March 6, 2014

MEMORANDUM TO: Stephanie Coffin, Acting Deputy Director
Division of Spent Fuel Storage and Transportation, NMSS

FROM: Norma Garcia Santos, Project Manager **/RA/**
Licensing Branch
Division of Spent Fuel Storage and Transportation, NMSS

Jorge Solis, Ph.D., Senior Thermal Engineer **/RA/**
Thermal and Containment Branch
Division of Spent Fuel Storage and Transportation, NMSS

SUBJECT: SUMMARY OF FEBRUARY 6, 2014, PUBLIC MEETING WITH EXELON GENERATION COMPANY, NUCLEAR ENERGY INDUSTRY, AND CASK SYSTEM VENDORS TO DISCUSS ISSUES ASSOCIATED WITH THE VACUUM DRYING PROCESS PERFORMED DURING SPENT NUCLEAR FUEL CASK LOADING OPERATIONS

Background

A public meeting was held on February 6, 2014, in Rockville, Maryland, at the request of the United States (U.S.) Nuclear Regulatory Commission (NRC) staff to discuss potential issues associated with the vacuum drying process performed during spent nuclear fuel cask loading operations.

The meeting was noticed on January 17, 2014 (ADAMS Accession No. ML14024A266). The meeting was open to the public. Exelon Generating Company, LLC (Exelon)[1] and the Nuclear Energy Institute (NEI) provided presentation slides on February 4 (ADAMS Accession No. ML14051A066) and February 5, 2014 (ADAMS Accession No. ML14051A046), respectively. The meeting attendees' list is provided as Enclosure 1. The meeting agenda is provided as Enclosure 2. NRC's, Exelon's, and NEI's presentation slides are provided as Enclosures 3, 4, and 5, respectively.

Discussion

On August 28, 2010, a cooling system (to keep cladding temperatures below allowable limits during cask loading operations) was left unattended overnight and found to be inoperable the next morning. Due to this event, the NRC conducted a reactive inspection at Byron Generating

[1] Exelon owns Byron Generating Station (Byron). Byron is the licensee under 10 CFR Part 72 "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, And Reactor- Related Greater Than Class C Waste."

Station (ADAMS Accession No. ML103140226). Based on this event, the staff raised questions regarding the vulnerability of the vacuum drying system and its components to failure modes that would allow air ingress into the canister. The staff also questioned the appropriate categorization of this system regarding its safety significance.

The vacuum drying system is currently categorized as non-important to safety. The staff is exploring whether there may be some components, within this system, that should be classified as important to safety, since their failure could directly impact spent fuel safety parameters. The vacuum drying process was performed inside the "control building," which would contain any radiological release, if a vacuum drying system failure occurred.

The staff, a representative from Exelon [Byron Generating Station (Byron)], and a representative from NEI exchanged views on the safety significance of these issues as well as details about the event and corrective actions taken by Exelon to address this issue. The public was allowed to comment multiple times throughout the meeting.

The discussion generally followed the agenda (Enclosure 2). The primary reason for the meeting was to discuss potential issues associated with the vacuum drying process performed during spent nuclear fuel cask loading operations. The staff is gathering information to determine if additional regulatory action is needed to address a potential generic issue related to the vacuum drying process[2]. To support this goal, the staff listened to presentations from Exelon on the event that occurred at Byron as well as from NEI on industry's views about the safety significance of the event and related actions taken by the industry.

Several representatives from the storage cask vendors and utilities (i.e., stakeholders) were also in attendance and participated during the meeting. Staff from Headquarters and the Regional Offices as well as a representative from the press attended the meeting. No regulatory decisions were made at this meeting.

Technical Discussion

The staff discussed concerns about potential vulnerabilities during the spent fuel vacuum drying process (ADAMS Accession No. ML14051A059). The staff wanted to understand:

1. If casks vendors and licensees were aware of vulnerabilities (e.g., failure modes that would allow air ingress into the canister) associated with components of the vacuum drying system and actions taken related to this issue.
2. The rationale for categorizing the vacuum drying system with regards to their significance to safety.
3. Actions to be taken by the licensee for maintaining the integrity of the fuel, if the vacuum drying system fails and the fuel temperature is relatively high.

During the meeting the staff summarized its concerns about the loss of cooling event. Byron used commercial grade equipment (i.e., hoses and valves) to perform the spent fuel vacuum drying and appeared that no compensatory measures were in place to promptly isolate and/or backfill the canister, if a hose rupture occurred. The staff stated that if a vacuum drying system

[2] See NRC's Information Notice 2011-10, "Thermal Issues Identified During Loading of Spent Fuel Storage Cask", dated May 2, 2011 (ADAMS Accession No. ML111090200).

failure were to occur and air leaked into the canister, oxidation could occur rapidly and cause significant swelling of fuel pellets and fragments. This failure could result in gross fuel cladding breaches and release of fission products to the surrounding cask environment, if an excessive temperature increase occurs for a prolonged period of time after water had been removed from the annulus. The staff is gathering additional information to determine whether additional regulatory actions may be needed.

