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RADIOLOGICAL PROTECTION GUIDELINES FOR THE FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM

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DISCLAIMER

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ABSTRACT

The need for a definitive basis for radiological guidelines and criteria for FUSRAP became apparent by 1981 and led ORO to sponsor a joint ANL/BNI/LANL/ORO effort under the chairmanship of Wayne Hansen (LANL) that resulted in a "final" FUSRAP radiological guidelines document in March 1983. A separate effort to develop guidelines for remedial action criteria for SFMP was in progress at PNL. The need to coordinate both efforts with impending revisions of DOE Radiological Protection Standards and impending new developments in EPA and NRC Radiological Protection Standards led to convening of the first DOE Workshop on Remedial Action Criteria in Gaithersburg, Maryland, in February 1984, followed by a second workshop in June 1984 at ANL. The major decisions were to base the criteria on dosimetry models and basic limits currently recommended by the International Commission on Radiological Protection, to emphasize the development and use of site-specific rather than generic guidelines and criteria for residual radionuclide concentrations in the ground, and to prepare a manual to accompany the guidelines that would present procedures and tables for deriving site-specific soil guidelines and criteria for the remedial action programs. A joint ANL/LANL/ORNL/PNL effort to prepare a definitive set of guidelines and a manual has been initiated. The scope, status, and current plans for this effort, and some of the key issues, are presented.

BACKGROUND

During and shortly after World War II, a number of sites that had been utilized by the U.S. Army Corps of Engineers Manhattan Engineer District and the U.S. Atomic Energy Commission (AEC) were decontaminated according to existing radiological criteria and released for unrestricted use. These sites had been used for research and for processing and storage of ore materials. Subsequent research on health effects from exposure to ionizing radiation led to the adoption of more stringent

criteria. In 1974, the AEC initiated identification of potential sites for remedial action based on records of prior use and radiological surveys. This work, which continued under the Energy Research and Development Administration in 1975 and the U.S. Department of Energy (DOE) in 1977, led to initiation of the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1979, with Oak Ridge Operations (ORO) as the lead field office.

As of 1980, radiological standards and guidelines for exposure levels and residual contamination were based on U.S. Nuclear Regulatory Commission (NRC) guidelines (for surface contamination and air and water concentrations) and standards and guidelines developed for the Grand Junction Remedial Action Program (for radon decay products and external gamma radiation exposure) (U.S. Dept. Energy 1980). The U.S. Environmental Protection Agency (EPA) regulations for mill tailings sites, proposed but not yet adopted at that time, were considered applicable for cleanup of open lands and contaminated buildings associated with the sites. Residual concentration guidelines for some radionuclides present at FUSRAP sites were lacking, and it was not clear that cleanup criteria based on the aforementioned standards and guidelines were appropriate for FUSRAP. Consequently, a review of radiological standards and guidelines was initiated in the fall of 1981 for the purpose of establishing a definitive set of guidelines and criteria for cleanup of FUSRAP sites.

The review, initiated by ORO, was carried out under the guidance of a five-member panel consisting of Wayne R. Hansen (Los Alamos National Laboratory [LANL], Chairman), William Bibb (ORO), E. Lea Keller (ORO), Carlyle J. Roberts (Argonne National Laboratory [ANL]), and Robert L. Rudolph (Bechtel National, Inc. [BNI]), and completed in March 1983 (U.S. Dept. Energy 1983). A project to review pathway analysis methods for estimating allowable residual concentrations of radionuclides in the ground was initiated and completed at the same time (Gilbert et al. 1983). Based on these studies, an initial draft of interim planning guidelines and criteria for residual radioactivity at FUSRAP sites was prepared by James K. Alexander (ORO) in March 1983 and circulated for comment. Revised versions were prepared in October 1983 and February 1984.

At the time the review was undertaken, a parallel effort was in progress at Pacific Northwest Laboratories (PNL) to develop and apply pathway analysis methods for determining allowable residual contamination levels of radionuclide mixtures in the soil (Napier 1982; Kennedy and Napier 1983a, 1983b). The focus of this effort was surplus facilities at the Hanford site, but it also provided a basis for developing guidelines and criteria for the DOE Surplus Facilities Management Program (SFMP) for which the Richland Operations Office (RO) was the lead field office.

