

**ADMINISTRATIVE CHANGE TO  
DOE O 458.1, RADIATION PROTECTION OF THE PUBLIC AND THE  
ENVIRONMENT**

LOCATION OF CHANGES:

Page	Paragraph	Changed	To
1	3.a(2) First sentence	The Administrator of NNSA must assure that NNSA employees and contractors comply with their respective responsibilities under this Directive.	The Administrator of the National Nuclear Security Administration (NNSA) must assure that NNSA employees and contractors comply with their respective responsibilities under this Directive.
3	4.b(1)(b)	Comply with ALARA requirements in paragraph 4.d. of this Order.	Comply with As Low As Reasonably Achievable (ALARA) requirements in paragraph 4.d. of this Order.
7	4.e(6)	Dose evaluation models that are codified or approved for use by DOE must be used. Alternative dose evaluation models, including those used by other regulatory agencies, national organizations or international organizations, must be approved for use by the Chief Health, Safety and Security Officer, or by the DOE Field Element Manager with the concurrence of a Cognizant Secretarial Officer and the Chief Health, Safety and Security Officer, or for NNSA sites by the NNSA Field Element Manager with the concurrence of the NNSA Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.	Models for dose evaluation calculations must be appropriate for their purpose. Dose evaluation models that are codified or approved for use by regulators of DOE or by DOE must be used where applicable. Alternatives to such codified or approved dose evaluation models to be used for demonstrating compliance with this Order must be approved by the Field Element Manager and, as determined necessary by the Field Element Manager, in consultation with their Cognizant Secretarial Officer and the Office of Health, Safety and Security.
8	4.f(2)	20 pCi (0.7 Bq) m <sup>-2</sup> sec <sup>-1</sup>	20 pCi (0.7 Bq)/m <sup>2</sup> -sec
9	4.g(4)(b)	50 pCi (2 Bq) per gram above background of settleable solids for beta-emitting radionuclides.	50 pCi (2 Bq) per gram above background of settleable solids for beta-gamma-emitting radionuclides.
9	4.g(5)(a)	The annual average concentration of a given radionuclide is greater than the DOE-approved <i>Derived Concentration Technical Standard</i> , DOE-STD-1196-2011, (DCS) value	The annual average concentration of a given radionuclide is greater than the DOE-approved derived concentration standard (DCS) value for water contained in the <i>Derived</i>

Page	Paragraph	Changed	To
		for water, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values,	<i>Concentration Technical Standard</i> , DOE-STD-1196-2011, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values,
9	4.g(7)	contamination limits	contaminant levels
11	4.h(1)	Management, Storage and Disposal of Radioactive Waste.	Management, Storage and Disposal of Radioactive Waste at DOE Sites.
14	Footnote 2	DOE O 430.1B Chg 1	DOE O 430.1B Chg 2
14	Footnote 2	DOE O 580.1 Chg 1	DOE O 580.1A
16-17	4.k(6)(a) Second sentence	Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive material but in which no residual radioactive material can be detected.	Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive material and in which the presence of residual radioactive material cannot be determined.
17	4.k(6)(b) <u>2</u>	DOE O 414.1C, <i>Quality Assurance</i> , dated 6-17-05	DOE O 414.1D, <i>Quality Assurance</i> , dated 4-25-11
21	4.k(6)(f) <u>2a</u>	DOE O 252.1, <i>Technical Standards Program</i> , dated 11-19-99	DOE O 252.1A, <i>Technical Standards Program</i> , dated 2-23-11
24	4.k(9)(b)	(See DOE O 226.1A).	(See DOE O 226.1B).
28	4.l(4)	DOE O 243.1, <i>Records Management Program</i> , dated 2-3-06.	DOE O 243.1A, <i>Records Management Program</i> , dated 11-7-2011.
28	4.l(5)(a)	Reporting requirements for this Order are contained in DOE M 231.1-2, <i>Occurrence Reporting and Processing of Operations Information</i> , dated 8-19-03, and DOE M 231.1-1A Chg 2, <i>Environment, Safety and Health Reporting Manual</i> , dated 6-12-07.	Reporting requirements for this Order are contained in DOE O 232.2, <i>Occurrence Reporting and Processing of Operations Information</i> , dated 8-30-11, and DOE O 231.1B, <i>Environment, Safety and Health Reporting</i> , dated 6-27-11.
28	4.l(6) Second sentence	The SI units, and becquerel (Bq), gray (GY), and sievert (Sv) may be provided parenthetically for reference with scientific standards.	The SI units, becquerel (Bq), gray (Gy), and sievert (Sv) may be provided parenthetically for reference with scientific standards.
30	5.c(2)	(See DOE O 470.2B, <i>Independent Oversight and Performance Assurance Program</i> , dated 10-31-02.)	(See DOE O 227.1, <i>Independent Oversight Program</i> , dated 8-30-11).
31	5.c(6)	Approves, or provides concurrence in Field Element Managers' approval of alternative dose	Consults in Field Element Managers' approval of alternative dose evaluation models, or for

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		evaluation models, or for NNSA sites, provides consultation to the NNSA Cognizant Secretarial Officer.	NNSA sites, provides consultation to the NNSA Cognizant Secretarial Officer.
31-37	References a-vv	A number of reference citations have been deleted/replaced or revised, and new references have been added.	<p>Deleted or replaced references for the following directives: DOE P 141.2; DOE M 231.1-1A; DOE M 231.1-2; DOE M 411.1-1C; DOE P 441.1; DOE O 450.1A; DOE P 450.2A; DOE M 450.1; DOE P 450.7; DOE O 470.2B.</p> <p>Updated references/ numbering in the following directives to read: DOE O 226.1B; DOE P 226.1B; DOE O 243.1A; DOE O 252.1A; DOE O 413.3B; DOE O 414.1D; DOE O 430.1B, Chg 2; DOE P 450.4A.</p> <p>Added new references: DOE O 227.1; DOE O 231.1B; DOE O 232.2, and technical references.</p> <p>Reference citations have been updated and re-numbered from a-vv to a-ss.</p>
37	8. <u>CONTACT</u>	<u>CONTACT</u> . Questions concerning this Order should be referred to the Office of Nuclear Safety, Quality Assurance and Environment at (202) 586-7870.	<u>CONTACT</u> . Questions concerning this Order should be referred to the Office of Environmental Protection, Sustainability Support and Corporate Safety Analysis at (202) 586-7870.
Att. 1 2	2.b(1)(b)	Comply with ALARA requirements in paragraph 2.d. of the Specific Requirements in this CRD.	Comply with As Low As Reasonably Achievable (ALARA) requirements in paragraph 2.d. of the Specific Requirements in this CRD.
Att.1 5	2.e(6)	Dose evaluation models that are codified or approved for use by DOE must be used. Alternative dose evaluation models, including those used by other regulatory agencies, national organizations or international organizations must be	Models for dose evaluation calculations must be appropriate for their purpose. Dose evaluation models that are codified or approved for use by regulators of DOE or by DOE must be used where applicable. Alternatives to such

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		approved for use by the Chief Health, Safety and Security Officer, or by the DOE Field Element Manager with the concurrence of a Cognizant Secretarial Officer and the Chief Health, Safety and Security Officer, or for NNSA sites by the NNSA Field Element Manager with the concurrence of the NNSA Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.	codified or approved dose evaluation models to be used for demonstrating compliance must be approved by the Field Element Manager.
Att. 1 7	2.f(2)	20 pCi (0.7 Bq) m <sup>-2</sup> sec <sup>-1</sup>	20 pCi (0.7 Bq)/m <sup>2</sup> -sec
Att.1 8	2.g(4)(b)	50 pCi (2 Bq) per gram above background of settleable solids for beta-emitting radionuclides.	50 pCi (2 Bq) per gram above background of settleable solids for beta-gamma-emitting radionuclides.
Att. 1 8	2.g(5)(a)	The annual average concentration of a given radionuclide is greater than the DOE-approved <i>Derived Concentration Technical Standard</i> , DOE-STD-1196-2011, (DCS) value for water, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values;	The annual average concentration of a given radionuclide is greater than the DOE-approved derived concentration standard (DCS) value for water contained in the <i>Derived Concentration Technical Standard</i> , DOE-STD-1196-2011, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values;
Att. 1 8	2.g(7)	contamination limits	contaminant levels
Att. 1 10	2.h First sentence	The contractor must establish and implement procedures and practices to ensure that management, storage and disposal of radioactive waste and spent nuclear fuel address the following elements:	The contractor must establish and implement procedures and practices to ensure that management, storage and disposal of radioactive waste and spent nuclear fuel on DOE sites address the following elements:
Att. 1 13	Footnote 4	DOE O 430.1B Chg 1	DOE O 430.1B Chg 2
Att.1 13	Footnote 4	DOE O 580.1 Chg 1	DOE O 580.1A
Att. 1 15	2.k(6)(a) Second Sentence	Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive	Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive

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		material but in which no residual radioactive material can be detected.	material and in which the presence of residual radioactive material cannot be determined.
Att. 1 16	2.k(6)(b) <u>2</u>	DOE O 414.1C, <i>Quality Assurance</i> , dated 6-17-05.	DOE O 414.1D, <i>Quality Assurance</i> , dated 4-25-11.
Att. 1 23	2.l(4)	Records must be retained until final disposition is authorized by DOE in accordance with the CRD to DOE O 243.1, <i>Records Management Program</i> , dated 2-3-06.	Records must be retained until final disposition is authorized by DOE.
Att. 1 23	2.l(5)(a)	Reporting requirements are contained in the CRDs to DOE M 231.1-2, <i>Occurrence Reporting and Processing of Operations Information</i> , dated 8-19-03, and DOE M 231.1-1A Chg 2, <i>Environment, Safety and Health Reporting Manual</i> , dated 6-12-07.	Reporting requirements are contained in the CRDs to DOE O 232.2, <i>Occurrence Reporting and Processing of Operations Information</i> , dated 8-30-11, and DOE O 231.1B, <i>Environment, Safety and Health Reporting</i> , dated 6-27-11.
Att. 1 24	2.l.(6) Second sentence	The SI units, and becquerel (Bq), gray (GY), and sievert (Sv) may be provided parenthetically for reference with scientific standards.	The SI units, becquerel (Bq), gray (Gy), and sievert (Sv) may be provided parenthetically for reference with scientific standards.
Att. 2 1	Definitions	<u>Actual or Likely Use Scenarios</u> — The reasonably anticipated future uses of land or property considering the history of use and implementable use restrictions, designations or controls; affected populations, or ecosystems, natural resources, or historic or cultural significance. For real property considerations also include Federal and State use designations; local zoning and future land use plans; and proximity to residences, commercial, industrial or unique cultural or historic areas.	<u>Actual or Likely Use Scenarios</u> — The current uses and reasonably anticipated uses in the foreseeable future of real and personal property considering the history of use; use restrictions, designations or controls; affected populations, ecosystems, or natural resources; and the property's historic or cultural significance. For real property considerations also include Federal and State use designations; local zoning and future land use plans; and proximity to residences, commercial or industrial areas, or areas of cultural or historic significance.
Att. 2	Definitions	<u>Clearance of Property</u> — The	<u>Clearance of Property</u> — The

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2		removal of property that contains residual radioactive material from DOE radiological control under 10 CFR Part 835 and DOE O 458.1.	removal of property that contains or may contain residual radioactive material from DOE radiological control under 10 CFR Part 835 and DOE O 458.1.
Att. 2 2	Definitions	<u>Derived Concentration Technical Standard (DCS)</u> — A DOE Technical Standard that documents the derived concentration value for a radionuclide in water that would result in a dose of 100 mrem in a year to a gender- and age- weighted reference person using DOE approved dose conversion factors and assuming continuous exposure.	<u>Derived Concentration Standard (DCS)</u> — A derived concentration value for a radionuclide in water that would result in a dose of 100 mrem in a year to a gender- and age- weighted reference person using DOE approved dose coefficients and assuming continuous exposure.
Att. 2 4	Definitions	<u>Measurement Quality Objectives (MQO)</u>	<u>Measurement Quality Objectives</u>

**ORDER**

**DOE O 458.1**

Approved: 02-11-2011  
Admin Chg 1: 03-08-2011  
Admin Chg 2: 06-06-2011  
Admin Chg 3: 1-15-2013

# **RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT**

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**U.S. DEPARTMENT OF ENERGY**  
Office of Health, Safety and Security





## **RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT**

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### 1. **PURPOSE.**

- a. To establish requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of the Department of Energy (DOE) pursuant to the Atomic Energy Act of 1954, as amended (AEA).
- b. The objectives of this Order are:
  - (1) To conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits established in this Order;
  - (2) To control the radiological clearance of DOE real and personal property;
  - (3) To ensure that potential radiation exposures to members of the public are as low as is reasonably achievable;
  - (4) To ensure that DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public; and
  - (5) To provide protection of the environment from the effects of radiation and radioactive material.

2. **CANCELLATION.** DOE Order 5400.5 *Radiation Protection of the Public and the Environment*, Chg 2, dated 1-7-93. Cancellation of a directive, does not, by itself, modify or otherwise affect any contractual or regulatory obligation to comply with the directive. Contractor Requirements Documents (CRDs) that have been incorporated into a contract remain in effect unless and until the contract is modified to either eliminate requirements that are no longer applicable or substitute a new set of requirements.

### 3. **APPLICABILITY.**

- a. **Departmental Applicability.**
  - (1) This Order applies to all Departmental elements that are responsible for, or provide support for, the management and operation of DOE sites conducting radiological activities or management of DOE radioactive material or property that can result in exposures of the public to radiation or radioactive material.
  - (2) The Administrator of the National Nuclear Security Administration (NNSA) must assure that NNSA employees and contractors comply with their respective responsibilities under this Directive. Nothing in this Order

will be construed to interfere with the NNSA Administrator's authority under section 3212(d) of Public Law (P.L.) 106-65 to establish Administration-specific policies, unless disapproved by the Secretary.

b. DOE Contractors.

- (1) Except for the equivalencies/exclusions in paragraph 3.c., the Contractor Requirements Document (CRD) sets forth requirements of this Order that will apply to contracts that include the CRD.
- (2) The CRD must be included in contracts under which the contractor manages or conducts radiological activities at DOE sites.

c. Equivalencies/Exemptions for DOE O 458.1. Equivalencies and Exemptions are granted consistent with the provisions of DOE O 251.1C, *Departmental Directives Program*, dated 1-15-09. Central Technical Authority (or designee) concurrence is required for both exemptions and equivalencies to this Order for nuclear facilities.