Exelon provided an overview of the loss of cooling event and a description of the annulus cooling system. Some highlights of the discussion were as follows:

1. A failure of the annulus cooling system went undetected resulting in an uncontrolled temperature increase in the annulus coolant.
2. Byron assumed that an FSAR design operating limit of the annulus coolant was exceeded.[3]
3. The vacuum drying system was secured at the time of the loss of annulus cooling event and that the event did not challenge the fuel clad temperature limit.

Exelon also discussed the following assumptions related to their analysis regarding this event. The maximum decay heat of the loading campaign in question was 24 kilowatts (kW). Exelon pointed out that this decay heat did not exceed the cask heat load limit. Exelon found that the procedures related to the vacuum drying process did not indicate that the annulus cooling temperature should be maintained below 125°F. Exelon addressed the issues related to this event within their corrective action program and shared operating experience with cask's vendors. Corrective actions included implementing programmatic and organizational changes, based on lessons learned, throughout Exelon's facilities such as:

1. Changing the project management structure by creating a center of expertise at the corporate level to define (as these relate to the spent fuel loading campaigns):
   a. Common expectations (e.g., active processes need additional oversight)
   b. Roles and responsibilities
   c. Planning, oversight, and management activities
2. Establishing a qualitative risk matrix (i.e., risk levels: green, yellow, and orange) to be used during loading campaigns, to be better informed about operations' risks.

Also, Exelon briefly discussed NRC's Information Notice (IN) 2011-10, "Thermal Issues Identified During Loading of Spent Fuel Storage Casks."

NEI provided an overview of the industry's views on the vacuum drying issue. NEI stated that there were inaccurate statements made by the NRC in the letter to vendors because:

1. The event at Byron involved the annulus cooling system, not the vacuum drying system;
2. Retrievability was a requirement (per 10 CFR 72.122[4]) of the loaded and certified cask; therefore, retrievability was not an issue;
3. The statement: *Safety analysis reports classify the vacuum drying system as not important to safety or fail to classify the system at all and therefore do not receive the same level of attention as those that are classified as important to safety,* implied that not important to safety components were provided less scrutiny than important to safety components which was a contradiction of a robust nuclear safety culture; and

[3] Exelon pointed out that their analysis assumed that the shell temperature would exceed 125ºC.
[4] 10 CFR 72.122, "Overall requirements"

4. Vacuum drying systems are appropriately classified as not important to safety in accordance with NRC guidance (i.e., NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems").[5]

Regarding the vulnerability of the vacuum drying system failure by a hose rupture and air ingress, NEI stated that a sequence of events would be needed for a radiological release.

The staff disagreed with NEI's comments on the letters issued to vendors regarding this meeting, and provided additional clarification to address NEI's concerns. The staff stated that it considered the annulus cooling system part of the vacuum drying process. In terms of spent nuclear fuel retrievability requirements, the staff stated that these requirements applied to the entire loading process, from cask loading to storage of the cask on the independent spent fuel storage installation (ISFSI) pad. The staff stated that, except for a hose breach, the vacuum drying system was more vulnerable because it was left unattended (i.e., no operator was present for taking action to control the event and mitigate the consequences, if needed).

The NEI representative also pointed out the following:

1. Byron performed an evaluation to ensure that the fuel still met the requirements of the FSAR.
2. There is no credible event that could affect the public health and safety related to the vacuum drying system, since there were no offsite releases.
3. Industry had taken actions due to Information Notice 2011-10, "Thermal Issues Identified During Loading of Spent Fuel Storage Casks," such as:
    a. Updating procedures:
        i. prior to operating the vacuum drying system
        ii. during the operation of the vacuum drying system (e.g., need a qualified operator and a supervisor)
        iii. isolating the canister to prevent air ingress
    b. During the fuel loading and drying process, the operator must ensure compliance with the technical specifications and the FSAR.
4. A significant amount of air would be needed for breaching the fuel cladding. If oxidation occurs, it would need to occur quickly in order to damage the fuel.
5. The event occurred at Byron's first loading campaign and the licensee implemented improvements to the process through their corrective actions program.
6. Active systems need to be monitored.
7. Each utility would address events through their corrective action program.

NEI and the Electric Power Research Institute[6] commended the staff for looking beyond a step in the vacuum drying to make a finding and propose further action.

Stakeholders and the staff discussed questions and provided comments related to this issue throughout the meeting. Attendees had an additional opportunity to comment after all presentations. The industry's participants acknowledged that an active system should not be

[5] NEI mentioned that active systems need to be monitored while in service so that appropriate actions can be taken in the event of loss of vacuum, and that updates to pre-operational checks and operating procedures ensure applicable monitoring is in place during all phases of vacuum drying.

