409.53

409.53/NLS/87/03/03

3/3/87

NOTE TO: Interested Parties

FROM: Nancy Still

SUBJECT: FRN ON 10 CFR PART 60, DEFINITION OF HLW

Enclosed for your information is a Federal Register Notice dated 2/27/87 regarding an Advance Notice of Proposed Rulemaking for changes to 10 CFR Part 60 on the Definition of High-Level Radioactive Waste.

NS

Nancy Still, Project Manager
State/Tribal Participation
Division of Waste Management

Enclosure: ANPRM on Part 60,
Definition of HLW,
dtd 2/27/87, 52FR5992

Signals were mailed out on 3/4/87

409.53/NLS/87/03/03

OFFICIAL CONCURRENCE AND DISTRIBUTION RECORD

NOTE TO: Interested Parties

FROM: Nancy Still, WMPC

SUBJECT: FRN ON 10 CFR PART 60, DEFINITION OF HLW

DATE: 3/3/87

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This document sent to attached list of HLW state/tribal, DOE, NRC, and federal agency contacts.

NUCLEAR REGULATORY COMMISSION

10 CFR Part 60

Definition of "High-Level Radioactive Waste"

AGENCY: Nuclear Regulatory Commission.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: The Commission has previously adopted regulations for disposal of high-level radioactive wastes (HLW) in geologic repositories (10 CFR Part 60). The Commission intends to modify the definition of HLW in those regulations so as to follow more closely the statutory definition in the Nuclear Waste Policy Act of 1982 (NWPA). In this advance notice of proposed rulemaking (notice), the Commission identifies legal and technical considerations that are pertinent to the definition of HLW and solicits public comment on alternative approaches for developing a revised definition.

DATES: Comment period expires April 29, 1987. Comments received after this date will be considered if it is practical to do so, but assurance of consideration can be given only for comments received on or before this date.

ADDRESSES: Send comments or suggestions to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Docketing and Service Branch. Copies of comments received and of documents referenced in this notice may be examined at the NRC Public Document Room, 1717 H Street NW., Washington, DC. Copies of NUREG documents may be purchased through the U.S. Government Printing Office by calling (202) 275–2060 or by writing to the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013–7082. Copies of NUREG and DOE documents may also be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

FOR FURTHER INFORMATION CONTACT: W. Clark Prichard, Division of Engineering Safety, Office of Nuclear Regulatory

Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 443–7668.

SUPPLEMENTARY INFORMATION:

I. Introduction and Background

Radioactive wastes contain a wide variety of radionuclides, each with its own half-life and other radiological characteristics. These radionuclides are present in concentrations varying from extremely high to barely detectable. One type of waste, generated by reprocessing spent nuclear fuel, contains both long-lived radionuclides which pose a long-term hazard to human health and other, shorter-lived nuclides which produce intense levels of radiation. This combination of highly-concentrated, short-lived nuclides together with other very long-lived nuclides has historically been described by the term "high-level radioactive wastes" (HLW). There has long been a recognition that such waste materials require long-term isolation from man's biological environment and that, in view of public health and safety considerations, disposal of such wastes should be accomplished by the Federal government on Federally owned land. This policy was codified by the Atomic Energy Commission (AEC) in 1970 in Appendix F to 10 CFR Part 50.

A. *Previous use of the term "HLW."* In Appendix F, HLW was defined in terms of the source of the material rather than its hazardous characteristics. Specifically, HLW was defined as "those aqueous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuels." As used in Appendix F, "high-level waste" thus refers to the highly concentrated (and hazardous) waste containing virtually all the fission product and transuranic elements (except plutonium) present in irradiated reactor fuel. The term does not include incidental wastes resulting from reprocessing plant operations such as ion exchange beds, sludges, and contaminated laboratory items, clothing, tools, and equipment. Neither are radioactive hulls and other irradiated and contaminated fuel structural hardware within the Appendix F definition.[1]

The first statutory use of the term "high-level radioactive waste" occurs in the Marine Protection, Research, and Sanctuaries Act of 1972 (Marine Sanctuaries Act). Congress adopted the Appendix F definition, but broadened it to include unreprocessed spent fuel as well.[2] Two years later, the AEC was abolished and its functions were divided between the Energy Research and Development Administration (ERDA, now the Department of Energy, DOE) and the Nuclear Regulatory Commission (NRC or Commission) by the Energy Reorganization Act of 1974, Pub. L. 93–438, 42 U.S.C. 5811. Under this legislation, certain activities of ERDA were to be subject to the Commission's licensing and regulatory authority. Specifically, NRC was to exercise licensing authority as to certain nuclear reactors and the following waste facilities:

(1) Facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under the [Atomic Energy] Act.

(2) Retrievable Surface Storage Facilities and other facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by the Administration [now DOE], which are not used for, or are part of, research and development activities.[3]

Although neither the statute nor the legislative history defines the term "high-level radioactive waste," earlier usage of the term in Appendix F and the Marine Sanctuaries Act is indicative of the meaning. The Commission so construed the statute when it declared spent nuclear fuel to be a form of HLW and, by the same token, when it found transuranic-contaminated wastes not to be HLW.[4]

A different statutory formula appears in the West Valley Demonstration Project Act (West Valley Act), enacted in 1980. This legislation authorizes the Department of Energy (DOE) to carry out a high-level radioactive waste management demonstration project for the purpose of demonstrating solidification techniques which can be used for preparing HLW for disposal. It includes the following definition:

> The term "high level radioactive waste" means the high level radioactive waste which was produced by the reprocessing at the Center of spent nuclear fuel. Such term includes both liquid wastes which are produced directly in reprocessing, dry solid material derived from such liquid waste and such other material as the Commission designates as high level radioactive waste for purposes of protecting the public health and safety.[5]

The Commission has not yet designated any "other material" as HLW under the West Valley Act. Rather, it has construed the term in a manner equivalent to the 10 CFR 50, Appendix F definition. That is, it is the liquid wastes in storage at West Valley and the dry solid material derived from solidification activities that are regarded as HLW, and it is DOE's plans with respect to such wastes that are subject to the Commission's review.

B. *Current NRC regulations.* The Commission has adopted regulations that govern the licensing of DOE activities at geologic repositories for the disposal of HLW. The regulations define HLW in the jurisdictional sense. That is, if the facility is for the "storage" of "HLW" as contemplated by the Energy Reorganization Act, the prescribed procedures and criteria would apply.[6] The appropriate definition for this purpose draws upon the understanding in 1974, as reflected in Appendix F and the Marine Sanctuaries Act, rather than the words of the West Valley Act of more limited purpose and scope.