- (1) Equivalency. Activities regulated by the Nuclear Regulatory Commission (NRC) or regulated by an NRC Agreement State under NRC AEA delegated authorities.
- (2) Equivalency. In accordance with the responsibilities and authorities assigned by Executive Order 12344, codified at 50 USC sections 2406 and 2511, and to ensure consistency through the joint Navy/DOE Naval Nuclear Propulsion Program, the Deputy Administrator for Naval Reactors (Director) will implement and oversee requirements and practices pertaining to this Directive for activities under the Director's cognizance, as deemed appropriate.
- (3) Exemption. This Order does not apply to the Bonneville Power Administration (BPA), in accordance with Secretarial Delegation Order Number 00-033.00B to the BPA Administrator and Chief Executive Officer, dated 7-20-09.

4. REQUIREMENTS.

a. Environmental Radiological Protection Program.

- (1) DOE must ensure that:
  - (a) DOE or DOE contractors operating sites or implementing projects, involving radiological activities that can affect the public or environment, establish and maintain a program that complies with applicable requirements of this Order.

- (b) The program, which is the composite of plans, procedures, protocols and other documents describing the methods used to achieve compliance, must be tailored to the hazard or risk and particular radiological activities being conducted at the site and relevant requirements of this Order.
- (c) For any determination that a requirement of this Order is not relevant, the basis for that determination is appropriate to the hazard and adequately documented.
- (2) DOE must document directions to the contractor necessary to correct any potential inadequacies or inappropriate determinations of relevancy.
- (3) DOE must ensure that long-term stewardship and institutional controls for protection of the public and environment determined necessary to meet the requirements of this Order are adequately documented and implemented as long as is necessary.

b. Public Dose Limit.

- (1) DOE radiological activities, including remedial actions and activities using Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), must be conducted so that exposure of members of the public to ionizing radiation will:
  - (a) Not cause a total effective dose (TED) exceeding 100 mrem (1mSv) in a year, an equivalent dose to the lens of the eye exceeding 1500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5000 mrem (50 mSv) in a year, from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose excepting:
    - 1 Dose from radon and its decay products in air [Radon is regulated separately e.g., under Paragraphs 4.f. and 4.h.(1)(d) in this Order and under Title 40 Code of Federal Regulations (CFR) Part 61, Subparts Q and T];
    - 2 Dose received by patients from medical sources of radiation, and by volunteers in medical research programs;
    - 3 Dose from background radiation;
    - 4 Dose from occupational exposure under NRC or Agreement State license or to general employees regulated under 10 CFR Part 835, and
  - (b) Comply with As Low As Reasonably Achievable (ALARA) requirements in paragraph 4.d. of this Order.

- (2) The public dose limit applies to members of the public located off DOE sites and on DOE sites outside of controlled areas, and to those exposed to residual radioactive material subsequent to any remedial action or clearance of property.

c. Temporary Dose Limits.

- (1) Special circumstances could affect a DOE radiological activity in such a manner that the potential dose to a member of the public could exceed a TED of 100 mrem (1 mSv) in a year.
- (2) The Field Element Manager<sup>1</sup> may request specific authorization for a temporary public dose limit higher than 100 mrem (1 mSv) in a year from a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer. This request must include documentation that justifies the need for the increase, the alternatives considered, and the application of the ALARA process.
- (3) A Cognizant Secretarial Officer must limit approval of such requests to no more than 500 mrem (5 mSv) TED, provided that the average TED over any 5 contiguous years does not exceed 100 mrem per year.
- (4) The specific exposure pathways excepted in paragraphs 4.b.(1)(a)1-4 are also excepted for temporary dose limits.

d. As Low As Reasonably Achievable (ALARA).

- (1) A documented ALARA process must be implemented to optimize control and management of radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable. The process must be applied to the design or modification of facilities and conduct of activities that expose the public or the environment to radiation or radioactive material.
- (2) The ALARA process must: consider DOE sources, modes of exposure, and all pathways which potentially could result in the release of radioactive materials into the environment, or exposure to the public; use a graded approach; and to the extent practical and when appropriate, be coordinated with the 10 CFR Part 835 ALARA process.
- (3) The ALARA process must be applied to all routine radiological activities. Though not applicable to non-routine radiological events (for example, accidental, unplanned, or inadvertent releases or exposures), the ALARA

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<sup>1</sup> Includes operation office, site office, field office, area office, project office and service center.

process is applicable during recovery and remediation activities associated with a non-routine event.

e. Demonstrating Compliance with the Public Dose Limit.

(1) Dose evaluations to demonstrate compliance with the public dose limit in paragraph 4.b.(1) of this Order and to assess collective dose must include the following:

(a) The TED to members of the public from exposure to radiation, airborne effluents, and liquid effluents, of DOE origin.

1 Compliance may be demonstrated by calculating dose to the representative person or to the maximally exposed individual (MEI).

2 Determination of the representative person or the MEI must include members of the public both on DOE sites outside of controlled areas and off DOE sites.

3 If it is suspected that any of the dose limits specified in paragraph 4.b.(1)(a) of this Order may be exceeded or the estimated TED for members of the public exceeds 25 mrem (0.25 mSv) in a year, then dose to the lens of the eye, skin and extremities must be evaluated.

(b) Analytical models that consider likely exposure pathways, such as:

1 Direct external radiation from sources located on-site;

2 External radiation from airborne radioactive material;

3 External radiation from radioactive material deposited on surfaces off-site;

4 Internal radiation from inhaled airborne radioactive material;

5 Internal radiation from radioactive material ingested with water, and with food from terrestrial crops or animal products (e.g., meat, eggs, milk);

6 Internal radiation from radioactive material ingested with aquatic food products such as fish, shellfish, crustaceans (e.g., crayfish, shrimp, crab, lobsters), and aquatic plants and algae;

- 7 External or internal radiation due to residual radioactive material on, or in, cleared real property; and
  - 8 Any other pathway unique to the DOE site or activity.
- (c) The dose to members of the public from DOE-related exposure sources only, if the projected DOE-related dose to the representative person or MEI is 25 mrem (0.25mSv) in a year or less. If the DOE-related dose is greater than 25 mrem in a year, the dose to members of the public must include both major non-DOE sources of exposure (excluding dose from radon and its decay products in air, background radiation dose, occupational doses and doses due to medical exposures) and dose from DOE-related sources.
- (d) Collective dose for members of the public resulting from radiation emitted and radioactive materials released from DOE radiological activities only (not including radon and its decay products). Collective dose for members of the public must be representative of the total dose and of adequate quality for supported comparisons, trending or decisions. Consistent with the graded approach, collective dose estimates may be truncated by distance (e.g., 50 miles) or individual dose level (e.g., 10 microrem) when integration of doses beyond such thresholds does not significantly affect data quality objectives. Where it is of concern, collective dose for members of the public resulting from radon and its decay products released by DOE radiological activities needs to be calculated separately from other radionuclides.
- (2) The estimated individual dose to the MEI or representative person that is representative of the persons or group likely to receive the most dose and is based on pathway and exposure parameters that are not likely to underestimate or substantially overestimate the dose, and, the collective dose (population dose) that is a realistic as practicable estimate of the sum of the doses to all members of the actual exposed population.
- (3) Site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of DOE radiological activities, land use, food supplies, and exposure pathway information must be updated, as necessary, to document significant changes that could affect dose evaluations.
- (4) Values of assumed default or site-specific parameters used in calculations must be identified and included with the documentation of the calculations.

- (5) Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.
- (6) Models for dose evaluation calculations must be appropriate for their purpose. Dose evaluation models that are codified or approved for use by regulators of DOE or by DOE must be used where applicable. Alternatives to such codified or approved dose evaluation models to be used for demonstrating compliance with this Order must be approved by the Field Element Manager and, as determined necessary by the Field Element Manager, in consultation with their Cognizant Secretarial Officer and the Office of Health, Safety and Security.
- (7) DOE-approved dose coefficients must be used to evaluate doses resulting from DOE radiological activities. Use of alternative dose coefficients must be approved by the Chief Health, Safety and Security Officer or by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.
- (8) Doses to members of the public from airborne effluents must be evaluated with the CAP-88 model or another EPA-approved model or method to demonstrate compliance with applicable subparts of 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*.
- (9) Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate the dispersal pattern in the environs, characterize the pathway(s) of exposure to members of the public and estimate the doses to individuals and populations in the vicinity of the site or operation commensurate with the nature of the DOE radiological activities and the risk to the public and the environment. Radiological monitoring must be integrated with the general environmental and effluent monitoring. Environmental monitoring must include, but is not limited to:
  - (a) Effluent Monitoring
  - (b) Environmental Surveillance
  - (c) Meteorological Monitoring. Meteorological monitoring must be commensurate with the level of site radiological activities, the site topographical characteristics, and the distance to critical receptors. The scope must be sufficient to characterize atmospheric dispersion and model the dose to members of the public over distances commensurate with the magnitude of potential source terms and possible pathways to the atmosphere.

- (d) Pre-operational Monitoring. Prior to the startup of a new site, facility or process with the potential to expose the public or environment to radiation or radioactive material, it is necessary to ensure that adequate knowledge exists to understand: 1) radiological background; 2) pertinent environmental and ecological parameters; and 3) potential pathways for human exposures or ecological/natural resource impacts either from existing data or documents (for example, NEPA evaluations or existing monitoring and surveillance programs, etc.) or from the conduct of a pre-operational study initiated at least one year prior to startup of a new operation.
- (10) Site-specific environmental monitoring criteria must be established to ensure that representative measurements of quantities and concentrations of radiological contaminants are conducted and that the effects from DOE radiological activities on members of the public and the environment are monitored sufficiently to demonstrate compliance with this Order.
- f. Airborne Radioactive Effluents. Radiological activities must be conducted in a manner such that the release of radioactive material to the atmosphere will:
  - (1) Be evaluated using the ALARA process established in paragraph 4.d. of this Order;
  - (2) Not cause radon-222 flux rates to exceed 20 pCi (0.7 Bq)/m<sup>2</sup>-sec averaged over the surface area overlaying waste, including the covering or other confinement structures, wherever radium-226 wastes are accepted for storage or disposal (See 40 CFR Part 61, Subparts Q and T);
  - (3) Meet compliance agreements under 40 CFR Part 61, Subparts H, Q, and T;
  - (4) Not cause the radon-220 and radon-222 decay product concentration, including background, to exceed 0.03 WL in buildings that are being released from DOE control. Further, a reasonable effort must be made to meet a 0.02WL generic guideline for annual average radon-220 and radon-222 decay product concentration, including background, in such buildings; and
  - (5) Not exceed 3 pCi/L annual average radon-220 and radon-222 concentration, not including background, at the site boundary if DOE activities release radon-220 and radon-222 or their decay products.
- g. Control and Management of Radionuclides from DOE Activities in Liquid Discharges. Operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities must:



- (1) Characterize planned and unplanned releases of liquids containing radionuclides from DOE activities, consistent with the potential for on- and off-site impacts, and provide an assessment of radiological consequences as necessary to demonstrate compliance with the requirements of this Order.
- (2) Comply with the ALARA process requirements in paragraph 4.d. of this Order.
- (3) Conduct activities to ensure that liquid releases containing radionuclides from DOE activities are managed in a manner that protects ground water resources now and in the future, based on use and value considerations.
- (4) Conduct activities to ensure that liquid discharges containing radionuclides from DOE activities do not exceed an annual average (at the point of discharge) of either of the following:
  - (a) 5 pCi (0.2 Bq) per gram above background of settleable solids for alpha-emitting radionuclides.
  - (b) 50 pCi (2 Bq) per gram above background of settleable solids for beta-gamma-emitting radionuclides.
- (5) Except for tritium and sanitary sewers, apply Best Available Technology (BAT) if at the point of discharge:
  - (a) The annual average concentration of a given radionuclide is greater than the DOE-approved derived concentration standard (DCS) value for water contained in the *Derived Concentration Technical Standard*, DOE-STD-1196-2011, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values,
  - (b) The discharge contributes greater than 10 mrem (0.1 mSv) annual TED to members of the public, or
  - (c) The collective dose from all DOE sources is greater than 100 person-rem (1 person-Sv) and the liquid discharge contributes 50 percent or more of this collective dose.
- (6) Control releases of tritium in a manner that has been established by application of the ALARA process.
- (7) Conduct radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contaminant levels in 40 CFR Part 141, *National Primary Drinking Water Regulations*.

- (8) Control discharges into sanitary sewers in accordance with the following requirements:
- (a) Except for excreta from patients and medical research volunteers treated with radioactive material, discharges of liquids containing radionuclides from DOE activities into non-Federally owned sanitary sewers are prohibited unless:
- 1 The material is readily soluble (or readily dispersed biological materials) in water;
  - 2 Such discharges comply with ALARA process requirements;
  - 3 BAT is applied to discharges of liquid releases containing radionuclides from DOE activities if the average monthly concentration level at the point of discharge into the sanitary sewer is greater than five times the DOE-approved DCS values for ingestion except for tritium which is addressed under paragraph 4.g.(6);
  - 4 Releases do not result in an annual discharge (above background) into sanitary sewers in excess of 5 Ci (185 GBq) of tritium; 1 Ci (37 GBq) carbon-14 or 1 Ci (37 GBq) of all other radionuclides combined;
  - 5 DOE operations are conducted to minimize long-term buildup of radionuclides in the sewage treatment plants that may create handling and disposal issues or interfere with plant operations;
  - 6 Operators of sewage treatment plants are informed of DOE practices and processes to radiologically control and clear discharges, and are notified of unusual discharges to sanitary sewers;
  - 7 The DOE Field Element Manager provides a report that describes and summarizes such discharges to sanitary sewers to appropriate local officials at least annually; and
  - 8 Existing agreements, contracts, statements of understanding or other formal arrangements with other agencies concerning the discharge of liquids containing radionuclides from DOE activities to sanitary sewers are not violated.

