HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY FUNCTIONAL ANALYSIS

Prepared for

Nuclear Regulatory Commission
Contract NRC-02-88-005

Prepared by

Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas

March 1992

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ACKNOWLEDGMENT

This report was prepared to document work performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA) for the U.S. Nuclear Regulatory Commission (NRC) under Contract No. NRC-02-88-005. The activities reported here were performed on behalf of the NRC Office of Nuclear Material Safety and Safeguards, Division of High-Level Waste Management. The report is an independent product of the CNWRA and does not necesarily reflect the views or regulatory position of the NRC.

1 INTRODUCTION

1.1 SCOPE

Under the Nuclear Waste Policy Act as amended (NWPA, 1987), the Nuclear Regulatory Commission (NRC) is required to promulgate technical requirements and criteria to be applied in the licensing of activities related to a geologic repository. While the repository licensing reviews will encompass a range of statutory concerns — including protection of the environment and the common defense and security — the technical requirements and criteria addressed by the NWPA are directed specifically at the protection of the health and safety of the public. The requirements and criteria must address these concerns during operations and for an extended period after repository closure.

This functional analysis is designed to identify those functions that either may give rise to or may satisfy the technical requirements and criteria that the Commission may appropriately apply in its protection of public health and safety. While in this analysis such functions are generally limited to activities at the repository site, certain functions (e.g., waste preparation and quality assurance) may be considered no matter where they may be performed, so long as their performance may affect the protection of health and safety in connection with the repository.

This functional analysis is the product of the first of three related tasks — the Repository Functional Analysis (RFA), the Repository Operational Criteria (ROC) feasibility study and the Repository Isolation Criteria (RIC) study. The results of the functional analysis provide a baseline for the identification of repository system functions, constraints, and generic system elements important to safety, and the correlation of those items with 10 CFR Part 60 and associated applicable regulations. That correlation analysis identifies functions, constraints, and generic system elements whose regulatory treatment may be incomplete or missing. That information, in turn, indicates related areas in need of examination in the ROC and RIC studies. Those studies are intended to provide the basis for the identification of any potential regulatory uncertainties of omission and the subsequent development of potential additional regulatory guidance.

Thus, the RFA provides a necessary datum for the completion of the regulatory uncertainty analysis of 10 CFR Part 60. Consistent with the need to focus on functions, constraints and generic system elements of the repository system that are important to safety and isolation, and as prescribed in the Procedure for High-Level Waste Management System Functional Analysis, section 4.1 (CNWRA, 1991), this analysis is limited to the physical repository system; i.e., the functions related to operational safety and isolation that are to be performed by the site, facilities, equipment, software, personnel and procedures that make up that physical disposal system. Consequently, it does not consider functions of, for example, site characterization, design, licensing or construction. These are functions of the program that will create that system. Selected program (or "programmatic") functions of the Nuclear Regulatory Commission (NRC) and/or the Department of Energy (DOE) may be the subject of a separate study.

As explained in section 3.3.3.2, the depth of this analysis was limited to the lowest level at which the NRC would be expected to provide formal regulatory guidance to the applicant on items important to safety and isolation. This is seen as the lowest level appropriate for an analysis intended to serve primarily as a tool in the identification of uncertainties of omission in the applicable regulation. It should be noted that, as would be expected, this level is well above the level to which the DOE is known to be developing their physical system functional analysis.

In addition, the products of this analysis were limited to "generic" functions, constraints, and system elements; that is, those that are applicable to any site and that allow for any detailed design and operational approaches that would satisfactorily accomplish the mission of the disposal system. This limitation is consistent with the Commission policy regarding the generic nature of 10 CFR Part 60 — the regulation with which the product of this analysis is correlated.

This report is being released ahead of the performance of the RIC study with the understanding that parts of the analysis related to postclosure may be modified as a result of that study.

1.2 DEFINITIONS OF TERMS

The following terms were used in the conduct of the Repository Functional Analysis.

SYSTEM

A system is a composite of elements that work together to accomplish a stated purpose. Elements may include personnel, processes and procedures, equipment, software, and facilities.

PROGRAM

A program is the set of activities and associated resources required to create a system that will satisfactorily accomplish the stated purpose. Depending on the nature of the system to be created, a program may include system engineering; research and investigation (e.g., to define the system operating environment and the constraints imposed on the system by that environment); design and development, often including the construction and test of a prototype of the system or a significant part of the system; creation of the deliverable physical system (which may include facility construction, equipment fabrication and assembly, preparation of system software and operational procedures, and training of operating personnel); and verification of the ability of the physical system to satisfactorily accomplish the stated purpose.

SYSTEM MISSION

The system mission is the purpose of the system; that is, the specific end objective(s) the system is intended to accomplish.

FUNCTIONAL ANALYSIS

Functional analysis is the systematic top-down decomposition of the system mission into its mission-dependent functions. The system mission is first broken down into the primary functions required for its accomplishment. Then, working one level at a time, each function is analyzed to identify the subfunctions required for its accomplishment. In addition to the actions required of the individual functions, this analysis identifies, as applicable, the sequences of those actions.

PARENT FUNCTION

The function from which a set of subfunctions is derived in the process of functional analysis; the function that is being decomposed at any one time during the conduct of functional analysis.

