criteria for non-licensee calculations and procedures.

b. Findings and Observations

The inspector's review and assessment of the licensee's owner acceptance review of licensee thermal calculations is documented in Section 4OA5.9 of this report.
The inspectors reviewed the licensee's approval process for ISFSI procedures. ISFSI procedures were created by the licensee and were not purchased as a deliverable. The licensee did review procedures from other sites as part of the procedure creation process. The inspectors review and assessment of licensee procedures is documented in Section 4OA5.2 and Section 4OA5.4.

(1) Unresolved Item - Licensee ISFSI Annulus Cooling System Important to Safety Classification

Introduction

The inspectors identified an unresolved item associated with the licensee's program that classifies ISFSI components and systems as either important to safety (ITS) or not important to safety (NITS). The inspectors identified that the licensee failed to have a procedure in place to classify ancillary pieces of equipment, not specifically classified in the Holtec FSAR, as ITS or NITS. The Holtec FSAR, Table 8.1.6 classifies ancillary pieces of equipment as ITS or NITS. The Holtec FSAR indicates that the maximum annulus cooling water temperature is 125$^{o}$F during vacuum drying operations. This temperature can only be achieved through some active means, and at the Byron Station, is achieved through the use of an annulus cooling system. Under medium and high heat loads, failure of this system would result in annulus cooling water exceeding the125$^{o}$F design basis limit absent some intervention.

Discussion

The system used by the licensee for HI-TRAC annulus cooling consists of a heat exchanger, submersible pump, temperature monitoring device, and chiller. The system is not classified as either ITS or NITS in the Holtec FSAR. The licensee purchased the chiller as commercial grade equipment and since the system was not identified within the Holtec FSAR, characterized the system as NITS.

The licensee initiated IR 1116408, "NRC Potential URIs from ISFSI Reactive Inspection," to determine whether the system needed to be re-designated as ITS. Subsequent to the completion of the inspection, the licensee utilized input from Holtec to make the ITS or NITS classification. Holtec Standard Procedure 345 is used to implement a graded classification approach, consistent with

NUREG/CR-6407. Using the evaluation matrix in Holtec Standard Procedure 345 the licensee classified the cooling system as NITS.

In Holtec's response to the licensee regarding its recommendation to classify the annulus cooling system as NITS, Holtec recommended the following:

"To preclude the possibility of peak cladding temperature exceeding 1058°F, administrative measures should be taken by the licensee to monitor the operation of the system and mitigate the likelihood of the annulus water temperature rising above 125°F by taking additional actions such as (a) regular monitoring of the device operability, (b) regular monitoring of the annulus bulk water temperature, and (c) procedurally establishing compensatory measures in order to mitigate the possibility of an adverse temperature condition. In the event of failure of the annulus cooling device which cannot be quickly restored (within 6 hours, based on the completion time for the similar condition in LCO 3.1.1 condition B from Amendment 5 of the Technical Specification), the cask should be backfilled with helium to the minimum limits as specified in Table 3-2, Appendix A, Amendment 3 of the Technical Specification (vacuum drying can be continued from that condition once the flushing system is restored)."

The inspectors reviewed the licensee's revised procedures for implementation of the Holtec recommendations. However, this issue will remain unresolved pending further review of the system classification as NITS by the SFST office. **(URI 05000454/2010007-03; 05000455/2010007-03; 07200068/2010002-03, Licensee ISFI Annulus System Important to Safety Classification.)**

.4 Review of ISFSI Program Management Oversight

a. Inspection Scope

The inspectors reviewed ISFSI program management oversight. The inspectors conducted interviews with various project management team members. Due to the limited scope of this inspection, which were the events that took place August 28 and 29, 2010, the inspectors focused on two areas; Procedure Creation Task, and Decision Making.

