IMPLEMENTATION GUIDE
for use with DOE M 435.1-1

Chapter II

High-Level Waste Requirements

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II. A. <u>Definition of High-Level Waste</u>.

High-level waste is the highly radioactive waste 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 other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

Objective:

The objective of this requirement is to provide the criteria for determining which DOE radioactive wastes are to be managed as high-level waste, and therefore, in accordance with DOE M 435.1-1, Chapter II, *High-Level Waste Requirements*, and Chapter I, *General Requirements and Responsibilities*.

Discussion:

As required in DOE M 435.1-1, Section I.1.C., Radioactive Waste Management, all radioactive wastes subject to DOE O 435.1 shall be managed as either high-level waste, transuranic waste, low-level waste, or mixed low-level waste. To assist in determining whether a particular waste stream is high-level waste, another waste type, or not addressed by DOE O 435.1 and DOE M 435.1-1, see the guidance that accompanies the requirement at Section I.1.C. For those waste streams that meet the definition of high-level waste cited above, the requirements of Chapter II of DOE M 435.1-1 shall be met.

This definition is consistent with the definition provided in the *Nuclear Waste Policy Act of 1982* (NWPA), as amended. It is slightly modified from the *Nuclear Waste Policy Act of 1982*, as amended, definition and, as discussed below, allows DOE to make a determination of what is high-level waste based on existing law.

The identification of high-level waste is considered relatively straightforward since it is <u>primarily</u> linked to the source from which it was derived, i.e., it is the highly radioactive material resulting from the reprocessing of spent nuclear fuel. However, the definition does imply a concentration limit by including solid material derived from liquid waste that contains fission products in sufficient concentrations. Background and knowledge of both the *Nuclear Waste Policy Act of 1982*, as amended, definition and the Nuclear Regulatory Commission definition, at 10 CFR Part 60, is needed to ensure that waste that is to be managed as high-level waste has been properly characterized to be high-level waste. High-level waste must be managed in accordance with Chapter II of DOE M 435.1-1.

Background. The following discussion is provided in terms of the *Nuclear Waste Policy Act of 1982*, as amended, definition but is fully applicable to the definition at Section II.A of DOE M 435.1-1. The *Nuclear Waste Policy Act of 1982*, as amended, provides 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. In the *Nuclear Waste Policy Act of 1982*, as amended, the term high-level radioactive waste is defined as:

> "(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."

Thus the *Nuclear Waste Policy Act of 1982*, as amended definition for high-level waste provides for the inclusion of both source-based material and concentration-based material as high-level waste.

Note that the *Nuclear Waste Policy Act of 1982*, as amended, does not mandate that materials regarded as high-level waste pursuant to this definition be disposed of in a geologic repository. Indeed, the *Nuclear Waste Policy Act of 1982*, as amended, directs the Secretary of Energy to continue and accelerate a program of research, development, and investigation of alternative means and technologies for the permanent disposal of high-level waste. DOE has not been specifically authorized by Congress to construct or operate facilities for disposal by alternative means, and it is not clear whether additional authorization might be needed in order to dispose of high-level waste by means other than emplacement in a deep geologic repository (*52 FR 5994*).

Also note that the *Nuclear Waste Policy Act of 1982*, as amended, definition and the definition for high-level waste in DOE's predecessor directive for radioactive waste management, DOE 5820.2A, are fundamentally the same. However, there is one exception. The *Nuclear Waste Policy Act of 1982*, as amended, provides for an additional mechanism for determining a waste is high-level waste. This mechanism is to allow the Nuclear Regulatory Commission (NRC) to determine, by rule, that a waste requires permanent isolation. The wording in Section II.A is slightly different than the *Nuclear Waste Policy Act of 1982*, as amended, to allow DOE to make a determination based upon existing law in Sections 202(3) and 202(4) of the *Energy Reorganization Act of 1974*.

The NRC has posited that, "radioactive wastes that have historically been referred to as high-level waste, i.e., reprocessing wastes, are initially both intensely radioactive and long-lived" (*52 FR 5994)*. However, these wastes contain a wide variety of radionuclides with some (e.g., Sr-90, Cs-137) having a relatively short half-life yet representing 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 managing such wastes. Other radionuclides, 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 in the *Nuclear Waste Policy Act of 1982*, as amended, to describe the type of disposal required to isolate them from the environment. Permanent isolation does not, however, equate to repository disposal, and can be conceivably attained by other means which comply with the requirements of 40 CFR Part 191. The Nuclear Regulatory 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" (*52 FR 5994*).

The *Nuclear Waste Policy Act of 1982*, as amended, identifies two sources of high-level waste. First, the *Nuclear Waste Policy Act of 1982*, as amended, definition of high-level waste refers to wastes produced by reprocessing spent nuclear fuel, which is essentially identical to the NRC's definition at 10 CFR Part 60 [(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]. However, there is one difference. The *Nuclear Waste Policy Act of 1982*, as amended, wording would classify solidified reprocessing waste as high-level waste only if such waste "contains fission products in sufficient concentrations." This phrase implies that liquid reprocessing waste may be partitioned or otherwise treated so that some of the solidified products will contain substantially reduced concentrations of radionuclides and thus not be high-level waste, i.e., incidental waste. Second, the *Nuclear Waste Policy Act of 1982*, as amended, authorizes the NRC to classify "other highly radioactive material" (other than reprocessing wastes) as high-level waste if that material "requires permanent isolation." Both of these elements of the *Nuclear Waste Policy Act of 1982*, as amended, definition are discussed further below by providing summaries of the Nuclear Regulatory Commission's attempt to revise the 10 CFR Part 60 definition of high-level waste.

In February 1987, the NRC published an Advanced Notice of Proposed Rulemaking, (*52 FR 5992*) announcing its intent to revise the definition of the term high-level radioactive waste that appears in 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories." In the Advanced Notice of Proposed Rulemaking, the Commission reviewed the previous statutory and regulatory uses of the term, the NRC's current regulations related to waste classification and disposal, and the pertinent provision of the *Nuclear Waste Policy Act of 1982*, as amended, with the purpose of considering a change to its own rules to conform to the *Nuclear Waste Policy Act of 1982*, as amended, definition. In particular, the NRC proposed to define high-level waste in a manner that would apply the term high-level radioactive waste to materials in amounts and concentrations exceeding numerical values that would be stated explicitly in the form of a table. Thus, high-level waste would be characterized by the kind of hazard that could only be guarded against by disposal in a geologic repository or equivalent facility. Those wastes that could be disposed of safely in a facility less secure than a repository would continue to be classified as low-level radioactive waste rather than as high-level waste.

At issue was whether the Commission should specify numerically the concentrations of fission products which it considered sufficient to distinguish high-level waste from non-high-level waste or, define high-level waste so as to add the *Nuclear Waste Policy Act of 1982*, as amended, (clause (a)) wastes with those which have traditionally been regarded as high-level waste (*52 FR 5994*), i.e. by the waste's source. In addition, the Commission raised the issue as to whether 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. The Commission stated that such concentrations are sufficient to produce significant radiation levels and to generate substantial amounts of heat and should be considered highly radioactive. Finally, the phrase permanent isolation was discussed and was believed to be much less subjective than is the term highly radioactive. The Commission suggested that the term clearly implies the degree of isolation afforded by a deep geologic repository, and a waste "requires permanent isolation" if it cannot be safely disposed of in a facility that is less secure than a repository. Furthermore, the Advanced Notice of Proposed Rulemaking (*52 FR 5995*) states that the Commission could determine which wastes require permanent isolation by evaluating the disposal capabilities of alternative, less secure, disposal facilities. The Commission noted that such less secure 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. The Commission suggested that any such wastes which cannot be safely disposed of in such facilities could be deemed to require permanent isolation and, if also highly radioactive, could be classified as high-level wastes (*52 FR 5995*).

In May 1988 (*53 FR 17709-17711*), the NRC published its Proposed Rule at 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," and stated that the proposed amendments to this Rule obviated "the need for altering existing classifications of radioactive wastes as high-level or low-level." In short, the NRC received nearly 100 comments on its February 1987 Advanced Notice of Proposed Rulemaking and almost all agreed with the Commission on one point: the use of the term high-level radioactive waste as used in the clause (b) of the *Nuclear Waste Policy Act of 1982*, as amended definition, serves to identify those wastes which require the degree of isolation afforded by a deep geologic repository. However, comments differed widely regarding the specific wastes perceived to require that degree of isolation. Some comments advocated classification of all radioactive wastes, other than the most innocuous, as high-level waste while other comments preferred to reclassify, as low-level waste, large quantities of defense reprocessing waste long regarded as high-level waste. Conspicuously absent from the comments was any consensus regarding the means to be used by the Commission to distinguish high-level waste from non-high-level waste. For example, the concept of a numerical definition of high-level waste was criticized as an invitation to dilute or fractionate wastes solely to alter their classification. From this discussion the Commission determined it would be best to proceed quite differently from its objective suggestion as set forth in the Advanced Notice of Proposed Rulemaking; i.e., the NRC abandoned their attempt to provide a risk-based definition for high-level waste. Instead, the Commission continued to embrace the definition at 10 CFR Part 60. In summary, the Commission stated that the preferable construction of the statute was to conform to the traditional definition, i.e., to define high-level waste by its source, not by its concentrations of fission products, and thus equate *Nuclear Waste Policy Act of 1982*, as amended, wastes with those wastes which have traditionally been regarded as high-level waste under Appendix F of 10 CFR Part 50 and the *Energy Reorganization Act of 1974* (ERA). The NRC stated that "NWPA (clause (a)) wastes have little significance for purposes of the NWPA since the Federal Government was already responsible for the disposal of all reprocessing waste at the time the statute was passed." Thus "materials that are high-level waste for purposes of licensing-jurisdiction provisions of the ERA will also be regarded as high-level waste under the NWPA. This would include the primary reprocessing waste streams at DOE facilities, though not the incidental wastes produced in reprocessing" (*53 FR 17709*).

Discussion. The above background information is intended to provide some background for the following discussion on determining what waste streams are, and are not, high-level waste. First, it is noted that the term reprocessing is not defined statutorily. However, reprocessing is considered by the Department to be those actions necessary to separate fissile elements (U-235, Pu-239, U-233, and Pu-241) and/or transuranium elements (e.g., Np, Pu, Am, Cm, Bk) from other materials (e.g., fission products, activated metals, cladding) contained in spent nuclear fuel for the purposes of recovering desired materials. Second, as discussed above, the concentration of fission products is not the primary consideration when making determinations using clause (a) of the *Nuclear Waste Policy Act of 1982,* as amended. The source of the waste is the primary parameter for making high-level waste determinations, not the activity or concentration of fission products. However, inclusion of solid wastes derived from the waste of spent nuclear fuel reprocessing activities is also a consideration if the concentration of fission products is sufficient. Third, it is recognized that the NRC's definition of high-level waste at 10 CFR 60.2, (which is consistent with the definition of high-level radioactive waste in 10 CFR Part 50, Appendix F), limits high-level waste to wastes that are the result of spent nuclear fuel reprocessing, beginning with the separation/first cycle solvent extraction step, or equivalent. Specifically it states high-level radioactive waste is:

> "(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." (10 CFR 60.2)

With regard to part (1) of this definition, it is noted that requirements for DOE-managed spent nuclear fuel, as of the time of the preparation of this guidance, have not been added to DOE O

435.1. Further, the hazards analysis performed to identify requirements for high-level waste did not address the functions associated with management of spent nuclear fuel. Thus the requirements contained in DOE M 435.1-1 do not apply to this DOE-managed spent nuclear fuel.

DOE M 435.1-1 supports the implementation of part (2) of the 10 CFR Part 60 definition to mean that high-level wastes are wastes that are generated as a product of reprocessing of spent nuclear fuel downstream of, and including, the first step in a separations process, and the consistent waste streams from subsequent extraction cycles or steps. Separation processes include aqueous separation processes, e.g., the Redox and the Purex processes, and nonaqueous processes, e.g., pyrometallurgical and pyrochemical processes. Wastes that are produced upstream of these separations processes, from such processes as chemical or mechanical decladding, fuel dissolution, cladding separations, conditioning, or accountability measuring, are not high-level waste. Such wastes are considered processing wastes and should be managed in accordance with the appropriate Chapters of DOE M 435.1-1, as either transuranic, mixed low-level, or low-level waste. In addition, these wastes may be commingled with materials-in-process that require further processing to separate desired materials from wastes. The following example is offered to clarify this interpretation.

Example: The spent nuclear fuel reprocessing operation at Site Z has been shut down for some time. In the haste of shutting down the operation a number of material streams and waste streams were left in the facility and are now being reviewed for disposition. The following table describes some of the streams, designation of the stream as high-level waste, or non-high-level waste, and the basis for the designation:

Stream	***Designation***	***Basis***
Fuel cladding hulls (leached, partially leached, and unleached)	*Non-high-level waste*	*Hulls are generated upstream of (before) the first step of a separations process. They should be characterized to determine proper classification (e.g., LLW, MLLW, or TRU).*
PUREX process first-cycle raffinate stream, Pu purification raffinate stream	*High-level waste*	*Both waste streams are generated by the first step, or subsequent steps, of a separations/decontamination process.*

Stream	***Designation***	***Basis***
Contaminated equipment/components: *a) Fuel Shear* *b) Fuel Dissolver* *c) First cycle solvent extraction column*	*a) Non-high-level waste* *b) Non-high-level waste* *c) High-level waste unless WIR Evaluation Process criteria are met.*	*a) Waste contained/trapped in a fuel shear was generated upstream of first step of separations process. Fuel shear should be characterized to determine proper classification (e.g., LLW, MLLW or TRU).* *b) Same as a).* *c) Waste contained/trapped in column was generated during first step of separations process. May be managed as non-high-level waste if column meets the Waste Incidental to Reprocessing Evaluation Process criteria.*
Electrometallurgical treatment products: *a) Metal waste form (includes uranium, fission products, noble metals)* *b) Ceramic waste form (includes fission products, some actinides)*	*a) High-level waste* *b) High-level waste*	*a) & b) Both waste streams are generated by the first step, or subsequent step, of a separation/decontamination process.*

As stated above, the Department recognizes that the *Nuclear Waste Policy Act of 1982*, as amended, grants the NRC the authority, through the rulemaking process, to designate other highly radioactive materials as high-level waste under existing law. For DOE, such existing law would primarily be sections 202(3) and (4) of the *Energy Reorganization Act of 1974*.

<u>Components and Equipment Contaminated with High-Level Waste</u>. As discussed in detail in the guidance to Section II.B, Waste Incidental to Reprocessing, components and equipment contaminated with high-level waste are not considered high-level waste by the application of the high-level waste definition in Section II.A, or the *Nuclear Waste Policy Act of 1982*, as amended, definition, <u>provided</u> they meet the conditions of either the Waste Incidental to Reprocessing Citation or Evaluation Process. In defining high-level waste both definitions use the term "highly

radioactive material" which is interpreted to mean waste material that is a result of reprocessing spent nuclear fuel and any liquid waste or solid material derived from such liquid. There is no precedence nor basis for including high-level waste-contaminated components and/or equipment within the definition. In fact, the identification of items excluded from high-level waste by the Atomic Energy Commission and subsequently by the Nuclear Regulatory Commission, includes not only radioactive (fuel) hulls and other irradiated and contaminated fuel structural hardware but also "ion exchange beds, sludges, and contaminated laboratory items, clothing, tools, and equipment" (*52 FR 5993*). Thus, inclusion of these items as candidates for the incidental waste process supports the DOE M 435.1-1 position that such contaminated items may not be high-level waste. If they are not, they are subject to management and disposal as another waste type, provided adequate protection is provided by their disposal as another waste type (e.g., low-level waste or transuranic waste).

Spent Nuclear Fuel. Spent nuclear fuel is defined in the *Nuclear Waste Policy Act of 1982*, as amended, as "fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing." Because this definition was developed with commercially-generated spent nuclear fuel in mind, it fails to differentiate between defense-related spent nuclear fuel (drivers) and target elements (materials irradiated to produce defense nuclear materials). For the purposes of managing high-level waste under DOE M 435.1-1, spent nuclear fuel includes spent driver elements and/or irradiated target elements that contain transuranium elements. Excluded from spent nuclear fuel are target elements, that after irradiation, contain no transuranium elements (e.g., those for the production of tritium) since such spent target elements contain neither fissile material nor long-life transuranic isotopes that require permanent isolation. Historically, such spent targets (reprocessed and unreprocessed) have been assayed, treated, and disposed of as low-level waste (Final Environmental Impact Statement, DOE/EIS-0271, *Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*, DOE 1999). DOE M 435.1-1 supports the continuation of this practice.

In April 1992, the Secretary of Energy approved a recommendation to phase out reprocessing of spent nuclear fuel at DOE's Savannah River Site and Idaho National Engineering Laboratory for the purpose of recovering highly enriched uranium for the weapons program (Secretary of Energy Decision Memo, dated April 28, 1992). In a similar action in December 1994 the Secretary of Energy approved a recommendation to prohibit the use of plutonium-239 and highly enriched uranium separated and/or stabilized during facility phaseout, shutdown, and cleanout activities for nuclear explosive purposes (Memorandum for the Secretary, approved December 20, 1994). From these actions it is evident that DOE no longer plans to reprocess spent nuclear fuel for the purposes of recovering fissile materials and significant quantities of additional high-level waste will not be generated in the future from these operations. However, it is recognized there may be limited reprocessing at some of the high-level waste sites for spent nuclear fuel that is considered "at risk materials." Similarly, for cost effective reasons as well as others, most DOE high-level waste sites continually add radioactive liquid wastes (e.g., cooling, water, decontamination solutions) that may, or may not be, high-level waste to their high-level waste storage systems. This practice effectively increases the volume of high-level waste to be managed, however, the net amount is usually minor due to the evaporation capabilities at the sites. Such co-mingling of high-level waste with other waste types should be performed considering the waste minimization objectives of DOE M 435.1-1, Section I.1.E.(20), Waste Minimization and Pollution Prevention.

Disposition of Surplus Weapons-Usable Plutonium. The Department has the authority to emplace surplus weapons-usable plutonium in immobilized high-level waste canisters and dispose of this waste form in the geologic repository constructed under the *Nuclear Waste Policy Act of 1982*, as amended, (NRC letter, C.J. Paperiello to L.H. Barrett, January 25, 1999). Thus this composite waste form (plutonium can in a high-level waste canister) is considered high-level waste and should be managed as such. Although the hazards analysis and requirements analysis prepared to support the development of the high-level waste chapter of DOE M 435.1-1 did not consider the inclusion of this waste form, its addition is not expected to change the requirements contained in the chapter.

Non-Routine High-Level Waste. There is acknowledgment of a sub-category of high-level waste, "non-routine high-level waste," that includes secondary radioactive solid wastes that meet the source-based portion of the definition for high-level waste, but may not meet the current immobilized high-level waste specification for a standard waste form, as defined by the DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS). The current EM-WAPS document was written to allow acceptance of a standard waste form, borosilicate glass canistered waste, but does recognize the production of “nonconforming canistered high-level waste forms” from the high-level waste form producers. Examples are expected to include immobilized waste that is suspected of being contaminated by foreign materials and glass samples that were generated during production. Such waste forms may be nonconforming and thus, may require review/acceptance by the DOE Office of Civilian Radioactive Waste Management. If accepted, they will be a nonstandard waste form. Such Office of Civilian Radioactive Waste Management acceptance is expected to include satisfying the requirements in the EM-WAPS and approval of a treatment and disposition plan.

> *Example: At Site X, non-conforming high-level waste has been generated as a result of high-level waste storage, pretreatment, and treatment activities. This waste includes:*
>
> - *glass chipped from high-level waste glass melters,*
> - *glass deposited on equipment*
> - *spilled high-level waste glass that was not captured in a canister,*
> - *glass samples/shards.*
>
> *The Site is currently managing these wastes as nonconforming high-level wastes since there are issues regarding contamination by foreign materials and the need to place*

> *these wastes in canisters. However, each canister is expected to meet the EM-WAPS specifications and be accepted by the Office of Civilian Radioactive Waste Management as non-standard canistered waste forms. If any do not meet the EM-WAPS specifications, they will be managed as non-conforming and the Office of Civilian Radioactive Waste Management acceptance, as nonstandard waste form, will be necessary by way of an Office of Civilian Radioactive Waste Management-approved action plan. The requirement for an action plan is included in the EM-WAPS, specifications 4, Quality Assurance.*

The high-level waste scraps identified in the above example are considered non-routine high-level waste forms. Currently both the Defense Waste Processing Facility at Savannah River and West Valley Demonstration Project vitrification processes have produced small amounts of this material and are storing it until a path forward can be determined.

Waste Incidental to Reprocessing. Those waste streams that meet the requirements of the waste incidental to reprocessing processes, either by citation or by evaluation, are also excluded from the scope of high-level waste. DOE M 435.1-1, Section II.B describes the process for making such determinations and the accompanying guidance on this section provides further details on this subject.

Interfaces Between the Office of Environmental Management and Office of Civilian Radioactive Waste Management. The guidance for high-level waste disposal (DOE G 435.1-1, Section II.S) provides information on the responsibilities and interfaces between the Offices of Environmental Management and Civilian Radioactive Waste Management.

Supplemental References:

1. *Nuclear Waste Policy Act of 1982,* as amended, Public Law 97-425, Section 2.(12), January 7, 1983.

2. *Energy Reorganization Act of 1974*, as amended, Public Law 93-438, Section 202 (3) and (4).

3. AEC, 1969. "Siting of Commercial Fuel Reprocessing Plants and Related Waste Management Facilities; Statement of Proposed Policy, 10 CFR Part 50, 'Licensing of Production and Utilization Facilities'," *Federal Register,* Vol. 34, No. 8712, Atomic Energy Commission, Washington, D.C., June 3, 1969.

4. AEC, 1970. "Siting of Commercial Fuel Reprocessing Plants and Related Waste Management Facilities, 10 CFR Part 50, 'Licensing of Production and Utilization

Facilities’,” *Federal Register*, Vol. 35, No. 17530-17533, Atomic Energy Commission, Washington, D.C., November 14, 1970.

5. NRC, 1987. “Advanced Notice of Proposed Rulemaking; 10 CFR Part 60, ‘Definition of High-Level Radioactive Waste,’” *Federal Register*, Vol. 52, No. 5992, U.S. Nuclear Regulatory Commission, Washington, DC, February 27, 1987.

6. NRC, 1988. “Proposed Rule; 10 CFR Part 61, Disposal of Radioactive Wastes, U.S. Nuclear Regulatory Commission, Washington, D.C., *Federal Register*, Vol. 53, No. 17709, May 18, 1988.

7. Claytor, 1992. R.A. Claytor, Assistant Secretary for Defense Programs, to The Secretary of Energy, memorandum, *A Decision on Phaseout of Reprocessing at the Savannah River Site (SRS) and the Idaho National Engineering Laboratory (INEL)*, U.S. Department of Energy, April 28, 1992.

8. Reis and Grumbly, 1994. V.H. Reis & T.P. Grumbly, Assistant Secretary for Defense Programs and Assistance Secretary for Environmental Management, memorandum, *Action: Commitment to Prohibit the Use of Plutonium-239 and Highly Enriched Uranium Separated and/or Stabilized During Facility Phaseout, Shutdown, and Cleanout Activities for Nuclear Explosive Purposes*, U.S. Department of Energy, December 20, 1994.

9. *Atomic Energy Act of 1954*, as amended, Public Law 83-703, Title II, Section 11, (dd), August 30, 1954.

10. NRC. *Disposal of High-Level Radioactive Wastes in Geologic Repositories*, 10 CFR Part 60, U.S. Nuclear Regulatory Commission, Washington, D.C.

11. Barrett, 1998. L.H. Barrett to C.J. Paperiello, letter, [no title], U.S. Department of Energy, Washington, D.C., December 10, 1998.

12. Paperiello, 1999. C.J. Paperiello to L.H. Barrett, letter, *U.S. Department of Energy Plans for Disposal of Surplus Weapons Plutonium*, U.S. Nuclear Regulatory Commission, Washington, D.C., January 25, 1999.

13. EPA. *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level Waste and Transuranic Radioactive Wastes*, 40 CFR Part 191, U.S. Environmental Protection Agency, Washington, D.C.

14. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

15. DOE, 1999. *Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*, Final Environmental Impact Statement, DOE/EIS-0271, U.S. Department of Energy, Savannah River Operations Office, March 1999.

16. ERDA, 1977. *Waste Management Operations, Savannah River Plant, Aiken, South Carolina*, Final Environmental Impact Statement, ERDA-1537, Energy Research and Development Administration, Washington, D.C., September 1977.

II. B. Waste Incidental to Reprocessing.

Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not high-level waste, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate. When determining whether spent nuclear fuel reprocessing plant wastes shall be managed as another waste type or as high-level waste, either the citation or evaluation processes described below shall be used:

(1) Citation. Waste incidental to reprocessing by citation includes spent nuclear fuel reprocessing plant wastes that meet the description included in the Notice of Proposed Rulemaking (34 FR 8712) for proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not limited to: contaminated job wastes including laboratory items such as clothing, tools, and equipment.

(2) Evaluation. Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that:

(a) Will be managed as low-level waste and meet the following criteria:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and

2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, *Performance Objectives*; and

3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, *Waste Classification*; or will meet alternative

requirements for waste classification and characterization as DOE may authorize.

(b) Will be managed as transuranic waste and meet the following criteria:

1. **Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and**

2. **Will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and**

3. **Are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954,* as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate.**

Objective:

The objective of this requirement is to ensure the implementation of a consistent and defensible process to make waste incidental to reprocessing determinations across the DOE complex. Implementation of the process will ensure DOE manages these waste streams within its regulatory authority for disposal.

Discussion:

Certain waste streams produced during the generation of high-level waste may be determined to be non-high-level waste through the waste incidental to reprocessing determination process. The processes for making such determinations are included as requirements in DOE M 435.1-1, Section II.B, and are described below. In conjunction with Section II.B is a requirement in Section I.2.F.(18), Waste Incidental to Reprocessing, which delineates the responsibilities of the Field Element Manager and the DOE Office of Environmental Management for making and reviewing such waste incidental to reprocessing determinations. The information and analysis necessary to support these determinations is included.

Background. In the Statement of Proposed Policy (*34 FR 8712*) for Appendix D, 10 CFR Part 50, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities," the Atomic Energy Commission (AEC) noted that the term high-level waste, as used in the proposed Appendix D, did not include all wastes originating from (spent nuclear fuel) reprocessing plant operations (Paragraphs 6 and 7). Such wastes, later referred to as incidental wastes by the Nuclear Regulatory Commission (NRC) (*52 FR 5993*), included waste streams such as ion exchange beds, sludges, and contaminated laboratory items, clothing, tools, and equipment. Additionally, this category included radioactive hulls and other irradiated and contaminated fuel structural hardware. Although this language (Paragraphs 6 and 7) concerning incidental waste was deleted from the final Policy under Appendix F, pending additional study (*35 FR 17530-17533*), the principle of incidental wastes has been continually supported by both the Department of Energy and the NRC , as well as their predecessors, even before the Proposed Rulemaking.

In its Advance Notice of Proposed Rulemaking for the Definition of High-Level Radioactive Waste at 10 CFR Part 60 (*52 FR 5992-6001*), the NRC introduced the term incidental wastes and stated that high-level waste does not include such waste streams. Additionally, the Commission stated (footnote 1, *52 FR 5993*) that "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 proposed Appendix D definition," if they met certain chemical concentrations. Additionally, in the NRC's Proposed Rule for 10 CFR Part 61, for shallow-land disposal of radioactive waste, the Commission stated that the preferable construction of the statute "...is to conform to the traditional definition (for high-level waste). Under this approach, materials that are HLW for purposes of the licensing-jurisdiction provisions of the *Energy Reorganization Act of 1974* will also be regarded as high-level waste under the *Nuclear Waste Policy Act of 1982*, as amended. This would include the primary reprocessing waste streams at DOE facilities, though not the incidental wastes produced in reprocessing" (*53 FR 17709*).

More recently, in response to a petition regarding disposal of waste at the Hanford site, the NRC (States of Washington & Oregon: Denial of Petition for Rulemaking, *58 FR 12342-12347*) commented that:

> "Assuming implementation of DOE's plans as described above, the Commission concludes that any radioactive material from the double shell tanks that is deposited in the grout facility would not be high-level radioactive waste subject to NRC's licensing jurisdiction. The responsibility for safely managing those wastes rest with the Department of Energy. The basis for the Commission's conclusion is that the reprocessing wastes disposed of in the grout facility would be 'incidental' wastes because of DOE's assurance that they:
>
> (1) have been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical;

(2) will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C LLW as set out in 10 CFR Part 61; and

(3) are to be managed, pursuant to the *Atomic Energy Act of 1954,* as amended, so that safety requirements comparable to the performance objectives set out in 10 CFR Part 61 are satisfied." (*58 FR 12345*)

A similar characterization was made for the West Valley Demonstration Project in the Technical Evaluation Report prepared by the NRC Office of Nuclear Material Safety and Safeguards, dated November 1988, which concluded there is reasonable assurance that the cement solidification of the decontaminated supernatant (incidental waste) will meet the waste form stability requirements of 10 CFR Part 61 (NRC Technical Evaluation, 11/88). This is an implicit recognition by the NRC that the separated low-activity fraction of high-level waste need not be managed and disposed as high-level waste.

The question of whether the NRC or DOE has the authority to make incidental waste determinations (using the evaluation process) was raised by NRC Commissioner Curtiss in December 1992 (SECY-92-391), as a precursor to the Commission's action on the 1993 Denial of Petition for Rulemaking. In response, the NRC staff (memo for Commissioner Curtiss from J. M. Taylor, 1/14/93) stated that DOE has the responsibility to make an initial determination, and if DOE concludes that the action is <u>not</u> subject to NRC jurisdiction, then DOE can undertake the activity without involving the NRC in any manner. However, if DOE concludes that NRC jurisdiction is unclear (i.e., the waste may be high-level waste and therefore potentially subject to NRC licensing), then DOE has two options: (1) consult with the NRC and then make a decision based on the results of the consultation; or (2) proceed without communication with the NRC. The staff response then cites the proposed letter from Bernero (USNRC) to DOE (transmitted March 2, 1993) that the NRC would call upon DOE to provide relevant technical information that would enable the NRC to make its own determination, should that be appropriate. (Although this decision applied to the Hanford case only, DOE's interpretation, based on discussions with NRC staff, is that it can be applied more broadly through DOE M 435.1-1.) These two memoranda are interpreted to mean that the NRC expects the DOE to consult with them for those waste streams that the DOE has some question of whether the waste stream is high-level waste. In addition, as discussed in the guidance to Section I.2.F.(18), the NRC has licensing authority over DOE facilities "authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by DOE and its predecessor agencies" (Sullivan, 1998).

<u>Determination Processes</u>. Consistent with these concepts, Section II.B of DOE M 435.1-1 offers two distinct processes by which DOE can determine whether reprocessing wastes can be managed as low-level or transuranic waste under DOE's *Atomic Energy Act* authorities: (1) by citation, and (2) by evaluation.

The citation process refers to those reprocessing waste items of the type that were discussed in the Statement of Proposed Policy for Appendix D, 10 CFR Part 50, as not being high-level waste. Although the exclusion of such items from the high-level waste definition was dropped from the final rule (Appendix F), the concept of incidental waste has been supported by DOE and the NRC. If a positive determination is made, the waste may require further characterization and/or acceptable (process) knowledge to determine its final waste classification and disposition, i.e., low-level or transuranic waste.

The evaluation process refers to those reprocessing wastes that have met, or will meet, the evaluation criteria cited above or other consistent protective criteria approved by the Department. Satisfying these criteria ensures the waste to be regulated and managed for disposal by the DOE according to the requirement for low-level or transuranic wastes, as appropriate.

Finally, if the requirements of neither of these processes can be met, the reprocessing waste is to be managed as high-level waste and its disposal must be in accordance with 10 CFR Part 60 and 40 CFR Part 191.

The distinction between the two processes is important because it is clear from background events that citation process waste streams were so identified because of the ease of determining up front that they do not pose the long-term hazards associated with high-level waste. Evaluation process wastes, on the other hand, generally require a case-by-case evaluation and determination. Consistent with this understanding, the responsibility for citation interpretations rests solely with the DOE Field Element Manager, although consultation with the Office of Environmental Management is encouraged. However, the Office of Environmental Management consultation is required for waste that has been determined to be incidental through the evaluation process. In addition, it is recommended that consultation with the NRC staff be considered for evaluation process determinations, although this is not required. Roles and responsibilities are further explained in the guidance to Section I.2.F.(18) of the General Requirements to DOE M 435.1-1.

Several meetings were held between staff personnel from the NRC and DOE to discuss the acceptability of this dual determination approach. NRC staff agreed with this approach, but recommended that sufficient guidance be developed for the implementation of both processes. This guidance document is provided, in part, to meet the NRC staff recommendation. The NRC staff also confirmed that it supports the position that DOE has authority to make incidental waste determinations that involve waste streams that are incidental by use of the citation process. For waste streams that are considered to be incidental by the evaluation process, and may be subject to NRC licensing if contained in a facility authorized by Congress for the express purpose of long-term storage, the staff suggested that communications with the NRC be maintained. This suggestion is consistent with the staff position discussed above and the letter from R. Bernero, USNRC, to J. Lytle, DOE-EM, dated March 2, 1993 and is provided in DOE M 435.1-1 by recommending consultation with the NRC staff on evaluation determinations. Such communication needs to: a) document the results of the analyses supporting DOE's conclusions; b) be adequate for review; c) be developed with good record-keeping; and d) be conducted under an adequate quality assurance process. Guidance for DOE M 435.1-1, Section I.2.F.(18),Waste Incidental to Reprocessing, provides additional information on these elements and the roles and responsibilities of the Field Element Manager, the DOE Headquarters , and the NRC.

The NRC staff also indicated that if they are requested to consult on such reviews that they would prefer to review evaluation process waste stream candidates on a macro basis, in lieu of reviewing individual waste streams or waste items. This is interpreted to mean that the NRC staff would prefer to review an analysis for a group of high-level waste streams that have similar characteristics or will require similar processing to meet the evaluation criteria, in lieu of individual waste streams or waste items. Such grouping of waste streams is expected to make the most efficient use of the NRC staff's resources and to avoid its involvement in each evaluation process determination for each candidate waste stream or item within the DOE complex. The Office of Environmental Management also prefers to see such grouping be submitted for consultation and coordination. Further discussion on this subject is provided below under the evaluation process.

DOE M 435.1-1 is not intended to create, or support the creation, of a new waste type titled incidental waste. Waste incidental to reprocessing refers to a process for identifying waste streams that would otherwise be considered high-level waste due to their sources of generation or concentration, but can be managed in accordance with the DOE requirements for transuranic or low-level waste, if the requirements for waste incidental to reprocessing are met.

Additionally, it is not the Department's intent to use the waste incidental to reprocessing process to circumvent high-level waste disposal standards by not disposing of high-level waste in the NRC-licensed geologic repository. The goal of the waste incidental to reprocessing determination process is to safely manage and dispose of a limited number of reprocessing waste streams that do not warrant geologic repository disposal because of their lack of long-term threats to the environment and man. Moreover, meeting the evaluation process requirements are difficult and resource intensive and therefore, the DOE high-level waste sites are encouraged to manage high-level waste in a manner that will permit treatment and disposal in a geologic repository. Therefore, non-standard high-level wastes, discussed in the guidance for Section II.A, may be one of the primary waste streams targeted for application of the waste incidental to reprocessing determination process.

To assist in making waste incidental to reprocessing determinations, Figure 1, "Decision Tree for Waste Incidental to Reprocessing Determinations," has been included in this guidance. This figure is a simple decision tree that provides some examples of reprocessing wastes and reprocessing waste streams that are interpreted to be included within each determination process, however, these examples are not considered all inclusive. It is expected that interpretations and determinations by the DOE sites, in conjunction with DOE Headquarters, may revise this list. Updates to this guidance will reflect such determinations and interpretations.

Application of the citation and evaluation processes is for two primary purposes: to support the determination to manage specific waste streams as non-high-level waste, i.e., as low-level or transuranic wastes; and to support closure activities of deactivated high-level waste facilities/sites. Table 1, "Citation and Evaluation Process Results," is provided to illustrate the six (positive) possible results that can result from applying the citation and evaluation process requirements to a waste stream. A negative result to applying both the citation and evaluation processes is possible with the result being that the waste stream is managed as high-level waste. The check symbols under the columns Low-Level Waste, Transuranic Waste, and Facility/Site Closure denote the Section II.B requirements that must be met in order for the waste stream to be managed as indicated by the column heading.

Table 1. Citation and Evaluation Process Results (NA = not applicable)

Requirement(s) Section	Low-Level Waste	Transuranic Waste	Facility/Site Closure
II.B.(1) Citation Process	✔	✔	**NA**
II.B.(2)(a)(1), (2), & (3) Evaluation Process	✔	**NA**	✔
II.B.(2)(b)(1), (2), & (3) Evaluation Process	**NA**	✔	✔

Following is a discussion on each of the determination processes, citation and evaluation. Included, where appropriate, is additional guidance/discussion on the analysis and documentation necessary for reprocessing waste streams to be managed as low-level waste or transuranic waste. Additional information on deactivated high-level waste facility/closure process is provided by the guidance to DOE M 435.1-1, Section II.U, Site Closure.

Citation Process. The citation process refers to those reprocessing waste items of the type that were discussed in the Statement of Proposed Policy for Appendix D, 10 CFR Part 50, as not being high-level waste (*34 FR 8712*). Figure 1 includes examples of wastes that have been interpreted to be included within the citation process. Included are:

- contaminated job wastes, a general category of wastes that are generated during high-level waste transfer, pretreatment, treatment, storage and disposal activities.

Included is protective clothing, personal protective equipment (PPEs), work tools, ventilation filter media, and other job-related materials necessary to complete high-level waste management activities;

- sample media (e.g., sampling vials, crucibles, other hardware);
- decontamination media and decontamination solutions (e.g., swabs, other decon work-related materials); and
- laboratory clothing, tools, and equipment.

Interpreted to be excluded from the citation process are the following:

- ion exchange beds;
- sludges;
- fuel cladding hulls and fuel structural hardware;
- process filter media; and
- contaminated components and equipment.

This list excludes three items: ion exchange beds, sludges, and fuel cladding hulls that were included in the Appendix D proposed language. The first two of these have been excluded from the citation process examples because of the potential long-term hazards their disposal may pose. However, they may be candidates for the evaluation process. The third example that has been excluded is fuel cladding hulls and fuel structure hardware. As explained in the guidance for Section II.A, wastes from processes preceding the first step in a separations process are not considered high-level waste and therefore are not subject to the waste incidental to reprocessing process. Fuel structural hardware and fuel cladding hulls are generated prior to the first cycle solvent extraction process, or equivalent, and are therefore not considered high-level waste. Also excluded from the examples of citation waste is high-level waste contaminated components and equipment. As discussed in the guidance to Section II.A, review of available supporting documentation has concluded that although contaminated components and equipment are not high-level waste, they can, and often do, retain significant amounts of residual waste even after extensive decontamination efforts. Therefore, it is considered inappropriate for such components and equipment to qualify under the citation process. However, they are considered candidates for the evaluation determination process described below.

The following examples of process filter media and ventilation filter media are provided to clarify the use of the term in the citation process examples above:

> *Examples: (1) At Site X, the high-level waste pretreatment process uses a filtration process to filter precipitated Cs-137 from the tank solution. Disposal of the failed (process) filter media from this process as transuranic, low-level, or mixed low-level, using the <u>citation</u> process, is considered inappropriate. However, the filter is a candidate for disposal as low-level or transuranic waste using the evaluation process. (2) The*

> *high-level waste storage tanks at this site include a HEPA filtration system. Disposal of the HEPA filters from this system as low-level or transuranic waste, using the* <u>*citation*</u> *process, is considered appropriate. (3) The same site has an effluent treatment facility (ETF) that treats overheads (evaporator distillate) from a high-level waste evaporator. Since these overheads are not considered to be high-level waste (there is no carryover of high-level waste to the waste stream) disposition of these failed filters does not need to be subjected to the waste incidental to reprocessing processes. They are managed as low-level or transuranic waste, as appropriate.*

As indicated in Table 1, meeting the requirement in Section II.B.(1) can result in the waste being managed as low-level waste or transuranic waste. The responsibility of interpreting the Appendix D proposed language and using the citation process is within the DOE's authority. As delineated in DOE M 435.1-1, Section I.2.F.(18), the authority to implement the citation process and make these interpretations rests with the DOE Program Office responsible for the management of the waste. In the case of high-level waste this responsibility has been assigned to the Field Element Manager at the DOE Field Office or Operations Office. Consultation and coordination with the DOE Office of Environmental Management for the citation process is encouraged to support consistent interpretations across the DOE complex, but is not required.

<u>Evaluation Process</u>. As shown in Figure 1, waste streams resulting from the reprocessing of high-level waste that not interpreted to be included within the citation process may be assessed for compliance with the evaluation process requirements. Examples of wastes streams that are anticipated to be candidates for the application of the evaluation process include:

- residual radioactive tank wastes whose removal is not considered to be technically and economically practical;
- contaminated storage, pretreatment, and treatment equipment (e.g., tank mixer/pumps, waste slurry processing tanks);
- thermocouple trees;
- vitrification melter components;
- failed vitrification melters;
- process filter media;
- other process equipment that contains some amounts of waste in the form of slurry, salt or glass.

The examples provided above are anticipated to meet the three evaluation process criteria; however, note that the list provided above is not all inclusive. Other reprocessing waste streams may be candidates for the evaluation process. However, any wastes that are determined to meet these criteria must be supported by the necessary information and analysis as described in the guidance for DOE M 435.1-1, Section I.2.F.(18). While the DOE Office of Environmental Management consultation and coordination is required by the requirement in Section I.2.F.(18), consultation with the NRC staff related to compliance with the evaluation requirements is also strongly encouraged. The NRC staff has participated in regulatory compliance reviews using these criteria in the past and has a level of expertise that is expected to complement the DOE Office of Environmental Management's review.

DOE maintains that contaminated equipment, components, etc., whose disposal can be demonstrated to not jeopardize the health and safety of the public, workers, and the environment can be managed as non-high-level waste. These waste streams could be managed as low-level waste, transuranic waste, or residual waste, which is part of a deactivated high-level waste closure action and meets the performance objectives of a low-level or transuranic waste disposal facility, provided the waste fits the requirements of the citation or evaluation process as delineated in Table 1. Guidance for each of the processes follows.

II. B.(2) Evaluation. Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that:

(a) Will be managed as low-level waste and meet the following criteria:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and

Although key radionuclides are not defined by the NRC in either the Denial of Petition for Rulemaking or the letter from R. Bernero to J. Lytle, dated March 2, 1993, it is generally understood that key radionuclides applies to those radionuclides that are controlled by concentration limits in 10 CFR 61.55. Specifically these are: long-lived radionuclides, C-14, Ni-59, Nb-94, Tc-99, I-129, Pu-241, Cm-242, and alpha emitting transuranic nuclides with half-lives greater than five years and; short-lived radionuclides, H-3, Co-60, Ni-63, Sr-90, and Cs-137. In addition, key radionuclides are those that are important to satisfying the performance objectives of 10 CFR Part 61, Subpart C. Analysis to date at DOE sites indicates other isotopes important to satisfying these performance objectives include Se-79, Sn-126, and Np-237.

Processing to remove the key radionuclides to the extent technically practical could be a chemical treatment process or a physical removal process. The examination of such processes should include a range of alternatives; from processes that have been demonstrated by plant-scale experience to be practical to those that have been demonstrated to be impractical due to their technological immaturity, uncertainty, or risk. Selection of the chosen “technically practical process” must be evaluated to a sufficient degree through a formal, documented assessment of such factors as technical risk, incompatible physical or chemical requirements with the waste, and potential impacts to the public, the worker and the environment.

The economically practical part of this requirement is determined by the development of total life-cycle costs for an alternative, or unit costs, e.g., cost per curie removed. Some subjectivity will be present in determining whether these costs are economically practical; however in general, the goal should be to determine a relationship between costs and removal of the key radionuclides and identify the point in this relationship at which removal costs increase significantly and thus become impractical. An economic assessment may not be considered necessary if a technology option is not first considered to be technically practical.

> *Example 1: To satisfy this criterion, Site X identified the available separation technologies for each of the main radionuclides of interest in the waste stream (Cs-137, Sr-90, transuranics, Tc-99, Se-79, Sn-126, C-14, I-129, H-3, and uranium), and individually, as well as collectively, evaluated each to determine the status of the technology and radionuclide removal efficiencies. A number of technologies were identified and evaluated, including some for which tests on actual waste had been conducted. The separation processes that were determined to be technically practical, due to their technical maturity and full-scale demonstrated applications, were then examined for economic practicability based on unit removal costs and process life-cycle costs. An initial evaluation determined that two separation technologies were deemed to be technically and economically practical and were selected for implementation for the removal of the key radionuclides identified. A report documenting the assessment of each of the technologies for technical practicality and economic practicality was issued by the site program manager. Since this was the first use of the Evaluation Process for this waste stream, or a similar waste stream, the site employed the consultation services of the NRC. Following their evaluation, the assessment, confirming that the requirement at II.B.(2)(a)1. had been met, along with the analysis that supports the position that the waste meets the other Evaluation requirements at II.B.(2)(a)2. and II.B.(2)(a)3., was forwarded to the DOE Headquarters for coordination and consultation, as required by Section I.2.F.(18).*

> *Example 2: The Site X facility and waste are the same as above except the economic evaluation determined that none of the separation technologies were deemed to be economically practical for removal of one of the radionuclides from a waste stream, due to excessively high unit costs ($/Ci removed) and life-cycle costs, when compared to direct disposal of the radionuclide as low-level waste. A report documenting this and the assessment of each of the technologies for technical practicality and economic practicality was issued by the site program manager. The waste stream that contained*

the radionuclide in question was analyzed for acceptance at a low-level waste disposal facility and it was concluded that the final waste form, incorporating the radionuclide, would meet the requirements at both II.B.(2)(a)2. (safety requirements comparable to the performance objectives in 10 CFR Part 61, Subpart C), and II.B.(2)(a)3. (solid physical form at a concentration that does not exceed the applicable limits for Class C, 10 CFR 61.55). Therefore, the waste stream was deemed acceptable for disposal as low-level waste.

II. B.(2)(a) Will be managed as low-level waste and meet the following criteria:

2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, *Performance Objectives*; and

<u>Low-level waste requirements</u>. When the waste stream is to be managed in accordance with low-level waste requirements, an assessment needs to be prepared that provides reasonable expectation that low-level waste performance objectives will be met. This assessment is consistent with the requirements for a performance assessment, as defined in DOE M 435.1-1, Section IV.P.(2). The Chapter IV performance objectives (Section IV.P.(1)) are considered comparable to those at 10 CFR Part 61, Subpart C. In some cases the requirement to prepare a performance assessment may be met in part, or totally, by the waste acceptance and waste certification programs established by Chapter IV of DOE M 435.1-1. As discussed in the guidance for Section IV.G, Waste Acceptance, performance assessment data are used to establish waste acceptance criteria. Additionally, a primary element of a performance assessment is analysis that demonstrates compliance with the performance objectives in DOE M 435.1-1, Section IV.P.(1). Therefore, if a waste form is certified as meeting a low-level waste disposal facility's waste acceptance criteria the waste form may meet the performance objectives in Section IV.P.(1) as well, provided performance assessment imposed limits, e.g., quantity of material, are also met. Documentation providing sufficient data to support this conclusion is submitted for coordination with the DOE Office of Environmental Management, as required by the requirement in Section I.2.F.(18).

Example: Site Y has a number of contaminated mixer/pumps that have been removed from a high-level waste storage tank and are considered waste. Following decontamination activities, characterization data show that the mixer/pumps can meet the waste acceptance criteria for an on-site low-level waste disposal facility. Documentation supporting this conclusion, and consistent with the requirements in Section IV.J, Waste Certification, is prepared. Additionally, documentation is prepared that concludes that meeting the disposal site's waste acceptance criteria meets the disposal facility's performance objectives which have been shown previously to be comparable to those in *the NRC's 10 CFR Part 61, Subpart C, Performance Objectives. Therefore Site Y concludes that the requirement at II.B.(2)(a)2. has been met and a stand-alone performance assessment for this waste stream is not necessary. The set of documentation supporting this conclusion is submitted to the DOE Office of Environmental Management for consultation and coordination as required by the requirement in Section I.2.F.(18).*

Often the location and design of a low-level waste disposal facility are not finalized at the time such an assessment is needed. In such cases, a preliminary or interim performance assessment should be prepared, and submitted to the Office of Environmental Management for coordination. Preparation and approval of a preliminary, or interim, as well as a final performance assessment to support the meeting of this requirement, need to meet the requirements at DOE M 435.1-1, Section I.2.E.(1), Disposal.