FUNCTION (OR SUBFUNCTION)

A function is an action that is necessary to accomplish the system mission. A function is performed by an element of the system and is one purpose for which that element is selected, designed, or trained. Functions may also relate to the properties and capabilities of the site, facilities, equipment, software, procedures, and personnel that are necessary for the accomplishment of the mission. In other words, system elements must, by selection or design, possess the capabilities to perform the functions required for the system mission.

Subfunctions are identified by decomposition of a parent function in response to a standard question without consideration of other functions, location within the array of functions, relative importance, or other such factors.

- A subfunction is identified if (and only if) it is "necessary" for the accomplishment of the parent function.

- The set of subfunctions for a given parent function is complete when all functions "sufficient" for the accomplishment of the parent function have been identified.

CONSTRAINT

A constraint is (i) a limitation on the performance of one or more functions, or (ii) a condition under which one or more functions must be performed, or (iii) a limitation or condition under which a generic system element must maintain its operational capabilities.

GENERIC SYSTEM ELEMENT

A generic system element is a constituent part of the physical system necessary to provide the ability to perform one or more functions under the applicable constraint(s) *in any potential geologic setting and for any potential design.* Generic system elements of the geologic repository are expected to include a geologic setting and operational facilities, equipment, software, procedures, and personnel. Generic system elements are not usually included in the body of a functional analysis. They are included in this analysis because of the frequency with which requirements of the NWPA and 10 CFR Part 60 are framed in terms of such system elements, and the consequent need for an understanding of the potential scope of the application of those requirements.

DISPOSAL PACKAGE

This term is borrowed from the NWPA [see 42 USCS 10101(10)] where it is defined as "the primary container that holds, and is in contact with, solidified high-level radioactive waste, spent nuclear fuel, or other radioactive materials, and any overpacks that are emplaced at a repository." In this analysis the term is used at all stages of the waste preparation and disposal process as a generic, design-independent name for the containment device(s) (and, as appropriate, overpack, packing, emplacement opening backfill or the like) to be used for the emplacement of the waste. This does not include a cask or similar temporary protective device that may be used exclusively during waste transport or waste transfer.

TRANSPORT

"Transport" is used exclusively in the context of transhipment of waste and other materials between major facilities by, for example, railcar or heavy truck; e.g., from a reactor to an Monitored Retrievable System (MRS) or from the West Valley Demonstration Project to a repository.

TRANSFER

"Transfer" is used exclusively in the context of movement of waste, disposal package components, assembled disposal packages and other materials within the confines of a given major facility that is attendant to the processes performed at that facility; e.g., at a repository, between receiving and a lag storage facility or from a lag storage facility to an emplacement location.

ENGINEERED BARRIERS

The NWPA defines this term as "manmade components of a disposal system designed to prevent the release of radionuclides into the geologic medium involved. Such term includes the high-level radioactive waste form, high-level radioactive waste canisters, and other materials placed over and around such canisters." [42 USCS 10101(11)]

FITNESS FOR DUTY

This term is intended to relate to general health, emotional stability, problems related to drugs or alcohol, excessive mental stress or any similar problems that could impair the ability of personnel to function in a safe and satisfactory manner.

SURFACE

In this analysis, "surface" includes potential near-surface facilities and/or equipment such as bunkers, shallow underground facilities, foundations, and buried utility lines.

1.3 PURPOSE OF THE REPORT

This report presents the results of the functional analysis of the geologic repository element of the high-level radioactive waste management system. The preliminary results were one of the basic inputs to the ROC Feasibility Study. In addition, this report will serve as a primary input to the RIC Study.

2 BACKGROUND

2.1 PURPOSE OF THE ANALYSIS

It is anticipated that the complete functional analysis for the entire high-level waste management system will be performed in as many as three parts encompassing each of the major segments of that system for which the NRC has licensing responsibilities: specifically, the geologic repository, an interim or long-term storage facility (e.g., the Monitored Retrievable Storage (MRS) facility) if approved by the Congress, and the transportation cask(s). This analysis of the geologic repository is the first of the three high-level waste management system functional analyses to be completed for the NRC.

The functional analysis serves a variety of purposes in the licensing process including the following.

- Identification of all functions, constraints, and generic system elements necessary for the accomplishment of the high-level waste management system mission. These provide a comprehensive basis for the identification of the subset of functions, constraints, and generic system elements that are related to radiological health and safety (i.e., those for which the NRC has regulatory responsibility). The functions and constraints so identified are referred to in this report as the repository "safety functions and constraints."

- Identification of safety functions and constraints with incomplete regulatory treatment. This is accomplished through the correlation of the safety functions and constraints with existing applicable regulations. These functions and constraints with their associated regulatory criteria are the subject of additional studies with the potential for the development of additional regulatory criteria or guidance. It should be noted that the same correlation has been performed for generic system elements related to radiological health and safety. The resulting list is helpful in this study and a variety of other studies. However, it is recognized that regulatory interest is focused primarily on complete treatment of functions and constraints with no need for complete recognition of safety-related system elements in Part 60. For that reason, the emphasis throughout this report is on "safety functions and constraints".

- Establishment of a comprehensive functional foundation to support the development of new rules or major revisions to existing rules.

