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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 07 1989

Post-remand

NOTE FOR: Commissioners Assistants

THRU: James L. Blaha, EDO JLB

FROM: Robert E. Browning, NMSS

SUBJECT: FIRST "WORKING DRAFT" OF THE ENVIRONMENTAL PROTECTION AGENCY'S (EPA) REVISED HIGH-LEVEL WASTE DISPOSAL STANDARD

Enclosed, per Margaret Federline's request of Mr. Robert Browning on July 6, 1989, is the first "working draft" of the Environmental Protection Agency's (EPA) revised high-level waste disposal standard.

Browning was also requested to inform you of the date when an Advisory Committee on Nuclear Waste (ACNW) consultant (Dr. Okrent) would be visiting with the NRC High-Level Waste Management Division (HLWM) staff to discuss performance assessment. We currently anticipate this visit will occur sometime in late July and will inform you as soon as a firm date is scheduled with the ACNW.

REBrowning
Robert E. Browning

Enclosure:
As stated

cc. H. Thompson
V. Stello
SECY
L. Roché
OGC

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PDR COMMS NRCC
CORRESPONDENCE PDR

WORKING DRAFT 1 OF 40 CFR Part 191

NOTE: This Working Draft has been prepared for discussion within EPA, and it has not been reviewed or approved by the Agency. Various aspects may be changed before it is published in the Federal Register for public review and comment. In particular, some Options may be eliminated and others may be added. This Working Draft is being placed in the Docket for this rulemaking for information purposes only.

Language that has been revised from the version of the rule that was promulgated in August 1985 is shown in *italics*. Since Subpart A of 40 CFR 191 is still in effect, changes to Subpart A will ultimately be proposed as a series of modifications to the existing rule. Since all of Subpart B was vacated and remanded to the Agency for reconsideration, all of the provisions shown here for Subpart B will be proposed as a new draft for public review and comment.

For further information please contact either Dan Egan or Ray Clark at (202) 475-9633.

A revised Part 191 is hereby incorporated into Title 40, Code of Federal Regulations, as follows:

SUBCHAPTER F - RADIATION PROTECTION PROGRAMS

PART 191 - ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR MANAGEMENT AND DISPOSAL OF SPENT NUCLEAR FUEL, HIGH-LEVEL AND TRANSURANIC RADIOACTIVE WASTES

Subpart A - Environmental Standards for Management and Storage

191.01 Applicability
191.02 Definitions
191.03 Standards
191.04 Alternative Standards
191.05 Effective Date

Subpart B - Environmental Standards for Disposal

191.11 Applicability
191.12 Definitions
191.13 Containment Requirements
191.14 Assurance Requirements
191.15 Individual Protection Requirements
191.16 Ground Water Protection Requirements
191.17 Alternative Provisions for Disposal
191.18 Effective Date

Appendix A *Calculation of Committed Effective Dose Equivalent*
Appendix B Table for Subpart B
Appendix C Guidance for Implementation of Subpart B

AUTHORITY: The Atomic Energy Act of 1954, as amended; Reorganization Plan No. 3 of 1970; and the Nuclear Waste Policy Act of 1982.

SUBPART A - ENVIRONMENTAL STANDARDS FOR MANAGEMENT AND STORAGE

191.01 Applicability

This Subpart applies to:

(a) radiation doses received by members of the public as a result of the management (except for transportation) and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at any facility regulated by the Nuclear Regulatory Commission or by Agreement States, to the extent that such management and storage operations are not subject to the provisions of Part 190 of Title 40; and

(b) radiation doses received by members of the public as a result of the management and storage of spent nuclear fuel or high-level or transuranic wastes at any facility that is operated by the Department of Energy and that is not regulated by the Commission or by Agreement States.

191.02 Definitions

Unless otherwise indicated in this Subpart, all terms shall have the same meaning as in Subpart A of Part 190.

(a) "Agency" means the Environmental Protection Agency.

(b) "Administrator" means the Administrator of the Environmental Protection Agency.

(c) "Commission" means the Nuclear Regulatory Commission.

(d) "Department" means the Department of Energy.

(e) "NWPA" means the Nuclear Waste Policy Act of 1982 (Pub. L. 97-425), as amended.

(f) "Agreement State" means any State with which the Commission or the Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended (68 Stat. 919).