Example: To meet requirement II.B.(2)(a)2., Site X prepared an interim performance assessment, in accordance with the requirements of DOE M 435.1-1, Section IV.P.(2), for a waste stream that meets the other two applicable evaluation process requirements. The performance assessment was considered interim because it was prepared before the selection of a disposal facility site and design were finalized and before the final low-level waste form was selected. The site forwarded a copy of the interim performance assessment and a draft authorization letter to the DOE Office of Environmental Management for coordination. The DOE Office of Environmental Management's review concluded that although the interim performance assessment was limited in information it did indicate that the performance objectives would be met. This finding was conditional on the review of subsequent performance assessments and other stipulations described in a site authorization letter. Although only an interim performance assessment, the review and concurrence requirements at DOE M 435.1-1 Section I.2.E.(1) for a performance assessment were applied.

In the case of facility/site closure with the residual waste characterized as low-level waste, the requirement to conduct a performance assessment to meet the criterion in Section II.B.(2)(a)2. should be coordinated with similar requirements in Section II.U, Site Closure, to avoid redundant analysis.

II. B.(2)(a) Will be managed as low-level waste and meet the following criteria:

3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10

CFR 61.55, *Waste Classification*; or will meet alternative requirements for waste classification and characterization as DOE may authorize.

10 CFR 61.55 Concentration Limits. To meet this criterion, DOE needs to demonstrate that the final waste form will not exceed the limits for Class C waste, as defined in 10 CFR 61.55. These calculations should compare, by major radionuclide, the expected concentration after the proposed treatment process with the limits as provided at 10 CFR 61.55. .

> *Example: To meet this criterion, Site X calculated an estimated total vitrified waste volume in conjunction with the projected radionuclide activities. From these calculations, the vitrified waste form is expected to meet the limits for 10 CFR 61.55 Class C, or less. This information was provided to the DOE Office of Environmental Management for coordination.*

Dilution of a waste stream to meet the concentration limits established in 10 CFR 61.55 is not permitted by the Department. While it is recognized that in the course of stabilizing a waste stream some changes in waste concentration may occur, actions to dilute a waste stream to meet the above concentration limits are prohibited. The NRC's Branch Technical Position on Concentration Averaging, dated January 17, 1995 (NRC, 1995), that supports the regulation at 10 CFR 61.55(a)(8), may be useful in making determinations. The Branch Technical Position states that, "the concentration of a radionuclide (in waste) may be averaged over the volume of the waste, or weight of the waste if the units (on the values tabulated in the concentration tables) are expressed as nanocuries per gram." This Branch Technical Position provides specific guidance to waste generators on the interpretation of the requirements in 10 CFR 61.55 as it applies to a variety of different types and forms of low-level waste.

Consistent with the discussion above for the requirement in Section II.B.(2)(a)2., certification that a waste form meets a low-level waste disposal facility's waste acceptance criteria may in part, or totally, meet this requirement since, in general, waste that meets the definition of low-level waste, as defined in Section IV.A, meets the concentration limits for Class C low-level waste, as set forth in 10 CFR 61.55. However, there are exceptions as discussed in the guidance for IV.A. For example, a waste form with a concentration of Cm-244 exceeding 100 nCi per gram meets the definition of low-level waste, per Chapter IV of DOE M 435.1-1 (Cm-244 is an alpha-emitting transuranic nuclide with a half-life of 18.1 years and is therefore not relevant to whether the waste is transuranic waste) however, it does not meet the concentration limits in Table 1 of 10 CFR 61.55 (Cm-244 has a half-life greater than 5 years and the concentration limit is 100 nCi per gram). Thus careful attention needs to be paid to ensure that the concentration limits set forth in 10 CFR 61.55 are not exceeded.

Alternative Requirements. If the limits contained at 10 CFR 61.55 for Class C low-level waste cannot be met, the DOE Field Element may request that the DOE Office of Environmental Management review and accept other provisions for the classification of the waste on a specific basis. This provision is similar to the requirement at 10 CFR 61.58, *Alternative Requirements for Waste Classification and Characteristics*. Analysis submitted to the DOE Office of Environmental Management must provide reasonable expectation that after evaluation of the specific characteristics of the waste, disposal site, and method of disposal, compliance with the low-level waste performance objectives can be achieved.

> *Example: Following consultation with the NRC, Site X requested the DOE Office of Environmental Management to review and accept an alternative to the Class C limits of 10 CFR 61.55 for the closure of a number of former high-level waste storage tanks. The provided analysis noted that the NRC method for deriving the Class C concentration limits in 10 CFR Part 61 is based on direct contact with the disposed waste by an inadvertent intruder scenario and that the overall standard for determining Class C concentrations limits is an annual dose equivalent to an inadvertent intruder of 500 mrem from all pathways. In the documentation provided to the DOE Office of Environmental Management the case was made that the intruder scenarios for the Class C determination are inappropriate because the residual waste in the tank will be immobilized and located at least 10 meters below the ground surface, and the tank system will be filled with a stable medium. A site-specific intruder analysis for a hypothetical closed tank system was provided to the DOE Office of Environmental Management for their review. The analysis concluded that the postulated site intruder would receive a dose well below the limit of 500 mrem per year and demonstrated that the tank closures will comply with the performance objectives of 10 CFR Part 61.*

II.B.(2)(b) Will be managed as transuranic waste and meet the following criteria:

1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and

This is the same requirement as II.B.(2)(a)1., and the process for meeting this requirement is the same. Therefore, the guidance for Section II.B.(2)(a)1. applies to this requirement.

II.B.(2)(b) Will be managed as transuranic waste and meet the following criteria:

2. Will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and

As discussed in the guidance above for Section II.B.(2)(a)3., Alternative Requirements, if the limits contained at 10 CFR 61.55 for Class C low-level waste cannot be met, the DOE Field Element may request that the DOE Office of Environmental Management review and accept other provisions for classification of the waste, on a specific basis. This provision is similar to the requirements at 10 CFR 61.58, *Alternative Requirements for Waste Classification and Characteristics*, which states:

> "The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a specific basis, if, after evaluation, of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives [P.O.] in Subpart C of this part."

In those cases where application of the alternative waste classification criteria results in the waste being characterized as transuranic waste, and disposal will be in a facility other than WIPP (e.g., onsite as part of a deactivated high-level waste closure activity or at another DOE transuranic waste disposal site), characterization/classification provisions may be proposed by a Field Element. In such cases, DOE Headquarters shall be consulted and an analysis submitted for review that provides reasonable assurance that after evaluation of the: (1) specific characteristics of the waste, (2) disposal site characteristics, and (3) method of disposal, compliance with applicable performance objectives can be achieved.

II.B.(2)(b) Will be managed as transuranic waste and meet the following criteria:

3. Are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate.

In those cases where the waste stream will be managed as transuranic waste and disposal will be in a facility other than the Waste Isolation Pilot Plant (WIPP) (e.g., onsite or at another DOE transuranic waste disposal site), the Department is currently responsible for determining compliance with 40 CFR Part 191 and ensuring the transuranic waste is disposed of safely. As explained in the guidance to Section III.P., Disposal, sites other than WIPP are regulated by the implementing agency, in this case, DOE. As discussed in the General Requirements Chapter of this DOE M 435.1-1, Section I.2.F.(15), Disposal, the Field Element Manager is responsible for reviewing and submitting a performance assessment to DOE Headquarters. The DOE Headquarters Deputy Assistant Secretary for Waste Management will establish a process similar to that used for low-level waste disposal facilities for reviewing and approving performance assessments. Additional details on the criteria for reviewing and approving 40 CFR Part 191 performance assessments is included in the guidance to Section III.P. Since performance assessment is defined, and the requirements for compliance and what must be included in a performance assessment for a transuranic waste disposal facility are discussed in 40 CFR Part 191, this section of the guidance and the transuranic waste chapter only contain reference to the 40 CFR Part 191 standards, with no additional minimum requirements for disposal.

As discussed in the guidance to Chapter III of DOE M 435.1-1, the Department plans to dispose defense transuranic waste at WIPP. Therefore, evaluations of treatment and disposal options for those streams must be taken into account.

As discussed above, the high-level waste sites are encouraged to group similar waste streams, that are to be subjected to the evaluation process, to support the process of coordinating with the DOE Office of Environmental Management and site review and approval. Such grouping is expected to expedite the decision process and make the most efficient use of limited resources in the DOE Office of Environmental Management. Following are two examples of grouping:

> *Example 1: At Site Y, the high-level waste treatment (vitrification) activities are nearing completion and plans for dispositioning the equipment contaminated with reprocessing wastes within the pretreatment and treatment processes are being formulated. Analysis indicates that decontamination activities can be held to a minimum if a number of contaminated pretreatment and treatment components (mixer/pumps, slurry transfer lines, slurry tanks, melter, process filter media) can be disposed as transuranic waste by way of the evaluation process. In lieu of submitting individual analysis for each of contaminated components, Site Y consults with the DOE Office of Environmental Management and the NRC staff on the methodology they propose for meeting the three appropriate evaluation requirements. Following such consultation, Site Y approves a methodology for meeting each of the three evaluation criteria for a group of these components.*
>
> *Example 2: At Site Z, closure analysis activities are underway for a number of high-level waste tanks. In reviewing the processes for removing the final amounts of high-level waste from the tanks, it is concluded that the evaluation process requirements can be met even if some small quantities of residual waste are allowed to remain in the tanks. In lieu preparing an analysis for each tank, the site submits a methodology for meeting each of the evaluation requirements for a group of the tanks. The methodology is submitted to the DOE Office of Environmental Management for coordination and acceptance of this methodology for the group of tanks is gained from the site program office. The closure activities proceed for the group of tanks.*

<u>Facility Closure</u>. Application of the evaluation process for deactivated high-level waste facility/site closures is to ensure that any residual waste or residual contaminated components are disposed appropriately. As indicated in Table 1, the requirements in Section II.B.(2)(a) 1., 2., and

3., or the requirements in Section II.B.(2)(b) 1., 2., and 3., must be met in order to manage the waste as non-high-level waste and allow the residual waste or residual contaminated components to be managed as low-level waste, or transuranic waste, as part of a deactivated high-level waste closure action. Closure actions for deactivated high-level waste facilities are distinguished from disposal of wastes incidental to reprocessing by the fact that closure actions normally involve facilities that are not total dismantled and remain in their operational location. However, because the residual material is part of a closure activity and will remain following closure, the disposal requirements in Section IV.P. and III.P. for low-level and transuranic wastes, respectively, are the appropriate requirements to satisfy Sections II.B.(2)(a)2. and II.B.(2)(b)3. The requirements for closure of these facilities and sites (groups of facilities) are in Section II.U, Site Closure.

The Field Element Manager is responsible for ensuring that the requirements of the evaluation process are met. DOE M 435.1-1, Section I.2.F.(18), Waste Incidental to Reprocessing, defines the responsibilities and roles of the Field Element Manager, the Office of Environmental Management, and the consultation role that NRC staff may take in implementing the evaluation process. Refer to the guidance for this section for additional information.

Mixed Waste. DOE M 435.1-1, Section II.C., Management of Specific Wastes, imposes the requirement that all high-level waste is to be considered mixed waste, unless demonstrated otherwise. This requirement applies to waste incidental to reprocessing determined wastes as well. Waste that is determined to be incidental to reprocessing by the application of the waste incidental to reprocessing determination processes should be considered mixed, unless demonstrated otherwise.

Compliance with this requirement is demonstrated by documented citation and evaluation processes that are implemented in a defensible manner and ensure that the Department is not exceeding its regulatory authority.

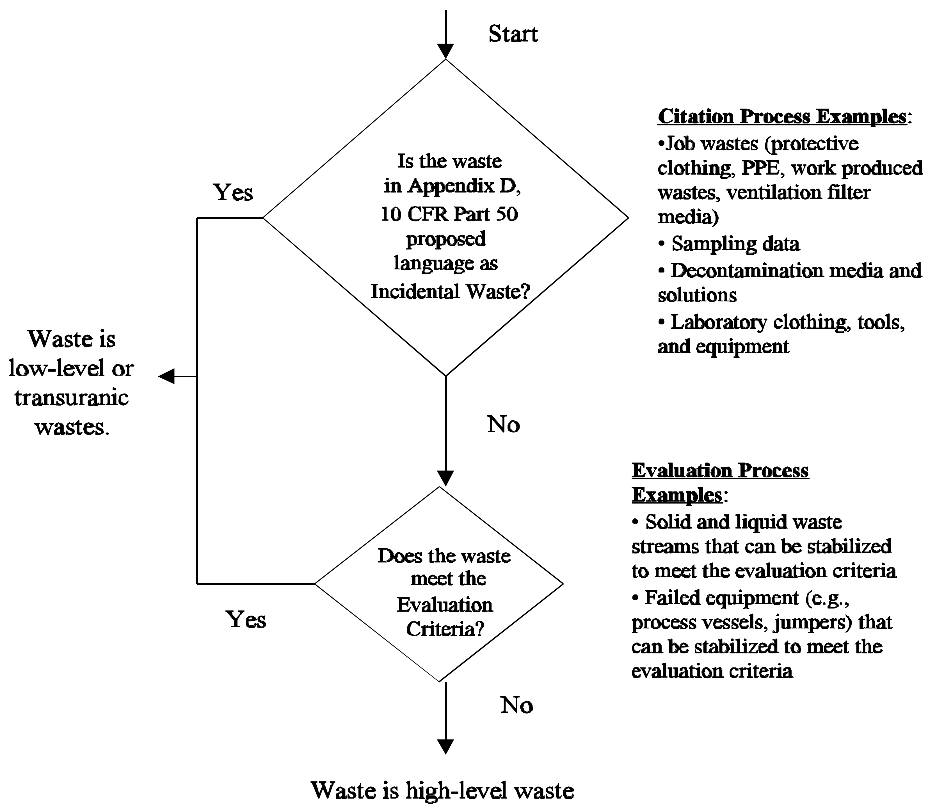

Figure 1 Decision Tree for Waste Incidental to Reprocessing Determinations

Supplemental References:

1. AEC, 1969. "Proposed Rule Making Statement of Proposed Policy; Siting of Commercial Fuel Reprocessing Plants and Related Waste Management Facilities, 10 CFR Part 50, 'Licensing of Production and Utilization Facilities,'" *Federal Register*, Vol. 34, No. 8712, Atomic Energy Commission, Washington, D.C., June 3, 1969.

2. AEC, 1970. "Siting of Commercial Fuel Reprocessing Plants and Related Waste Management Facilities, 10 CFR Part 50, 'Licensing of Production and Utilization Facilities,'" *Federal Register*, Vol 35, No. 17532, Atomic Energy Commission, Washington, D.C., November 14, 1970.

3. *Energy Reorganization Act of 1974*, Public Law 93-438, Section 202 (3) and (4).

4. DOE, 1979. *Final Environmental Impact Statement: Long-Term Management of Defense High-Level Radioactive Wastes*, DOE/EIS-0023, Savannah River Plant, November, 1979.

5. NRC, 1987. "Advanced Notice of Proposed Rulemaking; 10 CFR Part 60, 'Definition of High-Level Radioactive Waste,'" *Federal Register*, Vol. 52, No. 5992, U.S. Nuclear Regulatory Commission, Washington, D.C., February 27, 1987.

6. Curtiss, 1992. NRC Commissioner J.R. Curtiss to J.M.Taylor, Executive Director for Operations, memorandum, *SECY-92-391: Denial of PRM-60-4-Petition for Rulemaking Regarding Classification of Radioactive Waste at Hanford*, U.S. Nuclear Regulatory Commission, Washington, D.C., December 29, 1992.

7. Taylor, 1993. J.M. Taylor, Executive Director for Operations to Commissioner Curtiss, memorandum, *Staff Response to Concerns Raised by Commissioner James R. Curtiss on Denial of PRM-60-4-Petition for Rulemaking Regarding Classification of Radioactive Waste at Hanford*, January 14, 1993.

8. NRC, 1993. "Denial of Petition for Rulemaking, 10 CFR Part 60, 'States of Washington and Oregon: Denial of Petition for Rulemaking'," *Federal Register*, Vol. 58, No. 12342, U.S. Nuclear Regulatory Commission, Washington, D.C., March 4, 1993.

9. Bernero, 1993. R. Bernero, USNRC, to J. Lytle, DOE-EM, letter, *Hanford Waste Tank Management*, U.S. Nuclear Regulatory Commission, Washington, D.C., March 2, 1993.

10. Paperiello, 1997. C. Paperiello, USNRC, to J. Kinser, DOE-RL, letter, *Classification of Hanford Low-Activity Tank Waste Fraction*, U.S. Nuclear Regulatory Commission, Washington, D.C., June 9, 1997.

11. DOE, 1998. *Life-Cycle Asset Management*, DOE O 430.1A, U.S. Department of Energy, October 14, 1998.

12. DOE, 1997. *Deactivation Implementation Guide*, Draft DOE G 430.1-3, U.S. Department of Energy, October 1, 1997.

13. DOE, 1997. *Decommissioning Implementation Guide*, Draft DOE G 430.1-4, U.S. Department of Energy, October 1, 1997.

14. NRC, 1988. *Cement Solidification of Decontaminated Supernatant Waste for West Valley Project*, Technical Evaluation, Office of Nuclear Material Safety and Safeguards, November 1988.

15. EPA. *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level Waste and Transuranic Radioactive Wastes*, 40 CFR Part 191, U.S. Environmental Protection Agency, Washington, D.C.

16. NRC, 1995. *Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position*, U.S. Nuclear Regulatory Commission, Washington, D.C., January 17, 1995.

17. Sullivan, 1998. M.A. Sullivan, DOE, to J.T. Greeves, USNRC, letter, *Natural Resources Defense Council Petition to Exercise Licensing Authority over Savannah River Site High-Level Waste Tanks*, U.S. Department of Energy, Washington, D.C., September 30, 1998.

18. NRC, 1993. "Confederated Tribes and Bands of the Yakima Indian Nation: Denial of Petition to Require License Application," *Federal Register*, Vol. 58, No. 64783, U.S. Nuclear Regulatory Commission, Washington, D.C., December 9, 1993.

19. NRDC Inc. v. Administrator, Energy Research and Development Administration, 606 F. 2d 126, (D.C. Cir. 1979), *affirming in part, remanding in part, reversing in part, vacating in part*, 451 F. Supp. 1245 (D.D.C. 1978), *denying motion in part, granting motion in part*, 5 NRC 550 (1977) (Commission Decision).

20. NRC, 1994. "F. Robert Cook: Denial of Petition to Require License Application from DOE with Respect to High-Level Waste," *Federal Register*, Vol. 59, No. 10439, U.S. Nuclear Regulatory Commission, Washington, D.C., March 4, 1994.

II. C. Management of Specific Wastes.

The following provide for management of specific wastes as high-level waste in accordance with the requirements in this Chapter:

(1) Mixed High-Level Waste. Unless demonstrated otherwise, all high-level waste shall be considered mixed waste and is subject to the requirements of both the *Atomic Energy Act of 1954*, as amended, the *Resource Conservation and Recovery Act,* as amended, DOE O 435.1, *Radioactive Waste Management,* and this Manual.

(2) TSCA-Regulated Waste. High-level waste containing polychlorinated biphenyls, asbestos, or other such regulated toxic components shall be managed in accordance with requirements derived from the *Toxic Substances Control Act,* as amended and DOE O 435.1, *Radioactive Waste Management,* and this Manual.

Objective:

The objective of this requirement is to ensure that all high-level waste is managed as mixed waste, unless demonstrated otherwise, and thus meets the requirements of both the *Atomic Energy Act of 1954,* as amended and the *Resource Conservation and Recovery Act* (RCRA), and that high-level waste that contains TSCA-regulated toxic components be managed in accordance with the requirements of the *Toxic Substances Control Act* (TSCA). The RCRA and TSCA (if applicable) statutes are to be met in addition to the requirements of DOE O 435.1 and DOE M 435.1-1.

Discussion:

DOE M 435.1-1 contains requirements for managing the radioactive character of high-level waste. Guidance for implementing those requirements is included elsewhere in this document. In developing DOE M 435.1-1 requirements, a safety and hazards analysis and an evaluation of the requirements necessary to control the identified hazards were performed. It was concluded that sufficient external regulations, promulgated pursuant to RCRA and TSCA, exist for controlling the non-radiological hazard.

RCRA Regulations. The reprocessing of Department of Energy spent nuclear fuel produces high-level waste that usually exhibits characteristics that render the high-level waste subject to the requirements of the *Resource Conservation and Recovery Act,* as well as the *Atomic Energy Act of 1954,* as amended.

Considering high-level waste to be a mixed waste is consistent with Department of Energy past practice. The previous Radioactive Waste Management Order, DOE 5820.2A (see page I - 1), specified that high-level waste was to be considered mixed waste unless demonstrated to the contrary.

The DOE Office of Civilian Radioactive Waste Management (OCRWM) has clearly stated that only spent nuclear fuel and high-level waste that is not regulated as hazardous waste under RCRA Subtitle C is planned to be disposed in the monitored geologic repository licensed by the Nuclear Regulatory Commission (NRC) under the *Nuclear Waste Policy Act of 1982*, as amended. Prior to acceptance for disposal, generators and custodians must determine and document that the waste is not regulated as a hazardous waste and is not prohibited from land disposal. Therefore, DOE must develop appropriate data to ensure State and/or EPA regulators that the applicable requirements have been addressed.

The processes that produce high-level waste from spent fuel usually involve the use of hazardous chemicals, so it is reasonable to assume that high-level waste is a mixed waste unless it is demonstrated to be otherwise. The reprocessing of spent nuclear fuel usually includes dissolution in acid followed by solvent extraction which is then often neutralized by addition of sodium hydroxide. The solvent is usually stripped from the component being extracted from the spent fuel. The solvent is recycled rather than disposed of as high-level waste. Furthermore, the fuel matrix and cladding are typically a source of hazardous metals. Thus, high-level waste typically exhibits the characteristics of corrosivity (pH < 2 or pH >12.5 (after neutralization)) and toxicity (because of the presence of one or more toxic metals).

Wastes exhibiting hazardous characteristics (see 40 CFR Part 261, Subpart C) must be treated for these characteristics prior to disposal. High-level wastes generated from the reprocessing of spent nuclear fuel exhibiting the characteristics of corrosivity (D002) and toxicity for metals (D004 – D011 corresponding to arsenic, barium, cadmium, chromium, lead, mercury, scandium, and silver) may be treated through vitrification in accordance with the Land Disposal Restriction (LDR) treatment standards specified in 40 CFR 268.40. The Environmental Protection Agency has determined that vitrification (HLVIT) is the best demonstrated available technology (BDAT) for treating high-level wastes that exhibit these characteristics. However, if additional characteristic waste codes become applicable to the high-level waste, e.g., D018: benzene, the treated high-level waste may need to meet the Universal Treatment Standards (40 CFR 268.48) for any underlying hazardous constituents (UHCs). A treatability variance (40 CFR 268.44) and/or determination of equivalent treatment (40 CFR 268.42(b)) may be necessary to fully comply with the LDR standards if a DOE site elects to use a technology other than vitrification, the BDAT, of if it is impractical to comply with all the standards applicable to individual waste codes.

High-level waste treated by vitrification but containing listed hazardous wastes (either from the reprocessing activities or from subsequent commingling of listed hazardous waste in high-level waste storage tanks) will remain subject to RCRA, unless a delisting request is also approved by the Environmental Protection Agency. The Office of Environmental Management "Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms" requires that the producer of the high-level waste perform the appropriate tests and procedures to determine whether the waste is a hazardous waste (see Specification 1.5). That specification also requires that high-level waste producers petition the Environmental Protection Agency to delist the waste if any RCRA listed components are found in immobilized high-level waste. Currently, high-level waste at some sites has been determined to contain listed wastes and high-level waste at other sites has been determined not to contain listed wastes.

> *Example: In the previous example, the resulting high-level wastes were mixed with various listed hazardous wastes for which a petition for delisting has not been approved. Even after the high-level waste is treated by vitrification, it may not be disposed in the Office of Civilian Radioactive Waste Management-managed monitored, geologic repository because the high-level waste continues to be considered a mixed waste until the Environmental Protection Agency approves a petition for delisting of the hazardous waste components.*

The RCRA requirements described above may be imposed by the Environmental Protection Agency or by states that have been granted these RCRA authorities by the Environmental Protection Agency. The authorized states are permitted to promulgate hazardous waste requirements that are more stringent than the federal requirements, as well as specifying the treatment permitting approach. Any state-level hazardous waste requirements will need to be reviewed on a state-by-state basis.

In summary, the operations performed in reprocessing spent nuclear fuel often produce high-level waste that exhibits hazardous characteristics. DOE practice is to assume that high-level waste is a mixed waste unless demonstrated otherwise. This approach provides a conservative basis for developing effective plans for high-level waste management including the capabilities for dealing with hazardous components and characteristics.

<u>PCB, Asbestos, and Other TSCA Wastes</u>. High-level wastes contaminated with PCBs do not meet the definition of mixed waste, however, the situation is similar to RCRA in that there are external regulations promulgated under the authority of the *Toxic Substances Control Act* that need to be complied with in addition to the requirements of DOE O 435.1 and the Manual. Waste managers responsible for managing PCB-containing products should consult the EPA requirements at 40 CFR Part 761. The regulations impose requirements for the destruction, storage awaiting destruction, and disposal of PCBs. Like mixed wastes, there are currently no provisions to accommodate PCBs (exceeding 50 ppm) at a geologic repository. Review of the EPA handbook, “Vitrification Technologies for Treatment of Hazardous and Radioactive Waste,” (EPA/625/R-92-002) finds that the combination of the vitrification process and off-gas removal

are capable of eliminating 99.99%, or better, of the organic constituents, including TSCA-regulated organics, in a waste stream. Therefore, vitrification, the BDAT for high-level waste exhibiting RCRA characteristics of corrosivity and toxicity for metals, is expected to meet the treatment requirements for PCBs and other TSCA-regulated toxic components, for those high-level waste streams that are determined to contain these components. At the time of the preparation of this guidance, no DOE high-level waste site had declared the presence of TSCA-regulated toxic components in their high-level streams. Planning for management of high-level wastes that include a component which is regulated under TSCA should be addressed in the Complex-Wide High-Level Waste Management Program and the appropriate Site-Wide Waste Management Programs (DOE M 435.1, Sections I.2.B.(1) and I.2.F.(1)).

The DOE M 435.1-1 requirements imposed on the radioactive component of RCRA or TSCA waste should not create a duplication of management activities that can be satisfied by compliance with a RCRA or TSCA requirement. Also, documentation required by RCRA or TSCA regulations which provides the same or similar information as required by DOE M 435.1-1 should be used to satisfy the DOE M 435.1-1 requirement.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. EPA. *Characteristics of Hazardous Wastes*, 40 CFR Part 261, Subpart C, U.S. Environmental Protection Agency, Washington, D.C.

3. EPA. *Lists of Hazardous Wastes*, 40 CFR Part 261, Subpart D, U.S. Environmental Protection Agency, Washington, D.C.

4. EPA. *Applicability of Treatment Standards*, 40 CFR 268.40, U.S. Environmental Protection Agency, Washington, D.C.

5. EPA. *Treatment Standards Expressed as Specified Technologies*, 40 CFR 268.42, U.S. Environmental Protection Agency, Washington, D.C.

6. EPA. *Universal Treatment Standards*, 40 CFR 268.48, U.S. Environmental Protection Agency, Washington, D.C.

7. EPA. *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions*, 40 CFR Part 761, U.S. Environmental Protection Agency, Washington, DC.

II. D. **<u>Complex-Wide High-Level Waste Management Program</u>.**

A complex-wide program and plan shall be developed as described under *Responsibilities,* 2.B and 2.D, in Chapter I of this Manual.

Objective:

The objective of this requirement is to ensure that development, documentation, and implementation of a complex-wide high-level waste management program. The complex-wide program and plan establishes the framework within which individual site programs operate.

Discussion:

The Department's management of high-level waste occurs at four sites that generate, store and treat waste, as well as at a to-be-determined disposal site which is to serve as the nation's central repository for high-level waste and spent nuclear fuel. A complex-wide program and plan are seen as necessary to establish the overall mission for the Department's management of high-level waste and to provide a framework within which the individual site programs operate. The *Radioactive Waste Management Manual*, DOE M 435.1-1, General Requirements (Section I.2.B) assigns the Assistant Secretary for Environmental Management's the responsibility for developing and maintaining complex-wide, waste-type programs. The *Manual* General Requirements (Section I.2.D) also assigns the Deputy Assistant Secretary for Waste Management the responsibility for developing and implementing complex-wide, waste-type program plans. The complex-wide high-level waste management program and plan should be developed following the guidance provided for General Requirements, Sections I.2.B and I.2.D.

Compliance with this requirement is demonstrated by the presence of a Complex-Wide High-Level Waste Management Program which includes the appropriate interfaces, technical information data inputs, and other elements described in Chapter I of this Manual.

Supplemental References:

1. *Toxic Substances Control Act*, as amended, October 11, 1976.

2. EPA, 1992. *Vitrification Technologies for Treatment of Hazardous and Radioactive Waste,* EPA Handbook, EPA/625/R-92/002, U.S. Environmental Protection Agency, Washington, D.C., May 1992.

II. E. Site-Wide High-Level Waste Management Program.

In addition to the items in Chapter I of this Manual, documentation of the Site-Wide Radioactive Waste Management Program shall include a description of the High-Level Waste Systems Engineering Management Program to support decision-making related to nuclear safety, including high-level waste requirements analysis, functional analysis and allocation, identification of alternatives, and alternative selection and system control.

Objective:

The objective of this requirement is to establish a structured and documented approach to evaluating alternatives as the preferred method for reaching informed decisions on any issue potentially affecting safety of high-level waste management safety systems, structures, components and processes. Such decisions include selecting the solutions for storage and treatment of high-level waste, through the design and fabrication of the hardware and the development of software required (if any) to process the waste.

Discussion:

In addition to the Site-Wide Radioactive Waste Management Program requirements in DOE M 435.1-1, Section I.2.F.(1), this additional requirement applies specifically to the management of high-level waste. The following guidance addresses that additional requirement only. Guidance on the implementation of the General Requirements can be found in DOE G 435.1-1, Section I.2.F.(1).

A systems engineering management program consists of requirements analysis, functional analysis/allocation, synthesis (developing alternatives), and systems analysis (evaluation of alternatives) and control. These elements of the process should be used progressively throughout the life cycle of the program to achieve objectives and to re-define requirements, designs and solutions for problems that may arise during program execution. A systems engineering management program should invoke a graded approach consistent with the importance to safety systems, structures, and components. Each of these elements is explained in detail in the interim standard for Systems Engineering (EIA/IS 632). This Interim Standard is also referenced in the Implementation Guide to DOE O 420.1. A brief overview of the systems engineering elements extracted from the standard is presented below:

(1) *Requirements Analysis*: An analysis of the needs, objectives, and requirements in the context of the mission, operations, environment, and the mandatory characteristics of the system should be performed to determine the functional and performance requirements for each primary system function.

An example of a functional requirement is to separate the high-level waste into a low activity stream and a high activity stream to minimize the waste required for disposal in the high-level waste repository. An example of a performance requirement is the percent of the total radionuclide source term that must be concentrated in the high activity stream (e.g. 98%) in order to qualify the low activity waste for non-repository disposal. In other words, the functional requirements tell what must be done and the performance requirements tell how well the function must be performed.

(1.1) Functional requirements identified in the requirements analysis should be used as the top-level functions for the functional analysis. Identification of requirements should include the degree of certainty in their estimate, their degree of criticality to mission success and their relationship to other requirements.

(1.2) Requirements should be validated to establish traceability, both upwards and downwards, so that each lower level requirement can be demonstrated to be derived from a higher level requirement.

(2) *Functional Analysis/Allocation*: A functional hierarchy should be defined and integrated down to the lowest level needed to support synthesis of solutions for people, products, and processes and management of risks. More than one logical set of functional and performance requirements could be developed to meet the high-level waste mission objectives.

(2.1) Functional requirements should be analyzed to determine the subsidiary functions required to accomplish the parent requirement.

For example, if the parent function is to separate the waste streams, subsidiary functions may be wash the sludge and perform ion exchange.

When time is critical to the performance or sequencing of a function, a time-line analysis should be performed. Functional requirements need to be logically sequenced with input, output and interface requirements clearly defined and traceable.

(2.2) Functional allocation should be performed to establish a performance requirement for each functional requirement. If all lower level functions are performed to meet their performance requirement, the performance requirement of the highest level function should also be satisfied.

Continuing the examples above, if sludge washing and ion exchange are the only two subsidiary functions contained under the parent function "separate the waste *streams," then their performance requirements together must produce a high activity waste stream that contains 98% of the waste.*

(2.3) Verification of functional and performance requirements should be accomplished by traceability.

(3) *Synthesis (develop alternative ways to meet the mission/objectives)*: Solutions for each logical set of functional and performance requirements should be defined and designed. This synthesis should be performed interactively with functional analysis/allocation to define a complete set of potential solutions.

In the examples above, one logical solution may be to allocate the 98% concentration to only 2 subsidiary functions, while an alternative solution would include three (or more) subsidiary functions in order to remove additional radionuclide species.

(3.1) The output of the synthesis should describe the complete system, including interfaces within the system and to external systems.

(3.2) Care should be exercised to verify that the process and product design requirements, and their implementation, satisfies the overall system requirement.

(4) *Systems Analysis and Control*: Systems analyses, trade-off studies and other analytical tools should be utilized to select preferred alternatives. Decisions should be documented, together with supporting material. Implementation of the selected alternative should be coupled with control mechanisms, such as risk management, configuration management, data management, and performance-based progress measurements, to assess status, identify potential problems and to formulate alternative solutions for timely management consideration.

The systems engineering management program documentation should include an approved Systems Engineering Management Plan (SEMP), Systems Engineering Master Schedule (SEMS) and a Systems Engineering Detailed Schedule (SEDS). The content of the SEMP, SEMS, and the SEDS are explained in EIA/IS-632.

Outputs of the application of the systems engineering process (inputs to decision making) should be documented in an integrated decision data base that organizes the data used and generated. The documentation should provide the audit trail of the systems engineering process outputs, decisions and results, as well as traceability of the process. Traceability as used here is slightly different from traceability used in the functional and performance analysis. Here the mission, objectives, the environment under which the mission must be executed and mandatory overall system performance is also included. Should any of these parameters change during the course of the project, this traceability will assist the decision manager to understand how the changes may impact on the decisions previously made.

Compliance with this requirement is demonstrated by a systems engineering management program based on EIA/IS-632, Systems Engineering, coupled with the identification of accountable individuals and their authorities. The implementation guide to DOE O 420.1 references EIA/IS-632 as an acceptable standard for systems engineering.

Supplemental References:

1. EIA, 1994. *Electronic Institutes Association*, Systems Engineering, EIA/IS-632, Washington, D.C., December 1994. (Standards Proposal No. 3537-A has been issued which proposes to upgrade and revise EIA/IS-632. When the proposed upgrade and revision is approved, the standard will be published as ANSI/EIA-632, and EIA-IS-632 will be CANCELED.)

2. DOE, 1995. *Facility Safety*, DOE O 420.1, U.S. Department of Energy, Washington, D.C., October 13, 1995.

3. DOE, 1995. *Implementation Guide for Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria*, (Implementation guide for DOE 420.1), DOE G 420.1-1, U.S. Department of Energy, Washington, D.C., September 1995.

II. F. Radioactive Waste Management Basis.

High-level waste facilities, operations and activities shall have a radioactive waste management basis consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. The following specific waste management controls shall be part of the radioactive waste management basis:

(1) Generators. The waste certification program.

(2) Pretreatment and Treatment Facilities. The waste acceptance requirements and the waste certification program.

(3) Storage Facilities. The waste acceptance requirements and the waste certification program.

Objective:

The objective of this requirement is to ensure that the hazards associated with high-level waste management facilities, operations, and activities have been identified, their potential impacts analyzed, and appropriate controls documented, implemented and maintained for the protection of workers, the public, and the environment.

Discussion:

As described in the guidance on Section I.2.F.(2), DOE M 435.1-1 requires the radioactive waste management basis to provide for development and documentation of measures to ensure the safe and efficient management of radioactive waste. The measures include processes, procedures, equipment specifications, instrument specifications, and other items that are intended to reduce the likelihood of, or the consequences from, a problem that could arise from managing high-level waste. Requiring an approved radioactive waste management basis for the initiation of new, or continuation of existing, radioactive waste management activities should prevent the operation of facilities for which safe design, configuration, and operation have not been demonstrated. The required elements of the radioactive waste management basis vary with the type of waste management operation or facility and the types of hazards associated with the operation or facility. The radioactive waste management basis documentation listed above for each of the three types of high-level waste management facilities, operations, and activities included in the scope of DOE O 435.1 are not complete lists of those items which should be included in a radioactive waste management basis. Several processes, procedures, and documents that are required by other directives and requirements describe radioactive waste management measures that should be considered part of the radioactive waste management basis.

The guidance at Section I.2.F.(2) discusses this aspect of the radioactive waste management basis in detail.

> *Example: At Site X a facility was designed and built for dry storage of vitrified high-level waste encapsulated in welded stainless steel canisters. Prior to transferring any high-level waste to the facility, the Field Element Manager reviewed and approved the documentation that was prepared and collected for the purpose of establishing the Radioactive Waste Management Basis. The documentation included two items required by DOE M 435.1-1— the waste acceptance requirements and the waste certification program. These two items are designed to ensure that the high-level waste transferred to the facility is appropriate and that the high-level waste transferred from the facility meets the waste acceptance requirements for the receiving facility. Additional documentation that established the Radioactive Waste Management Basis was prepared in response to requirements other than DOE M 435.1-1 and consisted of the facility-specific procedures implementing the Site X radiological control program, health and safety plan, training program, quality assurance program, and record-keeping plan.*

Also, as discussed in the Section I.2.F.(2) guidance, if a high-level waste management facility operates under an approved Authorization Basis, it may not need any additional controls to demonstrate that it has a radioactive waste management basis. In this case, the Authorization Basis documentation should be reviewed and evaluated to determine whether it sufficiently covers the requirements needed for a radioactive waste management basis. The Field Element Manager has the responsibility to ensure the high-level waste management facilities under his or her authority have a radioactive waste management basis.

> *Example: The Liquid Radioactive Waste Handling Facilities at Site A (which include the Tank Farms, the In-Tank Precipitation Process, and the Replacement High-Level Waste Evaporator) are used for management of highly radioactive and hazardous materials. They are Category 2 nuclear facilities which renders them subject to a wide range of DOE nuclear safety requirements. A review of the Authorization Basis documentation revealed that the Authorization Basis includes the following documents and the associated programs:*
>
> - *Safety Analysis Reports (SARs)*
> - *Technical Justification for Continued Operation/Basis for Interim Operation/Design Basis Accident Analysis Report*
> - *Operational Safety Requirements/Technical Safety Requirements*
> - *Technical Standards*
> - *SAR Update Request Packages*

- *Other Documents Identified by DOE-SR and WSRC as Authorization Basis Documents (Safety Evaluations, Exemptions, Unreviewed Safety Questions Evaluation)*
- *DOE Safety Evaluation Reports*
- *Listing of Documents that are to be Configuration Managed but are not Authorization Basis Documents*

Included within these documents are what the site considers to be the complete set of operational requirements relied upon by the site to ensure that the public, workers, and the environment are protected from the hazards associated with the management of the radioactive waste handled in the facilities. For example, the establishment of limits of fissionable material and chemical constituents that can be transferred to the waste tanks by the generators is included in the SARs. These limits are essentially equivalent to the limits that must be set for the waste acceptance requirements in this chapter (see Section II. J). A radioactive waste management basis statement is prepared that concludes the radioactive waste management basis is covered in the Authorization Basis documents.

For a facility that generates high-level waste, the radioactive waste management basis is to include the program for certifying that waste meets the waste acceptance requirements of the facility(ies) to which the waste will be sent. The waste certification program should be reviewed against the applicable requirements of DOE M 435.1-1 and approved in accordance with the manual before becoming part of the radioactive waste management basis. As discussed in guidance on Section I.2.F.(2), several other processes and procedures are also part of the complete radioactive waste management basis at a generating facility.

Example: A spent nuclear fuel reprocessing canyon generates high-level waste. The radioactive waste management basis includes the waste certification procedures, the safety and health plan, the training program, and the waste transfer procedure in addition to the Authorization Basis. These elements are documented in a facility-specific radioactive waste management basis statement covering the canyon, its operations, and its activities.

Facilities that store or treat high-level waste must have approved waste acceptance requirements (Section II. J of DOE M 435.1-1) prior to the issuance of a radioactive waste management basis. The waste acceptance requirements will usually suffice as the documentation of the radiological, physical, and chemical limitations on waste that can be safely received at the facility, provided they are developed correctly considering the hazards of the waste to be managed, and are kept up to date. A facility that stores or treats waste is expected to have a waste certification program. Waste from these facilities will have to be certified as meeting the waste acceptance requirements of the facility to which it will be transported, and the facilities have the potential for generating radioactive waste (e.g., secondary processing streams from treatment, monitoring and sampling, radioactive release cleanup). Consequently, storage and treatment facilities should also have an approved waste certification program as part of their radioactive waste management basis.

> *Example: A storage facility that stores vitrified mixed high-level waste has approved waste acceptance requirements and a waste certification process to verify that the waste meets the Office of Environmental Management Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS). The radioactive waste management basis statement references the waste certification process and the waste acceptance requirement documentation, which in turn invokes the EM-WAPS. The basis statement also cites the RCRA permit issued for storage of mixed high-level waste.*

Requirements that apply to disposal of high-level waste have been developed by the Nuclear Regulatory Commission and will be applied to the disposal facilities, operations, and activities of the DOE Office of Civilian Radioactive Waste Management. Other facilities for high-level waste management must be covered by an approved radioactive waste management basis. At the end of the useful life of non-disposal facilities, most or all of the high-level waste will be removed in preparation for closure. (In this discussion the word "all" is enclosed in quotes to suggest removal of radioactive material to the extent that the facility can be released for unlimited use.) If all of the high-level waste is removed, then the facility need no longer be considered a radioactive waste facility and an approved radioactive waste management basis is no longer needed. In other cases residual high-level waste will be in the facility being closed, and the facility will be subject to an approved radioactive waste management basis. However, if the residual waste in the facility is determined to be incidental to reprocessing, then the waste is managed as low-level waste or transuranic waste, as appropriate. Under those conditions, either (1) the facility would be subject to an approved radioactive waste management basis appropriate for the category of the remaining radioactive waste as long as the waste remains in the facility or (2) the activities and operations leading to release of the facility for unlimited use would be performed under a radioactive waste management basis appropriate for the radioactive waste.

As part of the radioactive waste management basis, site personnel should implement a system or process for tracking the waste inventory at a storage, pretreatment or treatment facility. Tracking the waste inventory is a means of ensuring that radionuclide limits established in accordance with a safety analysis will not be exceeded. In addition, a system or process for accurately tracking waste received at a facility can facilitate providing information to the complex-wide waste management data system (see guidance for Section I.2.D.(2)).

Compliance with these requirements is demonstrated by a documented radioactive waste management basis statement signed by the Field Element manager or a designee (see I.1.A, Delegation of Authority) for each high-level waste management facility, operation, or activity. Using a graded approach, it may be possible to include multiple activities under a single radioactive waste management basis, but it should be possible to objectively identify which activities are covered. Further, the radioactive waste management basis statement should include or reference the measures that are established on a facility-specific basis to address the unique waste management requirements and circumstances for each facility, operation, and/or activity.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS),* Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. NRC. *Disposal of High-Level Radioactive Wastes in Geologic Repositories,* 10 CFR Part 60, U.S. Nuclear Regulatory Commission, Washington, D.C.

II. G. Quality Assurance Program.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Product Quality. The requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description*, shall apply to those high-level waste items and activities important to waste acceptance/product quality.

(2) Audits and Assessments. The evaluation and assessment requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description*, and associated implementing procedures shall be met for high-level waste acceptance and product quality activities, in addition to the assessment requirements of other DOE directives and requirements identified in Chapter I of this Manual.

Objective:

The objective of this requirement is to ensure that those items and activities important to waste acceptance/product quality are identified and controlled by a quality assurance program that implements the requirements of the Office of Civilian Radioactive Waste Management's Quality Assurance Program, as defined in DOE/RW-0333P, including the audit and assessment requirements.

Discussion:

In addition to the quality assurance requirements contained in Section I. 1.E.(12), Quality Assurance Program, of DOE M 435.1-1, General Requirements, the final high-level waste form must meet the quality assurance requirements published by the Office of Civilian Radioactive Waste Management . These quality assurance requirements are imposed on the waste form Producers by Specification 4., "Quality Assurance Specification," of the *Waste Acceptance Produce Specifications for Vitrified High-Level Waste Forms,* DOE/EM-0093 (EM-WAPS). The OCRWM requirements are contained in the "Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program (QARD)," (DOE/RW-0333P) which is the principal quality assurance document for the OCRWM Program.

The QARD establishes the minimum elements of the quality assurance program and identifies the program commitments necessary for the development and implementation of such a Quality assurance program. As stated in the Introduction to the QARD, the QARD applies to the following high-level waste activities: acceptance; transport and; high-level waste form development through qualification, production, and acceptance.

The current revision of the QARD is organized into sections, supplements, appendices, and a glossary. The 18 Sections contain requirements that are common to all OCRWM Program activities including high-level waste activities such as high-level waste form development. The five Supplements contain requirements for specialized activities, e.g, software, sample control, field survey and the three Appendices contain requirements that are specific to the high-level waste form production, storage and transportation, and the Mined Geologic Disposal System.

Waste form producers may, but are not required by OCRWM, develop specific quality assurance procedures that comply with the requirements of the QARD, or they may modify existing procedures, as necessary, to meet the QARD requirements. If the latter approach is taken, a crosswalk to demonstrate how the QARD requirements are met by the site quality assurance procedures should be generated.

Product Quality. Important to the subrequirement (1) is the concept that the QARD requirements apply only to those high-level waste items and activities that have been designated as important to waste acceptance/product quality. While a list of these items and activities is not included in either the EM-WAPS or the QARD, their identification is essential for identifying the bounds of applicability of the QARD. These items and activities are broadly defined as those which affect the ability of the waste Producers to produce a canistered waste form that meets the EM-WAPS requirements. Both of the existing vitrification facilities, DWPF and WVDP, have developed a methodology for identifying such items and activities for their respective site and have maintained a list of these items. Refer to these for further details on the approach taken at each site (references included below).

Audits and Assessments. Subrequirement (2) requires that in addition to the audits and assessments that are required under Section I.1.E., Requirements of Other Regulations and DOE Directives, or Section I.2.F.(10), Evaluations, Section 18.0 of the QARD, Audits, establishes specific requirements for performing internal and external Quality assurance audits to verify compliance with, and to determine the effectiveness of, the Quality assurance program. Refer to Section 18 for the specific requirements. In addition, numerous other assessment requirements are contained throughout the QARD that must be met for those items and activities that are applicable to the QARD requirements. Included are:

- Section 2.2.6 Surveillances
- Section 2.2.7 Management Assessments
- Section 2.2.8 Readiness Reviews
- Section 2.2.9 Peer Reviews

Responsibilities for conducting audits are identified in several documents. A Memorandum of Agreement between the Office of Civilian Radioactive Waste Management and the Office of Waste Management specifies quality assurance responsibilities between these two organizations (see reference) while letters between the high-level waste sites and the Office of Waste Management assign audit responsibilities between these organizations.

Compliance with this requirement is demonstrated by documented evidence that the requirements of the QARD have been met for those items and activities that are determined to be waste product quality affecting; and the QARD audit, readiness reviews, and assessment requirements have been met.

Supplemental References:

1. DOE, 1997. *Office of Civilian Radioactive Waste Management, Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program*, Revision 8, DOE/RW-0333P, U.S. Department of Energy, November 13, 1997.

2. DOE, 1996. *Memorandum of Agreement Between the Office of Waste Management and the Office of Civilian Radioactive Waste Management for Coordination of Quality Assurance Activities Associated with High-Level Waste and Spent Nuclear Fuel*, U.S. Department of Energy, May 23, 1996.

3. DOE, 1996. *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, Revision 2, DOE/EM-0093, U.S. Department of Energy, December 1996.

4. DOE, 1997. *WVDP Waste Acceptance Manual*, Revision 7, WVDP-200, U.S. Department of Energy, April 22, 1997.

5. DOE, 1996. *DWPF Waste Acceptance Reference Manual*, Revision 4, WSRC-IM-93-45, U.S. Department of Energy, February 1996.

II. H. Contingency Actions.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Contingency Storage. For off-normal or emergency situations involving high-level waste storage or treatment, spare capacity with adequate capabilities shall be maintained to receive the largest volume of waste contained in any one storage vessel, pretreatment facility, or treatment facility. Tanks or other facilities that are designated for high-level waste contingency storage shall be maintained in an operational condition when waste is present and shall meet all the requirements of DOE O 435.1, *Radioactive Waste Management,* and this Manual.

(2) Transfer Equipment. Pipelines and auxiliary facilities necessary for the transfer of waste to contingency storage shall be maintained in an operational condition when waste is present and shall meet the requirements of DOE O 435.1, *Radioactive Waste Management,* and this Manual.