It should be emphasized that NRC's existing regulations in Part 60 do not require that any radioactive materials, whether HLW or not, be stored or disposed of in a geologic repository.[7]

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[1] See 34 FR 8712, June 3, 1969 (notice of proposed rulemaking), 35 FR 17530 at 17532, November 14, 1970 (final rule). Incidental wastes generated in further treatment of HLW (e.g., decontaminated salt with residual activities on the order of 1,500 nCi/g Cs–137, 30 nCi/g Sr–90, 2 nCi/g Pu, as described in the Department of Energy's FEIS on long-term management of defense HLW at the Savannah River Plant, DOE/EIS–0023, 1979) would also, under the same reasoning, be outside the Appendix F definition.

[2] Sec. 3, Pub. L. 92–532, as amended by Pub. L. 93–254 (1974), 33 U.S.C. 1402.

[3] Sec. 202, Pub. L. 93–438, 42 U.S.C. 5842. Nuclear waste management responsibilities were subsequently transferred to the Department of Energy. Secs. 203(a)(6), 301(a), Pub. L. 95–91, 42 U.S.C. 7133(a)(6), 7151(a).

[4] Proposed General Statement of Policy, "Licensing Procedures for Geologic Repositories for High-Level Radioactive Wastes," 43 FR 53869, 53870, November 17, 1978; Report to Congress, "Regulation of Federal Radioactive Waste Activities," NUREG–0527 (1979), 2–1, 2–2, Appendix G.

[5] Sec. 6(4), Pub. L. 96–368, 42 U.S.C. 2021a note.

[6] NRC regulations are codified in 10 CFR Part 60 (Part 60). DOE is required to have a license to receive source, special nuclear or byproduct material at a geologic repository operations area. § 60.3. A geologic repository operations area is defined to refer to a "HLW facility" which in turn is defined as a facility subject to NRC licensing authority under the Energy Reorganization Act of 1974, note 3, *supra*. § 60.2 The Part 60 definition of HLW, *ibid.*, is as follows:

"High-level radioactive waste" or "HLW" means: (1) Irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

[7] In the event that commercial reprocessing of irradiated reactor fuel is pursued, Appendix F of 10 CFR Part 50 would require that the resulting reprocessing wastes be transferred to a Federal repository.

Nor do they provide that radioactive materials must be HLW in order to be eligible for disposal in a geologic repository. Part 60 expressly provides for NRC review and licensing with respect to any radioactive materials that may be emplaced in a geologic repository authorized for disposal of HLW. The term "high-level radioactive waste" in Part 60 identifies the class of facilities subject to NRC jurisdiction.

The Commission has also adopted regulations related to land disposal of low-level radioactive wastes (10 CFR Part 61). Based on analyses of potential human health hazards, these regulations identify three classes of low-level radioactive wastes which are routinely acceptable for near-surface disposal, with "Class C" denoting the highest radionuclide concentrations of the three. Class C does not, however, denote a maximum concentration limit for low-level wastes. The low-level waste category includes all wastes not otherwise classified, while HLW is currently defined by source (rather than concentration or hazard) and is limited to reprocessing wastes and spent fuel. Thus, there is no regulatory limit on the concentrations of LLW, and some LLW (exceeding Class C concentrations) may have concentrations approaching those of HLW. These are the wastes which the Commission wishes to evaluate for possible classification as HLW. The Appendix to this notice presents information on the volumes and characteristics of wastes with radionuclide concentrations exceeding the Class C concentration limits. (This Appendix was prepared in 1985. DOE is currently carrying out a study of "above Class C" wastes which will update the information presented here.)

C. *Nuclear Waste Policy Act of 1982.* The Nuclear Waste Policy Act of 1982 (NWPA), Pub. L. 97-425, provides for the development of repositories for the disposal of high-level radioactive waste and establishes a program of research, development, and demonstration regarding the disposal of high-level radioactive waste.[8] The NWPA follows, with some modification, the text of the West Valley Act. For purposes of the NWPA, the term "high-level radioactive waste" means:

(A) 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 concentrations; and

(B) Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation.[9]

It should be noted that the NWPA does not require that materials regarded as HLW pursuant to this definition be disposed of in a geologic repository. Indeed, the NWPA directs the Secretary (of DOE) to continue and accelerate a program of research, development and investigation of alternative means and technologies for the permanent disposal of HLW.[10] Part 60 and the changes discussed in this notice would allow for consideration of such alternatives by the Commission. Nevertheless, the NWPA does not specifically authorize DOE to construct or operate facilities for disposal by alternative means, and new legislative authorization might be needed in order to dispose of HLW by means other than emplacement in a deep geologic repository.

II. Considerations for Defining "High-Level Radioactive Waste".

Wastes which have historically been referred to as HLW (i.e., reprocessing wastes) are initially both intensely radioactive and long-lived. These wastes contain a wide variety of radionuclides. Some (principally Sr-90 and Cs-137) are relatively short-lived and represent a large fraction of the radioactivity for the first few centuries after the wastes are produced. These nuclides produce significant amounts of heat and radiation, both of which are of concern when disposing of such wastes. Other nuclides, including C-14, Tc-99, I-129 and transuranic nuclides, have very long half-lives and thus constitute the longer-term hazard of the wastes. Some of these nuclides pose a hazard for sufficiently long periods of time that the term "permanent isolation" is used to describe the type of disposal required to isolate them from man's environment. The Commission considers that these two characteristics, intense radioactivity for a few centuries followed by a long-term hazard requiring permanent isolation, are key features which can be used to distinguish high-level wastes from other waste categories.

The NWPA identifies two sources of HLW, each of which is discussed separately in the following sections.

A. Clause (A)

Clause (A) of the NWPA definition of HLW refers to wastes produced by reprocessing spent nuclear fuel and thus is essentially identical to the Commission's current HLW definition in 10 CFR Part 60. Clause (A) is, however, different in one respect. The NWPA wording would clasify solidified reprocessing waste as HLW only if such waste "contains fission products in sufficient concentrations"—a phrase that may reflect the possibility that liquid reprocessing wastes may be partitioned or otherwise treated so that some of the solidified products will contain substantially reduced concentrations of radionuclides.

The question, then, is whether Commission should (1) numerically specify the concentrations of fission products which it would consider "sufficient" to distinguish HLW from non-HLW under Clause (A); or (2) define HLW so as to equate the Clause (A) wastes with those which have traditionally been regarded as HLW.