b. Findings and Observations

The project team was tasked with creating procedures for all evolutions associated with cask loading and unloading. Creating procedures for use in a nuclear environment is a special skill that requires extensive knowledge of not only the technical and process issues but also about licensing requirements and their associated guidance/bases documents. Additionally, procedure creation is governed by the licensee's quality assurance policy and procedures. The project team recognized that the site currently has personnel that routinely create/modify procedures. Project managers sought to engage various site groups/staff members for assistance in completing the procedure creation task. A significant percentage of personnel on-site who are knowledgeable in the area of spent fuel cask loading contributed to the creation of procedures. A byproduct of this arrangement is that there is a limited list of personnel that can provide a truly independent assessment of the work product. Following the event, an independent review was achieved via reviews conducted by the Plant Operational

Review Committee. These reviews resulted in resource changes and procedural revisions that improved procedure quality. The inspectors concluded that the project managers relied on a group of internal subject matter experts to ensure that procedures being created were not only of sufficient detail and clarity but also in alignment with station commitments and expectations. The methods employed by the project staff were not effective in producing procedures that were in alignment with station commitments and expectations.

Since this was a first time evolution for the site, it would be expected that a high level of technical rigor be applied to resolve any condition that is identified that is unexpected or outside procedural guidance. One method for ensuring appropriate technical reviews are conducted is through the use of independent peer reviews. On the night of the event, a supervisor made decisions regarding the configuration of the cask and vacuum drying equipment. This decision was made by the supervisor after consultation with a subject matter expert and discussions with project management. Procedures in place at the time of the event allowed unspecified reconfiguration of the equipment at the direction of supervision. The supervisor spoke with project management personnel prior to reaching their decision. Therefore, the inspectors could only conclude that the ISFSI project managers were aware of and in agreement with the decision. The inspectors believe that the collaborative nature of this decision diluted the level of independence that the project managers provided. The inspectors determined that it would have been appropriate to engage additional site resources to provide a peer review that was fully independent. Although the inspectors concluded that additional peer reviews were appropriate, it was not clear that a peer group, lacking personnel experience in spent fuel storage, would have been influenced less than the supervisor and project managers were by the information provided by the subject matter expert.

.5 <u>Review of the Licensee's Decision-Making and Communications that Contributed to the Event</u>

a <u>Inspection Scope</u>

The inspectors concluded and assessed the licensee's decision-making and communications that contributed to the event. In order to support an assessment of the role that the licensee's decision-making and communication standards had on the event, the inspectors conducted interviews with various members of licensee staff. A chronology was developed to make clear what was known and when it was known. The last piece of data used to create a contextual model was risk perception. As this activity was new to the licensee, it was important to understand what risk the licensee associated with certain equipment states, I.E., if equipment not addressed specifically in technical specifications is non-functional, how was risk assessed and were the planned actions in alignment with the perceived risk?

b. <u>Findings and Observations</u>

The inspectors concluded that the equipment used to cool the annulus was not addressed in TS. The FSAR does address the need to maintain the annulus water temperature below 125°F but does not address the specific method or equipment required to do so. This is a common practice within licensing documents when many different methods exist and creating documentation for every combination is impractical.

The licensee missed an opportunity to address this issue when they translated their licensing and technical documents into procedures. The failure to properly translate licensing and technical documents into procedures contributed to this event.

On the evening of the event, the supervisor needed to determine what configuration to place the equipment in until operations were resumed in the morning. One of the questions that the supervisor needed to answer was; how important is the cooling equipment? Since the equipment was not addressed specifically in the TS or the FSAR, the manager might have concluded that the equipment was NITS. The supervisor decided that it would be prudent to speak to the technical expert that was assigned to the project. The technical expert had been involved in cask loading campaigns at other locations and their understanding of the process was extensive. The supervisor and technical expert spoke at length regarding the need for and consequences associated with the possible loss of cooling function. The technical expert assured the supervisor that securing cooling when operations were halted for the evening or even over the weekend was routine. The technical expert believed that if the annulus was full of water that the heat rise overnight would present no risk to the fuel. Being a first time evolution, the supervisor lacked sufficient personal experience to predict the heat rise with a loss of cooling. The supervisor had no reason to doubt the technical expert's experience or knowledge in this subject. Following a discussion with project management, the supervisor decided that, based on a review of the licensing documents and discussions with the technical expert, securing the submersible pump and configuring the cooling system such that only the transfer cask was being cooled would be sufficient until morning.