Objective:

The objective of this requirement is to mitigate the impacts on the public, workers, and environment in the event that a leak develops in a vessel storing high-level waste or in a facility processing high-level waste. The mitigation is provided by ensuring spare waste storage capacity is a required part of a site's emergency management program. To meet this objective, there needs to be both capacity to handle the largest volume of any single storage vessel or liquid waste in process, and the capability to transfer the waste.

Discussion:

This requirement shall be implemented through and included in site emergency management programs that are required by DOE O 151.1, *Comprehensive Emergency Management System.* The directive DOE O 151.1 is referenced in DOE M 435.1-1, Chapter I and is considered necessary for the safe management of radioactive waste. The Comprehensive Emergency Management System requires the development of a complex-wide system for preparing for and managing emergencies. At the site level, personnel are to establish an Operational Emergency Base Program that provides the framework for responding to events involving, among other impacts, health and safety, and the environment. The program requires a qualitative hazards survey to identify the emergency conditions, describe the potential impacts, and summarize the planning and preparedness requirements that apply.

During the development of the requirements of DOE M 435.1-1, *Radioactive Waste Management Manual*, a waste management hazard and safety analysis identified the loss of confinement of a storage tank or waste processing facility containing radioactive wastes as a hazard requiring mitigation. In addition to requiring facility designs to maintain waste confinement (see DOE M 435.1, Section II.P.(2)(b)), the ability to respond to leaks or other off-normal conditions if they occur was also considered necessary. Consequently, the requirements to have adequate spare capacity and the ability to transfer waste to the spare capacity were established. This requirement is applicable to storage and processing of both liquid high-level waste and solid high-level waste (e.g., calcine).

Operating procedures are to be developed and utilized for transfer of high-level waste to contingency storage. The procedures need to address maximum operational capacities and limits for components of the operational system (e.g., spare storage capacity available in vessels). The procedures are to define and address all possible emergency transfer scenarios needed to comply with this requirement.

Contingency Storage. Contingency storage is to be provided for both high-level waste storage and for high-level waste pretreatment and treatment facilities. In the case of storage vessels, adequate volumetric capacity must be available to receive the largest volume of waste stored in any single vessel. In the case of pretreatment or treatment facilities, adequate capacity must be available to allow in-process wastes in the facility to be moved as necessary to storage or holding tanks in the event of emergency or off-normal conditions. These storage or holding tanks may be other process vessels within the facility.

The requirement also requires that tanks, or other facilities, that are designated for high-level waste contingency storage be maintained in an operational condition when waste is present and that they meet all the requirements of DOE O 435.1 and DOE M 435.1-1. The operational requirement is to ensure that all the elements required for safe operation of a functional high-level waste storage tank that contains waste also are applied to a contingency storage tank. This is intended to include the implementation of an approved authorization basis, or radioactive waste management basis, as well as the implementation of operating procedures by trained and qualified personnel. Development and implementation of these operational elements need to be planned and completed prior to the designation of a tank or other facility as contingency storage since the need for contingency storage may be urgent.

The requirement that contingency storage facilities meet all of the Order and Manual requirements is recognized as demanding, and may be difficult for some DOE sites to meet. However, the requirement is considered necessary due to the hazardous nature of high-level waste and the potential consequences of loss of confinement of a tank's contents. Of particular importance to contingency storage units is complying with the requirements in Section II.Q, Storage, which provides for a structural integrity program. As discussed in the guidance to Section II.Q, a structural integrity program ensures structural strength and leak-tightness of all tanks designed for use as high-level waste storage.

The requirement in DOE M 435.1-1, Section II.H.(1) does not preclude the designation of existing single-shell tanks (i.e., do not meet the secondary confinement (design) requirements of DOE M 435.1 Section II.P.(2)(b)) present at some DOE sites, from being designated contingency storage facilities. Existing single-shell tanks that can meet all the requirements of DOE M 435.1-1, Chapter II, without having to undergo significant modifications, may be candidates for designation as contingency storage units. As explained in the guidance to DOE M 435.1-1 Section II.P.(2)(b) the secondary confinement requirements apply to new, and modifications to existing, tanks. The requirement that must be met for single-shell tanks is the structural integrity program (DOE M 435.1-1, Section II.Q.(2)) which includes elements such as verifying leak-tightness and structural strength, identifying corrosion modes, and ultimately identifying the tank's safe operating envelope.

Spare capacity may be provided by a single vessel or by the combined available volume in multiple vessels. In cases where radiation protection considerations allow, spare capacity could be provided by portable vessels, tankers, e.g., rail-tank cars, or tank trucks if they meet the other requirements of DOE M 435.1-1. Due to the potential for airborne radioactive material, impoundments or bermed areas open to the air generally are not be used for spare storage capacity.

> *Example: Liquid high-level waste is stored in six underground storage tanks with a design capacity of 250,000 gallons each. The waste in the tanks has the same chemical and radiological characteristics. One tank contains 200,000 gallons and each of the others contain about 100,000 gallons. Capabilities exist to retrieve waste and transfer it among the six tanks. This system meets the requirement because the largest volume of 200,000 gallons can be distributed between any two of the other tanks.*

Spare capacity may be shared by different waste types, however mixing radioactive wastes of different types needs to be evaluated and is generally not acceptable.

> *Example 1: A tank farm has tanks containing high-level waste which has been determined not to be a mixed waste or high-level waste or has other tanks that are contaminated with listed hazardous wastes. A spare empty tank is maintained and available for emergency transfers of either waste.*

> *Example 2: A tank farm contains both liquid high-level waste and liquid transuranic waste in separate tanks. If the spare capacity were provided by excess capacity in tanks that contain high-level waste, use of the capacity for transuranic waste would be undesirable. Transferring transuranic waste into a tank containing high-level waste,*

would result in a mixture that would no longer be eligible for disposal at the Waste Isolation Pilot Plant which, by law, cannot dispose of high-level waste. Therefore, waste managers need to identify different spare capacity to accommodate the two different waste types.

In addition to the spare storage capacity discussed above, other measures may also need to be implemented. An obvious action is to immediately stop the flow of any materials into the tank system or tank annulus (if applicable), and inspect the system to determine the cause of the leak. If the leak site is determined to be above the tank bottom, transferring tank contents until it is at a level below the leak site would satisfy the requirement. Additionally, some tank systems include a partial secondary liner in the form of a drain pan or a leak sump. In general the volume capacity of these structures is limited; however, the viability of recirculating leaked contents from these structures to the primary tank or vessel as an initial mitigation measure may be assessed. Such re-circulation may preclude the release of a leaking tank's contents to the soil, while contingency transfer and storage systems are being prepared to remove the contents from a leaking tank or vessel.

<u>Transfer Equipment</u>. The ability to perform the transfer is just as important as having the capacity. Equipment necessary to transfer each vessel or treatment facility volume of high-level waste in the event of a leak or other off-normal condition is to be identified and documented.

Example: Calcined radioactive waste is stored in six underground bins with a capacity of 10,000 cubic feet each. The waste in all of the bins is similar, and each bin contains 3,000 cubic feet of calcined high-level waste. Although there are transfer lines to any of the bins from a central diversion box, the bins were constructed without the capability to retrieve the waste. This situation does not comply with the requirement at II.H.(2). Although there is adequate capacity, the ability to transfer the waste does not exist. An exemption would be required.

In addition, mechanisms must be in place to ensure the equipment identified as necessary to transfer the contents of each tank can be made available quickly. One approach is to inspect and/or test the identified equipment and components, as part of a routine waste management maintenance program (see DOE M 435.1-1, Section I.1.E.(9)).

If the cost of procuring and maintaining such items is economically impractical, an acceptable alternative would be to have agreements with vendors to procure the necessary equipment and have it shipped to the site within a specified period of time. Under this approach the use of other mitigative measures to reduce impacts to the environment from a leaking tank or vessel may be necessary. Such mitigative measures might include re-circulation of leaked contents from sumps or pans to the primary tank, as discussed above, or the initiation of emergency remediation actions in accordance with facility emergency plans.

The capability to perform an emergency transfer of high-level waste is to be maintained at all times. Procedures need to be prepared and operations personnel qualified in the operation of equipment and those procedures necessary for the transfer of high-level waste to contingency storage facilities.

> *Example: A large shielding block is in place over a diversion box that needs to be accessed during an emergency transfer of high-level waste. The block must be moved by a crane. Therefore, a suitable crane must be on-site or an agreement with a vendor that such a crane can be delivered within a specified time period, is in place. Additionally, operators qualified to operate valves within the diversion box must be available when needed.*

Many DOE sites have agreements in place with their State and/or EPA regulators that may overlap, or conflict, with the requirements in this section. Obviously such agreements must be honored and the intent of these requirements is not to interfere with them. Thus, some interpretation of these requirements will be necessary to ensure that spare waste storage capacity is available and that the necessary transfer equipment is available on a real time basis, i.e., at the earliest practicable time.

Compliance with these requirements is demonstrated if adequate spare capacity and transfer equipment exist for emergency transfers of all high-level waste. This includes maintaining high-level waste contingency storage facilities and transfer equipment/facilities in an operational condition when waste is present.

Supplemental References:

1. DOE, 1995. *Comprehensive Emergency Management System*, DOE O 151.1, U.S. Department of Energy, Washington, D.C., September 25, 1995.

II. I. Corrective Actions.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Order Compliance. Corrective actions shall be implemented whenever necessary to ensure the requirements of DOE O 435.1, *Radioactive Waste Management*, and this Manual are met.

Objective:

The objective of this requirement is to ensure that actions will be taken to preclude, minimize, or mitigate hazards whenever a situation arises at a high-level waste management facility that could threaten worker or public safety, or the environment.

Discussions:

DOE M 435.1-1, Section I.2.G, states that all personnel have a responsibility to identify conditions that require corrective actions to achieve compliance with the Order and Manual requirements or to address health and safety conditions that pose an imminent or possible danger. The Manual states that this responsibility includes considering shutdown or curtailment of facilities and activities, if warranted by the seriousness of the circumstances. This requirement ensures that this responsibility is implemented for all high-level waste management facilities and activities. DOE M 435.1-1, Section I.2.F.(20), requires the Field Element Manager to ensure that a process exists for proposing, reviewing, approving, and implementing corrective actions when necessary to ensure that the requirements of DOE O 435.1 and DOE M 435.1-1 are met, and to address conditions that are not protective of the public, workers, or the environment.

Corrective actions are activities which, when implemented, will correct a noncompliant or hazardous condition. These activities can include improvements to documentation (e.g., procedures, plans, authorization basis documents), training and qualification programs or procedures, physical and process design changes, changes to operating conditions, or a combination of these activities.

Corrective Action System. A corrective action system exists for addressing noncompliant or hazardous conditions for high-level waste management facilities, operations and activities. Corrective actions in response to quality assurance program assessments are addressed in the *Implementation Guide for Use with Independent and Management Assessment Requirements of 10 CFR 830.120* and DOE O 414.1, *Quality Assurance.* The corrective action system provides for documenting noncompliant or hazardous conditions, identifying the organizations or individuals responsible for developing and implementing corrective actions, providing corrective action status, and tracking progress through final implementation of the actions. The corrective action system is instituted as a fundamental part of the systematic evaluation of radioactive waste activities that is implemented by the site-wide radioactive waste management program (see guidance for Section I.2.F.(1)).

A problem requiring corrective action could range from a minor deviation from a procedure, to a situation that poses an immediate threat to health and safety from an uncontrolled release of large quantities of radioactive material. For situations where a problem could pose an immediate risk to a worker, member of the public, or damage to the environment, immediate shutdown of the process or facility may be appropriate as the first step in addressing the problem. (see guidance for Section II. I.(2)).

> *Example: An employee of the Site K high-level waste vitrification facility noticed that the procedure for taking a high-level waste slurry sample was not being followed correctly by a waste technician. Such action could allow a release of high-level waste slurry into the facility's operating corridor from the sampling station. The employee alerted the sampling shift manager who in turn alerted the facility operations manager. The facility corrective action system resulted in a corrective action plan that identified the sampling station manager as the responsible individual for assuring proper training of operations personnel on implementing sampling procedures. A reminder memo was sent to the affected staff and a follow-up review was scheduled for 45 days after the occurrence.*

If a facility or activity can be allowed to operate while a noncompliant or hazardous condition exists, the allowance and any associated limitations must be defined as part of the facility or activity's radioactive waste management basis and/or authorization basis documentation, identified as a configuration controlled item in a configuration management plan or included in a revision or modification to an operating procedure or similar controlled documentation. If a noncompliance impacts safety associated with use of a procedure, system, or facility, the corrective action system must provide for preventing the use (e.g., locking out) of the affected procedure, system, or facility.

> *Example: In the example above, slurry sampling activities were curtailed so that no slurry sampling was allowed. Due to the potential for a release of high-level waste slurry into the operating corridor of the facility and significant personnel contamination, waste sampling activities were curtailed until operator training was completed.*

Compliance with this requirement is demonstrated if a corrective action system addresses noncompliant or hazardous situations involving high-level waste management facilities in a systematic fashion, and allows identification of problems by all personnel.

Supplemental References:

1. DOE, 1996. *Implementation Guide for Use with Independent and Management Assessment Requirements of 10 CFR 830.120 and DOE O 414.1 Quality Assurance,* DOE G 414.1-1, U.S. Department of Energy, Assistant Secretary for Environment, Safety and Health, Washington, D.C., August 1996.

II. I.(2) Operations Curtailment. Operations shall be curtailed or facilities shut down for failure to establish, maintain, or operate consistent with an approved radioactive waste management basis.

Objective:

The objective of this requirement is to limit the operation of waste management activities and facilities as necessary to avoid creation of near- or long-term safety or environmental hazards.

Discussion:

DOE M 435.1-1 requires that a radioactive waste management basis be established for each radioactive waste management activity or facility. The radioactive waste management basis is to include those additional constraints specific to waste management activities (e.g., requirements of the *Manual*) that are determined to be necessary for safety and environmental protection. Field Element Managers are responsible for ensuring a radioactive waste management basis is developed, reviewed, approved, and maintained for each DOE radioactive waste management facility, operation, or activity. (DOE M 435.1-1, Section I.2.F.(2)). The guidance for that requirement should be consulted for additional details on the development, review, and approval of a radioactive waste management basis. Also, additional discussion concerning the radioactive waste management basis for high-level waste generator, pretreatment, treatment, and storage facilities is discussed under guidance for the requirement at Section II. F.

As part of his or her responsibilities for maintaining the radioactive waste management basis for high-level waste management facilities, operations, and activities under his/her authority, the Field Element Manager evaluates the compliance of the facilities, operations, and activities with the constraints and controls documented in the radioactive waste management basis by ensuring that routine assessments are conducted. If the Field Element Manager determines, either through routine assessment or by virtue of an occurrence or off-normal event, that a facility, operation, or activity is not operating in compliance with an approved radioactive waste management basis, the operation must be curtailed or shut down. The action taken is commensurate with the hazards associated with the noncompliance and with the continued operation of the facility.

This requirement is to be implemented in a graded manner. Actions to be taken are based on assessments of adherence to radioactive waste management bases, and can range from shutdown of an operation or facility to placing limits or constraints on what activities can be performed or how the activities are to be performed. Shutdown of a facility involves stopping all operations in the facility except surveillance or monitoring activities necessary to maintain the facility in a safe standby condition. Shutdown is considered appropriate when there is either a potential imminent threat to safety or environmental protection that cannot be mitigated, or a blatant failure to establish or comply with a radioactive waste management basis.

Alternatively, there may be cases where the facility, operation, or activity assessment determines that the radioactive waste management basis is not current or has been violated but there is no imminent threat to public, worker, or environmental protection. In such a case, the Field Element Manager may decide that shutdown of the facility is not necessary. It may be sufficient to impose certain limits until the radioactive waste management basis is made current. The limits imposed may prohibit the generation, receipt, or processing of certain waste streams, or may involve constraints on the processes that may be performed.

> *Example: Site Z conducts biennial assessments of high-level waste Evaporator Y for compliance with its radioactive waste management basis. The 1996 biennial assessment found two non-compliance findings and five observations. The corrective action system implemented at Site Z requires the non-compliance findings to be entered and formally responded to with corrective action plans, but not the observations. The non-compliances were in document control and operations training, so evaporator operations were not curtailed in any way while both the document control and training procedures were revised. The facility was assessed again in 1997 to determine if the corrections were in place, which was an accelerated assessment schedule from the normal biennial assessments.*

The action taken in response to the failure to establish a radioactive waste management basis is to be clearly documented in a formal communication (e.g., letter, memorandum). Such communication needs to identify the reason for the shutdown or curtailment, and identify what is necessary to initiate restart. Generally, development of a corrective action that is implemented through the corrective action system, as discussed in the preceding section, would be appropriate for responding to a shutdown or curtailment of activities at a high-level waste management facility.

In concert with Core Requirement #6 of the Integrated Safety Management System, “Feedback and Improvement,” the Field Element Manager should use the audits and assessments to identify opportunities for improvement in the implementation of an activity or facility’s radioactive waste management basis. Identified improvement actions should be shared with like organizations and tracked by management to determine whether they are yielding the anticipated improvements.

Communicating the results of assessment upward in the DOE and contractor organization will allow the findings to reach the management level with the authority necessary to effect improvements.

Compliance with this requirement is demonstrated by a documented system of routine assessments to determine whether waste management activities and facilities are operating in accordance with an approved radioactive waste management basis that provides for graded limitations that can be placed on activities and operations that do not have, or are operating outside of, an approved radioactive waste management basis, including shutdown of the facility.

Supplemental References:

1. DOE, 1996. *Safety Management System Policy*, DOE P 450.4, U.S. Department of Energy, Washington, D.C., October 15, 1996.

2. DOE, 1997. *Line Environment, Safety and Health Oversight,* DOE P 450.5, U.S. Department of Energy, Washington, D.C., June 26, 1997.

3. DOE, 1997. *Safety Management Functions, Responsibilities, and Authorities Policy,* DOE P 411.1, U.S. Department of Energy, Washington, D.C., 1997.

4. DOE, 1997. *Manual of Safety Management Functions, Responsibilities, and Authorities*, DOE M 411.1, U.S. Department of Energy, Washington, D.C., October 8, 1997.

5. DOE, 1999. *Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 98-1, Department of Energy Plan to Address and Resolve Safety Issues Identified by Internal Independent Oversight*, U.S. Department of Energy, Washington, D.C., March 10, 1999.

II. J. Waste Acceptance.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Technical and Administrative. Waste acceptance requirements for all high-level waste storage, pretreatment, or treatment facilities, operations, and activities shall specify, at a minimum, the following:

(a) Allowable activities and/or concentrations of specific radionuclides;

(b) Acceptable waste form that ensures the chemical and physical stability of the waste under conditions that might be encountered during transfer, storage, pretreatment, or treatment;

(c) The basis, procedures, and levels of authority required for granting exceptions to the waste acceptance requirements shall be contained in each facility's waste acceptance documentation. Each exception request shall be documented, including its disposition as approved or not approved; and

(d) Pretreatment, treatment, storage, packaging, and other operations shall be designed and implemented in a manner that will ultimately comply with DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,* or DOE/RW-0351P, *Waste Acceptance System Requirements Document,* for non-vitrified immobilized high-level waste.

Objective:

The objectives of the waste acceptance requirements are to ensure that: high-level waste which is to be received at a facility contains only the radionuclides that the facility can safely manage, and only in concentrations and/or total activities which are compatible with the work to be undertaken in the facility; no high-level waste management activity jeopardizes compliance with waste disposal specifications, including DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS), or DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD), for non-vitrified immobilized high-level waste; and formal procedures exist and a decision process is clear concerning the granting of exceptions to waste acceptance requirements.

Discussion:

As discussed in the guidance to DOE M 435.1-1, Section I.2.F.(6), the waste acceptance requirements establish the conditions for waste that facilities can safely receive. Therefore, the acceptance requirements for high-level waste storage, pretreatment, or treatment facilities, operations and activities include all requirements that high-level waste must meet to be acceptable for receipt, and for the subsequent storage, pretreatment, or treatment that it will undergo.

In conducting the analyses for development of the DOE M 435.1-1 requirements, minimum acceptance requirements that must be specified in waste acceptance documentation for storage, pretreatment, and treatment facilities that must be specified in the waste acceptance documentation for these types of high-level waste management facilities in order for high-level waste to be safely handled were identified. Guidance on subrequirement (a) is provided below under Radionuclide Content or Concentration. Guidance on subrequirement (b) is provided under Waste Form. Guidance on subrequirement (c) is provided under Exceptions. Guidance on subrequirement (d) is provided under Waste Acceptance Product Specifications.

Development of Waste Acceptance Requirements. A facility receiving high-level waste for storage, pretreatment, or treatment is required to document the waste acceptance requirements for the facility. These requirements have their foundation in facility design capabilities such as volume, handling, weight, allowable contents, and radiological limits (i.e., criticality, radiation, contamination). Other requirements may include any number of regulations promulgated by the EPA, NRC, DOT, the host state, and DOE itself. The designer and operator of the facility receiving waste are likely to be most knowledgeable of the requirements and limitations of the facility and, therefore, are in the best position to establish the waste acceptance requirements or criteria that must be met for waste sent to the facility.

DOE is planning to dispose high-level waste in a geologic repository consistent with the *Nuclear Waste Policy Act of 1982*, as amended. This plan was outlined in Secretary Hodel's letter to President Reagan (DOE, 2/6/85), in which the Secretary recommended that "the Department proceed with plans and actions to dispose of defense waste in a commercial repository." President Reagan's finding, in accordance with Section 8 of the *Nuclear Waste Policy Act of 1982*, as amended (Presidential memo, 4/30/85), was that he found no basis to do otherwise and the Department has since implemented plans to dispose high-level waste in a geologic repository consistent with the *Nuclear Waste Policy Act of 1982,* as amended.

The DOE Office of Civilian Radioactive Waste Management has issued the WASRD that describes the functions to be performed and the technical requirements for a Waste Acceptance System for accepting spent nuclear fuel and high-level radioactive waste into the Civilian Radioactive Waste Management System. From this document, the Office of Environmental

Management has developed and implemented the EM-WAPS. Additional information on this document is discussed below under Waste Acceptance Product Specifications.

Personnel responsible for high-level waste storage, pretreatment, or treatment facilities are to consider the EM-WAPS in developing waste acceptance criteria. Criteria to be considered include limiting the concentrations of species that may inhibit the formation of glass, organic compounds, and RCRA-listed hazardous wastes.

The waste acceptance requirements and documentation for a facility receiving waste for storage, pretreatment, or treatment are prepared using a graded approach commensurate with the hazards associated with the management of the waste in the facility and the complexity of the activities to be conducted in the facility and upon the waste. The waste acceptance requirements document for a facility which receives large quantities of high-level waste, or high-level waste with highly variable contents, or both, may need to address many hazards and consequently may be more detailed. By contrast, an immobilized high-level waste storage facility that stores only EM-WAPS compliant waste may only need a minimal set of requirements.

The EM-WAPS, legislation, regulations, safety analysis reports, technical safety requirements, criticality analyses, and other appropriate safety or authorization basis documents are used to establish the waste acceptance criteria for facilities receiving high-level waste for storage, pretreatment, or treatment. These documents and analyses provide the basis for radioactivity (concentration and inventory) limits, allowable chemical content, waste form and/or packaging stability requirements, and other necessary waste canister or waste form requirements to ensure that the facilities design bases, performance, and operating bases are not compromised.

Radionuclide Content or Concentration. Radiological limits for storage, pretreatment, and treatment facilities may be derived from a number of technical as well as administrative sources. In developing limits for radionuclide concentrations, personnel need to consider storage and treatment facility limitations, the EM-WAPS, safety analysis reports, and criticality analyses.

At many high-level waste management sites, the storage and treatment facilities require the control of certain constituents or concentrations of species to ensure safe storage, pretreatment and treatment of the waste. Such limits, for example, support corrosion protection, prevent the accumulation of flammable or explosive species, limit the radionuclide content, or meet regulatory limits. Storage, pretreatment, and treatment facilities need to include appropriate waste acceptance requirements that protect their authorization or radioactive waste management basis.

The current EM-WAPS for vitrified waste forms contains a number of specifications to be considered during the development of the waste acceptance requirements for high-level waste pretreatment and treatment facilities. These include Specification 1.5, “Hazardous Waste,” which precludes the inclusion of RCRA-listed components in the final high-level waste form, and

Specification 3.5, “Chemical Compatibility,” which requires that the waste producer ensure that the final waste form is compatible with the canister material.

The safety analysis report or authorization basis for a high-level waste management facility may identify specific radionuclides that warrant special attention from a worker safety standpoint or an offsite release standpoint due to an upset or accident condition.

> *Example: At Site Z the safety analysis for the high-level waste tank farm has established a limit on the concentration of Cs-137 in Type V Tanks to < 0.6Ci/gal. This limit is set for these tanks because they do not have secondary confinement. The limit ensures that the risk of the Cs-137 reaching the environment is comparable to the accepted risk associated with the waste in a double confinement tank.*

Any criticality analyses conducted in accordance with the Criticality Safety Program in conformance with DOE M 435.1-1, Section I.1.E.(4), may also result in limitations on acceptance of fissile radionuclides. These limitations should be included in the waste acceptance requirements, as appropriate.

Waste Form. Waste acceptance requirements specify that wastes received at the facility are in a physically/chemically stable form. Waste acceptance requirements for a high-level waste pretreatment or treatment facility need to specify the physical and chemical precautions and conditions under which untreated waste can be received at the facility so that facility safety and effective operations will not be compromised. Any physical or chemical stabilization of waste prior to transfer to a facility receiving waste for storage, pretreatment, or treatment needs to be done according to a systematic process that includes consideration of bench-scale testing and verification that the process is producing satisfactory results.

The waste acceptance requirements need to specify waste streams, classes, or categories of waste requiring application of specific physical or chemical stabilization methods, as determined by the results of safety analyses. Acceptable waste streams or waste forms are specified by the waste acceptance requirements. The waste acceptance requirements also need to identify any of the following specific technical requirements that must be included to ensure that waste received at any storage, pretreatment, or treatment facility is consistent with the operating/authorization basis of the facility:

- allowable heat generation rates;
- any specific radionuclides or chemical or hazardous materials that are prohibited from acceptance at the facility. This may include pyrophoric materials, explosives, or materials that might cause violent reactions during storage, pretreatment, or treatment; and

- any specific requirements associated with acceptance of high-level waste needing out-of-the-ordinary attention for receipt, storage, pretreatment, or treatment.

Exceptions. Waste acceptance requirements are established to ensure that facilities can safely manage the waste received for storage, treatment, or disposal. Waste acceptance requirements need to be documented, contain clear and precise criteria specifying the radionuclide limits in the form of contents or concentrations that can be accepted, the limitations and prohibitions on waste streams received, and the limits, prohibitions, or instructions concerning any other technical information to assure that the waste is compatible with the safety basis of the facility, and which will result in acceptable waste at subsequent steps in managing the high-level waste. Thus, exceptions or deviations to waste acceptance criteria must not be routine and must be carefully reviewed and documented. The procedures for granting exceptions need to clearly state the entire process for requesting an exception, describe acceptable bases for granting exceptions, and identify any additional information that is needed to supplement the documentation normally provided for waste transfers. The approval process is clearly stated, including identification of the officials who have the authority to approve the exception.

> *Example: At Site Y, the transfer of a high-level waste solution that is non-compliant with one or more of the receiving facility-specific waste acceptance requirements may be requested, and allowed, because analysis concludes that blending of the transferred waste with the existing tank inventory will result in the blended tank waste being compliant with the receiving tank's waste acceptance requirements. The Site Y procedure includes an administrative process that requires a technical basis for the proposed exception and requires the appropriate reviews, approvals and documentation.*

Waste Acceptance Product Specifications. This subrequirement is intended to ensure that any high-level waste management activities such as storage, pretreatment, treatment, packaging, and any other operations shall be conducted in a manner that will facilitate the acceptance of the final immobilized high-level waste form by the Office of Civilian Radioactive Waste Management. The current EM-WAPS include are the technical specifications that waste form producers are required to meet in order to ensure acceptance of their vitrified high-level waste into the Civilian Radioactive Waste Management System. The Office of Environmental Management (EM) and the Office of Civilian Radioactive Waste Management have agreed the Office of Environmental Management is to provide the final waste form specifications to the waste form producers and the Office of Environmental Management will ensure that the EM-WAPS is consistent with the technical baselines as defined in the WASRD. The EM-WAPS governs all elements of the final, canistered, waste form which includes the borosilicate waste glass, the stainless steel canister, and the sealed canistered waste form.

As waste form requirements for immobilized high-level waste were developed, the Department and its operating contractors selected borosilicate glass as a reference waste form. Several high-level waste sites subsequently identified a vitrified waste form for their sites, and two high-level waste vitrification facilities are currently operating to produce canisters of borosilicate waste-glass. The EM-WAPS was written to such borosilicate glass specifications. Recently, however, several new high-level waste streams have been identified. One such high-level waste stream is the proposed insertion of small immobilized surplus plutonium containers within a standard high-level waste canister. Molten vitrified high-level waste is then poured around these plutonium cans yielding a matrix immobilized waste form. This composite high-level waste stream is considered high-level waste and can be disposed as such. Another proposed high-level waste stream results from immobilizing the waste resulting from reprocessing certain spent nuclear fuels using an electro-metallurgical process. In this case a non-vitrified waste form will result. In both these cases a product that adheres to all the existing requirements of DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*, is not possible. The exact waste form specifications that these two proposed waste forms must meet are unknown at this time; however, they will be incorporated in DOE/RW-0351P, *Waste Acceptance System Requirements Document*. That document is therefore cited for those unique immobilized high-level waste forms that cannot meet the requirements of DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS).

The waste acceptance process requires demonstration of compliance with the EM-WAPS via four different documents, each prepared by the waste producers, reviewed and accepted by the Office of Environmental Management, and provided to the Office of Civilian Radioactive Waste Management. These four documents are: the Waste Form Compliance Plan (WCP); the Waste Form Qualification Report (WQR); production records and; the storage and shipping records. The producers included in Revision 2 of the EM-WAPS are Savannah River Site, the West Valley Demonstration Project, and Hanford. Decisions on a final waste form at the Idaho National Environmental Engineering Laboratory have not progressed to the point that it has been included in the current EM-WAPS.

The EM-WAPS provides detailed specifications that must be met by the producers in order for the final waste form to be acceptable to the Civilian Radioactive Waste Management System for disposal. Amplification on these specifications is considered beyond the scope of this guidance. Reference is made to existing Waste Compliance Plans for Defense Waste Processing Facility and the West Valley Demonstration Project, both of which provide a detailed description of the methods by which they comply with each specifications. Following are the titles of each of the summaries specification within the EM-WAPS:

- Waste Form Specifications;
- Canister Specifications;
- Canistered Waste Form Specifications;

- Quality Assurance Specification; and
- Documentation and Other Requirements.

Example: At Site Z, a vitrification operation's analysis concluded the potential for a significant savings in plant operating labor costs if the welding of canisters could be delayed until the vitrification melter operations were shut down for maintenance, which was normally every 30 days. Thus the proposal was to stage unwelded canisters in the facility, for as long as 30 days, until melter operations personnel were free to make the closure welds. However, review of the facility's Waste Compliance Plan, Waste Qualification Reports, and the EM-WAPS determined that there was a risk that organic contaminants may enter the open canisters that would be held for welding. Such contamination would violate the EM-WAPS, Specification 3.4, Organic Materials Specification, and the plan was rejected.

Compliance with these requirements is demonstrated by waste acceptance requirements that are well documented and contain clear and precise criteria specifying: allowable activities and concentrations; acceptance forms; a clear description of the process for obtaining an exception to the acceptance criteria; and operations shall be implemented in a manner that does not jeopardize the final waste form's ability to meet the EM-WAPS.

Supplemental References:

1. DOE, 1999, *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

2. DOE, 1996. *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, Revision 2, DOE/EM-0093, U.S. Department of Energy, December 1996.

3. DOE, 1994. *DWPF Waste Form Compliance Plan*, Revision 4, WSRC-IM-91-116-0, U.S. Department of Energy, December 1994.

4. DOE, 1997. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 12, WVDP-185, U.S. Department of Energy, December 1997.

5. DOE, 1985. *An Evaluation of Commercial Repository Capacity for the Disposal of Defense High-Level Waste,* DOE/DP/0020/1, U.S. Department of Energy, Washington, D.C., June 1985.

6. Hodel, 1985. Secretary Hodel to President Reagan, memorandum, *Use of Commercial Repository for Disposal of Defense High-Level Nuclear Waste*, U.S. Department of Energy, Washington, D.C., February 6, 1985.

7. Reagan, 1985. President Reagan to Secretary Herrington, memorandum, *Disposal of Defense Waste in a Commercial Repository,* Washington, D.C., April 30, 1985.

II. J.(2) Evaluation and Acceptance. The receiving facility shall evaluate waste for acceptance, including confirmation that the technical and administrative requirements have been met. A process for the disposition of non-conforming wastes shall be established.

Objective:

The objective of this requirement is to establish a process by which a facility receiving high-level waste for storage, pretreatment, or treatment determines that the waste being transferred is acceptable in accordance with the waste acceptance requirements and for that process to specifically address the management of waste that does not conform with all of the requirements when it is received at the facility.

Discussion:

This requirement makes it the responsibility of officials at a facility to which waste is transferred to confirm that waste is in compliance with the established waste acceptance requirements, and also to provide a mechanism by which the officials confirm that waste can be accepted and safely managed at the facility.

Evaluation and Acceptance. The methodology for implementing the evaluation and acceptance of high-level waste needs to be flexible and defined on a facility-specific basis. The complete process and procedures, including the responsibilities of the generating facility, need to be clearly documented so that both the generator and the facility receiving the waste understand the process that will be used. As with the implementation of other parts of the DOE M 435.1-1, this requirement is implemented using the graded approach. Facilities receiving high-level waste from many generators may need to implement more detailed waste evaluation and acceptance processes than a facility receiving waste from a few generators.

The evaluation and confirmation process consists of one or more of the following approaches that can contribute to high confidence that the waste presented meets the waste acceptance requirements of the facility receiving waste for storage, pretreatment, or treatment:

- Testing, sampling, and analysis of the contents of a representative sample of waste packages as they are received at the facility;

- Testing and analysis of a number of samples taken by the generator facility;

- Detailed review of sampling and analysis data generated by the sending facility or an independent laboratory employed by the generating facility;

- Audit, surveillance, or observation of the sender's waste characterization activities and processes and waste certification programs.

Testing, sampling, and analysis of the contents of a representative sample of waste is complicated by the fact that additional risk is posed because of the process required to take and analyze a liquid sample. Therefore, consideration is given to the additional risk and potential worker dose when deciding which approach is appropriate. Likewise, analysis of the samples taken by the generator may involve additional risk, and also may be expensive to implement. If this method is employed, samples which are representative, either statistically or correlated with generator profiles, need to be obtained for analysis. This sampling includes samples from the generators sending the greatest amount of waste to the facility for storage, pretreatment, or treatment; or samples containing the critical radionuclides as identified in the waste acceptance requirements.

The use of detailed reviews of the sampling and analysis data gathered by others needs to include an evaluation of the methodologies used for collecting the sample, maintaining the integrity of the sample and data (e.g., through a chain of custody), and performing chemical analyses and radioanalyses. As above, the samples collected need to be representative of the waste, either statistically or with a bias towards large generators or generators of significant radionuclides (i.e., those that are most limiting for the storage, pretreatment, or treatment).

The use of assessments, audits, or reviews to verify compliance of the waste generators' certification programs with acceptance requirements are conducted on a regular schedule. The documentation of the verification process includes review of the organization and authorities; frequency of assessments; methods to be employed; the information that will be documented as a result; and the qualifications of personnel.

Example: At Site K, DOE and contractor management teams for the high-level waste program conduct a quarterly management assessment of waste generators' waste certification programs to ensure their programs are compliant with the current tank farm waste acceptance requirements. This assessment program is in addition to the receiving facility's (high-level waste tank farm) monthly audit program that reviews high-level waste generator sampling, transfer, packaging, and laboratory analysis procedures, and training requirements.

Non-Conforming High-Level Waste. Facilities receiving waste for storage, pretreatment, or treatment must have a documented process to be used in the event a non-conforming waste is received. Facility procedures need to discuss how non-conforming waste will be segregated from acceptable waste, the process for notifying the sender of the non-conformance, and the acceptable methods for dispositioning the non-conforming waste. The process includes prior notice to the waste sender of the actions to be taken by the facility receiving the waste and the sender's obligations, particularly regarding the cost of the actions, to support the disposition of the non-conforming waste.

> *Example: At Site X, a batch of supernate is transferred from a reprocessing canyon to a high-level waste storage tank, after which it is determined that the transferred batch is non-compliant with the receiving tank due to its low concentration of corrosion inhibitors (nitrites). Upon receipt and discovery of the non-compliance, an analysis indicates that even after blending of the transferred waste with the nitrite-rich waste in the tank, the blended waste is non-compliant with the waste acceptance requirements of the receiving tank. This condition will require the addition of sodium nitrite to the receiving tank to correct the molar concentration of the supernate. The cost for the addition of sodium nitrite is charged to the reprocessing canyon management.*

Compliance with this requirement is demonstrated by the waste acceptance requirements for a high-level waste management facility, including a process for evaluation and acceptance of incoming waste, to ensure that the acceptance criteria of the facility receiving the waste are met. The process includes one of, or a combination of: (1) testing, sampling, and analysis of representative samples of incoming waste; (2) testing, sampling, and analysis of samples of waste taken at the generator facility; (3) evaluation of testing, sampling, and analysis of data provided by the generator; or (4) audits, reviews, surveillances, or observations of generator waste certification programs and characterization activities. Additionally, waste acceptance requirements for storage, pretreatment, or treatment facilities need to have documented procedures if waste that does not conform to the waste acceptance criteria is received at a facility.

Supplemental References:

1. DOE, 1999, *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

2. DOE, 1996. *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, Revision 2, DOE/EM-0093, U.S. Department of Energy, December 1996.

3. DOE, 1994. *DWPF Waste Form Compliance Plan*, Revision 4, WSRC-IM-91-116-0, U.S. Department of Energy, December 1994.

4. DOE, 1997. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 12, WVDP-185, U.S. Department of Energy, December 1997.

II. K. <u>Waste Generation Planning</u>.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Life-Cycle Planning. Prior to waste generation, planning shall be performed to address the entire life cycle for all high-level waste streams.

(2) Waste With No Identified Path to Disposal. High-level waste streams with no identified path to disposal shall be generated only in accordance with approved conditions which, at a minimum, shall address:

(a) Programmatic need to generate the waste;

(b) Characteristics and issues preventing the disposal of the waste;

(c) Safe storage of the waste until disposal can be achieved; and

(d) Activities and plans for achieving final disposal of the waste (compliance with DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*).

Objective:

The objective of this requirement is to provide for the disposal of all high-level waste that is generated by ensuring that: the specific waste management facilities necessary for safe management of the waste from the time it is generated up to and including its disposal are identified prior to the generation of a new high-level waste stream; plans are developed for resolving issues that prevent disposal, and for safe, long-term storage for high-level waste with no path to disposal; and sites are discouraged from generating high-level waste that does not have an identified path to disposal.

Discussion:

For purposes of this requirement, the term disposal has essentially the same meaning as compliance with the DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS). The EM-WAPS was prepared by the Office of Environmental Management (EM) to document the applicable specifications for producing a high-level waste form acceptable to the Office of Civilian Radioactive Waste Management for disposal. The *Nuclear Waste Policy Act of 1982*, as amended, charges the Office of Civilian Radioactive Waste Management with responsibility for management and disposal of high-level waste. The Office of Civilian Radioactive Waste Management has prepared DOE/RW-0351P, *Waste*

Acceptance System Requirements Document (WASRD), which includes the waste acceptance requirements on which the EM-WAPS is based. The linkages described among these applicable documents and organizations are consistent with the related requirement of this Manual (Section II.S., Disposal) that high-level waste be disposed of "…in accordance with the provisions of the *Nuclear Waste Policy Act of 1982*, as amended." In the guidance for this requirement, the term disposal is, therefore, interchangeable with compliance with the EM-WAPS.

Life-cycle planning. Planning, prior to generating high-level waste, is intended to address high-level waste streams that have not yet been generated. High-level waste streams that are first generated after issuance of the Order are subjected to this requirement. Waste that has already been and continues to be generated is addressed in the site-wide program requirements (see Section I.2.F.(1)). Waste generator planning is closely linked to characterization, certification, and transfer requirements (see Sections II.L, II.M, and II.N) which comprise the waste generator requirements program described in DOE M 435.1-1 (see Chapter I, Section I.2.F.(7)).

> *Example 1: A batch of spent fuel stored at Site X is deteriorating and reprocessing is necessary to reduce risk. The reprocessing will begin two years after issuance of DOE O 435.1 in an existing reprocessing canyon. The spent fuel is different from that previously reprocessed in the canyon, and necessary process changes will produce a waste stream unlike those previously produced. Therefore, the waste generation planning requirements of DOE O 435.1 must be applied.*
>
> *Example 2: A reprocessing canyon that was operating when DOE O 435.1 went into effect continued to operate. Neither the spent fuel input nor the process chemistry or equipment was changed. In this case, the high-level waste generator planning requirements would not apply. The continued reprocessing would be addressed by the site-wide planning requirements (see Sections I.2.F.(1) and II.E).*

Planning needs to address the life-cycle of high-level waste from generation through compliance with the EM-WAPS, including the interim steps of high-level waste management. This can be accomplished by preparing a high-level waste stream life cycle description and reviewing it with managers of the facility(ies) that are expected to manage the high-level waste. The high-level waste stream life cycle description is a sequential description of each step in high-level waste treatment, storage, and transfer to the Office of Civilian Radioactive Waste Management. It provides sufficient information to determine what treatment and storage capabilities are needed so that their availability can be determined. The high-level waste generator needs to confirm with operators of each management facility to be used that based on the current knowledge of the high-level waste stream characteristics and planned facility capacity the high-level waste stream can be managed by the facility.

Example: The new Site X waste stream described in the first example above will be subjected to chemical dissolution and separations. The high-level waste resulting from the process will be solidified. At various stages in this series of operations, temporary or long-term storage will likely be required waste generation planning will include preparation of a high-level waste stream life cycle description consisting of identification and explanation of each of these steps and explanation of the interfaces between the steps. The generator of the waste holds discussions with operators of facilities that may be able to manage the waste and incorporates relevant information on waste management needs and the availability of facilities to meet those needs in written plans.

A measure to determine whether a high-level waste stream has an identified path to compliance with the EM-WAPS is the availability of the necessary facilities and operations. A planned facility is considered to be available if it has been authorized (e.g., a line item in a Congressional appropriation or equivalent approval for design and construction). For purposes of planning for compliance with the EM-WAPS by a high-level waste stream, a facility or capabilities that are part of a program or strategic plan, but have not been authorized, are not considered available. If a planned or available facility is canceled, the generator site will need to revise the planning for the life cycle of the high-level waste. An alternate path to compliance with the EM-WAPS needs to be identified and documented, or approval to generate the high-level waste needs to be obtained from the cognizant Field Element Manager as required in DOE M 435.1-1, Section I.2.F.(19), and plans need to be made for ultimate compliance with the EM-WAPS.

The generator is responsible for ensuring that high-level waste is not generated unless there is due consideration of ultimate compliance with the EM-WAPS. However, it is not the objective of this requirement to prohibit, under all conditions, the generation of high-level waste that does not have an identified, achievable path to compliance with the EM-WAPS. In meeting the DOE O 435.1 planning requirement, it is appropriate for high-level waste management organizations to provide assistance to the generator in determining the high-level waste management path, particularly in cases where the high-level waste management organization may utilize offsite storage facilities for post-immobilization storage. Once the waste is determined to comply with the EM-WAPS, storage conditions are maintained to ensure continued compliance with the EM-WAPS.

<u>Waste streams that do not satisfy the EM-WAPS</u>. There are instances where programmatic needs may necessitate the generation of high-level waste without an identified path to compliance with the EM-WAPS. In these instances, the Field Element Manager must ensure development of a process for identifying generation of high-level waste with no path to compliance with the EM-WAPS and approving the conditions under which such high-level waste can be generated (DOE M 435.1-1, Section I.2.F.(19)). This process is intended to heighten the awareness of high-level waste generators that a long-term commitment is made with the generation of such a high-level waste. The long-term commitment arises from the potential for prolonged storage of

this high-level waste and from the work necessary to resolve issues that prevent compliance with the EM-WAPS.

Under the current DOE high-level waste management configuration, there is a process for the Office of Civilian Radioactive Waste Management acceptance of high-level waste that complies with the EM-WAPS. As noted above, the EM-WAPS is based on requirements such as those in the WASRD. In addition, there are facilities for pretreatment, treatment, and storage of some high-level waste that will be needed prior to compliance with the EM-WAPS.

The conditions for generating a high-level waste without an identified path to compliance with the EM-WAPS include various evaluations and considerations that involve both the high-level waste generator and high-level waste management organizations. The decision to proceed with the activity generating the high-level waste needs to consider the following:

(a) The need to generate the high-level waste. There needs to be a clear identification of the programmatic mission being served that results in the generation of high-level waste with no identified path to compliance with the EM-WAPS. Alternate means of accomplishing the mission without generating the high-level waste need to also be discussed.

(b) High-level waste characteristics which prevent compliance with the EM-WAPS. The reasons that a high-level waste cannot comply with the EM-WAPS need to be identified to support development of plans for ultimately achieving compliance with the EM-WAPS. These may be technical or programmatic reasons. For example, high-level waste needs to be vitrified in a borosilicate glass matrix (Specification 1.1) in order to comply with the EM-WAPS. If an appropriate vitrification facility is not available, the lack of such a facility would be identified as a reason the high-level waste does not have a path to compliance with the EM-WAPS. Similarly, if a high-level waste is categorized as mixed high-level waste because of the presence of a listed hazardous waste and approval for delisting has not been granted by EPA, that would be cited as a reason for no path forward to compliance with the EM-WAPS (Specification 1.5).

(c) Adequate containment capabilities and facilities for the expected duration of the storage period. If the high-level waste cannot comply with the EM-WAPS pending the resolution of programmatic or technical issues, safe storage must be available. In order to evaluate the ability to provide for the storage of the high-level waste, there needs to be an estimate of the amount of the high-level waste that will be generated, as well as an estimate of the time the high-level waste will be in storage. Identification of acceptable storage facilities should be a prerequisite to generating the high-level waste.

(d) <u>Plans for resolving the issues that prevent compliance with the EM-WAPS</u>. The decision to generate high-level waste with no identified path to compliance with the EM-WAPS also needs to be based on a plan to achieve compliance with the EM-WAPS eventually. The plan identifies the activities being pursued to resolve issues preventing compliance with the EM-WAPS and a schedule for their resolution. The activities described may be detailed if the issue is technical and involves only a few sites. For example, plans to develop vitrification capabilities necessary to make a high-level waste that complies with the EM-WAPS could be detailed. The plans would identify the studies, engineering analyses, environmental analyses, design and construction activities, and projected dates for performing them, as appropriate. In other cases that are more programmatic in nature, the activities and schedules will be less detailed. For example, providing for compliance with the EM-WAPS for failed vitrification melters may require a programmatic decision by DOE. The plan for addressing this requirement needs to identify the data collection and options analyses to be performed by the site and address how they fit with the actions being taken by the Complex-Wide High-Level Waste Management Program (see DOE M 435.1-1, Section II.D). Included in the EM-WAPS are provisions for addressing acceptance of non-standard wastes. The generator must obtain delivery and procedure confirmation from the Office of Civilian Radioactive Waste Management prior to transferring such wastes.

If the activities or schedules for conducting the activities are adversely impacted (e.g., as a result of testing, design, funding profile, DOE policy) then they need to be updated. Updates to the schedule and minor modifications of the activities would not be a basis for re-evaluating the generation of the high-level waste. However, major modifications of the activities (e.g., changes in plans for developing the treatment facility or changes in the WASRD) would result in a re-evaluation and re-confirmation of the acceptability of continuing to generate the high-level waste. All changes in plans for resolving issues preventing compliance with the EM-WAPS are coordinated with the Headquarters Office of Waste Management so their impact on the complex-wide high-level waste management program can be reflected in the High-Level Waste Program Plan (see DOE M 435.1-1, Section I.2.D.(l)).