SFMP sites differ from FUSRAP sites in that they were not cleaned to levels that would permit release for unrestricted use and have remained under the ownership and control of DOE. However, the cleanup problems for some of the SFMP sites are essentially the same--especially for remote SFMP (RSFMP) sites (i.e., sites that are excess to programmatic needs and

located outside major DOE research and development or production areas). Thus, the guidelines and criteria for FUSRAP sites were extended to include RSFMP sites.

Because of the need to reach a consensus on FUSRAP/RSFMP guidelines and criteria, and also to make them consistent with proposed revisions of DOE radiation protection standards and guidelines and with proposed NRC and EPA standards and guidelines, a DOE Workshop on Remedial Action Criteria under the chairmanship of Arthur J. Whitman (DOE) was convened in Gaithersburg, Maryland, on February 22-24, 1984. This workshop resulted in another draft of the guidelines that was distributed in April 1984. A second workshop was held at Argonne National Laboratory on June 26-27, 1984, and revised versions of the guidelines were distributed in July 1984 and October 1984. There were 44 participants in the first workshop whereas the second workshop was limited to a working group of 18. A final version of the guidelines will be issued in November 1984. A companion manual of procedures and data for deriving site-specific guidelines and criteria will be prepared by representatives from Argonne National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratories.

The following report is a summary presentation of the major issues that have arisen and the approaches that were used to resolve them.

ISSUES

Major issues that were identified and addressed in the DOE workshops include:

- Risk/dose limits and dosimetry models
- Limits vs. guidelines
- Generic vs. site-specific limits and guidelines
- Implementation of DOE ALARA policy
- Allowable residual contamination levels
- Choice of scenarios for long-term exposure

The complexity of the issues, the limited time and resources available to the working group, the need to build a consensus among differing viewpoints within the group, and the need to be able to justify the DOE position if negotiations were necessary to resolve interagency differences made it imperative to start from a common framework that represented the collective judgment of the most knowledgeable experts in the field of radiation protection. It was generally agreed that the recommendations of the International Commission on Radiological Protection (ICRP) would best serve this purpose. These recommendations were taken as the starting point. They are generally consistent with the other sources of guidance--i.e., the National Council on Radiation Protection and Measurements (NCRP), United Nations Scientific Committee on the Effects of

Atomic Radiation (UNSCEAR), and National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR)--and address more directly the issues involved in setting FUSRAP/RSFMP guidelines and criteria.

A major concern is that there should be no FUSRAP II; the radiological protection standards for remedial action should be enduring standards in order to avoid the need for another remedial action program for the same sites at some future time. However, this concern must be balanced against other considerations. The cost of the DOE remedial action programs will amount to several hundred million dollars, and the cost increases as the limits and guidelines become more stringent. If the limits and guidelines are set too low, not only will there be a needless waste of resources for the remedial action programs, but a precedent will be set for unnecessary expenditures for future decommissioning and decontamination operations. More than a balancing of risk and cost is involved; the balancing of different risks is also a major concern. Resources are finite, and if large sums are spent to reduce one societal risk, fewer funds remain for reduction of other societal risks. Furthermore, one can reach a point where the increase in ordinary occupational risk (e.g., injuries and fatalities from equipment and vehicle accidents) outweighs the reduction in public risk from moving the residual contamination.

The focal point of the foregoing concerns, and a fundamental issue that affects all of the other issues, is the basic risk and/or dose limit from uncontrolled use of a facility or site. The current DOE dose limits, specified in DOE Order 5480.1A, are: the annual dose equivalent or dose equivalent commitment to individuals at the point of maximum probable exposure should not exceed 0.5 rem to the whole body, gonads, or bone marrow, and 1.5 rem to all other organs. These limits were established over a decade ago and are consistent with recommendations of the ICRP in Publication No. 2 (1960). They are based on dosimetry models described in ICRP Publication No. 6 (1964). The ICRP issued new recommendations and new dosimetry models in 1977 and 1978. DOE radiological protection standards are undergoing review and will probably be revised based on these recommendations and the expected updating of NRC and EPA standards and guidelines; hence, use of current DOE dose limits does not appear advisable in view of the need for an enduring limit. A major concern is that DOE, EPA, and NRC standards and guidelines should be reasonably consistent. This is not easy to accomplish given the independence of the agencies and differing agency missions and needs for accomplishing these missions.

The consensual resolution of the dose limit issue was to adopt the recommendations of the ICRP: 500 mrem/yr for occasional exposure and 100 mrem/yr for continuing or repeated exposure occurring over a period of many years. These limits apply to an effective dose equivalent based on dosimetry models specified in ICRP Publications No. 26 and 30, using a 50-year dose equivalent commitment. Background, medical, and occupational exposures are not included in these basic limits.

