

U.S. DEPARTMENT OF ENERGY GUIDELINES  
FOR RESIDUAL RADIOACTIVE MATERIAL AT  
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM  
AND  
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).<sup>\*</sup> The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material

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<sup>\*</sup>A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

and to protect the public and the environment are provided for (1) residual concentrations of radionuclides in soil,\* (2) concentrations of airborne radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactivity or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be

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\*"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

## B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated

by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent". Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

### C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

#### C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m<sup>2</sup>. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below-surface area less than or equal to 25 m<sup>2</sup> exceeds the authorized limit or guideline by a factor of  $(100/A)^{1/2}$ , where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds

30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or (2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

## C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.\* In any case, the radon decay product concentration

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\*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of  $1.3 \times 10^5$  MeV of potential alpha energy.

(including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

### C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20  $\mu$ R/h and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

### C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)\* and will be applied in a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

### C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and

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\*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

TABLE 1 SURFACE CONTAMINATION GUIDELINES

Radionuclides <sup>b</sup>	Allowable Total Residual Surface Contamination (dpm/100 cm <sup>2</sup> ) <sup>a</sup>		
	Average <sup>c,d</sup>	Maximum <sup>d,e</sup>	Removable <sup>d,f</sup>
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	5,000 $\alpha$	15,000 $\alpha$	1,000 $\alpha$
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 $\beta$ - $\gamma$	15,000 $\beta$ - $\gamma$	1,000 $\beta$ - $\gamma$

<sup>a</sup> 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.

<sup>b</sup> 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.

<sup>c</sup> Measurements of average contamination should not be averaged over an area of more than 1 m<sup>2</sup>. For objects of less surface area, the average should be derived for each such object.

<sup>d</sup> The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

<sup>e</sup> The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>.

<sup>f</sup> The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should 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 cm<sup>2</sup> is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to other appropriate limits and guidelines (i.e., state or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and subsequent guidance or superceding Orders require compliance with applicable Federal and state environmental protection standards.



The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

- a. 5000.3, Unusual Occurrence Reporting System
- b. 5440.1C, Implementation of the National Environmental Policy Act
- c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution
- d. 5480.2, Hazardous and Radioactive Mixed Waste Management
- e. 5480.4, Environmental Protection, Safety, and Health Protection Standards
- f. 5482.1A, Environmental, Safety, and Health Appraisal Program
- g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
- h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements
- i. 5820.2, Radioactive Waste Management

#### E.1 Interim Storage

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.
- b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).
- c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.

- d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

## E.2 Interim Management

- a. A site may be released under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.
- b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.
- c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

## E.3 Long-Term Management

### Uranium, Thorium, and Their Decay Products

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

- b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the wastes shall not (1) exceed an annual average release rate of 20 pCi/m<sup>2</sup>/s and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.
- c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).
- d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.
- e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

#### Other Radionuclides

- f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

#### F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a

portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate protection, giving due consideration to health and safety, the environment, and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

#### F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, on the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

#### F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment.

The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

### F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

- a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.
- b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.
- c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.
- d. Where the cost of remedial action for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive material does not pose a clear present or future risk after taking necessary control measures. The likelihood

that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

#### G. SOURCES

Limit or Guideline	Source
<u>Basic Dose Limits</u>	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
<u>Generic Guidelines for Residual Radioactivity</u>	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
<u>Control of Radioactive Wastes and Residues</u>	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

## H. REFERENCES

- International Commission on Radiological Protection, 1977. Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977). ICRP Publication 26. Pergamon Press, Oxford. [As modified by "Statement from the 1978 Stockholm Meeting of the ICRP." Annals of the ICRP, Vol. 2, No. 1, 1978.]
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- U.S. Atomic Energy Commission, 1974. Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors. June 1974.
- U.S. Department of Energy, 1986. Formerly Utilized Sites Remedial Action Program. Summary Protocol: Identification - Characterization - Designation - Remedial Action - Certification. Office of Nuclear Energy, Office of Terminal Waste Disposal and Remedial Action, Division of Remedial Action Projects. January 1986.
- U.S. Department of Energy, 1987. Supplement to U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites. A Manual for Implementing Residual Radioactive Material Guidelines. Prepared by Argonne National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratory for the U.S. Department of Energy. [In press.]
- U.S. Environmental Protection Agency, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites; Final Rule (40 CFR Part 192). Federal Register 48(3):590-604 (January 5, 1983).
- U.S. Nuclear Regulatory Commission, 1982. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, D.C. July 1982.

