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Exelon Nuclear

10 CFR 71.95

RA05-15

February 07, 2005

ATTN: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

LaSalle County Station, Units 1 and 2
Facility Operating License Nos. NPF-11 and NPF-18
NRC Docket Nos. 50-373 and 50-374 71-9225

Subject: Report in Accordance with Requirements of 10 CFR 71.95 - Presence of Water in Shipping Cask

References: Certificate of Compliance (CoC) No. 9225, Revision 36

This report is submitted pursuant to 10 CFR 71.95, "Reports," documenting the discovery of water in a NAC International, (NAC), Legal Weight Truck (LWT) shipping cask upon unloading at the Studsvik Nuclear AB Hotcell facility in Sweden. This water represents a violation of Item 7 of the referenced CoC, which states, "The cask must be dry (no free water) when delivered to a carrier for transport." After unloading, approximately 1.5 to 2 liters of water was reported to be in the sealed inner canister and approximately 5-10 centiliters in the cask cavity.

The attachment contains the written report required in accordance with 10 CFR 71.95.

Should you have any questions or require additional information, please contact Alison Mackellar at (630) 657-2817.

Respectfully,

Susan Landahl

Susan Landahl
Site Vice-President
LaSalle County Station
Exelon Generation Company, LLC

Attachment: Report in Accordance with Requirements of 10 CFR 71.95 - Presence of Water in Shipping Cask

cc: NAC International

NMSS01

ATTACHMENT
REPORT IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR 71.95
PRESENCE OF WATER IN SHIPPING CASK

INDEX

ATTACHMENT
REPORT IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR 71.95
PRESENCE OF WATER IN SHIPPING CASK

1.0 ABSTRACT

In December 2004, Exelon Generation Company, LLC (EGC) was made aware by NAC International (NAC) that a shipment of irradiated fuel from LaSalle County Station (LSCS) to the Studsvik Nuclear AB Hotcell Facility in Studsvik, Sweden that occurred in October 2003, was not made in proper compliance with the shipping cask's Certificate of Compliance (CoC). Item 7 of the CoC states, "The cask must be dry (no free water) when delivered to a carrier for transport." Contrary to this requirement, approximately 1.5 to 2 liters of water was reported to be present in the sealed inner canister and approximately 5-10 centiliters in the cask cavity after unloading.

The investigation performed by EGC was not able to definitively identify the cause of the water in the inner canister and cask, but did identify three potential causes and developed corrective actions for each. The potential causes were the failure to thoroughly qualify a new configuration of the shipping cask prior to use, design weaknesses in the inner canister, and the use of inappropriate instrumentation for vacuum drying of the cask and canister.

Corrective actions to which NAC committed include performing an evaluation of the drying process for BWR/PWR failed fuel configurations, adding a requirement to the NAC operating procedure to confirm CoC compliance upon package arrival, and use of an appropriately ranged digital vacuum gauge. EGC will develop a governing procedure to address corporate, station, and vendor responsibilities regarding future irradiated fuel shipments.

2.0 NARRATIVE

As a result of the LSCS and Quad Cities Nuclear Power Station (QCNPS) fuel failures, which occurred in 2001 and 2002, a failed fuel shipment from LSCS to the Studsvik Nuclear AB Hot Cell Facility in Studsvik, Sweden was planned for additional examination of the fuel rods.

The original scope of the shipment consisted of 6 fuel rods to be shipped – 5 failed rods and 1 non-failed rod. The rods were as follows:

- Assembly 29A032, Rod A5 (Failed rod)
- Assembly 29A032, Rod A4 (Non-failed rod)
- Assembly 29C170, Rod C9 (Failed rod)
- Assembly 29C232, Rod F1 (Failed rod)
- Assembly 28A034, Rod C2 (Failed rod with long axial crack)
- Assembly 19A201, Rod A4 (Failed rod, severed)*

* Note that this rod was later removed from the inner canister and not included in the final shipment.