Fulfillment of these purposes supports the regulatory strategy and an Overall Review Strategy (ORS). Establishment of Compliance Determination Strategies (CDS) will bound the development of the Compliance Determination Methods (CDM) for each Regulatory Requirement which will be used in formuation of the License Application Review Plan (LARP) to guide the NRC staff when reviewing the DOE License Application.

It should be noted that the scopes of both the NWPA and 10 CFR Part 60 extend beyond purely functional subjects to include repository constraints and generic system elements. Consequently, in order to provide a complete basis for the purposes stated above, it was necessary to extend the Repository Functional Analysis in the same manner. This is a necessary step in the conventional system engineering process of allocating functions to system elements and developing system design criteria, and it does not in any way compromise the validity of this analysis.

2.2 RELATIONSHIP TO SYSTEMATIC REGULATORY ANALYSIS

SRA is the process that assesses the statutory and regulatory responsibilities of the NRC in a comprehensive, structured manner. SRA begins with the identification of statutory and regulatory requirements relevant to the high-level radioactive waste management system. The SRA proceeds through the identification and evaluation of uncertainties that may be associated with the requirements, and the development of methods for reducing such uncertainties. The strategies and methods for assessing compliance with the requirements, and the technical evidence required for those assessments also are identified as part of the SRA. Additional NRC information requirements are defined as necessary for uncertainty reduction or as appropriate to the compliance determination strategies and methods.

The most immediate of several applications of the results of the Repository Functional Analysis involved the identification of the subset of geologic repository functions, constraints and generic system elements that are related to radiological health and safety. The correlation of the safety functions and constraints with 10 CFR Part 60 provided a test of the completeness or "correlation" of the rule. (The processes used for identification and correlation are described in Section 4 of this report.) Safety functions and constraints incompletely treated or omitted in the rule were or will be the subject of additional analysis in the ROC and RIC studies with the potential to identify new uncertainties leading to rulemaking action or the development of 2additional regulatory guidance.

The ROC study is part of a potential rulemaking action announced in 55 FR 28771 of July 13, 1990. The preliminary results of the Repository Functional Analysis that related to the repository operational phase aided in the identification of operations activities, constraints, and generic system elements important to safety to receive attention in that study. This is discussed further in section 2.4. The full scope of the study is described in Section 3.6.4 of the CNWRA FY92-93 Operation's Plan for the Division of High-Level Waste Management.

A similar study has been completed on the mining regulations cited in 10 CFR 60.131(b)(9). In this case, functions, constraints, and generic system elements associated with properties of the subsurface facility and those involving worker nonradiological safety were selected and correlated with the mining regulation (30 CFR Part 57) to identify those requirements applicable to the geologic repository.

RIC is a study patterned after ROC that will be devoted to the postclosure phase of the geologic repository. The relationship of this functional analysis to the RIC study is discussed in section 2.5.

Development of the functional analysis also provides key details to be considered in the preparation of regulatory guidance, including a comprehensive reference source for use in the definition and review of (i) the analytical results necessary to support a NRC determination of compliance (i.e., Technical Review Components) for inclusion in the Format and Content Regulatiory Guide, (ii) the development of Compliance Determination Methods for inclusion in the License Application Review Plan (LARP), and (iii) details for consideration in the definition of other elements of the regulatory program.

2.3 RELATIONSHIP TO CNWRA 90-003

The Center report on regulatory and institutional uncertainties in 10 CFR Part 60 (CNWRA, 1990) identified, described and categorized regulatory and institutional uncertainties present in the then current regulation. The study described in this report was conducted to identify additional regulatory uncertainties resulting from the omission or incomplete treatment in the regulation of functions, constraints and/or generic system elements that are related to radiological health and safety. Thus, the results of this study serve to augment those reported in CNWRA 90-003.

2.4 RELATIONSHIP TO REPOSITORY OPERATIONAL CRITERIA FEASIBILITY STUDY

The primary objective of the ROC feasibility study is to develop the basis for regulatory guidance related to the repository operations (preclosure) phase. The ROC study includes the definition of "ROC Topics". These "Topics" address two areas: (i) the requirements of groups of "non-functions" (e.g., definitions, siting criteria, environmental concerns) relative to the site characterization, construction, and operations phases as well as a "post-operations holding" period; and (ii) the safety functions, constraints, and generic system elements associated with certain individual elements of the operational phase (e.g., principle activities, major facilities). The RFA and the identification of repository safety functions (reference section 4.1) provided a major part of the background used to (i) identify the safety functions associated with each ROC Topic and (ii) develop potential operational criteria for each ROC Topic.

2.5 RELATIONSHIP TO REPOSITORY ISOLATION CRITERIA STUDY

The RIC study will complete the regulatory uncertainty analysis of 10 CFR Part 60 by examining the correlation between postclosure safety functions and constraints identified in this analysis and the current regulatory criteria. Where appropriate for the study and consistent with the functional analysis ground rules, those safety functions and constraints may be developed in greater detail. Wherever the regulatory treatment of a safety function or constraint is determined to be incomplete, a candidate regulatory uncertainty will be identified and investigated further. Isolation criteria will be postulated for each confirmed potential uncertainty. As in ROC, each such potential uncertainty and its associated postulated uncertainty reduction language will be reviewed and dispositioned by an NRC Uncertainty Reduction Task Team.