The distinction between occasional and prolonged exposure has not been defined by the ICRP. Definitions in terms of a limit on the accumulated dose over the prolonged period have proven to be too complicated and open to objections regarding logical consistency. It is expected that a time period of 5 years will be adopted in the final version: for exposure under/over 5 years, a 500/100 mrem limit will apply.

The question of "limits", "guidelines", and "criteria" has led to some discussion and confusion, both with regard to the meaning of these terms and when they should be applied. In the final version, it is expected that these terms will be used with the following meaning. A limit is a quantity that should not be exceeded, regardless of cost, if compliance is technically feasible. A guideline is a quantity used to guide a course of action. It can be a procedure or a numerical value. Numerical values are intended to provide bases for setting limits and should not be treated as limits. During much of the workshop discussion, the word "criterion" was used in the sense of "limit". In the final version, it will be used only in the generic sense as a standard on which a judgment or decision may be based, in which sense it could refer to either a limit or guideline. The term "authorized limit", in the sense used in ICRP Publication 26 (1977) will be used in place of "criterion".

It was generally agreed that residual radionuclide concentrations in soil material derived from basic limits by means of generic models should be guidelines rather than limits. There was some consideration of designating concentrations derived by site-specific models as criteria; current plans for the final version are that all derived quantities will be designated as guidelines, and authorized limits based on these guidelines will be established as a separate step. The reasons for this are the large uncertainty in all derived values and the desirability of having a separate limit authorization review for each site before authorized limits for a site are established, even though it is expected that, in most circumstances, the authorized limits will be set equal to the guidelines.

The generic/site-specific issue has been resolved as follows. Generic guidelines borrowed or adapted from existing regulations will be used for residual contamination that can be expected to result in a dose that is largely independent of site characteristics, and site-specific guidelines will be used for residual contamination for which the dose is likely to be site-dependent. Surface contamination, external exposure levels, and airborne concentrations of radon decay products are considered to be in the former category; residual concentrations of radionuclides in soil material in the latter. Thorium and radium concentrations in soil material are, however, treated generically for two reasons. One is that derived soil concentration guidelines for these radionuclides can drop below the range of concentrations that occur naturally in the soil. Such low values can be attributed to the conservative assumptions used in the derivation and would result in unreasonably low guideline concentrations. Therefore, it is more reasonable to set generic guidelines that are slightly above the normal range of background concentrations. Another reason is that EPA has established standards for residual concentrations

and radium contamination in soil (40 CFR 192). These standards specify concentrations that are slightly above the range of natural background concentrations.

Questions regarding implementation of DOE's ALARA policy proved especially difficult to resolve. Traditionally, ALARA has been applied to reduce exposures below authorized limits after these authorized limits have been set. Considerations used in establishing authorized limits have recently been referred to as an application of ALARA policy. This can have two undesirable consequences. One is that, having used a process labeled as "ALARA" in setting authorized limits, the argument that ALARA requirements have been met and no further application of the policy is necessary might be used, either explicitly or implicitly. This would be contrary to the intent of ALARA policy. Another is that the limits may be set so low that they cannot be met without incurring unreasonable costs that are not commensurate with the risk reduction. Consequently, in the final version of the guidelines, the term "ALARA" will be used only for procedures and policies applied after authorized limits have been set. Furthermore, ALARA policy will be stated in terms of procedures, not as established numerical guidelines or limits to be specified in addition to the authorized limits. A discussion of ALARA guidelines will not be given in the guidelines document; it will be covered briefly in the manual. A reasonable viewpoint is that ALARA policy is merely the use of common sense in a conscientious attempt to keep radiation exposure to levels that are as low as reasonably achievable, and that it is not feasible to spell out detailed rules for use of common sense.

Four categories of residual contamination are covered in the guidelines document: (1) residual concentrations of radionuclides in solid material; (2) airborne radon decay product concentrations in occupied or habitable structures; (3) external gamma radiation levels; and (4) surface contamination. It is to be noted that the first category plays a markedly different role than the last three in setting cleanup criteria. Measurements of the last three categories made at the time a site is certified for release are relevant only for near-term exposure (i.e., during a period of less than 100 years). One cannot reasonably expect values measured at the time of release to be applicable for estimating individual radiation doses in the long term. The long-term estimates of individual exposure and dose are, therefore, based on the residual concentrations of radionuclides in the soil material. The dose to individuals from the last three categories can also be expected to be essentially the same for all sites; hence, as noted above, the residual contamination level guidelines can reasonably be adapted from existing generic standards.