The inspectors determined that the actions taken by licensee staff were, at all times, in accordance with their current understanding of risk. When licensee staff became aware of new information, risk was promptly reassessed.

The inspectors concluded that the supervisor should have engaged regulatory affairs and/or site engineering to resolve any uncertainty with respect to the configurations permitted within the license or the possible consequences associated with equipment failures. The inspectors concluded that the failure to engage additional site resources was a missed opportunity.

The inspectors concluded that consulting with a subject matter expert was appropriate; however, the information given by the subject information was incorrect. This incorrect information influenced the supervisor's technical assessment and therefore perceived risk. The inspectors believe that basing actions on incorrect information contributed to this event.

.6 <u>Review of the Licensee's Response to the Event</u>

a. <u>Inspection Scope</u>

The inspectors reviewed and assessed the licensee's response to the event. An NRC inspector was on-site on Sunday August 29th and was able to observe the licensee's response. The inspector attended licensee meetings and was given periodic status updates of the licensee's immediate response plans. The inspector observed licensee actions in the Control Room and in the Fuel Handling Building.

b. Findings and Observations

On the morning of August 29, 2010, the licensee discovered that the chiller used for cooling of the annulus region had unexpectedly shut off. The licensee immediately worked to install a backup chiller, and at approximately 9:30 AM restored the new chiller to service. The inspector requested, for their own information, that the licensee take a HI-TRAC annulus temperature reading. This request was made approximately 1 hour and 30 minutes after the annulus chiller was returned to service. Measurements were recorded at 1 hour and 30 minutes, 2 hours, and 2 hours and 30 minutes after the annulus chiller was returned to service with corresponding temperatures of 115$^o$F, 107$^o$F, and 104$^o$F respectively. From this information, the inspector questioned the licensee whether they had exceeded the Holtec FSAR design bases. The Inspector determined that given these temperature data points, there was a potential that the 125$^o$F annulus temperature design limit had been exceeded.

After the inspector requested a temperature reading, the licensee's immediately began taking temperature readings every 30 minutes. The licensee initially took temperature readings at one location in the HI-TRAC, between the HI-TRAC and the MPC, approximately 6 inches below the top of the MPC. After several hours the licensee began to take temperature readings at four locations in the HI-TRAC annulus, each approximately 6 inches below the top of the MPC, spaced apart by 90 degrees. The licensee continuously monitored the MPC until vacuum drying was complete.

Initially, there appeared to be uncertainty in regards to the licensee's understanding of the 125°F annulus temperature limit. The Holtec FSAR states that, "The entire outer surface of the MPC shell is postulated to be at a bounding maximum temperature of 125°F." This indicates that the water in the annulus shall be at a maximum of 125°F. However, the licensee believed that the 125°F limit was applicable to water flowing into the annulus rather than water in the annulus. IR 01107151 states "The water at 125 is the assumed limit for the water supply to the annulus not for water temperatures in the annulus." The NRC inspector questioned the licensee on this issue.

The licensee contacted the cask system CoC holder and vendor, Holtec, to gain a better appreciation of the safety significance of the event. Holtec informed the licensee that they did not believe any safety limits associated with peak fuel cladding temperatures were exceeded. The licensee requested Holtec perform a thermal analysis of the Byron Station site specific canister to analytically determine peak cladding temperatures. This analysis is discussed further in Section 4OA5.9.

The inspectors verified that the Control Room was aware of the issue. The Control Room was in the process of determining whether the issue was reportable under 10 CFR 72.75. The licensee concluded the issue was not reportable after receiving the thermal analysis from Holtec which demonstrated that no fuel cladding safety limits were exceeded.

The licensee staffed the Outage Control Center to verify that the event was receiving proper oversight. The Outage Control Center was staffed until: a backup annulus cooling source was established, helium backfilling procedures were re-verified to comply with the design basis, communications protocols were reviewed, and oversight was transferred to a specific ISFSI team.

The licensee decided that the safest configuration for the MPC to be in was filled with helium. During the remainder of the vacuum drying process the licensee maintained the annulus temperature under 110$^{o}$F. The licensee completed vacuum drying during the morning of September 3, 2010. The vacuum drying process took over 125 hours. The licensee backfilled the MPC with helium following completion of vacuum drying.