- (b) DOE facilities discharging liquids containing radionuclides from DOE activities into sanitary sewer systems owned by the Federal government are not subject to the requirements in paragraph 4.g.(8)(a) of this Order if:
    - 1 The system provides treatment in accordance with the environmental radiological protection program and
    - 2 Sludge from the system is disposed of in accordance with this Order and applicable Federal, State, and municipal regulations.
  - (9) Prohibit the use of soil columns.
  - (10) Manage the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and ground water and prevent the creation of future cleanup sites.
  - (11) Ensure that storm water runoff containing radionuclides from DOE activities is considered, as appropriate, as a pathway of exposure that has the potential for on- and off-site impacts. Using a graded approach, the receiving ecosystem including, but not limited to, wetlands, floodplains, streams, ponds, basins and lakes must be monitored to evaluate human or ecological impacts when warranted based on site specific risk.
- h. Radioactive Waste and Spent Nuclear Fuel.
- (1) Management, Storage and Disposal of Radioactive Waste at DOE Sites.
    - (a) Radiological activities must be conducted in a manner such that radiation exposure to members of the public from management and storage of radioactive waste complies with ALARA process requirements and does not result in a TED greater than 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.
    - (b) DOE management of spent nuclear fuel, and high-level and transuranic wastes at a disposal facility which is not regulated by the NRC must comply with the requirements of this Order and 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes.*
    - (c) Management, storage and disposal of low-level radioactive waste must be conducted in a manner such that exposure to members of the public to radiation from radioactive waste complies with

ALARA process requirements, and does not exceed a TED of 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.

- (d) Management, storage and disposal of 11e.(2) byproduct material, as defined in Section 11e.(2) of the AEA and other wastes containing uranium and thorium and their decay products which are not subject to the requirements of 40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, are not at facilities licensed by the NRC, or are not disposed of at DOE low-level waste disposal facilities, must be in accordance with the requirements of paragraph 4.h.(1) of this Order and DOE-approved plans.

1 Disposal facilities for uranium and thorium wastes must be designed to:

- a Remain effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years and
- b Provide reasonable assurance that releases of radon-222 to the atmosphere will not: (1) exceed an average release rate of 20 picocuries per square meter per second or (2) increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

2 For wastes containing significant concentrations of radium and thorium, special considerations must be given to measures to prevent inadvertent human intrusion.

3 Before any potentially biodegradable contaminated wastes are placed in a disposal facility, such wastes must be conditioned so that the generation and escape of biogenic gases will not cause the emission or dose limits in paragraph 4.h.(1) of this Order to be exceeded and that bio-degradation within the facility will not result in premature structural failure.

4 All plans for the management and disposal of these wastes must provide for institutional controls and long-term stewardship of the disposal facility necessary to ensure continued performance.

- (e) AEA Section 11e.(3) and 11e.(4) Byproduct Material. Discrete sources of radium-226, accelerator produced radioactive material, or naturally-occurring radioactive material (NORM) that pose a threat similar to discrete sources of radium-226, which are defined as Section 11e.(3) or 11e.(4) byproduct material in the AEA, must be managed as high-level waste, low-level waste or 11e.(2) material as appropriate under DOE AEA authorities and in compliance with the requirements of this Order and DOE O 435.1 Chg 1.

i. Protection of Drinking Water and Ground Water.

- (1) DOE sites must provide a level of radiation protection for persons consuming water from a drinking water system operated by DOE, directly or through a DOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR Part 141, *National Primary Drinking Water Regulations* (that is, not exceed the radionuclide maximum contaminant levels (MCLs)).
- (2) Ground water must be protected from radiological contamination to ensure compliance with dose limits in the Order and consistent with ALARA process requirements. To this end, DOE must ensure that:
  - (a) Baseline conditions of the ground water quantity and quality are documented;
  - (b) Possible sources of, and potential for, radiological contamination are identified and assessed;
  - (c) Strategies to control radiological contamination are documented and implemented;
  - (d) Monitoring methodologies are documented and implemented; and
  - (e) Ground water monitoring activities are integrated with other environmental monitoring activities.

j. Protection of Biota.

- (1) Radiological activities that have the potential to impact the environment must be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations.
- (2) When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota then evaluations must be done

to demonstrate compliance with paragraph 4.j.(1) of this Order in one or more of the following ways:

- (a) Use DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.
  - (b) Use an alternative approach to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2002, Table 2.2.
  - (c) Use an ecological risk assessment to demonstrate that radiation and radioactive material released from DOE operations will not adversely affect populations within the ecosystem.
- k. Release and Clearance of Property. Release or clearance of property with the potential to contain residual radioactive material must be conducted in accordance with the requirements in paragraph 4.k. of this Order.<sup>2</sup>
- (1) Property control and clearance processes must be developed and implemented in accordance with the dose limits in paragraph 4.b. under any plausible use of the property and the ALARA process requirements in paragraph 4.d. of this Order must be met before property is cleared.
  - (2) Dose Constraints. Unless alternative dose constraints are approved by issuance of a directive or memorandum by the Chief Health, Safety and Security Officer or for NNSA, the Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer, the following dose constraints for DOE residual radioactive material must be applied to each specific clearance of property for any actual or likely future use of the property:
    - (a) Real property – a TED of 25 mrem (0.25 mSv) above background in any calendar year;
    - (b) Personal property - a TED of 1 mrem (0.01 mSv) above background in any calendar year.
  - (3) Residual Radioactive Material. Property potentially containing residual radioactive material must not be cleared from DOE control unless either:

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<sup>2</sup> In addition to paragraph 4.k of this Order, the following may have applicable requirements regarding clearance of property: 41 CFR Chapter 109, *Department of Energy Property Management Regulations*; 10 CFR Part 770, *Transfer of Real Property at Defense Nuclear Facilities for Economic Development*; DOE O 430.1B Chg 2, *Real Property Asset Management*; and DOE O 580.1A, *Department of Energy Personal Property Management Program*.

- (a) The property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or
  - (b) The property is evaluated and appropriately monitored or surveyed to determine:
    - 1 The types and quantities of residual radioactive material within the property;
    - 2 The quantities of removable and total residual radioactive material on property surfaces (including residual radioactive material present on and under any coating);
    - 3 That for property with potentially contaminated surfaces that are difficult to access for radiological monitoring or surveys, an evaluation of residual radioactive material on such surfaces is performed which is:
      - a Based on process and historical knowledge meeting the requirements of paragraph 4.k.(5) of this Order and monitoring and or surveys, to the extent feasible and
      - b Sufficient to demonstrate that applicable specific or pre-approved DOE Authorized Limits will not be exceeded; and
    - 4 That any residual radioactive material within or on the property is in compliance with applicable specific or pre-approved DOE Authorized Limits.
- (4) Evaluation of the Need for Maintaining Institutional Controls for Real Property. Real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls or impacting long-term stewardship of adjacent DOE real property. In situations where transfer of the real property to other use would impact long-term radiological protection of adjacent DOE properties, it must be demonstrated that the impact of the property clearance would not result in noncompliance for the adjacent property with the requirements of this Order, DOE O 435.1 Chg 1, or other applicable statutes, regulations or orders.
- (5) Process and Historical Knowledge. Organizations responsible for radiological clearance of property, when they rely in part, on process knowledge as a basis for clearance decisions, must establish a documented evaluation process, using a graded approach, for applying process and

historical knowledge to determine if property potentially contains residual radioactive material.

- (a) This process must include procedures for evaluating operational records and operating history, including the use of any radioactive materials or radiation generating devices.
  - (b) For real property, this process must address each specific property individually. If several parcels of land are contiguous, or if several structures are located in the same area and have a common operational history, a single evaluation for all of the properties is acceptable.
  - (c) If available process and historical knowledge cannot demonstrate that property does not contain residual radioactive materials, radiological monitoring or surveys must be conducted to supplement process and historical knowledge evaluations.
  - (d) If not supplemented by radiological surveys, process and historical knowledge evaluations must be adequate to determine:
    - 1 Whether the property has ever been used for radiological activities or in areas that could have resulted in the presence of residual radioactive material within or on the property or
    - 2 Whether property formerly containing residual radioactive material has been decontaminated and demonstrated to meet DOE Authorized Limits, and has not been used in a manner or in areas that could have resulted in the re-contamination of the property.
  - (e) For property that is determined to potentially contain residual radioactive material under paragraph 4.k.(5)(d)1, or determined to be re-contaminated under paragraph 4.k.(5)(d)2, the process and historical knowledge evaluation must also include an assessment of the types and quantities of residual radioactive material and the sources and pathways by which the property became contaminated.
- (6) Authorized Limits.
- (a) Authorized Limits must be established and approved for the clearance of any property with residual radioactive material to provide reasonable assurance that the requirements of paragraphs 4.k.(1) and 4.k.(2) are met. Authorized Limits may be applied to property for which process knowledge cannot establish the absence



of residual radioactive material and in which the presence of residual radioactive material cannot be determined.

(b) Authorized Limits must:

- 1 Be developed in accordance with the ALARA requirements in paragraph 4.d. of this Order;
- 2 Be based on the applicable dose constraint, supported by a complete exposure pathway analysis using appropriate methodologies, techniques, parameters and models (such as the RESRAD family of codes) that meet DOE quality assurance requirements under DOE O 414.1D, *Quality Assurance*, dated 4-25-11;
- 3 Be expressed in terms of concentration of radioactivity per unit surface area (e.g., dpm per 100 cm<sup>2</sup>), radioactivity per unit mass (e.g., pCi per gram) or volume (e.g., pCi per ml), total radioactivity, or DOE controls and restrictions, if applicable;
- 4 Explicitly state any restrictions or conditions on future use of the property necessary to ensure the basic dose limit and applicable dose constraint are not exceeded;
- 5 Include written notification of applicable Federal, State, or local regulatory agencies, or Tribal governments;
- 6 Be approved in accordance with paragraph 4.k.(6)(d); and
- 7 In addition to paragraphs 4.k.(6)(b)1-6, for clearance of personal property only:
  - a Be based on expected annual quantity of property to be cleared or
  - b Be based on expected total amount of property cleared over the life of the project for specific remedial action or decontamination and decommissioning projects and
  - c Prior to clearance of metals, the Field Element Manager must determine that there is no practical internal DOE opportunity for reuse or recycle of the material or equipment.

(c) Applications for DOE approval of Authorized Limits must contain the following:

- 1 A description of the property.
  - 2 Specific limits proposed for each radionuclide or group of radionuclides and/or external radiation exposure, surrogate metrics, or conditions used to limit radionuclides.
  - 3 Potential collective dose to the exposed population and the potential dose to a member of the public most likely to receive the highest dose for both: actual or likely future use, and plausible future use of the property.
  - 4 ALARA assessments conducted under paragraph 4.d. of this Order for the proposed clearance action to include, at a minimum, the effects of:
    - a Implementing the proposed Authorized Limits;
    - b Implementing alternative levels of residual radioactive material instead of the proposed Authorized Limits;
    - c Not implementing the proposed Authorized Limits, i.e., not proceeding with the proposed clearance action.
  - 5 A description of the procedures and radiological monitoring or surveys to be used to demonstrate compliance with proposed limits.
  - 6 Identification of any restrictions or conditions on the future use of the property upon which the proposed limits are based, and the means by which the restrictions or conditions will be implemented and maintained.
  - 7 Evidence of notification of applicable Federal, State or local regulatory agencies or Tribal governments.
  - 8 An estimated date for when the property will be cleared and an estimate of when the property will be released from DOE control.<sup>3</sup>
- (d) DOE Approval of Authorized Limits. All Authorized Limits must be approved in writing. The use of pre-approved Authorized Limits

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<sup>3</sup> This information is needed to support the DOE expectation stated at 72 FR 31904, 31906 (10 CFR Part 835, June 8, 2007) that the material, equipment, or real property to which the 10 CFR Part 835.1(b)(6) exclusion is applied will be released from DOE control according to a specified time interval.

are approved by the Field Element Manager under paragraph 4.k.(6)(f). Otherwise:

- 1 Authorized Limits for real property require Field Element Manager approval in consultation with the Cognizant Secretarial Officer.
- 2 The Field Element Manager approves Authorized Limits for personal property (including any restrictions or conditions on future use of the personal property) under the following conditions:
  - a Clearance of the property must not cause a TED to a member of the public in excess of 1 mrem (0.01 mSv) in any year or a public collective dose of more than 10 person-rem (0.1 person-Sv) in any year due to residual radioactive material for any actual or likely future use of the property;
  - b Documentation supporting the Authorized Limits is provided to the responsible Cognizant Secretarial Officer and the Chief Health, Safety and Security Officer at least 45 working days prior to the intended implementation date of the Authorized Limits; and
  - c The Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer does not notify the Field Element Manager within 30 working days of receipt of application that the documentation is incomplete or that the Authorized Limits are not acceptable.

Otherwise; Authorized Limits for personal property must be approved by the Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.

- 3 Authorized Limits for property that has not been released from DOE control must meet the criteria in paragraphs 4.k.(6)(a) through (d) of this Order and be approved by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer if such property is to be excluded from the provisions of 10 CFR Part 835.

- (e) Revision of Authorized Limits. If established Authorized Limits are found to be not protective, appropriate or practical to apply for a specific type or portion of property, further clearance for that specific type or portion of property must not proceed without revised Authorized Limits.
- 1 An application for revised Authorized Limits must be submitted in accordance with the requirements in paragraphs 4.k.(6)(a) through (d) of this Order.
  - 2 Approval of revised Authorized Limits must be provided in accordance with the requirements in paragraph 4.k.(6)(d) of this Order.
  - 3 In addition to the requirements of applicable paragraphs of 4.k.(6) of this Order, requests for approval of revised Authorized Limits must include a justification for the need for the revised Authorized Limits. Justifications for revised Authorized Limits must be based upon one of the following:
    - a Complying with existing Authorized Limits would pose a clear and present risk of injury to general employees or members of the public; or
    - b Complying with existing Authorized Limits would produce environmental harm (e.g., destruction of artifacts, ecological damage, loss of cultural assets) that is clearly excessive compared to the potential health benefits to persons exposed to affected properties; or
    - c Complying with existing Authorized Limits is unreasonably costly relative to long-term benefits and where the residual radioactive material does not pose a clear present or future potential of exceeding the public dose limit of paragraph 4.b.(1) of this Order; or
    - d Portions of the project or activity for which the scenarios or assumptions used to establish the existing Authorized Limits are overly conservative, or where more appropriate scenarios or assumptions indicate that other limits are applicable or

appropriate for protection of the public and the environment; or

- e New information which indicates the existing Authorized Limits are not sufficient to meet the protective requirements of this Order.

(f) Pre-Approved Authorized Limits.

1 The following values have been pre-approved by DOE for use as Authorized Limits, and may be used as specified below instead of developing and approving specific Authorized Limits.

- a For radium-226 and radium-228 in soil - 5 pCi/gram (0.2 Bq/gram) in excess of background levels, averaged over 100 m<sup>2</sup>, in the first 15 cm depth of the surface layer of soil; and 15 pCi/gram (0.56 Bq/gram) in excess of background levels, averaged over any subsequent 15 cm subsurface layer of soil plus an ALARA assessment. If both thorium-230 and radium-226 or both thorium-232 and radium-228 are present and not in secular equilibrium, the appropriate pre-approved limit must be applied to the radionuclide with the higher concentration.

