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

March 26, 2018

NRC INFORMATION NOTICE 2018-05: LONG-TERM FISSILE MATERIAL ACCUMULATION DUE TO UNANALYZED OR IMPROPERLY ANALYZED CONDITIONS AT FUEL CYCLE FACILITIES

ADDRESSEES

All holders of, and applicants for, a fuel facility license under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 70, "Domestic Licensing of Special Nuclear Material," and all holders of, and applicants for, a construction permit or operating license for a production facility, including a radioisotope production facility, under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

Although they do not have hazards associated with inadvertent criticality as a result of the presence of fissile material, this information may also be useful to holders of, and applicants for, a license under 10 CFR Part 40, "Domestic Licensing of Source Material."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operating experience involving unanticipated, long-term accumulation of fissile material in uncontrolled geometry systems due to improper analysis of credible plant conditions.

The NRC encourages recipients to review the information contained in this IN for applicability to their facilities and to consider actions, as appropriate, to avoid similar issues. However, no specific action is required.

DESCRIPTION OF CIRCUMSTANCES

At an NRC-licensed fuel cycle facility, fuel is produced through a series of operations in order to support a variety of research and test reactor product lines. These operations take place in a glovebox line, which is maintained in an argon atmosphere. This atmosphere is maintained by an air purification system which removes oxygen and moisture from the process to address fire safety concerns. For radiation protection purposes, the atmosphere also provides a negative pressure inside the glovebox line. The system is purified using a desiccant material located inside two desiccant filters. In July 2017, the licensee performed maintenance on the desiccant filters to address decreased system performance. Upon removal of the filters from their location within an equipment cabinet, the licensee discovered unexpected fissile material in both desiccant filters. The licensee assumed that the system was non-fissile (i.e., non-uranium

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bearing), and therefore had no documented controls to prevent or monitor fissile material accumulation. Additionally, the system was not routinely surveyed to detect or monitor the accumulation of fissile material. Due to the unfavorable geometric properties of the filters, the unknown moderation conditions inside the filters, and the presence of an unknown quantity of fissile material mass, the licensee declared an "alert[1]" emergency action level (EAL).

The licensee immediately physically separated the two filters to minimize neutronic interaction, isolated the area with personnel access restrictions, suspended work in other areas pending an extent of condition review, performed non-destructive assay (NDA) measurements to estimate the fissile mass present, and performed nuclear criticality safety (NCS) calculations to determine the minimum fissile mass needed for criticality. Upon comparing the measurements to the calculated minimum critical mass, the licensee determined criticality was not imminent and terminated the "alert" EAL.

High-efficiency particulate arrestance (HEPA) filters that were installed between the gloveboxes and desiccant filters as part of a separate ventilation system, were designed to ensure subcriticality within the HEPA filters themselves. However, the possibility of fissile material carryover beyond the HEPA filters and into the desiccant system was not considered in the licensee's integrated safety analysis (ISA). From its follow-up investigation, the licensee identified that this carryover condition had occurred at some previous point in time. The condition was discovered around 1986, after which the licensee developed an NCS analysis that identified controls to prevent the unsafe accumulation of fissile material within the desiccant filters. However, the controls were discontinued, and the accident sequence was not included or considered during the development of the licensee's ISA. The licensee determined that the desiccant filters were last cleaned and the media was replaced in 1986, allowing material to accumulate undetected for approximately 30 years.

The licensee identified that the HEPA filter design and installation were inadequate for the referenced glovebox line. Both the crushing section and the blending section of the glovebox line had significant gaps between the spacer and the gasket of the filter, allowing for fissile material carryover beyond the HEPA filters. In addition, the licensee discovered that fissile material could enter the desiccant system through the air purification system's argon purge lines when the vacuum pump for the air purification system was operating. The licensee determined that these issues resulted, in part, from the difficulty in achieving an effective seal during routine HEPA filter change-outs. The licensee implemented corrective actions to ensure easier and more consistent HEPA filter change-outs.

BACKGROUND

10 CFR 70.61(b) requires that the risk of each credible high-consequence event be limited such that its likelihood of occurrence is highly unlikely. 10 CFR 70.61(d) requires that the risk of nuclear criticality accidents be limited by assuring that all nuclear processes will be subcritical under both normal and credible abnormal conditions. These requirements necessitate that, through the ISA, a licensee evaluates all credible pathways that could potentially lead to a consequence of concern.

[1] As defined in 10 CFR 30.4 and 10 CFR 70.4; *Alert* means events may occur, are in progress, or have occurred that could lead to a release of radioactive material, but that the release is not expected to require a response by offsite response organizations to protect persons offsite.

DISCUSSION

The chronic buildup of fissile material in uncontrolled geometry equipment and areas that are either inaccessible or difficult to monitor has been a long-standing challenge in the nuclear fuel cycle industry. Through the review of documented operating experience, the NRC has identified instances where improper analysis, or in some cases no analysis, of credible events was performed by certain licensees. Some licensees have based their analyses on incorrect assumptions which have resulted in the unanticipated buildup of fissile material.

As discussed in IN 2015-08[2], approximately three ounces of fissile solution were discovered at an NRC-licensed facility in a junction box during troubleshooting of a resistance temperature detector in the uranium recovery area. The licensee determined that a thermowell had failed as a result of pitting corrosion, allowing the solution to leak into the junction box. The electrical conduit exiting the junction box provided a flow path that could have allowed the solution to enter an unfavorable geometry electrical box had chronic leakage continued to occur undetected. In performing the associated analysis, the licensee did not identify this potential flow path or consider the electrical box.