After the MPC was helium backfilled and seal welded, the licensee placed a stop work order on the remainder of ISFSI operations. The stop work order was placed in effect until: subsequent procedural steps could be verified to be in accordance with design bases, validation efforts were assessed through a senior leadership team challenge, enhanced management oversight was placed on the project, and the plant manager approved resumption of project activities following a senior management team challenge.

.7 Review of Plant and ISFSI Cask Documents and Records to Confirm the Adequacy of the Licensee's Assessment

a. Inspection Scope

The inspectors reviewed and assessed ISFSI cask documents and records to confirm the adequacy of the licensee's assessment, and the licensee's planned corrective actions.

b. Findings and Observations

The inspectors noted that the assessment process for the site could be broken down into two time dependent components: short term assessments and long term assessment plans.

The inspectors observed that ISFSI activities were promptly placed on hold following this event. The hold was in-place until the licensee developed an understanding of the event from a licensing and technical perspective as well as a work control perspective. Extensive communication between the licensee and the cask system vendor took place as a result of this event. The licensee commissioned additional analysis from the vendor to ensure their assessment of the event had an adequate technical basis. The licensee reviewed the procedures that were in use at the time of the event and found them to be inadequate. The licensee provided additional resources to the project to address procedural short comings as well as additional levels of review; cross discipline team reviews and management challenges of revised procedures. The licensee engaged the fleet organization to ensure that other sites were aware of the challenges that were occurring on-site. The licensee initiated a root cause analysis of this event. The inspectors concluded that the licensee's short term assessment was adequate. The inspectors believe that the actions taken as a result of the assessment support this determination.

The strongest learning tool in the corrective action program on-site is root cause analysis. This event warranted the use of the root cause tool. The root cause charter indicates that the licensee will be exploring the following topic areas: procedure development, procedure acceptance process, personnel training and qualifications, management oversight of the ISFSI project, communications, and use of operating experience [prior to event; from sites with cask loading in progress or complete]. The inspectors determined that the areas selected by the licensee in the root cause charter were appropriate. The inspectors concluded that the combination of short term assessments and long term assessment plans were adequate to address this event.

.8 Review of the Licensee's Planned Corrective Actions

a. Inspection Scope

The inspectors reviewed and assessed the licensee's planned corrective actions.

b. Findings and Observations

The licensee documented the event in its corrective action program under IR 01107151, "Annulus Chiller Unit Tripped Overnight." The licensee's immediate corrective actions have been previously discussed in Section 4OA5.6.

The licensee performed a root cause investigation to determine what causes led to the events of August 28 and 29, 2010. At the closing of the reactive inspection, the licensee had not completed their root cause analysis. Although the root cause evaluation had not been completed, additional corrective action items were initiated by the root cause team. The ISFSI procedures were reviewed by licensee ISFSI technical experts, given cross disciplinary reviews, and submitted for review by a senior level management team. The licensee conducted additional training for fuel handlers on the annulus cooling system. The licensee's communication plan was revised to ensure the shift manager and duty station manager were contacted when issues arise in order that appropriate organizational support is given to the project to successfully resolve issues. The licensee created a scheduled observation plan for critical activities related to the ISFSI project to provide additional management oversight. The licensee worked with Holtec to classify the annulus cooling system under the Holtec safety classifications process.

The ISFSI project has requested copies of underlying design calculations used to support the Holtec TS and FSAR to ensure all potential gaps are addressed in the revised procedures. The ISFSI project was directed to compare site procedures to other sites procedures in order to identify potential gaps.

A Nuclear Event Report (NER) was sent out by Exelon's corporate office to address fleet wide corrective actions at each operating site. The NER required that before the next dry cask storage campaign, each site review dry cask storage procedures for alignment with the respective cask Certificate of Compliance and Final Safety Analysis Report. This review was instructed by the NER to include a senior level challenge board and to be certified by each respective Site Vice President.

