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Decontamination Issues Related to Museum Operations

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ABSTRACT

Museums in Canada have been found to possess radioactive items. The origin of the radiation can be broadly categorized as either natural (generally radioactive ores) and anthropogenic (generally luminous gauges).

Radioactive ores, bearing naturally occurring uranium and thorium, can generate radiation fields many times greater than the ambient background levels. In addition, they will increase the ambient radon level and potentially generate loose contamination. Radioluminescent gauges, especially bearing radium (Ra-226), can also generate significant radiation fields. This is especially true if many gauges are located in close proximity. In addition, the radon may outgas from these gauges, and generate a loose contamination problem in enclosed spaces (such as display cases).

In this paper, we discuss the specific results of radiological decontamination investigations at three museums, namely The Canadian Museum of Nature (in Aylmer) and the RCAF Memorial Museum (in Trenton) and the Quebec Air and Space Museum (in Montreal).

The primary conclusion is that museums holding radioactive materials will have the requirement to be surveyed for loose contamination periodically with the potential for periodic decontamination caused by radon out-gassing, public access to displays bearing radioactive material must be restricted, and comprehensive radiation safety programs at museum facilities must be developed.

I. THE CANADIAN MUSEUM OF NATURE

The Canadian Museum of Nature was found to store a number of radioactive ore samples in its facility located in Aylmer, Quebec. SAIC Canada was contacted by the Museum to investigate gamma radiation fields around the ore collection that were a potential concern for Museum employees and researchers working in the immediate areas. Likewise, individuals responsible for the ore collection had requested advice in the development and implementation of radiation safety measures.

Decommissioning and decontamination protocols were followed as developed in the SAIC Canada Master Plan for Radiological Decommissioning [Reference 1]. Field gamma spectroscopy was performed in and around the mineral storage cabinet, and indicated the presence of Bi-214 and Pb-214 (as well as K-40). This confirmed the assumption that the measured radiation levels were due to uranium progeny within the ore samples. A field estimate of the U-238 activity was performed using the gamma spectroscopy and doserate results, and was calculated as 2.4 GBq [Reference 2].

The radiation fields measured are as high as 200 µSv/hr in the radioactive mineral storage room (Figure 1), and above background levels were observed 10 to 15 m from this room. At the time the investigation was performed, the CNSC (then AECB) guidance was "In areas normally occupied by any other person than atomic radiation workers radiation levels shall not exceed 2.5 microSieverts per hour". It was therefore clear that the dose rates around the storage cabinets exceeded the regulatory guidance. The radiation dose rates discovered have potential to lead to an individual receiving more than the annual dose limit of 1 mSv for the general public.

The following recommendations were made to the Museum, based upon the findings.

(1) Radiation shielding should be used to reduce the radiation fields in areas adjacent to the radioactive mineral storage room. A sand-filled concrete wall will reduce the measurements by approximately one order of magnitude.

(2) The requirement for the Museum of Nature to store radioactive ore should be reviewed.

(3) The possible presence of loose contamination should be investigated. Loose contamination consists of small particles of radioactive material which may be spread from the radioactive ore storage room.

(4) A radiation safety program for the Museum of Nature was recommended, to address, at a minimum: dosimetry and dose monitoring, contamination control, routine surveying and sampling requirements, training, assigning responsibilities and quality assurance.

