

**§ 962.3 Byproduct material.**

(a) For purposes of this part, the term *byproduct material* means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

(b) For purposes of determining the applicability of the Resource Conservation and Recovery Act (42 U.S.C. 6901 *et seq.*) to any radioactive waste substance owned or produced by the Department of Energy pursuant to the exercise of its atomic energy research, development, testing and production responsibilities under the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.*), the words “any radioactive material,” as used in paragraph (a) of this section, refer only to the actual radionuclides dispersed or suspended in the waste substance. The nonradioactive hazardous component of the waste substance will be subject to regulation under the Resource Conservation and Recovery Act.

determining the suitability of the Yucca Mountain site for the location of a geologic repository. DOE will use these methods and criteria in analyzing the data from the site characterization activities required under section 113 of the Nuclear Waste Policy Act.

(b) This part does not address other information that must be considered and submitted to the President, and made available to the public, by the Secretary under section 114 of the Nuclear Waste Policy Act if the Yucca Mountain site is recommended for development as a geologic repository.

**§ 963.2 Definitions.**

For purposes of this part:

*Applicable radiation protection standard* means (1) For the preclosure period, the preclosure numerical radiation dose limits in 10 CFR 63.111(a) and (b) and 63.204; and

(2) For the postclosure period, the postclosure numerical radiation dose limits in 10 CFR 63.311 and 63.321 and radionuclide concentration limits in 10 CFR 63.331.

*Barrier* means any material, structure or feature that prevents or substantially reduces the rate of movement of water or radionuclides from the Yucca Mountain repository to the accessible environment, or prevents the release or substantially reduces the release rate of radionuclides from the waste. For example, a barrier may be a geologic feature, an engineered structure, a canister, a waste form with physical and chemical characteristics that significantly decrease the mobility of radionuclides, or a material placed over and around the waste, provided that the material substantially delays movement of water or radionuclides.

*Cladding* is the metallic outer sheath of a fuel rod element; it is generally made of a corrosion resistant zirconium alloy or stainless steel, and is intended to isolate the fuel from the external environment.

*Closure* means the final closing of the remaining open operational areas of the underground facility and boreholes after termination of waste emplacement, culminating in the sealing of

**PART 963—YUCCA MOUNTAIN SITE SUITABILITY GUIDELINES**

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AUTHORITY: 42 U.S.C. 2011 *et seq.*; 42 U.S.C. 7101 *et seq.*; 42 U.S.C. 10101, *et seq.*

SOURCE: 66 FR 57336, Nov. 14, 2001, unless otherwise noted.

**Subpart A—General Provisions**

**§ 963.1 Purpose.**

(a) The purpose of this part is to establish DOE methods and criteria for

shafts and ramps, except those openings that may be designed for ventilation or monitoring.

*Colloid* means any fine-grained material in suspension, or any such material that can be easily suspended.

*Criteria* means the characterizing traits relevant to assessing the performance of a geologic repository, as defined by this section, at the Yucca Mountain site.

*Design* means a description of the engineered structures, systems, components and equipment of a geologic repository at Yucca Mountain that includes the engineered barrier system.

*Design bases* means that information that identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be constraints derived from generally accepted "state-of-the-art" practices for achieving functional goals or requirements derived from analysis (based on calculation or experiments) of the effects of a postulated event under which a structure, system, or component must meet its functional goals. The values for controlling parameters for external events include:

(1) Estimates of severe natural events to be used for deriving design bases that will be based on consideration of historical data on the associated parameters, physical data, or analysis of upper limits of the physical processes involved; and

(2) Estimates of severe external human-induced events to be used for deriving design bases, that will be based on analysis of human activity in the region, taking into account the site characteristics and the risks associated with the event.

*DOE* means the U.S. Department of Energy, or its duly authorized representatives.

*Engineered barrier system* means the waste packages, including engineered components and systems other than the waste package (e.g., drip shields), and the underground facility.