(g) "Spent nuclear fuel" means fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

(h) "High-level radioactive waste," as used in this Part, means high-level radioactive waste as defined in the Nuclear Waste Policy Act of 1982 (Pub. L. 97-425).

(i) "Transuranic radioactive waste," as used in this Part, means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than twenty years, per gram of waste, except for: (1) high-level radioactive waste; (2) wastes that the Department has determined, with the concurrence of the Administrator, do not need the degree of isolation required by this Part; or (3) wastes that the Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

(j) "Radioactive waste," as used in this Part, means the high-level and transuranic radioactive waste covered by this Part.

(k) "Storage" means retention of spent nuclear fuel or radioactive wastes with the intent and capability to readily retrieve such fuel or waste.

(l) "Disposal" *[definition moved to Subpart B]*

(m) "Management" means any activity, operation, or process (except for transportation) conducted to prepare spent nuclear fuel or radioactive waste for storage or disposal, or the activities associated with placing such fuel or waste in a disposal system.

(n) "Site" means an area contained within the boundary of a location under the effective control of persons possessing or using spent nuclear fuel or radioactive waste that are involved in any activity, operation, or process covered by this Subpart.

(o) "General environment" means the total terrestrial, atmospheric, and aquatic environments outside sites within which any activity, operation, or process *regulated by this or any other regulation established under the authority of the Atomic Energy Act of 1954, as amended, takes place.*

(p) "Member of the public" means any individual except during the time when that individual is a worker engaged in any activity, operation, or process that is covered by the Atomic Energy Act of 1954, as amended.

(q) "Dose equivalent" means the product of absorbed dose and appropriate factors to account for differences in biological effectiveness due to the quality of radiation and its spatial distribution in the body. The unit of dose equivalent is the "rem."

(r) "Committed effective dose equivalent" means the normalization of the individual dose equivalents from specific radionuclides to specific organs in terms of external radiation to the whole body, at a level of equivalent total risk. The method used to calculate the effective whole body dose is

described in Appendix A of this Part.

191.03 Standards

(a) Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities regulated by the Commission or by Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual *committed effective* dose equivalent to any member of the public in the general environment resulting from: (1) discharges of radioactive material and direct radiation from such management and storage and (2) all operations covered by *Part 61*; shall not exceed 25 millirems.

(b) Management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities that are operated by the Department and that are not regulated by the Commission or Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual *committed effective* dose equivalent to any member of the public in the general environment resulting from: *(1)* discharges of radioactive material and direct radiation from such management and storage *and (2) all operations covered by Part 61;* shall not exceed 25 millirems.

[NOTE: In this draft, Section 191.03(b) has been modified so that its applicability is not limited to disposal facilities operated by the Department; it now includes management and storage at other types of facilities as well.]

191.04 Alternative Standards

(a) The Administrator may issue alternative standards from those standards established in 191.03(b) for waste management and storage activities at facilities that are not regulated by the Commission or Agreement States if, upon review of an application for such alternative standards:

(1) The Administrator determines that such alternative standards will prevent any member of the public from receiving a continuous exposure of more than 100 millirem per year *committed effective* dose equivalent and an infrequent exposure of more than 500 millirem *committed effective* dose equivalent in a year from all sources, excluding natural background and medical procedures; and

(2) The Administrator promptly makes a matter of public record the degree to which continued operation of the facility is expected to result in levels in excess of the standards specified in 191.03(b).

(b) An application for alternative standards shall be submitted as soon as possible after the Department determines that continued operation of a facility will exceed the levels specified in 191.03(b) and shall include all information necessary for the Administrator to make the determinations called for in 191.04(a).

(c) Requests for alternative standards shall be submitted to the Administrator, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, D.C., 20460.

191.05 Effective Date

The *modifications to* this Subpart shall be effective on [60 days after publication in the FEDERAL REGISTER].

SUBPART B - ENVIRONMENTAL STANDARDS FOR DISPOSAL

191.11 Applicability

This Subpart applies to:

(a) radioactive materials released into the accessible environment as a result of the disposal of spent nuclear fuel or high-level or transuranic radioactive wastes;

(b) radiation doses received by members of the public as a result of such disposal; and

(c) radioactive contamination of certain sources of ground water in the vicinity of disposal systems for such fuel or wastes.