3 FUNCTIONAL ANALYSIS

3.1 ANALYSIS REQUIREMENTS

The statutory basis for the high-level waste management system, the nature of the applicable regulations, and the intended applications of the functional analysis all imposed certain requirements on the conduct of the analysis. These requirements may be summarized as follows.

3.1.1 STATUTORY LIMITS

Requirement: Define repository functions, constraints and generic system elements within the limits of the statutory system requirements and properties.

The Nuclear Waste Policy Act, the Atomic Energy Act, and the Energy Reorganization Act define the purpose of the high-level waste management system and the basis for the associated regulatory program. The applications of these requirements in the functional analysis are described in sections 3.2, 3.3.1 and 3.3.2.

3.1.2 REGULATION-INDEPENDENT ANALYSIS

Requirement: Define the functions, constraints and generic system elements independent of pre-existing regulatory requirements.

The avoidance of pre-existing regulatory requirements as a basis for the analysis has special significance in this study since a primary application of the results is to examine the completeness of 10 CFR Part 60. Consequently, the analysis could not be based on or be limited by that regulation.

3.1.3 SITE- AND DESIGN-INDEPENDENT ANALYSIS

Requirement: Avoid preconceptions by defining the functions, constraints and generic system elements in a manner that is independent of site-specific conditions, or specific design approaches or solutions (e.g., a specific emplacement approach).

Since the regulations applicable to the high-level waste management system are generic in nature, the identified functions, constraints and generic system elements also must be applicable to any site and must allow for any design and operations approaches that contribute to the satisfactory accomplishment of the repository mission. This requirement was satisfied, in part, by defining the minimum number of requirements and/or properties for the system concept used in the analysis. This is discussed further in section 3.2.

3.1.4 NONJUDGMENTAL ANALYSIS

Requirement: Identify all functions, constraints and generic system elements necessary for the system mission free of overt or hidden judgments of their relative importance.

It is essential that the functional analysis be performed in the most objective manner possible in order to avoid the introduction of biases that could distort the functional description of the system. One of the most common biases is preconceived ideas of relative importance, often to the extent of omitting functions, constraints or generic system elements that are perceived as "unimportant".

The functional analysis was performed without consideration of the relative importance of the identified functions, constraints and generic system elements. The actual importance of the principal functions, constraints and generic system elements to safety and waste isolation will be established by subsequent analyses such as performance assessments and sensitivity studies.

3.1.5 DISCIPLINED ANALYSIS

Requirement: Implement a disciplined, top-down analytical method to identify repository functions, constraints and generic system elements.

A disciplined approach was required in the analysis to ensure (i) satisfaction of the preceding requirements and (ii) complete and consistent development of the functions, constraints and generic system elements. This discipline was imposed by continual emphasis on a set of analysis control mechanisms including:

- The use of standardized question(s) to elicit the desired responses from the technical contributors;
- The use of a checklist of commonly occurring functions and constraints to further stimulate responses;

- Systematic top-down development of the functions with exhaustive analysis of each parent function before proceeding to the next;

- Concentration on the standardized question(s) in the context of the subject parent function;

- Development of process functions in their natural sequence; and necessary constraints and generic system elements based on the process functions;

- Double-checking identified functions, constraints and generic system elements "on the go" to ensure they were within the defined system limits, generic, free of site/design assumptions, clearly and completely described, and that the functional context was clear;

- Reviewing, re-reviewing and independently reviewing the results of the analysis employing the same process used in the development of the analysis.

This process is detailed in TOP-001-07 (CNWRA, November 13, 1991).

3.2 STATUTORY BASIS FOR REPOSITORY CONCEPT

Any functional analysis must employ some concept of the system being analyzed. This should, of course, be at the highest level possible in order to avoid preconceived specific design approaches. In the case of a high-level waste repository, it is sufficient to establish that the chosen system concept is a deep geologic repository rather than, say, sub-seabed disposal or deep space disposal. In this instance, the NWPA includes several specific requirements and properties for the repository system.

The analysis requirements of section 3.1 are met, in part, by defining the minimum number of system-level requirements and/or properties within the statutory basis for the system concept used in the analysis. The system requirements and properties are intended solely to define the limits of the overall system concept for which functions are to be identified. For the geologic repository, these were limited to those provided in the NWPA.

The NWPA statutory bases for the repository system concept are as follows.

- "The term 'repository' means any system licensed by the Commission that is intended to be used for, or may be used for, the permanent deep geologic disposal of high-level radioactive waste and spent nuclear fuel . . Such term includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted." [42 USCS 10101(18)]

- "The term 'disposal' means the emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste." [42 USCS 10101(9)]

- ". . provide reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and . . spent nuclear fuel . . disposed of in a repository." [42 USCS 10131(b)(1)]

- ". . provide for the use of a system of multiple barriers in the design of the repository . ." [42 USCS 10141(b)(1)(B)]

- ". . prohibit the emplacement in the first repository of a quantity of spent fuel containing in excess of 70,000 metric tons of heavy metal or a quantity of solidified high-level radioactive waste resulting from the reprocessing of such a quantity of spent fuel . ." [42 USCS 10134(d)]

- ". . repository . . shall be designed and constructed to permit the retrieval of any spent nuclear fuel . . for any reason pertaining to the public health and safety, or the environment, or for . . recovery of the economically valuable contents of . . spent fuel." [42 USCS 10142]