[6] Also known as EPRI.

left unattended and empathized that the vacuum drying process itself was secured since the canister was isolated for the time the system was left unattended. Cask vendors and industry stated that the active vacuum drying process is never left unattended because the variables to control the cask drying are monitored at all times. One of the attendees also noted that the vacuum system was monitored every 6 hours. Another individual noted that once the cask was valved-off, there was no way for knowing what happened inside of it.

The staff continued expressing concerns on the current classification of vacuum drying systems, since its vulnerability to failure modes was not currently addressed in the FSAR. The NRC staff stated that it appears that the causes of the event could be related to the lack of adequate guidance in the FSAR resulting from the current vacuum drying system classification. The staff stated that controlling operating limits at the vacuum drying system appears to be important and may warrant a reclassification. Reclassification of this process would ensure more attention to the system in the FSAR, including addressing possible failure modes with recovery actions. This should ensure implementation of more detailed operating procedures and limiting conditions for operation during the loading campaign.

An attendee expressed concern about classifying the vacuum drying system as an item important to safety, since it may take time away from current items related to safety. Related to this topic, an individual pointed out that licensees already have technical specifications related to the vacuum drying process; moreover, this individual was not aware of air in leakage due to a failure of a hose during vacuum drying operations. As part of the discussion, the NEI representative showed the audience a piece of the vacuum drying hose and pointed out that those hoses were tested and could be repaired quickly during loading operations.

NRC Management pointed out that it would be beneficial for staff from the Division of Spent Fuel Storage and Transportation (SFST) to observe the operation of the vacuum drying system. One of the staff's concerns was that the system was left unattended overnight and an unanalyzed condition occurred; observing current operations may help to gain a better understanding of the process in the field. The NRC was also interested to learn more about the qualitative methodology developed by Exelon for risk-informing the spent fuel loading process. An internal follow up meeting may be scheduled to discuss this topic. The NRC concluded the meeting by thanking the attendees and stating that the discussion from the meeting would help the staff in making a determination on a path forward.

TAC No. LA0215

Enclosures:
1. Meeting Attendance List
2. Agenda
3. NRC's Presentation: "Potential Issues with Spent Fuel Vacuum Drying Process"
4. Exelon's Presentation: "Byron Loss of Annulus Cooling Event"
5. NEI's Presentation: "Industry Views on Vacuum Drying"

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Distribution:
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ADAMS P8 Package: ML14065A014 Memo: ML14065A015

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United States Nuclear Regulatory Commission
Protecting People and the Environment

MEETING ATTENDANCE LIST

Meeting with Holtec International, NAC International, EnergySolutions, Transnuclear, Inc., Nuclear Energy Institute, Exelon Corp., and the Nuclear Regulatory Commission

February 6, 2014

Name	Organization
Mark Lombard	NRC
Christian Araguas	NRC
Michele Sampson	NRC
Jorge Solis	NRC
Norma Garcia Santos	NRC
Robert Einziger	NRC
Ricardo Torres	NRC
JoAnn Ireland	NRC
Joseph Borowsky	NRC
Jimmy Chang	NRC
Haile Lindsay	NRC
Jason Piotter	NRC
Tae Ahn	NRC
Rhex Edwards	NRC
Don Shaw	AREVA
Michael Williams	AREVA
Venkata Venigalla	AREVA
Kamran Tavassoli	AREVA
Timothy Lloyd	AREVA
Hui Liu	AREVA
Franklin Verbos	Duke-Energy
William Murphy	Duke-Energy
Robert Quinn	Energy Solutions
Loriann Picke	Entergy
Keith Waldroe	EPRI
Kevin Donovan	Exelon
Debu Mitra-Majumdar	HOLTEC
Jay Rendos	HOLTEC
Ihor (Bill) Babiak	First Energy Corp.
Tom Danner	NAC International
Kristopher Cummings	NEI
Glenn Schwartz, P.E.	PSEG Nuclear Fuels
Mike Oswald	STPEGS
Timothy Hall	STPEGS
Paul Plantes	Yankees
Carlyn Greene	Ux Consulting
Roy Warterman	Xcel Nuclear

Enclosure 1

U.S.NRC
United States Nuclear Regulatory Commission
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AGENDA

Meeting with Holtec International, NAC International, EnergySolutions, Transnuclear, Inc., Nuclear Energy Institute, Exelon Corp., and the Nuclear Regulatory Commission

February 6, 2014
9:00 a.m. – 12:00 p.m.
OWFN Room 1-F16/1-G16 (Commission Hearing Room)

Purpose

To discuss vacuum drying systems to understand how cask vendors would minimize the probability of a confinement boundary failure with subsequent air ingress at high temperatures.

Topic	Lead
Introduction/Purpose of Meeting	Nuclear Regulatory Commission (NRC)
Opening Comments	NRC and Other Participants
Vacuum Drying Systems	NRC
Byron Independent Spent Fuel Storage Installation Experience	Exelon Corp.
Experience with Vacuum Drying Systems	Nuclear Energy Institute
General Discussion	NRC and Vendors
Opportunity for Public Comments	All
Closing Remarks	NRC and Vendors
Adjourn	

Enclosure 2