

DRAFT

**INVENTORY OF MATERIALS WITH
VERY LOW LEVELS OF RADIOACTIVITY
POTENTIALLY CLEARABLE
FROM VARIOUS TYPES OF FACILITIES**

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addition, this report considers not only the disposition of materials at the time of license termination, but also clearance during routine operations. As such, this inquiry probes more deeply into additional subcategories of materials licensees in order to better understand the possible impacts of the alternatives on the different categories of licensees.

2.5.4 Large Medical Facilities (1,224 NRC licensees)

The investigation into NRC-licensed medical licensees was divided into three phases. In the first phase, the available and pertinent literature was reviewed. In the second phase, the information obtained from the review was validated and expanded upon by meetings and correspondence with Radiation Safety Officers (RSOs) at selected hospitals. In the third phase, information gathered in phases 1 and 2 was put into a form more useful for assessing the costs and benefits of the clearance alternatives.

2.5.4.1 Literature Review and Interviews

“Lessons Learned in Decommissioning Medical Facilities”

This paper, prepared by Victor Evdokimoff of Boston University Medical Center (BUMC) and published in *The Radiation Protection Journal*, Vol. 77, No. 5 Supplement, November 1999, describes the decontamination of two medical facilities.

The first decontamination operation consisted of renovating seven floors of a 10-story hospital in 1994, where all existing structures and equipment were removed with only the exterior of the building remaining. Since this building had been used for 50 years, the cleanup activities involved contamination accumulated over a long period of time. The second decommissioning project involved the demolition of three buildings in 1997.

The 1994 decommissioning was performed in accordance with NRC guidance provided in NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination* (NRC 1994). Since many of the MARSSIM concepts were first introduced in this guidance, the manual can be considered a precursor to MARSSIM. Unlike MARSSIM, the guidelines also incorporate specific cleanup criteria, as presented in Table 2-93. These levels are identical to those set forth in Regulatory Guide 1.86.

Table 2-93. Acceptable Surface Contamination Levels Based on NUREG/CR-5849

Nuclides ^a	Average ^{b,c,f} (dpm/100 cm ²)	Maximum ^{b,c,d,f} (dpm/100 cm ²)	Removable ^{b,c,e,f} (dpm/100 cm ²)
U-nat, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-133, I-131	1,000	3,000	200
Beta/gamma emitters (nuclide with decay modes other than alpha emissions or spontaneous fission) except Sr-90 and other noted above	5,000 βγ	15,000 βγ	1,000 βγ

- a Where surface contamination by both alpha- and beta/gamma-emitting nuclides exists, the limits established for alpha- and beta/gamma-emitting nuclides should apply independently.
- b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrument.
- c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
- d The maximum contamination level applies to an area not more than 100 cm².
- e The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, then pertinent levels should be reduced proportionately and the entire surface should be wiped.
- f The average and maximum radiation levels associated with surface contamination resulting from beta/gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

In accordance with these guidelines, the seven floors of the building (about 60,000 square feet) were divided into affected and unaffected areas. An area was defined as either a room in a lab, a room with many labs, or even a piece of equipment within a room, such as a hood. A total of 291 affected areas were identified. Within these areas, 70 contaminated spots were found in 32 hoods, 70 were found on 28 bench tops, 66 were found on the floors of 23 rooms, and 31 were found in cabinets in nine rooms. The 290 unaffected areas identified were found to contain two contaminated spots. Out of 4,114 dry wipe tests taken, only 12 swipes indicated removable contamination above the release limits, and 5 of these were contaminated with tritium.

It was determined that very little of the contamination was removable. The average level of contamination was 30,000 dpm/100 cm² primarily from tritium and C-14. The authors concluded

that about 14 percent of the total surface area of the floors was contaminated, and only 0.3 percent of the contaminated areas contained removable contamination.

The 1997 decommissioning was performed in accordance with MARSSIM guidance. A scoping survey was performed which surveyed 10 percent of the affected areas and 1 percent of the unaffected areas. The scoping survey found no contamination above background in Building 1, which was a four-story patient care facility abandoned 15 years prior to the survey. Building 2 was a four-story research building also abandoned 15 years prior to the survey. Out of 30 areas designated as affected, 4 contaminated spots were found. These consisted of H-3 and C-14 on some animal cages, inside freezers, and on some counter tops. Since the scoping survey found some contamination, a 100-percent survey of Building 2 was performed, but no additional contamination was found. There was no contamination detected in the areas of Building 2 designated as unaffected.

Building 3 was a six-story research building in use for 40 years and vacated several months prior to the survey. In the 21 areas designated as affected, seven contaminated spots were found on counter tops. As a result, a 100-percent survey was performed which uncovered no additional contamination.

In the areas designated as unaffected, the scoping survey found Ra-226 contamination on the floor and under the floor tiles in a corridor. The contamination resulted from a 70 mCi spill and contaminated a 40 square foot area of concrete under the floor tiles. The contamination was removed with a jackhammer. As a result of this finding, a 100-percent survey was performed, but no additional contamination was found.

The overall cost of the 1994 program was several hundred thousand dollars, while the overall cost of the 1997 program was tens of thousands of dollars. The primary difference in the costs was the result of MARSSIM protocols that reduced the number of samples required for analysis and the extent of the surveys.

Interview with Victor Evdokimoff

In addition to his paper, Mr. Evdokimoff supplied additional information in telephone interviews characterize more fully the potential impacts of the alternatives on medical facilities. Mr. Evdokimoff also answered several questions in writing.