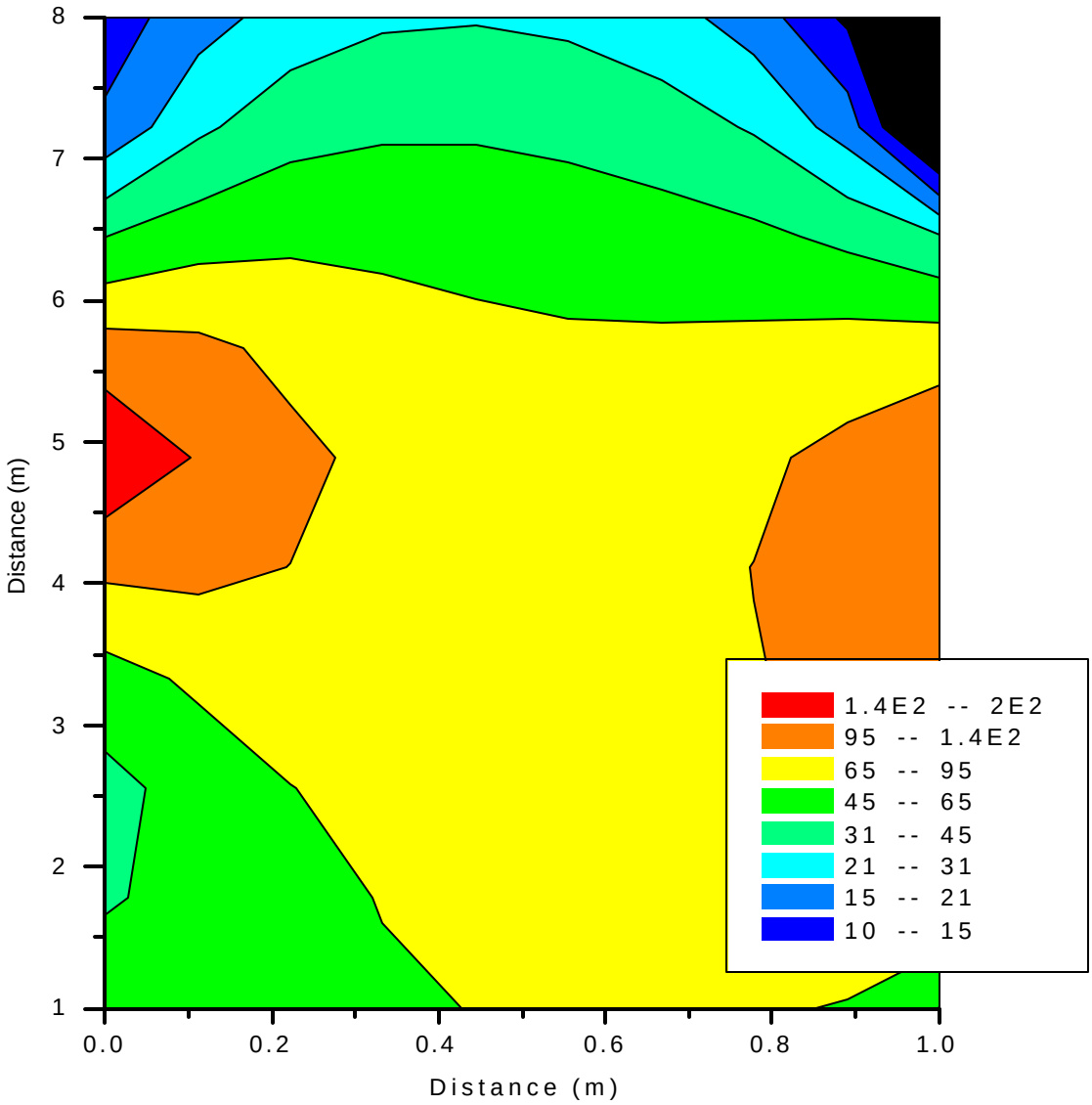

Figure 1 - Dose rate contour map near radioactive ore cabinet (mSv/hr)

II. RCAF MEMORIAL MUSEUM

The RCAF Memorial Museum is located at 8 Wing, CFB Trenton. The museum was a former curling rink and is currently displaying Canadian Forces and Royal Canadian Air Force memorabilia. The museum is also the location of a restoration project for a World War II vintage Halifax bomber, being performed by numerous civilian volunteers. Both the museum and the Halifax restoration shop areas are open to the public [Reference 3].

Stored at the museum are numerous Ra-226 bearing gauges and dials, and inspection lead to the suspicion of possible loose contamination in and around the workshop area.

As a result of this field investigation, numerous sources of radioactive material, mainly in the form of aircraft dials and gauges bearing ^{226}Ra luminescent paint, were found in the museum and the workshop areas. In addition, over one-third of the swipes taken in the museum and the workshop areas showed contamination levels well above the regulatory limits for loose alpha and beta contamination.

The results of the field investigation indicated that there were numerous aircraft dials and gauges bearing ^{226}Ra-based radioluminescent paint in the museum, curator and restoration area (see, for example, Figure 2). Numerous gauges were found with broken faces and bodies in the restoration shop area (Figure 3).