Summary of Changes to:  
U.S. Department of Energy Guidelines for Residual Radioactive Material at  
FUSRAP and Remote SFMP Sites.

### INTRODUCTION:

The revised U.S. DOE Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (SFMP) Sites dated March 1987, comply with DOE's standards for protecting the public and are effectively the same as the previous version of the Guidelines. They are consistent with recommendations of the International Commission on Radiological Protection (ICRP) and relevant and applicable Federal/state rules or regulations. The Guidelines encompass:

- Basic Dose Limits to be applied to remedial action projects.
- Residual Radioactive Material Guidelines for Remedial Actions.
  - Generic and derived guidelines for concentrations of radionuclides in soil.
  - Hot Spot Limits for radionuclides in soil.
  - Radon in air guidelines.
  - External Gamma radiation guidelines.
  - Surface contamination guidelines for buildings and equipment.
  - Air and water guidance.
- Authorized Limits for remedial actions (Site Specific Cleanup Limits).
- Guidance for Control of Residual Radioactive Material.
  - Interim Storage.
  - Long-term Management.
- Provisions for Supplemental Limits and Exceptions.
- Sources and references for guidelines.

Differences between the March 1987, version and the previous version of the guidelines are generally procedural in nature or are editorial changes made to clarify certain aspects of the guidelines that have been misinterpreted in the past. The procedural changes relate to the implementation of guidance for limiting hot spots and the exceptions or supplemental limit provisions of the document. The guidance for hot spots were modified to include an approach that is more conservative but can be more easily implemented in the field. The exceptions section of the previous version was changed to differentiate exceptions (deviations from the generic or derived guidelines that require restrictions on site use to ensure compliance with DOE standards) from supplemental limits (deviations from site specific generic or derived guidelines that occur due to specific considerations and do not require restrictions on site use to ensure compliance with DOE standards).



### General discussion and considerations:

The guidelines for radionuclides in soil are generic or derived depending on the radionuclides of concern. For radium and thorium, generic guidelines have been adopted from the EPA Standards (40 CFR 192) for uranium mill tailings remedial actions. These EPA standards were determined to be appropriate for many FUSRAP sites and are generally applied at sites contaminated with uranium and thorium ores or tailings. Conditions at the FUSRAP site are sufficiently similar to uranium mill tailings sites and associated vicinity properties being remediated under the Uranium Mill Tailings Remedial Action Program (UMTRAP) to ensure equivalent levels of protection. However, in the Residual Radioactive Material Guidelines, the Department has recognized the limitations of the EPA standards for radium and thorium in soil in certain contamination situations. These DOE Guidelines provide specific guidance for the treatment of hot spots and take into account multiples or mixtures of radionuclides for situations when radionuclides other than or in addition to radium or thorium and their associated decay products are present. These additions effectively result in a more conservative guideline. In addition, the Department's guidance requires application of the As Low As Reasonably Achievable (ALARA) philosophy in the field which may be applied but is not required under the UMTRA standards.

In other areas as with soil contamination, the guidelines are consistent with UMTRAP and other EPA standards; however, the use of UMTRAP standards is not defacto. Care is taken to ensure appropriate application of standards or limits. Dose evaluations and engineering alternative analyses are applied to storage and disposal sites. In general, materials of higher concentrations are provided greater isolation as required to ensure the dose standards and other appropriate limits are consistently achieved. Similarly, application of the exceptions provisions of the DOE Guidelines require equal and in some cases more detailed analysis and evaluation than is required for UMTRAP Sites under EPA Standards. In order to obtain approval for a specific exception or supplemental limit, dose evaluations, assessments of potential impacts, and/or cost-benefit analyses are required. These analyses must go through a formal approval procedure which include multiple reviews to by DOE field offices and headquarters ensure that the public and environment are adequately protected.

