DOE'S PROCESS AND IMPLEMENTATION GUIDANCE FOR DECOMMISSIONING, DEACTIVATION, DECONTAMINATION, AND REMEDIAL ACTION OF PROPERTYWITH RESIDUAL CONTAMINATION

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Abstract

This paper presents DOE's requirements, process, and implementation guidance for the control and release of property that may contain residual radioactive material. DOE requires that criteria and protocols for release of property be approved by DOE and that such limits be selected using DOE's As Low as is Reasonably Achievable (ALARA) process. A DOE Implementation Guide discusses how the levels and details (e.g., cleanup volumes, costs of surveys, disposal costs, dose to workers and doses to members of the public, social and economic factors) of candidate release options are to be evaluated using DOE's ALARA process. Supporting tools and models for use within the analysis are also highlighted.

Introduction

The U.S. Department of Energy operates a variety of nuclear facilities (e.g., reactors, accelerators, weapons test facilities, medical and research facilities), many of which are aging and undergoing remediation and decommissioning. DOE has developed a process and implementation guidance for DOE and contractor personnel who perform cleanup of property contaminated with residual radioactive material and who must determine the disposition of property under the requirements in Order DOE 5400.5 [1] and its proposed successor, 10 CFR Part 834 [2]. The control and release of property containing residual radioactivity has its basis in the analysis of candidate release options using the DOE As Low As is Reasonably Achievable (ALARA) process [3].

Principal Requirements

Site-specific authorized limits are used to govern releases of sites, structures, and materials such as soil. Authorized releases are those approved by DOE to permit the release of property from DOE control. The DOE's framework of radiation protection standards for workers and the general public is presented in another paper within these Proceedings [4]. Requirements for the control and release of property containing residual radioactive material include the following: (a) doses shall not exceed applicable dose limits (1 millisievert per year, mSv/y) and constraints (one quarter of the primary dose limit, 0.25 mSv/y); (b) authorized limits shall be derived through application of the DOE ALARA process; (c) survey or characterization of the property; (d) compliance with other applicable U.S. federal or state requirements; (e) appropriate public involvement and notification; (f) independent verification of the radiological condition of the property prior to its release; and (g) compliance with DOE quality assurance requirements.

Implementation Guidance

The DOE options analysis process and supporting guidance for selecting an appropriate release option is described in the *DOE Implementation Guide for Control and Release of Property with Residual Radioactive Material* [5]. The *Implementation Guide* contains guidance for the control and release of both real (e.g., land and structures) and non-real (e.g., equipment and tools) property. This paper focuses on guidance for the release of lands and structures. Key elements of the process are highlighted below.

ALARA Principles and Process as the Basis for Authorized Release

ALARA, as applied by DOE, is not a numerical level or limit, but rather a process which is to be used to ensure that appropriate factors are taken into consideration in arriving at decisions, in this case regarding the control and release of property, which could affect the degree of protection for workers and the public against radiation. The ALARA process considers dose, cost, and health risk, as well as public, political, cultural, ecological, and site-specific considerations for the candidate release options being evaluated. It is DOE's experience that political sensitivities and public perception, rather than dose and health risk factors, are often the key determinants for whether or not material is ultimately approved for release.

Use Scenarios

Authorized release options must be evaluated to ensure that doses to individuals using the property under "actual" and "likely use" scenarios will be below the dose constraint. Actual and likely use scenarios represent the expected use of the property within the reasonably foreseeable future (e.g., the first fifty years). Authorized release options should also consider potential doses under the "worst plausible use" of the property over the long term to assess the consequences should restrictions that control use of the material fail or expectations of use be incorrect.

Evaluation of Individual and Collective Dose

The DOE does not allow the release of property that is likely to cause an individual to receive a dose at or near the primary dose limit. This is because DOE's primary dose limit applies to all sources and pathways combined, and the assumption that there is potential for an individual to also receive doses from other sources of radiation (e.g., licensed facilities; normal operating releases). Therefore, DOE requires that authorized limits be constrained at 0.25 mSv/y to the maximum exposed individual, considering actual and likely future use scenarios. The ALARA release options analysis is completed for several dose levels, with at least two dose levels below the 0.25 mSv/y recommended constraint. The dose levels are spaced to adequately describe the dose-cost benefit relationship, and at least one option that controls potential annual individual doses to a few tens of microsieverts or less is typically evaluated. Although the individual dose constraint is used to ensure that an individual or group of individuals does not receive an inordinate fraction of the dose, in general, it is the monetary value of preventing collective dose that should be compared to costs and other factors when conducting the release options analysis process. Therefore, in those cases where collective dose is significant it should be a controlling factor in the ALARA analysis of options, and in the final selection of the release option. If collective doses for release options are likely to exceed 1 person-Sv/y, then a quantifiable optimization analysis should be considered. In these

cases, one or more alternatives that reduce collective doses to less than 0.10 person-Sv/y are to be considered.