ATTACHMENT
REPORT IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR 71.95
PRESENCE OF WATER IN SHIPPING CASK

All five fuel rods in the final shipment were discharged in mid-cycle during the LSCS Unit 2 outage in October 2002. All fuel was fabricated with the maximum U-235 enriched zones being slightly less than 5 wt%. The active fuel length for the ATRIUM9 non-gadolinium fuel is 149 inches. All fuel rods shipped were from a BWR 9x9 fuel matrix and the fuel was all contained in a rod holder. The ATRIUM9 fuel design and pellet diameter is less than 0.49 inches. All five rods in the shipment had been cooled in the spent fuel pool in excess of 300 days. Discharge bundle exposures for the fuel range from 16.2 to 36.8 GWD/MT. The calculated decay heat was less than 2.1 KW per package. The final selection of the rods shipped did not affect any plant design attribute.

The Legal Weight Truck (LWT) cask proposed by NAC for the LSCS shipment was not licensed to ship failed light water reactor fuel. This necessitated a cask CoC revision.

Due to the added challenge of shipping failed fuel, an additional requirement to load the fuel rods into a "sealed" configuration inner canister was developed. This shipment was the first time a "sealed" configuration was used for full-length fuel rods in a LWT cask. Due to the condition of the rods, NAC also determined that these rods would be encapsulated to add an additional barrier in order to limit the spread of contamination and confine gross particles within the inner canister. The fuel capsules were designed with small flow holes to allow drainage of any trapped water from the fuel rods and subsequent removal. The failed rods fit tightly into the capsules.

Prior to the inner canister arriving at LSCS, NAC performed informal testing of the drying process simulating the sealed inner canister configuration with capsules; however, this test did not simulate failed rods inside the capsules. This testing did not satisfy NAC's internal quality procedures that require appropriate design verification be performed and documented.

From August 6 to August 8, 2003, Framatome-ANP and LSCS Reactor Services personnel completed the individual fuel rod encapsulations for all six rods and loading of the capsules into the inner canister. This was performed in the Spent Fuel Pool in accordance with Framatome and NAC loading procedures. The inner canister lid was installed after inspecting the o-rings and applying Dow Corning sealant. The lid bolts were torqued, and an open vent was installed due to heat concerns with the fuel inside the inner canister. The inner canister, still containing water, resided in the Spent Fuel Pool pending the cask CoC approval from the NRC.

On September 24, 2003, the NRC approved and issued Revision 36 of CoC Number 9225 for the NAC LWT cask. The NRC had informed NAC that the severed rod (A4) could only be shipped if tighter leakage requirements were satisfied for secondary containment. NAC evaluated this and concluded that the inner canister did not meet the tighter leakage standards. A one-time Exemption Request was submitted to the NRC to permit shipment of the severed rod but review and approval times did not support the desired shipping window. Thus, rod A4 was removed from the inner canister before loading the cask.

ATTACHMENT
REPORT IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR 71.95
PRESENCE OF WATER IN SHIPPING CASK

On September 29, 2003, Framatome ANP and LSCS Reactor Services crews removed the inner canister lid to remove severed failed rod A4. Based on interviews with Framatome personnel, the crew did re-inspect the o-rings but did not re-apply additional sealant on the o-rings for the inner canister lid prior to re-installing as it was judged acceptable in accordance with the NAC procedure. The lid removal and re-installation was performed under the supervision of a NAC Field Engineer and the LSCS Fuel Handling Supervisor.

On October 1, 2003, NAC personnel, with the oversight of the LSCS Fuel Handling Supervisor, performed the inner canister blow down and drying process to remove water. The drying procedure was executed as specified in the Safety Analysis Report for the cask.

The NAC vacuum drying process consisted of connecting a vacuum pump system to the inner canister to extract water contained within the inner canister and the capsules, which had drain holes to ensure water from within the rods would be removed. The process for spent fuel shipment involves evacuating the inner canister (and cask) to 1/2p (where p = water vapor pressure adjusted for spent fuel pool temperature), then monitoring for 15 minutes. The vacuum pump is then stopped and pressure is monitored for 10 minutes. If the pressure rise is less than 1/4p, the canister/cask is considered adequately dried.

