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

August 26, 2019

NRC INFORMATION NOTICE 2019-05: POTENTIAL OVER-PRESSURIZATION OF HIGH SPECIFIC-ACTIVITY ALPHA-EMITTING RADIOACTIVITY SOURCES

ADDRESSEES

All holders of and applicants for a specific byproduct materials license under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material." All Radiation Control Program Directors and State Liaison Officers.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees about the possibility of significant pressure build-up in high specific activity alpha-emitting sources, such as americium-241 (Am-241) or plutonium-240 (Pu-240), caused by radiolysis and production of hydrogen. This IN requires no action or written response on the part of an addressee. The NRC is providing this IN to the Agreement States for their information and for distribution to their licensees as appropriate.

DESCRIPTION OF CIRCUMSTANCES

A 5 mL flame-sealed borosilicate glass ampoule was used to store an aqueous radioactive reference source containing 1.5 mCi (55.5 MBq) of Am-241. The source was stored sealed for 12 years. During that time, sufficient hydrogen gas was generated from radiolysis to over-pressurize the glass ampoule and cause it to fail. Contamination and potential for personnel radiation exposure resulted from the source failure.

BACKGROUND

In August 2017 a 5 mL glass ampoule, which contained 1.5 mCi (55.5 MBq) of Am-241 when sealed on 15 July 2005, ruptured in the laboratory of an NRC licensee. The licensee’s investigation determined that alpha decay of the Am-241 source produced sufficient hydrogen gas (H_2) during that time to result in an internal pressure of 25 atmospheres (atm) within the source ampoule. The mechanism for production of H_2 was the radiolysis (dissociation) of water molecules within the sample matrix into hydrogen and oxygen ions. Radiolysis occurred due to ionization of the charged alpha particles moving through the matrix water, and the subsequent recombination of hydrogen ions produced H_2 gas.

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DISCUSSION

The flame-sealed borosilicate glass ampoule is a commonly used long-term storage container for liquid radioactive reference standards. This container has been used and distributed by standards laboratories since at least early in the 20th century. This glass ampoule is expected to be strong enough to contain 2 atm pressure, and is believed by the licensee to be adequate to contain 5-6 atm. The rupture of this high-specific activity source was the first occurrence of this problem for the licensee, with ampoule pressure increasing continuously from time of sealing in 2005 until the failure of the glass in August 2017 at approximately 25 atm internal pressure.

The licensee described long-standing experience with the borosilicate glass ampoule as a standard reference material configuration, which provides useful capabilities to researchers because it can be opened and re-sealed by flame-sealing. The scientific staff also has expressed reluctance to consider alternative source containers because of the past historical precedent of its use and long-standing experience with the glass ampoule. The licensee placed additional radioactive sources with the potential to be at risk due to similar characteristics into robust pressure containers, pending further evaluation. The licensee also planned to screen any similar sources, properly dispose of them if not needed, and subject them to a detailed hazard analysis before being put back into use.

Original Source characteristics:
Am-241, 1.5 mCi (55.5 MBq) on 15 July 2005
Specific activity 3.433 Ci/g (127 GBq/g)
Volume = 5 mL
Chemical Form: $AmCl_3$ in 1M HCl

Source activity as of 8 Aug 2017 (approximate date of failure):
Am-241, 1.3 mCi (47.6 MBq) in 4.48 mL

If absorbed into the body, alpha-emitting radionuclides can produce large doses to target organs (bone surfaces in the case of Am-241). In this case, the contamination resulting from the failed ampoule was not immediately detected. Personnel exposures occurred over the course of several days before the contamination was identified, creating the potential for inadvertent additional exposures of other personnel due to spreading contamination. In addition to potential radiation exposure, adverse impacts to laboratory operations occurred during the assessment of the event and in recovery. Assessment of the actual internal doses from exposure required months of follow-up bioassay sampling and analysis.

GENERIC IMPLICATIONS

Similar sources with these high specific-activity characteristics have been available since the 1990s, so it may be only recently that sufficient time has elapsed time to generate the observed internal hydrogen gas pressure. Therefore, it is timely and important for any licensee possessing similar sources to anticipate the possibility of over-pressurization and of failure of source containers not designed to withstand sufficient pressure buildup.

Limited Information is available for one additional similar event, which occurred at the International Atomic Energy Agency (IAEA) Seibersdorf Austrian Research Center Laboratory on August 3, 2008. The IAEA event involved a high specific-activity Pu-240 reference source which was sealed in 1993, therefore creating roughly a 15-year period of hydrogen gas buildup. Follow-up actions identified by IAEA staff included the potential need to periodically relieve the built-up pressure.

This IN is being published to alert potentially affected licensees about the over-pressurization and subsequent container failure of a high-specific activity alpha-emitting source and to sensitize others who may possess similar high specific-activity sources to the hazard.

CONTACT

This IN requires no specific action nor written response. Please direct any questions about this matter to the technical contact(s) listed below or the appropriate regional office.

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

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