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Surface Radiological Free Release Program for the Battelle Columbus Laboratory Decommissioning Project

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ABSTRACT

This paper was prepared for the Second Residual Radioactivity and Recycling Criteria Workshop and discusses decommissioning and decontamination activities at the Battelle Columbus Laboratories Decommissioning Project (BCLDP). The BCLDP is a joint effort between the Department of Energy (DOE) and Battelle Columbus Operations to decontaminate fifteen Battelle-owned buildings contaminated with DOE radioactive materials. The privately owned buildings located across the street from The Ohio State University campus became contaminated with natural uranium and thorium during nuclear research activities.

BCLDP waste management is supported by an extensive radiological free-release program. Miscellaneous materials and building surfaces have been free-released from the BCLDP. The free-release program has substantially reduced radioactive waste volumes and supported waste minimization. Free release for unrestricted use has challenged regulators and NRC licensees since the development of early surface-release criteria. This paper discusses the surface radiological free-release program incorporated by the BCLDP and the historical development of the surface radiological free-release criteria. Concerns regarding radiological free-release criteria are also presented.

SURFACE RADIOLOGICAL RELEASE PROGRAM FOR BATTELLE COLUMBUS LABORATORIES DECOMMISSIONING PROJECT

Introduction

The Battelle Columbus Laboratories Decommissioning Project is an extensive project to remediate 15 buildings and associated facilities such that they can be released for unrestricted use to the general public. This document establishes the technical basis by which present radiological surface release criteria are applied to accomplish the remedial action.

Radiological release criteria for surfaces were first defined in ANSI N13.12 (draft), "Control of Radioactive Surface Contamination on Materials, Equipment, and Facilities to Be Released for Uncontrolled Use" and were later published in U.S. Nuclear Regulatory Commission Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors". There is little difference between these two standards, and both serve as guidance documents when establishing surface radiological release criteria. The Department of Energy (DOE) Order 5400.5, "Radiation Protection of the Public and the Environment" also provides release criteria for surface radioactivity and the criteria stated therein contain only subtle differences from those in the other reference documents. For the BCLDP, DOE Order 5400.5 and Regulation Guide 1.86 will be used to provide criteria that are followed as upper limits of radioactive surface contamination for unconditional release of equipment, materials, and areas. DOE Order 5400.5 requirements are mandatory for the BCLDP because the radioactive material being removed is the property of the DOE and the DOE provides 90% funding for the project. Regulatory Guide 1.86 requirements are mandatory because Battelle is an NRC Licensee and the BCLDP is being conducted under an NRC required decommissioning plan.

Release Criteria

The surface radiological release criteria for the BCLDP are shown in Table 1, "Surface Contamination Guidelines for BCLDP." These criteria are provided by DOE Order 5400.5 "Radiation Protection of the Public and the Environment," which reference Regulatory Guide 1.86. DOE Order 5400.5 does not define the release levels for nuclides such as transuranics (TRU), Ra-226 and Th-230, therefore, BCLDP will adopt the guidance of Regulatory Guide 1.86 for these isotopes and these limits are also shown in Table 1. The criteria in Table 1 are the maximum allowable quantities of radioactive material that may be left on surfaces of equipment and buildings that are released to the general public for unrestricted use. The term "Unconditional Free Release" is a generally accepted term in industry that is used synonymously with this unrestricted use. It is the policy of the BCLDP to aggressively apply

the principles of As Low As Reasonably Achievable (ALARA) to release criteria. The release criteria stated in Table 1 shall be applied as an upper limit of radioactive surface contamination for free release of equipment, materials, and areas by BCLDP.

Release limits are grouped into several categories depending on the radiotoxicity of the radioisotope as seen in Table 1. For each area, BCLDP will identify radioisotopes through analytical techniques and determine their corresponding activity fractions. Release limits can then be determined on the weighted activity fraction of each radioisotope. If radioisotopes or activity fractions are not known or vary significantly, then release limits will be based on the most restrictive nuclides to be encountered by the BCLDP. These release limits for gross alpha and gross beta-gamma activity are shown in Table 2.