*Event sequence* means a series of actions and/or occurrences within the natural and engineered components of a geologic repository operations area

that could potentially lead to exposure of individuals to radiation. An event sequence includes one or more initiating events and associated combinations of repository system component failures, including those produced by the action or inaction of operating personnel. Those event sequences that are expected to occur one or more times before permanent closure of the geologic repository operations area are referred to as Category 1 event sequences. Other event sequences that have at least one chance in 10,000 of occurring before permanent closure are referred to as Category 2 event sequences.

*Geologic repository* means a system that is intended to be used for, or may be used for, the disposal of radioactive wastes in excavated geologic media. A geologic repository includes the engineered barrier system and the portion of the geologic setting that provides isolation of the radioactive waste.

*Geologic repository operations area* means a high-level radioactive waste facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted.

*Geologic setting* means geologic, hydrologic, and geochemical system of the region in which a geologic repository is or may be located.

*High-level radioactive waste* means

(1) The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentration; and

(2) Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation.

*Human intrusion* means breaching of any portion of the Yucca Mountain disposal system within the repository footprint by any human activity.

*Infiltration* means the flow of a fluid into a solid substance through pores or small openings; specifically, the movement of water into soil and fractured or porous rock.

*Initiating event* means a natural or human induced event that causes an event sequence.

*Near-field* means the region where the adjacent natural geohydrologic system has been significantly impacted by the excavation of the repository and the emplacement of the waste.

*NRC* means the U.S. Nuclear Regulatory Commission or its duly authorized representatives.

*Perched water* means ground water of limited lateral extent separated from an underlying body of ground water by an unsaturated zone.

*Preclosure* means the period of time before and during closure of the geologic repository.

*Preclosure safety evaluation* means a preliminary assessment of the adequacy of repository support facilities to prevent or mitigate the effects of postulated initiating events and event sequences and their consequences (including fire, radiation, criticality, and chemical hazards), and the site, structures, systems, components, equipment, and operator actions that would be relied on for safety.

*Postclosure* means the period of time after the closure of the geologic repository.

*Radioactive waste or waste* means high-level radioactive waste and other radioactive materials, including spent nuclear fuel, that are received for emplacement in the geologic repository.

*Reasonably maximally exposed individual* means the hypothetical person meeting the criteria specified at 10 CFR 63.312.

*Reference biosphere* means the description of the environment, inhabited by the reasonably maximally exposed individual. The reference biosphere comprises the set of specific biotic and abiotic characteristics of the environment, including, but not limited to, climate, topography, soils, flora, fauna, and human activities.

*Seepage* means the inflow of ground water moving in fractures or pore spaces of permeable rock to an open space in the rock such as an excavated drift.

*Sensitivity study* means an analytic or numerical technique for examining the effects on model outcomes, such as radionuclide releases, of varying speci-

fied parameters, such as the infiltration rate due to precipitation.

*Site characterization* means activities, whether in the laboratory or in the field, undertaken to establish the geologic conditions and the ranges of the parameters of a candidate site relevant to the location of a repository, including borings, surface excavations, excavations of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing needed to evaluate the suitability of a candidate site for the location of a repository, but not including preliminary borings and geophysical testing needed to assess whether site characterization should be undertaken.

*Surface facilities* means all permanent facilities within the restricted area constructed in support of site characterization activities and repository construction, operation, and closure activities, including surface structures, utility lines, roads, railroads, and similar facilities, but excluding the underground facility.

*System performance* means the complete behavior of a geologic repository system at Yucca Mountain in response to the features, events, and processes that may affect it.

*Total system performance assessment* means a probabilistic analysis that is used to:

(1) Identify the features, events and processes (except human intrusion) that might affect the Yucca Mountain disposal system and their probabilities of occurring during 10,000 years after disposal;

(2) Examine the effects of those features, events, processes, and sequences of events and processes (except human intrusion) on the performance of the Yucca Mountain disposal system; and

(3) Estimate the dose incurred by the reasonably maximally exposed individual, including associated uncertainties, as a result of releases caused by all significant features, events, processes, and sequences of events and processes, weighted by their probability of occurrence.

