UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555

September 28, 2016

NRC INFORMATION NOTICE 2016-13: URANIUM ACCUMULATION IN FUEL CYCLE FACILITY VENTILATION AND SCRUBBER SYSTEMS

ADDRESSEES

All holders of and applicants for a fuel facility license under Title 10 of the *Code of Federal Regulation*s (10 CFR) Part 70, "Domestic Licensing of Special Nuclear Material" and 10 CFR Part 70, Subpart H, "Additional Requirements for Certain Licensees Authorized To Possess a Critical Mass of Special Nuclear Material."

All holders of and applicants for a construction permit or operating license for a production facility, including facilities dedicated to the production of medical radioisotopes such as molybdenum-99, under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees about the potential for uranium accumulation in off-gas ventilation and scrubber systems and some potential causal factors that could contribute to this type of event. Over time, uranium can build up in areas that are difficult to inspect and clean. As a result, a criticality safety evaluation (CSE) mass limit could be exceeded and challenge controls designed to meet the performance requirements of 10 CFR 70.61(b) and 10 CFR 70.61(d) and the double contingency principle[1].

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

[1] As described in 10 CFR 70.4, "Definitions", the double contingency principle means that process designs should incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

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DESCRIPTION OF CIRCUMSTANCES

During the most recent planned annual wet scrubber system cleanout at a low-enriched fuel fabrication facility, personnel noticed an abnormal amount of material buildup in the inlet transition region and associated ductwork (i.e., elbow). Over the course of the 2-day maintenance evolution, approximately 197 kilograms of material were removed from the scrubber transition region. The transition region is considered an unfavorable geometry from a criticality perspective. Because facility personnel assumed that this material had a low uranium concentration, operators attempted to break up and wash away the material to facilitate its removal. Facility personnel did not sample the material to confirm the uranium concentration before conducting any activities that could have disturbed the as-found condition. After the material was removed, grab samples of the material were taken to analyze for uranium concentration.

The grab sample results indicated that the uranium concentrations ranged from 34 weight percent (wt %) – 55 wt% which corresponded to approximately 87 kilograms of uranium. As such, the CSE mass limit of 29 kilograms was exceeded by a factor of 3. After the cleanout activities were completed, the scrubber was restarted. The scrubber operated for 6 weeks and then facility personnel shut it down to perform another cleanout of the inlet transition region and elbow. Facility personnel removed about 24 kilograms of material, which corresponded to approximately 5 kilograms of uranium. The scrubber was restarted following the 6 week cleanout. Approximately 1 week later, while discussing extent of condition, the licensee decided to shut down the scrubber again and thoroughly inspect the entire scrubber to ensure that the scrubber was free of uranium accumulation. An additional 184 kilograms of material was removed from the scrubber body, and about 71 kilograms of material was removed from the packing material. The scrubber was shut down and the licensee commenced extent of condition and root cause evaluations and implemented several short-term corrective actions.

BACKGROUND

The scrubber in question was put into service in 2002. This scrubber combined two ventilation systems. In 2009, an additional feed stream was rerouted to the scrubber in question. This particular scrubber operates as a cross-flow horizontal packed-bed scrubber that uses a recirculating scrubbing liquid to absorb soluble gas molecules and knock down suspended solids, including uranium-bearing particles vented from several processes. The scrubber was originally designed to scrub mostly acidic off-gas; however, many of the current feed streams contain ammoniated off-gas.

From 2002 through 2009, facility personnel removed and inspected the scrubber inlet transition region and elbow on three different occasions and noticed material buildup. Information on the volume, weight, and wt% of the material was not accurately and consistently recorded. For the next 7 years leading up to the event, the annual scrubber cleanout did not involve removing the inlet elbow and all the packing for inspection and cleaning. Instead, the elbow and transition region sections were periodically pressure-washed through a cleanout port.

About 1 month before the most recent annual scrubber maintenance, the elbow and transition region were pressure-washed with a new sprayer that allowed cleaning of the upper surface of the scrubber. As described above, during the cleaning, operators observed that a large piece of accumulated material was dislodged from the upper surface of the transition region. During the annual scrubber maintenance, the inlet transition region and elbow were removed and cleaned. The material was weighed and sampled to reveal 87 kilograms of uranium, which exceeded the

CSE mass limit of 29 kilograms of uranium. As part of the extent of condition, facility personnel inspected scrubber and ventilation system components that had been permanently removed from service for years, and discovered some accumulation of uranium-bearing material.