Radiological Release Logic for the BCLDP

Consistent with the requirements of DOE Order 5400.5, Section II.5, "Release of Property Having Residual Radioactive Material," and the DOE Radiological Control Manual, Section 422, "Release to Uncontrolled Areas," all facilities, areas, buildings, equipment, and materials, having surface activity or activity concentrations in excess of applicable limits (Table 1) shall require decontamination; and/or removal and disposal as radioactive waste. Facilities, buildings, areas, equipment, and materials that do not have detectable contamination, (i.e., above the Lower Limit of Detection [LLD]) and are not suspected of potential internal contamination, shall be released without any further assessment or evaluation. As required by DOE Order 5400.5, Section II.2.b, "ALARA Evaluations," formal ALARA evaluations and cost benefit analyses shall be performed as part of Decontamination and Decommissioning Plans for facilities, buildings, and large volumes of associated equipment and materials with residual radioactivity above the LLD.

As dictated in DOE Order 5400.5, Section II.5.c.1-4, "Release of Materials and Equipment," individual items not addressed by specific Decontamination & Decommissioning plans with residual radioactivity above the LLD but below applicable limits will also be subjected to an ALARA process and assessed for potential contamination prior to release by the BCLDP. This ALARA process consists of a field assessment by a trained evaluator (usually a Health Physics Supervisor) prior to releasing any materials or equipment with detectable contamination below the limit. BCLDP Procedure HP-OP-011, "Release of Materials from Radiologically Controlled Areas" further defines and establishes requirements for the uncontrolled release of materials and equipment from radiological areas.

It is the practice of the BCLDP that all releases of buildings, areas, materials, and/or equipment will meet or better the limits and criteria found in Table 1. In addition, for buildings, areas, materials, and/or equipment with residual radioactivity below those in Table 1 but above the LLD radiation detection equipment, it is the practice of the BCLDP to use sound ALARA principles and analyses to determine what, if any, decontamination actions are warranted prior to release. It should be made clear this does not mean that all materials, equipment, areas, or buildings will be released at or near the LLD since there may not be a reasonable ALARA basis to do so.

Table 1. Surface Contamination Guidelines for BCLDP

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm²)[1]		
	Average[3,4]	Maximum[4,5]	Removable[4,6]
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra 228, Th-228, Th-230, Pa-231	Reserved (100)*	Reserved (300)*	Reserved (20)*
Th-Natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.[7]	5,000	15,000	1,000

(1) 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 measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

(2) Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

(3) Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

(4) The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr and 1.0 mrad/hr, respectively, at 1 cm.

(5) The maximum contamination level applies to an area of not more than 100 cm^2

(6) The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

(7) This category of radionuclides includes mixed fission products, including the Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

* Regulatory Guide 1.86

Table 2. Release Limits for Gross Activity (Unknown Isotopes) - Regulatory

EMISSION	REMOVABLE (dpm/100 cm^2)	TOTAL (Fixed and Removable) (dpm/100 cm^2)
Alpha	*20	*100
Beta - Gamma	**200	**1000

* Based on TRU, Ra-226 and Th-230
** Based on Sr-90 and Th-232

Natural and Electronic Background

The application of release criteria standards cannot be successfully applied without the understanding of background. Two types of background exist: natural and electronic. Natural and electronic background significantly impact the release criteria by the following:

- Natural background, by providing a quantity of radioactive material which is available to be detected.
- Electronic background, by influencing the least amount of radioactivity that can be measured by a particular instrument.

It is necessary to distinguish the difference of the two types of background. Obviously, the term background could apply to either. The following are the terms as accepted by industry practice.

Generic term - natural background, the amount of radioactive material that exists in a substance, surface, or material as a result of nature. The quantity of natural background is generally expressed in terms of picocuries/gram (pCi/g), femtocuries/liter (10^{-15} Ci/l), milligrams/milliliter (mg/ml), disintegrations per minute (dpm), or other suitable combinations of activity or quantity per unit mass or area. Cosmic radiation is also considered a part of natural background. Natural background is detectable and must be accounted for when making activity determinations. For example, field beta/gamma type instruments, might have background that ranges from 100 to 500 counts/minute. For a laboratory type alpha scintillation counter, the background might be 1 count per 2 minutes of counting time.

Generic term - electronic background, the amount of electronic signal produced by electronic noise which results in a meter or scaler deflection. Instrument background is generally expressed in counts per minute (cpm), picocuries/gram (pCi/g), milligrams/liter (mg/l), or other suitable units. Electronic background (background) is determined by measuring the signal output for a particular instrument when subjected to an area or matrix that contains no radioactive material other than natural or cosmic radiation.