1. Numerically Specifying Concentrations of Fission Products

The first option considered is to numerically define "sufficient concentrations" of fission products. Liquid reprocessing wastes may contain significant amounts of non-radioactive salts, and removal of these salts prior to waste solidification may be desirable for both economic and public health and safety reasons. Removal of salts in this way would result in a smaller volume of highly radioactive wastes, which might reduce the cost and radiological impacts associated with transportation and occupational handling of those wastes. Nevertheless, any salts removed from liquid HLW would retain residual amounts of radioactive contaminants. By establishing numerical limits on the concentrations of fission products, the Commission would be identifying those wastes from reprocessing that require disposal in a deep geologic repository or its equivalent. The proper classification of the salts discussed above would then be made on the basis of the numerical limits on radionuclide concentrations and the salts would be disposed of accordingly. In other cases, certain radionuclides may be removed from the bulk liquid reprocessing waste (as has been done in removing cesium and strontium from wastes at Hanford), raising similar questions about the classification of the remaining waste and acceptable methods of disposal. For these reasons, there would be merit in numerically specifying the

[8] For purposes of the NWPA, "spent nuclear fuel" is distinguished from "high-level radioactive waste," but the provisions of the statute dealing with such spent nuclear fuel are not of present concern.

[9] Sec. 2(12), Pub. L. 97-425, 42 U.S.C. 10101(12). Sec. 2(16) also authorizes the Commission to classify certain radioactive material as low-level radioactive waste.

[10] Sec. 222, Pub. L. 97-425, 42 U.S.C. 10202.

concentrations of radionuclides in solidified reprocessing wastes which would distinguish HLW from non-HLW.

(Clause (A) refers to solidified waste "that contains fission products in sufficient concentrations." No mention is made of the long-lived transuranic radionuclides which are also present in liquid reprocessing wastes but, since the transuranics constitute the predominant long-term hazard of reprocessing wastes, such nuclides must be considered as well in defining reprocessing wastes that should be regarded as HLW. With this view, a numerical classification of solidified wastes under Clause (A) could be derived in the same manner, and contain the same concentration limits, as the numerical definitions developed under Clause (B). Derivation of concentration limits under Clause (B) is discussed in the following section of this notice.)

2. Traditional Definition

The alternate approach is to define HLW so as to equate the category of Clause (A) wastes with those wastes which have traditionally been regarded as HLW under Appendix F to 10 CFR Part 50 and the Energy Reorganization Act. The advantage of this option is that the term HLW retains its utility in defining the facilities that are subject to NRC licensing. That is, all materials that have traditionally been considered HLW for purposes of the Energy Reorganization Act would also be regarded as HLW under the Nuclear Waste Policy Act. The disadvantage is that some materials might continue to fall within the HLW classification even though they do not require the degree of isolation afforded by a repository. They would be called "HLW" even though the technical community might not so regard them.

3. Other Considerations Regarding Clause (A) Options

The Commission would add two observations regarding the options discussed above.

a. Development of a definition under Clause (A), as suggested by the first option, would not alter the Commission's existing authority to license DOE waste facilities, including defense wastes facilities, under the Energy Reorganization Act of 1974 (ERA). Any classification of wastes as non-HLW on the basis that they do not contain "sufficient concentrations" of fission products would be irrelevant in determining whether such wastes must be disposed of in licensed disposal facilities. For example, if DOE were to pursue its proposal for in-place stabilization of the Hanford "tank" wastes (see DOE/EIS-0113, March, 1986), most or all of the disposal "facilities" for those wastes would need to be licensed by the NRC.

b. Retaining the traditional definition for purposes of Clause (A) does not limit the Commission's ability to establish at some later date criteria to define wastes that require the isolation afforded by a deep geologic repository or its equivalent. That is, wastes requiring such isolation could be identified by terms other than "high-level".

B. Clause (B)

Clause (B) of the NWPA authorizes the Commission to classify "other highly radioactive material" (other than reprocessing wastes) as HLW if that material "requires permanent isolation." The Commission considers that both characteristics (highly radioactive and requiring permanent isolation) must be present simultaneously in order to classify a material as HLW.[11] Each of these characteristics is discussed in turn in the following sections.

1. Highly Radioactive

The Commission proposes [12] to consider a material "highly radioactive" if it contains concentrations of short-lived radionuclides in excess of the Class C limits of Table 2 of 10 CFR Part 61. Such concentrations are sufficient to produce significant radiation levels and to generate substantial amounts of heat. Moreover, the Class C concentration limits for short-lived nuclides approximate the actual concentrations of those nuclides present in some existing reprocessing wastes (see NUREG-0946, Table 4).

2. Permanent Isolation

The phrase "permanent isolation" in NWPA is much less subjective than is "highly radioactive." Within the context of NWPA, "permanent isolation" clearly implies the degree of isolation afforded by a deep geologic repository.[13] Thus, a waste "requires permanent isolation" if it cannot be safely disposed of in a facility less secure than a repository. The Commission will determine which wastes require permanent isolation by evaluating the disposal capabilities of alternative, less secure, disposal facilities.[14] Any wastes which cannot be safely disposed of in such facilities will be deemed to require permanent isolation and, if also highly radioactive, would be classified as high-level wastes.

The approach which the Commission proposes to pursue to determine which wastes requires permanent isolation will be an extension of the 10 CFR Part 61 waste classification analyses and will consist of the following steps.

a. *Establish acceptance criteria.* 10 CFR Part 61 currently contains performance objectives for disposal of radioactive wastes in a land disposal facility. These performance objectives will serve as acceptance criteria for waste classification analyses, but might need to be supplemented for specific types of facilities or wastes. The Part 61 performance objectives may also need to be supplemented to accommodate any environmental standards for non-HLW which may be promulgated by the U.S. Environmental Protection Agency pursuant to its authority under the Atomic Energy Act of 1954, as amended.

b. *Define disposal facility.* The hazard which a radioactive waste poses to public health depends, in part, on the nature of the facility used for its disposal. Thus, a reference disposal facility, less secure than a repository, needs to be defined in terms of the characteristics which contribute to isolation of wastes from the environment. For land disposal facilities, such characteristics might include depth of disposal, use of engineered barriers, and the geologic, hydrologic and geochemical features of a disposal site.

c. *Characterize wastes.* Wastes will be characterized in terms of the factors which determine their hazard and behavior after disposal, including

[11] The Commission would not find tenable the argument that a material requires permanent isolation *because* it is highly radioactive. The need for permanent isolation correlates with the length of time a material will remain hazardous. Long half-lives, in turn, correlate with low rather than high levels of radioactivity.

[12] All references to "proposals" by the Commission refer only to its tentative views. No formal proposals will be developed until comments are received in response to this notice.

[13] The NWPA includes the following definitions:

The term "disposal" means the emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

The term "repository" means any system licensed by the Commission that is intended to be used for, or may be used for, the permanent deep geologic disposal of high-level radioactive waste and spent nuclear fuel, whether or not such system is designed to permit the recovery, for a limited period during initial operation, of any materials placed in such system. Such term includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted.