Figure 2 - Radium bearing gauges in museum display case

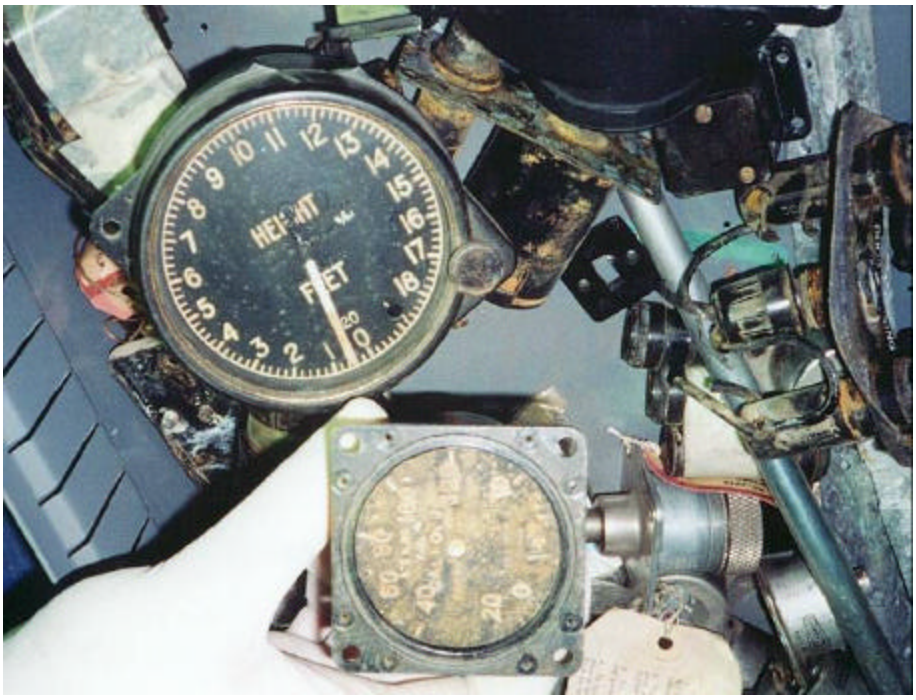

Figure 3 - Broken gauges found in storage area

The maximum gamma dose rate in a position of normal approach (50 cm) in the shop area was found to be 8.6 µSv/hr, with some gauges approaching 100 µSv/hr on contact. The maximum gamma dose rate in a position of normal approach (50 cm from display) in the museum area (navigation display) was found to be 6 µSv/hr. Both dose rates exceeded the maximum allowable by Department of National Defence for storage of radioactive material.

Seventy swipes (Figure 4) were taken around the shop area, mainly in the location of the aircraft gauges. Approximately one-third of all swipes taken were found to have levels of beta and/or alpha contamination above regulatory limits, with the maximum value being four thousand times the regulatory limit for loose beta emitters of 0.5 Bq/cm^2. The cause of the loose contamination may be a combination of brittle paint dispersal from broken gauges, cross-contamination and radon out-gassing.