Determining Background

Accurately determining both types of background must be accomplished before applying release criteria. Two industry accepted practices exist for determining natural background in materials. The first method is to accurately measure the naturally-occurring radioactivity in materials with the appropriate analytical instrument. This is accomplished by collecting a clean sample of similar material from an uncontaminated source. An example of this type of natural background determination is to measure the radioactivity in a piece of lumber from the hardware store or a quart of motor oil from Wal-Mart®. The expected results for such an analysis would be 1 to 2 pCi/g in wood for natural uranium and less than 0.1 pCi/l for mixed fission products in oil. This same process can also be applied to chemical contaminates in various matrices.

The other type of material background analysis is a statistical procedure called Chauveneus Determination. This process requires making a large number of radiation measurements in a defined area and then casting out the larger measured results. The average of the smaller remaining results is considered to be background for the defined population.

Both of these techniques are applied for determination of natural background for the BCLDP.

Instrumentation

Release surveys will be performed using suitable instrumentation and industry standards. It should be noted that the upper end of the release criteria defined in the applicable regulatory standards and being applied to the BCLDP were developed in part based on the detection limitations of the field instruments available at the time the standards were published. The BCLDP will utilize field instruments, laboratory techniques, and survey techniques capable of achieving detection limits at or below the upper bounds of the release criteria stated in Table 1. Current BCLDP instruments have detection limits lower than the surface contamination guidelines for the most restrictive nuclides shown in Table 1. However, the BCLDP will not continue to upgrade with state-of-the-art detection systems simply to drive the lower limit of detection (LLD) continually lower. Surfaces with detectable radioactive contamination levels

greater than the LLD but less than the stated release criteria will be evaluated based upon ALARA analyses for decontamination, disposal, or free release. Materials greater than the release criteria will be decontaminated or disposed of as of radioactive waste.

Program Implementation

The surface radiological free-release program is implemented through highly qualified health physics technicians. The health physics technicians perform extensive radiological surveys for fixed and removable contamination.

The BCLDP presently has 49 health physics technicians. Of the 49 health physics technicians, 38 meet the American National Standard Institute (ANSI) requirements for Senior Health Physics Technician. Additionally, 13 of the senior technicians are certified by the National Registry for Radiation Protection Technologists. Only senior technicians are qualified and allowed to perform radiological free-release surveys.

Each free-release survey is documented and reviewed for accuracy prior to materials' being removed from a radiologically controlled area. Once materials are certified for free-release, they must be removed from the radiologically controlled area within thirty days or the survey becomes invalid. Materials not removed from radiologically controlled areas within thirty days must be resurveyed prior to their removal. Similarly, building areas are isolated once free-release surveys have been completed, to prevent cross-contamination.

Once building surfaces are surveyed for free-release, the Independent Verification Contractor (IVC) is notified. The IVC checks the survey work performed to ensure that the free-release criteria have been met. The IVC for the Battelle Columbus Laboratories Decommissioning Project designated by the Department of Energy is the Oak Ridge Institute for Science and Education (ORISE) in Oak Ridge, Tennessee.

ORISE provides personnel and equipment on-site to perform independent surveys. the duration of the survey work performed by ORISE, of course, depends on the size of the facility being evaluated. For smaller areas, ORISE may choose to evaluate only the final survey report and analyze samples collected by the BCLDP at its analytical laboratory.

Upon completion of the survey performed by the IVC, a formal free-release statement will be issued by ORISE, releasing the property for unrestricted use.

Conclusion and Recommendations

By successful implementation of current surface radiological release criteria, the BCLDP has released in excess of 55,000 cu.ft. of materials that would have otherwise been disposed of as low-level radioactive waste. In addition to these materials, several areas from Battelle-owned buildings have been released for unrestricted use. To date, areas from King Avenue Buildings 5, 6, 7, and 9 and West Jefferson Buildings JS-1, 10, and 12 have been free-released for unrestricted use.

Although the stated release criteria have been implemented for the good of the BCLDP, new surface radiological release criteria should be developed based on risk analysis. The new release criteria should incorporate the industry developments in radiological monitoring equipment and provide consideration for facility use after free-release. The new criteria might also incorporate standards for conditional release for decontaminated facilities that would not be occupied by specific groups of the general public.

The release criteria must be developed based on acceptable risk and cost-effective implementation. Most importantly, surface radiological release criteria must be capable of being implemented in the field.