[14] These facilities might make use of intermediate depth burial or various engineering measures, such as intruder barriers, to accommodate wastes with radionuclide concentrations unsuitable for disposal by shallow land burial.

physical and chemical forms of the waste, the radionuclide concentrations and associated radiological characteristics, the waste volumes, and the heat generation rates. The wide range of types and characteristics of wastes arising from industrial, biomedical and nuclear fuel cycle sources makes this a particularly critical step in the waste classification process—especially for wastes to be generated in the future (e.g., decommissioning wastes).

d. *Develop assessment methodology.* Analytical methods (including mathematical models and computer codes) for projecting disposal system performance will be acquired or developed. For land disposal facilities, such methods include models of groundwater flow and contaminant transport. An assessment methodology also includes descriptions of the natural and human-initiated disruptive events or processes which could significantly affect disposal system performance as well as the analytical means for evaluating the impacts of such events or processes.

e. *Evaluate disposal system performance.* The performance of the alternative disposal facility will be evaluated to estimate the public health hazards from disposal of various types and concentrations of wastes. Hazards below the acceptance criteria of item (a) above indicate an acceptable match of waste type and disposal option. Wastes which cannot be safely disposed of in the alternative facility will be classified as requiring permanent isolation.

A practical difficulty with classifying wastes as described here is that alternative disposal facilities are currently unavailable. Thus, classification of wastes in this manner requires many assumptions about the performance of nonexistent disposal facilities. Such analyses will inevitably involve substantial uncertainties.

It is also possible that no alternative disposal facility will ever be needed for commercially-generated "above Class C" wastes. (Disposal of such wastes is a Federal, rather than State, responsibility.) Because of the overhead costs of developing and licensing new facilities, the relatively small volumes of such wastes, and the low heat generation rates of some of these wastes, it might prove most economical to dispose of all such wastes in a repository. Nevertheless, the Commission recognizes a "chicken-and-egg" problem here. Until wastes are classified as HLW or non-HLW, it may be difficult for the DOE to make decisions regarding appropriate types of disposal facilities. Therefore, despite the uncertainties involved, the Commission proposes to select a hypothetical alternative disposal facility which will serve as the basis for carrying out waste classification analyses.

Previous analyses by the NRC (NUREG–0782, draft EIS for 10 CFR Part 61) suggest that disposal facilities with characteristics intermediate between shallow land burial and geologic repository disposal may be most effective in protecting against short-term radiological impacts associated with inadvertent intrusion into a disposal facility. These "intermediate" facilities may be much less effective in providing enhanced long-term isolation of very long-lived radionuclides. If this preliminary view is supported by subsequent analyses, wastes with concentrations above the Commission's current Class C limits for long-lived nuclides (Table 1 of 10 CFR Part 61) would require permanent isolation. In the following sections, the Commission will assume, for the sake of illustration, that Table 1 is an appropriate interpretation of the term "requires permanent isolation."

3. Conceptual Definition of "High-Level Waste

The Commission proposes to Classify wastes as HLW under Clause (B) of the NWPA definition only if they are both highly radioactive and in need of permanent isolation. As discussed above, the Commission considers that wastes should be considered to be highly radioactive if they contain concentrations of short-lived radionuclides which exceed the Class C limits of Table 2 of 10 CFR Part 61. The Commission also assumes, for illustrative purposes, that the radionuclide concentrations of Table 1 of Part 61 are appropriate for identifying the concentrations of long-lived radionuclides requiring permanent isolation. Solidified reprocessing wastes would similarly be classified as HLW only if they contain both short- and long-lived radionuclides in concentrations exceeding Tables 2 and 1, respectively.

It is assumed that a revised definition of HLW would appear in the definitions section of Part 60, and that the materials encompassed by the definition would be subject to the containment requirements of that regulation. It would also serve incidentally to define the materials covered by DOE's waste disposal contracts. This definition would apply only to wastes disposed of in a facility licensed under Part 60. As discussed elsewhere in this notice, there would be no alteration of the Commission's authority to license disposal of HLW under provisions of the Energy Reorganization Act. Some technical amendments would be needed to preserve the jurisdictional provisions of existing Part 60—i.e., to indicate that Part 60 applies to the DOE facilities described in sections 202(3) and (4) of the Energy Reorganization Act, and for that purpose the proposed definition of HLW would not be controlling.

A conceptual, revised definition of HLW could be stated as follows:

"High-level radioactive waste" or "HLW" means: (1) Irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, (3) solids into which such liquid wastes have been converted, and solid radioactive wastes from other sources, provided such solid materials contain both long-lived radionuclides in concentrations exceeding the values of Table 1 and short-lived radionuclides with concentrations exceeding the values of Table 2.

TABLE 1

Radionuclide	Concentration[1] (Ci/m³)
C-14	8
C-14 in act. metal	80
Ni-59 in act. metal	220
Nb-94 in act. metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting TRU, $t_{1/2}$ > 5 yr	[2]100
Pu-241	[2]3,500
Cm-242	[2]20,000

[1] If a mixture of radionuclides is present, a sum of the fractions rule is to be applied for each table. The concentration of each nuclide is to be divided by its limit, and the resulting fractions are to be summed. If the sum exceeds one for both tables, the waste is classified as HLW.

[2] Units are nanocuries per gram.

TABLE 2

Radionuclide	Concentration [1] (Ci/m³)
Ni-63	700
Ni-63 in act. metal	7,000
Sr-90	7,000
Cs-137	4,600

[1] If a mixture of radionuclides is present, a sum of the fractions rule is to be applied for each table. The concentration of each nuclide is to be divided by its limit, and the resulting fractions are to be summed. If the sum exceeds one for both tables, the waste is classified as HLW

4. Status of wastes not classified as HLW

The NWPA, the Low-Level Radioactive Waste Policy Act, and the Commission's regulations in 10 CFR Part 61 currently classify wastes as "low-level" if they are not otherwise classified as high-level wastes or certain other types of materials (e.g., uranium mill tailings). Classification of certain wastes as HLW, under Clause (B) of the NWPA definition, would reduce the amount of waste classified (by default) as LLW and, more importantly, would establish a distinct, concentration-based boundary between the two classes of waste.

If this conceptual definition of Clause (B) were adopted, certain wastes with radionuclide concentrations above the Class C limits of 10 CFR Part 61 would not be classified as HLW because they do not contain the requisite combination of short- and long-lived nuclides. These wastes would continue to be classified as special types of low-level wastes analogous to DOE's "transuranic" waste category. Any such wastes generated by defense programs would continue to fall under DOE's responsibility for disposal, and no NRC licensing of facilities intended solely for their disposal, such as the Waste Isolation Pilot Plant (WIPP), would be authorized.