However, this Subpart does not apply to disposal directly into the oceans or ocean sediments. This Subpart also does not apply to wastes disposed of before August 15, 1985.

191.12 Definitions

Unless otherwise indicated in this Subpart, all terms shall have the same meaning as in Subpart A of this Part.

(a) "Disposal" means [OPTION 1.A] permanent isolation of spent nuclear fuel or radioactive waste from the accessible environment with no intent of recovery, whether or not such isolation permits the recovery of such fuel or waste. For example, disposal of waste in a mined geologic repository occurs when all of the shafts to the repository are backfilled and sealed.

(a) "Disposal" means [OPTION 1.B] placement of spent nuclear fuel or radioactive waste in a disposal system, whether or not such placement permits the recovery of such fuel or waste, except that placements for experimental purposes that include pre-established plans for the removal of the fuel or waste do not constitute disposal.

(b) "Disposal system" means any combination of engineered and natural barriers that isolate spent nuclear fuel or radioactive waste after disposal.

(c) "Waste," as used in this Subpart, means any spent nuclear fuel or radioactive waste isolated in a disposal system.

(d) "Waste form" means the materials comprising the radioactive components of waste and any encapsulating or stabilizing matrix.

(e) "Barrier" means any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment. For example, a barrier may be a geologic 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 waste, provided that the material or structure substantially delays movement of water or radionuclides.

(f) "Passive institutional control" means: (1) permanent markers placed at a disposal site, (2) public records and archives, (3) government ownership and regulations regarding land or resource use, and (4) other methods of preserving knowledge about the location, design, and contents of a disposal system.

(g) "Active institutional control" means: (1) controlling access to a disposal site by any means other than passive institutional controls; (2) performing maintenance operations or remedial actions at a site, (3) controlling or cleaning up releases from a site, or (4) monitoring parameters related to disposal system performance.

(h) "Controlled area" means: (1) a surface location, to be identified by passive institutional controls, that encompasses no more than 100 square kilometers and extends horizontally no more than five kilometers in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system; and (2) the subsurface underlying such a surface location.

(i) "Ground water" means water below the land surface in a zone of saturation.

(j) "Aquifer" means an underground geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

(k) "Lithosphere" means the solid part of the Earth below the surface, including any ground water contained within it.

(l) "Accessible environment" means: (1) all of the lithosphere that is beyond the controlled area; (2) the atmosphere; (3) land surfaces; (4) surface waters; and (5) the oceans.

(m) "Transmissivity" means the hydraulic conductivity integrated over the saturated thickness of an underground formation. The transmissivity of a

series of formations is the sum of the individual transmissivities of each formation comprising the series.

(n) "Community water system" means a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

(o) "Class I ground water" means ground water of unusually high value. It is highly vulnerable to contamination and includes: (1) irreplaceable sources of drinking water or (2) ground water that is ecologically vital. Ground water may be considered "irreplaceable" if it serves a population of 2,500 or more and if delivery of comparable quality and quantity of water from alternative sources in the area would be economically infeasible or precluded by institutional constraints.

(p) "Special source of ground water" means those Class I ground waters that: (1) are within the controlled area encompassing a disposal system or are less than five kilometers beyond the controlled area; and (2) are supplying drinking water for 2,500 or more persons as of the date that the Department chooses a location within that area for detailed characterization as a potential site for a disposal system.

(q) "Class II ground water" means all non-Class I ground water currently used, or potentially available, for drinking water.

(r) "Class III ground water" means ground waters that are saline or otherwise contaminated beyond levels that would allow use for drinking or

other beneficial purposes. This includes ground waters: (1) with a total dissolved solids concentration over 10,000 milligrams per liter; or (2) that are so contaminated by naturally occurring conditions, or by the effects of broad-scale human activity (i.e., unrelated to disposal of radioactive wastes), that they cannot be cleaned up using treatment methods reasonably employed in public water supply systems.

(s) "Class IIIA ground water" means Class III ground waters that are highly or moderately interconnected to adjacent ground waters of higher class or surface waters.

(t) "Class IIIB ground water" means Class III ground waters characterized by a low degree of interconnection to adjacent ground waters of higher class or surface waters.