The Heise Model CM Dial Pressure Gauge used for drying had a scale of 0 to 2070 mm Hg (0 to 2070 torr). Therefore, when a vacuum was approached, the instrument was operating at the lowest end of the scale. The accuracy for this model Heise gauge was 0.1% full scale which correlates to +/ – 2 torr. Furthermore, the drying acceptance criterion would be difficult to detect to the required degree of accuracy. Use of this gauge was not optimal from a range and readability standpoint.

The inner canister drying occurred in the fuel preparation machine submerged in the spent fuel pool, and took approximately 12-14 hours to complete. This duration was not unexpected as water was to be extracted from inside failed fuel rods and their close-fitting encapsulating tubes. Following drying, the inner canister was filled with one atmosphere pressure of inert cover gas. The hoses were then removed at the quick disconnects, leaving the inner canister in its final sealed configuration.

The inner canister was loaded into the cask and the cask was dried using the same criteria. Cask drying was also performed by NAC with the oversight of the LSCS Fuel Handling Supervisor, and took about 27 hours to complete. The cask drying evolution was completed on October 3, 2003.

The cask left LSCS on October 6, 2003. On October 7, 2003, the cask was loaded onto the INF1 vessel BBC Denmark, operated by Poulsen Shipping, to ship the cask from Newport News, Virginia to Port Wallhamn, Sweden. Radiological surveys of the cask conducted at LSCS prior to shipment, and at the outbound shipping port, indicated there was no contamination or radiological concerns with the cask. The ship arrived at Port

Wallhamn, Sweden on October 20, 2003. The cask was then transported by truck to Studsvik on October 20, 2003.

On October 21, 2003, Studsvik personnel began unloading the cask and inner canister. Upon opening the cask lid, a small amount of water (estimated to be 5 to 10 centiliters) came out of the cask opening. Interviews with Studsvik personnel indicated this water was relatively clean. When removing the inner canister and its lid, more water (unquantified but reported as small) came out from the inner canister opening. This water was described as highly contaminated. No personnel contaminations resulted from this water drainage incident. Studsvik personnel indicated the inner canister lid removal was difficult and required additional tooling to remove. The fuel rods were removed from the inner canister and capsules and processed into the hot cell for their intended root cause examination. The capsules were reported to be in good condition and the flow holes appeared to be unobstructed.

On October 22, 2003, Studsvik personnel backed the cask away from the hot cell connection. An additional amount (unquantified but reported as small) of water reportedly came out of the cask opening. Two Studsvik personnel received external clothing contamination from contact with this water. The water also ran down the outside of the cask resulting in cask surface contamination.

There is no water source within the hot cell facility that could have introduced water to the cask or inner canister. Additionally, the cask was always maintained closed when not docked to the hot cell transfer port, and was maintained horizontally at all times. Thus, it is believed that the water originated from LSCS.

On October 29, an EGC Fuel Reliability Engineer (FRE) was attending an Organization for Economic Cooperation and Development (OECD) meeting at Studsvik and had the opportunity to briefly tour the facility while the LSCS fuel shipment was at the hot cell. During this tour, Studsvik personnel indicated the inner canister was more contaminated than expected. The FRE recalls that he asked if any water was present in the cask and inner canister. The answer he received was that there was a small amount in the inner canister. The FRE believed the small quantity of water was residual moisture or small droplets that may have seeped out of the rods through condensation during the shipment to Sweden.