Example: Processing of the new Site X high-level waste stream described in the first example above requires precipitation and removal of excess chromium to enable compliance with the product consistency specification in the EM-WAPS (Specification 1.3). Site X management plans to build a facility for chromium removal to supplement its existing reprocessing facilities, but Congress has not yet appropriated the funds for design and construction. For purposes of the waste generator planning, the chromium *removal facility was not available and the generator planning for the life cycle of the waste elected to seek approval from the cognizant Field Element Manager to generate the waste in the absence of an available path to compliance with the EM-WAPS. The generator considered elimination of the need for chromium removal, but that option was found to be technically infeasible. The Field Element Manager approved the generation of the waste anyway, based on consideration and documentation of the following four factors:*

- *(a) the need to generate the high-level waste;*
- *(b) high-level waste characteristics which prevent compliance with the EM-WAPS;*
- *(c) adequate containment capabilities and facilities for the expected duration of the storage period; and*
- *(d) plans for resolving the issues that prevent compliance with the EM-WAPS.*

Compliance with this requirement is demonstrated by individual sites establishing a process for evaluating the life cycle of high-level waste prior to its generation, including the identification of high-level wastes with no path to compliance with the EM-WAPS and appropriate records justifying the newly generated high-level waste streams. The process would be considered acceptable if, before generating high-level waste, the Field Element Managers responsible for operation of the needed treatment and storage facilities approve generation of the high-level waste. Records substantiating high-level waste generation planning would be of two types. First, site personnel would have records showing the location(s) where high-level waste will be treated and stored, the estimated period of storage, and confirmation that the personnel managing the facilities agree that the high-level waste can be managed at those facilities. Second, the waste generation organization would have records documenting the decision to generate a high-level waste that does not have a known path to compliance with the EM-WAPS. This second set of records is judged to be adequate if they include an explanation of the need for the process that generates the high-level waste, a discussion of the reason it cannot be disposed of, and an up-to-date schedule of activities being pursued to resolve constraints to the compliance with the EM-WAPS of the subject high-level waste.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

II. L. Waste Characterization.

High-level waste shall be characterized using direct or indirect methods, and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance requirements of the facility receiving the waste.

Objective:

The objective of this requirement is to ensure that sufficient knowledge of high-level waste's characteristics (e.g., chemical, physical, radiological) is available to support workers during handling the waste and to support effective decision-making for its management. This information is to be maintained from generation, through storage, pretreatment and treatment in sufficient detail to ensure that the requirements of the DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS) are met. Waste, that is identified through the waste incidental to reprocessing process to be non-high-level waste, shall be characterized in a manner that ensures subsequent treatment and disposal requirements for low-level waste and transuranic waste can be met.

Discussion:

The *Radioactive Waste Management Manual*, General Requirements, assigns the Field Element Manager the responsibility of ensuring development and approval of a program that addresses the responsibilities of waste generators (DOE M 435.1-1, I.2.F.(7)). The generator requirements are to address hazards associated with a waste management facility receiving unexpected volumes or types of waste, or receiving waste that may not meet the applicable waste acceptance requirements. Generator requirements address generation planning, waste characterization, waste certification, and waste transfer. The characterization requirement addresses the hazards associated with insufficiently characterizing the waste to ensure safe storage, and to ensure pretreatment or treatment operations result in a waste form that meets the requirements of the EM-WAPS. In addition, characterization data that are collected during generation, storage, and after pretreatment or treatment of high-level waste need to be reliable and in sufficient detail to ensure subsequent management can be conducted safely and to meet the waste acceptance requirements of all subsequent receiving facilities. Accurate characterization of high-level waste is essential to: 1) waste planning by generators, as required by Section II.K; 2) waste transfers by generators and other senders of waste, as required by Section II.N; and 3) waste certification by both senders and receivers, as required by Section II.M.

In conducting the analyses for development of the DOE M 435.1-1 requirements, minimum characterization requirements were identified as necessary to ensure safe management of high-level waste from generation, storage, pretreatment and treatment processes. Guidance for requirements for minimum characterization for all high-level waste generation, storage, pretreatment, and treatment facility activities is provided in subrequirement (2) of Section II.L, paragraphs (a) through (d). Guidance for the requirements for data quality objectives and hazardous characteristics is provided in subrequirements (1) and (3), respectively, of Section II.L.

Waste characterization is defined as:

> "The identification of waste composition and properties, such as by review of process knowledge, or by nondestructive examination, nondestructive assay, or sampling and analysis, to comply with applicable storage, treatment, handling, transportation, and disposal requirements."

Thus, waste characterization is a tool for gathering information that will support defensible decisions regarding safety, process, and environmental matters in the management of high-level waste. The magnitude of such decisions may vary from whether individual high-level waste streams are compatible for mixing in a storage tank to whether their mixing may reduce the likelihood of producing an acceptable final (glass) high-level waste form. The following sections of guidance address elements of characterization activities that support defensible decision making: use of indirect methods, characterization documentation, characterization for safe storage, and characterization for treatment to meet the EM-WAPS.

Use of Indirect Methods. In the safety and hazards analysis performed in support of development of DOE M 435.1-1, the use of indirect methods of characterizing high-level waste was identified as a potentially significant factor in maintaining accurate characterization of high-level waste. The use of indirect methods is particularly applicable when nondestructive evaluation or sampling and analysis will potentially expose operations personnel to additional radiation. Indirect methods for characterization of high-level waste are based on the materials or processes used to generate the waste, as well as the analytical data obtained from the process or waste stream. Indirect methods for characterization are also considered to include information regarding the process that generated the waste stream, the physical form and materials composing the waste, the chemical constituents of the waste, and the nature of the radioactivity present.

Indirect methods may be used to describe high-level waste if the source information is consistent, defensible, and auditable. The use of indirect methods is justified by its potential to minimize personnel exposure and to reduce the high costs of intrusive sampling and analysis. In practice, indirect methods can be effectively used where high-level waste is generated in well known and tightly controlled processes for which the product is highly predictable.

By using indirect methods, where appropriate, the potential exists for minimizing the exposure of operating personnel to radiation and complying with the as low as reasonably achievable (ALARA) principle for keeping exposures to a minimum. Additionally, characterization of high-level waste by the use of indirect methods reduces the volume of sample materials and laboratory equipment and expendables that would be contaminated due to the analyzing of the sample.

While the development of a process for identifying and documenting high-level information to support indirect methods is not required for high-level waste by DOE M 435.1-1, the following guidance provides an overview of elements of an acceptable process for assembling such documentation:

- Information to support indirect methods is compiled in an auditable record.
- Correlations within waste streams in terms of time of generation, waste generation processes, analytical data, and site-specific facilities should be clearly described.
- A reference list of applicable documents, databases, quality control protocols, and other sources of information that support the indirect methods is prepared.
- Procedures which outline the methodology that is to be used to identify and assemble auditable, acceptable records to support indirect methods, including the origin of the documentation, how the assembled information was or will be used, and any limitations associated with the information.

Characterization data gained by indirect methods must be within the acceptable range of certainty and precision. Additionally, the effects of time-dependent processes must either be negligible or predictable. Acceptable information to support indirect methods can be verified by collection and comparison of statistically valid analytical sampling of processing records. The periodicity of sampling and analysis should correlate with the nature of any changes in the process creating the waste or with changes that are being documented in characterization data. Finally, the data must be consistent with the requirements contained in the EM-WAPS. In particular, data collected and used for indirect methods that are considered “waste product affecting” must be verifiably correct and defensible and the strategy for its use must be described and defended by each waste producer in their waste compliance plan and waste qualification reports.

Indirect methods documentation should follow the process and include the documentation elements described below with particular emphasis on data quality assurance. As discussed in DOE M 435.1-1, Section II.N, Waste Transfer, this documentation needs to be organized and assembled in a manner that allows it to be transferred to the facility or operation that is to receive the waste.

Example: At the Site Z there is a high level of confidence in the mass balance data available from the generator (Q-Canyon) for a particular high-level waste stream that is scheduled to be transferred from a storage tank to the sludge wash (pretreatment) process. Review of the waste processing information by trained and knowledgeable personnel concludes that the data are reliable and that, in lieu of sampling and analysis, *an indirect method will be used to characterize and certify the waste for transfer. This decision and the quality of the data is documented and included in the documentation that is transferred with the waste.*

Characterization Documentation. The requirement states that characterization data shall be documented in sufficient detail to enable the waste acceptance requirements of the receiving facility to be met. The following elements are considered essential to this process for obtaining and controlling characterization data:

Organization(s) and Responsibilities - Identification of the organizations involved and responsible for characterization of high-level waste.

Quality Assurance - Characterization data need to be subjected to a clearly identified and well-documented quality assurance program. In the case of characterization data that applies to high-level waste, items and activities important to waste acceptance/product quality need to apply the quality assurance requirements of DOE/RW-0333P, *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program,* as specified in DOE M 435.1-1, Section II.G, Quality Assurance Program.

Procedures - The process for obtaining waste characterization data is formalized in procedures and need to describe how to follow the steps that are provided and the administrative process for ensuring the data are of acceptable quality. Procedures need to be developed for sampling, packaging, transportation, laboratory analysis, and data control.

Procurement/Purchasing Controls - The procurement and/or purchasing of items or services that are used in characterizing high-level waste need to be controlled and documented. Procurement includes the purchase of sampling equipment and sample transport containers as well as services such as laboratory analyses (onsite or offsite). Requirements are dictated by the type of procurement, but needs to include, or reference: the technical specifications for the item/service being procured; identification of quality assurance requirements including any required inspections; specifications of documentation requirements (e.g., certification of compliance or conformance, laboratory analytical results); and a statement ensuring access to the provider's facilities as necessary to perform audits and inspections.

Document/Data Change Control - Records that contain characterization data, whether they have been generated through sampling and analysis, nondestructive assay, or indirect methods, need to be subject to document and data change control. In addition, the documentation of waste characterization procedures and the quality assurance program are subject to control. Document and data change control includes review, approval, and distribution to designated recipients (users), and a controlled process for making revisions to documents. Existing document and data control programs at a site may be adequate for high-level waste characterization data, but will need to be reviewed to ensure the objectives of DOE M 435.1-1 requirements are met.

Training - Characterization data are generated and managed only by personnel that are properly trained to recognize the significance of the data.

Records - Waste characterization records include those that are necessary to meet the waste acceptance requirements of receiving facilities and as specified by the waste certification program, as specified in Section II.M.

Existing programs at a site may provide the framework within which the elements of waste characterization can be addressed (e.g., quality assurance, training, document control). The waste acceptance requirements of a facility to which the waste is to be sent may impose additional requirements on what is to be included in the waste characterization data.

Characterization for Safe Storage. Characterization data for high-level waste streams are developed to ensure that the transfer and addition of a high-level waste solution, slurry, or sludge does not present an added risk to the storage systems that receive it, i.e, the transferred material must be compatible with the tank and its contents. These data are based on an analysis of the waste stream through either sampling, indirect methods, or a combination of both, and must be in a form consistent with the receiving facility's waste acceptance requirements. Consideration also is given, and documented, to facilities or operations downstream of the receiving facility to ensure that waste acceptance requirements for these facilities will not be violated.

Example: At Site Z, a high-level waste stream is planned to be transferred by a generator to the high-level waste tank farms. Characterization of the waste is conducted by the generator to ensure that not only are the waste acceptance requirements of the receiving tank satisfied, but also the waste acceptance requirements of the pretreatment and treatment facilities, downstream of the waste storage tanks. These downstream facilities require a more extensive chemical analysis to ensure that the waste is acceptable for making a quality glass waste form.

Various techniques can be employed to characterize high-level waste. Techniques include sampling and analysis, nondestructive assay techniques, and the use of indirect methods. In selecting the characterization technique for a particular waste stream, trade-offs are considered to determine which is most appropriate. Trade-off analyses are part of an ALARA process which needs to consider:

- radiation exposure to operations and sampling personnel;
- potential for contamination or other abnormal events;
- costs (personnel, resources and schedule);
- reliability and confidence level of the data;
- availability of data to support indirect methods;
- required management activities (audits, evaluations); and
- re-engineering of sampling operations to reduce worker hazards.

Balancing these competing considerations is considered necessary to meet the requirement. As discussed in the guidance for the data quality objectives process, Section II.L.(1), the characterization technique chosen is dependent on the data required, and the quality of such data.

> *Example: At Site K, additional characterization data for the contents of Tank 300 are needed promptly to ensure that the addition of 75,000 gallons of a decontamination solution to the existing 400,000 gallons of high-level waste slurry will not generate a vapor phase of waste product that is combustible. While the contents of the existing tank have not been characterized by sampling, its contents are well documented through the generator documentation (e.g., mass balance calculations). In addition, controls to ensure additional wastes have not been transferred to the tank are in place and considered reliable. Furthermore, plans to sample and analyze the tank contents conclude that a potential exists for significant worker exposure and unacceptable programmatic schedule delays due to laboratory workload. Thus the decision is made, through a documented "trade-off" analysis, that the risks of adding the solution to the tank, using indirect methods about the existing tank waste and knowledge about the decontamination solution, are lower than the risks of sampling and analyses.*

<u>Characterization for Treatment to Meet the Office of Environmental Management-Waste Acceptance Product Specifications (EM-WAPS)</u>. For high-level waste, an appropriate level of characterization data must be available from the time of generation of the waste stream through storage, pretreatment, treatment, and post-treatment storage to ensure that the final waste form meets the requirements of the EM-WAPS, applicable revision. The current EM-WAPS outlines the technical specifications the waste form Producers are required to meet in order to ensure acceptance of their vitrified high-level waste into the Civilian Radioactive Waste Management System. The Office of Environmental Management and the Office of Civilian Radioactive Waste Management have agreed that the Office of Environmental Management is to provide the final waste form specifications to the waste form producers and that the Office of Environmental Management will ensure that the EM-WAPS is consistent with the technical baselines as defined in the Office of Civilian Radioactive Waste Management's DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD). Thus, the EM-WAPS governs all elements of the final, canistered, waste form which includes the borosilicate waste glass, the stainless steel canister, and the sealed canistered waste form.

The waste acceptance process requires demonstration of compliance with the EM-WAPS through four different documents, each prepared by the waste producers, reviewed and accepted by the Office of Environmental Management, and provided to the Office of Civilian Radioactive Waste Management. These four documents are: the Waste Form Compliance Plan; the Waste Form Qualification Reports; the production records; and the storage and shipping records. The waste producers included in Revision 2 of the EM-WAPS are the Defense Waste Processing Facility at the Savannah River Site, the West Valley Demonstration Project, and the Hanford Site. Final waste form developmental work at the Idaho National Environmental Engineering Laboratory has not progressed to the point that it has been included in the current EM-WAPS.

The EM-WAPS provides detailed specifications that must be met by the waste producers in order for the final waste form to be acceptable to the Office of Civilian Radioactive Waste Management for disposal. Amplification on these specifications is considered beyond the scope of this Implementation Guide; however, Refer to the current Waste Compliance Plans and Waste Qualification Reports for the Defense Waste Processing Facility and the West Valley Demonstration Project, both of which provide a detailed description of the methods by which they comply with each of the specifications. Following are the titles of each of the summary specifications within the EM-WAPS:

1. Waste Form Specifications
2. Canister Specifications
3. Canistered Waste Form Specifications
4. Quality Assurance Specification
5. Documentation and Other Requirements

The level of characterization needed and the data required for the production of an acceptable final high-level waste form are described in the EM-WAPS (included in supplement references) and are not reproduced in this Guide. However, the strategy for complying with these specifications is left to each waste producer. Each strategy is defined in the waste producer's Waste Compliance Plan and demonstrated in their Waste Qualification Reports.

Examples: (1) Section 1.1, "Chemical Specification," of the EM-WAPS, requires that each waste producer project, in their Waste Qualification Report, the chemical composition of the final waste form, by oxides present that are in concentrations greater than 0.5 percent. (2) Section 1.2, "Radionuclide Inventory Specification," of the EM-WAPS requires that each waste producer project, in their Waste Qualification Report, the inventory of radionuclides that have half-lives longer than 10 years and that are, or will be, present in concentrations greater than 0.05 percent of the total radioactive inventory, indexed to the years 2015 and 3115. For both specifications each waste producer is required to provide a strategy on how these projections will be made.

Waste Incidental to Reprocessing. Waste streams that are subjected to the waste incidental to reprocessing determination processes (DOE M 435.1-1, Section II.B) need to be adequately characterized to support the conclusions reached in applying the two processes, i.e., the citation process and the evaluation process. For those waste streams that are determined to be non-high-level waste by the use of these processes, the applicable characterization requirements are included in DOE M 435.1-1, Section III.J for transuranic waste, and Section IV.I for low-level waste.

Compliance with this requirement is demonstrated by the existence of records that document characterization data for high-level waste that are consistent with the waste acceptance requirements of high-level waste storage, pretreatment, or treatment facilities. In addition, the records need to be consistent with the characterization data required by the current version of the EM-WAPS. For those waste streams that are subjected to the waste incidental to reprocessing process(es), adequate characterization data records must exist to support the conclusion.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, Revision 2, DOE/EM-0093, U.S. Department of Energy, December 1996.

2. EPA, 1994. *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, U.S. Environmental Protection Agency, Washington, D.C., September 1994.

3. DOE, 1994. *DWPF Waste Form Compliance Plan*, Revision 4, WSRC-IM-91-116-0, U.S. Department of Energy, December 1994.

4. DOE, 1995. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 11, WVDP-185, U.S. Department of Energy, February 1995.

5. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

II. L.(1) Data Quality Objectives. The data quality objectives process, or a comparable process, shall be used for identifying characterization parameters and acceptable uncertainty in characterization data.

Objective:

The objective of this requirement is to invoke a process for determining the type, quantity, and quality of characterization data needed to support the safe management of high-level waste so as to ensure that needed data are acquired, the data meet the objectives they are being collected for, and resources are not wasted on unnecessary, incomplete or unusable data collection efforts.

Discussion:

The type, quantity, and quality of characterization data obtained for the safe management of high-level waste need to be consistent with the purpose for which the characterization information will be used. As discussed in the guidance to DOE M 435.1-1, Section II.L., the uses of high-level waste characterization data include: complying with storage, pretreatment, and treatment facilities' waste acceptance requirements; meeting the final waste form specifications of the EM-WAPS; evaluating high-level waste confinement integrity; determining radiation shielding and other protective measures; evaluating compliance with processing requirements; and meeting regulatory commitments. This requirement is included in DOE M 435.1-1 to ensure that only the appropriate characterization data to support the safe management of high-level waste is generated. The requirement is intended to promote a structured process for the collection, and use, of high-level waste characterization data and avoid the collection of data that is neither necessary nor defensible.

The requirement invokes the use of a process to provide the structured approach for determining the type, quantity, and quality of characterization data needed. Such a process, called data quality objectives, has been developed by the US Environmental Protection Agency (EPA) and is documented in EPA's QA/G-4, *Guidance for the Data Quality Objectives Process*. However, use of other comparable processes that employ a structured process to yield similar results are also supported.

The objectives of applying a structured process such as the data quality objectives process are to:

- Manage and control the risks of making incorrect decisions;
- Determine the data required to support making specific decisions;
- Determine the type and quality of required data;
- Allow decision makers, stakeholders, data users, and relevant technical experts to participate in planning and assessment;
- Determine the quantity, location, and type of samples required;

- Quantify the uncertainty in data through development of statistical sampling plans; and

- Reduce overall costs by identifying resource-efficient sample collection and analytical methods by optimizing the sample and analysis plans.

The data quality objective process is a strategic planning approach based on the scientific method that is used to prepare for a data collection activity. The value of using this process to develop high-level waste characterization parameters is that it: saves resources by making characterization data collection operations more resource-effective; enables characterization data users and others to participate in characterization data planning; and provides a structured method for defining characterization data performance requirements, i.e., quality.

The process for establishing characterization needs via the data quality objectives process requires input from various waste management organizations and interested groups to establish a clear understanding of the characterization data needs and the level of data quality that is acceptable for making high-level waste management decisions.

The Field Element Manager is to ensure that managers of generator facilities assume responsibility for key activities in the data quality objectives (or similar) process by:

- Designating the author of the data quality objectives document.
- Participating in development of the initial data quality objectives strawman.
- Identifying the stakeholders.
- Participating in stakeholder meetings.
- Selecting members of the expert panel.
- Participating in the review of the final data quality objectives process.
- Approving the data quality objectives document prior to submission to the Field Element Manager.
- Identifying activities that initiate a data quality objectives revision based on the extent of the revision.

The managers of generator facilities should rely on personnel within the facility organization to support the elements of the data quality objectives process. Those personnel may be supplemented by subject matter experts (e.g., facilitators, samplers, laboratory personnel, statisticians, safety personnel, quality assurance personnel). The facilitator may be part of the generator organization or a consultant. The facilitator’s role is to keep meetings focused, maintain the document development schedule, and troubleshoot administrative and logistics problems.

The data quality objectives process consists of seven steps. The output from each step influences the choices that will be made later in the process. Even though the data quality objectives process is depicted as a linear sequence of steps, in practice it is iterative, e.g., the outputs from one step may lead to a reconsideration of prior steps. This iteration is encouraged since it will ultimately lead to a more efficient data collection design.

During the first six steps of the process, a team of process-cognizant personnel should develop decision performance criteria (data quality objectives) that will be used to develop the data collection design. The final step of the process involves developing the data collection design based on the data quality objectives developed in the first six steps. The first six steps should be completed before the team attempts to develop the data collection design because the design is dependent on a clear understanding of the first six steps taken as a whole.

Following is a listing and brief description of each of the seven steps. This is followed by an example of how the data quality objectives process can be applied to the generation of high-level waste characterization data.

1. State the Problem – Concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem.

2. Identify the Decision – Identify what questions the study will attempt to resolve, and what actions may result.

3. Identify the Inputs to the Decision – Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.

4. Define the Study Boundaries – Specify the time periods and spatial area to which decisions will apply. Determine when and where data should be collected.

5. Develop a Decision Rule – Define the statistical parameter of interest, specify the action level, and integrate the previous data quality objective outputs into a single statement that describes the logical basis for choosing among alternative actions.

6. Specify Tolerable Limits on Decision Errors – Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

7. Optimize the Design – Evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all data quality objectives.

Example: At Site Z, the operator of a spent nuclear fuel reprocessing facility plans to restart an existing fuel dissolution process line that will generate a new high-level waste stream that is significantly different in chemical/radionuclide composition than has been generated at the site before. Proper management of this new waste stream has been recognized by the site's waste management organization as a significant challenge to the high-level waste management program. It has also been recognized that proper characterization data, and the quality of this data, are critical to the safe management of this waste. For this reason, and to ensure unnecessary and unusable data are not generated, the high-level waste management organization organized a team of cognizant waste management personnel to implement the data quality objectives process with the purpose of defining the type, quantity, and quality of characterization data needed. The site team used the EPA Data Quality Objectives process as follows:

The problem was identified as the introduction of a new high-level waste stream to the site's high-level waste management system. The question that needed to be answered was: What characterization data are needed to support management of this new waste stream? (Management was defined to include all storage, pretreatment, treatment, and post treatment storage activities at the site that are needed.) Inputs needed were identified as: waste acceptance requirements for all affected facilities, authorization basis/limits for all affected facilities, radiological limits/ controls, RCRA requirements, state/local regulations, EM-WAPS, characterization data quality/accuracy requirements. The boundaries were defined as the high-level waste management system and the low-level/mixed low-level waste management system for secondary waste streams. Other boundaries identified were that the new waste stream would be generated for only 5 years, beginning in 12 months, and that the total quantity would not exceed 1,000,000 gallons of liquid waste. A major identified constraint/risk to data identification/ collection was the fact that this waste has been produced at bench-scale testing only, and that the characteristics of the waste at full-scale operations may vary from these results. Key parameters included: chemical composition, radionuclide composition, pH, nitrate/nitrite/hydroxide concentrations, volatile/flammable species, organics, RCRA-listed wastes, fissile material, challenges to receiving facility authorization bases, and receiving tank waste characteristics.

From the set of parameters identified above, key decision rules were developed. For example, if the pH of the waste is equal to, or less than, 9.5, the waste is unacceptable for transfer to the tank farm. For each of identified twenty parameters an acceptable range of errors was established. These were based on sampling/analysis and operational experience. For example, the calculation, or measurement, of the pH of the new waste stream must be within a 95% confidence range; with the most severe consequence being violation of the tank farm's authorization basis. Finally, with the individual characterization parameters identified, a review of the entire collection was conducted to *ensure consistency and completeness. This review resulted in the number of the parameters being deleted and the establishment of a final set of characterization parameters for the new waste stream. These parameters were incorporated into a waste characterization plan for the restarted fuel dissolution process.*

The above description of the steps using the data quality objectives process, and the example, are provided as an introduction to the process. A more detailed description of the process can be found in the referenced EPA Guide. The data quality objectives process is most useful during the planning stages of identifying high-level waste characterization and uncertainty parameters, i.e., before the data are needed and collected. The value of the process is diminished significantly if the characterization data have already been collected and are being used.

Compliance with this requirement is demonstrated by the documented use of a data quality objectives, or comparable process, for determining the type, quantity, and quality of characterization data needed to safely manage high-level waste.

Supplemental References:

1. EPA, 1994. *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, U.S. Environmental Agency, Washington, D.C., September 1994.

II. L.(2) Minimum Waste Characterization. Characterization data shall, at a minimum, include the following information relevant to the management of the waste:

(a) Physical and chemical characteristics;

(b) Volume, including the waste and any solidification media;

(c) Radionuclides or source information sufficient to describe the approximate radionuclide content of the waste; and

(d) Any other information which may be needed to demonstrate compliance with the requirements of the DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,* or DOE/RW-0351P, *Waste Acceptance System Requirements Document*, for non-vitrified, immobilized high-level waste.

Objective:

The objective of this requirement is to establish minimum high-level waste data that have been determined to be necessary for safe and effective management during the life cycle of the waste.

Discussion:

In the process of developing DOE O 435.1 and DOE M 435.1-1, characterization of high-level waste was identified as an activity in the life-cycle management of waste with a significant potential for loss of adequate waste management controls which could result in exposure or release of radioactivity. This requirement identifies those critical characterization data points that must be known at all times to ensure safe handling and proper management. These requirements are considered the minimum categories of data that the data quality objectives process (DOE M 435.1-1, II.L.(1)) should require and address. The sections below provide guidance on each of the specific characteristics.

Physical and chemical characteristics. The physical and chemical characteristics information needed should be guided by data needs of the storage, pretreatment, or treatment processes that the waste is expected to be exposed to and the waste acceptance requirements established for the facilities and processes that perform these operations. Physical properties should include a description of the material, its phase (solid or liquid), density, consistency, temperature, and conductivity. Chemical properties should include pH, reactivity, chemical compounds present, and hazardous and/or toxic constituents present. However, the complete list of properties that are needed is guided by the receiving facility's or operation's waste acceptance requirements. Additionally, the high-level waste EM-WAPS, Specification 1.1, "Chemical Specification," has specific requirements regarding the identification of the chemical composition of the final (immobilized) waste form that must be reported in the Waste Qualification Report, for each waste type, by high-level waste producers. Establishment of the characterization data requirements must consider these and other EM-WAPS data requirements.

Volume, including the waste and any solidification media. Volume and weight information is necessary for proper control of immobilized high-level waste storage, transportation, and disposal as well as control of canistered waste handling systems. The EM-WAPS, Specifications 3.6, "Fill Height Specification," and 3.11, "Specifications for Weight and Overall Dimensions," require that the filled canister volume, weight, and overall dimensions be reported in the Storage and Shipping Records that will accompany each canister to the geologic repository disposal site. The method and basis for meeting these EM-WAPS requirements are described by each waste producer in their Waste Compliance Plan and the Waste Qualification Reports.

Additionally, the EM-WAPS, in Specification 1.1, "Chemical Specification," requires waste producers to include chemical composition projections of the final high-level waste form. These projections must include all elements, including waste material and solidification media, (e.g., glass frit) that are present in concentrations greater than 0.5 percent, by weight, in the final waste form. As with the volume and weight information, the methods and basis for meeting this EM-WAPS requirement must be described by each waste producer in their Waste Compliance Plan and the Waste Qualification Reports.

Radionuclides or source information sufficient to describe the approximate radionuclide content of the waste. Radionuclide information for liquid (pre-immobilized) high-level waste and the final waste form is necessary to support proper personnel radiation protection and control for managing high-level waste. It ensures that all high-level waste management facilities are inherently safe with respect to criticality. For the final waste form**,** the EM-WAPS, Specification 1.2, "Radionuclide Inventory Specification," requires that each waste producer project, in their Waste Qualification Reports, the total quantities of individual radionculides in each canistered waste form that are to be shipped to the repository. Additionally, Specification 3.9, "Specification for Maximum Dose Rates," of the EM-WAPS, sets limits on the surface (on contact) gamma dose rates and neutron dose rate at the time of shipment of the final waste form. Included in the Storage and Shipping Records must be either the calculated or measured values for both gamma and neutron dose rates at the time of shipment. Finally**,** Specification 3.7, "Specification for Removable Radioactive Contamination on External Surfaces," sets specific limits on the non-fixed (removable) radioactive contamination that is allowed on the exterior surface of each canistered waste form. The methods and basis for meeting these specifications must be described by each waste producer in their Waste Compliance Plan and Waste Qualification Reports. Following is an example of the type of characterization data that meet this requirement:

> *Example: Radionuclide characterization data for high-level waste sludge contained in a tank at Site X include:*
>
> > *Basis: Analysis based on results of 24 samples of dried sludge.*
> > *Volume: 37.9 m^3 or 10,000 gallons*
> > *Density: 2.4 g/cc*
> > *Chemical Composition: by element, wt. % and imprecision (% relative standard deviation)*
> > *Radionuclide Composition: by radionuclide, wt %, and imprecision (% relative standard deviation)*

For pre-immobilized high-level waste, the waste acceptance requirements for the storage, pretreatment, and treatment facilities at which waste will be received dictate the radionuclide parameters that are needed. Parameters which may be required include:

- total activity of the transferred waste, in curies;

- identity and activity per unit mass of the major radionuclides. For purposes of this guidance, major radionuclides are those which are determined to be of importance to the receiving pretreatment, storage, or treatment facility. These may be dictated by the facility's authorization basis and/or radioactive waste management basis.

All of the data requirements described above may not be required for all phases in the life-cycle management of high-level waste. The specific data needs will be determined by the waste acceptance requirements of a particular receiving pretreatment, storage, or treatment facility**.** To assure the receiving facility's waste acceptance requirements are met, follow the waste certification process which is included of Section II.M.

Compliance with this requirement is demonstrated by the existence of records that document characterization data for high-level waste that are consistent with the minimum characterization data requirements.

Supplemental References:

1. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, April 1999.

II. L.(3) Hazardous Characteristics. Waste characterization processes shall yield sufficient chemical and physical data to clearly identify any hazardous characteristics that may degrade the ability of structures, systems, and components to perform their radioactive waste management function.

Objective:

The objective of this requirement is to ensure availability of hazardous characteristics information about high-level waste that could impact the integrity of confinement and containment systems, the operation of process equipment, and the effectiveness of waste processes and other related activities.

Discussion:

In conducting the hazard analyses for the development of the DOE M 435.1-1 requirements, the identification and control of the hazardous constituents of high-level waste were identified as being potentially significant factors in maintaining the high-level waste management facilities' safety envelope for storage, pretreatment, and treatment operations. The term hazardous characteristics, used in this requirement, is not to be confused with the RCRA use of the same term. Management of high-level waste streams that exhibit hazardous characteristics, as defined by RCRA, e.g., corrosivity or toxicity for metals, is discussed in the guidance to DOE M 435.1-1, Section II.C.

Hazardous characteristics of high-level waste are any qualities of the waste that pose a threat to the safe management of high-level waste. These can be derived from compounds, chemicals, or elements contained in the waste.

A facility's waste acceptance requirements and/or authorization basis will normally require characterization data that are necessary to prevent these characteristics from jeopardizing the safe confinement or containment of high-level waste. The following examples of parameters are provided for consideration:

- minimum pH of waste, since the high-level waste tanks at many of the sites are constructed of carbon steel. Solutions below a pH of 7 cause general corrosion of the steel;
- volatile species, e.g., benzene and ammonia, that may generate flammable or detonable concentrations of vapor in tanks and process vessels;
- corrosive species, e.g., chlorides and sulfates, that may cause corrosion of carbon steel waste storage tanks;
- organic compounds, e.g., tributyl phosphate, that may generate flammable or detonable concentrations of vapors in tanks and process vessels;
- shock sensitive compounds, e.g., silver nitride, that may breach the confinement systems of high-level waste system processes.

Compliance with this requirement is demonstrated by the existence of records that document the chemical and physical data for characteristics of high-level waste that may pose a hazard to high-level waste structures, systems, and components.

Supplemental References: None.

II. M. Waste Certification.

A waste certification program shall be developed, documented, and implemented to ensure that the waste acceptance requirements of facilities receiving high-level waste for storage, pretreatment, treatment, or disposal are met.

Objective:

The objective of this requirement is to ensure that waste transferred to a facility for storage, pretreatment, treatment, or disposal meets the receiving facility's waste acceptance requirements to reduce the likelihood that transferred wastes contain unacceptable materials or characteristics, and to avoid hazards that would occur from the transportation and handling of waste packages which do not meet acceptance requirements. Certification also ensure that the storage, pretreatment, treatment, or disposal facilities receiving the waste operate within limits of established safety and/or performance assessments.

Discussion:

As discussed in the guidance for Radioactive Waste Generator Requirements (Chapter I, Section I.2.F.(7)), the Field Element Manager is to ensure development and approval of a program that addresses the responsibilities of a waste generator. The generator requirements are to address hazards associated with a waste management facility receiving unexpected volumes or types of waste, or receiving waste that may not meet the waste acceptance requirements of the facility to which it is transferred. The generator requirements address generation planning, waste characterization, waste certification, and waste transfer. As discussed in this guidance, a certification program is to be established by generators of radioactive waste to provide a mechanism for confirming that waste is in compliance with the waste acceptance criteria of the facility to which the waste is being transferred. The certification program is required by any organization or facility that transfers waste to another facility.

The certification program is part of the waste generator program that is developed and approved by the Field Element Manager, or designee. The certification program requires that an authorized official confirm that waste meets the waste acceptance requirements of the facility to which it is being transferred. Additional guidance, correlated to the specific requirements in Waste Acceptance Requirements, Section II.J, is provided below.

<u>Program Development and Documentation</u>. The waste certification program needed to meet this requirement consists of a documented, structured process that works in concert with the DOE M 435.1-1 requirements for waste acceptance (Section II.J) and waste transfer (Section II.N) to control the transfer of waste to storage, pretreatment, treatment, or disposal facilities. Development of the waste certification program involves defining and documenting controls for those items and activities that affect certifying that a waste and its packaging meets the waste acceptance criteria of the receiving facility. This includes confirmation that the final (vitrified) waste form meets the requirements of the EM-WAPS, thus ensuring acceptance of the waste into the Civilian Radioactive Waste Management System. The documentation should include the following:

(Note: For those "Items and Activities Important to Waste/Product Quality," as defined by each high-level waste producer as part of their Waste Compliance Program/Plan, additional requirements, as specified in RW-0333P (Quality Assurance Requirements and Description) apply (see DOE G 435.1-1, Section II.G, Quality Assurance Program, for details)).

Organization(s) and Responsibilities. Certification program documentation needs to identify the organizations involved in the certification process and the responsibilities of each. Official(s) who are authorized to certify waste are identified in the documentation.

Quality Assurance. The certification program is subject to a quality assurance program. The quality assurance program that applies to waste certification activities needs to be identified and documented. The use of an existing quality assurance program under which the certification activities will be performed is acceptable and appropriate.

Procedures. The process for certifying waste needs to be formalized in procedures. The procedures describe to the user the steps that are to be followed and the administrative process for ensuring waste streams are certified. The procedures also require a signed statement certifying waste meets the appropriate criteria.

Procurement/Purchasing Controls. The procurement and/or purchase of items or services that are significant to certifying that a waste package meets the waste acceptance criteria of a receiving facility need to be documented. Such procurements may include the purchase of materials such as waste containers or laboratory services (onsite or offsite). As dictated by the type of procurement, the documentation should include or reference the technical specifications for the item/service being procured, identification of quality assurance requirements, including any required testing or inspections, specification of documentation to be provided on delivery (e.g., fabrication inspection and/or test records, a certificate of compliance or conformance, laboratory analytical results), and a statement ensuring access to the provider's facilities as necessary to perform audits and inspections. The certification program ensures that the procurement documentation is reviewed and approved by an official with knowledge of the need, intent, and requirements for the procurement. The program also provides for documented verification commensurate with the relative importance and complexity of the items or services being procured.

Document Control. The principal documents that constitute the certification program need to be subject to document control. Program documentation will identify which documents are to be controlled. The waste certification program description, waste certification procedures, and quality assurance program documentation need to all be subject to document control. Document control includes review and approval, distribution to designated recipients (users), and a controlled process for making changes to the documents. Existing document control programs at a site may provide the necessary controls for documents that are part of the waste certification program.

Training. The certification program needs to identify the training requirements for the various individuals that are involved in the program. At a minimum, the program requires training of the official who certifies the waste packages to the waste acceptance criteria of the facility(ies) to which the waste is being transferred. In addition, individuals will need to be trained to the procedures that control the part of the certification process with which they are involved.

Records. The certification program documentation needs to describe the management of certification records (see guidance for Section II. M.(1)).

Example: At Site Z, the Office of Defense Programs generates much of the high-level waste that is sent to the waste storage tanks which are managed by the high-level waste management organization. Using the above guidance, Defense Programs should work with the receiving facility to define the waste certification program. Through a review of the existing site procedures, site personnel may determine that the waste certification program can operate under the existing site document control program, procurement process, records management program, and training program. The certification program documentation would include identification of these other programs as applying, identify the facilities from which waste would be transferred, designate the officials responsible for waste certification at those facilities, and develop procedures (within the document control program) that ensure compliance with the waste acceptance criteria. Within the existing programs, site personnel would identify the training requirements, records to be maintained and retention times, technical specifications and receipt requirements for obtaining waste packaging materials, and requirement for analytical data. However, the existing site quality assurance program was found to be inadequate and required the generation of new quality assurance documentation to support the Defense Programs Certification Program. Operating within the parameters defined by the high-level waste program, Defense Programs would be able to certify waste for transfer to the high-level waste tank farms.

As noted in the preceding example, existing programs at a site may provide the framework within which elements of the waste certification program can be addressed (e.g., quality assurance, training, document control). The waste acceptance requirements of the facility to which the waste is to be sent may impose additional requirements on what is to be included in the waste certification program. Whether or not the waste acceptance requirements of the facility to which waste is transferred mandate a waste certification program, the organization transferring the waste is responsible for developing and implementing a certification program to provide internal assurance that the waste acceptance requirements will be met.

Implementation. The waste certification program is implemented through the use of documented controls, processes, and procedures. The key document in a waste certification program is the certification statement, or equivalent. The certification statement is the documentation signed by a designated official that certifies that the waste meets the appropriate requirements. Following is a listing of the summary specifications, derived from DOE/EM-0093, *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, (EM-WAPS) for the final waste form, that include the elements recommended for consideration in the development of certification statements. While these specifications are specific to the final (vitrified) waste form they should be applied during generation, storage, pretreatment, and treatment activities, as appropriate, to ensure actions are not taken that may jeopardize final waste form compliance with them. (Amplification on the summary and detailed specifications that are included is considered beyond the scope of this Guide. Reference is made to the Waste Compliance Plans and Waste Qualification Reports for the Defense Waste Processing Facility (DWPF) and the West Valley Demonstration Project, both of which provide a detailed description of the methods by which they each comply with the specifications.)

1. Waste Form Specifications
2. Canister Specifications
3. Canistered Waste Form Specifications
4. Quality Assurance Specifications
5. Documentation and Other Requirements

Graded Approach. A graded approach is used in implementing the waste certification program. The above elements are recommended for both intrasite as well as intersite transfers of high-level waste. While it is recognized that there currently are no intersite transfers of liquid high-level waste, there may, at a later date, be transfers of the final waste form between sites to accommodate interim storage. Intersite transfers involve not only certifying that the waste is in compliance with the requirements for the receiving facility itself, but also with Department of Transportation requirements. However, even though the above elements should be considered, the process may be shortened and simplified for on-site transfers where the organizational relationships and knowledge of the waste and waste generating activities may reduce the information that needs to be documented and transferred with each transfer. For on-site transfers, much of the information may already be available to the receiving facility.

> *Example: For on-site transfers, the receiving facility/organization may already have a waste stream profile provided by the generator facility/organization. Because of the existence of the waste stream profile, the certification may be as simple as an individual*

trained to the waste transfer and certification procedures signing a waste transfer request that provides the radionuclide inventory of the waste transfer being transferred and the waste stream identification number.

The waste acceptance requirements of the facility receiving the waste (see DOE M 435.1-1, Section II. J.) may dictate which items must be part of the certification statement. Even if such information is not dictated by the receiving facility, the waste acceptance criteria should be used as a resource for identifying key elements to include on the waste certification statement.

Compliance relative to the development and documentation portion of the certification requirement is demonstrated by a waste certification plan that identifies the organizations involved, assigns responsibilities for implementing the program, and describes or references the quality assurance, training, procurement controls, records management, and procedures to be used by the program. Acceptable performance relative to implementing the program is demonstrated by the appropriate personnel being trained, having and following the procedures that govern their part of the waste certification process, the waste certification plan and procedures being current and controlled in accordance with a document controls program, and records related to certification (e.g., certification statements, training records, procurement records, characterization records, packaging records) being generated and managed in accordance with established site program.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. WSRC, 1994. *DWPF Waste Form Compliance Plan*, WSRC-IM-91-116-0, Westinghouse Savannah River Corporation, Aiken, South Carolina, December 1994.

3. DOE, 1997. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 12, WVDP-185, U.S. Department of Energy, December 1997.

II. M.(1) Certification Program. The waste certification program shall designate the officials who have the authority to certify and release waste for shipment; and specify what documentation is required for waste generation, characterization, shipment, and certification. The program shall provide requirements for auditability, retrievability,

and storage of required documentation and specify the records retention period.

Objective:

The objective of this requirement is to ensure the development of waste certification programs that clearly identify the documentation required for certifying waste, specifying which personnel have the authority to make the certification, and establishing a traceable and verifiable record of and basis for certification.

Discussion:

Officials must designate who has the authority to certify that waste meets the waste acceptance requirements of the receiving facility. To avoid having personnel who are not knowledgeable of waste acceptance and transfer requirements authorizing the release of waste, the program needs to identify, by title or name, the officials who are authorized to certify. The officials are qualified by virtue of their position, responsibilities, and training to make this certification. The official(s) have sufficient familiarity with the waste being generated and needs to have been trained relative to the acceptance criteria of the receiving facility (and applicable transportation requirements) to be able to certify in writing that the waste is acceptable for transfer. The official(s) also need to have the authorization from the receiving facility to transfer the waste (see DOE M 435.1-1, Section II. N., Waste Transfer). Implementation of this element should be tailored to specific site needs and situations.

> *Example: On-site transfers of high-level liquid waste from multiple facilities to the high-level waste tank farm may involve multiple personnel (e.g., one for each generator or process) being trained and having the authority to certify waste as meeting the tank farm's waste acceptance requirements. However, for the transfer of waste from the tank farm to an on-site pretreatment or treatment facility, there may be a single designated official at the site who has been trained relative to the acceptance criteria of the pretreatment or treatment facility's waste acceptance criteria that is authorized to certify the waste as ready for transfer.*

The waste certification program needs to specifically identify the documentation that needs to be produced to support the certification that waste meets the waste acceptance criteria of the receiving facility. The required documentation may include the following:

> <u>Waste Stream Profile</u> (or record relating the waste to a previous profile). The waste stream profile is a description of the waste stream, generally identifying the source, physical and chemical description, and upper limits on radionuclides.

Radionuclide Characterization Data. Radionuclide characterization data include the concentration and/or inventory of radionuclides as determined by characterization (see guidance for DOE M 435.1-1, Section II. L., Waste Characterization).

EPA Uniform Hazardous Waste Manifest. The EPA manifest is required by 40 CFR Part 262 for the transfer of a hazardous or mixed waste.

Chain of Custody or Equivalent Documentation, and Packaging Data. (See guidance for Waste Transfer, DOE M 435.1-1, Section II.N).

Radiological Survey Results (or documentation referencing a survey record). Survey results include the determination of the surface contamination of the waste package and the external dose rate (see Section II.L.).

Bill of Lading. A document indicating the contents of a shipment.

Certification Statement. The statement required by DOE M 435.1-1 to document that waste is in compliance with the acceptance criteria of the facility to which the waste is being shipped.

Authorization to Transfer. Documentation indicating that an official from the facility to which the waste is to be shipped has authorized transfer of the waste to the facility.

For the final (vitrified) waste form, most, if not all, of the above recommended elements of the waste certification program should be met by meeting the requirements of the *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* EM-WAPS (DOE/EM-0093). Specifically, compliance with Specification 5.1, “Specification for Waste Acceptance Documentation,” requires the development of production records (5.1.3) and storage and shipping records (5.1.4). Development of these documents should provide the necessary program documentation elements. An example of a production record table of contents for the Defense Waste Processing Facility is included as an attachment to the EM-WAPS. The information that is to be provided within the production record is expected to meet recommended elements of the certification statement.

As noted for other elements of this requirement, the organization developing the certification program uses a graded approach in determining which of these documents are needed. Regardless of the extent of the required documentation, the certification statement can serve as a checklist that all of the waste acceptance criteria have been considered and the waste is in compliance.

In order to ensure that information is available if or when it is needed in the future, the waste certification program needs to identify which records are to be maintained and how they are to be maintained. The certification program documentation may include specific records management requirements or may simply invoke an existing acceptable records management program. Although no minimum record retention times are established in DOE M 435.1-1, certain records need to be maintained indefinitely. Whereas hazardous waste regulations require only a three-year retention period, the DOE geologic repository has specific requirements for disposal of high-level waste and are specified in the EM-WAPS, Specification 5.1.3 and RW-0333P, *U.S. Department of Energy Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program*. Generating, storage, pretreatment, or treatment facility waste management records may not be required beyond the life of the facility or operation, provided pertinent information has been supplied to the facility where the waste will be disposed.

> *Example: Operations personnel at a high-level waste tank farm would maintain records of when they received waste, what the waste was (characterization data provided by the generator), and to whom the waste was eventually transferred. Once the final waste form is produced (via immobilization) and the EM-WAPS- and RW-0333P-required production records and storage and shipping records are developed, the organization responsible for the storage records would not need to retain records on these waste streams. This is because the production records and storage and shipping records are to be maintained as lifetime quality assurance records that transfer with the waste at the time of disposal to the Office of Civilian Radioactive Waste Management.*

To meet the requirement for auditability and retrievability, the method of records storage and retention needs to allow a person to trace shipment or waste package information back to the generator certification data (e.g., characterization data, source data, packaging data). In accordance with the DOE M 435.1-1, Waste Transfer requirements (Section II. N), information on the source and characteristics of the waste are to be transferred along with the waste. However, it is not the intent of this requirement to cause the creation of the certification statement for existing waste that was received without such information (i.e., waste in storage as of the issuance of DOE O 435.1). Such documents should be created only for any subsequent transfers of waste.

Compliance with this requirement is demonstrated by records showing that each waste transfer is certified as having met the waste acceptance criteria of the facility to which it was transferred, that the certification statement is supported by additional records regarding the waste source, characterization, and packaging, and that the waste certification and transfer is in accordance with a documented program.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. DOE, 1995. *Quality Assurance Requirements and Description and Description for the Civilian Radioactive Waste Management Program*, Revision 5, DOE/RW-0333P, U.S. Department of Energy, Washington, D.C., October 2, 1995.

3. WSRC, 1994. *DWPF Waste Form Compliance Plan*, WSRC-IM-91-116-0, Westinghouse Savannah River Corporation, Aiken, South Carolina, December 1994.

4. DOE, 1997. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 12, WVDP-185, U.S. Department of Energy, Washington, D.C., December 1997.

II. M.(2) Certification Before Transfer. High-level waste shall be certified as meeting the waste acceptance requirements before it is transferred to the facility receiving the waste.

Objective:

The objective of this requirement is certify that waste meets the acceptance requirements of the storage, pretreatment, treatment, or disposal facility before it is transferred, to prevent transferring waste that could endanger receiving facility personnel, and to avoid the delay and potential hazards associated with corrective actions taken to remedy non-compliant conditions.

Discussion:

The waste certification requirements above address development, implementation, and content of a waste certification program. The requirement that waste be certified before transfer ensures that the program is effective in preventing the transfer of waste that does not meet the waste acceptance criteria of the facility receiving the waste for storage, treatment, or disposal. In accordance with this requirement, waste is released for transfer to another facility only after there is a certification by an authorized official that the waste acceptance requirements have been met. Ensuring certification occurs prior to allowing the physical transfer of waste prevents potential hazards associated with managing waste rejected by the facility to which it is transferred. Requiring certification before waste is transferred also reduces the likelihood of having to recall a waste transfer due to a discovery by the certification official, after the waste is transferred, that the waste does not comply with the waste acceptance requirements.

Certification that the waste is ready for transfer and meets the waste acceptance criteria and the applicable transportation requirements, is a control point in the transfer process. The procedures controlling waste transfer do not allow the transfer to occur unless the certification statement has been signed. Once signed, the certification statement becomes part of the record for the transfer of the waste (see Waste Transfer, Section II.N).

Compliance with this requirement is demonstrated by the presence of a certification program approved by the DOE Field Element Manager (or designee), documented approval from the receiving facility to implement the certification program, if needed, procedures which mandate the use of a certification statement, and dated records of waste certification.

