UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, DC 20555-0001

February 9, 2015

NRC INFORMATION NOTICE 2015-03: IMPROPER OPERATION OF SPENT FUEL TRANSFER CASK NEUTRON SHIELD EQUIPMENT LEADING TO ELEVATED RADIATION LEVELS ADJACENT TO SPENT FUEL TRANSFER CASK

ADDRESSEES

All holders of and applicants for an independent spent fuel storage installation (ISFSI) license or a certificate of compliance (CoC) under Title 10, "Energy," of the *Code of Federal Regulations* (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."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to:

- Inform addressees of improper operation of spent fuel transfer cask neutron shield equipment that resulted in elevated area radiation levels and unplanned dose to personnel

- Make addressees aware of vulnerabilities in procedures and equipment design that could inadvertently cause unexpected high levels of radiation from improper operations

The NRC expects recipients to review the information for applicability to their facilities and to consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

BACKGROUND

Description of Spent Fuel Storage System

The dry shielded canister used at the facilities discussed in this information notice is a high integrity stainless steel welded pressure vessel that confines fuel assemblies from a boiling water reactor and maintains an internal helium atmosphere. Stainless steel cover plates and thick carbon steel shielding material form the top and bottom end of the dry shielded canister. The top and bottom cover plates are double seal welded to the stainless steel cylindrical shell to form the dry shielded canister's containment pressure boundary. The transfer cask is a non-pressure retaining double shell cylindrical vessel with a welded bottom plate and bolted top cover plate. The space between the shells contains radiological shielding material.

The transfer cask is designed for on-site transport of the dry shielded canister to and from the plant's spent fuel pool and the ISFSI. The transfer cask provides the principal radiological

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shielding and heat rejection mechanism for the dry shielded canister and spent nuclear fuel assemblies during handling in the fuel building, dry shielded canister closure operations, transport to the ISFSI, and transfer to the horizontal storage module. The transfer cask also provides primary protection for the loaded dry shielded canister during off-normal and load drop-accidents postulated to occur during the transport operations. The transfer cask includes an outer steel jacket that makes up the outer boundary of the integral neutron shield tank, which is filled with water for neutron shielding. The transfer cask outer cylindrical shell makes up the inner boundary of the neutron shield tank.

During operation, a small 5-gallon tank called the neutron shield pressurization tank or an overflow tank is connected to the vent port of the neutron shield tank to act as an expansion volume and makeup source to account for volumetric changes in the shield water. The space between the outside surface of the dry shielded canister and the inside surface of the transfer cask is referred to as the transfer cask annulus. This volume is filled and subsequently emptied during cask loading operations.

DESCRIPTION OF CIRCUMSTANCES

Distinctly different incidents at two nuclear facilities resulted in (1) levels of radiation (most notably neutron radiation) that were higher than expected adjacent to spent fuel storage transfer casks, and (2) unplanned personnel dose. Both facilities, the Cooper Nuclear Station (CNS) and Susquehanna Steam Electric Station (SSES), utilized a Transnuclear (TN) NUHOMS-61BT CoC No. 1004 (Amendment 9) fuel storage system.

Cooper Nuclear Station

In November 2010, a TN NUHOMS-61BT dry shielded canister was located in the reactor building's railroad airlock area on a transport trailer awaiting final preparations for transport to the ISFSI. Before transport, residual water is normally drained from the transfer cask annulus. The drain hose was mistakenly connected to the neutron shield tank drain port instead of the transfer cask annulus drain port. Over time, the opening of the neutron shield tank drain port caused water to be siphoned and discharged from the neutron shield tank out through the drain hose connected to the neutron shield tank drain port. Approximately 40 percent (220.8 gallons) of the neutron shield volume drained onto the floor under the dry shielded canister. This resulted in higher than expected neutron dose rates near the spent fuel transfer cask. The unintentional draining of the transfer cask neutron shield resulted in a temporary halt to ISFSI work and an increase in dose to the workers involved. Twenty employees at CNS received an unplanned dose.

Additional information is available in "Cooper Nuclear Station Inspection of the Independent Spent Fuel Storage Installation Report Nos. 05000298/2010009 and 07200066/2010001," dated July 10, 2012 and available in the Agencywide Documents Access and Management System (ADAMS) under accession No. ML12192A620.

Susquehanna Steam Electric Station

In August 2013, SSES began loading spent fuel assemblies into a TN NUHOMS-61BT dry shielded canister. Procedures directed SSES personnel to attach a neutron shield pressurization tank to the neutron shield tank vent connection port on the transfer cask to ensure that the neutron shield tank was full. No water was observed to flow into the neutron shield tank and SSES personnel concluded that the neutron shield tank was full. The loaded transfer cask/dry shielded canister was moved out of the cask storage pit of the spent fuel pool after loading. The dry shielded canister inner top cover was welded in place and initial draining of the dry shielded canister commenced. Health Physics technicians observed neutron dose rates that were higher than expected and restricted access to the side of the transfer cask. Subsequently, a secondary indication of increased dose rates was reported after chemistry personnel observed that radiation monitors in the area were reading higher than normal. In reaction to the increased dose rates, maintenance personnel exercised the fitting, repositioned the neutron shield pressurization tank, and observed it drain into the neutron shield tank, indicating the neutron shield tank was not full. SSES then filled the transfer cask neutron shield tank using a fill line that was already connected to the fill port. Health Physics technicians surveyed and confirmed that neutron dose rates returned to expected levels. Dosimeters were collected from the workers and read. No appreciable amount of dose was distinguishable from background readings. SSES determined that the neutron shield tank was not filled in preparation for this loading campaign. A hydraulic lock or air binding developed in the hose from the neutron shield pressurization tank which prevented the flow of water from the neutron shield pressurization tank into the neutron shield tank. This caused a false indication that the neutron shield tank was full.