As provided by the amendments to the Low-Level Radioactive Waste Policy Act,[15] the Federal government is responsible for disposal of all commercially-generated "above Class C" wastes; it is contemplated, under the amendments, that the NRC would be responsible for licensing the facilities for their disposal. The Commission would continue to permit disposal of wastes containing naturally-occurring or accelerator-produced materials in licensed facilities provided there was no unreasonable risk to public health and safety.

III. Legal Considerations Related to the Nuclear Waste Policy Act

The exercise of NWPA Clause (B) authority may give rise to a number of legal questions which are discussed below.

A. *Disposal of waste generated by materials licensees.* The NWPA established a Nuclear Waste Fund composed of payments made by the generators and owners of "high-level radioactive waste" (including spent fuel) that will ensure that the costs of disposal will be borne by the persons responsible for generating such waste. The Nuclear Waste Fund is to be funded with moneys obtained pursuant to contracts entered into between the Secretary of Energy and persons who generate or hold title to high-level radioactive waste.

The statute addresses the particulars of contracts with respect to spent nuclear fuel and solidified high-level radioactive waste derived from spent nuclear fuel used to generate electricity in a civilian nuclear power reactor. It further limits the authority of the Commission to issue or renew licenses for utilization and production facilities—i.e., for present purposes, nuclear reactors and reprocessing plants—unless the persons using such facilities have entered into contracts with the Secretary of Energy.

The absence of any reference to materials licensees (e.g., fuel fabricators, some research laboratories) suggests that the Nuclear Waste Fund was not intended to apply to their activities. As a result, there could be a question if the Commission were to define materials licensees' waste as high-level waste, because the waste might thereby become ineligible for disposal in a repository. The reason is that the law prohibits disposal of HLW in a repository unless such waste was covered by a contract entered into by June 30, 1983 (or the date the generator or owner commences generation of or takes title to the waste, if later). Few contracts have been entered into with materials licensees except those who are also facility licensees. Thus, it can be argued that the Commission should refrain from designating as HLW, under Clause (B),[16] materials generated by materials licensees.

The Commission is not persuaded by such an argument. The statutory language dealing with the Commission's classification of materials as HLW refers solely to considerations relating to the nature of the wastes, and the character of the licensee generating or owning the waste is simply not relevant. If there are good reasons to treat that waste from materials licensees as HLW, the Commission regards it as likely that any statutory impediment to the acceptance of such waste at a geologic repository could be modified.

B. *Confidence regarding disposal capacity for power reactors.* The availability of waste disposal facilities for wastes generated at commercial power reactors has been the subject of controversy and litigation. The NWPA addresses these concerns by establishing a Federal responsibility to provide for the construction and operation of a geologic repository, leaving undefined (i.e., to the discretion of the Commission) the classes of materials that require permanent isolation in such a facility. Whatever materials they may be, however, they must be transferred to DOE for disposal; and the presons responsible for generating the waste must enter into contracts with DOE which provide for payment of fees sufficient to offset DOE's costs of disposal. Existing facility licensees were required to enter into such contracts by June 30, 1983.

The Commission believes that the purpose of the NWPA can best be accomplished if all the highly radioactive wastes generated by facility licensees (reactors and reprocessing plants) which require permanent isolation are covered by waste disposal contracts with DOE. This would assure that DOE can and will accept possession of such wastes when necessary. Further, in the absence of such assurance, the basis for Commission confidence that these wastes will be safely stored and disposed of would be subject to question even if concerns about the disposal of the licensees' spent nuclear fuel had been laid to rest. Accordingly, if there are any highly radioactive materials (other than those previously regarded as HLW) that are generated by facility licensees and that require permanent isolation, the Commission believes that, for purposes of the NWPA, they should be regarded as "high-level waste." The Commission has reviewed the terms of DOE's standard waste disposal contract and believes that classifying such additional materials as HLW would require no changes to the contract terms.

C. *Implications with respect to disposal methods.* Under the Atomic Energy Act of 1954, the Commission is authorized to establish such standards to govern the possession of licensed nuclear materials as it may deem necessary or desirable to protect health.[17] Under this authority, the Commission may classify materials according to their hazards and may prescribe requirements for the long-term management or disposal thereof. It is not necessary to label materials as HLW under the NWPA in order to require their disposal in a geologic repository or other suitably permanent facility.

The Commission exercised this authority with respect to concentrated

[15] Low-Level Radioactive Waste Policy Amendments Act of 1985, Pub. L. 99-240, Sec. 3, 42 U.S.C. 2021c.

[16] The Nuclear Waste Fund is governed by Sec. 302, Pub. L. 97-425, 42 U.S.C. 10222. The prohibition of disposal of HLW not covered by timely contracts is set out in sec. 302(b)(2).

[17] Sec. 161b., Pub. L. 83-703, 42 U.S.C. 2201(b).

reprocessing wastes by specifying, in Appendix F to 10 CFR Part 50, that any such wastes generated at licensed facilities are to be transferred to a Federal repository for disposal. More recently, the Commission classified certain low-level wastes as being generally acceptable for near-surface disposal (10 CFR Part 61). On the basis of further consideration, the Commission could specify appropriate disposal means for wastes exhibiting radionuclide concentrations greater that those defined in Part 61. Thus, the Commission need not exercise NWPA Clause (B) authority in order to assure that radioactive wastes from licensed activities are disposed of properly. Moreover, the identification of material as HLW under Clause (B) would not by itself mandate that such material must be disposed of in a geologic repository. Since the NWPA authorizes only a single method of permanently isolating HLW—geologic repositories—classification of materials as HLW may effectively preclude disposal of such wastes by other means. Nevertheless, the Commission's regulations will continue to leave open the prospect of disposal by other means if Congress should so authorize.

D. *Relationship to State role.* Section 3 of the Low-level Radioactive Waste Policy Act (LLRWPA), Pub. L. 96-573, 42 U.S.C. 2021b., enacted in 1980, defines a State responsibility to provide, pursuant to regional compacts, for the disposal of "low-level radioactive waste" (LLW).[18] Such waste is defined to mean "radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or by-product material as defined in section 11.e.(2) of the Atomic Energy Act of 1954."

The Low-Level Radioactive Waste Policy Amendments Act of 1985, Pub. L. 99-240, 42 U.S.C. 2021c., limited the range of LLW for which the States must provide disposal capacity. Specifically, the States are not responsible for wastes with radionuclide concentrations in excess of the Class C limits of 10 CFR Part 61. Instead, the Federal government now assumes responsibility for providing disposal capacity for such wastes. Thus, classification of "above Class C" wastes as HLW or non-HLW will have no impact on State government responsibilities.

E. *Impact on existing technical criteria.* NRC's regulations in Part 60 include technical criteria to be applied in licensing DOE's receipt and possession of source, special nuclear, and byproduct material at a geological repository. The regulations would accommodate the disposal of any radioactive materials, including spent fuel, reprocessing wastes, or any other materials which could be disposed of in accordance with the specified performance objectives.