Supplemental References: None.

II. M.(3) Maintaining Certification. High-level waste that has been certified as meeting the waste acceptance requirements for transfer to a pretreatment, treatment, storage, or disposal facility shall be managed in a manner that maintains its certification status.

Objective:

The objective of this requirement is to ensure certified waste is managed so as to maintain the validity of the certification status to avoid the unnecessary handling of the waste stream or final waste form packages that would be involved in recertifying waste.

Discussion:

There may be instances where waste must be stored prior to being transferred to the next stage in the waste management process. If waste is certified as meeting the waste acceptance criteria of the receiving facility prior to storage, it needs to be stored and controlled so that the certification remains valid until the waste can be transferred.

> *Example: As of the issuance of this guidance, the siting of the geologic repository for high-level waste disposal had not been decided. However, high-level waste treatment facilities at the Savannah River Site and West Valley Demonstration Project are producing and certifying final waste forms that must be managed in accordance with the requirements of the EM-WAPS. These requirements include, for example, Specifications 1.4.2, "Control of Temperature for Phase Stability" and 5.1.4, "Storage and Shipping*

> *Records." For the first specification, temperature monitoring of the canister storage areas maintains certification status. For the second specification, both internal and external audits ensure the documentation and permanent records support continued certification status.*

Actions necessary to certify a waste that involves the potential of radiation exposure of workers should be deferred, if possible, until there is a reasonable expectation that the waste can be transferred to the receiving facility within the time that the certification is valid. Routine monitoring required for waste in storage may not permit all activities that could result in worker exposure to be deferred.

This requirement is not to be interpreted in a manner that would interfere with a facility performing an acceptable waste management function. Therefore, if a waste is certified as meeting the waste acceptance criteria of a treatment facility, the requirement to maintain the certification of the waste is not intended to prevent the treatment facility from proceeding with the treatment even though such action would seemingly violate the certified status of the waste. The requirement is instead intended to ensure that the waste be stored, transported, and staged at the treatment facility in a manner that will allow personnel to treat the waste. In spite of the protection provided for the waste, sampling prior to treatment may still be a necessary process control step.

Specific requirements for protecting the certification status of a waste are generally negotiated with the receiving facility. Requirements to be considered include protecting the waste, preventing unauthorized introduction of material into the waste, and protecting the data on the waste package. The Waste Transfer requirements (DOE M 435.1-1, Section II. N.) also address protecting waste packages and data to ensure that characterization and packaging data remain accurate and useable by waste managers. Final high-level waste form packages (canisters) need to be protected from the elements in a manner that meets the storage requirements of the EM-WAPS. In addition, it is necessary to be able to relate each waste package to information about the contents of the package. For the final high-level waste form, the EM-WAPS-required production record provides the necessary data. Also required by the EM-WAPS are other container (canister) requirements for identification, labeling, length and diameter (Specifications 2.3 and 2.4).

Compliance with this requirement is demonstrated by site personnel showing that the storage of liquid high-level waste and final waste form packages (canisters) are managed in facilities in a manner that does not negate their certification status. Further, it is possible to trace each package to its certification and the information supporting that certification.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. DOE, 1995. *Quality Assurance Requirements and Description and Description for the Civilian Radioactive Waste Management Program*, Revision 5, DOE/RW-0333P, U.S. Department of Energy, Washington, D.C., October 2, 1995.

3. WSRC, 1994. *DWPF Waste Form Compliance Plan*, WSRC-IM-91-116-0, Westinghouse Savannah River Corporation, Aiken, South Carolina, December 1994.

4. DOE, 1997. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 12, WVDP-185, U.S. Department of Energy, Washington, D.C., December 1997.

II. N. Waste Transfer.

The following requirements are in addition to those listed in Chapter I of this Manual.

(1) Authorization. High-level waste shall not be transferred to a storage, treatment, or disposal facility until personnel responsible for the facility receiving the waste authorize the transfer.

Objective:

The objective of this requirement is to ensure that transfers of high-level waste are made only with the cognizance and approval of personnel at the facility receiving waste so the preparation can be assured for its safe management.

Discussion:

As discussed in the guidance for DOE M 435.1-1, Section I.2.F.(7), General Requirements, the radioactive waste generator program includes consideration for the generation planning, characterization, certification, and transfer of high-level waste. During the development of DOE O 435.1 and DOE M 435.1-1, a review of waste management functions indicated that the transfer of waste without the knowledge of personnel at the facility to which it was sent presented a potential hazard. If waste is transferred to a facility without prior authorization, the controls necessary for the proper and safe management of the waste may not be in place. As a consequence, the waste may have to be rejected and returned to the sender. This requirement represents a control to minimize the potential for exposures and releases during the handling and transfer of high-level waste.

Safe transfer of the waste can only be assured if the facility receiving the waste for storage, pretreatment, or treatment has considered the acceptability of the waste versus its safety operating constraints. Personnel at a storage, pretreatment, or treatment facility which authorize the transfer of waste are indicating that they have the capability to receive the waste and manage it in a manner that is protective of its workers, the public, and the environment. Therefore, for purposes of safe life-cycle management it is essential that authorization be received before transfer of high-level waste to a storage, pretreatment, or treatment facility. Meeting this requirement is the responsibility of the organization or individual transferring (sending) the waste.

The transfer of high-level waste represents moving the waste through a pipeline or to another part of a facility through a pipeline. The analysis of the hazards associated with the management of radioactive waste in the development of DOE O 435.1 and DOE M 435.1-1 indicated that the transportation of liquid high-level waste represents a potential risk of containment and/or confinement failure. In order to minimize this risk, the transfer of high-level waste should be minimized. The following are considered transfers:

(1) Waste is physically moved from one location to another, even if ownership does not change.

(2) Waste is physically moved from one location to another and ownership changes.

(3) Waste is not physically moved, but ownership changes.

The actions and documentation necessary to obtain authorization will depend on the specific storage, pretreatment, or treatment facility to which waste is to be transferred. In some cases, the submittal of a waste stream profile which provides a description of the waste and a range of the waste characteristics, augmented by conversations with the generator, may provide enough information for the storage, pretreatment, or treatment facility staff to be confident that they can safely manage the waste. In other cases, the waste acceptance requirements of the storage, pretreatment, or treatment facility may dictate that an onsite visit and review of the generator's waste certification program be performed. In order to expedite the transfer of waste, staff responsible for sending the waste need to ensure they understand what information and activities need to be completed in order to receive transfer authorization.

Authorization to transfer waste needs to be received in writing and should state the scope of the authorization. The authorization may specify a specific group of transfers or specific number of transfers of a particular waste type. However, it is acceptable for the written authorization to specify a waste stream(s) which the generator can send on a routine basis. Any additional conditions or notification requirements can be included in the written authorization. Whereas it is the responsibility of the storage, pretreatment, or treatment facility receiving the waste to prepare the written authorization, the organization sending the waste must understand which waste has been authorized.

Example: At Site Z, a high-level waste stream is periodically generated and transferred to the high-level waste storage tanks. The waste stream is designated by the number XX-2233. Consistent with site procedures, the generator prepares a waste stream profile which describes the characteristics and projected generation rate of the waste stream and provides it to the waste management organization responsible for operation of the tank farm. The waste management organization reviews the waste stream profile and calls the generator facility representative to clarify the information on the waste stream profile. The waste management organization has previously reviewed the generator's certification program. Based on the certification program and the waste stream profile, the waste management organization prepares a letter authorizing the generator to transfer any waste that meets the XX-2233 profile until further notice. The authorization *letter also states that the generator must provide the waste management organization notice of the volume of the waste that is to be transferred 48 hours before a transfer occurs.*

When high-level waste is transferred (moved from one location to another) and the "ownership" of the waste does not change (i.e., the same individual is responsible for both facilities), a separate letter authorizing transfer may not be required. Recognizing that the intent of this requirement is to ensure that the waste is expected and can be safely managed at the facility to which it is being transferred, other documentation can serve as the written authorization.

Example: The manager of the waste management organization is the official responsible for authorizing transfer of waste to either of two separate waste tank storage facilities, Tank Farm C and Tank Farm D. Even though the waste acceptance criteria are the same for the two tank farms, waste is accepted and logged into each facility separately. The manager decides to consolidate all of the waste into one tank at Tank Farm C for more efficient management. The written authorization to transfer is provided by the certification statement indicating that the waste meets Tank Farm C waste acceptance requirements, and the documentation of the new storage location on the waste characterization and packaging data.

Compliance with this requirement is demonstrated by sites having procedures that require a confirmation of authorization before releasing waste for transfer, and records showing that transfers are made in accordance with written authorizations.

Supplemental References: None.

II. N.(2) Data. Waste characterization data and generation, storage, pretreatment, treatment, and transportation information for high-level waste shall be transferred with or traceable to the waste.

Objective:

The objective of this requirement is to establish and maintain information about the characteristics of waste and the waste packaging to ensure that sufficient information to support management of waste in a manner that is protective of workers, the public, and the environment.

Discussion:

The *Radioactive Waste Management Manual*, General Requirements, assigns the Field Element Manager the responsibility of ensuring development and approval of a program that addresses the responsibilities of waste generators (DOE M 435.1-1, Section I.2.F.(7)). The generator requirements are to address hazards associated with a waste management facility receiving unexpected volumes or types of waste, or receiving waste that may not meet the applicable waste acceptance requirements. Generator requirements address generation planning, waste characterization, waste certification, and waste transfer. The requirement for traceability of data addresses the hazards associated with transferring waste without providing adequate information about the packaging and its content. Establishing and maintaining the identity of the waste, as well as maintaining controls based on the waste's hazards, are vital to its safe transfer. Acquisition of information about the waste is addressed in the guidance on Waste Characterization (DOE M 435.1-1, Section II.L). Certification that waste is ready for transfer (i.e., meets the waste acceptance requirements and transportation requirements) is discussed in the guidance on Waste Certification (DOE M 435.1-1, Section II.M). Maintenance of documentation regarding transfer of waste is discussed later in this section of guidance.

Establishing, maintaining, and communicating accurate information on high-level waste is essential to the safe and proper management of the waste. In the process of developing DOE O 435.1 and DOE M 435.1-1, transfer was identified as the activity in the life-cycle management of waste with the greatest potential for loss of information about waste packages or waste characterization data, and the associated loss of adequate waste management controls to avoid exposure or release of radioactivity. Therefore, when waste is transferred, the waste characterization and packaging data must be properly transferred to the new "owner" (i.e., responsible waste manager) of the waste.

> *Example: An abnormally high-activity slurry of high-level waste was transferred to a treatment (vitrification) facility for solidification. The waste was characterized and the waste characterization information listed on the waste certification statement. Although the waste met the waste acceptance criteria for the treatment facility and an authorization to make the transfer was granted, the characterization information was not transmitted before, or at the time of, the waste transfer. Since recent previous transfers had been lower activity, i.e., normal, special radiological protection measures, required for the high-activity waste at the vitrification facility's sampling station, were not invoked. During the first transfer of waste to the sampling station, local radiation monitors alarmed, signaling the operators that the activity of the waste warranted implementing the special rad protection procedures. Had the characterization information been documented and transferred with the waste, treatment facility personnel would have known it was high-activity waste and would have imposed the proper controls on the waste to protect sampling station personnel.*

Sufficient information about the packaging should be provided to the storage, treatment, or disposal organization to which waste packages are transferred to ensure that the packages are handled safely. Packaging is defined as a receptacle and any other components or materials necessary for the receptacle to perform its required containment function. The waste package is the packaging plus its contents (i.e., the waste). The information about the packaging that is transferred with the waste should be supported by and traceable to the more detailed packaging procurement information (see guidance on Packaging and Transportation, DOE M 435.1-1, Section II.O)

When waste is initially placed in the packaging, the organization packaging the waste should document and manage information regarding its characteristics (e.g., radioisotopic inventory, total activity, radiation dose, waste form). When the waste package is physically transferred or the "ownership" has changed, the information regarding the waste package must be provided to the organization that acquires responsibility for the waste.

The DOE/EM-0093, *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms* (EM-WAPS), requires packaging of the final (vitrified) waste form in a stainless steel canister to perform the necessary containment function. Proper documentation of packaging design and procurement records is necessary to ensure safe handling of a waste package. Specification 5.1.3, "Production Records," of the EM-WAPS provides the content requirements for Production Records that must be met to allow disposal at the geologic repository. The organization that procures the waste packaging is responsible for properly documenting the essential information regarding the procurement. The purchaser should maintain this information to answer future questions about subsequent procurements and address questions concerning the adequacy of the package for its intended purpose. Examples of the content of Production Records for the Defense Waste Processing Facility and the West Valley Demonstration Project are included in the EM-WAPS at Appendix E. Included within the Production Records are the following information on the canisters: canister material specification and compliance information (2.1), canister fabrication and closure methods (2.2), canister length and diameter (2.4), and final (filled) canister weight and overall dimensions (3.11).

Compliance with this requirement is demonstrated by procedures requiring that characterization and packaging data be provided with each transfer and documented records of transfers show that the information is being provided.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. WSRC, 1994. *DWPF Waste Form Compliance Plan*, WSRC-IM-91-116-0, Westinghouse Savannah River Corporation, Aiken, South Carolina, December 1994.

3. WVNS, 1995. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, WVDP-185, Revision 11, West Valley Nuclear Services Company Incorporated, West Valley, New York, February 1995.

4. DOE, 1995. *Hazardous Waste Determination of the DWPF Product*, Revision 0, WSRC-IM-91-116-13, U.S. Department of Energy, February 1995.

II. N.(3) Records and Transfer Reporting. The records and transfer requirements for canistered high-level waste forms shall comply with DOE/EM-0093, *Waste Acceptance Product Specification for Vitrified High-Level Waste Forms*, or DOE/RW-0351P, *Waste Acceptance System Requirements Document*, for non-vitrified, immobilized high-level waste.

Objective:

The objective of this requirement is to ensure that the hazardous waste requirements of DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,* (EM-WAPS), are met in order to support the determination that the final (canistered) waste form is acceptable to the high-level waste geologic repository.

Discussion:

The current EM-WAPS are the technical specifications the waste form producers are required to meet in order to ensure acceptance of their vitrified high-level waste into the Civilian Radioactive Waste Management System. The Office of Environmental Management (EM) and the Office of Civilian Radioactive Waste Management have agreed that the Office of Environmental Management is to provide the final waste form specifications to the waste form producers and that the Office of Environmental Management will ensure that the EM-WAPS is consistent with the technical baselines as defined in DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD). Thus the EM-WAPS governs all elements of the final, canistered, waste form which includes the borosilicate waste glass, the stainless steel canister, and the sealed canistered waste form.

The following background is provided to clarify the roles of the EM-WAPS and the WASRD. As the waste form requirements for immobilized high-level waste developed, the Department and its operating contractors selected borosilicate glass as a reference waste form. Several high-level waste sites subsequently identified a vitrified waste form for their sites, and two high-level waste vitrification facilities are currently operating to produce canisters of borosilicate waste-glass. Recently, several new high-level waste streams have been identified. One such high-level waste stream is the proposed insertion of small immobilized surplus plutonium containers within a standard high-level waste canister; molten vitrified high-level waste is then poured around these plutonium cans yielding a matrix immobilized waste form. This composite high-level waste stream is considered high-level waste and can be disposed as such. Another proposed high-level waste stream results from immobilizing the waste resulting from reprocessing certain spent nuclear fuels using an electro-metallurgical process. In this case a non-vitrified waste form will result.

In both these cases, a product that adheres to all the existing requirements of DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,* is not possible. The exact waste form specifications that these two proposed waste forms must meet are unknown at this time; however, they will be incorporated in DOE/RW-0351P, *Waste Acceptance System Requirements Document*. That document is therefore cited for those unique immobilized high-level waste forms that cannot meet the requirements of DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS).

As discussed in the guidance for DOE M 435.1-1, Section I.2.F.(7), General Requirements, the radioactive waste generator program includes consideration for the generation planning, characterization, certification, and transfer of high-level waste. In order to ensure the final high-level (immobilized) waste form meets the specifications of the EM-WAPS, the characterization and transfer responsibilities should include a determination of whether the waste stream includes hazardous wastes, as defined by EPA's or authorized states' *Resource Conservation Recovery Act* (RCRA) requirements.

Specification 1.5, "Hazardous Waste Specification," of the EM-WAPS, requires that each producer determine and report to the Office of Civilian Radioactive Waste Management the presence, or absence, of any hazardous waste listed in the RCRA requirements contained in the Code of Federal Regulations (CFR), Title 40, Sections 261.30 through 261.33, "Lists of Hazardous Waste," in the waste or in any feed stream proposed for storage or disposal. Furthermore, any RCRA-listed component in the waste shall require the producer to petition EPA and the authorized state(s) to delist the waste as provided under Title 40, Subpart C, "Rulemaking Petitions," Part 260.22. Finally, the producer shall perform the appropriate tests and procedures, as described under Title 40, Subpart C, "Characteristics of Hazardous Waste," Parts 261.20 through 261.24, to determine if the waste that will be received by the Office of Civilian Radioactive Waste Management, for transportation and disposal, exhibits any hazardous characteristics. Any such waste that is shown to have hazardous characteristics shall be treated to remove such characteristics.

A material is hazardous waste if: a) it contains a listed hazardous waste component, or b) it exhibits hazardous characteristics (ignitability, corrosivity, toxicity, reactivity). Thus, a final (vitrified) waste form would be considered hazardous if it contains a listed hazardous waste or is characteristically hazardous.

To comply with the first part of the EM-WAPS Specification, a review of the practices and procedures at a site, from waste generation through post-treatment storage, should be performed to determine if RCRA-listed hazardous wastes are present or introduced into the high-level waste system. If the conclusion of such a review is negative, i.e., there are no RCRA-listed hazardous components present in the pre-vitrified waste, then a declaration, with adequate supportive documentation, is needed in the producer's Waste Qualification Reports. If, however, the review finds that listed waste components are present, then the Producer must petition the EPA and the authorized state(s) to delist the waste for the final waste form to be acceptable to the disposal repository. Additional information on the delisting process can be found at 40 CFR 260.22, "Petitions to Amend Part 261 to Exclude a Waste Produced at a Particular Facility."

The second part of the EM-WAPS Specification requires that the final (vitrified) waste form not exhibit hazardous characteristics. A review of the final waste form (currently vitrified glass) is expected to conclude that the glass is a stable waste form and therefore is not corrosive, ignitible, or reactive. However, to demonstrate that the final waste form is not characteristic hazardous waste for toxicity, the glass should be subjected to the appropriate tests and procedures as described in the cited regulations. Currently, the appropriate test is the Toxicity Characteristic Leaching Procedure (TCLP) found at 40 CFR 261.24, "Toxicity Characteristic," which is the EPA mandated test for determining whether a waste form retards the release of specific contaminants, i.e., hazardous metals (i.e., arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and organics. If the glass passes this test, i.e., it contains concentrations lower than the values presented in the requirements for the specific contaminants, then it is not characteristic hazardous waste.

Further amplification on the EM-WAPS Specification is considered beyond the scope of this Implementation Guide. Refer to the EM-WAPS and the Waste Compliance Plans and Waste Qualification Reports for the Defense Waste Processing Facility and the West Valley Demonstration Project for additional information. Both provide detailed descriptions of the methods by which they each comply with this specification.

Compliance with this requirement is demonstrated by documenting compliance with Specification 1.5 of the EM-WAPS.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. WSRC, 1994. *DWPF Waste Form Compliance Plan*, WSRC-IM-91-116-0, Westinghouse Savannah River Corporation, Aiken, South Carolina, December 1994.

3. WVNS, 1995. *Waste Form Compliance Plan for the West Valley Demonstration Project High-Level Waste Form*, Revision 11, Draft E, WVDP-185, West Valley Nuclear Services Company Incorporated, West Valley, New York, February 1995.

4. DOE, 1995. *Hazardous Waste Determination of the DWPF Product*, Revision 0, WSRC-IM-91-116-13, February 1995.

5. EPA. *Petitions to Amend Part 261 to Exclude a Waste at a Particular Facility* ,40 CFR Part 260 Subpart C, U.S. Environmental Protection Agency, Washington, D.C.

6. EPA. *Characteristics of Hazardous Wastes*, 40 CFR Part 261, Subpart C, 261.20 through 261.24, U.S. Environmental Protection Agency, Washington, D.C.

7. EPA. *Lists of Hazardous Wastes*, 40 CFR Part 261, Subpart D, 261.30 through 261.33, U.S. Environmental Protection Agency, Washington, D.C.

8. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

II. O. <u>Packaging and Transportation</u>.

The following requirements are in addition to those in Chapter I of this Manual.

(1) Canistered Waste Form. Immobilized high-level waste shall meet the requirements of the DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,* or DOE/RW-0351P, *Waste Acceptance System Requirements Document,* for non-vitrified immobilized high-level waste.

Objective:

The objective of this requirement is to ensure that the final high-level waste form satisfies packaging and transportation requirements as specified in DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS), or DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD), for non-vitrified immobilized high-level waste. These documents provide the technical specifications the waste form is required to satisfy in order to ensure acceptance of the vitrified waste form into the Civilian Radioactive Waste Management System.

Discussion:

The packaging and transportation requirement of DOE M 435.1-1 is narrowly focused on producing a canistered waste form for which there is a path forward. To achieve that goal, consideration must be given to the packaging requirements contained in the EM-WAPS or the WASRD, prior to the generation of the final high-level waste form. The EM-WAPS is based on the WASRD, which was developed by the Office of Civilian Radioactive Waste Management (RW) and establishes the specifications that high-level waste must satisfy to be acceptable to the Office of Civilian Radioactive Waste Management. For purposes of DOE O 435.1, “acceptable” is evidenced by documentation that the canistered waste form satisfies the specifications described in the EM-WAPS. Satisfaction of the EM-WAPS is intended to be essentially the same as acceptability for disposal.

The Office of Civilian Radioactive Waste Management is responsible for developing geologic disposal capability for high-level waste and for transporting the high-level waste to the repository. Additional information relevant to the Office of Civilian Radioactive Waste Management’s responsibilities and the interfaces between the Office of Civilian Radioactive Waste Management and the Office of Environmental Management are included in the guidance for Section II.S, Disposal.

The following background is provided to clarify the roles of the EM-WAPS and the WASRD. As the waste form requirements for immobilized high-level waste developed, the Department and its operating contractors selected borosilicate glass as a reference waste form. Several high-level waste sites subsequently identified a vitrified waste form for their sites, and two high-level waste vitrification facilities are currently operating to produce canisters of borosilicate waste-glass. Recently several new high-level waste streams have been identified. One such high-level waste stream is the proposed insertion of small immobilized surplus plutonium containers within a standard high-level waste canister; molten vitrified high-level waste is then poured around these plutonium cans yielding a matrix immobilized waste form. This composite high-level waste stream is considered high-level waste and can be disposed as such (Draft EIS, DOE/EIS-0283-D, *Surplus Plutonium Disposition Draft Environmental Impact Statement*, DOE, 1998). Another proposed high-level waste stream results from immobilizing the waste resulting from reprocessing certain spent nuclear fuels using an electro-metallurgical process. In this case a non-vitrified waste form will result.

In both these cases a product that adheres to all the existing requirements of EM-WAPS is not possible. The exact waste form specifications that these two proposed waste forms must meet are unknown at this time; however, they will be incorporated in WASRD. That document is therefore cited for those unique immobilized high-level waste forms that cannot meet the requirements of EM-WAPS.

The EM-WAPS requirements apply only to the vitrified waste forms that have been qualified by the Office of Civilian Radioactive Waste Management and include waste packaging requirements. Qualification may be sought for additional waste forms at sites that do not currently have high-level waste processing facilities in operation. Transportation of liquid high-level waste is not anticipated and is not addressed by the requirements in the EM-WAPS.

> *Example: Most of the high-level wastes at INEEL are now in the form of a calcine. Production processes and waste stream input for preparation of a final canistered waste form are likely to differ significantly from the processes at Savannah River and at West Valley. Therefore, waste management personnel at INEEL will develop waste acceptance product specifications tailored to their high-level waste stream and consistent with the WASRD.*

The EM-WAPS specifications are divided into three technically oriented categories -- waste form specifications, canister specifications, and canistered waste form specifications -- and two administratively oriented categories -- quality assurance specifications and documentation and other requirements.

<u>Waste Form Specifications</u>. The EM-WAPS includes specifications for several elements relevant to packaging and transportation. Waste form specifications in the EM-WAPS include chemical

composition, radionuclide inventory, product consistency, phase stability, hazardous waste, and safeguards reporting. Descriptions of the tests for establishing compliance with the waste form specifications are to be included in the Waste Form Compliance Plan. The Waste Form Qualification Report contains the results of all of these tests except for the safeguards information. The results are reported on a canister-by-canister basis in the production records.

> Chemical Composition and Radionuclide Inventory: These specifications require projection or reporting of specific chemical, crystalline phase, and radionuclide information and provide that the waste form be a borosilicate glass.
>
> Product Consistency: This requirement provides for consistency (with the benchmark glass described in the environmental assessment on Waste Form Selection for Savannah River Plant High-Level Waste) in the glass composition.
>
> Phase Stability: This specification requires information on the glass transition temperature, a time-temperature-transformation diagram, and temperature control.
>
> Hazardous Waste: This specification requires determination of the presence or absence of any hazardous waste. The results of the determination are to be reported to the Office of Civilian Radioactive Waste Management.
>
> Safeguards: The final waste form specification in the EM-WAPS is for safeguards purposes. Satisfaction of this specification requires reporting of quantities of uranium and plutonium isotopes on a canister-by-canister basis.

Canister Specifications. Canister specifications in the EM-WAPS include materials, fabrication and closure, identification and labeling, and canister length and diameter. Descriptions of the tests for establishing compliance with the canister specifications are to be included in the Waste Form Compliance Plan. The Waste Form Qualification Report generally contains the test results. Data on individual canisters (materials, fabrication, closure, length, diameter, wall thickness) are captured in the production records.

> Materials: The material specification requires that the canister be made of austenitic stainless steel.
>
> Fabrication and Closure: The fabrication and closure specification requires that the closed canister be leak-tight under well-defined vacuum conditions. The Waste Form Qualification Report provides evidence that the fabrication and closure methods can produce a canister that satisfies the leak-tightness criterion.

Identification and Labeling: The identification and labeling specification imposes requirements for the alphanumeric identifiers used, where they are located, and other requirements for readability and durability.

Length and Diameter: The length and diameter specification provides the dimensional ranges for these parameters.

Canistered Waste Form Specifications. Canister specifications in the EM-WAPS include requirements on free liquid, gas content, various kinds of reactivity, organic materials, chemical compatibility, canister fill height, removable contamination, heat generation, maximum dose rates, subcriticality, weight and overall dimensions, drop tests, handling features, and plutonium concentration. Descriptions of the tests or methods for establishing compliance with the canistered waste form specifications are to be included in the Waste Form Compliance Plan. The Waste Form Qualification Report generally contains the test results. Fill height data on individual canisters are captured in the production records. Storage and Shipping Records document, by canister, information on removable contamination tests, heat generation rate, dose rate, and weight.

Free Liquid: The free liquid specification prohibits detectible liquid in the canistered waste form.

Gas Specification: The gas specification includes requirements on allowable gases and their partial pressures inside the canister at closure as well as gases that could be generated after sealing the canisters.

Reactivity: The reactivity of the contents of the canister requires that the generator ensure that there are not detectable amounts in a canister of materials that are explosive, pyrophoric, or combustible.

Organic Materials: The organic materials specification prohibits detectable amounts of organic material in the canistered waste form after closure.

Chemical Compatibility: The chemical compatibility specification addresses interaction between the canister and its contents.

Fill Height Specification: The fill height specification requires that each canister be filled to at least 80 percent of the empty volume of the canister.

Removable Contamination: The removable contamination specification provides limits on allowable radioactive material contamination and guidance on performing wipe tests to evaluate contamination levels.

Heat Generation: The heat generation specification establishes a maximum rate of 1500 watts per canister, at the year of shipment, and requires reporting of expected heat generation rates.

Dose Rate: The specification for maximum surface dose rate provides that the gamma rate not exceed ten thousand rem per hour and that the neutron rate not exceed 10 rem per hour.

Subcriticality: The subcriticality specification establishes the maximum calculated effective multiplication factor and states that criticality shall not be possible unless at least two unlikely, independent changes occur in conditions essential to nuclear criticality safety.

Weight and Dimensions: The specifications for weight and overall dimensions require that the canistered waste form not exceed 2,500 kilograms. This specification also establishes height and diameter limits for the canistered waste form.

Drop Test: The drop test specification requires that the canistered waste form withstand a seven-meter drop onto an essentially unyielding surface.

Handling Features: The handling features specification establishes the standard canistered waste form features that allow for grasping and moving the canistered waste form. The generator describes the grapple in the Waste Form Compliance Plan and provides the designs in the Waste Form Qualification Report.

Plutonium Concentration: The plutonium concentration specification requires that the concentration in the canistered waste form be less than 2500 grams per cubic meter.

Quality Assurance Specifications. Generators of high-level waste are required to establish a quality assurance program to verify that the specifications established in the EM-WAPS are satisfied. The quality assurance program must be consistent with the *Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description*, DOE/RW-0333P, and with the *Office of Civilian Radioactive Waste Management Waste Acceptance System Requirements Document*. Guidance to Sections I.E.(12) and II.G of DOE M 435.1-1 provide additional information on these documents.

Documentation and Other Requirements. The four key records that provide documentation for determining compliance with the EM-WAPS and the results of those determinations are the Waste Form Compliance Plan, the Waste Form Qualification Report, the Production Records, and the Storage and Shipping Records.

Waste Form Compliance Plan: The Waste Form Compliance Plan describes tests, analyses, and process controls for demonstrating compliance with the EM-WAPS as well as commitments to meet the EM-WAPS.

Waste Form Qualification Report: The Waste Form Qualification Report is the record of results of the tests and analyses to demonstrate the producers ability to comply with the EM-WAPS.

Production Records: The Production Records provide descriptions of each canistered waste form.

Storage and Shipping Records: The Storage and Shipping Records provide physical description of the individual canistered waste forms and document any abnormal events that occur during storage.

Compliance with the transportation and packaging requirement of DOE M 435.1-1 can be demonstrated with a waste certification process that documents that the specifications of the EM-WAPS have been met.

Supplemental References:

1. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, April 1999.

2. DOE, 1982. *Waste Form Selection for the Savannah River High-Level Waste Environmental Assessment*, DOE/EA-0179, U.S. Department of Energy, Washington, D.C., 1982.

3. DOE, 1995. *Quality Assurance Requirements and Description*, DOE/RW-0333P, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C., October 2, 1995.

4. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

5. Paperiello, 1999. C.J. Paperiello to L.H. Barrett, letter, *U.S. Department of Energy Plans for Disposal of Surplus Weapons Plutonium*, U.S. Nuclear Regulatory Commission, Washington, D.C., January 25, 1999.

6. DOE, 1998. *Surplus Plutonium Disposition Draft Environmental Impact Statement*, DOE/EIS-0283-D, U.S. Department of Energy, Washington, D.C., July 1998.

II. P. Site Evaluation and Facility Design.

The following requirements are in addition to those in Chapter I of this Manual:

(1) Site Evaluation. Proposed locations for high-level waste facilities shall be evaluated to identify relevant features that should be avoided or must be considered in facility design and analyses.

(a) Each site proposed for a new high-level waste facility or expansion of an existing high-level waste facility shall be evaluated considering environmental characteristics, geotechnical characteristics, and human activities.

(b) Proposed sites with environmental characteristics, geotechnical characteristics, or human activities for which adequate protection cannot be provided through facility design shall be deemed unsuitable for the location of the facility.

Objective:

The objective of this requirement is to ensure that natural environmental factors, human activities, and geotechnical characteristics of proposed sites are considered in selecting the location and design features of new high-level waste management facilities or significant modifications of existing facilities. In addition, that locations are avoided if facility design cannot compensate for poor site characteristics, environmental conditions, or adverse human activities.

Discussion:

The *Radioactive Waste Management Manual* (DOE M 435.1-1), *General Requirements and Responsibilities,* Section I.1.E, invokes the requirements of DOE O 420.1, *Facility Safety,* and DOE O 430.1A, *Life-Cycle Asset Management,* in site evaluation and facility design. In the development of DOE M 435.1-1, it was determined that specific attention should be given to selection of a waste management facility location with consideration given to the beneficial and detrimental aspects of the site.

Site evaluation includes the identification and characterization of potential sites for new high-level waste management facility or expansion of existing facilities. Selection of sites for DOE facilities is generally constrained to those federal lands owned and managed by DOE. Within DOE reservations, the process of selecting sites has the purpose of identifying the best location with consideration of features which are desirable for a facility. In addition, it is recognized that often a *National Environmental Policy Act* (NEPA) analysis will be conducted prior to the initiation of the site evaluation process. The results of this process should be considered during the site evaluation process to ensure the bounds of the NEPA analysis are not exceeded. Finally, the site evaluation process produces a set of data and analysis that is often used to establish a facility's authorization basis and Radioactive Waste Management Basis (RWMB). Therefore, data and analysis quality, as well as records management, are important and must be ensured.

In the context of this requirement the terms environmental factors/characteristics (natural and human), geotechnical characteristics, and human activities are used to capture specific site elements that determine its suitability for the proposed facility. These include:

- ecology - the flora and fauna that have evolved and adapted to the other environmental characteristics of the site;
- topography - the physical features of the ground surface at and around the site;
- meteorology - the normal and extreme weather events of the site;
- hydrology - the surface and ground water at the site;
- geology - the sediment and structural features of the earths crust at the site;
- seismology - the earthquake potential of the area;
- volcanology - the volcano potential of the area;
- soil characteristics - characteristics of the soil that affect its load-bearing, water infiltration;
- human activities - proximity of the public and human-induced events both internal and external to the facility;
- emergency services and response - proximity of services and population sheltering; and
- hazards to other facilities - proximity of existing facilities and proposed facility.

Potential regional impact due to construction, operation or decommissioning of the facility and the extent of such regional impacts will be determined on the basis of measurable effects on the population or the environment from the construction, operation, or decommissioning of the facility.

Various requirements and guidance documents exist for compliance with *National Environmental Policy Act* requirements that are relevant for evaluation of a site. These include DOE O 451.1A, *National Environmental Policy Act Compliance Program*, and the "Green Book" (the NEPA Compliance Guide). The "Green Book" includes guidance for performing habitat evaluations. This guide should be consulted in evaluating characteristics of potential sites to assess potential impacts on biological resources including any endangered or threatened species.

Characterization of a site should result in collecting the data necessary to support a decision on acceptability of a site and for use in site-specific design of a facility. The site characterization and selection process will vary from one DOE site to the next because of substantial differences in the environmental/geotechnical characteristics or human activities of the sites. Similarly, the interests of stakeholders which vary from site to site are likely to influence the issues to be addressed in site characterization and selection. The level of characterization should be established using a data quality objective-type process where the type and amount of information to be collected is commensurate with the hazards and the decisions which have to be made based on the data. The resulting site characterization program should include the investigations and studies needed to evaluate site and facility performance.

<u>Natural Phenomena Hazards</u>. The characterization of a site for natural phenomena hazards is to identify the range of normal and extreme natural events that should be taken into account in the siting and design of the facility. The amount of characterization necessary will be influenced by the hazard associated with the facility and release of the radionuclide inventory. Guidance on characterization and consideration of natural phenomena hazard in the design of DOE facilities is contained in the following standards supporting implementation of *Facility Safety* (DOE O 420.1):

- *Natural Phenomena Hazards Characterization Criteria*;
- *Natural Phenomena Hazards Assessment Criteria*;
- *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*;
- *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*; and
- *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities*.

Example: A new immobilized high-level waste storage facility is being considered at Site X. Due to the environmental setting, wind effects, seismic activity and volcanic ash *are factors that have to be considered in the design regardless of the location selected at the site. However, due to the local topography, concerns about flooding can be addressed by selecting a location on the site's central plateau. A similar facility is being considered at Site Y. The Site Y evaluation includes the consideration of flooding and high winds in the design regardless of location. However, seismic concerns are minimal because of the region of the country; also flooding impacts can be mitigated by selecting an appropriate area of the site.*

In carrying out characterization activities, field studies should be performed so as to not compromise the integrity of the land to be dedicated to waste management activities. This is particularly relevant to disposal facilities where improper design or installation of core sampling or groundwater sampling wells can lead to a preferential path for the migration of contaminants from a facility. Also, the characterization should be carried out in accordance with the site's quality assurance program, including maintaining records of data collected. Documentation of the results of the site characterization program is not only needed for use in facility design and establishment of facility-specific safety design criteria, but may also provide information necessary for complying with requirements of the NEPA process.

Human Activities. The site of a proposed high-level waste management facility should be evaluated with respect to the effects of the facility on human activities and the effect of human activities on the facility. Effects of the facility location on human activity should include consideration of

- transportation routes;
- present and future population distribution;
- present and proposed land and water uses in the region and the hazards they may pose to the proposed facility; and
- any special characteristics that would influence the consequences of releases of radioactive material during the life cycle of the facility.

The potential impact of the waste management facility construction, operation, and decommissioning should be evaluated, considering current and future land use plans and population distribution. Evaluation and selection of the location for a facility should ensure that there is and will remain a buffer between the facility and the public. Such considerations in site selection provide defense-in-depth by ensuring there is space for corrective actions to be taken if there are unplanned releases and by establishing distance for attenuation of such releases so that impacts are minimized.

Example: Site X is going to construct a facility to treat high-level waste to make it acceptable for off-site disposal. There are no natural environmental characteristics that make any of the proposed locations superior to others. However, one location is in the center of the site and the others are either near the current site boundary or in areas being cleaned up so they can be released from DOE control. Because the criteria for selecting a site include consideration of the proximity to current and future populations, the location near the center of Site X is preferred.

Another aspect of human activities is the affect that they may have on the waste management facility. Locating a facility near other facilities on or near the DOE site may impact the design or performance of the facility. For instance, a tall building may create a wake on its downwind side that would cause the exhaust effluent to be dragged down to ground surface in a short distance with the potential of impacting workers or nearby member of the public. To counter act this effect, the waste management facility would have to extend its stack higher than the wake effect, or an alternative location for the facility should be considered.

The term “adequate protection” is intended to support the protection of the worker, public, and the environment to the extent required by applicable requirements, e.g., 10 CFR Part 835, and DOE Orders, e.g., DOE 5400.5. Therefore, a site should be selected based on the protection it affords in meeting the requirements contained in applicable regulations and DOE Orders through site characteristics and/or facility design features.

Compliance with this requirement is demonstrated by performing an appropriate site evaluation for new facilities or expansions of existing facilities, and by the ensuring that the environmental and geotechnical characteristics of the site which are significant to protection of workers, the public or the environment are accounted for in selection of the site or through facility design.

Supplemental References:

1. DOE, 1997. *Design Consideration Manual*, Draft, U.S. Department of Energy, 1997.

2. DOE, 1992. *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities*, DOE-STD-1024-92, Change 1, U.S. Department of Energy, 1992.

3. DOE, 1993. *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, DOE-STD-1021-93, Change 1, U.S. Department of Energy, 1993.

4. DOE, 1994. *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, Change 1, U.S. Department of Energy, 1994

5. DOE, 1994. *Natural Phenomena Hazards Characterization Criteria*, DOE-STD-1022-94, Change 1, U.S. Department of Energy, 1994.

6. DOE, 1995. *Natural Phenomena Hazards Assessment Criteria*, DOE-STD-1023-95 Change 1, U.S. Department of Energy, 1995.

7. DOE, 1995. *Implementation Guide for Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria*, Revision G, U.S. Department of Energy, September 1995.

8. DOE, 1997. DOE O 451.1A, *National Environmental Policy Act Compliance Program*, U.S. Department of Energy, June 1997.

9. DOE, 1998. *National Environmental Policy Act Compliance Guide*, U.S. Department of Energy, Office of NEPA Policy and Assistance, August 1998.

10. NRC. *Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation*, 10 CFR Part 72, U.S. Nuclear Regulatory Commission, Washington, D.C.

11. DOE. *Occupational Radiation Protection*, 10 CFR Part 835, U.S. Department of Energy, Washington, D.C.

12. DOE, 1993. *Radiation Protection of the Public and Environment*, DOE 5400.5, Change 2, U.S. Department of Energy, January 1993.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

Objective:

The objective of this requirement is to ensure that a minimum set of high-level waste facility design requirements determined from hazards analyses or policy considerations are applied to high-level waste management facilities.

Discussion:

The general design requirements included at DOE M 435.1-1, Sections II.P.(2)(a) through (j), are included as requirements to ensure adequate protection of the public, workers, and the environment from nuclear hazards. The requirements contained in these sections apply to all high-level waste management facilities, except for: II.P.(2)(b), Confinement; II.P.(2)(e); Consideration of Decontamination and Decommissioning; and II.P.(2)(h), Structural Integrity, which apply to new or modifications to existing high-level waste facilities. Modification is generally considered to be an action that significantly increases the probability of a nuclear accident or requires a change to an operations' authorization basis (Implementation Guide for DOE O 420.1, draft Revision G). Discretion is intended to allow upgrading of existing safety equipment or the installation of minor new improvements without subjecting the process to onerous procedural requirements and thus discouraging improvements. However, modifications to facility design and construction during the design and construction phase shall conform to the design requirements established in this section for new facilities.

For additional design assistance, refer to the DOE Handbook, DOE-HDBK-1132-99, *Design Considerations*. This Handbook includes information and considerations for the design of systems typical to nuclear facilities, design considerations specific to various types of special facilities, and information useful to various design disciplines. The Handbook specifically includes design considerations for confinement systems and radiation protection and effluent monitoring systems as well as good practices and design principles that should be considered in specific design disciplines.

The analysis of the hazards associated with the management of high-level waste in the development of DOE O 435.1 and DOE M 435.1-1 indicated that appropriate general design requirements are essential to ensuring the protection of the public, workers, and the environment. Therefore the intent of these requirements is to have them applied to all high-level waste management facilities, both existing and new. However, it is recognized that in some cases it may not be practical, or possible, to apply these requirements to existing high-level waste facilities or operations. In such cases, an exemption to the requirement may be warranted. These situations are separate from the exceptions noted above. Exemptions to the requirements may be due to conditions such as limited programmatic usage, expected short service life of the operation, or other reasons that make long-term, capital intensive upgrades unreasonable. In this case, non-compliance with the subject requirements requires the use of the exemption process, as provided at DOE M 435.1-1, Section I.1.E. Section I.1.E. provides for the use of an exemption to a requirement provided it is processed in accordance with the requirements of DOE M 251.1-1A, *Directives System Manual*. The guidance to Section I.1.E. provides additional information on the DOE M 251.1-1A exemption process.

Example: At Site Q, it is determined that the requirement in DOE M 435.1-1, Section II. P.2.(d), Ventilation, is not met by an existing high-level waste pretreatment process. The process has been shutdown for an extended period of time but has been maintained in a standby mode pending a decision on whether it is needed for future high-level waste processing/treatment missions. Specifically, the existing process has an air filtration system that provides adequate decontamination factors for the radionuclides of concern but lacks proper fire protection to the filter media. In accordance with DOE M 251.1-1A, Chapter VII, "Exemptions," an Exemption Request is prepared that supports the position that application of the requirement is not justified by any safety and health benefit at this time. If the decision is made to restart the process, the decision to upgrade the fire protection system for the ventilation system will be revisited. The Exemption Request is processed in accordance with the requirements contained in paragraph 4., Exemption Process, in Chapter VII.

The application of these requirements to all existing high-level waste facilities may conflict with the direction or guidance provided by some other DOE Orders that are invoked by the DOE M 435.1-1, General Requirements, Section I.1.E, Requirements of Other Regulations and DOE Directives. In such cases the requirements contained in DOE M 435.1-1 have precedence over requirements contained in other DOE Directives invoked by DOE M 435.1-1.

Example: Section I.1.E.(18), Site-Evaluation and Facility Design, invokes DOE O 420.1, Facility Safety. Guidance to DOE O 420.1 states that the design criteria included in that Order are "applicable to the design and construction of new nonreactor nuclear facilities and for modifications to existing nonreactor nuclear facilities when modifications significantly increase the probability or consequences of a nuclear accident or require a change in the Technical Safety Requirements (TSRs) of a facility. The definition of the term 'significant' is intentionally left to the judgment of the proposing contractor and the approving DOE authority to define 'significant.' In part, this is intended to allow upgrading of existing safety equipment or installation of minor new improvements without subjecting the process to onerous procedural requirements and thus discouraging improvements." Thus, under DOE O 420.1, an existing high-level waste management facility that is to be "in-significantly" modified does not have to meet the design requirements of DOE O 420.1. However, under DOE M 435.1-1, the same high-level waste management facility must meet the design requirements of DOE M 435.1-1, Section II.P.2.(a) through (j), or the requirements that are not to be implemented are subjected to the DOE M 251.1-1A exemption process. The requirements contained in DOE M 435.1-1 have precedence, and should be implemented, in lieu of those contained in DOE O 420.1 (invoked by DOE M 435.1-1, Section I.1.E).

A "backfit" process has been discussed by the Department in the past to address changes that may be required through the imposition of a new DOE safety requirement. Such changes are particularly problematic for many high-level waste facilities and systems that have been in existence for over 20 years. It is not the purpose of DOE O 435.1 and DOE M 435.1-1 to create such a process for the Department; however an existing or new field-office or Program Secretarial Office backfit analysis and review process may be applied to determine whether implementation of a proposed backfit could be justified on the basis of a substantial safety improvement or on a cost-benefit basis. One example of a candidate process is contained in expired DOE N 5480.5, *Imposition of Proposed Nuclear Safety Requirements*, which expired in 1993 because of an administrative provision. Another candidate process is described Draft DPOM-FS-300, "Treatment of Proposed Backfits," which was developed for the Office of Defense Programs, but not formally adopted. A third candidate process is documented in Westinghouse Savannah River Company, High Level Waste Management Engineering Procedure, ENG. 12, "HLWMD Backfit Analysis Procedure." For development of new backfit processes Nuclear Regulatory Commission requirements in 10 CFR 50.109 and 10 CFR 76.76 should be consulted.

Compliance with this requirement is demonstrated by documentation that supports the implementation of the requirements at Section II.P.2.(a) through (j), or documentation that supports implementation of the "Necessary and Sufficient Closure Process" or "Integrated Safety Management System," or the DOE M 251.1-1A, Exemption Process.

Supplemental References:

1. DOE, 1998. *Directives System* and *Directives System Manual*, DOE O 251.1A and DOE M 251.1-1A, U.S. Department of Energy, January 30, 1998.

2. DOE, 1995. *Implementation Guide for Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria*, Revision G, U.S. Department of Energy, September 1995.

3. DOE, 1993. *Defense Programs Operations Manual, "Treatment of Proposed Backfits,"* Draft DPOM-FS-300, Revision 0, U.S. Department of Energy, February 5, 1993.

4. DOE, 1999. *Design Considerations*, DOE-HDBK-1132-99, U.S. Department of Energy, Washington, D.C., April 1999.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(a) Safety (Safety Class and Safety-Significant) Structures, Systems, and Components. Safety structures, systems, and components for high-level waste storage, pretreatment, and treatment facilities shall be designated and designed consistent

with the provisions of DOE O 420.1, *Facility Safety*; DOE 5480.22, *Technical Safety Requirements*; and DOE 5480.23, *Nuclear Safety Analysis Reports*.

Objective:

The objective of this requirement is to ensure the identification and function of safety-class and safety-significant structures, systems, and components for high-level waste management facilities are consistent with the provisions of applicable DOE Orders.

Discussion:

DOE M 435.1-1, Section I.1.E.(8), requires that the management of radioactive waste management facilities, operations, and activities prepare and maintain hazard analysis documentation and that an authorization basis be prepared, as required by DOE O 425.1A, *Startup and Restart of Nuclear Facilities,* DOE 5480.21, *Unreviewed Safety Questions,* DOE 5480.22, *Technical Safety Requirements*, and DOE 5480.23, *Nuclear Safety Analysis Reports.* For high-level waste management facilities implementation of these Orders require an integrated approach to the development of a high-level waste operation's safety analysis, hazard analysis, and accident analysis, all of which contribute to the operation's Authorization Basis. An Authorization Basis defines the aspects of a high-level waste facility's design basis and operational requirements that are relied upon by DOE to authorize operations. Details of this integrated approach are provided in the DOE Standard, DOE-STD-3009-94, as well as the Department's recently issued Guide for an Integrated Safety Management System, DOE G 450.4-1. Following is a summary of this approach; refer to these documents, and the guidance for each, for further details.