Time Intervals for Integrating Collective Doses and for Assessing Doses to Current versus Future Generations

Most residual contamination concerns are due to the presence of long-lived radionuclides. These long-lived radionuclides may have the potential for causing doses to persons for more than one generation. If initial options analysis suggests that doses to future generations may be important, optimization analyses are conducted to integrate collective doses for periods longer than the first generation of use, possibly up to about two hundred years. If collective doses are integrated over periods longer than a few hundred years, data should be evaluated qualitatively, as uncertainties in such data are too large for its use in a quantitative ALARA analysis. Ultimate disposition of the contaminated material is also factored into the policy decision for the cleanup effort. Consideration of disposal impacts are difficult to assess and compare quantitatively beyond a few hundred years because of uncertainties in land use and other factors over long periods at both the disposal site and the cleanup site.

Evaluation of Site-Specific Factors in the Release Options Analysis

Site-specific factors may also be important in the evaluation and selection of release options. For example, specific waste management units may have waste acceptance criteria that are based on local background radiation levels. Wastes, such as soil, from one region having high background could conceivably exceed waste acceptance criteria if local radiation background levels are low, even if it has very little residual contamination. Similarly, actions to remove soil with small amounts of residual radioactive material in low background soils may in balance have a negative benefit if background levels in the replacement soil are high. Such factors are to be considered when selecting remedial alternatives for mitigating the effects of residual radioactive material. Finally, when non-radioactive contaminants are present coincident with residual radioactive material, decontamination or remedial measures should consider the hazards of both materials and be in compliance with other applicable regulations governing such material.

Specific Applications of the Authorized Release Process

Land

Authorized limits (e.g., in Bq/kg) for release or control of residual radioactive materials in soils are developed consistent with the requirements, goals, and guidance presented above. The RESidual RADioactivity (RESRAD) code, developed by DOE, is recommended for assessing potential dose associated with the release or use of soils containing radionuclides. An overview of the RESRAD family of codes is presented in another paper within these Proceedings [6]. The *Implementation Guide* contains supporting guidance on appropriate soil averaging areas, and the evaluation of hot spots that have residual radioactive material above levels in the surrounding area. Methods for site-specific surveys and averaging areas, and statistically-based sampling protocols are provided in the Multi-Agency Radiation Survey and Site Investigation Manual [7]. Specific concentration limits are provided for radium (185 Bq/kg for soils within the top 0.15 m of soils; 555 Bq/kg in any subsequent 0.15 m layer), which are maximum concentrations permitted in soils for properties being released from DOE control. DOE requires that ALARA be implemented when these limits are applied, such that

the authorized limits are selected at or below these concentrations, unless site-specific dose assessments can justify alternative concentrations.

Structures

The *Implementation Guide* contains surface activity guidelines providing allowable total residual surface activities (dpm/100 cm^2) for groups (e.g., transuranics; alpha; beta-gamma) of radionuclides for release of structures. Release of property at these surface activity guidelines ensures that doses are well below the primary dose limit and generally less than 0.25 mSv/y. Measurements to demonstrate compliance with these surface activity guidelines should be made according to guidance in the Environmental Implementation Guide for Radiological Survey Procedures [8]. DOE requires that ALARA be implemented when these values are used, such that the authorized limits are selected at or below these concentrations. When using these guidelines for structures, primary emphasis is placed on continued use of the structure under an appropriate use scenario. Consideration is also given to the ultimate disposition of the structure in the future. The DOE has also established separate limits for radon in habitable structures. Property may be released if indoor radon levels are less than 0.02 working level (i.e., about 148 Bq/m^3). The DOE has not established DOE-wide approved activity guidelines for release of structures containing residual radioactive material in mass or volume. Authorized limits in these cases must be derived consistent with the requirements and processes discussed previously in this paper.

References

[1] DEPARTMENT OF ENERGY, Order DOE 5400.5, Radiation Protection of the Public and the Environment, February 8, 1990 and supplements dated 6/5/90 and 9/4/92.

[2] DEPARTMENT OF ENERGY, 10 CFR Part 834, "Radiation Protection of the Public and the Environment; Proposed Rule", Federal Register Vol. 58, March 25, 1993 [58 FR 16268].

[3] DEPARTMENT OF ENERGY, DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with 5400.5, Interim Guidance, 1997.

[4] MICHAELS, D. IAEA-SM-359/P-2.3, "Criteria for Radioactive Materials Cleanup at U.S. Department of Energy Facilities", International Symposium on Restoration of Environments with Radioactive Residues (Proceedings).

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[7] DEPARTMENT OF DEFENSE, U.S. DEPARTMENT OF ENERGY, U.S. ENVIRONMENTAL PROTECTION AGENCY, U.S. NUCLEAR REGULATORY COMMISSION, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), 1997.

[8] DEPARTMENT OF ENERGY, DOE Environmental Implementation Guide for Radiological Survey Procedures, 1997.