Materials categorized as high-level waste are subject to a containment requirement (§ 60.113(a)(1)(i)(A)) and to specified waste package design criteria and waste form criteria (§ 60.135 (a-c)). These criteria apply to wastes characterized by the presence of fission products generating substantial amounts of heat at the time of emplacement, but with much reduced heat generation after decades or a few centuries.[19] The rule also explicitly provides that design criteria for waste types other than HLW will be addressed on an individual basis if and when they are proposed for disposal in a geologic repository (§ 60.135(d)).

If additional materials were to be designated as high-level waste, the Commission would need to consider whether the existing repository design criteria are appropriate with respect to such materials.

F. *Applicability of HLW definition to naturally-occurring and accelerator-produced radioactive materials.* Clause (B) of the NWPA provides that the Commission may extend the definition of the term "high-level radioactive waste" to include material requiring permanent isolation only where this is "consistent with existing law." The applicable existing law is the Atomic Energy Act of 1954, under which the Commission has authority to regulate the possession and use of "source material," "special nuclear material," and "byproduct material." There are other radioactive materials, however: naturally-occurring radionuclides, such as radium, and accelerator-produced radionuclides. These are not covered by the Atomic Energy Act and hence there would be no statutory basis, consistent with existing law, for the Commission to require that they be disposed of at facilities licensed by the Commission or otherwise to regulate their possession or use. Accordingly, no legal basis exists for the Commission to classify such materials as HLW or non-HLW.

Nevertheless, as already noted, 10 CFR Part 60 contemplates that "other radioactive materials other than HLW" may be received for emplacement in a geologic repository. This provision of Part 60 would not be altered by expanding the definition of HLW. Part 60 provides that waste package requirements for such wastes will be determined on a case-by-case basis when these wastes are proposed for disposal. Thus, it might be determined, on the basis of technical considerations, that certain naturally-occurring or accelerator-produced radioactive waste materials present hazards similar to licensed materials that are defined as high-level waste and that such material should be disposed of in a geologic repository developed under NWPA. If so, plans for such disposal can be reviewed under Part 60 and the Commission could impose such packaging or other requirements as appropriate to protect public health and safety.

IV. Issues on Which Public Comments are Particularly Sought.

The Commission invites comments on all the issues identified in this notice and any other issues that might be identified. However, comments (with supportive rationale) in response to the following would be particularly helpful.

1. Two options are presented for defining reprocessing wastes under Clause (A) of NWPA. The first option proposes to define the "sufficiency" of fission product concentrations in solidified reprocessing wastes in a manner analogous to its treatment of "highly radioactive" and "requires permanent isolation" under Clause (B) (i.e., by examining the hazards posed by wastes if disposed of in facilities other than a repository). The second option interprets Clause (A) as encompassing all those wastes which have heretofore been considered high-level waste under Appendix F to 10 CFR Part 50 and the Energy Reorganization Act. Which of these two approaches is preferable?

2. The Commission proposes that the current Class C concentration limits of 10 CFR Part 61 serve to identify radionuclide concentrations which are "highly radioactive" for purposes of Clause (B) of the NWPA definition. Would an alternative set of concentration limits be preferable? If so, how should such limits be derived?

3. The Commission proposes to equate the "requires permanent isolation" wording of the NWPA definition with a level of long-term radiological hazard requiring disposal in a geologic repository. Are the Commission's

[18] States are not responsible for disposal of LLW from atomic energy defense activities or Federal research and development activities.

[19] The Commission's expectation that HLW would generate significant amounts of heat is reflected in the discussion of transuranic waste in the notice of proposed rulemaking on the Part 60 technical criteria. 46 FR 35284, July 8, 1981. Reduction of the heat load, for example by removal of cesium-137 and strontium-90, could result in different containment requirements. 48 FR 28196, June 21, 1983 (final rule).

proposed analyses appropriate for identification of concentrations requiring permanent isolation?

4. Although, under section 121 of NWPA, no environmental review is required with respect to the definition of HLW, the Commission would welcome identification of any environmental consequences associated with the matters discussed in this notice.

5. Some waste materials, such as certain laboratory wastes or some sealed sources, may be highly concentrated, yet contain only relatively small total quantities of radioactive materials. Is there a need for a special provision (e.g., a minimum total quantity of activity) before a waste should be classified as HLW?

6. What difficulties (legal, administrative, financial, or other) would an expanded definition of HLW cause in implementing the provisions of the NWPA?

7. The Commission's regulations do not generally require that any particular type of waste be disposed of in any specified type of facility. Would such a requirement be appropriate?

8. As discussed in this notice, the Commission has no legal authority to classify naturally-occurring or accelerator-produced radioactive materials (NARM) as HLW or non-HLW. Nevertheless, such materials may be presented for disposal at facilities licensed by the Commission. When the Commission carries out its proposed analyses to identify "other highly radioactive material that . . . requires permanent isolation," should NARM be included in the analyses?

9. Are there issues other than those identified in this notice which the Commission should consider in developing approaches to implement its authority?

Separate Views of Commissioner Asselstine

Commissioner Asselstine is concerned about the potential for creating a confusing situation if the Commission were to adopt the first option under Clause (A). The first option is to numerically specify concentrations of fission products in defining high-level wastes. Under this approach, it is conceivable that material considered high-level waste for the purposes of licensing under the Energy Reorganization Act of 1974 will also be considered low-level waste for the purposes of the Nuclear Waste Policy Act (NWPA) of 1982. Wastes presently being stored at the Hanford waste tanks, which have traditionally been classified as high-level wastes, would likely be reclassified as above Class C low-level waste under the first option. Commissioner Asselstine requests public comment on how this reclassification would affect the NRC's licensing authority over the long-term storage or *in situ* disposal of the Hanford waste tanks. Commissioner Asselstine also requests comments on whether there are alternative approaches to achieving the stated purpose of this advanced notice of proposed rulemaking of identifying wastes subject to the provisions of the NWPA without altering the traditional definition of high-level waste and thus creating this potential for confusion.

List of Subjects in 10 CFR Part 60

High-level waste, Nuclear power plants and reactors, Nuclear materials, Penalty, Reporting requirements, Waste treatment and disposal.

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Dated at Washington, DC, this 20th day of February 1987.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

Appendix—Volumes and Characteristics of Wastes Exceeding Class C Concentration Limits

For a number of years NRC has had an ongoing program to develop regulations and criteria for disposal of low-level radioactive waste. At the time this program was initiated, there was a well-documented need for comprehensive national standards and technical criteria for the disposal of low-level waste. The absence of sufficient technical standards and criteria was seen to be a major deterrent to the siting of new disposal facilities by states and compacts.