In November 2003, EGC was notified by NAC that the inner canister was contaminated (but there was no mention of the cask contamination). In December 2003, Studsvik personnel decontaminated the cask and returned it to NAC. At this time, Studsvik personnel set the inner canister aside in a "spare" cask owned by the Studsvik facility for decontamination at a later time. The inner canister was pulled from the cask for decontamination efforts in April 2004. On April 5 Studsvik notified NAC and Framatome (but not EGC) by e-mail that there was water present and inquired on the loading arrangement of the cask. On April 16 the inner canister was tilted forward to allow the water to drain into a 3.3 liter bucket. Studsvik personnel took a photograph of the bucket of water. The bucket was approximately half full indicating the amount of water drained

was about 1.5 to 2.0 liters. Radiological readings inside the inner canister indicated an activity level of 300 mSieverts/hr (which equates to 30R/hr), with the presence of alpha particles.

As decontamination of the canister became a higher priority, EGC solicited Framatome to help expedite the decontamination efforts. On June 10, 2004, Studsvik notified Framatome by e-mail that there was 1.5 liters of water found during the decontamination process. Studsvik also mentioned they cleaned the inner canister with fresh water and the activity level decreased to 50 mSieverts/hr and that further decontamination would continue.

Framatome forwarded this notification to EGC Nuclear Fuels (NF) on June 10 with a concern on the decontamination efforts, not recognizing that the water represented a CoC violation. Similarly, this e-mail was forwarded within EGC NF to individuals following the decontamination efforts. As there had been no mention of a shipping problem over the previous eight months after the rods had been discharged to the hot cell, EGC NF believed that the water had been introduced during the decontamination efforts. None of the individuals who reviewed the e-mail notification recognized the water as being a shipping violation issue.

On October 6, 2004, at a planning meeting in Amsterdam for an unrelated project, Studsvik personnel mentioned the water issues of the LSCS cask and inner canister to NAC personnel. NAC requested formal notification for more details. Studsvik provided the written notification to NAC on October 12, 2004. Upon receipt, NAC generated an internal self-identification report (SIR) for investigation. The SIR was subsequently closed to a Corrective Action Report. NAC notified EGC 's Vice President Nuclear Fuel of this situation on December 9, 2004.

3.0 POTENTIAL CAUSES

- NAC failed to thoroughly qualify a new configuration of the shipping cask prior to use. NAC performed informal testing of the drying process simulating the sealed inner canister configuration with capsules; however, this test did not simulate failed rods inside the capsules. This testing did not satisfy NAC's internal quality procedures that require that appropriate design verification be performed and documented.

- The use of an inappropriate gauge to monitor the vacuum drying process may have caused false indication of dryness within the canister and cask. The gauge was being used at the lowest end of its scale and was not sensitive enough to accurately monitor pressure changes in the range necessary.

- The potential for a design weakness in the inner canister that could have allowed in-leakage through either the lid or the quick disconnects following

the drying process while the canister was underwater in the Spent Fuel Pool could not be eliminated.

4.0 SAFETY CONSEQUENCES ASSESSMENT

4.1 Radiological Impact

The LSCS shipment resulted in two Studsvik employees experienced external clothing contamination when a small amount of water was encountered upon opening the cask and canister; and the canister was found contaminated more than expected and may require disposal (depending on future decontamination success).

4.2 Criticality

The LWT cask is fully licensed for all fuel acceptable for cask loading to remain sub critical under the most optimal moderation condition in normal or accident conditions. The five fuel rods shipped were well within cask CoC limitations on total enriched fuel and posed no criticality issue even under optimum moderation conditions. Further, use of the internal encapsulating tubes for this shipment provided significant additional geometry control.

4.3 Transportation

No transportation events were reported during the shipment and no external cask contamination was reported indicating the cask integrity was not jeopardized during the actual shipment.

A potential transportation risk existed in that the internal water would have pressurized the canister and the cask if the cask had been subjected to a design basis shipping accident with attendant fire. No shipping accident occurred. However, to address this concern, NAC performed an evaluation, documented in Reference 5 and subsequently reviewed by EGC in Reference 6.

NAC prepared a bounding, conservative analysis that determined the cask internal pressure would rise to no more than 304 psig assuming a design basis fire with 2 liters of internal water. The licensed design pressure of the cask at the time of the LSCS shipment was 168 psig, which has subsequently been increased to support the Department of Energy (DOE) tritium project to 600 psig.