.9 Verification by SFST Staff that FSAR Safety Limits were not Exceeded and Determination of Margins of Safety.

a. Inspection Scope

The inspectors reviewed the licensee's thermal evaluation of the HI-TRAC under loss of annulus cooling during vacuum drying operations. Specifically, the inspector reviewed

Holtec Report No. HI-2104725, “Vacuum Drying Fuel Temperature Calculation of Byron Cask 1 Under Loss of Annulus Circulation,” to verify the licensee adequately determined peak cladding thermal safety limits were not exceeded during the event.

b. Findings and Observations

To address the loss of the annulus cooling event during vacuum drying operations for the Byron Station ISFSI Cask 1, the licensee performed a thermal analysis based on a two-dimensional thermal model consistent with the Holtec FSAR, Revision 5. The analysis included a three zone heat distribution consistent with the cask loading plan data developed for the first loading campaign at the Byron Station ISFSI with a total heat load of 21.376 kilowatts. Based on observations by the licensee personnel that the annulus water did not boil off, the licensee conservatively assumed the MPC shell reached a temperature of 232°F (boiling temperature of water under the hydrostatic pressure at the bottom of the annulus.) Based on this model and assumptions, the licensee’s predicted a maximum peak cladding temperature of 985°F which is, per SFST ISG-11, below the allowable safety limit of 1058° for moderate burn-up fuel during short-term loading operations.

The NRC SFST staff reviewed the adequacy of the licensee’s thermal model and assumptions and also independently developed a thermal model to verify the licensee’s predicted maximum temperatures. The staff’s quarter-symmetry thermal model consisted of a three-dimensional representation of the canister, including the spent fuel cells, basket, basket plates, cask cavity, MPC shell, bottom plate, and MPC lid. The spent fuel decay heat data was obtained from the licensee’s cask loading plant data. Based on this model, the staff predicted a peak cladding temperature of 990°F which is very close to the licensee’s predicted value. For moderate burn-up fuel, the dominant cladding failure mechanism is expected to be creep (stress rupture) of the cladding. To limit the amount of spent fuel that could be released from the cladding under short-term operations (e.g., vacuum drying) the maximum calculated cladding temperatures should be maintained below 1058°F. The basis for using 1058°F is established by the creep tests conducted on irradiated Zircaloy-4 rods (R. E. Einziger, S. D. Atkin, D. E. Stellbrecht, and V. Pasupathi. 1982. “High Temperature Postirradiation Materials Performance of Spent Pressurized Water Reactor Fuel Rods Under Dry Storage Conditions.” Nuclear Technology, v. 57, p. 65.).

Based on the licensee’s thermal evaluation and predicted maximum cladding temperatures and staff’s confirmatory analysis, the staff concludes that the integrity of the spent fuel was not compromised during the loss of annulus cooling event.

(1) Unresolved Item - Thermal Models in FSAR Design Basis Analysis May Not be Conservative

Introduction

The inspectors identified an unresolved item associated with peak cladding temperature thermal analyses during short term vacuum drying operations as described in the Holtec FSAR and the associated use of the Holtec FSAR at the Byron Station.

Discussion

SFST ISG-11 discusses that cladding temperature limits should not exceed 1058 $^{o}$F during short term operations. During an independent review of the licensee's failure to provide adequate cooling to the Byron Station ISFSI MPC during vacuum drying operations, a SFST technical reviewer assessed the Holtec FSAR Revision 5 design basis calculation for adequacy. When comparing the results of the reviewer's model to the results provided by Holtec's model which were subsequently incorporated into the Holtec FSAR, Revision 5, a potential discrepancy was noted. The Holtec FSAR, Revision 5, states that during steady state vacuum drying of an MPC-32 canister with a heat load of 28.74 kilowatts and a shell temperature postulated at 125$^{o}$F, fuel cladding temperatures will not exceed 1040$^{o}$F. The SFST reviewer's model calculated fuel cladding temperatures in excess of 1058 $^{o}$F.

The licensee documented this concern in its corrective action program under IR 1116408, "NRC Potential URIs from ISFSI Reactive Inspection." The licensee commissioned canister specific two dimensional thermal analyses for each remaining canister in the licensee's campaign. An additional safety factor was included in the licensee's analyses to ensure that any discrepancies between the NRC model and the Holtec model would not result in peak cladding temperatures in excess of 1058$^{o}$F.