(u) *"High-yield aquifer"* means *either*: (1) an aquifer that: (i) is saturated with water having less than 10,000 milligrams per liter of total dissolved solids; (ii) is within 2,500 feet of the land surface; (iii) has a transmissivity greater than 200 gallons per day per foot, provided that any formation or part of a formation included within the source of ground water has a hydraulic conductivity greater than 2 gallons per day per square foot; and (iv) is capable of continuously yielding at least 10,000 gallons per day to a pumped or flowing well for a period of at least a year; or (2) an aquifer that provides the primary source of water for a community water system as of the effective date of this Subpart.

(v) "Man-made radionuclide" means any radionuclide classified as source, byproduct, or special nuclear material under the Atomic Energy Act of 1954, as amended.

(w) "Undisturbed performance" means the predicted behavior of a disposal system, including consideration of the uncertainties in predicted behavior, if the disposal system is not disrupted by human intrusion or the occurrence of unlikely natural events.

(x) "Performance assessment" means an analysis that: (1) identifies the processes and events that might affect the disposal system; (2) examines the effects of these processes and events on the performance of the disposal system; and (3) estimates the cumulative releases of radionuclides, considering the associated uncertainties, caused by all significant processes and events. These estimates shall be incorporated into an overall probability distribution of cumulative release to the extent practicable.

(y) "Heavy metal" means all uranium, plutonium, or thorium placed into a nuclear reactor.

(z) "Implementing agency," as used in this Subpart, means the Commission for spent nuclear fuel or high-level or transuranic wastes to be disposed of in facilities licensed by the Commission in accordance with the Energy Reorganization Act of 1974 and the Nuclear Waste Policy Act of 1982, and it means the Department for all other radioactive wastes covered by this Part.

191.13 Containment Requirements

(a) Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall:

(1) have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (Appendix B); and

(2) have a likelihood of less than one chance in 1,000 of exceeding ten times the quantities calculated according to Table 1 (Appendix B).

(b) Performance assessments need not provide complete assurance that the requirements of 191.13(a) will be met. Because of the long time period involved and the nature of the events and processes of interest, there will inevitably be substantial uncertainties in projecting disposal system performance. Proof of the future performance of a disposal system is not to be had in the ordinary sense of the word in situations that deal with much shorter time frames. Instead, what is required is a reasonable expectation, on the basis of the record before the implementing agency, that compliance with 191.13(a) will be achieved.

(c) Between 10,000 years and 100,000 years after disposal, undisturbed performance of the disposal system should not result in projected release rates that are much greater than those allowed by section 191.13(a)(1).

New 3

191.14 Assurance Requirements

To provide the confidence needed for long-term compliance with the requirements of 191.13, disposal of spent nuclear fuel or high-level or transuranic wastes shall be conducted in accordance with the following provisions, except that these provisions do not apply to facilities regulated by the Commission (see 10 CFR Part 60 for comparable provisions applicable to facilities regulated by the Commission):

(a) Active institutional controls over disposal sites should be maintained for as long a period of time as is practicable after disposal; however, performance assessments that assess isolation of the wastes from the accessible environment shall not consider any contributions from active institutional controls for more than 100 years after disposal.

(b) Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring.

(c) Disposal sites shall be designated by the most permanent markers, records, and other passive institutional controls practicable to indicate the dangers of the wastes and their location.

(d) Disposal systems shall be selected and designed to keep releases to the accessible environment as small as reasonably achievable, taking into

account technical, social, and economic considerations.

(e) Disposal systems shall use different types of barriers to isolate the wastes from the accessible environment. Both engineered and natural barriers shall be included.

(f) Places where there has been mining for resources, or where there is a reasonable expectation of exploration for scarce or easily accessible resources, or where there is a significant concentration of any material that is not widely available from other sources, should be avoided in selecting disposal sites. Resources to be considered shall include minerals, petroleum or natural gas, valuable geologic formations, and ground waters that are either irreplaceable because there is no reasonable alternative source of drinking water available for substantial populations or that are vital to the preservation of unique and sensitive ecosystems. Such places shall not be used for disposal of the wastes covered by this Part unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future.

(g) Disposal systems shall be selected so that removal of most of the wastes is not precluded for a reasonable period of time after disposal.

191.15 Individual Protection Requirements

Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation that, for 1,000 years after disposal, undisturbed performance of the disposal system

shall not cause the annual *committed effective* dose equivalent *due to all potential pathways* from the disposal system to any member of the public in the accessible environment to exceed 25 millirems. *[OPTION 2.A] These pathways shall include* the assumption that individuals consume 2 liters per day of drinking water from any *high-yield aquifer* outside of the controlled area.