Based upon the NAC evaluation and subsequent re-licensing of the cask to 600 psig, had the cask been subjected to a design basis accident (fire), no leakage of radioactive contents would have occurred.

One of the five contained fuel rods in the cask shipment was intact. The NAC evaluation of cask cavity pressure (304 psig) included venting of this rod.

Although not licensed for wet shipments, the NAC LWT cask with a small amount of residual water (in this instance, approximately 2 liters), would not pose a risk during a design basis accident (fire) based upon the NAC evaluation. The fuel would not go critical and the cask would not release radioactive contents to the environment.

Although not in accordance with the CoC, the LSCS shipment was successfully accomplished without impact to the public and no impact would have occurred even under the worst potential accident scenario (fire) based upon evaluations conducted to date.

5.0 CORRECTIVE ACTIONS

The following corrective actions have been developed in response to this event:

- NAC will perform a formal testing evaluation to qualify the drying process for the BWR/PWR failed fuel configuration prior to its next use. This evaluation will use a revised free-flowing inner canister configuration which does not require drying while submerged in the pool and eliminates the use of quick disconnects and a sealed lid. EGC NF will track completion of this qualification.

- NAC will require use of an appropriately ranged digital gauge capable of reading to a vacuum of 10^{-1} torr with a minimum readability of 1 torr.

- EGC will develop a governing procedure to address corporate, station, and vendor roles and responsibilities as well as other shipping considerations (e.g., reporting requirements, use of qualified package, use of appropriate instrumentation) that need to be addressed for future irradiated fuel shipments.

- NAC will add a requirement to their generic operating procedure to confirm with the receiver of a shipment that the package arrived in compliance with the CoC. EGC NF will track completion of this action.

6.0 PREVIOUS EVENTS

During March 2004 a spent fuel shipment from Indonesia to DOE Savannah River Site, as documented in a letter from NAC International to U.S. NRC dated July 22, 2004, and a subsequent follow-up report dated October 15, 2004, observed the presence of water in two casks upon unloading. Based on the information documented in the referenced letters, the volume of water in each cask was estimated to be less than 2 liters. Note that these shipments took place subsequent to the LSCS shipment but prior to the date of this report.

ATTACHMENT
REPORT IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR 71.95
PRESENCE OF WATER IN SHIPPING CASK

7.0 CONTACT INFORMATION

Should you have any questions or require additional information, please contact Ms. Alison Mackellar at (630) 657-2817.

8.0 EXPOSURE EXTENT

On October 22, 2003, two Studsvik personnel received external shoe and clothing contamination while backing the cask away from the hot cell connection.

9.0 REFERENCES

1. Certificate of Compliance (CoC) No. 9225, Revision 36

2. Letter from Thomas C. Thompson, (NAC International) to E. William Brach, (U. S. NRC), "Report per Requirements of 10 CFR 71.95 – Presence of Water in Cask Cavity," dated July 22, 2004

3. Letter from Thomas C. Thompson, (NAC International) to U. S. NRC, "Follow-up Report to NAC International 10 CFR 71.95 Communication of Presence of Water in Cask Cavity," dated October 15, 2004

4. EGC Engineering Change No. 334718, "Fuel Rod Selection for Transportation using NAC-LWT Cask," dated September 26, 2003

5. NAC International evaluation, "Evaluation of the Pressure Due to the Water in the LWT Cask," No. CAR 04-01 Revision 0, dated February 3, 2005

6. EGC Engineering Change No. 353671, "Acceptance Review of NAC International Evaluation of Potential Internal Pressure in the NAC LWT Cask under Accident Scenario for the LaSalle to Studsvik Irradiated Fuel Shipment in October 2003," dated February 3, 2005

7. EGC Root Cause Evaluation, "Spent Fuel Shipment Not in Compliance With Cask Certificate due to the Presence of Free Water," dated January 27, 2005