This unresolved issue will remain open pending additional SFST review of the design basis fuel cladding temperatures documented in the Holtec FSAR, Revision 5, and the use of this FSAR at the Byron Station. **(URI 05000454/2010007-04; 05000455/2010007-04; 07200068/2010002-04, Thermal Models in FSAR Design Basis Analysis May Not Be Conservative.)**

4OA6 Management Meetings

.1 Exit Meeting Summary

On September 17, 2010, the inspectors presented the inspection results to Mr. B. Adams and other members of the licensee staff. The licensee acknowledged the issues presented. The inspectors confirmed that none of the potential report input discussed was considered proprietary.

ATTACHMENT: SUPPLEMENTAL INFORMATION

## SUPPLEMENTAL INFORMATION

## KEY POINTS OF CONTACT

Licensee Personnel
*B. Adams, Plant Manager
*A. Daniels, Nuclear Oversight Manager
*B. Spahr, Maintenance Director
B. Youman, Work Management Director
*C. Gayheart, Operations Director
*D. Gudger, Regulatory Assurance Manager
*D. Kelly, Outage Services Manager
*E. Bogue, Training Manager
*J. Anderson, Project Manager
*J. Lanagan, NRC Coordinator
*M. Wolfe, Reactor Services Manager
S. Greenlee, Engineering Director
T. Hulbert, NRC Coordinator
*T. Spelde, ISFSI Project Manager

*Licensee and Contractor Employees in Attendance during the August 23, 2010 ISFSI Interim Exit Meeting

## LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

| | | |
|---|---|---|
| 05000454/2010007-01; 05000455/2010007-01; 07200068/2010002-01 | NCV | Inadequate Procedures for Implementing FSAR Required Annulus Cooling (Section 4OA5.2) |
| 05000454/2010007-02; 05000455/2010007-02; 07200068/2010002-02 | URI | Non-Inert Atmosphere May Challenge Fuel Integrity (Section 4OA5.2) |
| 05000454/2010007-03; 05000455/2010007-03; 07200068/2010002-03 | URI | Licensee ISFSI Annulus Cooling System Important to Safety Classification (Section 4OA5.3) |
| 05000454/2010007-04; 05000455/2010007-04; 07200068/2010002-04 | URI | Thermal Models in FSAR Design Basis Analysis May Not be Conservative (Section 4OA5.9) |

Closed

| | | |
|---|---|---|
| 05000454/2010007-01; 05000455/2010007-01; 07200068/2010002-01 | NCV | Inadequate Procedures for Implementing FSAR Required Annulus Cooling (Section 4OA5.2) |

## LIST OF DOCUMENTS REVIEWED

The following is a list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspectors reviewed the documents in their entirety, but rather, that selected sections of portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