The development of a high-level waste management facility Authorization Basis is necessary to assure safe operation of a facility, operation, or activity. A critical element of all high-level waste management facility's Authorization Basis is a facility-specific, or operation-specific Safety Analysis Report. DOE 5480.23 requires the development of a Safety Analysis Report for Hazard Category 1, 2, and 3 operations for the purpose of ensuring a facility can be constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations. Since most high-level waste management facilities or operations are designated Hazard Category 2 or 3 operations, through the process prescribed in the DOE-STD-1027-92, they require the preparation of a Safety Analysis Report. (Note: For those high-level waste management facilities that are designated a hazard category below Hazard Category 3, as defined by DOE-STD-1027-92 (e.g., Radiological Facilities), refer to the DOE-EM Limited Standard, DOE-EM-STD-5502-94, for guidance on safety analysis requirements.) The requirement in Section II.P.(2)(a) does not apply to facilities, operations, or activities that are below Hazard Category 3.

DOE 5480.23, through DOE-STD-1027-92, also requires the preparation of a hazard analysis for Hazard Category 1, 2, and 3 operations, with the purpose of systematically identifying facility hazards and accident potentials through a hazard identification and evaluation process. The importance of a hazard analysis centers on its thoroughness since it requires evaluation of the complete spectrum of hazards and accidents that an operation may be subjected to.

From the hazard analysis, a limited subset of accidents (i.e., design-basis accidents) that bound the envelope of accident conditions and to which the operation could be subjected, are carried forward to the accident analysis. The accident analysis is used to designate safety-class structures, systems, and components by comparing the accident consequences to DOE's (Offsite) Evaluation Guidelines for the public. Information obtained from specific accidents or representative accidents are used to specify function requirements for safety-class structures, systems, and components in the Safety Analysis Report. The safety-class designation of structures, systems, and components are reserved for those structures, systems, and components needed for public protection, and as such carries with it the most stringent requirements (e.g., enhanced inspection, testing and maintenance, and special instrumentation and control systems). With the identification of a high-level waste facility's safety-class structures, systems, and components, Technical Safety Requirements (TSR) can be derived by using the screening criteria provided by DOE 5480.22, *Technical Safety Requirements.* Technical Safety Requirements for safety-class structures, systems, and components are generally restricted to those that are needed to meet the DOE Evaluation Guidelines for public protection. See DOE-STD-3009-94, for a discussion on the DOE Evaluation Guidelines.

> *Example: At Site X, the high-level waste vitrification plant hazard analysis and accident analysis concludes that an explosion of the melter will result in the maximally exposed offsite individual receiving a dose at the site boundary that exceeds the DOE Evaluation Guidelines. To mitigate such a release, the melter cell offgas monitoring system is designated a safety-class structure, system, and component. Development of the Technical Safety Requirements for the facility conclude that a Technical Safety Requirement "Safety Limit" and an accompanying "Limiting Control Setting" is required to prevent this accident from occurring.*

Likewise, safety-significant structures, systems, and components, which are the major contributors to the defense-in-depth philosophy and worker safety, are identified by a hazard analysis. Safety-significant structures, systems, and components are developed by qualitatively evaluating the credible accidents and designating structures, systems, and components that further protect the onsite workers or support defense-in-depth.

> *Example: At Site Y, the high-level waste evaporator hazard analysis and accident analysis concludes that during the design basis earthquake, a number of evaporator support systems could fail (e.g., normal power, emergency power, cooling water,*

instrument air, steam, and ventilation) causing components associated with the evaporator's safe shutdown to fail. Analysis indicates that the DOE Evaluation Guideline for public exposures is not exceeded, however, radiological and chemical exposures to onsite workers could be significant. Therefore a number of structures, systems, and components at the evaporator are designated safety-significant: instrument air, primary ventilation system, and the emergency power system. In addition, a number of Technical Safety Requirements (Limiting Conditions of Operation) are assigned to support worker protection and defense-in-depth. Included are hardware and administrative actions that ensure continued supply of ventilation air to the evaporator, off-gas filtration, air flow monitoring, seismic detection, and backup power supply.

Compliance with this requirement is demonstrated if safety-class and safety-significant structures, systems, and components designations are consistent with the cited DOE Orders and Technical Standards. In addition, the design and maintenance of these designated structures, systems, and components shall be consistent with the hazard analysis, accident analysis, and Safety Analysis Report that supports the facility's Authorization Basis.

Supplemental References:

1. DOE, 1994. *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports,* DOE-STD-3009-94, U.S. Department of Energy, Washington, D.C., July 1994.

2. DOE, 1997. *Integrated Safety Management System Guide*, DOE G 450.4-1, U.S. Department of Energy, Washington, D.C., November 1997.

3. DOE, 1992. *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C., December 1992.

4. DOE, 1994. *DOE Limited Standard, Hazard Baseline Documentation*, DOE-EM-STD-5502-94, U.S. Department of Energy, Washington, D.C., August 1994.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(b) Confinement. High-level waste systems and components shall be designed to maintain waste confinement. The following requirements apply to new or modifications to existing high-level waste tank systems, ancillary systems, and components.

1. Secondary confinement systems shall be designed to prevent any migration of wastes or accumulated liquid out of the waste system; shall be capable of detecting, collecting, and retrieving releases into the secondary confinement; and shall be constructed of, or lined with, materials that are compatible with the waste(s) to be placed in the waste system.

Objective:

The objective of these requirements is to ensure that high-level waste is invoked in the high-level waste system process vessels, structures, and ancillary systems and components by emphasizing the importance of secondary confinement and the integrity of system and component connections.

Discussion:

In addition to the facility and general design requirements contained in Chapter I, General Requirements (Section I.1.E), the above requirements for high-level waste confinement shall be met. The term "confinement" is defined in Attachment 2, Definitions, to DOE M 435.1-1, as:

> "The control or retention of radioactive materials within a designated boundary. Primary confinements are process enclosures and other spaces normally containing radioactive material. Secondary confinement surrounds one or more primary confinement systems."

In broad terms, the purpose of confinement systems is to minimize the spread of radioactive and/or hazardous materials and the release of these materials in facility effluents during normal operations, abnormal operations, and potential accidents. These requirements and much of the following guidance is based on detailed requirements developed by the Environmental Protection Agency in support of hazardous waste confinement in 40 CFR Parts 264 and 265, Subpart J, *Tank Systems.* Most untreated, mobile high-level waste is also a mixed waste that must also meet certain hazardous waste requirements. The 40 CFR Parts 264 and 265 requirements allow implementation of one set of requirements for both the radioactive and chemical hazard. A primary function of process equipment is to provide primary confinement and prevent or mitigate radioactive and/or hazardous material releases to the environment. Process equipment that provides primary confinement includes tanks, piping, pressure vessels, pumps, valves, and glove boxes. Secondary confinement systems are those systems that provide the next level of confinement and may include a second barrier incorporated in process equipment, e.g., double-walled tanks, double-walled piping systems, and glove boxes, as well as ventilation and offgas systems, that further prevent or mitigate uncontrolled releases of radioactive and/or hazardous materials to the environment. The need for redundancy and the degree of redundancy in these systems should be determined by the safety analysis process and maintenance concerns for both active and passive components.

For a specific high-level waste facility or operation, the number and arrangement of confinement systems or barriers and their required characteristics need to be determined on a case-by-case basis. Factors that need to be considered in confinement system design include type, quantity, form and conditions for dispersing the high-level waste material during normal operations and design basis conditions. Engineering evaluations, trade-offs, and experience should be used to develop practical designs that achieve confinement system objectives. The adequacy of confinement systems to perform effectively the needed functions should be documented and accepted through the facility or operation Safety Analysis Report.

The intent of the requirement at Section II.P.(2)(b)(1) is to impose secondary confinement requirements on high-level waste systems and ancillary components and to ensure that the secondary confinement system shall prevent the outflow of high-level waste to the soil, groundwater, or surface water during the high-level waste system's design life. Design of the secondary confinement system needs to be integrated with the hazard analysis and safety analysis process to ensure that the risks of high-level waste collecting outside the primary confinement are addressed. Integration of this requirement is best assessed by monitoring the volume of waste in the tank and monitoring the surrounding soil, groundwater, and surface water for the inflow of waste.

This requirement also prescribes the provisions for designing and constructing the secondary confinement of a high-level waste system. Detection requirements of the secondary confinement systems for failure of the primary confinement is also provided by Section II.P.(2)(b)(2) and Section II.T, Monitoring Program.

Additional guidance, consistent with the performance-based requirements in DOE M 435.1-1, is recommended to promote effective implementation of the higher level requirements. Additionally, secondary confinement systems need to be:

- Constructed of or lined with materials that are compatible with the waste(s) to be placed in the tank system and have sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrological forces), physical contact with the waste to which it is exposed, climatic conditions, and the stress of daily operation (including stresses from nearby vehicular traffic);

- Placed on a foundation or base capable of providing support to the secondary confinement system, resistance to pressure gradients above and below the system, and capable of preventing failure due to settlement, compression, or uplift;

- Provided with a leak-detection system that is designed so that it will detect the failure of either the primary or secondary confinement structure or the presence of any release of hazardous waste or accumulated liquid in the secondary confinement system in accordance with facility requirements determined from safety analyses or environmental permit restrictions; and

- Sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills, or precipitation. Spilled or leaked waste and accumulated precipitation should be removed from the secondary confinement system to meet facility administrative controls or operational requirements determined from safety analyses or environmental permit restrictions.

Secondary confinement for tanks may include devices such as vaults and double-walled tanks. A vault is normally either a steel-lined concrete vessel containing the primary confinement vessel or a concrete vessel properly protected by sealants to protect the concrete from the effects of the waste. Double-walled tanks are normally steel or concrete tanks with two walls. Leakage from the primary wall is retained between the two tank walls until it is detected and can be removed.

In general, vault systems need to be:

- Designed or operated to contain 100 percent of the capacity of the largest tank within its boundary;

- Designed or operated to prevent infiltration of precipitation into the secondary confinement system unless the collection system has sufficient excess capacity to contain infiltration. Such additional capacity should be sufficient to contain precipitation from a 25-year, 24-hour rainfall event;

- Constructed with chemical-resistant water stops in place at all joints (if any);

- Provided with an impermeable interior coating or lining that is compatible with the stored waste and that will prevent migration of waste into the concrete;

- Provided with a means to protect against the formation of and ignition of vapors within the vault, if the waste being stored or treated is:

    1. ignitable waste; or
    2. reactive waste and may form an ignitable or explosive vapor;

- Provided with an exterior moisture barrier or be otherwise designed or operated to prevent migration of moisture into the vault if the vault is subject to hydraulic pressure.

Example: At Site Z, a high-level waste separations facility was constructed to remove strontium and cesium from the liquid residue from dissolution of spent fuel. The tanks, pumps, valves, piping, and additional ancillary equipment is enclosed in a concrete vault to provide secondary confinement and to protect workers from radiation. The inside surfaces of the vault were coated with an epoxy resin to prevent absorption of any releases from the primary confinement into the concrete vault. The expansion joints of the vaults are sealed with a flexible silicone sealer to help contain any releases from the primary confinement and to prevent intrusion from the exterior of precipitation, surface water, and groundwater. The waste to be processed is not ignitable or reactive, so provision for controlling such vapors need not be included.

The intent of the guidance in paragraphs (iii), (iv), and (vi) above is to protect secondary confinement systems from the harmful effects of high-level waste and to prevent the migration of groundwater into the secondary confinement system.

Double-walled tanks are to:

- Designed as an integral structure (i.e., an inner tank completely enveloped within an outer shell) so that any release from the inner tank is contained by the outer shell.
- Protected, if constructed of metal, from both corrosion of the primary tank interior and of the external surface of the outer shell; and
- Provided with a built-in continuous leak detection system capable of detecting any releases of high-level waste in the outer shell in accordance with facility requirements determined from safety analyses or environmental permit restrictions.

The intent of this guidance is to design and construct the primary and secondary confinement systems as one integral system and to provide continuous leak detection system capability within the secondary confinement system. Detection of leaked wastes in the secondary confinement system is important to alert operators of a release from the primary vessel and removal is necessary to reduce the potential for contamination and exposure.

High-level wastes or treatment reagents are not be placed in a tank system if they could cause the tank, its ancillary equipment, or the containment system to rupture, leak, corrode, or otherwise fail.

Due to the hazardous nature of high-level waste and potential airborne and liquid pathway contamination it poses, the requirements that apply to high-level waste facilities apply also to ancillary equipment. Ancillary equipment is considered to include piping, valves, jumpers, valve pits, and other equipment with which the high-level waste can reasonably be expected to be in contact.

Variances or Exemptions to Secondary Confinement Requirements. Variances or exemptions from the secondary confinement requirements for new non-immobilized high-level waste handling, transfer, and storage facilities may not meet exemption criteria because of the potential hazard and releases/exposures liquid or calcined high-level waste may pose. The high-level waste hazard analysis conducted in support of preparing DOE M 435.1-1 identified numerous pathways for the release of high-level waste with the principle one being loss of, or lack of, secondary confinement. Additionally, the selected scenarios that involved loss of, or lack of, secondary confinement resulted in high hazard consequences. Therefore, an exemption from the secondary confinement requirements for new high-level waste facilities that are involved in the handling, transfer, and storage of non-immobilized high-level waste, i.e., high-level waste that has not yet been immobilized in its final glass or ceramic form that meets the EM-WAPS specifications, is not likely to meet exemption criteria.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(b) Confinement.

2. Tank and piping systems used for high-level waste collection, pretreatment, treatment, and storage shall be welded construction, except where remote configurations or periodic rerouting of high-level waste streams require non-welded construction.

Objective:

The objective of this requirement is to ensure that high-level waste tank and piping systems provide the maximum protection possible to the public and the environment by requiring welded construction except in those cases where remoteness or rerouting of the component/piping requires non-welded construction to support operations.

Discussion:

The intent of the requirement for tank and piping systems to be welded construction whenever feasible is to offer the maximum protection possible to systems containing high-level waste.

However, it is recognized that welded construction is not practical where transferring of high-level waste streams requires frequent rerouting, e.g., jumpers within tank farm diversion boxes or when the remoteness, service life, or maintenance requirements of a component/piping requires the use of jumpers. In such cases non-welded construction of piping systems is considered adequate when use of non-welded connections is supported by the operations' authorization basis or radioactive waste management basis.

Example 1: At Site X, a new storage tank is to be added to the existing high-level waste tank farm. The new tank is to be constructed at a significant distance from the existing tanks using welded piping. However, to support transfers, the connection to the existing tank farm is made at a diversion box that utilizes piping jumpers with non-welded connections.

Example 2: At Site Y, a high-level waste transfer pump is located in a shielded transfer pit that requires periodic removal for maintenance. Piping and instrumentation connections to the pump use jumpers, in lieu of welded connections, to facilitate remote removal.

Supplemental References:

1. EPA. *Tank Systems*, 40 CFR Parts 264 and 265 Subpart J, U.S. Environmental Protection Agency, Washington, D.C.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(c) Lifting Devices. The design of hoisting and rigging devices shall comply with the following specific requirements:

1. Lifting devices that are designated as safety class or safety significant shall be designed to prevent free fall of loads.

2. Loading and unloading systems for lifting devices that are designated as safety class or safety significant shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

Objective:

The objective of this requirement is to ensure that special attention is devoted to the design of hoisting and rigging devices in order to avoid releases that could result from dropping a container of high-level waste and to avoid damage to high-level waste containers and systems (e.g., transfer, pretreatment, treatment) that could occur by dropping equipment, containers, or other objects.

Discussion:

The hazards analysis performed to guide development of DOE M 435.1-1 revealed that lifting and rigging activities pose a high hazard for many high-level waste activities. In particular, physical and chemical treatment of high-level waste in large storage tanks often involves the use of large, heavy equipment such as mixers and pumps. Typically, the access to the tanks is through relatively small risers. Manipulation of loads in restricted spaces with the additional complication of high radiation and reduced visibility due to use of containment huts requires that precautions be taken to guard against dropping loads into and onto containers, transfer equipment (e.g., pipelines, valves), and other systems containing high-level waste.

Lifting devices that are designated as safety class or safety significant are subject to the additional requirements for “design to prevent free fall” and “fail safe interlocks on devices for loading and unloading systems for lifting devices.” These requirements also apply when the lifting device is not itself a safety class or safety significant device but it could position loads above safety class or safety significant structures, systems, and components. Safety class structures, systems, and components means structures, systems, and components (SSCs) that are relied upon to protect the safety and health of the offsite public as identified by the safety analysis. Safety significant SSCs means structures which are not designated as safety class SSCs, but whose preventive or mitigative function is a major contributor to defense-in-depth (i.e., prevention of uncontrolled material release) and/or worker safety, as determined from hazard analyses. (These definitions are taken from the guide for DOE O 450.4).

> *Example: An underground tank containing 500,000 gallons of high-level waste is determined to have separated into layers, and one of the layers appears to contain materials that are reacting to form a potentially explosive gaseous product. The decision has been made to mix the contents of the tank to reduce the potential for abrupt release of accumulations of explosive gas. The mixer chosen weighs 2 tons and must be inserted through a three foot diameter riser. Because of the potential for damage to the tank and release of high-level waste, as well as contamination of workers involved in the activity, the lifting device is classified as a safety significant SSC and the special requirements for prevention of free fall of loads and fail safe interlocks for loading and unloading devices must be applied. In this case, the mechanism used to grasp or hook the pump must include an interlock to prevent lifting of the pump unless it is securely*

grasped or hooked. Also, the lifting device (e.g., crane, hoist, fork lift) must include a system to prevent free fall of the pump. The lifting activity described in this example is also subject to the critical lift provisions of DOE-STD-1090-96 as required by the hoisting and rigging operational requirements in Section II.V.(1).

Compliance with this requirement can be demonstrated by the development and implementation of procedures that:

- Identify safety class and safety significant lifting devices and safety class and safety significant structures systems and components that would be adversely impacted by the failure of the lifting device;

- Establish the requirements of II.P.(2)(c) as high-level waste design requirements for the lifting device and the associated loading and unloading system; and

- Assures the design requirements are incorporated in the construction and modification of the lifting devices.

Supplemental References:

1. NRC. *Disposal of High-Level Radioactive Wastes in Geologic Repositories,* 10 CFR Part 60, Subpart E, Technical Criteria, paragraph 60.131(b)(10), U.S. Nuclear Regulatory Commission, Washington, D.C.

2. DOE, 1996. *Hoisting and Rigging*, DOE STD 1090-96, U.S. Department of Energy, Washington, DC, September 1996. (a U.S. Department of Energy standard).

3. DOE, 1997. *Integrated Safety Management System Guide*, DOE G 450.4-1, U.S. Department of Energy, Washington, D.C., November 1997.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(d) Ventilation.

1. Design of high-level waste pretreatment, treatment, and storage facilities shall include ventilation through an appropriate filtration system to maintain the release of radioactive material in airborne effluents within the applicable requirements.

Objective:

The objective of this requirement is to ensure that airborne releases of radioactive materials will at all times be maintained within limits specified in applicable DOE Orders and regulations and requirements of other relevant Federal and State agencies.

Discussion:

Ventilation, filtration, and off-gas systems need to be designed to ensure that the releases of airborne radioactive particulate material during normal and off-normal conditions conform to:

- the limits specified in 10 CFR Part 835, *Occupational Radiation Protection*, for workers and for members of the public in controlled areas;

- the limits established in other applicable DOE Orders such as DOE 5400.5, *Radiation Protection of the Public and the Environment*, and

- generally applicable standards for releases of radioactive material to the environment that have been promulgated by the Environmental Protection Agency, including those for the *Clean Air Act*, 40 CFR Part 61.

The limits for release cited in DOE 5400.5, *Radiation Protection of the Public and the Environment*, and in the *Clean Air Act* requirements, 40 CFR Part 61, are for the DOE site (i.e., all the activities of the Department at that site), not for individual facilities. Therefore, the operational limits for any individual facility should be established based on the potential impacts from all facilities on the site. Consistent with Departmental practices, and an underlying principle in development of the Radioactive Waste Management Manual, airborne releases should be kept as low as reasonably achievable.

Attention to fire protection for filtration on these ventilation systems is important because of the potential presence of flammable and explosive gases that led to the requirement for ventilation. Guidance for fire protection of filtration systems in ventilation plenums for nuclear facilities is provided in *Fire Protection Design Criteria*, DOE-STD-1066-97. Typical requirements address materials of construction, location of filters, fire ratings of protective walls, and internal detectors for fire and high heat.

To preclude the ventilation system itself from becoming a source of ignition for these gases, the ventilation systems need to employ spark-proof technology.

> *Example: Spark-proof fan motors, spark-proof dampers and actuating mechanisms and spark-proof fan/fan-grill combinations are used in the ventilation system for Tank 400 at*

Site Z because of the presence of flammable gases that could burn if an ignition source were present.

This requirement specifies that the design of ventilation systems include appropriate filtration so the emissions from the ventilation system do not exceed established limits. This subrequirement is to be implemented using the graded approach. This requirement is intended to ensure that high-level waste management facilities have adequate filtration, not to dictate that each facility must have a particular type of air filtration. Therefore, the safety analysis or assessment for each facility should provide the basis for determining the level of filtration required.

Example: A new facility is to be built at Site Z for pretreatment of liquid high-level waste prior to transferring the waste to an existing vitrification facility. The pretreatment process equipment will be housed in a new building that protects it from the elements and provides confinement for any radioactive liquid or air particulates that may leak from the process equipment. While the portions of the building occupied by workers will be shielded from the process equipment, ventilation will also be required to mitigate any release of airborne radioactive material. The design of the facility must provide for ventilation and appropriate filtration of the exhaust from the system.

Compliance with the ventilation requirements can be demonstrated by:

- incorporating necessary ventilation systems (as indicated by safety analyses or assessments) in the design of high-level waste management equipment and facilities, and

- providing filtration capability for each ventilation system, as appropriate, to meet regulatory requirements for emissions of radioactive materials under normal and off-normal conditions.

Supplemental References:

1. DOE. *Occupational Radiation Protection*, 10 CFR Part 835, U.S. Department of Energy, Washington, D.C.

2. EPA. *National Standards for Hazardous Air Pollutants*, 40 CFR Part 61, U.S. Environmental Protection Agency, Washington, D.C.

3. DOE, 1990. *Radiation Protection of the Public and the Environment*, DOE 5400.5, U.S. Department of Energy, Washington, D.C., February 8, 1990.

4. DOE, 1997. *Fire Protection Design Criteria*, DOE-STD-1066-97, U.S. Department of Energy, Washington, D.C., March 1997.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(d) Ventilation.

2. When conditions exist for generating gases in flammable and explosive concentrations, ventilation systems or other measures shall be provided to keep the gases in a non-flammable and non-explosive condition. Where concentrations of explosive or flammable gases are expected to approach the lower flammability limit, measures shall be taken to prevent deflagration or detonation.

Objective:

The objective of this requirement is to keep concentrations of flammable and explosive gases below the lower flammability limits. However, in those instances where the concentrations of such gases are expected to approach or exceed the lower flammability limit, the objective is to prevent detonation or deflagration by an alternate means. These means could include oxygen/oxidant control or employing designs which prevent ignition (i.e., spark-proof technologies).

Discussion:

Ventilation systems that are required for equipment and facilities that generate and accumulate quantities of flammable and/or explosive gases in concentrations that would pose a risk of fire and/or explosion need to be capable of moving a sufficient volume of gases to limit concentrations of flammable and/or explosive gas to safe levels at all times.

Example: Tank 400 at Site Z generates flammable organic gases. The tank was constructed and filled with high-level waste in the 1980s. This tank must be equipped with a ventilation system, and the volume of air circulated through the headspace must be sufficient to maintain concentrations below the lower flammability limit for the organics present. The ventilation system must include filtration for removing radioactive particulates that may be in the ventilation exhaust so release limits are not exceeded.

Attention to fire protection for filtration on these ventilation systems is important because of the potential presence of flammable and explosive gases that led to the requirement for ventilation. Guidance for fire protection of filtration systems in ventilation plenums for nuclear facilities is provided in *Fire Protection Design Criteria,* DOE-STD-1066-97. Typical requirements address materials of construction, location of filters, fire ratings of protective walls, and internal detectors for fire and high heat.

The hazard analysis supporting revision of the DOE requirements for management of high-level waste identified the potential for generation, accumulation, and ignition of flammable and explosive gases in high-level waste storage tank headspace as one of the highest risk scenarios. The analysis indicated that such scenarios could result in uncontrolled releases of radioactive material to the environment and exposure of workers and the public to radiation from the releases.

When conditions exist for generating gases in flammable and explosive conditions, designs of high-level waste facilities shall include active ventilation systems with the capability to remove sufficient quantities of gases to preclude the accumulation of flammable and explosive gases in concentrations that pose a safety hazard. However, it may not be practical to keep concentrations below the lower flammability or explosivity limits 100% of the time with ventilation systems. There may be infrequent period where "puff" releases of gases will result in concentrations that approach or exceed the lower flammability or explosivity limits for a brief interval of time. In addition, some processes may routinely result in relatively large releases of such gases. In such cases, facility designs should include alternate features to preclude deflagration or detonation. This could be accomplished through the use of spark-proof fan motors, actuating mechanisms, and fan/grill combinations. Other features, such as the insertion of a sufficient flow of an inert gases into the headspace, may also provide a practical means to dilute the concentrations of these gases or the available oxygen/oxidants, and to thereby preclude deflagration and detonation.

> *Example: Tank 400 at Site Z generates flammable organic gases. The tank was constructed and filled with high-level waste in the 1980s. This tank has been equipped with a ventilation system, circulated with the capability to circulate through the headspace a volume of air sufficient to maintain concentrations below the lower flammability limit for the organics present for 98% of the time. Since the concentrations of flammable gases are above the lower flammability limit for the remaining 2% of the time, the ventilation system design also includes spark proof technology. The ventilation system includes filtration for removing radioactive particulates that may be in the ventilation exhaust so release limits are not exceeded.*

> *Example: An existing tank at site X is generating flammable gases following the receipt of waste from another tank. The tank design does not include an active ventilation system. Without mitigative actions, concentrations of flammable gases will increase to levels approaching the lower flammability limit. Calculations have demonstrated the*

feasibility of introducing nitrogen into the tank head space in sufficient volume to displace the oxygen and maintain the concentrations well below the lower flammability limit. This approach has been selected as the preferred option in view of the cost for installing an active ventilation system to provide the same level of safety.

Compliance with the ventilation requirements can be demonstrated by:

- identifying new and existing equipment and facilities that require ventilation systems, or other features to preclude or mitigate the hazards posed by the accumulation of flammable and explosive gases in concentrations above the lower flammability limit or the lower explosivity limits of such gases,

- incorporating ventilation systems, or other features, (as indicated by the safety analyses or assessments) in the design of such high-level waste management equipment and facilities, and,

- providing filtration capability for each high-level waste facility ventilation system as appropriate, to meet regulatory requirements for emissions of radioactive materials under normal and off-normal conditions.

Supplemental References:

1. DOE. *Occupational Radiation Protection*, 10 CFR Part 835, U.S. Department of Energy, Washington, DC.

2. EPA. *National Standards for Hazardous Air Pollutants*, 40 CFR Part 61, U.S. Environmental Protection Agency, Washington, D.C.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(e) Consideration of Decontamination and Decommissioning. Areas in new and modifications to existing high-level waste management facilities that are subject to contamination with radioactive or other hazardous materials shall be designed to facilitate decontamination. For such facilities a proposed decommissioning method or a conversion method leading to reuse shall be described.

Objective:

The objective of this requirement is to ensure the incorporation of the concept of life-cycle waste management into the design and construction of radioactive waste management facilities to minimize the amount of radioactive waste that must be managed in the future, and to reduce the number of facilities that must be dismantled rather than used for another purpose.

Discussion:

During the development of DOE O 435.1 and DOE M 435.1-1, the concept of life-cycle management of waste was identified as a key theme that would promote safety and provide a long-term benefit in reducing hazards associated with radioactive waste management. This requirement was developed to extend the life-cycle management of waste concept to the design of facilities used for the management of radioactive waste. The goals of applying this concept at the design stage are to minimize the future generation of waste and to promote the planning for subsequent beneficial use or decommissioning of a facility at the end of its original mission. Decontamination and decommissioning activities are becoming a significant part of the life-cycle costs for high-level waste facilities. This requirement also addresses this situation by promoting proactive consideration of design features that facilitate decontamination and dismantlement activities that will lead to a beneficial use or decommissioning.

New high-level waste facilities are defined as those whose design basis is not approved. (The term design basis is defined in the definitions attachment to the Manual). Thus, if a high-level waste facility's design basis is defined, the requirements of this section are applicable. Similarly, if a significant modification to an existing facility is to be made, this requirement applies. Application of these requirements to existing facilities should be considered and applied on a case-by-case basis. To support this decision, an analysis should be conducted comparing the expected benefits of the application of these requirements to the costs of implementing such measures. These costs should include programmatic impacts current cost and schedule impacts, as well as potential impacts such as additional worker exposure due to radiation and chemical hazards, and future costs.

Design to Facilitate Decontamination. Decontamination is defined in Attachment 1 to DOE O 430.1A, *Life-Cycle Asset Management*, as "the removal or reduction of residual radioactive and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition." In conjunction with DOE O 430.1A, DOE M 435.1-1 requires that high-level waste facilities incorporate measures to reduce areas of contamination, or to simplify decontamination of areas that may become contaminated with radioactive or hazardous materials to facilitate either decommissioning or reuse of the facility. Following are design features that should be considered:

- Service piping, conduits, and ductwork should be kept to a minimum in areas that could be potentially contaminated, and their design, if included in such areas, should be arranged to facilitate decontamination.

- Cracks, crevices, and joints should be filled and finished smooth to prevent accumulation of contaminated material.

- Walls, ceilings and floors in areas vulnerable to contamination should be finished with washable or strippable coverings.

- Metal liners, e.g., stainless steel cell lining, should be used in areas that have the potential to become highly contaminated with high-level waste materials.

- Contaminated or potentially contaminated piping systems should have provisions for flushing and/or cleaning.

- Accessible, removable covers for inspection and cleanouts should be provided.

- Construction materials that reduce the amount of radioactive materials requiring disposal and that are easily decontaminated should be selected.

Design to Support Decommissioning. Decommissioning, also defined in DOE O 430.1A, is "actions taken at the end of the life of a facility to retire it from service with adequate regard for the health and safety of the public and workers and protection of the environment." Design features that should be considered to support decommissioning or a reuse of the facility include:

- Use of modular radiation shielding, in lieu of or in addition to, monolithic shielding walls.

- Use of modular, separable confinements to preclude contamination of fixed portions of the structure.

- Designs that facilitate cut-up, dismantlement, removal, and packaging of contaminated equipment, such as glove boxes, air filtration equipment, large tanks and vessels, and ductwork, from the facility.

- Use of localized liquid transfer systems that avoid long runs of buried, contaminated piping. Special provisions should be included in the design to ensure the integrity of joints in buried pipelines.

- Piping systems that carry contaminated or potentially contaminated liquid should be free draining by gravity.

- Location of exhaust filtration components of ventilation systems should be at or near individual enclosures to minimize long runs of internally contaminated ductwork.

- Equipment, including effluent decontamination equipment, should preclude, to the extent practical, the accumulation of radioactive or other hazardous materials in relatively inaccessible areas, including turns in piping and ductwork.

- Provisions for suitable clearances, where practical, to accommodate remote handling and safety surveillance equipment required for future decontamination and decommissioning.

- Use of lifting devices on large tanks and equipment.

Decommissioning and Reuse Planning. Due to the high life-cycle costs of high-level waste facilities, the second part of the requirement is intended to promote post-mission planning of high-level waste facilities by requiring the identification of possible decommissioning methods, or reuses, of high-level waste facilities, as early as possible. To meet this requirement, high-level waste facility designs, or significant modification efforts, should include analysis to determine the best decommissioning methods, using currently available technologies, and factor the results of this analysis into the facility’s design. Likewise, if a reuse of the facility is envisioned, any features that can support this reuse mission should be considered in the design effort.

At the time of the preparation of this guidance, the “Decommissioning Implementation Guide,” Draft G 430.1-4, was in preparation to incorporate deactivation and decommissioning requirements currently contained in DOE 5820.2A, Chapter V. Refer to this Guide, and DOE O 430.1A, *Life-Cycle Asset Management*, for further information on deactivation and decommissioning activities. Also, refer to DOE-STD-1120-98, referenced below, on the integration of safety and health requirements into facility disposition activities.

Compliance with this requirement can be demonstrated by the existence of design documentation that indicates decontamination was considered during the design of new high-level waste facilities or significant modifications to high-level waste facilities. Additionally, documentation should demonstrate that post-mission planning was considered, as early as possible in the life of a facility, to assist in the identification of possible decommissioning methods or facility reuse.

Supplemental References:

1. DOE, 1998. *Life-Cycle Asset Management,* DOE O 430.1A, U.S. Department of Energy, October 14, 1998.

2. DOE, 1997. *Decommissioning Implementation Guide*, Draft G 430.1-4, U.S. Department of Energy, October 1, 1997.

3. DOE, 1997. *Integration of Safety and Health into Facility Disposition Activities*, DOE-STD-1120-98, U.S. Department of Energy, Washington, DC, Draft for DOE Complex Wide Review 9/26/97, September 26, 1997.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(f) Maintenance Exposure Reduction. Remote maintenance features and other appropriate techniques to maintain as low as reasonably achievable (ALARA) personnel exposures shall be incorporated into each high-level waste facility.

Objective:

The objective of this requirement is to incorporate engineered features into the high-level waste facilities to minimize total personnel radiation exposures at high-level waste facilities in accordance with ALARA principles.

Discussion:

Those structures, systems, and components for which operation, maintenance, and required inspections may involve occupational exposure must be designed, fabricated, located, shielded, controlled, and tested so as to control external and internal radiation exposures to personnel. Features may be employed individually or in combination to achieve this objective. Some features include the following:

- preventing the accumulation of radioactive material in those systems requiring access (e.g., minimizing bends and piping low points);
- decontaminating those systems to which access is required;
- controlling access to areas of potential contamination or high radiation; measuring and controlling contamination of areas requiring access;
- minimizing the time required to perform work in the vicinity of radioactive components;

- shielding personnel from radiation exposures; and
- providing remote maintenance features.

Existing DOE Orders address many of the concerns relevant to maintenance exposure reduction. The policy for DOE 4330.4B, Maintenance Management Program, includes the requirement that "…DOE property be maintained in a manner which promotes … worker health… while meeting the programmatic mission." The guidance for this order includes the development of goals and objectives such as "…minimize radiological exposure…" consistent with the DOE requirements for occupational radiation protection.

The principal DOE requirements for occupational radiation protection are found in 10 CFR Part 835, *Occupational Radiation Protection*, and include requirements for maintaining doses as low as reasonably achievable (ALARA). Section 835.101 specifically states that DOE activities shall be conducted in compliance with a radiation protection program that includes formal plans and measures for applying the ALARA process to occupational exposures. ALARA also includes consideration of economic as well as technical factors. As noted in DOE M 435.1-1, Section I.1.E.(13), the requirements of 10 CFR Part 835 apply to radioactive waste management facilities, operations, and activities which include maintenance activities.

> *Example: In a high-level waste processing facility, a component decontamination cell and contact-handled maintenance facility are provided. The decontamination cell incorporates remote decontamination capabilities to reduce contamination levels so that contact maintenance can be performed in reduced radiation fields. The contact-handled maintenance facility is located adjacent to the decontamination cell and incorporates features such as enhanced lighting and temporary shielding to facilitate maintenance.*

> *Example: In a high-level waste vitrification facility, manipulators and remotely operated work arms are sized to perform certain maintenance functions in addition to limited operational tasks. Specific maintenance functions such a tool could perform include change of melter components not accessible by in-cell cranes.*

Compliance with this requirement can be demonstrated by having and implementing a Maintenance Management Program that includes due emphasis on radiation protection. The radiation protection requirements must not only maintain exposures at or below prescribed limits, but also must incorporate ALARA principles.

Supplemental References:

1. DOE. *Occupational Radiation Protection*, 10 CFR Part 835, U.S. Department of Energy, Washington, D.C.

2. DOE, 1994. *Maintenance Management Program,* DOE 4330.4B, U.S. Department of Energy, Washington, D.C., February 10, 1994.

3. DOE, 1998. *Worker Protection Management for DOE Federal and Contractor Employees,* DOE O 440.1A, U.S. Department of Energy, Washington, D.C., March 27, 1998.

4. DOE, 1998. *Occupational Exposure Assessment,* DOE G 440.1-3, U.S. Department of Energy, Washington, D.C., March 30, 1998.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(g) Facilities for the Receipt and Retrieval of High-Level Waste.

1. Designs for storage facilities shall incorporate features to facilitate retrieval capability.

2. High-level waste receipt and retrieval systems shall be designed to complement the existing storage facilities for the safe storage and transfer of high-level waste.

Objective:

The objective of this requirement is to ensure that the interfaces for input to and transfer from high-level waste storage facilities are designed to facilitate subsequent removal of the waste, and that they are fully compatible with the high-level waste to be stored, including necessary packaging and transfer operations, and with structural and other limitations of storage facilities.

Discussion:

Facilities for the receipt and retrieval of high-level waste must be designed to allow safe handling, storage, and retrieval of the wastes. Therefore, before new facilities are constructed and employed to store high-level waste, strategies for retrieval of that waste need to be identified and the essential features of those strategies for retrieval of that waste need to be incorporated into the design of the facilities. Design of existing facilities need to be reviewed to identify essential additional features that could be engineered into the facility to provide for acceptable handling and retrieval.

Example: At Site Z, a new tank farm is being designed for storage of high-level waste from reprocessing of deteriorating spent fuel. The reprocessing is intended to remove isotopes that can be used in power reactors, but the separations process is not highly efficient, so significant quantities of special nuclear material will remain in the high-level waste to be vitrified and disposed of with the fission products. Because of the higher than normal concentrations of special nuclear material, special efforts will be made to design the tanks so most of the liquid high-level wastes can be removed from the tanks. Design features include:

- *configuration of tank bottoms to slope toward the low point of tanks to promote removal of most of the waste;*
- *installation of a residuals pump-out line at the low point of each tank;*
- *elimination of internal structural members in the tanks that could interfere with waste removal and clean-out activities for closure; and*
- *incorporation of adequate risers to accommodate anticipated in-tank activities such as mining, pumping, and wash-down of the tank walls.*

In the interest of identifying the structural needs and other requirements that can be incorporated in the design of new facilities, t is important to anticipate the types of activities that may be performed for retrieval of high-level waste. For existing facilities whose structural integrity limitations would not support the loads for an integral retrieval capability, additional structural support would be provided to eliminate or minimize imposed loads on the tank structure.

Example: The strategy for retrieval of liquid waste from a storage tank involves the use of a robotic arm whose weight must be born by the tank structure. The associated loads need to be included in the structural design requirements for the tank, as well as provisions for access. The structural integrity program would also use these loads in assessing the structural integrity of the tank over its life, to assure the tank's integrity can be maintained during retrieval.

The retrieval of canistered waste for shipment to another storage facility or to a disposal facility will require transferring the waste into a shipping cask certified by the Nuclear Regulatory Commission under 10 CFR Part 71. Additional requirements of the Department of Transportation (49 CFR Part 193, Subpart I) and the DOE Orders, DOE O 460.1A and DOE O 460.2, may also affect the design of the receipt and retrieval features.

Implementation of this requirement must be coordinated with several other related requirements of this Manual. DOE M 435.1-1, Section II. J. specifies that Waste Acceptance Requirements be developed for storage facilities, and the receiving features of storage facilities must be designed to support any evaluation and acceptance activities necessary to ensure compliance with the Waste Acceptance Requirements. Finally, the receipt and retrieval features must be designed to be compatible with the general requirements for waste management including Worker Protection (Section I.1.E.(21)), Radiation Protection (Section I.1.E.(13)) including maintaining exposures as low as reasonably achievable, and Safeguards and Security (Section I.1.E.(16)).

Compliance with this requirement for new facilities can be demonstrated by the existence of design documentation of the receipt and retrieval features of high-level waste storage facilities to provide for necessary evaluation and acceptance activities, and demonstrating that retrieval operations can be performed under conditions likely to prevail at the time of removal. Compliance with this requirement for existing facilities can be demonstrated by evaluating the receipt and retrieval features of storage facilities and the existence of design documentation for modifications to systems as required to allow retrieval operations to be safely and effectively performed under conditions likely to prevail at the time of removal of the waste

Supplemental References:

1. NRC. *Packaging and Transportation of Radioactive Material,* 10 CFR Part 71, U.S. Nuclear Regulatory Commission, Washington, D.C.

2. USDOT. *Shippers-General Requirements for Shipments and Packaging-Radioactive Materials,* 49 CFR Part 173, Subpart I, U.S. Department of Transportation, Washington, D.C.

3. DOE, 1996. *Packaging and Transportation Safety,* DOE O 460.1A, U.S. Department of Energy, Washington, D.C., October 2, 1996.

4. DOE, 1995. *Departmental Materials Transportation and Packaging Management,* DOE O 460.2, U.S. Department of Energy, Washington, D.C., September 7, 1995.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(h) Structural Integrity. Designs for new tanks shall contribute to the confinement requirement at Section II.P.(2)(b) of this Manual by:

1. Incorporating features to avoid critical degradation modes at the proposed site where practicable, or minimize degradation rates for the critical modes; and

2. Incorporating features to facilitate execution of the Structural Integrity Program required by Section II.Q.(2) of this Manual.

Objective:

The objective of this requirement is to incorporate engineering features into the design of new tanks that will allow for longer service life and to facilitate implementing the Structural Integrity requirement at Section II.Q.(2) after the new tanks are placed in service.

Discussion:

For any new tanks that may be constructed to store high-level waste, the service life is to be specified. A primary determinant of service life is the structural integrity (leak-tightness and structural stiffness) of the tank. Confidence that the design service life of new tanks will be realized can be attained by selection of materials and design features that will avoid critical degradation modes or minimize their degradation rates. The critical modes and rates of interest are those that result from the chemistry of the waste to be stored in the tank, the chemistry of its in-situ environment, and loads that are anticipated to be imposed during its lifetime.

BNL-UC-406, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks* identifies guidelines for establishing a structural integrity program for high-level waste storage tanks. It includes both design and operational features. For tanks constructed without access for inspection, the uncertainty associated with assessment of structural integrity is greater because material degradation and remaining thickness must be inferred from indirect data such as derived corrosion rates. However, new tanks can be designed to provide access for robotic instruments to travel between the primary and secondary containers to directly assess the degradation experienced and the material thickness remaining. Access to conduct other tests (e.g. coupon tests) can also be provided in new tanks to obtain other critical data so as to minimize personnel exposures.

> *Example: Based on information provided through the structural integrity program at DOE M 435.1-1, Section II.Q.(2), the remaining service life of five existing tanks at Site XX cannot meet operational requirements. Therefore, five new tanks are to be designed and constructed to store high-level waste. The planned service life for the new tanks, with a range of uncertainty, has been established as a design requirement. Based on characterization of the existing waste to be transferred to the new tanks, and*

characterization of the site geology, the corrosion modes and rates have been established for alternative materials, Site XX has developed a strategy for retrieval of the waste from the tanks using a robotic arm. Loads that will be experienced by the tank structure from normal soil loads, loads from anticipated ground motion, loads from retrieval and decommissioning activities, and loads for operational and maintenance activities have been estimated and established as design requirements. The capability for access by robotic devices to assess structural degradation and remaining thickness has also been established as a design requirement as has the capability to monitor critical structural loads with instrumentation during the service life of the tanks has also been established as a design requirement.

The actions necessary to comply with this requirement are complementary to those identified in the guidance for the Structural Integrity requirement at Section II.Q.(2)., except that the actions are undertaken prior to selection of the materials and the design of the structure. These actions include:

1. Establishing the design load requirement based on loads anticipated during the service life of the tank. These loads include: normal soil load; loads from anticipated ground motion; thermal loads; loads from retrieval and decommissioning activities; and, loads related to maintenance and operational activities.

2. Establishing design requirements for acceptable corrosion modes and rates based on the chemistry of the waste that will be stored in the tanks and the in-situ chemistry of the site and the supporting structure.

3. Establishing design requirements to implement the structural integrity program at paragraph II.Q.(2), including access for instrumentation to assess degradation and remaining material thickness

4. Establishing other design requirements which would significantly increase confidence that the design service life will be achieved (e.g., access for coupon tests; cathodic protection).

Supplemental References:

1. BNL, 1997. *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, BNL-UC-406, Brookhaven National Laboratory, Upton, NY, January 1997.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(i) Instrumentation and Control Systems. Engineering controls shall be incorporated in the design and engineering of high-level waste treatment, storage, pretreatment, and treatment facilities to provide volume inventory data and to prevent spills, leaks and overflows from tanks or confinement systems.

Objective:

The objective of this requirement is to include engineering controls in the design of high-level waste pretreatment, treatment and storage facilities to minimize the likelihood of loss of confinement during normal and abnormal operations. Additionally, the requirement is to ensure the incorporation of engineering controls that alert operations personnel of an impending and actual loss of confinement.

Discussion:

During the development of the DOE O 435.1 and DOE M 435.1-1, a hazards analysis and a requirements analysis concluded that the loss of confinement due to a spill, leak or overflow at a high-level waste treatment or storage facility could pose a significant risk to both workers and the environment. That analysis resulted in the inclusion of this requirement to be applied to all high-level waste treatment and storage facilities. In the context of this requirement, pretreatment is a subset of treatment and affected facilities include process vessels, tanks and bins that serve as a level of confinement for high-level waste in the liquid, slurry, or solid (e.g., calcine) state. Storage facilities include underground high-level liquid waste storage tanks as well as storage bins for calcined material.

This requirement is invoked to support prompt detection and prevention of conditions which could lead to release of radioactive material from high-level waste pretreatment, treatment, and storage facilities. This is also closely related to the design requirement for monitoring systems. However, this requirement addresses implementation of controls that prevent the loss of confinement whereas the monitoring design requirement is intended to address detection of loss of containment.

For clarification, engineering controls in this requirement are considered to be those systems or design characteristics that are provided to prevent or mitigate the loss of confinement from high-level waste storage facilities and which provide volume inventory data. Examples of engineering controls include flowmeters, level-sensing devices, liquid and solid level alarms, anti-siphon devices overflow prevention features, and any other instrumentation and controls that maintain sufficient freeboard within the storage unit.

Loss of confinement at a high-level waste pretreatment, treatment or storage facility can result from overflows, spills, leaks and siphoning of waste from the storage unit. Incorporation of design measures at these facilities to prevent such loss of confinement is necessary, but their presence alone is not considered sufficient to meet this requirement. Engineering controls must also be subject to periodic inspection and maintenance to ensure proper operation. In spite of rigid maintenance and surveillance, such equipment can fail over its expected service life. Therefore, to fully meet this requirement, mitigative measures to reduce the loss of confinement are necessary. These mitigative measures should be implemented in conjunction with the required measures of confinement, as specified by DOE M 435.1-1, Section II.P.(2)(b), Confinement, of this guidance.

Example 1: At Site X High-Level Waste Tank Farm, an engineering control on a waste tank includes a waste feed line shut-off valve, which is activated by a tank level-sensing device, to prevent overflow of waste from the tank. For defense-in-depth, a double-contained overflow line is attached to the tank to channel any overfill to a spare waste tank at the tank farm.

Example 2: A facility is being designed to separate high-level liquid from precipitated solids as the mixture is withdrawn from a storage tank. The separations process is a continuous operation, with the liquid being transferred to a storage tank. To avoid loss of containment, an interlock is included in the design which prevents feed from entering the separations process and liquid from being discharged unless the supernatant receiving tank is below ninety-five percent full.

The graded approach should be used for determining the appropriate level of engineering controls to incorporate into the design of high-level waste management facilities. As indicated in the preceding examples, sensing devices, alarms, and spill or overflow prevention features are most appropriate in facilities storing liquids or with continuous, automatic processes. Other instances involving bulk or solid high-level waste may need to invoke these controls, as well as a simple shutoff switch which could prevent overfilling.

It is recognized that incorporation of engineering controls to meet this requirement may be directed by the facility-specific safety analysis for the storage unit or group of storage units. Such safety analysis may dictate that some of the engineering controls be designed as safety-class or safety-significant systems, structures or components (SSC) to ensure they survive the design-basis accidents. Use of the safety analysis process prescribed by DOE 5480.23, "Nuclear Safety Analysis Reports," to identify the necessary engineering controls to meet this requirement for both new, and upgrades to existing, high-level waste storage facilities is encouraged.

Compliance with this requirement is demonstrated by the incorporation of engineering controls that provide timely information to facility operations personnel regarding the volumes of high-level waste being stored, automatic shut-off, anti-siphoning devices, and automatic sensing devices, and mitigative measures to minimize the spread of high-level waste in the event of loss of confinement.

Supplemental References:

1. DOE, 1995. *Implementation Guide for Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria*, DOE O 420.1, Revision G (Draft), Facility Safety, U.S. Department of Energy, Washington, D.C., September 1995.

II. P.(2) Facility Design. The following facility design requirements, at a minimum, apply:

(j) Volume Monitoring Systems. Monitoring and/or leak detection capabilities shall be incorporated in the design and engineering of high-level waste storage, pretreatment, and treatment facilities to provide rapid detection of failed confinement and/or other abnormal conditions.