- b Previously approved guidelines and limits (such as the surface activity guidelines) may continue to be applied and used as Pre-Approved Authorized Limits until they are replaced or revised by Pre-Approved Authorized Limits issued under this Order.

2 Other Pre-Approved Authorized Limits must be approved by the Chief Health, Safety and Security Officer or the responsible Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.

- a The approvals may be made through a DOE memorandum but must be included in a DOE directive issued under DOE O 251.1C or a Technical Standard under DOE O 252.1A, *Technical Standards Program*, dated 2-23-11, within eighteen months of issuance.

- b Pre-Approved Authorized Limits must provide reasonable expectation that their implementation will comply with the requirements in paragraphs 4.k.(1) and 4.k.(2) of this Order.
    - c The scope of applicability (e.g., property, activities, or radionuclides) and conditions of, or restrictions on, their use must be documented.
  - 3 Pre-Approved Authorized Limits may be used for any radiological activity instead of developing specific Authorized Limits if their use is documented in the environmental radiological protection program and the specific application of the Authorized Limits is approved by the responsible Field Element Manager.
- (g) Documentation of Approved Authorized Limits. Approved Authorized Limits and approved revised Authorized Limits and supporting documentation must be made available to the public.
- (7) Clearance of Environmental Restoration, Deactivation and Decommissioning, and Other Cleanup Materials.
  - (a) Clearance of property with residual radioactive material from environmental restoration activities, including deactivation and decommissioning, must meet the requirements of this Order. Environmental restoration activities using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process may demonstrate compliance with the requirements of this Order (including public dose assessments, ALARA analysis, and consideration of scenarios) using documentation from the CERCLA process and any necessary supplemental information.
  - (b) For the purpose of clearance of real or personal property, approved CERCLA remediation criteria may be considered equivalent to Authorized Limits if the appropriate Field Element Manager has determined that the criteria meet the requirements in this Order for Authorized Limits, and provided that the use of the criteria as DOE Authorized Limits is documented and approved as would be an Authorized Limit. Compliance with all requirements of this Order not met through the CERCLA process must also be demonstrated.
  - (c) Field Elements performing environmental restoration activities involving clearance of real or personal property with residual radioactive material under CERCLA that use the CERCLA analysis and documentation in lieu of DOE O 458.1-specific

analysis and documentation to demonstrate compliance with this Order must:

- 1 Submit certification to a Cognizant Secretarial Officer that compliance with the requirements of this Order for clearance of property has been met using documentation from the CERCLA process and
- 2 Submit the relevant CERCLA documentation and any additional information necessary to demonstrate that the requirements for Authorized Limits have been met to a Cognizant Secretarial Officer and provide a copy to the Chief Health, Safety and Security Officer.

(8) Radiological Monitoring or Surveys.

(a) All radiological monitoring or surveys performed in support of clearance of property must:

- 1 Use methodologies sufficient to meet measurement objectives such as those in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, the *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)* or other methodologies approved by DOE;
- 2 Meet Measurement Quality Objectives;
- 3 Use DOE-approved sampling and analysis techniques, if applicable; and
- 4 Include an evaluation of non-uniformly distributed residual radioactive material, if applicable.

(b) Instrumentation used for radiological monitoring or surveys must be capable of detecting and quantifying residual radioactive material consistent with the applicable Authorized Limits, and be:

- 1 Periodically maintained and calibrated on an established frequency;
- 2 Appropriate for the type(s), levels, and energies of the radiation(s) encountered; and
- 3 Appropriate for existing environmental conditions and routinely tested for operability.

- (9) Documentation and Verification.
- (a) DOE elements responsible for radiological clearance of property must ensure that final radiological monitoring or surveys are conducted and that documentation is prepared that shows that the clearance meets applicable DOE Authorized Limits, or other applicable requirements including associated restrictions or institutional controls (See DOE P 454.1).
  - (b) DOE Field Element Managers responsible for oversight of clearance processes must implement oversight duties to verify that the contractor assurance program is ensuring that the applicable radiological clearance requirements have been met. DOE must determine the type and scope of oversight activities necessary to independently verify compliance. Such oversight must use a graded approach commensurate with the Department's requirements to implement DOE oversight functions (See DOE O 226.1B).
    - 1 The graded approach to the independent verification activities must be commensurate with the scope, complexity, and risk associated with the clearance action. The oversight must, at a minimum, ensure procedures, instruments, data and analyses, and documentation used for the clearance are adequate to comply with the requirements of this Order.
    - 2 Oversight for personal property releases will be graded at the discretion of DOE to include formal assessments, if necessary, but at a minimum must include operational awareness of radiological monitoring and survey instrumentation, radiological survey procedures, recordkeeping, methodologies, and techniques used for the clearance of such property to ensure their adequacy. If deemed appropriate by the Field Element Manager, such as in cases of high technical complexity or poor historical performance, a more formal independent verification process (e.g., peer review, third party support in review of clearance processes or independent audit or sampling) may be instituted.
    - 3 The independent verification activities required for the clearance of all real property must, at a minimum, include review of the radiological characterization report or data, but, as appropriate, may include independent surveys or sample analysis to verify compliance. If the real property is to be transferred to the public, or managed by another



agency/entity other than DOE or a new facility constructed, an independent verification plan will be prepared and independent verification surveys and sample analysis will be conducted to verify compliance, unless determined to be unneeded by DOE because, for example, the transferred property will be under a license.

4 Independent verification must be performed by DOE personnel not directly involved in the specific clearance action or by a contractor who is independent of the contractor conducting clearance activities. The personnel performing independent verification activities must:

- a Report directly to DOE,
- b Have sufficient authority and freedom to report unresolved issues to the Field Element Manager, and
- c Be qualified or have sufficient knowledge and experience to oversee radiological clearance activities.

(10) Public Notification of Clearance of Property.

- (a) Field Element Managers must, as appropriate, incorporate information on site clearance policies and protocols, process knowledge decisions, approved Authorized Limits, any approved revised Authorized Limits, use of pre-approved Authorized Limits, and property control and clearance programs into effective site public notification and communications programs.
- (b) Information on approved Authorized Limits, any approved revised Authorized Limits, use of pre-approved Authorized Limits, results of radiological monitoring and surveys of cleared property with type and quantity of property cleared, and independent verification results must be summarized in the Annual Site Environmental Report.
- (c) The responsible field element must make documentation on clearance of property available to the public and to the property owner or recipient as appropriate.

(11) Final Clearance Documentation. Clearance of property must be documented. The contents of the documentation or the mechanism for documenting information may be tailored to the need, situation, and type of property being cleared. For ongoing, routine clearances, e.g., clearance

of personal property from controlled areas, such documentation may be based on the general process(es) rather than each specific clearance. In general, the documentation must describe the clearance process(es) and the property being cleared.

- (a) The documentation must serve to demonstrate requirements have been met, show criteria used for clearance, identify the property's destination or disposition, as appropriate, and provide additional confidence to DOE and assurance to other interested parties that the public and the environment are being protected. The documentation must indicate any Authorized Limits, including any revised or pre-approved Authorized Limits used for the clearance, and include information and data supporting the clearance of property such as radiological certification and independent verification results and summarize the annual quantities cleared.
- (b) Field Element Managers or their designees must ensure in the preparation and maintenance of documentation that property being sold or otherwise cleared from DOE radiological control:
  - 1 Meets all DOE radiological protection requirements,
  - 2 Is not required to be controlled for national security reasons, and
  - 3 Meets DOE property control requirements.

1. Records, Retention and Reporting Requirements.

- (1) Records must be maintained to document compliance with the requirements of this Order.
- (2) Required records include the following:
  - (a) Information and data necessary to identify and characterize releases of radioactive material to the environment, their fate in the environment, and their probable impact on radiation dose to members of the public, and any impacts on ecological systems.
  - (b) Documentation of individual and collective dose to members of the public due to radiological activities. This includes documentation of site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of the radiological activity and assumed default values or site-specific parameters used in calculations.
  - (c) Requests for specific authorization for temporary public dose limits, and subsequent approvals and other related actions.

- (d) Identification of radiological activities subject to environmental radiological protection program requirements, and descriptions of the measures to be used in implementing these requirements.
- (e) Documentation of actions taken to implement the ALARA process identified in paragraph 4.d. of this Order.
- (f) Documentation of actions taken to demonstrate compliance with the public dose limit [See paragraph 4.e.(1) of this Order].
- (g) Documentation of actions taken to implement the BAT selection process in regulating liquid discharges, including documentation of analyses and factors considered to be important, including alternative processes, for the BAT selection process.
- (h) Effluent monitoring and environmental surveillance information and data, including:
  - 1 Results of effluent monitoring for determining sources of radiation and radioactive material that provide direct exposure to members of the public and releases of radioactive material in liquid or airborne effluent;
  - 2 Results of surveys for radiation and radioactive material in the environment;
  - 3 Results of surveys, measurements, and calculations used to determine the dose to members of the public and ecological receptors from external and internal radiation sources;
  - 4 Meteorological data used in assessing dose; and
  - 5 Results of pre-operational monitoring.
- (i) Documentation related to the long-term management of radioactive waste and residual radioactive material.
- (j) Final documentation for clearance of property containing residual radioactive material.
- (k) Documentation of:
  - 1 Approved Authorized Limits for routine clearance of property for unrestricted or restricted use and the scenarios evaluated in selecting the limits,
  - 2 Approved revised Authorized Limits for clearance of property, and

3 Written notification of applicable Federal, State or local regulatory agencies or Tribal governments (See paragraph 4.k.(6) (c) 7 of this Order).

- (1) Annual summaries related to clearance of property.
  - (3) Records required by this Order must be maintained by, or transferred to, DOE upon cessation of a DOE radiological activity at a site.
  - (4) Records must be retained until final disposition is authorized by DOE in accordance with DOE O 243.1A, *Records Management Program*, dated 11-7-2011.
  - (5) Reporting.
    - (a) Reporting requirements for this Order are contained in DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*, dated 8-30-11, and DOE O 231.1B, *Environment, Safety and Health Reporting*, dated 6-27-11.
    - (b) The responsible Field Element Manager must notify a Cognizant Secretarial Officer and the Chief Health, Safety and Security Officer within 30 calendar days when it has been identified that any requirement in this Order that is not required to be reported under paragraph 4.l.(5)(a) has not been met.
  - (6) Units. Unless otherwise specified, the quantities used in the reports and records required by this Order must be clearly indicated in special units of curie, rad, roentgen, or rem, including multiples and subdivisions of these units, or other conventional units, such as dpm, dpm/100 cm<sup>2</sup>, or mass units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv) may be provided parenthetically for reference with scientific standards.
- m. Implementation. Full implementation of the requirements of this Order must be completed within 18 months of its issuance, unless a different implementation schedule is approved by a Cognizant Secretarial Officer.

## 5. RESPONSIBILITIES.

- a. Cognizant Secretarial Officers (or Designees).
  - (1) Ensure that the requirements of this Order are implemented throughout organizations under their purview.
  - (2) Request through the annual Department budgetary process the funding and resources needed to implement the requirements of this Order.

- (3) Assess as part of line oversight of field elements under their purview, the implementation of the requirements, and the responsibilities of paragraph 5.b. of the Order.
- (4) Approve Temporary Dose Limits in accordance with paragraphs 4.c.(2) and (3) of this Order.
- (5) Approve or consult on Authorized Limits for clearance of property in accordance with the requirements of this Order.
- (6) Notify a field organization if the requested Authorized Limit, revised Authorized Limit, or supporting materials are incomplete or not acceptable within 30 working days of receipt of a submitted application.
- (7) Identify to which contracts the CRD should apply and notify the cognizant contracting officer.

b. Field Element Managers.

- (1) Implement the requirements in this Order for radiological activities under their purview. Such implementation must include, but may not be limited to ensuring that:
  - (a) Environmental radiological protection programs are established and maintained,
  - (b) Reviews of the sites' effectiveness in implementing the requirements in this Order are conducted, and
  - (c) All records, reports, and documentation required by this Order are prepared, issued, and/or retained in accordance with applicable requirements.
- (2) Approve applicable Authorized Limits for clearance of property in accordance with the requirements of this Order.
- (3) Ensure that sites' annual budget requests include the funding and resources needed to implement the requirements of this Order.
- (4) Determine the type and scope of oversight activities necessary to independently verify compliance and implement the site independent verification activities.
- (5) Ensure that appropriate capabilities are maintained for monitoring and assessing routine and unplanned releases of radioactive materials, consistent with the types of radioactive materials released, release modes, and radiological activities conducted.

- (6) Ensure that agreements, permits, leases, licenses, or other legally-binding obligations between DOE and a tenant or concessionaire entered into after the effective date of this Order, require that the tenant or concessionaire take actions relating to matters within the scope of the contract that facilitate DOE's compliance with this Order.
- (7) Temporarily suspend any requirement of this Order when doing so is in their judgment necessary to minimize damage to life or property or to protect public health or safety. Whenever this provision is invoked, such suspension and the reason for it are to be reported to a Cognizant Secretarial Officer and to the Chief Health, Safety and Security Officer at the earliest practicable time.
- (8) Approve use of an alternative approach capable of demonstrating that the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2002, Table 2.2.
- (9) Ensure survey methods and modeling are adequate to meet the requirements of this Order, and consult with the Office of Health, Safety and Security as necessary.

c. Chief Health, Safety and Security Officer.

- (1) Develops new, or revises existing DOE directives, policies, guidance, standards, requirements and procedures related to this Order and CRD, and provides assistance on implementation issues.
- (2) Plans and conducts appraisals to determine compliance with requirements of this Order. (See DOE O 227.1, *Independent Oversight Program*, dated 8-30-11).
- (3) Evaluates the effectiveness of Departmental elements' implementation of the requirements and responsibilities of this Order.
- (4) Provides consultation to Cognizant Secretarial Officers on approval decisions related to the following:
  - (a) Requests for specific authorizations for a temporary public dose limit and
  - (b) Authorized Limits for real and personal property, and property excluded from the provisions of 10 CFR Part 835.
- (5) Approves or provides consultation to Cognizant Secretarial Officers' approval decisions, or for NNSA sites provides consultation to the NNSA Cognizant Secretarial Officer, on the following:
  - (a) The use of alternative dose coefficients,

- (b) Alternative dose constraints for DOE residual radioactive material, and
  - (c) Other (Alternative) Pre-Approved Authorized Limits.
- (6) Consults in Field Element Managers' approval of alternative dose evaluation models, or for NNSA sites, provides consultation to the NNSA Cognizant Secretarial Officer.
- (7) Following receipt of Authorized Limit applications provides consultation to Cognizant Secretarial Officers on whether the supporting documentation is incomplete, or if the Authorized Limits are not acceptable.
- d. Office of the Chief Financial Officer, in coordination with other Departmental elements, ensures that requests for funding by Departmental elements responsible for the development of policies, directives, and programs for maintaining the radiological protection of the public and the environment are considered in the annual budget requests.
- e. Contracting Officers or Representatives. Modify contracts to incorporate the Contractor Requirements Document in Attachment 1.