As also discussed in IN 2015-08, accumulated solids in a catch tray beneath low-level dissolvers were scraped together into several large piles at an NRC-licensed facility. The catch tray typically collected small quantities of uranium. In evaluating this process, the licensee assumed that the material allowed to accumulate in the catch tray was in the form of a solution, which was intended to represent a conservative bounding configuration. Based on this assumption, the licensee implemented engineered controls to restrict the geometry of any possible accumulation to a safe slab height. These controls, however, were ineffective at restricting the geometry of solids to a safe slab height. This was identified after operators scraped accumulated material in the catch tray into several large piles, which exceeded established safe slab height limits, in preparation for moving the material into safe volume containers. Additionally, upon discovery of the piles, the licensee assumed that the uranium concentration would be low due to the nature of the low-level dissolver process. The licensee did not have sufficient controls in place to ensure that the uranium concentration of chronic accumulation was, in fact, low. Furthermore, there were not sufficient controls to monitor the mass of the fissile material that was allowed to accumulate.

As discussed in IN 2016-13[3], a licensee discovered an accumulation of fissile material in excess of established criticality safety limits in a scrubber designed to remove uranium and other suspended solids. Although the accident sequence of accumulation in the scrubber and its inlet transition was analyzed by the licensee, the criticality safety analysis was based on improper technical assumptions, including an assumption that uranium carryover would be low.

Through the review of operating experience, the NRC has identified that similar contributing factors (i.e., incorrect assumptions and improper analysis of credible events) have been present when these events have occurred. In the most recent event involving the desiccant filters, the licensee assumed that the material in the system was non-fissile and therefore no longer

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[2] Information Notice 2015-08, "Criticality and Chemical Safety Event Involving Unanalyzed Conditions and Unanticipated Unavailability of IROFS [items relied on for safety] at Fuel Cycle Facilities," dated September 2, 2015 (Agencywide Document Access and Management System (ADAMS) Accession No. ML15176A708).
[3] Information Notice 2016-13, "Uranium Accumulation in Fuel Cycle Facility Ventilation and Scrubber Systems," dated September 28, 2016 (ADAMS Accession No. ML16252A171).

included the unfavorable geometry filters in the annual NDA survey. In this scenario, there were neither controls to prevent, nor routine monitoring to detect, accumulation in the filters. In the other referenced events, routine monitoring was either not performed or was ineffective at detecting an unsafe buildup of fissile material because the respective licensees made incorrect assumptions regarding expected fissile material concentrations.

The desiccant filter and scrubber events both involved the accumulation of fissile material within process ventilation or air purification systems. However, the concern over fissile material accumulation in uncontrolled geometry is not limited to material carryover in the gas phase into ductwork, filter housings, and scrubbers. The thermowell event involved the carryover of uranium in the form of a solution and the catch tray event involved material in the form of a solid. Based on this operating experience, the NRC has identified instances where licensees have underestimated the amount of entrained uranium carryover or distances such material can travel in ventilation ductwork, even if siphon breaks or air gaps—which are very effective at preventing backflow of the solution, but may be ineffective for uranium entrained in off-gas—are present. An important part of meeting the requirements of 10 CFR 70.61(b) and (d), involves ensuring that all credible pathways for fissile material (i.e., either in the form of a solution or a finely divided solid) to reach uncontrolled geometry are considered.

Following the issuance of IN 2016-13, several licensees performed extent-of-condition reviews to assess whether their facilities were subject to the conditions described in the IN. At the facility where unanticipated uranium accumulation was discovered in two desiccant filters, the licensee had not evaluated the desiccant system because it was not considered a ventilation system. Licensee extent-of-condition reviews that are too narrowly focused on a particular system or operation rather than focusing on a holistic review of credible events, may result in missed opportunities to identify similar issues in seemingly dissimilar processes.

In addition, the use of unverified process assumptions, including those relied on in determining that an event sequence is “not credible,” can result in a licensee failing to identify process characteristics that need to be controlled to ensure subcriticality under all credible abnormal conditions. These events suggest that areas perceived as low risk, which have no controls applied (e.g., ventilation and ancillary systems, low-concentration solutions, low-level waste), may be subject to a higher degree of incorrect technical assumptions. In the most recent desiccant filter event, the air purification system was considered non-fissile, and the potential for uranium accumulation in the filters was not considered. The accumulated material in the catch tray for the low-level dissolvers was assumed to be of low uranium concentration based on the material type and quantity processed, and the uranium carryover to the scrubber was assumed to be low without any verification. Narrowly assessing analytical assumptions can result in a missed opportunity for licensees to detect latent safety issues. Those safety issues may include the inadequate identification of all normal and credible abnormal conditions, incorrect conclusions that actually credible conditions are not credible, incorrect assumptions with respect to technical parameters associated with process operations, and inadequate application of controls.

CONCLUSION

Recognizing the variability among processes and conditions throughout the fuel cycle industry, the NRC reviewed operating experience and identified that incorrect assumptions have led to inadequate analysis of credible events and have been a contributing factor in the unanticipated accumulation of fissile material.

The NRC encourages addressees to consider the information in this IN for applicability to their processes and facilities. The operating experience referenced in this IN suggests that there may be credible events or conditions whose likelihood has either been underestimated or not considered, especially those events or conditions involving the potential for long-term fissile material accumulation. Additionally, recent operating experience suggests that areas perceived as low risk, which have no controls applied, may be subject to a higher degree of improper analysis due to unchallenged or unverified assumptions.

CONTACTS

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

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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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ADAMS Accession No.: ML18022A211; *concurred via email

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