*Underground facility* means the underground structure, backfill materials, if any, and openings that penetrate the underground structure (e.g., ramps,

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shafts and boreholes, including their seals).

*Waste form* means the radioactive waste materials and any encapsulating or stabilizing matrix.

*Waste package* means the waste form and any containers, shielding, packing, and other absorbent materials immediately surrounding an individual waste container.

*Yucca Mountain disposal system* means the combination of underground engineered and natural barriers within the controlled area that prevents or substantially reduces releases from the waste.

*Yucca Mountain site* means the candidate site in the State of Nevada recommended by the Secretary to the President under section 112(b)(1)(B) of the Nuclear Waste Policy Act of 1982 (NWPA) (42 U.S.C. 1032(b)(1)(B)) on May 27, 1986.

### Subpart B—Site Suitability Determination, Methods, and Criteria

#### § 963.10 Scope.

(a) The scope of this subpart includes the following for both the preclosure and postclosure periods:

(1) The bases for the suitability determination for the Yucca Mountain site as a location for a geologic repository;

(2) The suitability evaluation methods for applying the site suitability criteria to a geologic repository at the Yucca Mountain site; and

(3) The site suitability criteria that DOE will apply in accordance with section 113(b)(1)(A)(iv) of the NWPA.

(b) DOE will seek NRC concurrence on any future revisions to this subpart.

#### § 963.11 Suitability determination.

DOE will evaluate whether the Yucca Mountain site is suitable for the location of a geologic repository on the basis of the preclosure and postclosure determinations described in §§ 963.12 and 963.15. If DOE's evaluation of the Yucca Mountain site for the location of a geologic repository under §§ 963.12 and 963.15 shows that the geologic repository is likely to meet the applicable radiation protection standards for the preclosure and postclosure periods,

then DOE may determine that the site is a suitable location for the development of such a repository.

#### § 963.12 Preclosure suitability determination.

DOE will apply the method and criteria described in §§ 963.13 and 963.14 to evaluate the suitability of the Yucca Mountain site for the preclosure period. If DOE finds that the results of the preclosure safety evaluation conducted under § 963.13 show that the Yucca Mountain site is likely to meet the applicable radiation protection standard, DOE may determine the site suitable for the preclosure period.

#### § 963.13 Preclosure suitability evaluation method.

(a) DOE will evaluate preclosure suitability using a preclosure safety evaluation method. DOE will evaluate the performance of the geologic repository at the Yucca Mountain site using the method described in paragraph (b) of this section and the criteria in § 963.14. DOE will consider the performance of the system in terms of the criteria to evaluate whether the geologic repository is likely to comply with the applicable radiation protection standard.

(b) The preclosure safety evaluation method, using preliminary engineering specifications, will assess the adequacy of the repository facilities to perform their intended functions and prevent or mitigate the effects of postulated Category 1 and 2 event sequences. The preclosure safety evaluation will consider:

(1) A preliminary description of the site characteristics, the surface facilities and the underground operating facilities;

(2) A preliminary description of the design bases for the operating facilities and a preliminary description of any associated limits on operation;

(3) A preliminary description of potential hazards, event sequences, and their consequences; and

(4) A preliminary description of the structures, systems, components, equipment, and operator actions intended to mitigate or prevent accidents.

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### § 963.14 Preclosure suitability criteria.

DOE will evaluate preclosure suitability using the following criteria:

(a) Ability to contain radioactive material and to limit releases of radioactive materials;

(b) Ability to implement control and emergency systems to limit exposure to radiation;

(c) Ability to maintain a system and components that perform their intended safety functions; and

(d) Ability to preserve the option to retrieve wastes during the preclosure period.