6. REFERENCES.

- a. P.L. 106-65, Title 32, National Nuclear Security Administration Act, as amended, which established a separately organized agency within the Department of Energy.
- b. 42 U.S.C. 2011, et seq., Atomic Energy Act of 1954, as amended, which authorizes the conduct of atomic energy activities and establishes authority for protecting the health and safety of the public.
- c. 42 U.S.C. 300f et seq., Safe Drinking Water Act (SDWA) as amended, which authorizes EPA to promulgate regulations under two specific programs: the first protects the Nation's public drinking water supplies; the second protects subsurface waters by regulating underground injection of materials.
- d. DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, dated 4-25-11, which establishes requirements and provides direction for implementing DOE P 226.1B, *Department of Energy Oversight Policy*.
- e. DOE P 226.1B, *Department of Energy Oversight Policy*, dated 4-25-11, which establishes DOE's expectations for the implementation of a comprehensive and robust oversight process that enables the Department's mission to be accomplished effectively and efficiently while maintaining the highest standard of performance for safety and security.

- f. DOE O 227.1, *Independent Oversight Program*, dated 8-30-11, which prescribes the requirements and responsibilities for DOE's Independent Oversight Program.
- g. DOE O 231.1B, *Environment, Safety and Health Reporting*, dated 6-27-11, which ensures the Department of Energy, including NNSA, receives timely and accurate information about events that have affected or could adversely affect the health, safety and security of the public or workers, the environment, the operations of DOE facilities, or the credibility of the Department.
- h. DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*, dated 8-30-11, which ensures that DOE and NNSA are informed about events that could adversely affect the health and safety of the public or the workers, the environment, DOE missions, or the credibility of the Department.
- i. DOE O 243.1A, *Records Management Program*, dated 11-7-2011, which sets forth requirements and responsibilities for implementing and maintaining a cost-effective records management program throughout DOE.
- j. DOE O 251.1C, *Departmental Directives Program*, dated 1-15-09, which defines requirements and responsibilities for implementing DOE's Directives Program, and establishes directives as the primary means to set, communicate, and institutionalize policies, requirements, responsibilities, and procedures for DOE elements and contractors.
- k. DOE O 252.1A, *Technical Standards Program*, dated 2-23-11, which promotes the use of voluntary consensus standards by DOE as the primary method for application of technical standards, and establishes and manages the Technical Standards Program including technical standards development, information, activities, issues and interactions.
- l. DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, dated 11-29-10, which provides the Department of Energy, including NNSA, with program and project management direction for the acquisition of capital assets with the goal of delivering projects within the original performance baseline, cost and schedule, and fully capable of meeting mission performance, safeguards and security, and environmental, safety and health requirements unless impacted by a directed change.
- m. DOE O 414.1D, *Quality Assurance*, dated 4-25-11, which contains requirements to ensure that DOE, including NNSA, products and services meet or exceed customers' expectations, to achieve QA for all work, and to establish additional process-specific quality requirements to be implemented under a QA program for the control of suspect/counterfeit items, and nuclear safety software.
- n. DOE O 430.1B, Chg 2, *Real Property Asset Management*, dated 4-25-11, which establishes a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming,



budgeting, and evaluation to program mission projections and performance outcomes.

- o. DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*, dated 7-9-99, which aids in implementing the requirements of DOE M 435.1-1, related to general requirements and responsibilities, high-level waste requirements, transuranic waste requirements and low-level waste requirements.
- p. DOE M 435.1-1, Chg 2, *Radioactive Waste Management Manual*, dated 6-8-11, which catalogs procedural requirements and existing practices to ensure that all DOE elements and contractors continue to manage DOE's radioactive waste in a manner that is protective of worker and public health and safety and the environment.
- q. DOE O 435.1, Chg 1, *Radioactive Waste Management*, dated 8-28-01, which establishes requirements to ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment.
- r. DOE P 450.4A, *Integrated Safety Management System Policy*, dated 4-25-11, which establishes DOE's expectation for environment, safety and health, including integrated safety management that will enable DOE's mission goals to be accomplished efficiently while ensuring safe operations at all Departmental facilities and activities.
- s. DOE P 454.1, *Use of Institutional Controls*, dated 4-9-03, which delineates how DOE will use institutional controls in the management of resources, facilities and properties under its control and to implement its programmatic responsibilities.
- t. DOE O 580.1A, Chg 1, *Department of Energy Personal Property Management Program*, dated 10-22-12, which sets forth requirements that implement and supplement laws, Executive Orders, Office of Management and Budget directives and any other agency issuances affecting DOE's personal property management program and establishes standards, practices, and performance expectations for the management of personal property owned or leased by DOE.
- u. DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, dated 7-02, which provides methods, models, and guidance within a graded approach that DOE and its contractors may use to evaluate doses of ionizing radiation to populations of aquatic animals, terrestrial plants, and terrestrial animals from DOE activities for the purpose of demonstrating protection, and provides dose evaluation methods that can be used to meet the requirements of DOE's Order on Radiation Protection of the Public and the Environment.

- v. DOE-STD-1196-2011, *Derived Concentration Technical Standard*, dated 4-11, which establishes the numerical values of Derived Concentration Standards in a manner reflecting the current state of knowledge and practice in radiation protection.
- w. DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, dated 1-91, which identifies those monitoring and surveillance elements that are considered high priorities for a radiological effluent monitoring and environmental surveillance program.
- x. EH-412-0014/1099, Information Brief: *The Long-Term Control of Property: Overview of Requirements in Orders DOE 5400.1 & DOE 5400.5*, dated 10-99, which summarizes DOE requirements for radiation protection of the public and environment to assist DOE elements plan and implement programs for long-term control (stewardship) of property.
- y. American National Standards Institute (ANSI) and Health Physics Society (HPS), 1999. ANSI/HPS N.13-12-1999, *Surface and Volume Radioactivity Standards for Clearance*, which contains recommendations on clearance of solid materials.
- z. American National Standards Institute (ANSI) and Health Physics Society (HPS), 2009. ANSI/HPS N 13.53-2009, *Control and Release of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)*, which contains recommendations on control of TENORM.
- aa. International Atomic Energy Agency, Safety Standards Series No. RS-G-1.7, 2004. *Application of the Concepts of Exclusion, Exemption and Clearance*, which contains recommendations for exemption of radioactive materials from administrative controls.
- bb. International Commission on Radiological Protection (ICRP) Publication 60, 1991, *1990 Recommendations of the International Commission on Radiological Protection*, Ann. ICRP Vol. 21(1-3), which provides recommendations regarding the fundamental principles of radiation protection. It specifically was used as a basis for radiation and tissue weighting factors in 10 CFR Part 835 and is considered here for consistency with other DOE regulations.
- cc. ICRP Publication 101, 2006, *Assessing Dose of the Representative Person for the Purpose of Radiation Protection of the Public and the Optimisation of Radiological Protection*, Ann. ICRP Vol. 36(3), provides bases for the development of ‘reference person’ and ‘representative person.’
- dd. ICRP Publication 103, 2007, *2007 Recommendations of the International Commission on Radiological Protection*, Ann. ICRP Vol. 37(2-4), which provides the most recent ICRP recommendations regarding the fundamental principles of

radiation protection. Concepts presented in this edition, such as 'reference person' and 'representative person' were used in this directive.

- ee. Interagency Steering Committee on Radiation Standards (ISCORS), *Federal Institutional Control Requirements for Radioactive Waste and Restricted Release of Property Containing Radioactive Material*, dated 12-99, which tabulates regulatory requirements for disposal of radioactive waste and restricted release of sites containing radioactive material for the Environmental Protection Agency, the Nuclear Regulatory Commission and the Department of Energy.
- ff. ISCORS Technical Report 2004-02 (DOE/EH-0676), *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation*, User's Guide, Version 1, dated 1-04, which presents a User's Guide for the RESRAD-BIOTA code. The RESRAD-BIOTA code provides a complete spectrum of biota dose evaluation capabilities, from methods for general screening, to comprehensive receptor-specific dose estimation.
- gg. National Council on Radiation Protection and Measurements (NCRP) Report No. 116, *Limitation of Exposure to Ionizing Radiation*, dated 3-93, which provides recommendations on specific dose limit criteria and methods of demonstrating compliance with the dose limits.
- hh. U.S. Nuclear Regulatory Commission NUREG-1575, Rev. 1 *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, Environmental Protection Agency (EPA) 402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1, dated 8-00, which provides comprehensive guidance on planning, conducting, assessing and documenting radiological surveys of sites with radioactive contaminants in surface soil and on building surfaces with a specific focus on the final status surveys that are carried out to demonstrate compliance with cleanup regulations.
- ii. NUREG-1576, EPA 402-B-04-001A, *Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)*, Vol. 1-3, National Technical Information Service Publication (NTIS PB) 2004-105421, dated 7-04, which provides guidance for the planning, implementation and assessment phases of projects involving laboratory analysis of radionuclides to ensure the generation of consistent and comparable data projects and programs and to ensure that laboratory data meet project-specific data quality objectives.
- jj. NUREG-1575, Supp. 1 *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)*, EPA 402-R-09-001, DOE/HS-004, dated 1-09, which is a multi-agency consensus document that supplements the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* by providing information on planning, conducting, evaluating, and

documenting radiological disposition surveys for the assessment of materials and equipment.

- kk. Yu, C., D.J. LePoire, J.-J. Cheng, E. Gnanapragasam, S. Kamboj, J. Arnish, B.M. Biwer, A.J. Zielen, A. Wallo III, W.A. Williams, and H. T. Peterson, Jr., *User's Manual for RESRAD-BUILD Version 3*, dated June 2003, which provides documentation for RESRAD-BUILD, a computer code used to evaluate potential health impacts in buildings contaminated with radioactive materials, and available at: <http://web.ead.anl.gov/resrad/>.
- ll. Yu, C., A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, A. Wallo III, W.A. Williams, and H. Peterson, *User's Manual for RESRAD Version 6*, dated July 2001, which provides documentation for the RESRAD pathway analysis computer code available at: <http://web.ead.anl.gov/resrad/>.
- mm. 10 CFR Part 20, *Standards for Protection Against Radiation*, which establishes standards for protection against ionizing radiation resulting from activities conducted by NRC licensees.
- nn. 10 CFR Part 770, *Transfer of Real Property at Defense Nuclear Facilities for Economic Development*, which establishes a process for disposing of unneeded real property at DOE's defense nuclear facilities for economic development purposes.
- oo. 10 CFR Part 835, *Occupational Radiation Protection*, which establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities.
- pp. 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*. Subpart H applies to the emissions of radionuclides other than radon from DOE facilities. Subpart Q applies to radon emissions from DOE facilities. Subpart T applies to radon emissions from the disposal of uranium mill tailings. Subpart A contains General Provisions.
- qq. 40 CFR Part 141, *National Primary Drinking Water Regulations* which prescribes radionuclide concentration limits for public drinking water.
- rr. 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes* which establishes requirements for the management and disposal of spent nuclear fuel, high-level, and transuranic wastes.
- ss. 41 CFR Chapter 109, *Department of Energy Property Management Regulations*, which establishes uniform DOE property management policies, regulations, and

procedures that implement and supplement the Federal Property Management Regulations.

7. DEFINITIONS. See Attachment 2.
8. CONTACT. Questions concerning this Order should be referred to the Office of Environmental Protection, Sustainability Support and Corporate Safety Analysis at (202) 586-7870.

BY ORDER OF THE SECRETARY OF ENERGY:



DANIEL B. PONEMAN  
Deputy Secretary



**CONTRACTOR REQUIREMENTS DOCUMENT**  
**DOE O 458.1, *RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT***

The provisions of this Contractor Requirements Document (CRD) apply to all radiological activities conducted by Department of Energy (DOE) and National Nuclear Security Administration (NNSA) contractors.

Regardless of the performer of the work, the contractor is responsible for complying with the requirements of this CRD and flowing down the CRD requirements to subcontractors at any tier to the extent necessary to ensure contractor compliance with the requirements.

1. GENERAL REQUIREMENTS.

- a. The contractor must establish and implement a program to protect the public and the environment against undue risk from radiation associated with DOE radiological activities through application of the Specific Requirements (paragraph 2.) in this CRD.
- b. The contractor must provide a schedule for full implementation of the Specific Requirements in this CRD as directed by DOE.
- c. The contractor must develop documentation that demonstrates how the Specific Requirements in this CRD are implemented.
- d. The contractor must obtain DOE line management approval of the documentation demonstrating compliance with the Specific Requirements in this CRD.

2. SPECIFIC REQUIREMENTS.

- a. Environmental Radiological Protection Program. The contractor conducting radiological activities must develop and implement a documented program which addresses compliance with the Specific Requirements in this CRD that are relevant to the particular activities being conducted.
  - (1) The program, (documented by the contractor's plans, procedures, protocols and other documents developed to implement the relevant requirements of this CRD) must be tailored to these activities and reflect a graded approach commensurate with the hazard or risk to the public and the environment resulting from the DOE operations.
  - (2) Where long-term stewardship and institutional controls for protection of the public and the environment are necessary to meet the Specific Requirements in this CRD, the contractor must ensure that the need for the controls is documented and maintained and to the extent the contractor is responsible, implement the controls. If the contractor is not responsible for implementation of the controls, the contractor must provide reasonable assurance that necessary controls are being implemented by the

responsible party prior to conducting activities that can affect the public or the environment.