191.16 Ground Water Protection Requirements *[OPTION 2.A: Eliminate 191.16]*

(a) Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation that, for 1,000 years after disposal, undisturbed performance of the disposal system shall not cause:

(1) any increase in the levels of radioactivity in any portion of a special source of ground water;

(2) [OPTION 2.B] any increase in the levels of radioactivity for any Class II ground waters from high-yield aquifers outside the controlled area such that a member of the public would receive more than 4 millirems annual committed effective dose equivalent from man-made radionuclides by drinking two liters per day of affected ground water;

(2) [OPTION 2.C] any increase in the levels of radioactivity for any Class II ground waters outside the controlled area such that a member of the public would receive more than 4 millirems annual committed effective dose equivalent from man-made radionuclides by drinking two liters per day of affected ground water;

(3) [OPTION 2.B] any increase in the levels of radioactivity for all other Class II ground waters or Class IIIB ground waters such that an individual can receive more than 25 millirems annual committed effective dose equivalent from all routes of exposure from the disposal system.

(3) [OPTION 2.C] any increase in the levels of radioactivity for Class IIIB ground waters such that an individual can receive more than 25 millirems annual committed effective dose equivalent from all routes of exposure from the disposal system.

(b) The level of radioactive contamination permitted in any Class IIIA ground water shall be determined by the class of ground water to which it is hydrodynamically connected. When the ground water sources are regulated at different levels of protection the most protective standard shall apply.

[OPTION 3.A: Sections 191.15 and 191.16 apply for 1,000 years after disposal]
[OPTION 3.B: Sections 191.15 and 191.16 apply for 10,000 years after disposal]

191.17 Alternative Provisions for Disposal

The Administrator may, by rule, substitute for any of the provisions of Subpart B alternative provisions chosen after:

(a) the alternative provisions have been proposed for public comment in the FEDERAL REGISTER together with information describing the costs, risks, and benefits of disposal in accordance with the alternative provisions and the reasons why compliance with the existing provisions of Subpart B appears inappropriate;

(b) a public comment period of at least 90 days has been completed, during which an opportunity for public hearings in affected areas of the country has been provided; and

(c) the public comments received have been fully considered in developing the final version of such alternative provisions.

191.18 Effective Date

The standards in this Subpart shall be effective on [60 days after publication in the FEDERAL REGISTER].

APPENDIX A - CALCULATION OF COMMITTED EFFECTIVE DOSE EQUIVALENT

H_E = Summation (for all organ or tissue, t) $H_t w_t$ where:

H_E = Committed effective dose equivalent (millirem)

H_t = Dose equivalent to organ or tissue, t (millirem)

w_t = Weighting factor for organ or tissue, t (dimensionless):

organ or tissue, t	weighting factor (w_t)
gonads	0.25
breast	0.15
red bone marrow	0.12
lung	0.12
thyroid	0.03
bone surfaces	0.03
remainder *	0.30

** remainder consists of the five remaining organs with the highest dose equivalent, with each one weighted at 0.06.*

NOTE: Dose equivalent is the product of absorbed dose and quality factor. Absorbed dose is defined as the energy imparted by ionizing radiation per unit mass of irradiated materials, at the location of interest, in the units of the rad.

APPENDIX B - TABLE FOR SUBPART B

- -

TABLE 1 - RELEASE LIMITS FOR CONTAINMENT REQUIREMENTS
(Cumulative Releases to the Accessible Environment
for 10,000 Years After Disposal)

Radionuclide	Release Limit per 10,000 MTHM or other unit of waste (see Notes) (curies)
Americium-241 or -243	1000
Carbon-14	1000
Cesium-135 or -137	10000
Iodine-129	1000
Neptunium-237	1000
Plutonium-238, -239, -240, or -242	1000
Radium-226	1000
Strontium-90	10000
Technetium-99	100000
Thorium-230 or -232	100
Tin-126	10000
Uranium-233, -234, -235, -236, or -238	1000
Any other alpha-emitting radionuclide with a half-life greater than 20 years	1000
Any other radionuclide with a half-life greater than 20 years that does not emit alpha particles	10000

[NOTE: New radionuclide risk factors are currently being evaluated, which may result in revised Release Limits in later Working Drafts of the rule. The factor of 10 increase in these Release Limits over those in the 1985 rule is caused by changing the unit of waste from 1,000 MTHM to 10,000 MTHM.]