- Provide "interim storage" of spent fuel and/or "long-term storage" of HLW and spent fuel (e.g., MRS), as approved by Congress. [42 USCS 10155, 10156 and 10161]

- ". . federal government will . . take title at the civilian nuclear power reactor site . . of spent nuclear fuel . ." [42 USCS 10156(a)(1)]

3.3 CONDUCT OF THE REPOSITORY FUNCTIONAL ANALYSIS

The repository functional analysis was accomplished in four steps:

- Definition of the mission of the high-level waste management system;

- Derivation of the repository system concept from the highest-order requirements and properties contained in the applicable statutory bases;

- Identification of the repository functions, constraints and generic system elements necessary and sufficient for the accomplishment of the system mission;

- Grouping and, as appropriate, consolidation of the repository functions, constraints and generic system elements and construction of the Functions List.

These steps are described in detail in the sections that follow.

3.3.1 DEFINITION OF THE SYSTEM MISSION

The NWPA was examined in depth to identify the primary objectives of the repository system; i.e., the key attributes of the repository mission. The objectives that appear repeatedly are "permanent disposal of high-level waste", "protection of public health and safety" and "protection of the environment". These objectives are probably best stated together in 42 USCS 10131(a)(4) [Sec. 111(a)(4)]. An excerption from that section of the NWPA provides the following repository mission statement:

Permanent Disposal of High-Level Radioactive Waste in Order to Protect the Public Health and Safety and the Environment.

3.3.2 DEFINITION OF THE HIGHEST-ORDER SYSTEM REQUIREMENTS AND PROPERTIES

The statutory system requirements and properties cited in section 3.2 define the limits of the overall system concept for which functions are to be identified. The following repository system concept requirements and properties were derived from the statutory bases:

- Disposal of high-level radioactive waste including spent fuel and defense wastes;
- Disposal in a deep mined geologic repository;
- Employ multiple barriers (including engineered barriers and the geologic setting) to ensure long-term postclosure containment and isolation from the environment;
- Ensure public and worker health and safety and protection of the environment in accordance with technical requirements and criteria promulgated by the Nuclear Regulatory Commission and generally applicable standards for radioactivity promulgated by the Environmental Protection Agency;
- Repository design and construction will permit the retrieval of spent fuel.

3.3.3 PERFORMANCE OF THE FUNCTIONAL ANALYSIS

3.3.3.1 Preparation of a functional analysis procedure

The analysis began with the preparation of the procedure, "High-Level Waste Management System Functional Analysis", to control the process, together with a Repository Functional Analysis Checklist. The checklist was designed to ensure that common functions, constraints and generic system elements were not overlooked and to help stimulate the thinking of the participating analysts.

The procedure includes statements of the purpose and objectives of the functional analysis, and provides specific guidance and criteria for the analysts in the conduct of the analysis.

The procedure also provides the rationale for the selection of the functional analysis technique used for this analysis. That rationale may be summarized as follows.

The nuclear waste management system mission is accomplished by a basically serial process. In addition, the primary application of the functional analysis is in the analysis of applicable generic regulations. This application requires only the higher-order functions — a maximum of five levels deep.

The "tree" technique is preferred for those systems characterized by a basically serial sequence of functions with alternative operating modes limited principally to contingency or emergency provisions. Because of its relatively economical development and presentation, this technique is also often used for the preliminary analysis of more complex systems or for the examination of only the higher-order functions of complex systems. The functions tree approach also provides the most visible traceability to the system mission and, as a result, clearly demonstrates the necessity of each function. Consequently, the NRC functional analysis needs for this system are readily satisfied by the development of a functions tree.

The application of alternative functional analysis techniques is discussed further in section 4.1 of the procedure.

The procedure also stresses that in the conduct of any system functional analysis, attention must be focused solely on the generic functions of the physical system (i.e., a site, facilities, equipment, procedures, software, and personnel) that would perform the system mission. Activities such as prelicensing research, site characterization, design, licensing and construction are functions of the program whose purpose is to create the physical repository system. Programmatic functions may be the subject of a separate program functional analysis.

3.3.3.2 *Identification of functions, constraints and generic system elements*

The repository functional analysis was performed for those high-level waste management system processes that have the potential to be performed at the geologic repository site. This included operations related to preparation of the waste for disposal, but specifically excluded potential interim storage (e.g., MRS) and interfacility waste transportation. The analysis included the identification of (i) the generic repository functions necessary and sufficient for the accomplishment of the system mission within the limits of the statutory system requirements and properties, (ii) the constraints related to necessary processes, and (iii) the principal generic system elements (facilities, equipment, software, procedures, and personnel) necessary to perform the required functions under the applicable constraints.

A systematic, top-down analysis was performed beginning with the highest repository function — the system mission defined in section 3.3.1. The analysis involved the decomposition of the mission into the primary functions necessary and sufficient for its accomplishment. Each function was subsequently systematically decomposed, in turn, into the subfunctions necessary and sufficient for its accomplishment independent of the development of other functions. As a result, near-identical functions may appear at more than one level and/or in more than one branch. Thus, the level and location of a function in the overall analysis has no significance relative to the importance or performance sensitivity of that function.