A significant milestone in this program was the promulgation of the regulation 10 CFR Part 61 ("Licensing Requirements for Land Disposal of Radioactive Waste") on December 27, 1982 (47 FR 57446). This regulation establishes procedural requirements, institutional and financial requirements, and overall performance objectives for land disposal of radioactive waste, where land disposal may include a number of possible disposal methods such as mined cavities, engineered bunkers, or shallow land burial. This regulation also contains technical criteria (on site suitability, design, operation, closure, and waste form) which are applicable to near-surface disposal, which is a subset of the broader range of land disposal methods. Near-surface disposal is defined as disposal in or within the upper 30 meters of the earth's surface, and may include a range of possible techniques such as concrete bunkers or shallow land burial. The Part 61 regulation is intended to be performance-oriented rather than prescriptive, with the result that the Part 61 technical criteria are written in relatively general terms, allowing applicants to demonstrate how their proposals meet these criteria for various specific near-surface disposal methods.

A waste classification system was also instituted in the regulation which establishes three classes of waste suitable for near-surface disposal: Class A, Class B, and Class C. Limiting concentrations for particular radionuclides were established for each waste class, with the highest limits being for Class C. The concentration limits were established based on NRC's understanding (at the time of the rulemaking) of the characteristics and volumes of low-level waste that would be reasonably expected to the year 2000, as well as potential disposal methods.

The Class C concentration limits are applicable to all potential near-surface disposal systems; however, the calculations performed to establish the limits are based on postulated use of one near-surface disposal method: shallow land burial. The Class C limits are therefore conservative since there may be other near-surface disposal methods that have greater confinement capability (and higher costs) than shallow land burial.

The regulation states that waste exceeding Class C concentration limits is considered to be "not generally acceptable for near-surface disposal," where this is defined in § 61.55(a) as "waste for which waste form and disposal methods must be different, and in general more stringent, than those specified for Class C waste." Thus, waste exceeding Part 61 concentrations generally has been excluded from near-surface disposal and is being held in storage by licensees. (This amounts to less than 1% of the approximately 3,000,000 ft^3 of commercial low-level waste annually being generated.) Given the current absence of prescriptive requirements for disposal of waste exceeding Class C concentration limits, the regulation allows for evaluation of specific proposals for disposal of such waste on a case-by-case basis. The general criteria to be used in evaluating specific proposals are the Part 61 performance objectives contained in Subpart C of the regulation.

Current NRC activities include analyses of low-level waste that exceeds Class C concentration limits to determine the extent to which alternative near-surface disposal systems (e.g. concrete bunkers, augered holes, deeper disposal) may be suitable for safe disposal of such waste. These analyses include a more detailed characterization of physical, chemical, and radiological characteristics of wastes that may be close to or exceed Class C concentration limits as well as development of improved methods for modeling the radiological and economic impact of disposal of these wastes. A related activity is development of more specific guidance for design and operation of alternative near-surface and other land disposal systems. These activities represent a continuation of the Part 61 rulemaking process as discussed in the December 27, 1982 notice of the final Part 61 regulation (47 FR 57446).

Wastes exceeding Class C concentrations are projected to be generated by nuclear power reactors and other supporting nuclear fuel cycle facilities, and also generated by

radioisotope product manufacturers and other facilities and licensees outside of the nuclear fuel cycle. Such wastes can be grouped as follows:

—Plutonium-contaminated nuclear fuel cycle wastes
—Activated metals
—Sealed sources
—Radioisotope product manufacturing wastes
—Other waste

Plutonium-contaminated nuclear fuel cycle wastes. These wastes are being generated from two principal sources. One source of waste arises from operations supporting the nuclear fuel cycle—i.e., post-irradiation radiochemical and other performance analyses of spent fuel rods from nuclear reactors (e.g., "burnup" studies). These operations generate about 200 ft^3 of plutonium-contaminated waste per year, much of which is believed to exceed Class C concentration limits. This waste consists of solidified liquids and other solid material such as scrap, trash, and contaminated equipment. Eventual decommissioning of the three facilities currently performing these analyses is expected to generate additional waste volumes, a portion of which is expected to exceed Class C concentration limits.

The second source of waste arises from fuel cycle licensees who have previously been authorized to use plutonium in research and development of advanced reactor fuels. None of these licensees is using plutonium now, and there is no prospect in the foreseeable future for such activities. In fact, each of the licensees in this category has either decommissioned, or is in the process of decommissioning, its facility. Some of the licensees have made contractual arrangements to transfer their decommissioning waste to DOE for retrievable storage. Approximately 5,000 to 10,000 ft^3 of waste, however, is projected to be generated on a one-time basis that will not be covered by contract.

Activated metals. Activated metals are typically generated as a result of long-term neutron bombardment of metals forming the structure or internal components of a nuclear reactor used for power production, radioisotope production, or other purpose (e.g., education, testing, research). Activated metal wastes are unlike most other wastes being generated in that the radionuclides form part of the actual metal matrix rather than being mixed with large volumes of other, nonradioactive material such as paper, cloth or resins. Radionuclide release is principally governed by the material corrosion rate, and for most reactor metals of concern (e.g., stainless steel), the corrosion rate is quite low.

To date, only a small fraction (about 200 ft^3/yr) of the activated metal waste currently being generated by nuclear power reactors has been identified as exceeding Class C concentration limits. Such waste appears to primarily consist of in-core instrumentation which is no longer serviceable. An example of this waste is a reactor flux wire which is physically small but may be high in activity. (A flux wire is a wire that is inserted into a tube running the length of the reactor core and used to make neutron flux measurements.)

Large quantities of activated metal wastes are projected to be generated in the future as a part of reactor decommissioning. Studies by NRC (NUREG/CR-0130, addendum 3 and NUREG/CR-0672, addendum 2) indicate that over 99% of the waste volume that is projected to result from nucler power reactor decommissioning will not exceed class C concentration limits and the 1% that is projected to exceed these limits will be almost all activated metals from core structure. Conservative estimates presented in these studies indicate that packaged quantities of decommissioning wastes exceeding Class C concentration limits will total about 4700 ft^3 for a large (1175 MWe) pressurized water reactor (PWR) and about 1660 ft^3 for a large (1155 MWe) boiling water reactor (BWR). Much smaller quantities of wastes exceeding Class C concentration limits may also be generated from future decommissioning of test, research, and education reactors.