Application of Table 1

NOTE 1: Units of Waste. The Release Limits in Table 1 apply to the amount of wastes in any one of the following:

(a) an amount of spent nuclear fuel containing 10,000 metric tons of heavy metal (MTHM) exposed to a burnup between 25,000 megawatt-days per metric ton of heavy metal (MWd/MTHM) and 40,000 MWd/MTHM;

(b) the high-level radioactive wastes generated from reprocessing each 10,000 MTHM exposed to a burnup between 25,000 MWd/MTHM and 40,000 MWd/MTHM;

(c) each 1,000,000,000 curies of gamma or beta-emitting radionuclides with half-lives greater than 20 years but less than 100 years (for use as discussed in Note 5 or with materials identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA);

(d) each 10,000,000 curies of other radionuclides (i.e., gamma or beta-emitters with half-lives greater than 100 years or any alpha-emitters with half-lives greater than 20 years) (for use as discussed in Note 5 or with materials identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA); or

(e) an amount of transuranic (TRU) wastes containing 10,000.000 curies of alpha-emitting transuranic radionuclides with half-lives greater than 20 years.

NOTE 2: Release Limits for Specific Disposal Systems. To develop Release Limits for a particular disposal system, the quantities in Table 1 shall be adjusted for the amount of waste included in the disposal system compared to the various units of waste defined in Note 1. For example:

(a) If a particular disposal system contained the high-level wastes from 50,000 MTHM, the Release Limits for that system would be the quantities in Table 1 multiplied by 5 (50,000 MTHM divided by 10,000 MTHM).

(b) If a particular disposal system contained 12 million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by 1.2 (12 million curies divided by ten million curies).

(c) If a particular disposal system contained both the high-level wastes from 50,000 MTHM and 5 million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by 5.5:

$$\frac{50{,}000 \text{ MTHM}}{10{,}000 \text{ MTHM}} + \frac{5{,}000{,}000 \text{ curies TRU}}{10{,}000{,}000 \text{ curies TRU}} = 5.5$$

NOTE 3: Release Limits for Disposal Systems with Small Amounts of Waste. The implementing agency need not use a Release Limit multiplier smaller than one (1). However, if the same implementing agency has jurisdiction over two or more disposal systems within 20 kilometers of one another, the total Release Limit multiplier for all of these nearby disposal systems may not be larger than the multiplier that would apply if all of the spent fuel or waste were located in one disposal system.

NOTE 4: Adjustments for Reactor Fuels with Different Burnup. For disposal systems containing reactor fuels (or the high-level wastes from reactor fuels) exposed to an average burnup of less than 25,000 MWd/MTHM or greater than 40,000 MWd/MTHM, the units of waste defined in (a) and (b) of Note 1 shall be adjusted. The unit shall be multiplied by the ratio of 30,000 MWd/MTHM divided by the fuel's actual average burnup, except that a value of 5,000 MWd/MTHM may be used when the average fuel burnup is below 5,000 MWd/MTHM and a value of 100,000 MWd/MTHM shall be used when the average fuel burnup is above 100,000 MWd/MTHM. This adjusted unit of waste shall then be used in determining the Release Limits for the disposal system.

For example, if a particular disposal system contained only high-level wastes with an average burnup of 3,000 MWd/MTHM, the unit of waste for that disposal system would be:

$$10{,}000 \text{ MTHM} \times \frac{(30{,}000 \text{ MWd/MTHM})}{(5{,}000 \text{ MWd/MTHM})} = 60{,}000 \text{ MTHM}$$

If that disposal system contained the high-level wastes from 60,000 MTHM (with an average burnup of 3,000 MWd/MTHM), then the Release Limits for that system would be the quantities in Table 1 multiplied by one (1):

$$\frac{60{,}000 \text{ MTHM}}{60{,}000 \text{ MTHM}} = 1$$

which is the same as:

$$\frac{60{,}000 \text{ MTHM}}{10{,}000 \text{ MTHM}} \times \frac{(5{,}000 \text{ MWd/MTHM})}{(30{,}000 \text{ MWd/MTHM})} = 1$$

NOTE 5: <u>Treatment of Fractionated High-Level Wastes.</u> In some cases, a high-level waste stream from reprocessing spent nuclear fuel may have been (or will be) separated into two or more high-level waste components destined for different disposal systems. In such cases, the implementing agency may allocate the Release Limit multiplier (based upon the original MTHM and the average fuel burnup of the high-level waste stream) among the various disposal systems as it chooses, provided that the total Release Limit multiplier used for that waste stream at all of its disposal systems may not exceed the Release Limit multiplier that would be used if the entire waste stream were disposed of in one disposal system.