The analysis was performed by groups of two to five CNWRA scientists and/or engineers selected for their knowledge and experience in the technical disciplines involved in the parent functions being addressed. The analysis was led by the CNWRA Manager, Waste Systems Engineering and Integration, who provided necessary training for the analysts and acted as a "facilitator" in the conduct of the analysis.

In the conduct of the analysis, strict adherence was maintained to the requirements of the functional analysis procedure including the distinction between system and program, and the use of the standardized questions and sequence of analysis; and to the requirements and ground rules of sections 3.1 and 3.3.2.

The development of a branch of a functional analysis normally terminates naturally when it reaches the point at which an appropriate or meaningful function can no longer be identified without the assumption of an approach to satisfying the subject parent function (in this application, the assumption of a site-specific condition or property, a subsystem selection, or a design solution). This criterion for termination of a branch of the analysis is consistent with the generic nature of Part 60. Consequently, branches are terminated at the lowest level generic function definable; that is, at the lowest level that is not design- or site-specific. Because that is also the lowest level at which generic formal regulatory guidance can be provided, this criterion also includes the properties of the first criterion below.

In the Functions List (Attachment A), the application of this criterion is indicated by the symbol "#" following the description of the function, constraint or generic system element.

Due to the regulatory application of this analysis, there were two additional criteria for truncating the development of a branch. First, a branch was developed only to the lowest level at which the NRC would be expected to provide formal regulatory guidance to the applicant. The "lowest level at which the NRC would be expected to provide formal regulatory guidance" is CNWRA judgment as to the lowest level at which NRC would be expected to provide guidance in the form of a Format and Content Regulatory Guide, License Application Review Plan (comparable to a reactor Standard Review Plan) or similar guidance. This is not intended to imply that these are the limits of the NRC program. In general, these are the lowest level at which specific information would be formally requested from the applicant (e.g., in a Format and Content Regulatory Guide), and one level below that at which an explicit generic rule (consistent with Part 60) would generally be considered appropriate. The application of this criterion in the analysis is noted by a "*" following the function, constraint or generic system element in Attachment A.

Second, if none of the possible subfunctions were in any way important to radiological health or safety, the branch was terminated at that level. In Attachment A, the application of this criterion is identified by the symbol "**".

Following the development of a subset of repository functions, the same process was applied to the identification of the key constraints applicable to those functions. As may be seen in Attachment A, the repository constraints primarily have to do with ensuring the ability to operate satisfactorily under adverse conditions, limiting adverse alterations of the geologic medium, limiting preclosure exposures, and limiting releases of radioactive and hazardous materials.

Upon completion of the identification of subfunctions and constraints for a primary repository function, the associated repository generic system elements were defined (reference Attachment A).

3.3.3.3 Review of the Functional Analysis Results

During the conduct of the analysis, the results were subjected to a variety of cross checks, tests for completeness, and critiques to ensure that each function and its description fit within the minimum system requirements and properties defined in section 3.3.2 above, and that it was independent of site-specific conditions, design solutions and pre-existing regulatory criteria.

Following completion of major sections of the analysis, a "test for completeness" was performed on the results. The test consisted of a limited review of available, related material; the identification of functions contained or implied in that material

which might also be required by the high-level waste management system; and the consideration of those functions for inclusion in the subject analysis. Related material included:

- Basalt Waste Isolation Project (BWIP) System Functional Analysis Document, DOE-Richland SD-BWI-CR-023, March 20, 1987;
- Waste Management System Requirements Document, Volume IV MGDS, DOE OCRWM, March 1990;
- To the extent applicable, 10 CFR Part 50 and 10 CFR Part 72.

3.3.4 PREPARATION OF THE FUNCTIONS LIST

The results of the repository functional analysis are presented in a "Functions List." This list uses the conventional decimal numbering system and multiple indentations to clearly display the tree-like relationships of the parent functions and subfunctions.

To aid the understanding and review of the results of the analysis and to maximize its value as a reference, the Functions List is organized in seven major sections corresponding to the seven primary functions of the physical waste management system. The analysis of the primary functions "Transport Waste Between Major Facilities" and "Store High-Level Waste" (e.g., in an MRS) were deferred as indicated in Section 3.3.3.2. The primary function "Plan Overall HLW Management Physical System Operations" was judged to be the lowest level of that branch for which the NRC would be expected to provide formal guidance. Consequently, for the reasons explained in Section 3.3.3.2, it was not developed further.

The four remaining primary functions (with the numbers assigned to them in the analysis) are:

2. Secure and Safeguard Radioactive Wastes
5. Prepare Waste for Disposal
6. Conduct Geologic Repository Waste Disposal Operations
7. Contain and Isolate Radionuclides (Postclosure)

Each of these sections of the Functions List is divided into three parts entitled "Functions", "Constraints" and "Generic System Elements". Each of those parts contains a complete listing of the indicated product of the analysis for that primary function. Also included for each function, constraint, and generic system element are the assigned Safety Category, the primary and supporting citations from 10 CFR Part 60 (or appropriate regulation referenced therein), and the assigned Correlation Category. These items are described in Section 4 of this report.

The three parts of these sections of the Functions List are structured as follows:

- Functions. This part includes operations planning and, as applicable, the functions of the basic waste disposal process such as "receive waste", "temporarily store waste", "transfer waste (intrafacility)", "package waste for disposal", "emplace waste disposal package", and "limit releases of radionuclides to the accessible environment".

