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28

From: "Scott Seaman" <ScottSeaman@earthlink.net>
To: <SECY@NRC.gov>
Date: Tue, Sep 12, 2006 12:01 AM
Subject: Comment on Requirements for Expanded Definition of Byproduct Material -- Radium

The Seaman Nuclear Corporation has been a manufacturer of moisture density gauges since 1962. Some of these gauges have utilized radium-226 beryllium sealed sources. It has been of interest to track the safety of our radium gauges. In the late 1990's we assembled the following information which may be of interest in the regulation of radium by the USNRC.

Seaman has never found, or been informed that a radium source in it's gauges had leaked. The manufacturer of these sources, Amersham (now know as AEA), has stated "we do not know about any leakage of double - encapsulated and welded Ra-226 Be sources of our production." 1.

Seaman gauges have been in use for over 40 years. During this period some incidents occurred which fit the description of "worst case" accident scenarios, where compactors have run over gauges. This accident history reveals that (a) no source has leaked radioactive material into the environment and (b) no accident has caused the source to be separated from it's shield.

The design of Seaman gauges affords more protection than competitive devices because the source in Seaman gauges never leaves the protective housing to conduct tests. In contrast, gauges that have the source protrude from the device to conduct tests place their source is a vulnerable position. Under accident conditions, the source can separate from the gauge and its shielding very easily, and is much more susceptible to rupture and release of radioactive material into the environment.

Do radium sealed sources have pressure build up that makes them more susceptible to leaking than sealed sources using other isotopes?

Of the type radium sealed sources used in Seaman gauges, there are two processes that may develop pressure within the capsule, radon and helium build-up. The amount of pressure build-up has been greatly exaggerated, causing unwarranted concern in some quarters.

The pressure produced by radon obtains its maximum value approximately 6 weeks after encapsulation. No further increase occurs, because radium is in a radioactive equilibrium with it's daughter products. At this point radium is decaying into radon at the same rate that radon is decaying into daughter elements which are solid metals. The internal pressure due to radon is 0.1 Pa (a minuscule amount, less than one-millionth of an atmosphere)2. The capsules are constructed to withstand pressures of 15,000 kPa. This yields a huge safety factor of 150 million.

"Helium buildup concept": The alpha particles from the decay of radium acquire orbital electrons to become helium gas. This helium theoretically leads to a pressure build-up in the source capsule.

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An experiment was performed at the University of Texas 3., to measure the actual pressure buildup within capsules (of the type used in Seaman density gauges). A special apparatus was built to contain and measure the pressure build-up in several 25 year old Ra 226 sealed sources. According to theoretical calculations it was expected that the helium gas would create a pressure of 4 mm of water (an insignificant 0.000387 atmospheres or 0.006 PSI). But in no case was any measurable pressure recorded! Due to these results it was assumed that the helium gas is absorbed in the structure of the radium sulfate crystals.

The Amersham Corporation, a leading supplier of nuclear sources to our industry, commented on this experiment: "Our own experience with up to 60 year old Ra 226 sources support these results".

In a review of the literature, the other process addressed that is known to cause significant pressure buildup occurs in aqueous solutions of alpha emitting radionuclides. The Air Force Institute of Technology investigated three possible causes for pressure buildup: Helium from alpha decay, radon emanation, and generation of hydrogen and oxygen by the radiolysis of water. This study concluded: "Thus the principal cause of the increase in pressure appears to be the radiolysis of water." 4. Since, the radium in the sealed sources of Seaman gauges is in the form of a ceramic pellet, this condition for significant pressure buildup is not present.

Notes:

1. Buchenberger, James M.; Amersham Corporation, Arlington Heights, Illinois. Personal communication June 3, 1988.

2. To convert ATM (atmospheres) or PSI (pounds per square inch) to Pa (Pascals) use the following conversion factors: PSI x 6,894 or ATM x 98,000).

3. Van Roosenbeek, Earl; Shalek, Robert J.; Moore, E. Bailey; Safe encapsulation period for sealed medical radium sources. The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine Vol. CII, No. 3, March 1968.

4. John, George, A Possible Hazard: Pressure Build-up in Sealed Ampoules of Radionuclides in Aqueous Solution, Health Physics p 977 vol. 49, 1985.

If further information is desired, please contact me at 414-762-5100.

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From: "Scott Seaman" <ScottSeaman@earthlink.net>

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