The derived limits established via procedures described in the Guidelines and supporting material comply with DOE Standards for protecting the public and are consistent with ICRP guidance which is generally being applied to most areas of radiation protection. ICRP states that the lifetime dose to a member of the general public should correspond to a maximum 100 mrem/year limit of life-long whole body exposure from all sources, excluding background and medical related doses. ICRP-26 indicates that in most cases that limit can be achieved by application of the 500 mrem/year dose limit. The report suggests that the application of the 500 mrem/year limit is likely to produce dose equivalents of less than 50 mrem/year. The report also indicates that maximizing assumptions usually made in selecting the critical groups result in actual doses to the most highly exposed individuals of values less than that postulated.

The Department's Guidelines use the 100 mrem/year value as a limit for life time exposure (instead of the 500 mrem/year limit) and derive allowable concentrations postulating worse case plausible use scenarios. In general, while plausible, these scenarios are highly unlikely and actual or likely use scenarios would produce potential doses much less than 100 mrem/year, probably on the order of a few mrem/year. As the intent of the ICRP guidance is to ensure that actual doses to the general public do not exceed 100 mrem/year over a lifetime and not to limit potential worst case doses, the Department's Guidelines clearly achieve this goal. The application of ALARA to the Guidelines, reduce exposures to levels that are still further below the postulated limit.

In summary, the DOE Guidelines represent implementable limits for residual radioactivity in the environment that comply with DOE Standards for protecting the public, meet the intent of ICRP guidance, and are consistent with existing guidelines and standards. The DOE Guidelines for residual radioactive material also conform to the DOE policy for implementing radiation protection activities in a manner that is as low as reasonably achievable.

#### Major Changes:

As indicated previously the primary changes to the Guidelines occurred in two areas. These changes are outlined below.

#### Hot Spot Criteria:

The July 1985 version of the Departments residual radioactive material guidelines required that "guidelines for local concentrations" be applied to all areas less than 30 square meters found to exceed an authorized limit or guideline for a 100 square meter area by a factor of 3 or greater. The factor of 3 requirement was not a clean-up limit, but rather a screening or action level. Basically, specific dose calculations were required for each area less than 30 square meters if the area exceeded 3 times the 100 square meter soil concentration guideline or limit. These calculations were found to be impractical for field application due to the requirement to perform dose calculations in the field.

In addition, analysis of the screening value (factor of 3) indicated there was a remote possibility that that value would not provide adequate protection of the general public for certain radionuclides for areas of contamination exceeding about 15 square meters. As a result the Department established a working group whose purpose was to develop hot spot criteria that would:

- Protect the public and environment.
- Be consistent with the guidelines.
- Facilitate field implementation.

The working group recommended that the hot spot criteria be defined as a multiple of the soil guidelines or authorized limits which represent the general soil concentration for radionuclides permitted over a 100 square

meter area, and that the factor be the squareroot of  $(100/A)$  where A is the area of the hot spot. This factor was applied to several typical radionuclides found at DOE remedial action sites including selected alpha, beta, and gamma emitters using the dose estimating methodology provided in the procedures manual, the "supplement" to the Guidelines. The assessment indicated that the  $(100/A)^{1/2}$  factor is sufficiently conservative to ensure the basic 100 mrem/year dose limit is maintained. For field application, the working group recommended that the hot spot limit be implemented in four discrete steps as shown in the attached table. The use of discrete steps adds further conservatism to the approach as well as simplifying field application. The attached table provides a summary of the working groups recommendations for the criteria and its implementation.

Theoretically, the  $(100/A)^{1/2}$  limit could allow very small areas of contamination to have high concentrations of radionuclides. While this does not, in general, pose a problem to most DOE remedial action sites due to the nature of the residues and DOE's ALARA philosophy, a maximum factor of 30 times the authorized limit was established as limit for small areas of contamination.

On December 2, 1986, the Department approved the revised hot spot criteria and directed that it be incorporated in the FUSRAP and SFMP Guidelines for residual radioactivity. The revised guidelines adopted this procedure, but also allow for the use of the specific dose calculations where it is appropriate.