- AD-AA-101; Processing of Procedures and T&RMs, Revision 21
- AD-AA-101-1002; Writer’s Guide for Procedures and T&RM, Revision 14
- AD-AA-101-F-01; Document Site Approval Form, Revision 2
- AD-AA-2001; Management and Oversight of Supplemental Workforce, Revision 7
- AD-AA-2001-1001; Oversight of Supplemental Personnel Responsibilities (Per INPO-
- AP-930, AD-AA-200, and AD-AA-2001) Job Familiarization Guide, Revision 2
- BFP FH-34; Draining the Spent Fuel Cask Chamber and Operating Portable Pumping Equipment, Revision 0
- BFP FH-64; Transporter Operations, Revision 4
- BFP FH-65; Spent Fuel Cask Site Transportation, Revision 5
- BFP FH-67; Trackmobile Undocumented Visual Inspection, Revision 0
- BFP FH-68; HI-TRAC Preparation, Revision 0
- BFP FH-69; HI-TRAC Movement Within the Fuel Building, Revision 0
- BFP FH-70; HI-TRAC Loading Operations, Revision 1
- BFP FH-71; Discrepancies and Corrective Actions, Revision 6
- BFP FH-71; MPC Processing, Revision 5
- BFP FH-72; HI-STORM Processing, Revision 0
- BFP FH-76; Transporter Undocumented Visual Inspection, Revision 2
- BFP FH-78; Vacuum Drying System Operation, Revision 2
- BFP FH-84; HI-TRAC Operations Within the Fuel Building, Revision 0
- Byron ISFSI Project Human Performance Plan, Revision 1, April 22, 2010
- Byron Station Plant Operations Review Committee (PORC # 10-18) Actions/Changes Tracking Log, ISFSI Dry Cask Storage Stack-Up and Download Process - Short Term Actions, September 03, 2010
- Byron Station Plant Operations Review Committee (PORC # 10-18) Actions/Changes Tracking Log, ISFSI Dry Cask Storage Stack-Up and Download Process - Long Term Actions, September 03, 2010
- Byron Station Plant Operations Review Committee (PORC #10-18) Meeting Agenda, September 03, 2010
- Byron Station Plant Operations Review Committee (PORC #10-19) Meeting Agenda, September 09, 2010
- CC-AA-304; Component Classification, Revision 5
- Document Number BFP FH-20 (Interim Change) Operation of Fuel Handling Building Crane, Revision 17
- Document Number BFP FH-20; Operation of Fuel Handling Building Crane, Revision 18
- Document Number OU-AP 216; Operation of the Spent Fuel Pool Bridge Crane, Revision 0
- Document Number OU-AP-204; Fuel Handling Activities in the Spent Fuel Pool for Byron and Braidwood, Revision 0
- Document Number OU-AP-229; Operation of the Spent Fuel Pool Sluice Gates for Byron and Braidwood Stations, Revision 0
- Dry Cask Storage Safety Plan

- Event/Issues Report Format, Attachment 2; Human Performance Issue Verbal Report Format (Byron Station)
- Holtec Document HI-1676066; Responses to Potential URIs on Vacuum Drying / Annulus Flush, Revision 1
- Holtec Document HI-2104725; Vacuum Drying Fuel Temperature Calculation of Byron Cask 1 Under Loss of Annulus Circulation, Revision 1
- Holtec Document PS-1421; Purchase Specification for the Supplemental Cooling System, Revision 4
- HU-AA-101; Human Performance Tools and Verification Practices, Revision 5
- HU-AA-104-101; Procedure Use and Adherence, Revision 4
- HU-AA-1211; IPA Briefing Worksheet, Revision 6
- HU-AA-1211; Pre-Job Briefings, Revision 5
- Inspection/Test Certificate – Slingmax Rigging Solutions, July 10, 2009
- IR 1103760; ISFSI Question - Potential Operation Error Affect on HI-STORM, September 05, 2010
- IR 1106006; NRC Identified Procedure Improvement Lessons Learned, August 24, 2010
- IR 1106879; Lessons Learned for Dry Cask Storage Processing, August 27, 2010
- IR 1107151; Annulus Chiller Unit Tripped Overnight, August 29, 2010
- IR 1107675; Holtec FSAR Table 1.2.2 Contains Incorrect Value for MPC 32, August 30, 2010
- IR 1108142; Discrepancy in BFP FH-71, August 31, 2010
- IR 1108234; Who is in Charge: Exelon or Contractors, August 31, 2010
- IR 1108255; ISFSI NRC Communications, August 21, 2010
- IR 1108576; Recovery Plan for ISFSI Loss of Annulus Cooling, September 01, 2010
- IR 1108790; Holtec ISFSI Letter on Vacuum Drying was Revised, September 1, 2010
- IR 1109610; MPC #90, Cask #1 Leak Test Specialist Inspection, September 03, 2010
- IR 1109620; Discrepancy in BFP FH-70, September 03, 2010
- IR 1109620; Discrepancy in BFP FH-70, September 03, 2010
- IR 1109629; Discrepancy in BFP FH-75, September 03, 2010
- IR 1109629; Discrepancy in BFP FH-75, September 03, 2010
- IR 1109916; ISFSI Observation and Lessons Learned, September 04, 2010
- IR 1109916; ISFSI Observations and Lessons Learned, September 04, 2010
- IR 1109925; Momentary Unexpected Load Decrease During MPC Download, September 04, 2010
- IR 1109925; Momentary Unexpected Load Decrease During MPC Download, September 04, 2010
- IR 1110008; Ed/TLD Dropped About 20 Feet, September 05, 2010
- IR 1110070; ISFSI HI-STORM Transporter Shutdown, September 05, 2010
- IR 1110070; ISFSI HI-STORM Transporter Shutdown, September 05, 2010
- IR 1110502; NOS ID – Hearing Protection Not Being Worn, September 07, 2010
- IR 1110521; NOS ID: Calculation Did Not List All Assumptions, September 07, 2010
- IR 1110606; Discrepancies in BFP FH-82, September 07, 2010
- IR 1110608; Discrepancy in BFP FH-70, September 07, 2010
- IR 1111015; Lessons Learned From Initial Byron DSF Cask Load, September 08, 2010
- IR 1111335; Procedure Deficiency with Cask COC Technical Specifications, September 08, 2010
- IR 1116408; NRC Potential URIs from ISFSI Reactive Inspection, September 17, 2010
- ISFSI & Crane Trolley Upgrade Project Communications Plan, Revision 3
- ISFSI 2010 Open Items, Various Revisions
- ISFSI Cask Loading Recovery Action Plan, Revision 4
- ISFSI Dry Cask Storage Organization Chart #2