NOTE 6: Treatment of Wastes with Poorly Known Burnups or Original MTHM. In some cases, the records associated with particular high-level waste streams may not be adequate to accurately determine the original metric tons of heavy metal in the reactor fuel that created the waste, or to determine the average burnup that the fuel was exposed to. If the uncertainties are such that the original amount of heavy metal or the average fuel burnup for particular high-level waste streams cannot be quantified, the units of waste derived from (a) and (b) of Note 1 shall no longer be used. Instead, the units of waste defined in (c) and (d) of Note 1 shall be used for such high-level waste streams. If the uncertainties in such information allow a range of values to be associated with the original amount of heavy metal or the average fuel burnup, then the calculations described in previous Notes will be conducted using the values that result in the smallest Release Limits, except that the Release Limits need not be smaller than those that would be calculated using the units of waste defined in (c) and (d) of Note 1.

NOTE 7: Use of Release Limits to Determine Compliance with 191.13. Once release limits for a particular disposal system have been determined in accordance with Notes 1 through 5, these release limits shall be used to determine compliance with the requirements of 191.13 as follows. In cases where a mixture of radionuclides is projected to be released to the accessible environment, the limiting values shall be determined as follows: For each radionuclide in the mixture, determine the ratio between the cumulative release quantity projected over 10,000 years and the limit for that radionuclide as determined from Table 1 and Notes 1 through 5. The sum of such ratios for all the radionuclides in the mixture may not exceed one with regard to 191.13(a)(1) and may not exceed ten with regard to 191.13(a)(2).

For example, if radionuclides A, B, and C are projected to be released in amounts Q_a, Q_b, and Q_c, and if the applicable Release Limits are RL_a, RL_b, and RL_c, then the cumulative releases over 10,000 years shall be limited so that the following relationship exists:

$$\frac{Q_a}{RL_a} + \frac{Q_b}{RL_b} + \frac{Q_c}{RL_c} \quad 1$$

APPENDIX C - GUIDANCE FOR IMPLEMENTATION OF SUBPART B

[NOTE: The supplemental information in this appendix is not an integral part of 40 CFR 191. Therefore, the implementing agencies are not bound to follow this guidance. However, it is included because it describes the Agency's assumptions regarding the implementation of Subpart B. This appendix will appear in the Code of Federal Regulations.]

The Agency believes that the implementing agencies must determine compliance with 191.13, 191.15, and 191.16 of Subpart B by evaluating long-term predictions of disposal system performance. Determining compliance with 191.13 will also involve predicting the likelihood of events and processes that may disturb the disposal system. In making these various predictions, it will be appropriate for the implementing agencies to make use of rather complex computational models, analytical theories, and prevalent expert judgment relevant to the numerical predictions. Substantial uncertainties are likely to be encountered in making these predictions. In fact, sole reliance on these numerical predictions to determine compliance may not be appropriate; the implementing agencies may choose to supplement such predictions with qualitative judgments as well. Because the procedures for determining compliance with Subpart B have not been formulated and tested yet, this appendix to the rule indicates the Agency's assumptions regarding certain issues that may arise when implementing sections 191.13, 191.15, and 191.16. Most of this guidance applies to any type of disposal system for the wastes covered by this rule. However, several sections apply only to disposal in mined geologic repositories and would be inappropriate for other types of

disposal systems.

Consideration of Total Disposal System. When predicting disposal system performance, the Agency assumes that reasonable projections of the protection expected from all of the engineered and natural barriers of a disposal system will be considered. Portions of the disposal system should not be disregarded, even if projected performance is uncertain, except for portions of the system that make negligible contributions to the overall isolation provided by the disposal system.