### § 963.15 Postclosure suitability determination.

DOE will apply the method and criteria described in §§ 963.16 and 963.17 to evaluate the suitability of the Yucca Mountain site for the postclosure period. If DOE finds that the results of the total system performance assessments conducted under § 963.16 show that the Yucca Mountain site is likely to meet the applicable radiation protection standard, DOE may determine the site suitable for the postclosure period.

### § 963.16 Postclosure suitability evaluation method.

(a) DOE will evaluate postclosure suitability using the total system performance assessment method. DOE will conduct a total system performance assessment to evaluate the ability of the geologic repository to meet the applicable radiation protection standard under the following circumstances:

(1) DOE will conduct a total system performance assessment to evaluate the ability of the Yucca Mountain disposal system to limit radiological doses and radionuclide concentrations in the case where there is no human intrusion into the repository. DOE will model the performance of the Yucca Mountain disposal system using the method described in paragraph (b) of this section and the criteria in § 963.17. DOE will consider the performance of the system in terms of the criteria to evaluate whether the Yucca Mountain disposal system is likely to comply with the applicable radiation protection standard.

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(2) DOE will conduct a separate total system performance assessment to evaluate the ability of the Yucca Mountain disposal system to limit radiological doses in the case where there is a human intrusion as specified by 10 CFR 63.322. DOE will model the performance of the Yucca Mountain disposal system using the method described in paragraph (b) of this section and the criteria in § 963.17. If required by applicable NRC regulations regarding a human intrusion standard, § 63.321, DOE will consider the performance of the system in terms of the criteria to evaluate whether the Yucca Mountain disposal system is likely to comply with the applicable radiation protection standard.

(b) In conducting a total system performance assessment under this section, DOE will:

(1) Include data related to the suitability criteria in § 963.17;

(2) Account for uncertainties and variabilities in parameter values and provide the technical basis for parameter ranges, probability distributions, and bounding values;

(3) Consider alternative models of features and processes that are consistent with available data and current scientific understanding, and evaluate the effects that alternative models would have on the estimated performance of the Yucca Mountain disposal system ;

(4) Consider only events that have at least one chance in 10,000 of occurring over 10,000 years;

(5) Provide the technical basis for either inclusion or exclusion of specific features, events, and processes of the geologic setting, including appropriate details as to magnitude and timing regarding any exclusions that would significantly change the dose to the reasonably maximally exposed individual;

(6) Provide the technical basis for either inclusion or exclusion of degradation, deterioration, or alteration processes of engineered barriers, including those processes that would adversely affect natural barriers, (such as degradation of concrete liners affecting the pH of ground water or precipitation

of minerals due to heat changing hydrologic processes), including appropriate details as to magnitude and timing regarding any exclusions that would significantly change the dose to the reasonably maximally exposed individual;

(7) Provide the technical basis for models used in the total system performance assessment such as comparisons made with outputs of detailed process-level models and/or empirical observations (for example, laboratory testing, field investigations, and natural analogs);

(8) Identify natural features of the geologic setting and design features of the engineered barrier system important to isolating radioactive waste;

(9) Describe the capability of the natural and engineered barriers important to isolating radioactive waste, taking into account uncertainties in characterizing and modeling such barriers;

(10) Provide the technical basis for the description of the capability of the natural and engineered barriers important to isolating radioactive waste;

(11) Use the reference biosphere and reasonably maximally exposed individual assumptions specified in applicable NRC regulations; and

(12) Conduct appropriate sensitivity studies.