- ISFSI Reactive Inspection Document Request; Due by Noon September 03, 2010
- ISFSI Safety/Human Performance Improvement Plan, Campaign Number 1,August 2010
- ISG-22; Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel
- Letter from Holtec International; Conversion of HI-STORM 100 CoC (Amendment 3) Backfill Limits, February 9, 2009
- LS-AA-125-1001; Attachment 2, Root Cause Investigation Charter, September 08, 2010
- LS-AA-125-1001; Root Cause Analysis Manual, Revision 7
- LS-BY-108; Attachment 1, 72.212 Evaluation Change Request # 01, Revision 0
- Maintenance Performance GAP 5; Industrial Safety 2010 WANO AFI OR.6-1
- MPC Backfill System No. 405 Technical Manual
- NF-AA-309; Move Sheet Package Cover; Special Instructions/Emergency Set-Down Instructions, Revision 2
- Open Item #79; ER-AA-2030, Conduct of Plant Engineering Manual 4.6.3 System Turnover
- Product Specification Sheet – Kuriyama of America, Inc.
- Project Plan # 28NOV07 for Byron Dry Cask Storage ISFSI
- Sequence of Event on August 28$^{th}$ and August 29$^{th}$
- Table 1.2.2; Key Parameters for HI-STORM 100 Multi-Purpose Canisters, Revision 5
- Table 3-2; MPC Helium Backfill Limits

## LIST OF ACRONYMS USED

| | |
|---|---|
| $^{o}$F | Degrees Fahrenheit |
| ADAMS | Agencywide Documents Access Management System |
| BFP | Byron Fuel Handling Procedure |
| CFR | Code of Federal Regulations |
| CoC | Certificate of Compliance 1014, Amendment 3 |
| FSAR | HI-STORM 100 Final Safety Analysis Report |
| HI-STORM | Holtec International Storage Cask |
| HI-TRAC | Holtec International Transfer Cask |
| IMC | Inspection Manual Chapter |
| IP | Inspection Procedure |
| IR | Issue Report/Inspection Report |
| ISFSI | Independent Spent Fuel Storage Installation |
| ISG | Interim Staff Guidance |
| ITS | Important to Safety |
| MPC | Multi-Purpose Canister |
| NCV | Non-Cited Violation |
| NER | Nuclear Event Report |
| NITS | Not Important to Safety |
| NMSS | Office of Nuclear Materials Safety and Safeguards |
| NRC | U.S. Nuclear Regulatory Commission |
| PARS | Publically Available Records |
| SDP | Significance Determination Process |
| SFST | Division of Spent Fuel Storage and Transportation |
| SNF | Spent Nuclear Fuel |
| TS | Technical Specification |
| URI | Unresolved Item |