The consensus of the working group was that soil concentration guidelines should be determined by site-specific pathway analyses. The large uncertainties in estimates based on such analyses present a problem. Estimates of soil guidelines by different analysts can differ by a factor of two or more and still be well within the irreducible margin of error. Well-defined guidelines are needed as a basis for setting authorized limits for certifying a site for release for unrestricted use, regardless

of such uncertainties. This problem was resolved by a decision to prepare a manual specifying appropriate procedures for use in deriving site-specific guidelines. This manual is to be prepared jointly by four of the DOE laboratories that have been involved in the development and application of methods for pathway analyses--ANL, LANL, ORNL, and PNL--and will be issued as a supplement to the guidelines document.

The choice of scenarios for use in estimating the dose to a maximally exposed individual is one of the critical assumptions in a pathway analysis for obtaining derived guidelines from dose limits. This integral part of the pathway analysis methodology will be covered in the manual.

GUIDELINES DOCUMENT

The guidelines document will have eight sections: (1) Introduction, (2) Basic Dose Limits, (3) Remedial Action Guidelines, (4) Authorized Limits, (5) Control of Radioactive Wastes and Residues from FUSRAP and RSFMP Sites, (6) Exceptions, (7) Regulatory Sources, and (8) References. A brief synopsis of the material that will be covered in each section is given below.

The Introduction will present the scope, definitions, and general statements regarding DOE policy on remedial action.

The section on Basic Dose Limits will identify the dosimetry model to be used and present the basic dose limits: 500 mrem/yr effective dose equivalent for occasional exposure and 100 mrem/yr effective dose equivalent for prolonged exposure, with 5 years as the dividing line between occasional and prolonged exposure.

The section on Remedial Action Guidelines will present the guidelines for allowable residual contamination levels (ARCL). These ARCL guidelines may be summarized as follows.

Residual Radionuclide Concentrations in Soil Material. Th-232, Th-230, Ra-228, and Ra-226: 5 pCi/g in the top 15 cm below the ground surface; 15 pCi/g below 15 cm. Concentration guidelines for all other radionuclides will be determined by site-specific pathway analyses using procedures outline in the supplementary manual.

Airborne Radon Decay Product Concentrations in Occupied or Habitable Structures. The target guideline 0.02 WL with an 0.03 WL maximum is used.

External Gamma Radiation Level. A guideline of 20 μR/h above background is used.

Surface Contamination. Surface contamination guidelines will be adapted from NRC standards (1982), as given in Table 1. They are applicable to both exterior and interior surfaces, but only to structures and equipment that will not be demolished and buried.

Table 1. Surface Contamination Guidelines

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

†[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 shall apply independently.

†[3] Measurements of average contamination shall not be averaged over an area of more than 1 m². For objects of less surface area, the average shall be derived for each such object.

†[4] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mR/h and 1.0 mR/h, respectively, at 1 cm.

†[5] The maximum contamination level applies to an area of not more than 100 cm².

†[6] The amount of removable radioactive material per 100 cm² of surface area shall be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. The numbers in this column are maximum amounts.

The section on Authorized Limits will identify the criteria used for certifying a site for release for unrestricted use. Authorized limits shall be set equal to the remedial action guidelines unless: (1) the exceptions (specified in the section on exceptions) are applicable, in which case the authorized limits may be set above the guideline value for the specific location or condition to which the exception is applicable; or (2) it can be clearly established, on the basis of site-specific data not used in establishing the guidelines, that limits below the guidelines are reasonable and can be achieved without appreciable increase in the cost of the remedial action.

The section on Control of Radioactive Wastes and Residues from FUSRAP and RSFMP Sites will specify operational and control requirements for both interim storage and long-term management of radioactive wastes and residues that remain onsite prior to release of a site for unrestricted use.

The section on Exceptions will specify the exceptional conditions that warrant setting authorized limits higher than the guidelines. The exceptions also cover situations in which conditions found during remedial action operations provide clear evidence that compliance with the authorized limits is not feasible.

The section on Regulatory Sources will identify the sources for guidelines that have been adapted from other regulatory standards and guidelines.

The References section will provide a list of references called out in the document, with full bibliographic information.

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