In the 1994 decontamination, the total floor area of the 7 floors was 60,000 square feet, which included an average of about 30 labs per floor, of which about half used radioactive materials. During the decontamination operation of these labs, 15 cubic feet of incinerator ash (containing 10 μCi of H-3/C-14), and 13.6 cubic feet of miscellaneous waste (containing 300 μCi of H-3/C-14) were disposed of as low-level waste. In addition, 30 linear feet of plumbing and drains contaminated with S-35 were placed in storage for radioactive decay.

In the 1997 decommissioning, 22.5 cubic feet of scabbled concrete (containing 100 μCi of Ra-226) and 30 cubic feet of miscellaneous metal and other wastes (containing 5.6 mCi of H-3/C-14) were disposed of as low-level radioactive waste.

Mr. Evdokimoff provided the following written comments:

1. *Given sufficient time to allow for decay of I-125, P-32 and S-35, most contaminants are weak beta emitters H-3, C-14.*
2. *Most contamination is fixed on floors, benchtops, hoods, cabinets and hot sinks. The contamination was easily removed from the surfaces saving considerably on radwaste costs. Wipe testing for removable contamination is a waste of time and money.*
3. *Since H-3 is a major contaminant, institutions that only do wipe tests and count them in a LSC will miss fixed H-3 contamination. Most medical research facilities do not have a windowless Proportional counter which is able to detect H-3 on surfaces.*
4. *I-125 release limits are exceedingly strict. Most institutions will not be able to meet the detection limit for free release of 20 dpm/100 cm sq removable.*
5. *Older medical facilities have labs that are separated from one another by doors. In my opinion this minimizes the spread of radioactive contamination. Today's medical facilities have open bench designs in which a floor could contain 30-50 benchtops one after another. This could result in declaring the whole floor an impacted area since many of these benchtops are radioactive use areas.*
6. *Most medical research institutions have competent and vigilant health physics staff that help keep contamination from researchers to a minimum. In my experience in reviewing thousands of lab surveys over 25 years at*

Boston University Medical Center (BUMC) and as a consultant, radioactive contamination in labs is very infrequent. In addition, if there is contamination, the micro to millicurie use levels contribute to low levels of contamination

7. *I agree with many of the observations provided by my colleague Ken Miller at HMC (see Appendix C). Our institution is two to three times larger than HMC. I believe my decommissioning findings can be generalized to other medical research facilities. My findings are that most areas and equipment are not contaminated. What little contamination exists is fixed from weak beta emitters.*
8. *Medical research facilities do not have the financial resources to pay for decommissionings that turn up very little contamination prior to release. We paid \$300,000 for a contractor with 3 people working 7 months in the 1994 decommissioning alone.*
9. *Hospitals that utilize nuclear medicine should not be confused with medical research facilities at a university, hospital or biotech firm. Medical research utilizes "CHIPS". The most commonly used radionuclides today are P-32 and S-35. There is a declining use of H-3, C-14 and I-125. Iodinations have declined and I-125 RIA kits are almost never used.*
10. *In our experience, 30% of the total radioactive use labs are turned over in a year. The researcher moves to another building. Our researchers seem to be moving around the institution constantly. Some leave and new Principle Investigators come. Almost all researchers use some radionuclides. Their grants depend on the use of radioactive materials. If they could not use radionuclides, they could not do research. Money is very tight for researchers who have to provide their own funding to come AND REMAIN at a medical research facility. If they lose a grant, they usually have to leave.*

Mr. Evdokimoff also commented on the clearance alternatives, as follows:

1. *1 mrem/yr, 0.1 mrem/yr, and zero above background. These dose limits are not justified. The LLD to detect these levels cannot be obtained. This effectively prevents release of materials that are probably not contaminated. If we cannot survey, then these materials would have to go out as radioactive waste. No one could afford this. Actions of this sort would cause researchers not to use radioactive tracers even those that are decayable because labs*

cannot be used for certain lengths of time. [S-35, a common radionuclide, has a half-life of 90 days.] Grants would be affected and ultimately medical research.

2. *Prohibition of release is not justified because of low risk, low contamination potential.*

The following are Mr. Evdokimoff's comments on NUREG /CR-1754 (the study of reference non-fuel-cycle facilities discussed in Section 2.5.3.1):

1. *This guide is too old to be used at all for generic medical research facilities.*
2. *H-3 and C-14 are usually used on the same benchtop. No mention of P-32 and S35 use. No research facility uses unsealed Am-241 or Cs-137.*
3. *The contamination levels seem high. Most surveys yield negative results. Walls and ceilings were not found to be contaminated in our decommissionings.*
4. *Medical facilities do not use glove boxes or hot cells.*
5. *Hot sinks, benchtops, floors cabinets, hoods and animal cages do get contaminated. Iodination hoods and its ductwork can be contaminated with I-125. Plumbing and hot sink traps also get contaminated.*

Site Visit

In order to validate and supplement the information summarized in the literature review, Hershey Medical Center in Harrisburg, Pennsylvania, was visited. Appendix D summarizes the results of that visit. This summary was reviewed and approved by Ken Miller, RSO of Hershey Medical Center.

Subsequent to the visit, additional questions arose that helped to clarify some of the material provided in Appendix D. The first question dealt with lower limits of detection. Mr. Miller explained that the medical center employs 100 dpm/100 cm² as the definition of "clean," and this is determined by counting wipe samples that can achieve the lower limits of detection necessary to demonstrate that a given surface meets the "clean" criteria. Surface scans using handheld survey instruments can observe contamination at the limits set forth in Regulatory Guide 1.86.