**§ 963.17 Postclosure suitability criteria.**

(a) DOE will evaluate the postclosure suitability of a geologic repository at the Yucca Mountain site through suitability criteria that reflect both the processes and the models used to simulate those processes that are important to the total system performance of the geologic repository. The applicable criteria are:

(1) Site characteristics, which include:

(i) Geologic properties of the site—for example, stratigraphy, rock type and physical properties, and structural characteristics;

(ii) Hydrologic properties of the site—for example, porosity, permeability, moisture content, saturation, and potentiometric characteristics;

(iii) Geophysical properties of the site—for example, densities, velocities

and water contents, as measured or deduced from geophysical logs; and

(iv) Geochemical properties of the site—for example, precipitation, dissolution characteristics, and sorption properties of mineral and rock surfaces.

(2) Unsaturated zone flow characteristics, which include:

(i) Climate—for example, precipitation and postulated future climatic conditions;

(ii) Infiltration—for example, precipitation entering the mountain in excess of water returned to the atmosphere by evaporation and plant transpiration;

(iii) Unsaturated zone flux—for example, water movement through the pore spaces, or flowing along fractures or through perched water zones above the repository;

(iv) Seepage—for example, water dripping into the underground repository openings from the surrounding rock.

(3) Near field environment characteristics, which include:

(i) Thermal hydrology—for example, effects of heat from the waste on water flow through the site, and the temperature and humidity at the engineered barriers.

(ii) Near field geochemical environment—for example, the chemical reactions and products resulting from water contacting the waste and the engineered barrier materials.

(4) Engineered barrier system degradation characteristics, which include:

(i) Engineered barrier system component performance—for example, drip shields, backfill, coatings, or chemical modifications, and

(ii) Waste package degradation—for example, the corrosion of the waste package materials within the near-field environment.

(5) Waste form degradation characteristics, which include:

(i) Cladding degradation—for example, corrosion or break-down of the cladding on the spent fuel pellets;

(ii) Waste form dissolution—for example, the ability of individual radionuclides to dissolve in water penetrating breached waste packages.

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(6) Engineered barrier system degradation, flow, and transport characteristics, which include:

(i) Colloid formation and stability—for example, the formation of colloidal particles and the ability of radionuclides to adhere to these particles as they may migrate through the remaining barriers; and

(ii) Engineered barrier transport—for example, the movement of radionuclides dissolved in water or adhering to colloidal particles to be transported through the remaining engineered barriers and in the underlying unsaturated zone.

(7) Unsaturated zone flow and transport characteristics, which include:

(i) Unsaturated zone transport—for example, the movement of water with dissolved radionuclides or colloidal particles through the unsaturated zone underlying the repository, including retardation mechanisms such as sorption on rock or mineral surfaces;

(ii) Thermal hydrology—for example, effects of heat from the waste on water flow through the site.

(8) Saturated zone flow and transport characteristics, which include:

(i) Saturated zone transport—for example, the movement of water with dissolved radionuclides or colloidal particles through the saturated zone underlying and beyond the repository, including retardation mechanisms such as sorption on rock or mineral surfaces; and

(ii) Dilution—for example, diffusion of radionuclides into pore spaces, dis-

persion of radionuclides along flow paths, and mixing with non-contaminated ground water.

(9) Biosphere characteristics, which include:

(i) Reference biosphere and reasonably maximally exposed individual—for example, biosphere water pathways, location and behavior of reasonably maximally exposed individual; and

(ii) Biosphere transport and uptake—for example, the consumption of ground or surface waters through direct extraction or agriculture, including mixing with non-contaminated waters and exposure to contaminated agricultural products.

(b) DOE will evaluate the postclosure suitability of the Yucca Mountain disposal system using criteria that consider disruptive processes and events important to the total system performance of the geologic repository. The applicable criteria related to disruptive processes and events include:

(1) Volcanism—for example, the probability and potential consequences of a volcanic eruption intersecting the repository;

(2) Seismic events—for example, the probability and potential consequences of an earthquake on the underground facilities or hydrologic system; and

(3) Nuclear criticality—for example, the probability and potential consequences of a self-sustaining nuclear reaction as a result of chemical or physical processes affecting the waste either in or after release from breached waste packages.