Objective:

The objective of this requirement is to mandate design and installation of equipment in high-level waste management facilities that is capable of identifying failures in containing high-level waste and other conditions that could result in exposure of the public, workers, or releases to the environment.

Discussion:

This requirement is invoked to address a group of high hazards was identified by the hazards analysis performed in support of DOE O 435.1 and DOE M 435.1-1 associated with the failure to promptly detect a release of high-level waste that could impact personnel, the public, or the environment. This particular requirement addresses the design of monitoring systems so that unexpected changes in quantity indications can be promptly checked to determine if they are a reflection of failure in high-level waste confinement facilities/systems and so that high-level waste transfers can be monitored to avoid overfilling. Monitoring for detecting releases that may be too small to be detected quickly, via volume changes, is addressed in DOE M 435.1-1 Section II.T, Monitoring.

The hazards analysis performed to guide development of DOE O 435.1 and DOE M 435.1-1 revealed that releases can result from failure of confinement or from failure to stop transfer of high-level waste when the receiving vessel (e.g., tank or bin) is full. The requirement discussed here is generally directed toward prompt detection of acute releases (releases that can be readily detectable) that become apparent over a time frame of hours or days. In contrast, the requirements for environmental monitoring (see Section II.T) for compliance with release limits is directed toward detection of releases that generally evolve slowly and may be detected by low threshold environmental monitoring devices weeks, months, or longer after the release begins.

> *Example: A large diameter storage tank for liquid high-level waste includes a mechanical level indicator that is read and recorded daily. The level indicator remained stable for six months following the last waste addition to the tank. The level indicator readings then began to show a downward trend that totaled two inches over a two week period. There could be causes for the level change other than leakage (see following additional discussion), but the level indicator change would alert operators of a potential problem that requires further investigation.*

Experience in the management of high-level waste has led to identification of various events for the release of high-level waste. Some of those factors include the generally corrosive (acidic or basic) chemical composition of liquid high-level waste, the use of vessel materials such as mild steel that are not highly resistant to corrosion and other chemical attack, the abrasive physical form of calcined high-level waste, and the absence of secondary confinement. The consequences of release of high-level waste, coupled with the factors threatening confinement, led to development of the requirement for monitoring. Other requirements of this chapter address Confinement (Section II.P.(2)(b)), Structural Integrity of storage tanks (Section II.P.(2)(h)), Structural Integrity Program (Section II.Q.(2)), and Instrumentation and Control Systems for high-level waste volume inventory (Section II.P.(2)(i)). The confinement requirement focuses on design of waste systems and components to ensure confinement and requires application of a number of specific design considerations. The Structural Integrity requirement focuses on assessment of the condition of confinement barriers and processes that promote anticipation of potential confinement weakness or failure based on known deterioration processes. The Instrumentation and Control requirement focuses on prevention of releases in contrast to this requirement, which emphasizes detection of releases.

Storage facility surface level is a relatively straightforward parameter to monitor. In general, the surface level in a vessel is an appropriate indicator of high-level waste volume. However, operations and mechanisms that could change the volume in a vessel must be considered to factor out explainable level changes.

> *Example 1: An unexpected chemical reaction generates gas that is trapped within the waste matrix or under a semipermeable layer of waste that retards percolation of the gas to the surface of the waste. This mechanism maintained the apparent surface level of high-level waste in a vessel even as liquid was leaking out.*

Example 2: Operating personnel at a high-level waste storage facility calculate the evaporation loss expected from a tank based on an assumed radionuclide inventory. The actual radionuclide inventory is much smaller than that assumed, so the actual heat generation rate is much smaller than that assumed. Overestimation of the waste volume change due to evaporation resulted in failure to detect leakage that was incorrectly assumed to be evaporative loss.

Gas generation and evaporation, as well as intentional additions to and removals from the vessels must be accurately accounted for if the waste level (or volume) is to be used to monitor for leakage. The monitoring capability should be coupled with instrumentation and control systems, such as automatic shutoffs and bypasses with alarms, that will alert operators that action is needed to prevent or mitigate a release.

For transfer systems, approaches such as continuous flow measurements and comparisons of total volume input to total volume output can be used to monitor the integrity of the transfer system. The containment integrity of waste transfer systems can also be monitored for radiation levels in excess of those expected from residual waste in the transfer system.

Example: A pneumatic transfer system for calcined high-level waste is enclosed in a concrete tunnel that provides significant shielding for an adjacent work area. Routine surveys along the outside of the tunnel revealed higher than normal residual activity when calcine was not being transferred. The surveys also showed progressively higher activity after each transfer of calcine. Examination inside the tunnel with a remotely operated camera revealed an accumulation of calcine fines below an elbow where abrasion from the calcine had apparently eroded a hole in the transfer line.

A highly reliable means of monitoring for releases is the use of secondary confinement, which is then checked for the presence of high-level waste. This monitoring approach should be applied to essentially any high-level waste management systems including pretreatment, treatment, storage, and transfer (see Section II.P.(2)(b)). It also offers the benefit of providing defense-in-depth to avoid the release of high-level waste.

Example: A high-level waste transfer line from a storage tank farm to a vitrification plant includes a secondary confinement barrier. The transfer line is constructed with sufficient pitch to cause any leakage into the outer line to flow back to the storage tank. A conductivity cell, with associated monitor, is included in the outer line to alert operators of a primary to secondary barrier leak, as a mitigative measure.

What constitutes rapid detection of failed confinement or provides indications of abnormal conditions needs to be established for each facility, operation, or activity. Monitoring system design requirements and engineering controls to address catastrophic failures will be established through the conduct of safety analyses. The failures and conditions being addressed by this requirement are not catastrophic, but could result in releases of radioactivity, or doses to workers or the public, in excess of established limits, if the leak was allowed to continue over a period of hours or days or individuals were not removed. Similarly if the failure results in releases of radioactivity to an air or liquid effluent stream, detection needs to occur rapidly enough to prevent environmental releases from exceeding annual limits.

A graded approach should be applied to design and operational implementation of this requirement for monitoring to detect acute releases promptly. For example, it may not be necessary to provide continuous monitoring of waste levels in high-level waste storage tanks that have had the pumpable liquids removed, to the extent possible, or in bins of stored calcined high-level waste the waste is not especially mobile. Occasional level verification with a non-permanent detection system for such cases is considered suitable and meets the intent of this requirement. On the other hand, highly mobile liquid waste in a single-walled, mild steel tank would probably require continuous monitoring coupled with alarms and transfer equipment.

Compliance with this requirement is demonstrated by the existence of design documents for high-level waste systems that include the capability to monitor waste volumes and detect volume changes in a time frame that will allow implementation of corrective measures to limit public and worker doses and releases to allowable levels.

Supplemental References:

1. EPA. *Containment and Detection of Releases*, 40 CFR 264.193 for Hazardous Waste Tank Systems, U.S. Environmental Protection Agency, Washington, D.C.

2. EPA. *General Operating Requirements*, 40 CFR 264.194 for Hazardous Waste Tank Systems, U.S. Environmental Protection Agency, Washington, D.C.

II. Q. Storage.

The following requirements are in addition to those in Chapter I of this Manual and also apply to facilities intended for management of high-level waste awaiting pretreatment, treatment or disposal, unless stated otherwise.

(1) Operation of Confinement Systems.

(a) Confinement systems shall be operated and maintained so as to preserve the design basis.

(b) Secondary confinement systems, where provided, shall be operated to prevent any migration of wastes or accumulated liquid out of the waste confinement systems.

Objective:

The objective of this requirement is to ensure that containment systems, both primary and secondary, are: (a) maintained to preserve the design capabilities of the systems to prevent the release of hazardous materials to the environment; and (b) operated so as to maximize the effectiveness of the design to contain wastes and accumulated liquids.

Discussion:

The establishment of appropriate operational procedures and diligence in executing the procedures are essential to maximize the effectiveness of the design capabilities of the waste containment system. The procedures need to be based on the operational assumptions that formed the basis for the system design.

Example: At Site Orange, the secondary containment system does not have instrumentation to detect liquids in the secondary system. Instead, provisions were included in the design to manually check for liquids. The design of the primary container does not assume that liquids will be present in the secondary system. Additionally, the presence of liquids in the secondary containment system will induce an unanticipated increase in the corrosion rate of the primary system that will reduce its service life. Operational procedures require daily checks for accumulated liquids in the secondary containment, and systems are provided and maintained to remove accumulated liquids promptly.

The stress of daily operational activities can impose degradation modes and increase the rate of degradation of confinement systems beyond those included in the design basis. It is important to identify the operational and maintenance assumptions that formed the basis for the system design. These factors normally include assumptions regarding the frequency and severity of loads imposed by naturally-induced and human-induced events. Naturally-induced events include pressure gradients (including static head and external hydrological forces), the physical contact with the waste, and climatic events. Human-induced events include stresses from nearby vehicular traffic, and operational events including sampling, installation and removal of pumps, and other operational activities that impose loads. If the stresses due to these factors exceed the stresses for which the system was designed, the service life can be substantially reduced which could result in unanticipated loss of confinement. As discussed in the guidance II.Q.(2), Structural Integrity Program, many of the single containment systems are already beyond the service life for which they were designed, and efforts are required to extend the service life of most tanks even further into the future. For this reason, as well as the consequences of containment failure, new high-level waste is not be placed into single confinement systems. New high-level waste imposes a greater heat and corrosive load, which is inimical to efforts to extend the service life of the oldest tanks.

> *Example: At Site Red, a mis-routing during transfer of waste has created a safety issue regarding criticality of the high-level waste in tank XYZ by the introduction of additional fissile material. A decision has been made to install pumps to re-suspend the fissile material. Because of the low viscosity of the waste, the pumps required for this unanticipated operation are much heavier than those assumed in the design of the tanks. In addition, the crane to install the pumps is much larger and heavier. The integrated operations and maintenance procedures at the site identify the design basis loads for the tanks. The maintenance organization has determined that the additional loads of the pump and crane are greater than the design basis loads for the tank confinement systems in the tank farm. Therefore, additional structures will be required to support the loads.*

Other operational and maintenance requirements of DOE M 435.1-1, e.g., Section II.Q.(2), Structural Integrity Program, Section II.J, Waste Acceptance, Section II.L, Waste Characterization; and Section II.M, Waste Certification, also directly relate to the successful operation of confinement systems to preclude migration of waste.

Compliance with this requirement is demonstrated by developing, documenting and implementing a program that integrates the operational and maintenance requirements of DOE M 435.1-1, (the above citations) with the design basis assumptions, implementing operational procedures that maximize the effectiveness of the system design, and by continually assessing and modifying the stresses of daily operational and maintenance activities to be as low as practical, and no greater than the stresses assumed in the design for the containment systems.

Supplemental References: None.

II. Q.(2) Structural Integrity Program.

(a) Leak-Tight Tanks In-Service. A structural integrity program shall be developed for each high-level waste storage tank site to verify the structural integrity and service life of each tank to meet operational requirements for storage capacity. The program shall be capable of:

1. Verifying the current leak-tightness and structural strength of each tank in service;

2. Identifying corrosion, fatigue and other critical degradation modes;

3. Adjusting the chemistry of tank waste, calibrating cathodic protection systems, wherever employed, and implementing other necessary corrosion protective measures;

4. Providing credible projections as to when structural integrity of each tank can no longer be assured; and

5. Identifying the additional controls necessary to maintain an acceptable operating envelope.

(b) In-Service Tanks that Have Leaked or Are Suspect. For each high-level waste storage tank in-service that is known to have leaked, or is suspect, a modified structural integrity program shall be developed and implemented to identify the safe operational envelope. The modified program shall be capable of:

1. Verifying the structural strength of each tank in-service which has leaked or is suspect;

2. Identifying corrosion, fatigue and other critical degradation modes;

3. Adjusting the chemistry of tank waste, calibrating cathodic protection systems, wherever employed, and

implementing other necessary corrosion protection measures;

4. **Determining which of the tanks that have leaked or are suspect may remain in service by identifying an acceptable safe operating envelope;**

5. **Providing credible projections as to when the acceptable safe operational envelope can no longer be assured; and**

6. **Identifying the additional controls necessary to maintain the acceptable safe operational envelope.**

When physical activities, as part of a structural integrity program, pose additional vulnerabilities, alternative measures shall be implemented to provide an acceptable storage operational envelope.

(c) Other Storage Components. The structural integrity of other storage components shall be verified to assure leak tightness and structural strength.

Objective:

The objectives of this requirement are to: (1) identify an acceptable safe operational envelope (where feasible) for tanks that are known, or suspected, to leak and where it is necessary to keep such tanks in-service for the interim; (2) provide an estimate of the remaining service life for each tank; (3) identify the frequency for monitoring in-tank waste chemistry; (4) extend the service life (leak-tightness and structural strength) of individual tanks to meet the operational requirements for storage capacity where such extensions are feasible; and (5) verify the structural integrity of transfer piping and other storage components prior to transfer of high-level waste.

Discussion:

In addition to the facility and general design requirements contained in DOE M 435.1-1, Section I.1.E., Requirements of Other Regulations and DOE Directives, high-level waste storage tanks, transfer piping and other storage components, shall be subject to a structural integrity program. During the development of DOE O 435.1 and DOE M 435.1-1, a hazards analysis and a requirements analysis concluded that there is a need for this requirement to preclude an uncontrolled release of high-level waste from storage systems due to loss of structural integrity. Although the analysis that prompted this requirement involved high-level waste “storage systems" that are likely to contain large quantities of liquid high-level waste for extended periods of time during which corrosion modes and rates could lead to loss of structural integrity, i.e., high-level waste underground storage tanks, high-level waste sites are encouraged to apply these requirements to all storage systems (e.g, process storage vessels, solid (calcined) high-level waste storage bins).

Meeting operational requirements for storage. Changes in DOE programs now require that high-level waste storage tanks remain in-service for a significantly longer time than ordinally planned. The Department has over two hundred and forty high-level waste storage tanks. These tanks have already exceeded their design service life, and many more tanks will exceed their original design service life before waste is removed from the tanks. If the structural integrity program is to meet its requirement to "verify the structural integrity and service life for each tank to met operational requirements for storage capacity" [Section II.Q.(2)(a)], the service life of the tanks must be extended beyond that for which they were designed. In the near term, predictive models will be required to estimate the remaining service life of specific tanks to determine whether operational requirements for waste storage can be met. The remaining service life extends to that point in time beyond which structural integrity (leak tightness and structural strength) cannot be assured. This estimate will be revised periodically with each reassessment of structural integrity. The purpose of the estimate is to provide management sufficient time to pursue alternatives for storage of the waste.

Guidelines for establishing a structural integrity program. BNL-UC-406, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks,* (referred to subsequently as "Guidelines") provides an acceptable process for establishing a structural integrity program. This set of Guidelines was finalized in January 1997 to promote the structural integrity of high-level waste storage tanks and transfer lines at facilities of the Department. In summary, the document lays out the essential elements of a structural integrity program. The procedures contained in the Guidelines provide an acceptable methodology to assess the structural integrity of existing tanks and to estimate the end of service life.

The primary elements of a structural integrity program are described in the Guidelines and include addressing possible aging degradation mechanisms for both steel and concrete components of tanks. In addition, the Guidelines identify an evaluation process to screen out non-significant aging mechanisms and contain the details for developing and maintaining such a program. Guidance Section II.P.(2)(h), Storage Tank Structural Integrity, incorporates recommendations from BNL-UC-406 on design information for underground high-level waste storage tanks. The following is a summary of some of the more salient points contained in BNL-UC-406 for operational aspects of a structural integrity program.

A structural integrity program is to be developed for each high-level waste tank farm site according to its specific needs. Although these programs are expected to be different from site to site according to the composition and nature of the wastes, intended use of the tanks, and specific structural features, there are several basic elements and considerations that are included in the program to ensure a systematic assessment of the tank's structural integrity. The structural integrity program is to be developed such that the steps required for verification of structural integrity can be performed. This requires collection of adequate data and their evaluation. The worst combination of material properties data and loadings during the service life of the tank system need to be considered in the structural analysis.

An assessment of the current material properties in the high-level waste tanks allows a verification of their current structural integrity. However, in order to demonstrate that at the end of the service life of a tank, structural integrity will be maintained, projection of the component degradation may be required. Alternatively, if the maximum service life of a tank is to be estimated, a prediction model needs to be developed as part of the structural integrity program. In either case, a demonstration of structural integrity for future operation requires periodic inspection and maintenance programs necessary components in an effective structural integrity program. Ultimately, if the integrity of a tank cannot be demonstrated, the program needs to provide adequate warning for management actions, such as retrieval of the waste.

The elements of a structural integrity program need to be defined and implemented in a logical sequence to achieve the above goals. The basic concern for integrity of high-level waste tanks is the degradation of structural materials. Therefore the first step of a structural integrity program is to identify any aging mechanisms that could cause material degradation. The next step is to quantify the degradation and determine its effect on performance of the two desired functions, leak-tightness and structural adequacy. Program features of the leak detection system and non-destructive examination will verify the leak tightness. A structural analysis program based on end-of-life material properties data will verify structural adequacy. If both analyses are successful, no further action is required. If not, additional steps should be considered such as preventive maintenance, and management options (e.g., retrieval). More specifically the major program elements are:

- Identification of Aging Mechanisms: the aging mechanisms that may cause degradation of the materials are identified considering tank-specific conditions, such as thermal loads, pH level, material types and chemical attack.

- Quantification of the Degree of Degradation: for each aging mechanism identified as part of the above process, the potential degradation of structural and material properties are quantified.

- Evaluation of the Effect of Degradation on Tank Integrity: determine the effect of the degradation on the intended functions of the tanks, i.e., leak tightness and structural adequacy

- Verification of Leak Tightness: data from a non-destructive examination are studied to estimate the potential for leakage, including inspections by robotic instruments in the annular space between the primary and secondary confinement barriers, where practicable.

- Verification of Structural Adequacy: since a reduction of material properties or significant geometric change can affect the ability of a tank structure to withstand imposed loads, all loads (hydrostatic, soil pressure, thermal, earthquake and other accidental loads including appropriate combinations of these) are considered in a structural analysis. Loads that are generated by the waste contents (e.g., thermal) need to be routinely monitored. Based on the severity of these loads, a schedule is established for monitoring (see Section II.T).

- Management Options: in addition to preventive maintenance and repair programs other options may need to be evaluated, e.g., removal of the supernate or retrieval of the tank's entire contents. Such actions will require decisions by the responsible waste management organization to ensure the decision is consistent with other elements of the program.

A systematic consideration of all the elements delineated in BNL-UC-406 is expected to result in a successful structural integrity program. The basic elements and considerations of the program contained in the BNL document is applicable to all high-level waste underground storage tanks. However, it is recognized that differences in how the data are accumulated, the degradations modes experienced, the frequency with which the structural integrity program must be repeated, and whether or not predictions of the end of service life will be required, may differ for certain tank farms or individual tanks; however, a documented technical basis needs to be available to support the structural integrity program at each site.

Scope. The scope of this requirement is limited to high-level waste tanks and does not apply to tank supporting systems that are covered by other requirements within DOE M 435.1-1. For example, the requirement does not apply to the functional integrity of the high-level waste tank ventilation system (see requirement at Section II.P.(2)(d). Likewise it does not apply to the monitoring and leak detection systems/equipment that provide identification of failed confinement, nor does this requirement apply to monitoring and leak detection systems/equipment that provide identification of abnormal conditions at high-level waste tanks and transfer lines (Section II.P.(2)(i)).

Modified structural integrity program for leaking tanks. Although some high-level waste storage tanks cannot meet the leak-tightness criteria of the structural integrity requirement, i.e., they have leaked in the past, or are suspected of leaking now, application of a modified structural integrity program remains important for such tanks that must continue in-service either to store high-level waste for the interim, or for contingency use. For tanks that are known to have leaked in the past, leak now, or are suspected of leaking (single containment or double containment), the requirement to verify leak tightness and structural strength is to confirm that the tanks do have sufficient structural strength and that the tanks do, or do not leak. Tanks that are known to have leaked in the past, and those whose leak-tightness cannot be verified, will be treated as leaking tanks and are subject to the requirements of the modified structural integrity program. Where storage requirements, including the requirement for contingency storage, necessitate the use of leaking tanks for some interim period, the modified structural integrity program for leaking tanks is required to be capable of determining an acceptable safe operating envelope in order to continue use of the tank for storage. The acceptable safe operating envelope is that portion of a structurally adequate tank for which leak-tightness can be verified. An acceptable operational envelope for continued storage could consider the location of the leak sites and the viscosity of the waste to be stored.

The modified structural integrity program is required to be capable of projecting how long the acceptable safe operating envelope can be sustained. The Guidelines provide detailed guidance on how to determine the remaining thickness of the tank wall, identify the degradation modes and rates and make projections of remaining service life. However, use of tanks that have leaked, and tanks for which structural integrity cannot be verified, is to be discontinued for storage, including contingency storage, as soon as capacity in a tank with no known or suspected leak sites becomes available. Verification of leak-tightness and making credible projections as to when the acceptable safe operating envelope can no longer be assured (Section II.Q.(2)(b)(5)) for leaking, or suspect leaking, single-shell tanks at some of the sites is not possible due to their configuration, waste levels, or the risks posed in trying to do so. In such cases, as illustrated in the examples below, management should identify the options, and, in those cases that waste must remain for some period of time, add the necessary controls, e.g., periodic pumping to remove as much of the pumpable liquids as possible, to provide an acceptable storage operational envelope. Under such conditions the requirements in Section II.Q.(2) are considered met.

The modified structural integrity program is also required to be capable of identifying additional controls that may be required to maintain an acceptable safe operating envelope. To be effective, these controls must address the operational and natural threats to safe storage. These threats include the following:

- Overfilling above the safe operational envelope;
- Permitting waste to be accepted which intensifies the critical corrosion modes;
- Internal Loads
    - High temperature and/or temperature cycling

  - High pressure and/or pressure cycling

- External loads
  - Unequalized soil and hydrologic loads as a result of reducing the volume of waste in the tank
  - Maintenance activities and installation and operation of retrieval equipment

- Inflow of groundwater through leak sites; and

- High viscosity liquid waste.

Example 1: At Site X, leak sites for two of the high-level waste storage tanks have been identified at elevations in the top half of each tank. Because of limited retrieval capability and other storage capacity, waste in only one of the tanks has been substantially retrieved. This tank has been designated as a contingency storage tank to accept waste up to an administratively controlled level, well below the elevation of the leak site. Waste in the other tank has only been partially retrieved to an administratively controlled level well below the elevation of the leak sites.

Example 2: At Site H, Tank DEF is known to leak, but the number of leak sites, and their exact locations, cannot be ascertained with a high degree of confidence. Retrieval capability to remove all of the waste does not exist, nor does capacity exist to store all of the waste in other tanks. A decision has been made to remove as much of the pumpable liquid as possible to minimize the consequences of any potential leak. Retrieval capability and contingency capacity are available to support this option. Periodic pumping will continue so as to remove any additional liquids that may become available (interstitial liquids or inflow of groundwater). These actions, together with the very low viscosity of the remaining waste, will help to minimize any further leakage to the environment and its consequences. These actions constitute an acceptable safe operational envelope, with controls, for continued use of the tank for storage where operational constraints preclude the removal of all of the waste.

Corrosion control. BNL-UC-406 also recommends measures to minimize corrosion, including adjustments to waste chemistry, and verification of corrosion rates following such adjustments. The following guidance, based on the primary features of the corrosion control program, are recommended. Refer to the referenced documents for additional details.

1) Ascertain the current in-situ chemical constituents. The chemical constituents of the waste may vary with depth in the tank as the waste settles out into relatively homogeneous zones. The levels at which the most critical corrosion mode(s) and

rate(s) are present are identified, monitored, and controlled. The critical corrosion zones are established to ensure leak-tightness and tank structural integrity. Once the critical zone(s) have been established, repeated actions to identify them should not be required unless the layers in the tank become disturbed.

A schedule for tank sampling is established that is consistent with the critical corrosion mode and rate and with the programmatic requirement to maintain tank integrity, as measured by leak-tightness and structural stability.

> *Example: At Site Z DOE is currently scheduled to complete treatment (solidification) of the high-level (tank) waste in the year 2025. This assumes that no new storage tanks will be built. These programmatic factors mean that some of the site's storage tanks must maintain their structural integrity through the year 2025. These requirements should be considered in establishing the frequency of tank sampling.*

If the projected lifetime of the tanks is very short and the material properties of the tanks have not degraded, then the sampling schedule can be relaxed. However, if the operational requirement for the tank to provide safe storage is relatively long, the corrosion rates are estimated to be high, and the material properties of the tank have degraded, then an aggressive sampling schedule would be necessary.

2) <u>Identify the corrosion modes and assess their rates</u>. Based on the current chemical constituents of the contained high-level waste, expected additional waste receipts, and the material properties of the tank, the corrosion modes and rates are assessed to determine the critical mode(s) and rate(s) that threaten tank leak-tightness and structural stability. Examples of corrosion modes that may be applicable are general corrosion, pitting, and cracking.

3) <u>Add chemicals to mitigate corrosion</u>. After identifying the critical corrosion modes for ensuring leak-tightness and structural stability, the chemistry of the waste are adjusted to mitigate corrosion. Projections for mitigation effectiveness consider the method by which the chemicals are introduced into the storage tank system and the time required for the treatment chemicals to reach the critical zones.

> *Example: Insertion of liquid corrosion-mitigating chemicals through tank inlet piping or tank risers and subsequently distributed by operations of mixing pumps may deliver them directly into the critical*

zones immediately. However, dry chemicals applied to the liquid surface of the wastes stored in the tank, without mixing, may have a long transport time to reach critical zones, or may not reach the zones without some agitation. Such an approach would require evaluation.

4) Validate the corrosion modes and rates in the tank as a result of the adjusted chemical constituents of the waste. In step # 3 above, chemicals were added to the waste to mitigate corrosion rates to a lower target level. In this step, tests are undertaken to determine if the lower targeted corrosion rate was actually achieved through the adjustment to waste chemistry. Projections of corrosion modes and rates based on adjusted tank waste chemistry are validated with tests involving specimens of the tank material at the critical corrosion zone(s). This can be accomplished in-situ or in controlled laboratory tests.

Example: Projections of corrosion modes and rates at Site X High-Level Waste Tank #1001 were validated by subjecting material coupons of the same material as the tank wall to simulated waste and the added corrosion-mitigating chemicals. Based on the results of the validation and the corrosion rates, a frequency for monitoring tank chemistry for corrosion should be established.

Similarly, active cathodic protection systems, where used, need to be calibrated and the impressed currents, if applicable, adjusted to minimize corrosion rates as part of the structural integrity program. The frequency for such calibrations and adjustments is to be established and justified with a technical basis. In addition, DOE Handbooks, such as DOE-STD-HDBK-1015 and -1017, provide information on both the corrosion theory and corrosion material sciences.

The structural integrity of in-service transfer piping needs to be assessed before each transfer of high-level waste. This assessment can be accomplished by pressure testing the pipelines with water or gas.

Compliance with this requirement for leak-tight tanks in service is demonstrated by implementing a structural integrity program for each tank site that should be consistent with the guidelines contained in this guidance and BNL-UC-406, as tailored for the conditions at each high-level waste storage tank site; or as modified by this guidance for leaking tanks.

Supplemental References:

1. BNL, 1997. *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, BNL-UC-406, Brookhaven National Laboratory, Upton, NY, January 1997.

2. DOE, 1992. *DOE Fundamentals Handbook, Chemistry*, DOE-HDBK-1015, Module 2: "Corrosion," U.S. Department of Energy, Washington, D.C., June 1992.

3. DOE, 1993. *DOE Fundamentals Handbook, Material Science*, DOE-HDBK-1017, Module 2: "Properties of Metals," U.S. Department of Energy, Washington, D.C., January 1993.

II. Q.(3) Canistered Waste Form Storage. Canisters of immobilized high-level waste awaiting shipment to a repository shall be:

(a) Stored in a suitable facility;

(b) Segregated and clearly identified to avoid commingling with low-level, mixed low-level, or transuranic wastes; and

(c) Monitored to ensure that storage conditions are consistent with DOE/EM–0093, *Waste Acceptance Product Specifications for Vitrified High-level Waste Forms,* or DOE/RW-0351, *Waste Acceptance System Requirements Document,* for non-vitrified immobilized high-level waste. Facilities and operating procedures for storage of vitrified high-level waste shall maintain the integrity of the canistered waste form.

Objective:

The objective of this requirement is to ensure that immobilized (vitrified) high-level waste is stored and monitored in a manner that meets DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS), or DOE/RW-0351, *Waste Acceptance System Requirements Document* (WASRD). Meeting the requirements of the EM-WAPS or the WASRD reflects the best current understanding of the waste acceptance criteria to support the geologic repository's safety case. Because the Nuclear Regulatory Commission will make the final determination of the adequacy of the acceptance criteria in conjunction with issuing the repository license amendment to emplace, these criteria are not final and changes to them may occur as the licensing process progresses.

Discussion:

During the development of DOE O 435.1 and DOE M 435.1-1 storage of immobilized (vitrified) high-level waste was reviewed for the potential risk to the public, workers and the environment. Because of its stability, storage of the final waste form is considered to pose a low risk.

However, it is critical, for the acceptance of the waste at the geologic repository (disposal site) that the waste has been stored and monitored in a manner consistent with the EM-WAPS and/or the WASRD. Meeting the requirements of these documents is essential because they contain the technical specifications that current waste form producers are required to meet before acceptance of their vitrified high-level waste, or non-vitrified high-level waste, into the Civilian Radioactive Waste Management System. A similar requirement for high-level waste treatment operations is included at DOE M 435.1-1, Section II.R, Treatment.

Since the objective of each of the three subrequirements (a through c) is to ensure to the greatest extent possible at this time that the waste is acceptable to the repository, each will be discussed in terms of the critical EM-WAPS or the WASRD specifications. These specifications are considered critical because they are considered important to storage operations; however, there may be other requirements that pertain to storage operations. Refer to the EM-WAPS and the WASRD for full details on each of the specifications and how they may impact storage operations. Enveloping all three of the subrequirements for vitrified high-level waste forms is the EM-WAPS Specification 4, Quality Assurance Specification and WASRD, Section 3.9, Quality Assurance. These specifications require waste producers to establish a quality assurance program that is consistent with the *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program* (DOE/RW-0333P) requirements. These requirements apply to storage as well as production operations. The following discussion focuses on the specifications for vitrified high-level waste, as defined in the EM-WAPS. However, similar specifications are expected to be developed in the WASRD in the near future and a discussion on these specifications will be added to this guidance at that time.

Subrequirement (a) is intended to ensure that immobilized high-level waste is stored in a facility that meets the requirements of the EM-WAPS. The EM-WAPS specifications that are considered critical to meeting this subrequirement are Specification 1.4.2, Control of Temperature for Phase Stability and Specification 3.7, Specification for Removable Radioactive Contamination on External Surfaces. The first specification is to certify that after initial cool-down the waste form temperature has not exceeded 400^{o} centigrade. The second specification prescribes the level of acceptable surface contamination on a canister at the time of shipment of beta- and gamma-emitting radionuclides and alpha-emitting radionuclides. Both of these specifications may require storage facility engineering controls (e.g., active ventilation systems) to ensure that the centerline temperature limit and the surface contamination limits are not exceeded.

Subrequirement (b) is intended to ensure that the immobilized high-level waste is clearly identified to avoid commingling it with other waste types and to reduce the potential for contaminating other wastes with high-level waste potentially requiring such waste to be sent to the high-level waste repository. The EM-WAPS specification that meets this subrequirement is

Specification 2.3, Identification and Labeling Specification, which prescribes the identifying label that is to be attached to each canister and the size and location of the label.

Subrequirement (c) is intended to ensure that all remaining specifications of the EM-WAPS are met to ensure the waste is acceptable to the waste repository. The EM-WAPS specification that is considered critical to meeting this subrequirement is Specification 5, Documentation and Other Requirements. This administrative specification, among other requirements, prescribes the contents of the Production Records and the Storage and Shipping Records. The Production Records identify the physical attributes of each canister of final waste form and the Storage and Shipping Records describe any abnormal events, such as thermal excursions, which have occurred during the storage of the canister.

Compliance with this requirement is demonstrated by documenting that the immobilized high-level waste is stored and monitored in compliance with the EM-WAPS or WASRD specifications, as applicable.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

2. DOE, 1995. *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program*, Revision 5, DOE/RW-0333P, U.S. Department of Energy, Washington D.C., October 1995.

3. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

II. R. Treatment.

Treatment shall be designed and implemented in a manner that will ultimately comply with DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-level Waste Forms,* or DOE/RW-0351P, *Waste Acceptance System Requirements Document,* for non-vitrified, immobilized high-level waste.

Objective:

The objective of this requirement is to ensure that high-level waste treatment (and pretreatment) activities are designed and implemented in a manner that does not jeopardize the final waste form's ability to meet DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (EM-WAPS), or DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD), for non-vitrified immobilized high-level waste. Meeting the requirements of the EM-WAPS or the WASRD ensures that the waste will be acceptable for disposal in a geologic repository managed by the Office of the Civilian Radioactive Waste Management.

Discussion:

During the development of DOE O 435.1 and DOE M 435.1-1, treatment of waste was identified as an activity that presented potential risks to the public, workers, and the environment. It was determined that requirements to address the weaknesses and conditions that could lead to potential adverse impacts already existed in external requirements (e.g., *Clean Air Act* or RCRA) or other DOE requirements and directives (e.g.,10 CFR Part 835, *Occupational Radiation Protection* or DOE O 360.1, *Training*). Consequently, DOE M 435.1-1, *General Requirements and Responsibilities*, Section I.2.F.(14), assigns the Field Element Manager an umbrella, performance-oriented responsibility for ensuring that waste treatment is protective of the public, workers, and the environment. This requirement focuses instead on the treatment actions necessary to make waste acceptable for subsequent waste management steps, e.g., disposal in a geologic repository.

This requirement was established to ensure that no pretreatment or treatment activities are undertaken that may jeopardize the final (vitrified and non-vitrified) waste forms ability to meet the specifications contained in the EM-WAPS or the WASRD. Meeting this requirement is essential since the EM-WAPS is the technical specifications that current high-level waste form producers are required to meet to ensure acceptance of their vitrified high-level waste into the Civilian Radioactive Waste Management System. Likewise, meeting the requirements of the WASRD is essential for non-vitrified high-level waste. Thus, it is critical that actions taken up to waste disposal, predominately pretreatment and treatment activities, do not compromise the ability of the waste form to meet these specifications. A similar requirement for high-level waste storage operations is included at DOE M 435.1-1, Section II.Q., Storage.

Refer to the EM-WAPS for vitrified waste forms for full details on each of the specifications and how they may be impacted by specific pretreatment or treatment operations. The following examples are offered to display how an action within a pretreatment or treatment facility could jeopardize the final waste forms ability to meet the EM-WAPS.

> *Example 1: At Site X, a change to expedite the production of canisters in the vitrification process is being proposed that may allow organic contaminants to enter the canister between the time of glass pouring and canister closure. However, Specification 3.4 of the EM-WAPS requires that the producer ensure that the canistered waste form does not contain detectable amounts of organic materials. Thus, prior to approval of such a change to the vitrification process, an evaluation needs to be conducted to determine the likelihood of such organic contamination. If organic contamination is possible the proposed change should not be allowed because it could violate the EM-WAPS specification and jeopardize the acceptance of the waste form.*

> *Example 2: At Site Y vitrification (treatment) facility, an order of empty canisters is received that are slightly out of tolerance with the canister diameter specification (63.0 cm versus the specification of 61.0 +1.5 cm, -1.0 cm). Due to vitrification schedule concerns, it is proposed by the plant operations management that the canisters be accepted and used. Such acceptance violates EM-WAPS Specification 2.4.2 and should not be allowed.*

Compliance with this requirement is demonstrated by programs and procedures being documented and used that ensure that high-level waste product specifications for disposal at a geologic repository are met, and final waste form acceptance documentation (production records and storage and shipping records) that certify the requirements of the EM-WAPS or the WASRD have been satisfactorily met.

Supplemental References:

1. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, DC, December 16, 1996.

2. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, April 1999.

II. S. Disposal.

Disposal of high-level waste must be performed in accordance with the provisions of the *Atomic Energy Act of 1954*, as amended, the *Nuclear Waste Policy Act of 1982*, as amended, or any other applicable statutes.

Objective:

The objective of this requirement is to ensure that high-level waste management activities, from generation through post-treatment storage, do not jeopardize the Department's ability to meet the provisions of the *Atomic Energy Act of 1954*, as amended, the *Nuclear Waste Policy Act of 1982*, as amended, and other applicable statutes for high-level waste disposal.

Discussion:

The safety and hazard analysis for management of radioactive waste, conducted to develop the essential requirements for DOE O 435.1 and DOE M 435.1-1, indicated that disposal is the most critical activity requiring controls because disposal is intended to be the last function conducted on the waste, yet the potential hazards from radioactive waste will continue far into the future. Although the disposal of high-level waste at a geologic repository may be regulated by the Nuclear Regulatory Commission (NRC) and the requirements of DOE O 435.1 and DOE M 435.1-1 do not apply to the repository, except as required by DOE O 435.1, Section 4.d., this requirement is necessary to ensure that DOE's high-level waste management activities support any applicable disposal requirements at a repository.

As discussed in the guidance for Section I.2.F.(15), Disposal, the Field Element Manager is responsible for ensuring that radioactive waste is disposed in a manner that protects the public, workers, and the environment. For high-level waste this requirement means that DOE's actions taken during generation, pre-treatment, treatment, and post-treatment storage must not jeopardize the final waste form's ability to meet the provisions of the *Nuclear Waste Policy Act of 1982*, as amended. This is accomplished through compliance with the requirements of the DOE Office of Environmental Management's Waste Acceptance Product Specifications (EM-WAPS). The following is a brief description of the programs and documents that ensure the EM-WAPS meets the provisions of the *Nuclear Waste Policy Act of 1982*, as amended. Also included is a brief description of the responsibilities and interfaces between the DOE Office of Environmental Management and the DOE Office of Civilian Radioactive Waste Management.

Nuclear Waste Policy Act of 1982, as amended. From the *Energy Reorganization Act of 1974*, the NRC was granted licensing and regulatory authority for the receipt, storage, and disposal of high-level radioactive wastes at a geologic repository. From this authority and the *Nuclear Waste Policy Act of 1982*, as amended, the NRC promulgated 10 CFR Part 60, "Disposal of

High-Level Radioactive Wastes in Geologic Repositories," which prescribes the "rules governing the licensing of DOE to receive and possess source, special nuclear, and byproduct material at a geologic repository operations area sited, constructed, or operated in accordance with the *Nuclear Waste Policy Act of 1982*."

In addition, the *Nuclear Waste Policy Act of 1982,* as amended, recognized the Federal responsibility for managing the disposal of spent nuclear fuel and high-level waste as defined in the *Nuclear Waste Policy Act of 1982*, as amended. The Office of Civilian Radioactive Waste Management, established under the *Nuclear Waste Policy Act of 1982*, as amended, developed the DOE/RW-0351P, *Waste Acceptance System Requirements Document* (WASRD) that describes the functions to be performed and the technical requirements for a "Waste Acceptance System" for accepting spent nuclear fuel and high-level radioactive waste into the Civilian Radioactive Waste Management System. The WASRD, which is subject to the requirements of the Office of Civilian Radioactive Waste Management DOE/RW-0333P, *Quality Assurance Requirements and Description Document*, establishes the requirements for acceptance of high-level waste into the geologic repository. The waste acceptance requirements contained in the WASRD are derived from a number of documents including statutes, regulations, and DOE directives; the primary requirements are contained in 10 CFR Part 60. The EM-WAPS is derived from the WASRD, and serves as the basis for the high-level waste producer's Waste Acceptance programs.

The EM-WAPS outline the technical specifications waste form producers are required to meet in order to ensure acceptance of their vitrified high-level waste into the Office of Civilian Radioactive Waste Management system. The Office of Environmental Management has the responsibility for providing product specifications to the waste form producers. The Office of Environmental Management also ensures that the EM-WAPS are in concert with the Office of Civilian Radioactive Waste Management WASRD. Compliance by the vitrified waste form producers with the current EM-WAPS ensures that the disposal provisions of the *Nuclear Waste Policy Act of 1982*, as amended, will be met. The specifications from the current EM-WAPS are not duplicated here; refer to the current EM-WAPS for additional information on each specification.

Atomic Energy Act of 1954, as amended. It is recognized that onsite disposal of high-level waste may be possible under the provisions of the *Atomic Energy Act of 1954*, as amended. However, the safety and hazards analysis conducted to support DOE O 435.1 and DOE M 435.1-1 did not evaluate disposal activities for high-level waste at a DOE site. Therefore, DOE O 435.1 and DOE M 435.1-1 do not include safety and administrative requirements for such activities. Further, DOE plans that high-level waste be treated to meet specifications for acceptance for disposal at a repository under the *Nuclear Waste Policy Act of 1982,* as amended. Onsite disposal of high-level waste is not consistent with these plans.

Interfaces Between the Office of Environmental Management and Office of Civilian Radioactive Waste Management . Responsibilities of, and interfaces between, the Office of Environmental Management and Office of Civilian Radioactive Waste Management for the management of high-level waste are defined in the Memorandum of Agreement between the Office of Environmental Management and Office of Civilian Radioactive Waste Management (*Memorandum of Agreement for Acceptance of Department of Energy Spent Nuclear Fuel and High-Level Radioactive Waste*), dated January 1999. Guidance on these requirements is provided here to assist in determining the boundaries of responsibilities for these two organizations.

The Memorandum of Agreement (MOA) responds to the requirements of the *Nuclear Waste Policy Act of 1982*, as amended, that Federal agencies requiring disposal services for spent nuclear fuel and/or high-level waste be accommodated by a suitable interagency agreement reflecting the terms and conditions set forth in the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste as provided in the *Nuclear Waste Policy Act of 1982*, as amended. Through the MOA, the Office of Environmental Management and Office of Civilian Radioactive Waste Management seek to achieve safe and timely disposal of DOE spent nuclear fuel and high level waste by identifying data needs, interface descriptions, and acceptance criteria and developing compliance procedures needed to support both the geologic repository license application to the NRC and the transportation system necessary to transfer DOE spent nuclear fuel and high-level waste to an Office of Civilian Radioactive Waste Management facility.

The following are the highlights of the MOA that support the management of high-level waste. These are provided to support the use of DOE O 435.1 and DOE M 435.1-1. Refer to the MOA for additional details. The MOA is available on the Internet at *http://www.rw.doe.gov/pages/resource/facts/moafin3r1.pdf*.

A. Data Needs

Any changes to the Waste Form Compliance Plan, Waste Form Qualification Report, Production Records and Storage and Shipping Records, which presently meet the Office of Civilian Radioactive Waste Management data needs, shall be coordinated between the Office of Civilian Radioactive Waste Management and Office of Environmental Management.

B. Design, Certification and Fabrication of Transportation and Storage Systems for DOE High-level waste

The Office of Environmental Management shall design, fabricate and store high-level waste pour canisters. The Office of Civilian Radioactive Waste Management shall be responsible for the design, NRC certification and fabrication of the transportation cask system.

C. Transportation and Loading Operations

The Office of Environmental Management shall be responsible for the Office of Environmental Management site infrastructure and shall provide all preparation, assembly, and inspections for loading high-level waste pour canisters into transportation casks and for the transportation of high-level waste to the Office of Civilian Radioactive Waste Management. For the loading of high-level waste pour canisters into the transportation casks, the Office of Civilian Radioactive Waste Management shall provide written procedures and training for cask handling and loading and information and parts necessary for cask maintenance. For the handling of high-level waste at an Office of Civilian Radioactive Waste Management facility, the Office of Environmental Management shall provide similar records to the Office of Civilian Radioactive Waste Management. The Office of Civilian Radioactive Waste Management shall be responsible for routine cask maintenance, while incidental maintenance is the responsibility of whichever organization possesses the cask.

D. Conformance and Safeguards Verification of High-level waste

The Office of Civilian Radioactive Waste Management shall perform conformance verification of all high-level waste delivered to the Office of Civilian Radioactive Waste Management and shall agree to accept the high-level waste that meets the acceptance criteria for disposal when the Office of Civilian Radioactive Waste Management has completed safeguards verification and determined that the material is properly loaded, packaged, marked, labeled and ready for transportation. The Office of Civilian Radioactive Waste Management reserves the right to refuse to accept improperly described high-level waste. If the Office of Civilian Radioactive Waste Management has already accepted improperly described high-level waste, the Office of Environmental Management must provide the Office of Civilian Radioactive Waste Management with a proper designation within 30 days. Temporary storage of improperly described high-level waste will be at the facility where the material resides at the time the improper designation is discovered.

E. Acceptance of High-level Waste

The Office of Civilian Radioactive Waste Management shall accept high-level waste at the Office of Environmental Management site after successful conformance and safeguards verification and shall be solely responsible for control of all material upon acceptance.

F. NRC Licensing for Storage and Disposal

The Office of Civilian Radioactive Waste Management shall have the lead responsibility in repository and storage facility (if needed) pre-licensing and licensing interactions with the NRC. The Office of Environmental Management shall support the Office of Civilian Radioactive Waste Management in these interactions.

G. Training

The Office of Environmental Management and Office of Civilian Radioactive Waste Management shall each be responsible for providing or acquiring training specific to their various responsibilities as described in the MOA.

H. Quality Assurance

The Office of Environmental Management and Office of Civilian Radioactive Waste Management shall abide by requirements of the Office of Civilian Radioactive Waste Management's *Quality Assurance Requirements and Description* (DOE/RW-0333P) and the Quality Assurance MOAs between the Office of Environmental Management and Office of Civilian Radioactive Waste Management. For high-level waste, this is the MOA between the Office of Waste Management and Office of Civilian Radioactive Waste Management for *Coordination of Quality Assurance Activities Associated with High-Level Waste and Spent Nuclear Fuel* (Appendix E to the MOA). Specific activities subject to Quality Assurance controls are defined in *Quality Assurance Requirements and Description*.

Compliance with this requirement is demonstrated by the preparation and acceptance of the waste acceptance documentation required by the EM-WAPS. This includes the Waste Form Compliance Plan, the Waste Form Qualification Report, Production Records, and Storage and Shipping Records. The contents of these documents are specified throughout the EM-WAPS.

Supplemental References:

1. *Nuclear Waste Policy Act of 1982,* as amended, Public Law 97-425, Section 2.(12), January 7, 1983.

2. *Atomic Energy Act of 1954*, as amended, August 30, 1954.

3. DOE, 1999. *Waste Acceptance System Requirements Document*, Revision 3, DOE/RW-0351P, U.S. Department of Energy, Washington, D.C., April 1999.

4. DOE, 1995. *Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program*, DOE/RW-0333P, U.S. Department of Energy, Washington, D.C., October 2, 1995.

5. DOE, 1996. *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms (EM-WAPS)*, Revision 2, DOE/EM-0093, U.S. Department of Energy, Washington, D.C., December 16, 1996.

6. DOE, 1999. Assistant Secretary for Environmental Management (EM) to the Director Office of Civilian Radioactive Waste Management (RW), memorandum, *Memorandum of Agreement for Acceptance of Department of Energy Spent Nuclear Fuel and High-Level Radioactive Waste*, Revision 1, U.S. Department of Energy, January, 1999. Available on the Internet at *http://www.rw.doe.gov/pages/resource/facts/moafin3r1.pdf*

7. EPA, 1985. "Final Rule; 40 CFR 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," *Federal Register*, Vol 50, No. 182, U.S. Environmental Protection Agency, Washington, D.C., September 19, 1985.

II. T. Monitoring.

High-level waste pretreatment, treatment, storage, and transportation facilities shall be monitored for chemical, physical, radiological, structural, and other changes that could indicate failure of systems confinement, integrity, or safety, and which could lead to abnormal events or accidents. Parameters that shall be sampled or monitored, at a minimum, include: temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, flammable or explosive mixtures of gases, level and/or waste volume, and significant waste chemistry parameters for non-immobilized high-level waste. Facility monitoring programs shall also include physical inspections to verify that control systems have not failed.

Objective:

The objectives of this requirement are to: specify minimum parameters for which data will be routinely collected and analyzed; ensure by physical inspection that instrumentation, controls, automatic monitoring systems, and automatic shut-off systems have not failed; sample the chemical characteristics (appropriate parameters and monitoring frequencies) of the waste necessary to support the requirements of the structural integrity program; and promptly evaluate the results of the inspections and sample analyses.

Discussion:

This monitoring requirement is intended to alert facility operators to releases and the potential for releases of radioactivity in effluents and to the generation of explosive and flammable gases from operations. During the development of DOE O 435.1 and DOE M 435.1-1, monitoring at radioactive waste management facilities was identified as an effective way to mitigate numerous weaknesses and conditions associated with all phases of the life-cycle of waste management. An analysis of existing departmental requirements for environmental monitoring in DOE 5400.1 and DOE 5400.5 found that they were applicable to all radioactive waste types and all radioactive waste management facilities. Many of the individual conditions that were evaluated in the safety and hazards analysis and that warranted monitoring are already monitored due to the implementation of the requirements in DOE 5400.1 and DOE 5400.5. Consequently, DOE M 435.1-1 Section I.1.E.(7), Environmental Monitoring, requires that these two DOE Orders be implemented for environmental monitoring of radioactive waste management facilities.