- b. Public Dose Limit. The contractor must establish and implement procedures and practices to address the following elements related to the public dose limit:
- (1) DOE radiological activities, including remedial actions and activities using Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), must be conducted so that exposure of members of the public to ionizing radiation will:
    - (a) Not cause a total effective dose (TED) exceeding 100 mrem (1mSv) in a year, an equivalent dose to the lens of the eye exceeding 1500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5000 mrem (50 mSv) in a year, from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose excepting:
      - 1 Dose from radon and its decay products in air [Radon is addressed separately e.g., under paragraphs 2.f. and 2.h. of the Specific Requirements in this CRD and under Title 40 Code of Federal Regulations (CFR) Part 61, Subparts Q and T];
      - 2 Dose received by patients from medical sources of radiation, and by volunteers in medical research programs;
      - 3 Dose from background radiation; and
      - 4 Dose from occupational exposure under Nuclear Regulatory Commission (NRC) or Agreement State license or to general employees regulated under 10 CFR Part 835, and
    - (b) Comply with As Low As Reasonably Achievable (ALARA) requirements in paragraph 2.d. of the Specific Requirements in this CRD.
  - (2) The public dose limit applies to members of the public located off DOE sites and on DOE sites outside of controlled areas, and to those exposed to residual radioactive material subsequent to any remedial action or clearance of property.
- c. Temporary Dose Limits. If special circumstances could affect a DOE radiological activity in such a manner that the potential dose to a member of the public could exceed a TED of 100 mrem (1 mSv) in a year the contractor must submit a request for specific authorization for a temporary public dose limit



higher than 100 mrem (1 mSv) in a year to the responsible Field Element Manager. This request must include documentation that justifies the need for the increase, the alternatives considered, and the application of the ALARA process. The specific exposure pathways excepted in paragraphs 2.b.(1)(a) 1-4 of the Specific Requirements in this CRD are also excepted for temporary dose limits.

- d. As Low As Reasonably Achievable (ALARA).
- (1) An ALARA process must be implemented to optimize control and management of radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable. The process must be applied to the design or modification of facilities and conduct of activities that can expose the public or the environment to radiation or radioactive material.
  - (2) The ALARA process must: consider DOE sources, modes of exposure and all pathways which potentially could result in the release of radioactive material into the environment, or exposure to the public; use a graded approach; and, to the extent practical and when appropriate, be coordinated with the 10 CFR Part 835 ALARA process.
- e. Demonstrating Compliance with the Public Dose Limit. The contractor must establish and implement procedures and practices to demonstrate compliance with the public dose limit and to address the following elements:
- (1) Dose evaluations to demonstrate compliance with the public dose limit in paragraph 2.b.(1) of the Specific Requirements in this CRD and assess collective dose must include the following:
    - (a) The TED to members of the public from exposure to radiation, airborne effluents, and liquid effluents, of DOE origin.
      - 1 Compliance may be demonstrated by calculating dose to the representative person or to the maximally exposed individual (MEI).
      - 2 Determination of the representative person or the MEI must include members of the public both on DOE sites outside of controlled areas and off DOE sites.
      - 3 If it is suspected that any of the dose limits specified in paragraph 2.b.(1)(a) of the Specific Requirements in this CRD may be exceeded or the estimated TED for members of the public exceeds 25 mrem (0.25 mSv) in a year, then

dose to the lens of the eye, skin, and extremities must be evaluated.

- (b) Analytical models that consider likely exposure pathways, such as:
- 1 Direct external radiation from sources located on-site;
  - 2 External radiation from airborne radioactive material;
  - 3 External radiation from radioactive material deposited on surfaces off-site;
  - 4 Internal radiation from inhaled airborne radioactive material;
  - 5 Internal radiation from radioactive material ingested with water, and with food from terrestrial crops or animal products (e.g., meat, eggs, milk);
  - 6 Internal radiation from radioactive material ingested with aquatic food products such as fish, shellfish, crustaceans (e.g., crayfish, shrimp, crab, lobsters), and aquatic plants and algae;
  - 7 External or internal radiation due to residual radioactive material on, or in, cleared real property; and
  - 8 Any other pathway unique to the DOE site or activity.
- (c) The dose to members of the public from DOE-related exposure sources only, if the projected DOE-related dose to the representative person or MEI is 25 mrem (0.25mSv) in a year or less. If the DOE-related dose is greater than 25 mrem in a year, the dose to members of the public must include both major non-DOE sources of exposure (excluding dose from radon and its decay products in air, background radiation dose, occupational doses and doses due to medical exposures) and dose from DOE-related sources;
- (d) Collective dose for members of the public resulting from radiation emitted and radioactive materials released from DOE radiological activities only (not including radon and its decay products). Collective dose for members of the public must be representative of the total dose and of adequate quality for supported comparisons, trending or decisions. Consistent with the graded approach, collective dose estimates may be truncated by distance (e.g., 50 miles) or individual dose level (e.g., 10 microrem) when integration of doses beyond such thresholds does

not significantly affect data quality objectives. Where it is of concern, collective dose for members of the public resulting from radon and its decay products released by DOE radiological activities needs to be calculated separately from other radionuclides.

- (2) The estimated individual dose to the MEI or representative person that is representative of the persons or group likely to receive the most dose and is based on pathway and exposure parameters that are not likely to underestimate or substantially overestimate the dose, and, the collective dose (population dose) that is a realistic as practicable estimate of the sum of the doses to all members of the actual exposed population.
- (3) Site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of DOE radiological activities, land use, food supplies, and exposure pathway information must be updated, as necessary, to document significant changes that could affect dose evaluations.
- (4) Values of assumed default or site-specific parameters used in calculations must be identified and included with the documentation of the calculations.
- (5) Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.
- (6) Models for dose evaluation calculations must be appropriate for their purpose. Dose evaluation models that are codified or approved for use by regulators of DOE or by DOE must be used where applicable. Alternatives to such codified or approved dose evaluation models to be used for demonstrating compliance must be approved by the Field Element Manager.
- (7) DOE-approved dose coefficients must be used to evaluate doses resulting from DOE radiological activities. Use of alternative dose coefficients must be approved by the Chief Health, Safety and Security Officer or by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.
- (8) Doses to members of the public from airborne effluents must be evaluated with the CAP-88 model or another EPA-approved model or method to demonstrate compliance with applicable subparts of 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*.

- (9) Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate the dispersal pattern in the environs, characterize the pathway(s) of exposure to members of the public and estimate the doses to individuals and populations in the vicinity of the site or operation commensurate with the nature of the DOE radiological activities and the risk to the public and the environment. Radiological monitoring must be integrated with the general environmental and effluent monitoring. Environmental monitoring must include, but is not limited to:
- (a) Effluent Monitoring
  - (b) Environmental Surveillance
  - (c) Meteorological Monitoring. Meteorological monitoring must be commensurate with the level of site radiological activities, the site topographical characteristics, and the distance to critical receptors. The scope must be sufficient to characterize atmospheric dispersion and model the dose to members of the public over distances commensurate with the magnitude of potential source terms and possible pathways to the atmosphere.
  - (d) Pre-operational Monitoring. Prior to the startup of a new site, facility or process with the potential to expose the public or environment to radiation or radioactive material, it is necessary to ensure that adequate knowledge exists to understand: 1) radiological background; 2) pertinent environmental and ecological parameters; and 3) potential pathways for human exposures or ecological/natural resource impacts either from existing data or documents (for example, NEPA evaluations or existing monitoring and surveillance programs, etc.) or from the conduct of a pre-operational study initiated at least one year prior to startup of a new operation.
- (10) Site-specific environmental monitoring criteria must be established to ensure that representative measurements of quantities and concentrations of radiological contaminants are conducted and that the effects from DOE radiological activities on members of the public and the environment are monitored sufficiently to demonstrate compliance with the Specific Requirements in this CRD.
- f. Airborne Radioactive Effluents. The contractor must establish and implement procedures and practices related to airborne radioactive effluents so that radiological activities are conducted in a manner such that the release of radioactive material to the atmosphere will:

- (1) Be evaluated using the ALARA process established in paragraph 2.d. of the Specific Requirements in this CRD;
- (2) Not cause radon-222 flux rates to exceed 20 pCi (0.7 Bq)/m<sup>2</sup>-sec averaged over the surface area overlaying waste, including the covering or other confinement structures, wherever radium-226 wastes are accepted for storage or disposal (See 40 CFR Part 61, Subparts Q and T);
- (3) Meet compliance agreements under 40 CFR Part 61, Subparts H, Q, and T;
- (4) Not cause the radon-220 and radon-222 decay product concentration, including background, to exceed 0.03 WL in buildings that are being released from DOE control. Further, a reasonable effort must be made to meet a 0.02WL generic guideline for annual average radon-220 and radon-222 decay product concentration, including background, in such buildings; and
- (5) Not exceed 3 pCi/L annual average radon-220 and radon-222 concentration, not including background, at the site boundary if DOE activities release radon-220 and radon-222 or their decay products.

g. Control and Management of Radionuclides from DOE Activities in Liquid Discharges. The contractor must establish and implement procedures and practices related to control and management of radionuclides from DOE activities in liquid discharges. Operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities must:

- (1) Characterize planned and unplanned releases of liquids containing radionuclides from DOE activities, consistent with the potential for on- and off-site impacts, and provide an assessment of radiological consequences as necessary to demonstrate compliance with the Specific Requirements of this CRD.
- (2) Comply with the ALARA process requirements in paragraph 2.d. of the Specific Requirements in this CRD.
- (3) Conduct activities to ensure that liquid releases containing radionuclides from DOE activities are managed in a manner that protects ground water resources now and in the future, based on use and value considerations.
- (4) Conduct activities to ensure that liquid discharges containing radionuclides from DOE activities do not exceed an annual average (at the point of discharge) of either of the following:
  - (a) 5 pCi (0.2 Bq) per gram above background of settleable solids for alpha-emitting radionuclides.

- (b) 50 pCi (2 Bq) per gram above background of settleable solids for beta-gamma-emitting radionuclides.
- (5) Except for tritium and sanitary sewers, apply Best Available Technology (BAT) if at the point of discharge:
  - (a) The annual average concentration of a given radionuclide is greater than the DOE-approved derived concentration standard (DCS) value for water contained in the *Derived Concentration Technical Standard*, DOE-STD-1196-2011, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values;
  - (b) The discharge contributes greater than 10 mrem (0.1 mSv) annual TED to members of the public; or
  - (c) The collective dose from all DOE sources is greater than 100 person-rem (1 person-Sv) and the liquid discharge contributes 50 percent or more of this collective dose.
- (6) Control releases of tritium in a manner that has been established by application of the ALARA process.
- (7) Conduct radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contaminant levels in 40 CFR Part 141, *National Primary Drinking Water Regulations*.
- (8) Control discharges into sanitary sewers in accordance with the following requirements:
  - (a) Except for excreta from patients and medical research volunteers treated with radioactive material, discharges of liquids containing radionuclides from DOE activities into non-Federally owned sanitary sewers are prohibited unless:
    - 1 The material is readily soluble (or readily dispersed biological materials) in water;
    - 2 Such discharges comply with ALARA process requirements;
    - 3 BAT is applied to discharges of liquid releases containing radionuclides from DOE activities if the average monthly concentration level at the point of discharge into the sanitary sewer is greater than five times the DOE-approved

DCS values for ingestion except for tritium which is addressed under paragraph 2.g.(6);

- 4 Releases do not result in an annual discharge (above background) into sanitary sewers in excess of 5 Ci (185 GBq) of tritium; 1 Ci (37 GBq) carbon-14 or 1 Ci (37 GBq) of all other radionuclides combined;
  - 5 DOE operations are conducted to minimize long-term buildup of radionuclides in the sewage treatment plants that may create handling and disposal issues or interfere with plant operations;
  - 6 The contractor notifies the responsible Field Element Manager of unusual discharges to sanitary sewers from DOE facilities;
  - 7 The contractor prepares and provides a report that describes and summarizes such discharges to sanitary sewers to the responsible Field Element Manager at least annually; and
  - 8 Existing agreements, contracts, statements of understanding or other formal arrangements with other agencies concerning the discharge of liquids containing radionuclides from DOE activities to sanitary sewers are not violated.
- (b) DOE facilities discharging liquids containing radionuclides from DOE activities into sanitary sewer systems owned by the Federal government are not subject to the requirements in paragraph 2.g.(8)(a) of the Specific Requirements in this CRD if:
- 1 The system provides treatment in accordance with the environmental radiological protection program and
  - 2 Sludge from the system is disposed of in accordance with the Specific Requirements in this CRD and applicable Federal, State, and municipal regulations.
- (9) Prohibit the use of soil columns.
- (10) Manage the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and ground water and prevent the creation of future cleanup sites.
- (11) Ensure that storm water runoff containing radionuclides from DOE activities is considered, as appropriate, as a pathway of exposure that has the potential for on- and off-site impacts. Using a graded approach, the

receiving ecosystem including, but not limited to, wetlands, floodplains, streams, ponds, basins and lakes must be monitored to evaluate human or ecological impacts when warranted based on site specific risk.