DISCUSSION

Any event that involves exceeding a criticality parameter limit established by the CSE and results in not meeting the double contingency principle is a criticality safety concern. In this case, the mass limit was exceeded by a factor of 3; moderation was available from the scrubber spray nozzles and the pressure-washing; and the scrubber packing, elbow, and transition region sections are all unfavorable geometries. As a result, the safety margin available to preclude an inadvertent criticality was significantly degraded.

The long-term accumulation of uranium in equipment with an unfavorable geometry, particularly in process ventilation and scrubber systems, has been a recurring issue throughout the nuclear fuel industry[2]. The amount of material that can be transported into process ventilation can be underestimated. Therefore, licensees are encouraged to verify the assumptions regarding the rate and mechanisms of accumulation. Furthermore, during process changes, licensees are encouraged to consider process conditions that can affect accumulation and the possible creation of chemical hazards when off-gas from different process areas is combined. Frequent inspection and cleanout may be necessary when the accumulation rate is poorly understood or controlled. The same rigor can be applied to the analysis and control of process areas even if they are considered auxiliary to the main process or are perceived to have low risk. Otherwise, areas perceived to be low risk may become safety-significant.

Several causal factors appear to have contributed to the occurrence of the event described in this IN. The following are some of the contributing causes that the NRC staff considers important to understand in helping to prevent similar events from occurring in the future:

- Administrative Items Relied On for Safety (IROFS). There are IROFS in certain criticality accident sequences that involve implementing a particular operating or maintenance procedure. It is important that these procedures provide the necessary details, clear instructions, and acceptance criteria to ensure that the intended function is reliable and available. Additionally, procedures implementing visual inspections are encouraged to contain specific pass/fail criteria, and the particular process equipment be designed so that personnel can perform an adequate inspection. In this event, the annual visual inspection and cleanout through the scrubber cleanout port was ineffective at identifying and removing the accumulated uranium-bearing material.

- Configuration Management. A series of plant modifications to various systems, spread out over several years, can have a collective and unintended effect on the overall integrated system. Sufficient management measures need to be in place to ensure that the configuration of facility processes continues to be managed effectively. In this event, a series of modifications were made to several different systems that unintentionally resulted in accumulating more uranium-bearing material in the scrubber than expected.

[2] See IN 2004-14 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML041760122), IN 2005-22 (ADAMS Accession No. ML051890406), and IN 2010-16 (ADAMS Accession No. ML100540070).

- Challenge Assumptions. Safety analyses and evaluations may include engineering and scientific assumptions. Incorrect assumptions can lead to non-conservatisms, inadequate evaluation of risks, and could improperly render certain events or accident sequences not credible. Licensees are encouraged to use information gained from system performance measurements and operating experience in order to verify and validate these assumptions. In this event, there was data and operating experience to suggest that the assumed low uranium concentration in the scrubber could have been challenged and its validity questioned during revisions and peer reviews of the CSEs.

- Conservative Decisionmaking. After an abnormal or unexpected condition is identified, facility personnel are encouraged to ensure that the as-found condition and causes are sufficiently understood in responding to the event and before deciding to return to normal operations. In this event, a large amount of deposited material was removed. However, while the material was appropriately collected into safe-volume containers as though it had a high uranium content, facility personnel assumed that the uranium concentration was low, decided to wash the material away, and did not report the event.

- Nuclear Safety Culture. Complex industrial facilities that process special nuclear material are confronted with criticality, chemical, and radiological hazards. In order to provide a safe environment for the workers and surrounding public stakeholders, facility personnel are encouraged to follow many guiding principles, including, but not limited to, maintaining a questioning attitude, avoiding complacency, and constantly examining engineering processes and procedures. In this event, some of the scrubber operators and process engineers were unaware of the uranium mass limits, and the criticality safety engineers were not adequately involved in the ventilation modifications, scrubber inspection and maintenance, and initial response to the discovery of unexpected material.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below.

/RA/

Craig G. Erlanger, Director
Division of Fuel Cycle Safety, Safeguards,
and Environmental Review
Office of Nuclear Material Safety
and Safeguards

/RA/

Louise Lund, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact Stephen Vaughn, NMSS/FCSE
301-415-3640
E-mail: Stephen.Vaughn@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, at http://www.nrc.gov, under NRC Library/Document Collections.

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OFFICE	**NMSS/FCSE/PORS**	**NMSS/FCSE/PORS**	*** R-II/DFFI**	***NMSS/MSTR/MSEB**	*** QTE**
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OFFICE	*** NRR/DPR/PRLB**	***NRR/DPR/PGCB/BC**	***NRR/DPR/PGCB/LA**	**NRR/DPR/D**	**NMSS/FCSE/D**
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