While the environmental monitoring mandated by DOE 5400.1 and DOE 5400.5 is adequate to detect after-the-fact releases of high-level waste to the environment, additional requirements are necessary to improve the detection of conditions that could provide warning of impending releases that could increase worker exposure and/or impact the environment. Some of the requirements contained in the *Nuclear Safety Analysis Reports* Order (DOE 5480.23), related DOE standards (DOE-STD-3009-93, DOE-STD-1027-92, DOE-EM-STD-5502-04), and the *Facility Safety* Order (DOE 420.1), provide information on the hazard categorization of facilities and the safety analyses to be performed. Through the conduct of safety analyses for high-level waste management facilities (e.g., storage, pretreatment, treatment, and transportation), facility personnel identify the quantity and form of radioactive material to be handled at the facility, the operations for managing the waste, and the associated hazards of this source term under the proposed operational scenario. The safety analysis establishes a basis for defining the acceptable operational envelope for the facility and provides the basis for identifying technical safety requirements if needed. The technical safety requirements may include requirements for monitoring; however, facility personnel need to also review the safety analysis to determine if it indicates other monitoring that would be prudent.

An effective monitoring program is dependent on the frequency and the rigor of the monitoring operations, and the effectiveness of the systems and devices in detecting changes and abnormal conditions. Therefore, facility managers must take these factors into consideration when designing the monitoring program to ensure that the high-level waste systems are being operated according to design.

The specified parameters to be monitored are selected based on their significance for anticipating and identifying undesirable conditions and the availability of a means for monitoring them. In addition, parameters to be monitored include those to ensure the protection of public health, the environment, and workers due to releases of radioactivity in ventilation exhausts and liquid effluent streams, and from unsafe concentrations of flammable and/or explosive gases in the waste. The accuracy and precision of measurement required is dictated by the expected variations in the parameters and the level of accuracy and precision needed to identify problems. The monitoring frequency for specific parameters is likewise determined based on the possible time variation of the parameter and the response time required to take mitigating action. For facilities that release radioactive effluents, frequent monitoring or continuous monitoring may need to be considered.

> *Example 1: A high-level waste treatment facility includes a holding tank that contains liquid high-level waste that can be held for months prior to processing. The tank is equipped with an induced draft ventilation system. The tank must include monitoring capability for temperature, radioactivity in the ventilation system, waste level and/or volume, and significant chemical parameters. Where the contents of the waste generate flammable or explosive mixtures of gases, monitoring capability must also be provided to detect the concentrations of such gases. The other minimum parameter (pressure) need not be monitored because the tank is ventilated, not closed.*

Example 2: A high-level waste treatment facility has an interim storage tank that contains liquid high-level waste. The minimum parameters specified in the monitoring requirement in DOE M 435.1-1 are monitored. The facility manager has identified additional parameters to be monitored and established a monitoring schedule based on the hazards identified in the Safety Analysis Report.

High-level waste management facilities are required to apply the monitoring requirement for the specified parameters using a graded approach. As previously noted, the methods used and the frequencies of monitoring are commensurate with the significance of changes in the parameters.

The monitoring of waste level and/or volume is required to address a high hazard that was identified by the hazards analysis performed in support of this Order and Manual -- the failure to promptly detect a release of high-level waste that could impact workers, the public, or the environment. The monitoring of these parameters addresses the operation of monitoring systems to detect vessel or transfer equipment failure that is of sufficient magnitude to cause a detectable volume change as well as to alert operators that a vessel (e.g., tank or bin) is approaching capacity so that overfilling can be avoided. This requirement is focused on operations, and is closely related to the requirement in Section II.P.(2)(j) which requires engineered monitoring systems.

There are a number of complicating factors that must be considered to meet the level/volume aspect of the monitoring requirement. Some of these factors could lead to failure to detect leaks and/or to over-react to changes in surface level indicators. These factors include the following:

(1) Irregular shaped crusts can form on the surface of the waste during storage, which could render automatic surface level detection devices unreliable for promptly detecting actual changes in the volume of the waste in a storage tank. The irregular crust could lead to false indications of increase, decrease, or no change in surface level and tank volume.

(2) High-level waste storage tanks with a very high thermal load will cause evaporation resulting in a decrease in tank surface level and volume. The decrease in tank volume must be correlated with the calculated rate of evaporation before a judgement can be made regarding whether the tank is leaking.

(3) Chemical conditions in the waste tank can result in gases generated within the waste becoming trapped within the waste matrix, leading to indications of false increases in the surface level.

(4) For underground storage tanks, an increase in the surface level can also result from an inflow of groundwater through leak-sites above the level of the waste, indicating a loss of structural integrity.

(5) Intentional additions to and removals from the storage vessels must also be considered in evaluating the monitoring results.

Example 1: An unexpected chemical reaction generates gas that is trapped within the waste matrix. The resulting rise in surface level precluded the detection of a leak in the tank by monitoring surface level only.

Example 2: Operating personnel at a high-level waste storage facility calculated the evaporative loss expected from a tank based on an assumed radionuclide inventory. The actual radionuclide inventory was much smaller than that assumed, so the actual heat generation rate was much smaller than that assumed. Overestimation of the change in waste volume due to evaporation resulted in failure to detect leakage that was incorrectly assumed to be evaporative loss.

The monitoring of waste chemistry parameters needs to be able to detect significant changes important to corrosion, and to the generation of explosive and/or flammable gases. The frequency of monitoring should satisfy the requirements identified by the structural integrity program in Section II.Q.(2), but the frequency of monitoring may need to be even greater if required to monitor the formation of gases.

Monitoring of waste chemistry parameters needs to:

(1) detect changes in the waste chemistry that cause changes in the rates of the critical corrosion modes previously identified;

(2) determine if new critical corrosion modes have been established;

(3) determine when adjustments to waste chemistry are required to maintain the predicted corrosion rates established by the structural integrity program [II.Q.(2)]; and

(4) monitor the formation and accumulation of any gases within the waste.

Other design related requirements of this chapter include Confinement in Section II.P.(2)(b) and Instrumentation and Control in Section II.P.(2)(i).

A graded approach is applied to operational implementation of this requirement for monitoring to detect releases promptly. The full suite of parameters to be monitored as well as the methods for monitoring them are tailored to the specific facility and vessel. For example, it may not be necessary to provide continuous monitoring of waste levels and waste parameters in bins of stored calcined high-level waste, since corrosion is not usually a problem.

Compliance with this requirement is demonstrated by: the identification of, and justification for, the parameters to be monitored and the frequency with which they will be monitored including coordination with the structural integrity program to identify important waste chemistry parameters and appropriate monitoring frequency; development and implementation of procedures and training to insure that disciplined and effective monitoring is sustained; and prompt evaluation of monitoring data by qualified personnel and prompt reporting of findings to management.

Supplemental References:

1. DOE, 1994. *DOE Limited Standard: Hazard Baseline Documentation*, DOE-EM-STD-5502-04, U.S. Department of Energy, Washington, D.C., August, 1994.

2. DOE, 1992. *Nuclear Safety Analysis Reports*, DOE 5480.23, U.S. Department of Energy, Washington, D.C., April 10, 1992.

3. DOE. *DOE Fundamentals Handbook, Material Science*, Corrosion, DOE-HDBK-1017.

4. BNL, 1997. *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, Brookhaven National Laboratory, BNL-UC-406, January 1997.

5. DOE, 1986. *Nuclear Safety Analysis and Review System*, DOE 5481.1B (canceled), U.S. Department of Energy, Washington, D.C., September 23, 1986.

6. DOE, 1992. *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C., December 1992.

7. DOE, 1993. *SAR Preparation Guide*, DOE-STD-3009-93, U.S. Department of Energy, Washington, D.C., 1993.

8. DOE, 1995. *Facility Safety*, DOE O 420.1, U.S. Department of Energy, Washington, D.C., October 13, 1995.

II. U. Closure. The following requirements for closure of deactivated high-level waste facilities and sites are in addition to those in Chapter I of this Manual.

(1) Decommissioning. Deactivated high-level waste facilities/sites shall meet the decommissioning requirements of DOE O 430.1A, *Life-Cycle Asset Management* and the requirements of DOE 5400.5, *Radiation Protection of the Public and the Environment*, for release; or

(2) CERCLA Process. Deactivated high-level waste facilities/sites shall be closed in accordance with the CERCLA process as described in Section I.2.F.(5); or

(3) Closure. Deactivated high-level waste facilities/sites shall be closed in accordance with an approved closure plan, as specified below. Residual radioactive waste present in facilities to be closed shall satisfy the waste incidental to reprocessing requirements of this Chapter.

(a) Facility/Site Closure Plans. A closure plan shall be developed for each deactivated high-level waste facility/site being closed that defines the approach and plans by which closure of each facility within the site is to be accomplished. This plan shall be completed and approved prior to the initiation of physical closure activities, and updated periodically to reflect current analysis and status of individual facility closure actions. The plan shall include, at a minimum, the following elements:

1. Identification of the closure standards/performance objectives to be applied from Chapter III or IV, as appropriate;

2. A strategy for allocating waste disposal facility performance objectives from the closure standards identified in the closure plan among the facilities/units to be closed at the site;

3. An assessment of the projected performance of each unit to be closed relative to the performance objectives allocated to each unit under the closure plan;

4. An assessment of the projected composite performance of all units to be closed at the site relative to the performance objectives and closure standards identified in the closure plan; and

5. Any other relevant closure controls including a monitoring plan, institutional controls, and land use limitations to be maintained in the closure activity.

Objective:

The objective of this requirement is to ensure that closure of deactivated high-level waste facilities follows one of three acceptable closure processes. The first requirement allows deactivated high-level waste management facilities that can meet the decommissioning requirements of DOE O 430.1A to be released for restricted or unrestricted use. The second part allows deactivated high-level waste facilities to be closed using the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) process to demonstrate compliance with DOE Orders and other requirements under the *Atomic Energy Act of 1954*, as amended. The final part defines the requirements that shall be met for all other deactivated high-level waste facilities that are to be closed.

Discussion:

In support of the requirements in Section II.U, there are a number of requirements in Chapter I of DOE M 435.1-1 that address closure and need to be considered with this section. These include Section I.2.E.(2), Site Closure Plans, which defines the roles and responsibilities of the Deputy Assistant Secretaries for Waste Management and/or Environmental Restoration and Section I.2.F.(8), Closure Plans, which defines the same for the Field Element Manager. Guidance for each of these sections describes the roles and responsibilities for developing, reviewing, approving, and implementing the closure documents required by this section. Additionally, Section I.2.F.(5), Environmental Restoration, Decommissioning, and Other Cleanup Waste, defines the roles and responsibilities for managing and disposing of radioactive waste resulting from environmental restoration activities and will likely include decommissioning activities. These activities may overlap with the closure requirements of this section and therefore need to be reviewed for applicability.

To understand the scope of the requirements in Section II.U, the following definitions are provided. Chapter I of DOE M 435.1-1 defines closure as:

> “Deactivation and stabilization of a radioactive waste facility intended for long-term confinement of waste.”

DOE O 430.1A, *Life-Cycle Asset Management*, defines deactivation as:

> “Process of placing a facility in a stable and known condition including the removal of hazardous and radioactive materials to ensure adequate protection of the worker, public

health and safety, and the environment thereby limiting the long-term cost of surveillance and maintenance. Actions include the removal of fuel, draining and/or de-energizing nonessential systems, removal of stored radioactive and hazardous materials, and related actions. Deactivation does not include all decontamination necessary for the dismantlement and demolition phase of decommissioning, e.g., removal of contamination remaining in the fixed structures and equipment after deactivation."

The scope of the closure requirements in Section II.U includes those activities necessary to complete the life cycle of former (deactivated) high-level waste facilities, or a group of facilities (herein named a site), by stabilizing residual hazardous and radioactive materials in a manner that ensures adequate protection of the worker, public health and safety, and the environment to limit long-term management of the facility. Activities that may be included are deactivation (as defined above), as well as post-deactivation activities, such as decontamination and decommissioning activities, both of which support placing a facility in a final state that requires the minimal amount of long-term management. The closure of deactivated high-level waste facilities is considered an activity that may be driven by DOE Orders, external regulations, local agreements, or both and therefore requires flexibility in meeting the objectives stated above. For this reason, the requirements in Section II.U provide three alternative paths to accomplishing closure: (1) meeting the decommissioning requirements of DOE O 430.1A and the release requirements and guidelines contained in DOE 5400.5; (2) following the CERCLA process to meet DOE requirements; or (3) meeting the requirements of a DOE-approved facility/site-specific closure plan. Following a brief discussion on the waste incidental to reprocessing determination process, each of these paths are discussed.

Waste Incidental to Reprocessing. Material remaining in a deactivated high-level waste management facility that meets the requirements in Section II.B for the Citation or Evaluation processes can be included in the closure process, as discussed in this guidance, and managed as either low-level waste or transuranic waste. If it does not meet the criteria for determining that the waste is incidental to reprocessing, then the residual waste must be managed as high-level waste.

As discussed in the guidance for Section II.A, Definition of High-Level Waste, DOE plans to dispose of high-level waste in a geologic repository consistent with the *Nuclear Waste Policy Act of 1982*, as amended. This plan was outlined in Secretary Hodel's letter to President Reagan (DOE, 2/6/85), in which the Secretary recommended that "the Department proceed with plans and actions to dispose of defense waste in a commercial repository." President Reagan's finding, in accordance with Section 8 of the *Nuclear Waste Policy Act of 1982*, as amended (Presidential memo, 4/30/85), found no basis to do otherwise and the Department has since implemented plans to dispose high-level waste in a geologic repository consistent with the *Nuclear Waste Policy Act of 1982*, as amended. Thus, any residual radioactive material remaining in deactivated high-level waste management facilities must meet the waste incidental to reprocessing evaluation process requirements for a high-level waste closure activity to continue under these requirements.

Decommissioning. Section II.U.(1), Decommissioning, provides the opportunity to close deactivated high-level waste facilities/sites by meeting the Department's public dose limits for residual radioactive material which allows restricted or unrestricted release of the property. The draft guide on decommissioning, Draft G 430.1-4, *Decommissioning Implementation Guide,* and Chapter IV of DOE 5400.5, *Radiation Protection of the Public and the Environment,* discuss the requirements/guidance on meeting these public dose limits. The draft DOE G 430.1-4 provides the framework and guidance for implementing DOE O 430.1A and DOE P 450.4, *Safety Management System Policy*, during decommissioning activities conducted as part of facility disposition. Draft DOE G 430.1-4 also addresses the implementation of the *Policy on Decommissioning of DOE Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), dated May 22, 1995 (commonly known as the Decommissioning Policy). Chapter IV, *Residual Radioactive Material*, of DOE 5400.5, defines the radiological protection requirements and guidelines for cleanup of residual radioactive material that are applicable to allow the free release of deactivated high-level waste facilities for use without radiological restrictions.

While it is believed the number of former high-level waste facilities or sites that can meet this criteria will be small, the requirement is provided to allow closure through meeting the prescribed dose limits and surface contamination guidelines, where possible. In order to make such a determination, release criteria should be developed on the basis of the guidelines found in Chapter IV of DOE 5400.5. Chapter IV of DOE 5400.5 includes additional information on the development of site-specific release criteria and guidelines. DOE policy requires residual radioactivity to be reduced in accordance with ALARA principles before a site is released. The principles of ALARA are discussed in both DOE 5400.5 and the guidance to DOE M 435.1-1, Section I.2.F.(12).

The roles and responsibilities of the Field Element Manager, the Program Office, and the Office of Environment, Safety, and Health that are to be met for this closure path are contained in DOE 5400.5 and DOE O 430.1A.

CERCLA Process. Section II.U.(2), CERCLA Process, allows deactivated high-level waste facilities/sites to be closed using the CERCLA process to demonstrate compliance with the *Atomic Energy Act* requirements in the DOE Orders. Information on use of the CERCLA process can be found in numerous documents published by the Environmental Protection Agency (EPA) and DOE. Some of these documents are included in the listing of supplemental references at the end of this guidance section. Additionally, guidance to DOE M 435.1-1, Section I.2.F.(5), provides information on the use of the CERCLA process for planning and managing onsite disposal of low-level waste resulting from environmental activities, which includes decommissioning and facility closure. (As noted in the guidance to Section I.2.F.(5), the requirement in Section I.2.F.(5) replaces the January 1997 guidance for complying with DOE 5820.2A and the May 1996 policy for demonstrating compliance with DOE 5820.2A for CERCLA or cleanup activities).

DOE high-level waste sites may follow the CERCLA process either because they are listed on the National Priorities List (NPL) or because the regulatory structure established in cleanup strategies (e.g., negotiated agreements) is based on CERCLA authority and procedures. As discussed in the guidance to Section I.2.F.(5), the CERCLA process may be used to demonstrate compliance with the requirements of DOE O 435.1 and DOE M 435.1-1 with regard to the safe management and onsite disposal of waste generated by environmental restoration activities.

Application of the CERCLA process to the closure of deactivated high-level waste management facilities involves the following:

- Remedial Investigation (RI) is a process undertaken to determine the nature and extent of the problem. The RI emphasizes data collection and site characterization and is generally performed concurrently and in an interactive manner with the feasibility study.

- Feasibility Study (FS) is undertaken to develop and evaluate options for remedial action. The FS emphasizes data analysis, using data gathered during the RI, and defines the objectives of the response action, to develop remedial alternatives and to undertake an initial screening and detailed analysis of the alternatives.

- Record of Decision documents the final selection of the cleanup option. This ROD also satisfies relevant NEPA requirements.

- Remedial Design is the technical analysis and procedures which follow the selection of the remedy and results in detailed plans and specifications for implementation.

- Remedial Action involves the actual construction or implementation of the cleanup.

As part of the Remedial Design, the applicable or relevant and appropriate requirements (ARARs) must be selected. The guidance for Section I.2.F.(5) provides additional information on the selection of ARARs and the applicability of DOE O 435.1 and DOE M 435.1-1 . This guidance also provides additional instructions on the applicability and demonstration of compliance with the performance objectives for a waste disposal facility in Section IV.P.(1) of DOE M 435.1-1.

The roles and responsibilities of the Field Element Manager and the Deputy Assistant Secretaries for Waste Management and Environmental Restoration for this closure path can be found in Sections I.2.F.(8) and I.2.E.(2), respectively.

Closure. Section II.U.(3), Closure, provides the third path for the closure of deactivated high-level waste facilities. This process includes the preparation of a closure plan that contains the elements defined in Sections II.U.(3)(a)(1) through (5). Each of these elements, as well as the expectations for a closure plan, are discussed below. The roles and responsibilities of the Field Element Manager, defined in Section I.2.F.(8), Closure Plans, and the Deputy Assistant Secretaries for Waste Management and Environmental Restoration, defined in Section I.2.E.(2), Site Closure Plans, are critical to the implementation of the closure process and need to be closely coordinated with the requirements in Section II.U.(3) to ensure the closure process meets its objectives.

Facility/Site Closure Plans. For each deactivated high-level waste facility or site, a closure plan must be developed. The general purpose of closure plans is to define the approach that will be taken for ensuring the long-term protection of the public and the environment from the closure of deactivated high-level waste facilities containing residual low-level or transuranic wastes. Included as part of this approach are the purpose and objectives of the closure action and general discussion of how the specific closure action fits within other past, and planned, closure actions. The closure plan should also address the three phases that a facility closure may experience. These are: (1) operational or interim closure; (2) final facility closure; and (3) institutional closure.

Operational, or interim closure, includes those activities that are conducted to stabilize a deactivated high-level waste facility, but do not include the final actions necessary to support minimal, long-term maintenance. Final closure activities include those activities that complete the physical activities necessary for the closure of the facility/site but do not include long-term institutional control activities. Institutional control closure follows final closure and includes the actions and measure necessary to ensure long-term stability of the site such as monitoring and land use limitations.

> *Example: Closure of a group of deactivated high-level waste tanks at Site K is planned and defined in a Closure Plan. Included is a schedule and list of activities that defines the activities planned for each phase of the closure. First is Interim Closure which will involve all the activities necessary, following bulk waste removal, to stabilize the tanks and their contents including filling them and the connecting piping with grout, to avoid subsidence. Stabilization also allows tank surveillance and maintenance activities to be reduced. The Final Closure phase is planned to be a CERCLA closure action that includes all the tanks and other facilities within the area of this group of tanks and includes the application of a cap, ground cover, and the installation of monitoring*

stations and permanent markers. The Institutional Closure phase is planned to last up to 100 years after the Final Closure phase and will include monitoring, land use limitations, and any necessary corrective actions, e.g., additional erosion protection, to ensure protection of the public and the environment.

The closure plan needs to address all activities to be performed during and following deactivation of a facility, including decommissioning, with emphasis on those activities required to minimize the need for long-term maintenance and maximize the stability of the closed facility. As with the closure of low-level waste disposal facilities, a period of active institutional control of 100 years is normally assumed during which access is controlled, and monitoring, and custodial maintenance is performed. However, longer periods of institutional control may be assumed when justification is provided in documented plans which describe long-term site land use or site remediation.

Closure plans need to include the conceptual/preliminary designs and approaches to be taken for each step in the closure process and should be coordinated with the monitoring plan (see discussion below) for the closure facility or site. The closure plan provides the details for accomplishing the closure requirements included in the design. The plan needs to be specific to the facility or site closure action, the characteristics of the site, and the residual wastes in the deactivated facility. The plan should provide a discussion of applicable DOE, Federal, State, and local closure requirements. A discussion of each activity to be performed during each phase of the closure process, and the relationship between the activities to achieve the desired result of minimum maintenance and long-term stability are to be provided. The methods for accomplishing each of the closure activities are to be provided for each phase of the closure, including those methods to be employed to minimize infiltration of water into the closed site and the final landscape. As part of this discussion, the plan needs to explain how contaminant migration will be controlled in the near-term and the long-term. A description of the cover designs for the closed units and their intended performance is included. Features of the plan which address the minimization of erosion by wind and water are also described, along with features to prevent intrusion into the closed unit by plants and animals.

The closure plan includes a summary description of how the activities to be performed will place the facility into a configuration which will allow the performance objectives identified (see requirement in Section II.U.(3)(a)(3)) to be met in both the short-term and the long-term. The schedule for completing facility closure accompanies this presentation. The schedule is to show each phase of closure and the preparation and approval of related documents and permits, such as the final assessment of projected performance, projected composite performance of all units to be closed at the site, safety analysis report, RCRA permit, or State approvals.

Example: The closure plan for Facility X provides a crosswalk summary of the elements of the facility closure to and the performance objectives for the closure of the facility.

The relationship between each feature included in the closure plan and the corresponding purpose of the feature with respect to the short-term and long-term performance of the facility is explained. How the various elements of the closure plan support minimizing the potential for the transport of contamination is provided. The closure plan includes the schedule for the facility closure that includes milestones and the steps for completing each step with dates of completion. The closure plan also lists, as part of the schedule, all needed permits and documents as part of the closure. Milestones are established for the completion of all documents and permits. The schedule includes allowances for review and approval of all documents and permits.

The closure plan also addresses corrective actions to be taken at each stage of the closure process. For example, it includes the elements of an inspection program, the inspection methods to be used, and the criteria to be used for initiating corrective actions. Specific corrective actions should be included for the occurrence of subsidence or the indication of contaminant migration. Other corrective actions to address potential issues such as uncontrolled facility or site access, natural phenomena, failure of monitoring equipment, ponding of water or excessive infiltration, erosion, or the presence of undesirable flora or fauna should also be included. The relationship between corrective actions to ensure compliance with the performance objectives and the monitoring program need to be clearly identified.

As required by Section II.U.(3)(a), each deactivated high-level waste facility or site, as defined in this guidance, shall have a plan that is complete and approved, as specified by the requirements in Sections I.2.F.(8) and I.2.E.(2), prior to physical closure activities. This requirement is intended to reduce the risk of committing a significant amount of resources to a closure action before the closure plan has been reviewed and approved by the appropriate levels of management. As explained in the guidance to these two sections closure plans are expected to be two-tier documents, i.e., their development and review/approval are expected to be conducted in two phases. This multi-phase process is considered necessary because it is recognized that much of the data needed to fulfill all the requirements in Section II.U.(3)(a) are not available initially, but become available as engineering data and/or other documents/permits are developed. However, Headquarters' review and approval is primarily focused on the first tier plans from which subsequent plans are developed.

The first tier plan, which is to be approved by the Deputy Assistant Secretaries for Waste Management and/or Environmental Restoration (Section I.2.E.(2)), is intended to define and bound the parameters of a closure action(s). This level of closure plan should include, at a minimum, the following topics:

- closure methodology;
- schedules and assumptions;
- site or individual closure standards/performance objectives;

- allocation of closure standard/performance objective budgets to individual facilities/sites;
- assessment (preliminary) of the projected performance of each unit to be closed relative to the allocated performance objectives;
- assessment (preliminary) of the projected composite performance of all units to be closed at the site;
- alternatives (if any);
- waste characterization data;
- closure controls plans; and
- stakeholder concerns.

While it is recognized that the availability of some of the above information may be limited and therefore, preliminary, it is necessary to ensure that a credible, bounding review can be conducted by DOE Headquarters.

The second tier of the closure plan, which is to be approved by the Field Element Manager, or designee, should provide the detailed information related to a specific unit or facility closure action that is bounded by the analyses contained in the first tier plan. The lower tier closure documentation should demonstrate that the performance objectives identified in the upper tier documentation can be met and maintained. As explained in the guidance to Sections I.2.E.(2) and I.2.F.(8), the first tier closure documentation should be approved by the Deputy Assistant Secretaries for Waste Management and/or Environmental Restoration before remedial action activities commence. However, design and field survey work can proceed prior to approval of a closure plan, particularly in the case where the data are needed to support elements required in the closure plan. Additionally, once the DOE Headquarters review/approval is gained on the first tier documentation and an authorization to proceed is issued, additional DOE Headquarters approvals are not required provided the bounding conditions defined in the approved first tier plan are not exceeded.

Example: Site ZZ plans to close a cluster of deactivated high-level waste tanks and an evaporator facility as a single closure unit. While detailed information concerning the closure actions is not available because of the lack of engineering analysis and RCRA permit discussions with the State, the Site prepares a first tier Interim Closure Plan that bounds the expected closure conditions. This plan includes a closure methodology, schedules and assumptions, identification of the closure site performance objectives (as required by Section II.U.3.(a)1.), preliminary waste characterization data, a strategy for apportioning the site performance objectives to each of the facilities within the site, preliminary closure controls, and current stakeholder concerns. This Interim Closure Plan for the site is submitted to the DOE Office of Environmental Management for review and approval. Approval and authorization to proceed is gained and the Site proceeds with the development of individual closure plans, development of assessments *of the projected performance of each tank, and an assessment of the projected composite performance of all the units within the closure unit. Further review and approval by the DOE Office of Environmental Management is not required since the analysis and assessments prepared as part of the second tier closure plan are bounded by the DOE Office of Environmental Management-approved plan.*

Once approved, closure plans are to be updated periodically, to reflect revised analysis and the status of individual facility closure actions that are part of a site closure. The closure plan is a living document that is updated through the operational life of the closure activities with specific information about the contents and actions of interim closures and other information necessary (e.g., monitoring locations) to support final closure. As discussed below, it is imperative that the relationship between the analysis conducted in the assessment of the projected performance of each unit (Section II.U.(3)(a)(3)) and the assessment of the projected composite performance of all units (Section II.U.(3)(a)(4)) be kept in mind as the closure activities commence. Any information that is incorporated into a closure plan or any changes made to the closure activities of a facility that impacts the analysis in either of these assessments should be incorporated into them as soon as possible so that the extent of their impact on the closure can be known and any required changes can be made effective as soon as possible.

Following is a brief discussion of each of the closure plan elements identified in Section II.U.(3)(a)(1) through (5).

1. Identification of closure standards/performance objectives to be applied from Chapter III or IV, as appropriate;

As discussed in the guidance to Section II.B., Waste Incidental to Reprocessing, residual waste in deactivated high-level waste facilities that remains as part of the facility's closure may be managed as either low-level waste or transuranic waste. Following is a discussion on identifying the appropriate radiological closure standards/performance objectives for each case.

Low-level waste. For deactivated high-level waste facilities or sites that are closed as low-level waste sites, the disposal facility performance objectives in DOE M 435.1-1, Section IV.P.(1) should be met. As discussed in guidance Section IV.P.(1), these performance objectives provide criteria to be used in a disposal facility performance assessment that define the desired level of protection of the public and the environment from disposed low-level waste. The analyses in the performance assessment demonstrates there is a reasonable expectation that, when actually measured, compliance with actual protection requirements will be easily achieved. A discussion on the performance objectives can be found in Section IV.P.(1).

Transuranic waste. For deactivated high-level waste facilities or sites that are closed as transuranic waste sites, the applicable performance objectives/requirements are contained in 40

CFR Part 191, *Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste*, as identified in the guidance to DOE M 435.1-1, Section III.P, Disposal. Within this regulation, Subpart B, Environmental Standards for Disposal, contains the applicable requirements at 40 CFR 191.13, Containment Requirements; 191.14, Assurance Requirements; 191.15, Individual Protection Requirements; 191.16, Ground Water Protection Requirements; and 191.17, Alternative Provisions for Disposal. The discussion contained in guidance to Section III.P provides additional information on the applicability of 40 CFR Part 191 to the disposal of transuranic waste at a non-Waste Isolation Pilot Plant (WIPP) site. As acknowledged in the guidance to Section III.P, DOE needs to develop 40 CFR Part 191 compliance criteria for the disposal of transuranic waste at sites, other than WIPP.

The term transuranic waste as used in the above discussion is consistent with the definition provided in DOE M 435.1-1, Section III.A, Definition of Transuranic Waste. Therefore, residual waste remaining in a deactivated high-level waste facility must meet the definition in Section III.A in order for it to be closed as a transuranic waste disposal site. If, for example, the waste meets one of the three exceptions included at Section III.A, it is not considered transuranic waste under the closure requirements.

In addition to the radiological standards discussed above, there may be nonradiological air, groundwater and surface-water standards that are applicable to the closure action. Identification of such standards includes needs to be included during the development of a closure plan, and included in the plan. These standards may include state and local, as well as other Federal standards such as inorganic contaminant standards, contained in the *Safe Drinking Water Act* (40 CFR 141.62). To identify these standards, it is recommended that a performance standards evaluation process, similar to the CERCLA criteria for the identification of ARARs, be considered.

2. <u>A strategy for allocating waste disposal facility performance objectives from the closure standards identified in the closure plan among the facilities/units to be closed at the site</u>;

Included in the closure plan is the strategy/method for apportioning the performance objectives/closure standards identified in Section II.U.(3)(a)(1) to each of the facilities/units to be closed at the site. This strategy defines how facility or unit-specific performance objectives are, or will be, established based upon the overall site performance objectives. The strategy or methodology provides reasonable assurance that the overall performance objectives will not be exceeded by either the summation of the individual facility closure actions or by future closure activities. Additionally, the method recognizes that constituents of concern (radionuclides or chemicals) from various facilities or areas may impact compliance points at different times due to varying closure scenarios and geological conditions.

The performance standards for the closure of a deactivated high-level waste facility are concentration or dose limits for specific radiological or chemical constituents released to the environment. These standards apply to various environmental media, at different points of compliance, at various periods during or after closure.

Example: Site Z conducted a preliminary evaluation of the environmental pathways and receptors for a deactivated high-level waste group (site) of tanks and determined that groundwater was the limiting pathway for radionuclides and chemicals of concern to impact receptors. Therefore, the strategy of apportioning performance objectives for the closure of the site, and to be included in the closure plan, was applied to the groundwater pathway only. This method involved the definition of a groundwater transport segments (GTS), identification of high-level waste tank systems and other non-tank sources in the GTS, apportionment of each source based on its contribution to total impacts, and the development of adjusted and tank-specific performance objectives.

3. An assessment of the projected performance of each unit to be closed relative to the performance objectives allocated to each unit under the closure plan;

With the allocation of overall performance objectives or closure standards to individual facilities, an assessment of the projected performance of each facility or unit compared to these objectives needs to be prepared. As discussed above, the residual material in a deactivated high-level waste facility may be managed as either low-level waste or transuranic waste. Following is a discussion on preparing an assessment of projected performance for each of these waste types.

Low-level waste. For deactivated high-level waste facilities or sites that are to be closed as low-level waste sites, the requirements for a radiological performance assessment for low-level waste disposal sites, in Section IV.P.(2) of DOE M 435.1-1, are to be met. As discussed in the guidance to this section, the objectives of a performance assessment are to ensure that all aspects of low-level waste disposal are evaluated in an assessment to provide reasonable assurance that the performance objectives will be met. All of the elements of a low-level waste performance assessment provided in the requirement in Section IV.P.(2) are considered appropriate for this type of a deactivated high-level waste closure activity. The applicable review and approval requirements for the closure plan, which includes an assessment of performance, are included in Section I.2.E.(2). A complete discussion on the preparation of a low-level waste disposal facility performance assessment can be found in the guidance to Section IV.P.(2).

Transuranic waste. Deactivated high-level waste facilities or sites that are to be managed as transuranic waste disposal sites must demonstrate compliance with 40 CFR Part 191. Details on the criteria for reviewing and approving 40 CFR Part 191 performance assessments are included in the guidance to Section III.P.

4. <u>An assessment of the projected composite performance of all units to be closed at the site relative to the performance objectives and closure standards identified in the closure plan</u>;

With assessments of the projected performance of each facility or unit completed relative to the performance objectives allocated to each unit (Section II.U.(3)(a)(3)), an assessment of the projected composite performance of all the applicable units to be closed needs to be prepared. The objective of such an assessment is to ensure that the potential dose to hypothetical members of the public from the cumulative residual radioactive material that is likely to remain on a DOE site is reasonably expected to not exceed the dose limits for protection of the public.

Low-level waste or transuranic waste disposal is not the only DOE activity that will leave residual radioactive material on a DOE site when operations have ceased. Environmental activities will be conducted to mitigate releases from former operations such as disposal of liquid radioactive waste to soil columns, but will not generally result in the removal of all of the radioactive material. Also facilities currently operating that involve the use of or handling of radioactive material or radioactive waste will eventually be closed and their closure may leave some residual radioactive material.

The assessment of the projected composite performance of all units/facilities to be closed at a site that are relevant to the performance objectives/closure standards identified in a closure plan, is considered a reasonably conservative assessment of the cumulative impacts from all the current and planned closure facilities/units. The composite analysis provides a suggestion of what could conceivably happen if DOE did not act to protect public health and safety and provides information that DOE can use for planning. For example, the results of the composite analysis can assist DOE in identifying those sources that most significantly contribute to the total projected dose and decide on priorities for remediation, or decide on closure alternatives for active or inactive closure sites. Hazard implications for some sources may be so low that little needs to be done beyond land control, minor maintenance, and monitoring.

The requirements and guidance to DOE M 435.1-1, Section IV.P.(3), Composite Analysis, provide additional information on the development of an assessment of composite performance.

Example: At Site X , deactivated high-level waste tanks and other high-level waste contaminated facilities will be closed at various time over a period of decades. For each closure action, in single facilities or groupings of facilities, the site identifies the potential impacts from all sources that can contribute to the specific closure action by identifying the limiting exposure pathways for the contamination to move. This is accomplished by defining a groundwater transport segment (GTS) for the facility to be closed and identifying and quantifying sources within the GTS. These sources include the facilities or sites being closed, past contamination sites and closures, and future closure sites that are known at the time. For this example these sites/sources include *closed seepage basins, a closed low-level waste disposal site, and a number of spill sites that are not expected to be remediated.*

In addition, the assessment of the projected performance of all units to be closed relative to the closure plan needs to be reviewed and updated as appropriate to keep the analysis current. Such updates should be performed to ensure the assumptions and parameters are appropriate to maintain the validity and effectiveness of the controls that are applied to the closure site. The guidance for DOE M 435.1-1, Section IV.P.(4), Performance Assessment and Composite Analysis Maintenance, provides additional information on maintaining the composite analysis.

5. Any other relevant closure controls including a monitoring plan, institutional controls, and land use limitations to be maintained in the closure activity.

The final required element of a closure plan is to include those closure controls that are needed to ensure that the primary health and environmental protection requirements needed are put in place. These controls are to include, at a minimum, a monitoring plan, institutional controls, and limits of land use. Each of these is discussed below.

Monitoring Plan. The closure plan addresses the post closure activities to be undertaken to ensure health and environment protection requirements are met. One of the elements that is considered key is the development and implementation of a monitoring plan. Such a plan needs to identify the monitoring activities that are to be conducted after the closure is completed. This plan includes a location map of the monitoring wells or monitoring points that are considered necessary, the data that are to be collected, and actions that will be taken in response to the results of the monitoring activities. Also, the monitoring plan defines the inspection program and the inspection methods to be used, and describes the criteria to be used for initiating corrective actions. Specific corrective actions need to be included for the occurrence of subsidence or the indication of contaminant migration. Other corrective actions to address potential issues, such as uncontrolled site access, natural phenomena, failure of monitoring equipment, ponding of water or excessive infiltration, erosion, or the presence of undesirable flora or fauna, need to be included. The relationship between corrective actions and the monitoring program needs to be clearly identified.

Example: At Site Z, a closure plan for the closure of a group of deactivated high-level waste tanks includes: a map of the monitoring wells to be maintained over the institutional control period after closure; sampling frequencies, sampling methods, monitoring parameters, and methods of analysis for each monitoring well; the data management methods, data analysis methods, data reporting and remedial action plan associated with the monitoring wells for the closed site; and an inspection program that provides criteria for inspecting and initiating corrective actions for the group of closed tanks.

Institutional Controls and Land Use Limitations. The intent of this requirement is to ensure that institutional control will continue at the closed site until it can be released and that local land use records appropriately record the use of the land as a closed radioactive waste facility/site. These actions provide additional protection against misuse of the land in the future and the possibility of an inadvertent intrusion.

Documentation of institutional control and land use assumptions for a closed facility or site that is to be managed as a low-level waste disposal site should meet the requirements of DOE M 435.1-1, Section IV.Q.(2), paragraphs (c) and (d) and follow the corresponding guidance. Similarly, closed facilities or sites that are to be managed as a transuranic waste disposal site are to meet similar requirements. As with a low-level waste disposal site, the closure plan should identify the necessary activities to be performed to ensure protection of public health and the environment.

Compliance with these requirements is demonstrated by successful closure and supporting documentation, e.g., decommissioning documentation, CERCLA documentation, or closure plan, which provides a reasonable expectation that the proposed closure conditions will achieve stability of the closed facility/site, reduce the need for active maintenance, and be protective of worker and public health and the environment.

Supplemental References:

1. DOE, 1998. *Life-Cycle Asset Management*, DOE O 430.1A, U.S. Department of Energy, October 14, 1998.

2. DOE, 1997. *Decommissioning Implementation Guide*, Draft DOE G 430.1-4, U.S. Department of Energy, October 1, 1997.

3. DOE, 1996. *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems*, Savannah River Site, ESH-CGP-96-0375, Revision 1, U.S. Department of Energy, July 10, 1996.

4. DOE, 1997. *Industrial Wastewater Closure Module for the High-Level Waste Tank 20 System*, Savannah River Site, ESH-CGP-97-0003, Revision 1, U.S. Department of Energy, January 8, 1997.

5. DOE, 1997. *Guidance for Complying with DOE Order 5820.2A, "Radioactive Waste Management," for Onsite Management and Disposal of Low-Level Waste Resulting from Environmental Restoration Activities*, U.S. Department of Energy, Washington, D.C., January 9, 1997. (Superseded by Guidance to DOE M 435.1-1, Section I.2.F.(5))

6. DOE, 1996. *Policy for Demonstrating Compliance with DOE Order 5820.2A for Onsite Management and Disposal of Environmental Restoration Low-Level Wastes Under the Comprehensive Environmental Response, Compensation, and Liability Act*, U.S. Department of Energy, May 31, 1996. (Superseded by Guidance to DOE M 435.1-1, Section I.2.F.(5))

7. DOE, 1995. *Decommissioning Resource Manual*, DOE/EM-0246, U.S. Department of Energy, Office of Environmental Management, August 1995.

8. Sullivan, 1998. M.A. Sullivan, DOE, to J.T. Greeves, USNRC, letter, *Natural Resources Defense Council Petition to Exercise Licensing Authority over Savannah River Site High-Level Waste Tanks*, U.S. Department of Energy, Washington, D.C., September 30, 1998.

9. DOE, 1985. *An Evaluation of Commercial Repository Capacity for the Disposal of Defense High-Level Waste,* DOE/DP/0020/1, U.S. Department of Energy, Washington, D.C., June 1985.

10. DOE, 1985. Secretary Hodel to President Reagan, memorandum, *Use of Commercial Repository for Disposal of Defense High-Level Nuclear Waste*, U.S. Department of Energy, Washington, D.C., February 6, 1985.

11. DOE, 1985. President Reagan to Secretary Herrington, memorandum, *Disposal of Defense Waste in a Commercial Repository*, Washington, D.C., April 30, 1985.

II. V. Specific Operations.

Specific requirements are provided for the operation of lifting devices and facilities for receipt and retrieval of high-level waste.

(1) Operation of Lifting Devices. Hoisting and rigging activities shall be conducted in accordance with the guidance provided in the DOE Standard "Hoisting and Rigging" (DOE-STD-1090-96).

Objective:

The objective of this requirement is to ensure avoiding releases of high-level waste that could result from dropping equipment, containers, or other objects that could damage high-level waste containers and systems (e. g., transfer, pretreatment, treatment) during hoisting and lifting operations.

Discussion:

The hazards analysis performed to guide development of DOE M 435.1-1 revealed that lifting and rigging activities pose a high hazard for many high-level waste activities. In particular, physical and chemical treatment of high-level waste in large storage tanks often involves the use of large, heavy equipment such as mixers and dehydrators. Typically the access to the tanks is through relatively small risers. Manipulation of loads in restricted spaces with the additional complication of high radiation and reduced visibility due to the potential presence of confinement huts, requires that precautions be taken to guard against dropping loads into and onto containers, transfer equipment (e.g., pipelines, valves) and other systems containing high-level waste.

The existing DOE standard for hoisting and rigging, DOE-STD-1090-96, includes a section on critical lift determinations (Sections 2.1) which is especially applicable to high-level waste activities. The critical lift designation applies if collision, upset, or dropping could result in:

- Unacceptable risk of personnel injury or significant adverse health impact (onsite or offsite);

- Significant release of radioactive or other hazardous material or other undesirable conditions;

- Undetectable damage that would jeopardize future operations or the safety of a facility; or

- Damage that would result in unacceptable delay to schedule or other significant program impact such as loss of vital data.

A lift needs to also be designated as critical if the load requires exceptional care in handling because of size, weight, close-tolerance installation, high susceptibility to damage, or other unusual factors.

Example: Transfers of liquid high-level waste among tanks is typically performed using underground piping systems with pumps and valves located in below-grade transfer boxes over which large shielding blocks are emplaced. Access to the pumps and valves requires lifting the shielding blocks. The potential for personnel injury, release of radioactive material, and delay in schedule or other significant program impact [including loss of transfer capability as required by DOE M 435.1-1, Section II.H.(2)] if a shielding block were dropped, renders lifts of these blocks subject to the critical lift provisions of DOE-STD-1090-96.

Requirements that apply to critical lifts appear in Section 2.2 of DOE-STD-1090-96. Included are appointment of a person in charge; preparation of a pre-job plan or procedure; use of experienced, trained, and qualified lift equipment operators; use of designated, qualified lift operations signalers; review of the plan or procedure and rigging sketches prior to the lift; and conduct of a pre-lift meeting to review and ask questions about the plan or procedure. The plan or procedure is to include identification of the items to be moved and key characteristics, such as size and weight, identification of the operating equipment to be used, and rigging sketches.

Compliance with this requirement for lifting devices can be demonstrated by existence of formal procedures for prior review of lifting activities to determine when the critical lift provisions of DOE-STD-1090-96 are to be applied. The procedures should also identify those lifting devices that are classified as safety-class or safety-significant. Procedures, programs, or other processes are to be in place to ensure the implementation of these requirements when necessary.

Supplemental References:

1. DOE, 1996. *Hoisting and Rigging*, DOE STD 1090-96, U.S. Department of Energy, Washington, D.C., September 1996 (a U.S. Department of Energy standard).

2. DOE, 1997. *Safety Management System Guide*, DOE G 450.4-1, U.S. Department of Energy, Washington, DC, November 1997.

II. V.(2) Operation of Facilities for Receipt and Retrieval of High-Level Waste. High-level waste receipt and retrieval systems shall be

operated and maintained consistent with high-level waste system features incorporated in the facilities. Strategies for retrieval of waste shall be analyzed to ensure that structural and radiological impacts are consistent with the facility design basis.

Objective:

The objectives of this requirement are to ensure the proper retrieval strategy will be employed for retrieval of high-level waste and to preserve the operability of design features for the safe receipt and retrieval of waste.

Discussion:

The threat to losing the design capabilities and safety features of systems for the receipt and retrieval of waste is very real given the long time period between design and installation of some of these system components and the time when they will be used. An aggressive program is necessary to continually ascertain the operability of system components and extend the service-life of systems and components to meet operational requirements. Operability of the system and components are threatened by budgetary and operational decisions. The assignment of insufficient priority to maintain the operability of components and safety features, the use of a retrieval strategy that is different from the design basis, and operation of systems by personnel who are inexperienced or untrained are challenges that must be addressed. Therefore, the essential components of systems for receipt and retrieval of waste, and their performance requirements, should be identified, maintained and, wherever practicable, used during normal operations. Similarly, wherever practical, procedures that will be used during receipt and retrieval should be incorporated into normal operations. Such an approach is necessary to derive confidence in the receipt and retrieval capabilities by demonstrating the operability of the equipment and the competence of the operating personnel.

Maintaining the viability of the facilities for receipt and retrieval of waste which were designed into the systems over the intervening time period between construction of the systems and that point in time when they will be used requires an understanding of the degradation modes and retrieval strategies that will be employed in the future and actions that must be employed to preserve safe operability.

This requirement is applicable to storage of high-level waste in the various stages of processing as well as to the canistered waste form. Liquid high-level waste presents special problems of retrieval, such as maintaining adequate knowledge of the content of the waste when it may be a mixture received from many sources, and ensuring that most of the liquid can be removed from the storage vessel for processing or for closure. Stored vitrified waste in metal canisters must also be monitored during storage to ensure the canisters can be retrieved and moved.

Implementation of this requirement must be coordinated with several other related requirements of this Manual. DOE M 435.1-1, Section II.P.(2)(g) requires that the design of the systems be based on the strategy selected for retrieval. Knowledge of that strategy is required to formulate and implement an operations and maintenance program. Sections II.P.(2)(h) and II.Q.(1) outline requirements for structural integrity. Finally, the receipt and retrieval features were designed to be compatible with the general requirements for waste management including Worker Protection (Section I.1.E.(21)), Radiation Protection (Section I.1.E.(13)) including maintaining exposures as low as reasonably achievable, and Safeguards and Security (Section I.1.E.(16)). If strategies other than the design basis strategy is planned for retrieval, an understanding of the impact of using a different strategy on structural integrity and on radiation protection is imperative.

> *Example: Tank farm "C" at site XYZ was designed and constructed based on a retrieval strategy involving the use of a robotic arm whose weight must be born by the tank structure. The associated loads were included in the structural design requirements for the tank as well as provisions for access. An integrated operations and maintenance plan has been developed and implemented for the receipt and retrieval systems. The integrated plan is focused on maintaining equipment and personnel operability to execute the design basis retrieval strategy. The integrated plan documents the structural and operational features included in the design to support the retrieval strategy. The plan includes the structural integrity program requirements outlined in DOE M 435.1-1 at II.Q.(1), the waste acceptance requirements of Section II.L, the waste certification requirements of II.M, and the radiation protection requirements of I.1.E, as they relate to preserving the design basis operability of the retrieval systems. Procedures for routine operations and maintenance, including transfer of waste, have been developed to be consistent with procedures to execute the planned retrieval strategy and are employed wherever practical*

Compliance with this requirement can be demonstrated by developing and implementing an integrated operations and maintenance program that includes the requirements of other relevant sections of DOE M 435.1-1.

Supplemental References:

1. NRC. *Packaging and Transportation of Radioactive Material,* 10 CFR Part 71, U.S. Nuclear Regulatory Commission, Washington, D.C.

2. USDOT. *Shippers-General Requirements for Shipments and Packaging-Radioactive Materials,* 49 CFR Part 173, Subpart I., U.S. Department of Transportation, Washington, D.C.

3. DOE, 1996. *Packaging and Transportation Safety,* DOE O 460.1A, U.S. Department of Energy, Washington, D.C., October 2, 1996.

4. DOE, 1995. *Departmental Materials Transportation and Packaging Management,* DOE O 460.2, U.S. Department of Energy, Washington, D.C., September 7, 1995.

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