- h. Radioactive Waste and Spent Nuclear Fuel. The contractor must establish and implement procedures and practices to ensure that management, storage and disposal of radioactive waste and spent nuclear fuel on DOE sites address the following elements:
- (1) Radiological activities must be conducted in a manner such that radiation exposure to members of the public from management and storage of radioactive waste complies with ALARA process requirements and does not result in a TED greater than 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.
  - (2) Management of spent nuclear fuel, and high-level and transuranic wastes at a disposal facility which is not regulated by the NRC must comply with the requirements of this CRD and 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes*.
  - (3) Management, storage and disposal of low-level radioactive waste must be conducted in a manner such that exposure to members of the public to radiation from radioactive waste complies with ALARA process requirements, and does not exceed a TED of 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.
  - (4) Management, storage and disposal of 11e.(2) byproduct material, as defined in Section 11e.(2) of the AEA and other wastes containing uranium and thorium and their decay products which are not subject to the requirements of 40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, are not at facilities licensed by the NRC, or are not disposed of at DOE low-level waste disposal facilities, must be in accordance with the requirements of paragraph 2.h. of the Specific Requirements in this CRD and DOE-approved plans.
    - (a) Disposal facilities for uranium and thorium wastes must be designed to:
      - 1 Remain effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years, and



- 2 Provide reasonable assurance that releases of radon-222 to the atmosphere will not:
- a Exceed an average release rate of 20 picocuries per square meter per second or
  - b Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.
- (b) For wastes containing significant concentrations of radium and thorium, special considerations must be given to measures to prevent inadvertent human intrusion.
- (c) Before any potentially biodegradable contaminated wastes are placed in a disposal facility, such wastes must be conditioned so that the generation and escape of biogenic gases will not cause the emission or dose limits in paragraph 2.h. of the Specific Requirements in this CRD to be exceeded and that bio-degradation within the facility will not result in premature structural failure.
- (d) All plans for the management and disposal of these wastes must provide for institutional controls and long-term stewardship of the disposal facility necessary to ensure continued performance.
- (5) Discrete sources of radium-226, accelerator produced radioactive material, or naturally-occurring radioactive material (NORM) that pose a threat similar to discrete sources of radium-226, which are defined as Section 11e.(3) or 11e.(4) byproduct material in the AEA, must be managed as high-level waste, low-level waste or 11e.(2) material as appropriate under DOE AEA authorities and in compliance with the Specific Requirements in this CRD and the requirements in the CRD to DOE O 435.1 Chg 1.
- i. Protection of Drinking Water and Ground Water.
- (1) The contractor must establish and implement procedures and practices to ensure that DOE sites provide a level of radiation protection for persons consuming water from a drinking water system operated by DOE, directly or through a DOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR Part 141, *National Primary Drinking Water Regulations* (that is, not exceed the radionuclide maximum contaminant levels (MCLs)).
  - (2) The contractor must protect ground water from radiological contamination to ensure compliance with dose limits in the Specific Requirements in this

CRD and consistent with ALARA process requirements. To that end the contractor must ensure that:

- (a) Baseline conditions of the ground water quantity and quality are documented;
- (b) Possible sources of, and potential for, radiological contamination are identified and assessed;
- (c) Strategies to control radiological contamination are documented and implemented;
- (d) Monitoring methodologies are documented and implemented; and
- (e) Ground water monitoring activities are integrated with other environmental monitoring activities.

j. Protection of Biota. The contractor must establish and implement procedures and practices to ensure that biota are protected and to address the following elements:

- (1) Radiological activities that have the potential to impact the environment must be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations.
- (2) When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota then evaluations must be done to demonstrate compliance with paragraph 2.j.(1) of the Specific Requirements in this CRD in one or more of the following ways:
  - (a) Use DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.
  - (b) Use an alternative approach to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2002, Table 2.2.
  - (c) Use an ecological risk assessment to demonstrate that radiation and radioactive material released from DOE operations will not adversely affect populations within the ecosystem.

k. Release and Clearance of Property. The contractor must establish and implement procedures and practices to ensure that release or clearance of property with the potential to contain residual radioactive material must be conducted in accordance

with DOE direction and in accordance with the requirements in paragraph 2.k. of the Specific Requirements in this CRD<sup>4</sup>.

- (1) Property control and clearance processes must be developed and implemented in accordance with the dose limits in paragraph 2.b of the Specific Requirements in this CRD under any plausible use of the property and the ALARA process requirements in paragraph 2.d of the Specific Requirements in this CRD must be met before property is cleared.
- (2) Dose Constraints. Unless alternative dose constraints are approved by issuance of a directive or memorandum by the Chief Health, Safety and Security Officer or for NNSA, the Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer, the following dose constraints for DOE residual radioactive material must be applied to each specific clearance of property for any actual or likely future use of the property:
  - (a) Real property – a TED of 25 mrem (0.25 mSv) above background in any calendar year;
  - (b) Personal property - a TED of 1 mrem (0.01 mSv) above background in any calendar year.
- (3) Residual Radioactive Material. Property potentially containing residual radioactive material must not be cleared from DOE control unless either:
  - (a) The property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or
  - (b) The property is evaluated and appropriately monitored or surveyed to determine:
    - 1 The types and quantities of residual radioactive material within the property;
    - 2 The quantities of removable and total residual radioactive material on property surfaces (including residual radioactive material present on and under any coating);
    - 3 That for property with potentially contaminated surfaces that are difficult to access for radiological monitoring or

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<sup>4</sup> In addition to paragraph 2.k of the Specific Requirements in this CRD, the following may have applicable requirements regarding clearance of property: 41 CFR Chapter 109, *Department of Energy Property Management Regulations*; DOE O 430.1B Chg 2, *Real Property Asset Management*; DOE O 580.1A, *Department of Energy Personal Property Management Program*.

surveys, an evaluation of residual radioactive material on such surfaces is performed which is:

- a Based on process and historical knowledge meeting the requirements of paragraph 2.k.(5) of the Specific Requirements in this CRD and monitoring and or surveys, to the extent feasible and
- b Sufficient to demonstrate that applicable specific or pre-approved DOE Authorized Limits will not be exceeded; and

4 That any residual radioactive material within or on the property is in compliance with applicable specific or pre-approved DOE Authorized Limits.

- (4) Evaluation of the Need for Maintaining Institutional Controls for Real Property. Real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls or impacting long-term stewardship of adjacent DOE real property. In situations where transfer of the real property to other use would impact long-term radiological protection of adjacent DOE properties, it must be demonstrated that the impact of the property clearance would not result in noncompliance for the adjacent property with the requirements of applicable statutes, regulations or DOE directives.
- (5) Process and Historical Knowledge. Contractors responsible for radiological clearance of property, when they rely in part, on process knowledge as a basis for clearance decisions, must establish a documented evaluation process, using a graded approach, for applying process and historical knowledge to determine if property potentially contains residual radioactive material.
  - (a) This process must include procedures for evaluating operational records and operating history, including the use of any radioactive materials or radiation generating devices.
  - (b) For real property, this process must address each specific property individually. If several parcels of land are contiguous, or if several structures are located in the same area and have a common operational history, a single evaluation for all of the properties is acceptable.
  - (c) If available process and historical knowledge cannot demonstrate that property does not contain residual radioactive materials,

radiological monitoring or surveys must be conducted to supplement process and historical knowledge evaluations.

(d) If not supplemented by radiological surveys, process and historical knowledge evaluations must be adequate to determine:

1 Whether the property has ever been used for radiological activities or in areas that could have resulted in the presence of residual radioactive material within or on the property or

2 Whether property formerly containing residual radioactive material has been decontaminated and demonstrated to meet DOE Authorized Limits, and has not been used in a manner or in areas that could have resulted in the re-contamination of the property.

(e) For property that is determined to potentially contain residual radioactive material under paragraph 2.k.(5)(d)1 of the Specific Requirements in this CRD or determined to be re-contaminated under paragraph 2.k.(5)(d)2 of the Specific Requirements in this CRD, the process and historical knowledge evaluation must also include an assessment of the types and quantities of residual radioactive material and the sources and pathways by which the property became contaminated.

(6) Authorized Limits.

(a) Authorized Limits for the clearance of any property with residual radioactive material must provide reasonable assurance that the requirements of paragraphs 2.k.(1) and 2.k.(2) of the Specific Requirements in this CRD are met. Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive material and in which the presence of residual radioactive material cannot be determined.

(b) Authorized Limits must:

1 Be developed in accordance with the ALARA requirements in paragraph 2.d. of the Specific Requirements in this CRD.

2 Be based on the applicable dose constraint, supported by a complete exposure pathway analysis using appropriate methodologies, techniques, parameters and models (such as the RESRAD family of codes) that meet DOE quality

assurance requirements under the CRD to DOE O 414.1D, *Quality Assurance*, dated 4-25-11.

- 3 Be expressed in terms of concentration of radioactivity per unit surface area (e.g., dpm per 100 cm<sup>2</sup>), radioactivity per unit mass (e.g., pCi per gram) or volume (e.g., pCi per ml), total radioactivity, or DOE controls and restrictions, if applicable.
  - 4 Explicitly state any restrictions or conditions on future use of the property necessary to ensure the basic dose limit and applicable dose constraint are not exceeded.
  - 5 In addition to paragraphs 2.k.(6)(b)1-4 of the Specific Requirements in this CRD for clearance of personal property only:
    - a Be based on expected annual quantity of property to be cleared or
    - b Be based on expected total amount of property cleared over the life of the project for specific remedial action or decontamination and decommissioning projects and
    - c Prior to clearance of metals, the contractor must provide the necessary information to support a determination by the Field Element Manager that there is no practical internal DOE opportunity for reuse or recycle of the material or equipment.
  - 6 Authorized limits must be submitted to the Field Element Manager to obtain DOE approval.
- (c) Applications for DOE approval of Authorized Limits must contain the following:
- 1 A description of the property.
  - 2 Specific limits proposed for each radionuclide or group of radionuclides and/or external radiation exposure, surrogate metrics, or conditions used to limit radionuclides.
  - 3 Potential collective dose to the exposed population and the potential dose to a member of the public most likely to

receive the highest dose for both: actual or likely future use, and plausible future use of the property.

- 4 ALARA assessments conducted under paragraph 2.d. of the Specific Requirements in this CRD for the proposed clearance action to include, at a minimum, the effects of:
    - a Implementing the proposed Authorized Limits;
    - b Implementing alternative levels of residual radioactive material instead of the proposed Authorized Limits;
    - c Not implementing the proposed Authorized Limits, i.e., not proceeding with the proposed clearance action.
  - 5 A description of the procedures and radiological monitoring or surveys to be used to demonstrate compliance with proposed limits.
  - 6 Identification of any restrictions or conditions on the future use of the property upon which the proposed limits are based, and the means by which the restrictions or conditions will be implemented and maintained.
  - 7 An estimated date for when the property will be cleared and an estimate of when the property will be released from DOE control.<sup>5</sup>
- (d) Property covered by Authorized Limits is subject to 10 CFR Part 835 requirements unless the criteria in paragraphs 2.k.(6)(a) through (c) of the Specific Requirements in this CRD have been met and the Authorized Limits have been approved by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer as required by the 10 CFR Part 835 exclusion.
  - (e) Revision of Authorized Limits. If established Authorized Limits are found to be not protective, appropriate or practical to apply for a specific type or portion of property, further clearance for that

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<sup>5</sup> This information is needed to support the DOE expectation stated at 72 FR 31904, 31906 (10 CFR Part 835, June 8, 2007) that the material, equipment, or real property to which the 10 CFR Part 835.1(b)(6) exclusion is applied will be released from DOE control according to a specified time interval.

specific type or portion of property must not proceed without revised Authorized Limits.

- 1 An application for revised Authorized Limits must be submitted in accordance with the requirements in paragraphs 2.k.(6)(a) through (d) of the Specific Requirements in this CRD.
- 2 In addition to the requirements of applicable paragraphs of 2.k.(6) of the Specific Requirements in this CRD, requests for approval of revised Authorized Limits must include a justification for the need for the revised Authorized Limits. Justifications for revised Authorized Limits must be based upon one of the following:
  - a Complying with existing Authorized Limits would pose a clear and present risk of injury to general employees or members of the public; or
  - b Complying with existing Authorized Limits, would produce environmental harm (e.g., destruction of artifacts, ecological damage, loss of cultural assets) that is clearly excessive compared to the potential health benefits to persons exposed to affected properties; or
  - c Complying with existing Authorized Limits is unreasonably costly relative to long-term benefits and where the residual radioactive material does not pose a clear present or future potential of exceeding the public dose limit of paragraph 2.b. of the Specific Requirements in this CRD; or
  - d Portions of the project or activity for which the scenarios or assumptions used to establish the existing Authorized Limits are overly conservative, or where more appropriate scenarios or assumptions indicate that other limits are applicable or appropriate for protection of the public and the environment; or
  - e New information which indicates the existing Authorized Limits are not sufficient to meet the protective requirements established by DOE.



(f) Pre-Approved Authorized Limits.

1 The following values have been pre-approved by DOE for use as Authorized Limits, and may be used as specified below instead of developing specific Authorized Limits.

a For radium-226 and radium-228 in soil - 5 pCi/gram (0.2 Bq/gram) in excess of background levels, averaged over 100 m<sup>2</sup>, in the first 15 cm depth of the surface layer of soil; and 15 pCi/gram (0.56 Bq/gram) in excess of background levels, averaged over any subsequent 15 cm subsurface layer of soil plus an ALARA assessment. If both thorium-230 and radium-226 or both thorium-232 and radium-228 are present and not in secular equilibrium, the appropriate pre-approved limit must be applied to the radionuclide with the higher concentration.

b Previously approved guidelines and limits (such as the surface activity guidelines) may continue to be applied and used as Pre-Approved Authorized Limits until they are replaced or revised by Pre-Approved Authorized Limits issued by the Department.

2 Pre-Approved Authorized Limits may be used for any radiological activity instead of developing specific Authorized Limits if their use is documented in the environmental radiological protection program and the specific application of the Authorized Limits is approved by the responsible Field Element Manager.

(g) Documentation of Approved Authorized Limits. Approved Authorized Limits and approved revised Authorized Limits and supporting documentation must be made available to the public.

(7) Clearance of Environmental Restoration, Deactivation and Decommissioning, and Other Cleanup Materials.

(a) Clearance of property with residual radioactive material from environmental restoration activities, including deactivation and decommissioning, must meet the Specific Requirements in this CRD. Environmental restoration activities using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process may demonstrate compliance with the Specific Requirements in this CRD (including public dose

assessments, ALARA analysis, and consideration of scenarios) using documentation from the CERCLA process and any necessary supplemental information.

- (b) For the purpose of clearance of real or personal property, approved CERCLA remediation criteria may be considered equivalent to Authorized Limits if the appropriate Field Element Manager has determined that the criteria meet the Specific Requirements in this CRD for Authorized Limits, and provided that the use of the criteria as DOE Authorized Limits is documented and approved as would be an Authorized Limit. Compliance with all Specific Requirements in this CRD not met through the CERCLA process must also be demonstrated.
- (c) If the contractor performs environmental restoration activities involving clearance of real or personal property with residual radioactive material under CERCLA that use the CERCLA analysis and documentation in lieu of analysis and documentation developed specifically to demonstrate compliance with the Specific Requirements in this CRD, the contractor must submit the relevant CERCLA documentation and any additional information necessary to demonstrate that the requirements for Authorized Limits have been met to the responsible Field Element Manager.

(8) Radiological Monitoring or Surveys.