- Constraints. This part contains those results that represent (a) a limitation on the performance of one or more functions, or (b) a condition under which a function must be performed or (c) a limitation or condition under which a generic system element must maintain its operational capabilities. This includes items such as "ensure the stability of facilities", "ensure the ability to function under naturally induced conditions", and "limit personnel radiation exposure during waste disposal operations". Because most constraints apply across all or very large segments of the associated functions, the constraints applicable to each primary function have been consolidated in this part of each section. This consolidation eliminates lengthy repetitions of the same constraints in association with each major subfunction.

- Generic System Elements. This part contains a list of generic repository elements that are necessary to provide the capability to perform the principal functions. Repository elements include the geologic setting, facilities and equipment (including non-waste handling facilities and equipment such as fire protection, labs, utilities, communication, etc.), software, procedures, and personnel.

This organization provides at least two advantages over alternative presentations: (i) it keeps together the related functions, constraints and generic system elements within each major branch of the original analysis, and (ii) it keeps together the functions, constraints and generic system elements that are necessary at different stages of the waste management process. Thus, the highly visible traceability of the "tree" format is retained.

4 ANALYSIS OF 10 CFR PART 60

The analysis of 10 CFR Part 60 was conducted in four additional steps:

- Development of criteria for "safety functions" and assignment of the criterion appropriate for each repository function, constraint and generic system element;
- Development of "correlation criteria" together with the logic for the application of those criteria;
- Correlation with Part 60 of the functions, constraints and generic system elements related to safety or isolation, and assignment of the appropriate correlation criterion to each;
- Independent review of the integrated results of the Repository Functional Analysis and the Part 60 Correlation Analysis.

Each of these steps is described in greater detail in the sections that follow.

4.1 IDENTIFICATION OF REPOSITORY "SAFETY FUNCTIONS"

The first step in the conduct of the correlation analysis for Part 60 was the development of criteria for "safety functions" and the identification of the functions, constraints and generic system elements that fit those criteria. "Safety functions" is a collective term for those functions, constraints, and generic system elements that have the potential to impact public or worker radiological health and safety.

The following are the criteria used to identify and categorize safety functions.

Safety Category	Criteria
1	ISOLATION. Functions, constraints and generic system elements whose loss or significant degradation would directly and adversely affect postclosure waste isolation; e.g., shorten or cause loss of postclosure containment; increase release rate to the geologic setting; increase, or reduce retardation of, radionuclide transport in the geologic setting.

2 PRECLOSURE CONTAINMENT. Functions, constraints and generic system elements important to safety; that is, whose loss or significant degradation would directly and adversely affect preclosure containment of high-level waste. This includes, for example, potential release-producing damage during waste handling including receipt, packaging, storage, intra-facility transfer, emplacement and retrieval; containment of radionuclides in, and control of releases from facilities in which waste is stored or handled; loss or significant degradatin of features designed to mitigate of the consequences of an accident or unsafe event.

3 EXPOSURE. Functions, constraints and generic system elements whose loss or significant degradation would directly and adversely affect radiation exposures (radiation control); e.g., radiological surveys control of contamination; control of radiation exposures; control of secondary radioactive waste materials; control of access to radiation areas.

4 SECONDARY EFFECT. Functions, constraints and generic system elements whose loss or significant degradation could indirectly (i.e., as a secondary effect) cause the loss of one or more functions important to isolation, radiological safety, or radiation control; e.g., radiological monitoring and alarm; inspection, testing and maintenance of facilities in which waste is stored or handled; some aspects of utilities, communications, fire control, mine safety, industrial safety, personnel training for radiological operations, procedures for radiological operations, and response to unsafe conditions.

5 NONSAFETY. Functions, constraints and generic system elements necessary for the system mission, but with no potential impact (i.e., less-than-secondary effect) on isolation, radiological safety, or radiation control; e.g., maintenance facilities, nonradiological environmental protection, control of hazardous (nonradioactive) effluents; administration.

It is important to recognize that these safety functions are not intended to measure the importance of a function, constraint, or generic system element; but only identify the general effect of its loss (or absence) or degradation.

It should be noted that in the Functions List (reference Attachment A) several of the generic system elements that are related to personnel and procedures are identified as important to radiological safety (Safety Category 2). The rationale is that (i) certain repository processes are important to radiological safety, and (ii) if the process is important to safety, the procedures that define and control the process and the personnel who carry out the procedures must also be important to safety. The conclusion is that certain processes, procedures and personnel may be equally as important to safety as certain structures, systems and components.

Initially, functions involving the handling of waste disposal package components prior to their assembly were considered to be non-safety related (Safety Category 5). However, it was decided that hidden damage to these components due to mishandling could ultimately result in loss of preclosure containment or the premature loss of postclosure containment. Therefore, these functions were upgraded to Safety Category 4.

4.2 CORRELATION OF SAFETY FUNCTIONS WITH 10 CFR PART 60

The correlation of each safety function in Safety Categories 1 through 4 with 10 CFR Part 60 was performed by searching the regulation to find language that (i) explicitly identifies the requirement (need) for the subject function, constraint or generic system element for the repository system, (ii) explicitly recognizes the applicability of the function, constraint or generic system element to the repository system, or (iii) implies to a reasonable engineer or scientist that the function, constraint or generic system element is necessary for the repository system.