#### Supplemental Limits and Exceptions:

The intent and mechanism for applying the exceptions provisions of the previous guidelines were in some cases confusing. The revision of this section and the separation of exception provisions into two categories exceptions (areas requiring controlled or restricted use to comply with the 100 mrem/year dose limit) and supplemental limits (for areas requiring no restrictions to comply with the dose limit) were done in an attempt to clarify the process. The revision stresses the following points:

- Exceptions or supplemental limits are generally for use at a portion of a site or vicinity property where specific circumstances dictate the guidelines or authorized limit established for the entire site and vicinity properties are not appropriate for the specific area of concern.
- Every effort should be made to minimize the use of exceptions or supplemental limits.
- Supplemental limits must be justified on a case-by-case basis using site specific data and must consider ALARA policy.

## APPLICATION OF HOT SPOT GUIDELINE

1. The method for determining Hot Spot Limits, which is based on the 100 mrem/year Dose Limit, as described in the FUSRAP procedures manual, shall still be applicable for determining allowable concentrations of radionuclides under inhomogeneous soil contamination conditions. However, the following approach, more appropriate for field applications, may be used in place of the Dose Limit method and is recommended for general applications.
2. For the alternative approach, the basic Hot Spot Limits will be calculated for each specific site by (see attached figure):

$$Shg = Sg * (100 \text{ m}^2/A)^{1/2}$$

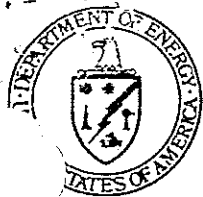
where, Shg - the Hot Spot Limit (pCi/gram)  
 Sg - the Authorized Limit for a specific site (pCi/gram)  
 A - the area of the hot spot in square meters  
 $(100/A)^{1/2}$  is the hot spot multiplication factor.

3. The limits shall be applied in the field over ranges of area with the factors being constant over a given area. The ranges and factors to be used are:

<u>Range</u>	<u>Factor (Multiple of Authorized Limit)</u>
<1 m <sup>2</sup>	10*
1 - <3 m <sup>2</sup>	6
3 - <10 m <sup>2</sup>	3
10 - 25 m <sup>2</sup>	2

\*Areas less than one square meter are to be averaged over the one square meter and that average shall not exceed ten times the Authorized Limit.

4. The average Authorized Limit is considered adequate to protect the public for areas larger than 25 square meters; hence, no special Hot Spot Limits are required for areas larger than 25 square meters.
5. Averaging of hot spots less than or equal to 25 square meters shall be done only over the local hot spot area.
6. Every reasonable effort shall be made to identify and remove any source which has a concentration of a radionuclide exceeding 30 times the Authorized Limit irrespective of area.



Department of Energy

Washington, DC 20545

JUN 26 1987

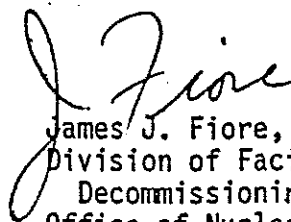
Dr. Stanley Lichtman  
Office of Radiation Programs (ANR-460)  
U.S. Environmental Protection Agency  
401 M Street, S.W.  
Washington, D.C. 20460

Dear Dr. Lichtman:

Enclosed for your information is a copy of the revised "U.S. Department of Energy (DOE) Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP) Sites." ~~These guidelines are used for DOE~~ remedial actions and decommissioning projects conducted under FUSRAP and SFMP. Also enclosed is a summary of the changes between these guidelines dated March 1987 and the previous version dated July 1985. The changes are primarily procedural in nature and were made to simplify field implementation of the guidelines. The guidelines still encompass an annual dose of 100 mrem as the primary dose limit and incorporate the Department's as low as reasonably achievable (ALARA) philosophy through all aspects of the program.

We are presently updating the manual for implementing the residual radioactivity guidelines and hope to have it completed later this year. In the interim, the Department will continue to use the September 1985 version of the manual along with interim guidance for implementing the updated hot spot criteria. If you have any questions regarding these guidelines and their implementation, call Andrew Wallo of my staff at 301-353-5439.

Sincerely,

A handwritten signature in cursive script, appearing to read "J. Fiore", is written over the typed name and title.

James J. Fiore, Director  
Division of Facility and Site  
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Office of Nuclear Energy

2 Enclosures

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