Scope of Performance Assessments. Section 191.13 requires the implementing agencies to evaluate compliance through performance assessments as defined in Section 191.12(q). The Agency assumes that such performance assessments need not consider categories of events or processes that are estimated to have less than one chance in 10,000 of occurring over 10,000 years. Furthermore, the performance assessments need not evaluate in detail the releases from all events and processes estimated to have a greater likelihood of occurrence. Some of these events and processes may be omitted from the performance assessments if there is a reasonable expectation that the remaining probability distribution of cumulative releases would not be significantly changed by such omissions.

Compliance with Section 191.13. The Agency assumes that, whenever practicable, the implementing agency will assemble all of the results of the performance assessments to determine compliance with 191.13 into a "complementary cumulative distribution function" that indicates the

probability of exceeding various levels of cumulative release. When the uncertainties in parameters are considered in a performance assessment, the effects of the uncertainties considered can be incorporated into a single such distribution function for each disposal system considered. The Agency assumes that a disposal system can be considered to be in compliance with 191.13 if this single distribution function meets the requirements of 191.13(a).

Compliance with Sections 191.15 and 191.16. When the uncertainties in undisturbed performance of a disposal system are considered, the implementing agencies need not require that a very large percentage of the range of estimated radiation exposures or radionuclide concentrations fall below limits established in 191.15 and 191.16, respectively. The Agency assumes that compliance can be determined based upon "best estimate" predictions (e.g., the mean or the median of the appropriate distribution, whichever is higher).

Institutional Controls. To comply with 191.14(a), the implementing agency will assume that none of the active institutional controls prevent or reduce radionuclide releases for more than 100 years after disposal. However, the Federal Government is committed to retaining ownership of all disposal sites for spent nuclear fuel and high-level and transuranic radioactive wastes and will establish appropriate markers and records, consistent with 191.14(c). The Agency assumes that, as long as such passive institutional controls endure and are understood, they: (1) can be effective in deterring systematic or persistent exploitation of these disposal sites; and (2) can reduce the

likelihood of inadvertent, intermittent human intrusion to a degree to be determined by the implementing agency. However, the Agency believes that passive institutional controls can never be assumed to eliminate the chance of inadvertent and intermittent human intrusion into these disposal sites.

Consideration of Inadvertent Human Intrusion into Geologic Repositories. The most speculative potential disruptions of a mined geologic repository are those associated with inadvertent human intrusion. Some types of intrusion would have virtually no effect on a repository's containment of waste. On the other hand, it is possible to conceive of intrusions (involving widespread societal loss of knowledge regarding radioactive wastes) that could result in major disruptions that no reasonable repository selection or design precautions could alleviate. The Agency believes that the most productive consideration of inadvertent intrusion concerns those realistic possibilities that may be usefully mitigated by repository design, site selection, or use of passive controls (although passive institutional controls should not be assumed to completely rule out the possibility of intrusion). Therefore, inadvertent and intermittent intrusion by exploratory drilling for resources (other than any provided by the disposal system itself) can be the most severe intrusion scenario assumed by the implementing agencies. Furthermore, the implementing agencies can assume that passive institutional controls or the intruders' own exploratory procedures are adequate for the intruders to soon detect, or be warned of, the incompatibility of the area with their activities.

Frequency and Severity of Inadvertent Human Intrusion into Geologic Repositories. The implementing agencies should consider the effects of each particular disposal system's site, design, and passive institutional controls in judging the likelihood and consequences of such inadvertent exploratory drilling. However, the Agency assumes that the likelihood of such inadvertent and intermittent drilling need not be taken to be greater than 30 boreholes per square kilometer of repository area per 10,000 years for geologic repositories in proximity to sedimentary rock formations, or more than 3 boreholes per square kilometer per 10,000 years for repositories in other geologic formations. Furthermore, the Agency assumes that the consequences of such inadvertent drilling need not be assumed to be more severe than: (1) direct release to the land surface of all the ground water in the repository horizon that would promptly flow through the newly created borehole to the surface due to natural lithostatic pressure--or (if pumping would be required to raise water to the surface) release of 200 cubic meters of ground water pumped to the surface if that much water is readily available to be pumped; and (2) creation of a ground water flow path with a permeability typical of a borehole filled by the soil or gravel that would normally settle into an open hole over time--not the permeability of a carefully sealed borehole.