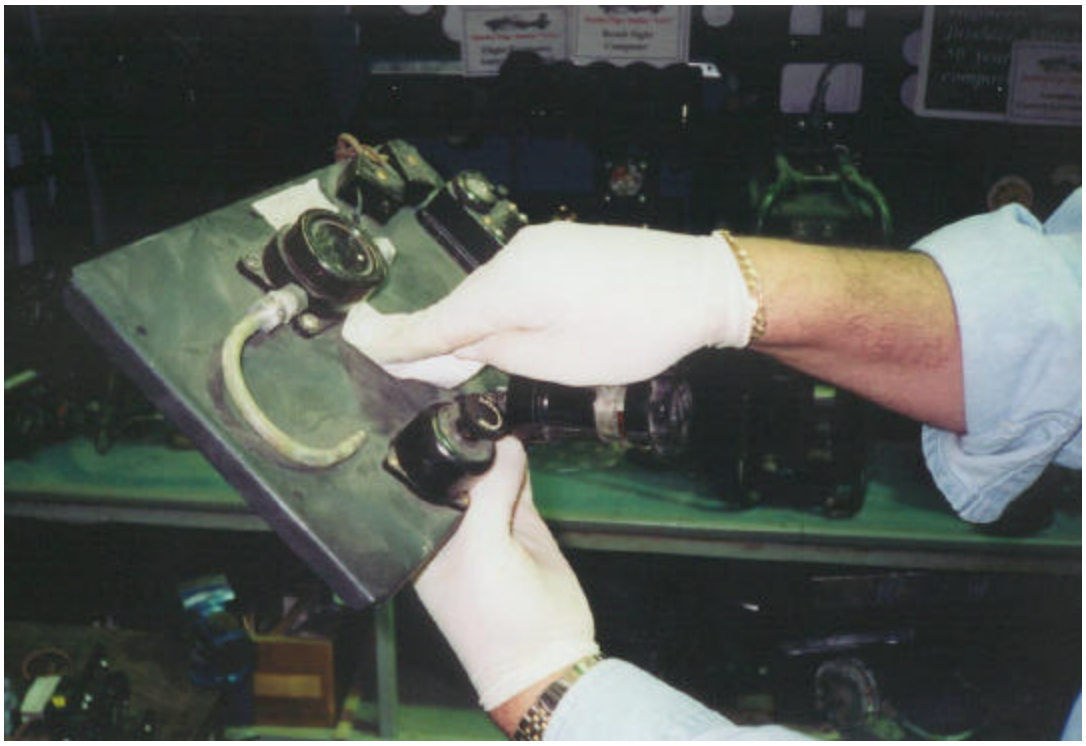

Figure 4 - Swipe being taken on instrument panel

Twenty swipes were taken around the museum area, mainly in the location of the aircraft gauges. Approximately one-half of all swipes taken were found to have levels of beta and/or alpha contamination above regulatory limits, with the maximum value being greater than 40 times the regulatory limit for loose alpha contamination of 0.05 Bq/cm^2. The cause of the loose contamination was likely a combination of cross-contamination before display and radon out-gassing.

III. ST. HUBERT AVIATION MUSEUM

More than forty (40) different radium aircraft dials and about ten (10) control panel switches were found to contain radioactive material above the detection rate of the field survey instruments. Swipe results indicated that the contamination levels of some of the aircraft dials exceeded the regulatory limit for both loose alpha and beta contamination.

The loose contamination was analyzed with liquid scintillation counting and found to consist of radium (Ra-226) and progeny [Reference 4].

Loose radium contamination was also detected on the office furniture of the museum; on the top surface of two desks and on the seat of one chair. Efforts to decontaminate the furniture were only partially successful (Figure 5). The chair and one of the desks were completely cleared of the contamination, however, the swipe results indicated that the alpha contamination level of another desk was approximately three (3) times the regulatory limit. The desk that could not be decontaminated, presumably because radium contamination had ingressed into the wood surface, was disassembled, and the contaminated portion packaged for disposal.

Three (3) swipes taken on the floor of the office area between the desks, also showed contamination levels of about 2.5 times the regulatory limits for loose alpha contamination.

Figure 5 - Desk decontamination

IV. SUMMARY

Over the past 10 years, SAIC Canada has conducted a large number of radiological decommissioning and decontamination procedures at both civilian and government facilities. Over this time, some of these activities have been conducted at museums.

Museums have been found to hold items that contain Ra-226 in the form of radioluminescent paints. The types of items typically found are watches, clocks, aircraft instruments, etc. Due to the widespread historical use of radium for radioluminescent dials and gauges, and its use in medicinal and cosmetic items, there is potentially a large amount of radium held in any museum operation. Museums dealing in natural history and geology often hold mineral samples, sometimes containing ores bearing natural uranium and thorium.

At the museums investigated, radiation levels as high as 200 µSv/hr have been observed. In addition, various levels of loose contamination (as determined by LSC) were found above regulatory limits of 0.5 Bq/cm^2 for beta emitters and 0.05 Bq/cm^2 for alpha emitters.

Museums holding radioactive materials (regardless of whether they are licensed by the CNSC) should (a) have a requirement to be surveyed for loose contamination periodically with the potential for periodic decontamination caused by radon out-gassing, (b) restrict public access to displays bearing radioactive material, and (c) institute comprehensive radiation safety programs. In addition, museum curation personnel should be trained in basic radiation safety principles.

ACKNOWLEDGMENTS

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