- (a) All radiological monitoring or surveys performed in support of clearance of property must:
  - 1 Use methodologies sufficient to meet measurement objectives such as those in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, the *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)* or other methodologies approved by DOE;
  - 2 Meet Measurement Quality Objectives;
  - 3 Use DOE-approved sampling and analysis techniques, if applicable; and
  - 4 Include an evaluation of non-uniformly distributed residual radioactive material, if applicable.
- (b) Instrumentation used for radiological monitoring or surveys must be capable of detecting and quantifying residual radioactive material consistent with the applicable Authorized Limits, and be:

- 1 Periodically maintained and calibrated on an established frequency;
    - 2 Appropriate for the type(s), levels, and energies of the radiation(s) encountered; and
    - 3 Appropriate for existing environmental conditions and routinely tested for operability.
  - (9) Documentation and Verification. Any contractor responsible for radiological clearance of property must ensure that final radiological monitoring or surveys are conducted and that documentation is prepared that shows that the clearance meets applicable DOE Authorized Limits, or other applicable requirements including associated restrictions or institutional controls (See DOE P 454.1).
  - (10) Public Notification of Clearance of Property. Information on approved Authorized Limits, any approved revised Authorized Limits, use of pre-approved Authorized Limits, results of radiological monitoring and surveys of cleared property with type and quantity of property cleared, and independent verification results must be summarized in the Annual Site Environmental Report.
  - (11) Final Clearance Documentation. Clearance of property must be documented. The contents of the documentation or the mechanism for documenting information may be tailored to the need, situation, and type of property being cleared. For ongoing, routine clearances, e.g., clearance of personal property from controlled areas, such documentation may be based on the general process(es) rather than each specific clearance. In general, the documentation must describe the clearance process(es) and the property being cleared. The documentation must serve to demonstrate requirements have been met, show criteria used for clearance, identify the property's destination or disposition, as appropriate, and provide additional confidence to DOE and assurance to other interested parties that the public and the environment are being protected. The documentation must indicate any Authorized Limits, including any revised or pre-approved Authorized Limits, used for the clearance, and include information and data supporting the clearance of property such as radiological certification and independent verification results. An annual summary of cleared property must be prepared and submitted to the Field Element Manager.
1. Records, Retention and Reporting Requirements. The contractor must establish and implement recordkeeping, retention and reporting procedures and practices to ensure that the following elements are addressed:

- (1) Records must be maintained to document compliance with the Specific Requirements in this CRD.
- (2) Required records include the following:
  - (a) Information and data necessary to identify and characterize releases of radioactive material to the environment, their fate in the environment, and their probable impact on radiation dose to members of the public, and any impacts on ecological systems.
  - (b) Documentation of individual and collective dose to members of the public due to radiological activities. This includes documentation of site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of the radiological activity and assumed default values or site-specific parameters used in calculations.
  - (c) Requests for specific authorization for temporary public dose limits, and subsequent approvals and other related actions.
  - (d) Identification of radiological activities subject to environmental radiological protection program requirements, and descriptions of the measures to be used in implementing these requirements.
  - (e) Documentation of actions taken to implement the ALARA process identified in paragraph 2.d. of the Specific Requirements in this CRD.
  - (f) Documentation of actions taken to demonstrate compliance with the public dose limit (See paragraph 2.e.(1) of the Specific Requirements in this CRD).
  - (g) Documentation of actions taken to implement the BAT selection process in regulating liquid discharges, including documentation of analyses and factors considered to be important, including alternative processes, for the BAT selection process.
  - (h) Effluent monitoring and environmental surveillance information and data, including:
    - 1 Results of effluent monitoring for determining sources of radiation and radioactive material that provide direct exposure to members of the public and releases of radioactive material in liquid or airborne effluent;
    - 2 Results of surveys for radiation and radioactive material in the environment;

- 3 Results of surveys, measurements, and calculations used to determine the dose to members of the public and ecological receptors from external and internal radiation sources;
  - 4 Meteorological data used in assessing dose; and
  - 5 Results of pre-operational monitoring.
- (i) Documentation related to the long-term management of radioactive waste and residual radioactive material.
  - (j) Final documentation for clearance of property containing residual radioactive material.
  - (k) Documentation of:
    - 1 Approved Authorized Limits for routine clearance of property for unrestricted or restricted use and the scenarios evaluated in selecting the limits; and
    - 2 Approved revised Authorized Limits for clearance of property.
  - (l) Annual summaries related to clearance of property.
- (3) Records required by the Specific Requirements in this CRD must be maintained by, or transferred to, DOE upon cessation of a DOE radiological activity at a site.
  - (4) Records must be retained until final disposition is authorized by DOE.
  - (5) Reporting.
    - (a) Reporting requirements are contained in the CRDs to DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*, dated 8-30-11, and DOE O 231.1B, *Environment, Safety and Health Reporting*, dated 6-27-11.
    - (b) The contractor must notify the Field Element Manager within 30 calendar days when it has been identified that any Specific

Requirement in this CRD that is not required to be reported under paragraph 2.1.(5)(a) has not been met.

- (6) Units. Unless otherwise specified, the quantities used in the reports and records required by the Specific Requirements of this CRD must be clearly indicated in special units of curie, rad, roentgen, or rem, including multiples and subdivisions of these units, or other conventional units, such as dpm, dpm/100 cm<sup>2</sup>, or mass units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv) may be provided parenthetically for reference with scientific standards.

3. DEFINITIONS. See Attachment 2.

## DEFINITIONS

1. Absorbed Dose (D) — The average energy imparted by ionizing radiation to the matter in a volume element per unit mass of irradiated material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).
2. Actual or Likely Use Scenarios — The current uses and reasonably anticipated uses in the foreseeable future of real and personal property considering the history of use; use restrictions, designations or controls; affected populations, ecosystems, or natural resources; and the property's historic or cultural significance. For real property considerations also include Federal and State use designations; local zoning and future land use plans; and proximity to residences, commercial or industrial areas, or areas of cultural or historic significance.
3. Airborne Discharges — Material released to the atmosphere in the form of dusts, fumes, particulates, mists, vapors, or gases.
4. ALARA (As Low As Reasonably Achievable) — An approach to radiation protection to manage and control releases of radioactive material to the environment, and exposure to the work force and to members of the public so that the levels are as low as is reasonably achievable, taking into account societal, environmental, technical, economic, and public policy considerations. As used in this Order, ALARA is not a specific release or dose limit but a process which has the goal of optimizing control and management of releases of radioactive material to the environment and doses so that they are as far below the applicable limits of the Order as reasonably achievable.
5. ALARA Process — A graded process for evaluating alternative operations, processes, and other measures, for optimizing releases of radioactive material to the environment, and exposure to the work force and to members of the public taking into account societal, environmental, technical, economic, and public policy considerations to make a decision concerning the optimum level of public health and environmental protection. A graded approach provides the flexibility to perform qualitative or quantitative ALARA analyses. For low doses, qualitative evaluations normally will suffice.
6. Authorized Limit — A limit on the concentration or quantity of residual radioactive material on the surfaces or within property that has been derived consistent with DOE directives including the ALARA process requirements. An authorized limit may also include conditions or measures that limit or control the disposition of property.
7. Background Radiation — Radiation from: (1) naturally occurring radioactive materials which have not been technologically enhanced (i.e., background radiation does not include TENORM); (2) cosmic sources; (3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices); (4) radon and its decay products in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and (5) consumer

- products containing nominal amounts of radioactive material or producing nominal amounts of radiation.
8. Best Available Technology (BAT) — The preferred technology for a particular activity, selected from among others after taking into account factors related to technology, economics, public policy, and other parameters. As used in this Order, the BAT is not a specific level of treatment, but is the conclusion of a selection process in which several alternatives are evaluated.
  9. BAT Selection Process — The evaluation of candidate alternative technologies in order to select the BAT after considering: technology; economics; the age of equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; other environmental impacts (including energy requirements); safety considerations; and policy considerations.
  10. Clearance of Property — The removal of property that contains or may contain residual radioactive material from DOE radiological control under 10 CFR Part 835 and DOE O 458.1.
  11. Collective Dose — The sum of the total effective dose to all persons in a specified population received in a specified period of time. For clearance of property the collective dose refers to the population potentially exposed to the cleared property. Collective dose is expressed in units of person-rem (or person-sievert).
  12. Committed Effective Dose ( $E_{50}$ ) — The sum of the committed equivalent doses to various tissues or organs in the body ( $H_{T,50}$ ), each multiplied by the appropriate tissue weighting factor ( $w_T$ )--that is,  $E_{50} = \sum w_T H_{T,50} + w_{\text{Remainder}} H_{\text{Remainder},50}$ , where  $w_{\text{Remainder}}$  is the tissue weighting factor assigned to the remainder organs and tissues and  $H_{\text{Remainder},50}$  is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rems (or sieverts).
  13. Committed Equivalent Dose ( $H_{T,50}$ ) — The equivalent dose calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed equivalent dose is expressed in units of rems (or sieverts).
  14. Controlled Area — Any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material as defined by 10 CFR Part 835.
  15. Derived Concentration Standard (DCS) — A derived concentration value for a radionuclide in water that would result in a dose of 100 mrem in a year to a gender- and age- weighted reference person using DOE approved dose coefficients and assuming continuous exposure.



16. Dose — A general term for absorbed dose, equivalent dose, effective dose, committed equivalent dose, committed effective dose, or TED as defined in this Order.
17. Effective Dose (E) — The summation of the products of the equivalent dose received by specified tissues or organs of the body ( $H_T$ ) and the appropriate tissue weighting factor ( $w_T$ )--that is,  $E = \sum w_T H_T$ . It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this Order, equivalent dose to the whole body may be used as effective dose for external exposures. The effective dose is expressed in units of rems (or sieverts).
18. Effluent Monitoring — The collection and analysis of samples of liquid and gaseous effluents or measurements of liquid and gaseous effluents performed to characterize and quantify radiological contaminants and process stream characteristics, assess radiation exposures of members of the public, and demonstrate compliance with applicable standards.
19. Environmental Surveillance — The collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media at the DOE site and surrounding environs and the measurement of external radiation to demonstrate compliance with applicable standards, assess radiation exposure of members of the public, and assess effects, if any, on the environment.
20. Equivalent Dose ( $H_T$ ) — The product of average absorbed dose ( $D_{T,R}$ ) in rad (or gray) in a tissue or organ (T) and a radiation (R) weighting factor ( $w_R$ ). For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rems (or sieverts).
21. External Dose or Exposure — That portion of the dose received from radiation sources outside the body (i.e., external sources).
22. Facility — Something that is built, installed, or established to serve a particular DOE radiological activity.
23. General Employee — An individual who is either a DOE or DOE contractor employee; an employee of a subcontractor; or an individual who performs work for or in conjunction with DOE or utilizes DOE facilities.
24. Internal Dose or Exposure — That portion of the dose received from radioactive material taken into the body (i.e., internal sources).
25. Liquid Discharge — The release to the environment of radioactive material in a liquid medium. The discharge generally occurs at a point, such as the end of a pipe, where it is released to any of several receptors in the environment, such as a waterway, land, sewer system, etc.

26. Maximally Exposed Individual — A hypothetical individual who – because of realistically assumed proximity, activities, and living habits – would receive the highest radiation dose, taking into account all pathways, from a given event, process, or facility.
27. Measurement Quality Objectives — A statement of a performance objective or requirement for a particular method performance characteristic.
28. Member of the Public — An individual who is not a general employee. An individual is not a member of the public during any period in which the individual receives an occupational dose.
29. Monitoring — The measurement of radiation levels, discharges or environmental releases, residual radioactive levels, quantities of radioactive material, or exposure to members of the public and the use of the results of these measurements to evaluate radiological discharges or releases or potential and actual dose resulting from exposures to radioactive material or radiation.
30. Personal Property — Property of any kind, except for real property.
31. Potential Dose — A calculated dose based on a postulated set of exposure conditions that have a reasonable probability of occurrence.
32. Public Dose — The dose received by members of the public from exposure to radiation and to radioactive material released by a DOE radiological activity whether the exposure is within a DOE site boundary or offsite.
33. Radiation — Ionizing radiation: alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this Order, does not include non-ionizing radiation, such as radio waves or microwaves, or visible, infrared, or ultraviolet light.
34. Radiation Weighting Factor ( $w_R$ ) — The modifying factor used to calculate the equivalent dose from the average tissue or organ absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate radiation weighting factor.
35. Radioactivity — The property or characteristic of radioactive material to undergo spontaneous transformations (disintegrations or decay) with the emission of energy in the form of radiation. It is measured by the rate of spontaneous transformations of a radionuclide. The unit of radioactivity is the curie, Ci (or becquerel, Bq).  
(1 Ci =  $3.7 \times 10^{10}$  Bq).
36. Radiological Activity — Any activity taken for, or by, DOE that has the potential to result in releases of radioactive material to the environment or exposures of members of the public to include all doses both present and future, from clearance activities and radiation generating devices. The activity may involve a single DOE facility, or

- combination of facilities and operations, possibly including an entire site or no fixed site at all.
37. Real Property — Land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached.
  38. Reference Person — A hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus for the purpose of standardizing radiation dose calculations.
  39. Remedial Actions — Those actions, consistent with permanent remedy, taken to control or remove radiological contaminants to prevent or to minimize doses to members of the public.
  40. Representative Person — An individual receiving a dose that is representative of the more highly exposed individuals in the population. This term is the equivalent of, and replaces, ‘average member of the critical group’. (Source: *ICRP Publication 103*, page 32).
  41. Residual Radioactive Material — Any radioactive material which is in or on soil, air, water, equipment, or structures as a consequence of past operations or activities of the Department or its predecessors.
  42. Sanitary Sewerage — A system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by, or for, the Department.
  43. Settleable Solids — (i) that matter in waste water which will not stay in suspension during a preselected settling period, such as one hour, but settles to the bottom; (ii) in the Imhoff cone test, the volume of matter that settles to the bottom of the cone in one hour; or (iii) suspended solids that can be removed by conventional sedimentation processes.
  44. Sewer — An artificial conduit, usually underground, for carrying off waste water and refuse.
  45. Site — Land or property upon which DOE facilities or activities are located and access to which is subject to DOE or DOE contractor control.
  46. Site Boundary — The perimeter of a DOE site, within which DOE or a DOE contractor normally can control access or restrict activities.
  47. Soil Column — An in-situ volume of soil through which liquid waste streams percolate from ponds, cribs, trenches, drain fields, or other areas or facilities used for the primary purpose of removing or retaining the suspended or dissolved radionuclides contained within the liquid process waste stream.
  48. Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) — Any naturally occurring radioactive materials whose radionuclide concentrations or

potential for human exposure have been increased above levels encountered in the natural state by human activities.

49. Tissue Weighting Factor ( $w_T$ ) — The fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The equivalent dose to tissue, ( $H_T$ ), is multiplied by the appropriate tissue weighting factor to obtain the effective dose (E) contribution from that tissue.
50. Total Effective Dose (TED) — Sum of the effective dose (for external exposures) and the committed effective dose.
51. Whole Body — For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.
52. Working Level (WL) — The potential alpha energy concentration of radon decay products in 1 liter of air, without regard to the degree of equilibrium, that will result in the emission of  $1.3 \times 10^5$  MeV of alpha particle energy.