Another source of activated metal waste is expected to arise as part of consolidation of spent fuel assemblies for storage and/or disposal. Spent fuel assemblies now being periodically discharged from nuclear power reactors are stored in on-site fuel storage pools. Each assembly is composed of a large number of fuel rods arranged in a rectangular array, and held in place by spacer grids, tie rods, metal end fittings, and other miscellaneous hardware. One option under consideration, for long-term waste storage and eventual disposal is to remove this hardware form the fuel rods. This allows the fuel rods, which contain the fission products which are of primary interest in terms of geologic repository disposal, to be consolidated into a smaller volume. This enables more economical storage and easier handling for transport and disposal. The hardware, which is composed of various types of corrosion-resistant metal such as Inconel or zircalloy, becomes a second waste stream which could potentially be safely disposed by a less expensive method than a geologic repository.

Based on information from DOE (DOE/RW-0006, September, 1984) about 12 kg of waste hardware would be generated per BWR fuel assembly, and about 26 kg per PWR fuel assembly. Assuming 200 fuel asemblies are replaced per year per large 1000 NWe) BWR, roughly 2400 kg of activated metal hardware would be generated per year per large BWR, and about 1700 kg per PWR. An approximate compacted volume is on the order of 50 ft^3/yr per large reactor, or about 4,000 ft^3/yr over the entire industry. Depending upon parameters such as the fuel irradiation history and the hardware elemental composition, particular pieces of separated hardware may or may not exceed Class C concentration limits.

Other than perhaps a few isolated cases, all of the spent fuel assemblies are being stored by licensees with the hardware still attached. Under the provisions of the NWPA, operators of nuclear power plants have entered into contracts with DOE for acceptance by DOE of the spent fuel for storage and eventual disposal. (See 48 FR 16590, April 18, 1983 for the terms of the contract.) Acceptance of the spent fuel by DOE implies acceptance of the activated hardware along with the fuel rods, with the result that disposal of the hardware would intrinsically be a Federal rather than a State responsibility. Disposal responsibility becomes less clear if licensees, seeking more efficient onsite storage, consolidated fuel themselves.

Sealed sources. A number of discrete sealed sources have been fabricated for a variety of medical and industrial applications, including irradiation devices, moisture and density gauges, and well-logging gauges. Each source contains only one or a limted number of radioisotopes. Sealed sources can range in activity from a few millionths of a curie for sources used in home smoke detectors to several thousand curies for sources used in radiotherapy irradiators. Sealed sources are produced in several physical forms, including metal foils, metal spheres, and metal cylinders clamped onto cables. The larger activity sealed sources typically consist of granules of radioactive materials encapsulated in a metal such as stainless steel.

Sealed sources are generally quite small physically. Even sources containing several curies of activity have physical dimensions which are normally less than an inch or two in diameter and 6 inches in length. These dimensions are such that, like activated metals, sealed sources may be considered to be a unique form of low-level waste. Characterizing sealed sources in terms of radionuclide concentration certainly appears to be of less utility than characterizing sealed sources in terms of source activity.

Depending upon the application, sealed sources may be manufactured using a variety of different radioisotopes. A review of the NRC sealed source registry was conducted to identify those source designs which may contain radioisotopes in quantities that might exceed Class C concentration limits. The principal possibilities appear to be those containing cesium-137, plutonium-238, plutonium-239, and americium-241. Large cesium-137 sources are generally used in irradiators, and while some large sources can range up to a few thousand curies, most which are sold appear to contain in the neighborhood of 500 curies. Cesium-137 is a beta/gamma emitter having a half-life of 30 years, which suggests that special packaging and disposal techniques can be readily developed for safe near-surface disposal of sources containing this isotope.

The remaining three isotopes are alpha emitters and are longer lived. Sources manufactured using these isotopes can range up to a few tens of curies, although most that have been sold appear to be much less than one curie in strength. Plutonium-239 sources are not commonly manufactured. Plutonium-238 sources have been manufactured for use as nuclear batteries for applications such as heart pacemakers. Plutonium-238 has also been used in neutron sources, although neutron sources currently being manufactured generally contain americium-241. Americium-241 is also used in a wide

variety of other industrial applications such as fill level gauges.

Neutron sources produce neutrons for applications such as reactor startup, well logging, mineral exploration, and clinical calcium measurements. These sources contain alpha-emitting radionuclides such as americium-241 plus a target material (generally beryllium) which generates neutrons when bombarded by alpha particles. Neutron sources can contain up to approximately 20 curies of activity.

It is difficult to project potential waste sealed source quantities and activities, since sealed sources as wastes are not routinely generated as part of licensed operations. In addition, sealed sources only become waste when a decision is made by a licensee to treat them as such. In many instances sources held by licensees may be recycled back to the manufacturer when they are no longer usable, and the radioactive material recovered and fabricated into new sources. Finally, source manufacturers are licensed by the NRC and NRC Agreement States to manufacture a particular source design up to a specified radioisotope curie limit. Most actual sources, however, contain activities considerably less than the design limit.

NRC staff estimates that licensees currently possess approximately 10,000 encapsulated sources having activities above a few thousandths of a curie and containing americium-241 or plutonium-238. Given the hypothetical case that all these sources were candidates for disposal, the total consolidated source volume would be only about 35 ft^3. After packaging for shipment, however, the total disposed waste volume would be significantly increased. The total activity contained in the sources is estimated to be approximately 70,000 curies.

Radioisotope product manufacturing wastes. Wastes exceeding Class C concentration limits are occasionally generated as part of manufacture of sealed sources, radiopharmaceutical products, and other materials used for industrial, educational, and medical applications. Volumes and characteristics of such wastes are difficult to project. However, it is believed that the largest volume of this waste consists of sealed sources which cannot be recycled, plutonium-238 and americium-241 source manufacturing scrap, and waste contaminated with carbon-14.

Sealed sources as a waste form are discussed above. Manufacture of large plutonium-238 and americium-241 sources is concentrated in only a few facilities, from which the generation of waste exceeding Class C concentration limits is believed to total only a few hundred ft^3 per year. Approximately 10 ft^3 per year of carbon-14 waste is generated as a result of radiopharmaceutical manufacturing.

Other wastes. Although the above discussed wastes are believed to be the principal wastes that are expected to exceed Class C concentration limits, other wastes may occasionally also be generated. For example, relatively small quantities of such wastes are currently being generated as part of decontamination of the Three Mile Island, Unit 2, nuclear power plant. However, these wastes are being generated as a result of an accident, are therefore considered abnormal, and are being transferred to DOE under a memorandum of understanding with NRC. Wastes exceeding Class C concentration limits and generated as part of the West Valley Demonstration Project are also being transferred to DOE for storage pending disposal.

Sealed sources and other waste containing discrete quantities of radium-226 may also exceed Class C concentration limits. Products containing radium-226 have been manufactured in the past for a variety of industrial and medical applications. Such wastes are not regulated by NRC but occasionally have been disposed at licensed low-level waste disposal facilities. NRC is currently investigating the impacts of disposal of such waste in order to provide guidance to States and other interested parties on safe disposal methods and any concentration limitations.

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