Additional information is available in “Susquehanna Steam Electric Station, Units 1 and 2; Flood Protection Measures, Surveillance Testing, and Drill Evaluation Report Nos. 05000387/2013005, 05000388/2013005, and 07200028/2013001,” dated February 14, 2014 (ADAMS Accession No. ML14045A295).

DISCUSSION

In both events, radiation levels that were higher than expected, including levels of neutron radiation, were experienced near the spent fuel casks because of a combination of cask design, operation, and human error. The design of the transfer cask uses shielding that consists of layers of stainless steel, carbon steel, and lead to reduce gamma, beta, and alpha radiation. Neutron radiation is shielded by water in the neutron shield tank, which can be filled and drained through the neutron shield tank vent and drain ports. The transfer cask is also equipped with an annulus drain port, which is identical in size and construction to the neutron shield tank vent and drain ports. The vendor did not provide any form of identification or marking to distinguish between these ports. After the spent fuel assemblies are loaded into the dry shielded canister and it is sealed with the first of two cover plates, water surrounding the fuel is removed and the interior of the sealed dry shielded canister is vacuum-dried and backfilled with helium. Now that the water inside the dry shielded canister (which had protected personnel with its neutron-shielding properties) is no longer present, the transfer cask neutron shield must be able to shield neutrons originating from the spent nuclear fuel.

Unanticipated neutron dose at CNS occurred because of the lack of shield water in the transfer cask neutron shield tank. Before being transported to the ISFSI pad, the transfer cask annulus drain valve was to be opened to remove any residual water in the annulus space between the transfer cask and the dry shielded canister. The bottom of the transfer cask was configured with three fill and drain ports that were identical and not identified by labels or tags. Two of the ports were for the transfer cask neutron shield tank vent and fill lines and the third was to drain the annulus space if water was still present after dry shielded canister loading and processing operations were completed. CNS personnel failed to connect the drain line to the annulus drain port, but instead, connected it to the neutron shield tank drain port, which resulted in the partial draining of the neutron shield tank. When workers opened the neutron shield tank drain port, water did not immediately flow out of the neutron shield tank. This was because a siphoning action was transferring water to a pressurization tank through the transfer cask neutron shield tank vent port. One CNS worker did notice that water had flowed into the neutron shield pressurization tank, but failed to realize that this indicated that the drain line was connected incorrectly to the neutron shield tank drain port. There are no other design features for this cask type that would allow workers to determine the transfer cask neutron shield tank level. After the siphoning action stopped, the neutron shield tank partially drained, which resulted in increased neutron dose rates and unanticipated neutron dose to workers.

The event at SSES resulted in increased levels of neutron radiation above those expected in the area adjacent to the transfer cask once the water was drained from the dry shielded canister. When the previous loading campaign was completed, the transfer cask neutron shield tank was properly drained as part of the Dry Fuel Storage demobilization work package and documented as specified in the SSES procedure. However, SSES personnel failed to fill the transfer cask neutron shield tank before this loading campaign, as required by procedure. When checking the level of the neutron shield tank, air binding of the line between the neutron shield pressurization tank and neutron shield tank occurred, preventing the flow of water from the neutron shield pressurization tank to the neutron shield tank. The neutron shield pressurization tank, once connected, provides the only means to verify adequate level in the neutron shield tank. Maintenance personnel received a false indication that the neutron shield tank was full because the neutron shield pressurization tank level did not change. During operations, SSES noted that the pressurization tank emptied, which was not a normal occurrence. They refilled the neutron shield pressurization tank, but failed to determine the cause, challenge existing conditions, or recognize this as an indication that the neutron shield tank was not filled. After refilling the neutron shield pressurization tank, air binding prevented outflow from the neutron shield pressurization tank to the neutron shield tank and it was assumed, again, that the neutron shield tank was full.

The cask shielding design and spent fuel assembly distribution within the dry shielded canister kept doses below the technical specification maximum allowable levels adjacent to the dry shielded canister. Proper monitoring programs and health physics procedures alerted the staff to unexpected radiological conditions and prevented further dose to workers before the initial cause was determined.

Based on the event at Cooper, TN now provides a transfer cask with color-coded and keyed Swagelok® fittings at each site where the transfer cask is provided. The fittings are installed at the annulus and neutron shield tank connections so that one cannot connect the line for the neutron shield tank to the annulus and vice versa. CNS also performed procedural revisions that include verification of the proper Swagelok® fittings during receipt of the transfer cask. Based on the event at SSES, TN provided its users with guidance on how to verify that the neutron shield tank is full of water by specifying that users should add water to the neutron shield tank drain port and verify water exits from the vent port into the neutron shield pressurization tank. When the neutron shield tank drain port is not accessible, TN recommended that users should remove the neutron shield tank pressure relief valve opposite the neutron shield tank vent line and add water into either the pressure relief port or the neutron shield pressurization tank and verify water exits the opposite port. SSES revised their procedures to incorporate the new method to verify the neutron shield tank is filled with water.

It is recommended that cask vendors and licensees evaluate their operating procedures and equipment to determine whether current neutron shield water level is susceptible to false indications as described above. To achieve this objective, consider the human factors and design deficiencies to ensure that adequate controls and steps are in place to prevent the inadvertent loss or inaccurate indication of neutron shield water.

CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or to the appropriate Office of Nuclear Material Safety and Safeguards project manager.

/RA/

Mark Lombard, Director
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Technical Contact: Jeremy Tapp, NMSS
301-287-9218
E-mail: Jeremy.Tapp@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections design deficiencies to ensure that adequate controls and steps are in place to prevent the inadvertent loss or inaccurate indication of neutron shield water.

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