In the latter case, the determination was made by asking, "Would a reasonable engineer or scientist interpret the language of the rule to include an implied requirement (need) for the subject function, constraint or generic system element." The reliance on an "implied requirement" is recognized in Attachment A by the symbol "@" following the Part 60 citation.

The distinctions in the three types of correlation cited above may be clarified best by examples.

- Constraint 6.22 states "Maintain emplacement opening/location mechanical stability during repository operations." Section 60.133(e) clearly identifies the need for underground facility design for safe operations including reduction of "the potential for deleterious rock movement . ." 30 CFR Part 57 identifies similar requirements from the perspective of conventional underground facility (mine) conditions (reference 10 CFR 60.131(b)(9)). These are seen as explicit recognition of the need for emplacement opening stability.

- Function 6.6 is "Emplace waste disposal package in geologic repository." Part 60 does not literally state, for example, that "the waste shall be emplaced . ." However, Part 60 contains numerous statements such as ". . presence of emplaced radioactive waste . ." and ". . [high-level waste] received for emplacement . ." Paragraph 60.21(b)(2) requires "Proposed schedules for . . emplacement of wastes . ." and paragraph 60.111(b) requires that the design ". . preserve the option for waste retrieval throughout the period during which wastes are being emplaced . ." Such statements are taken to provide ample recognition of the applicability of this function to the repository system.

- Constraint 6.6 states "Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used)." An explicit comparable requirement is not found in Part 60. However, 60.133(a) states that ". . engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides."; 60.133(h) requires that "Engineered barriers shall be designed to assist . . in meeting the performance objectives . ."; and 60.133(i) indicates that the design must take into account the thermal and thermomechanical response of the host rock and groundwater system. The Center judgment is that this combination of requirements would be interpreted by a "reasonable engineer or scientist" to recognize a need for backfill chemical and physical stability (if emplacement opening backfill is used).

There are many other cases in which the requirement, and consequently the correlation, is no more than inferential. An example of this condition involves 10 CFR 60.31(a)(6). Section 60.31 is solely concerned with the determinations to be made by the Commission as grounds for construction authorization. It is, in other words, an example of NRC "self-regulation". The requirement of 60.31(a)(6) is that, as a condition for construction authorization, the Commission must find that DOE-proposed operating procedures in the license application are adequate. Yet 60.21, which specifies the required content of the license application, does not require submission of proposed operating procedures. Thus, it is only by inference in an NRC self-regulation that one may determine that DOE must submit proposed repository operating procedures in the application for construction authorization. In this and similar instances, correlation was recorded with respect to the regulatory text containing the implied requirement. In such cases, the citation in the Functions List is followed by the symbol "@".

When a correlation was found, the Part 60 requirement was identified as either "primary" or "supporting" according to the nature of the statement, and the citation of the requirement was entered in the appropriate column in the functional analysis (see Attachment A). In many cases, this distinction is admittedly tenuous.

4.3 DEVELOPMENT AND APPLICATION OF PART 60 "CORRELATION CRITERIA"

4.3.1 DEFINITION OF "CORRELATION CRITERIA"

Two fundamental criteria were defined for the conduct of the Part 60 Correlation Analysis. The initial criterion considered the recognition in Part 60 of the need for each safety function. The understanding of the CNWRA is that the regulation (or its authorizing statute) must contain reasonable recognition, either explicit or implied, in order to provide a basis for subsequent regulatory guidance and enforcement. This is seen as the overriding requirement for the rule.

The next criterion related to the presence in Part 60 of applicable regulatory criteria. "Criteria" is used here in its broadest sense which includes performance objectives as well as design and siting criteria. If potentially applicable regulatory criteria provide wide general guidance (e.g., most of 60.131), another "reasonable engineer or scientist" test was applied to determine applicability of those criteria to the subject function, constraint or generic system element. In such a case the question was, "Would a reasonable engineer or scientist interpret the language of the Part 60 criteria to be applicable to the subject function, constraint or generic system element?" Again, reliance on that judgment is recognized in Attachment A by the symbol "@" following the Part 60 citation.

The analysis reported here does not make a judgment as to the "sufficiency" of the regulatory criteria; that is, whether the applicable criteria are sufficient to protect public health and safety in the context of the subject function, constraint or generic system element. That question is deferred to the ROC study for preclosure functions, constraints and generic system elements and to the RIC study for postclosure functions. As described in section 4.3.2, this analysis merely identifies for examination in those studies, areas where there is a question as to the completeness of the regulatory recognition or criteria.

4.3.2 PERFORMANCE OF THE CORRELATION ANALYSIS

The sections of Part 60 that were correlated with each safety function were analyzed for the extent of their explicit or implicit recognition of the subject safety function and the regulatory criteria provided. The analysis of the regulatory recognition and criteria was based on the question, "Would a reasonable engineer or scientist interpret the language of the regulation to (i) recognize the need of the system for the subject function, constraint or generic system element, and (ii) provide criteria for the subject function, constraint or generic system element that are applicable to the public health and safety." Based on that analysis, each safety function was assigned to the appropriate "correlation category". The criteria for the Part 60 Correlation Analysis and the logic for their application are displayed in Figure 1.

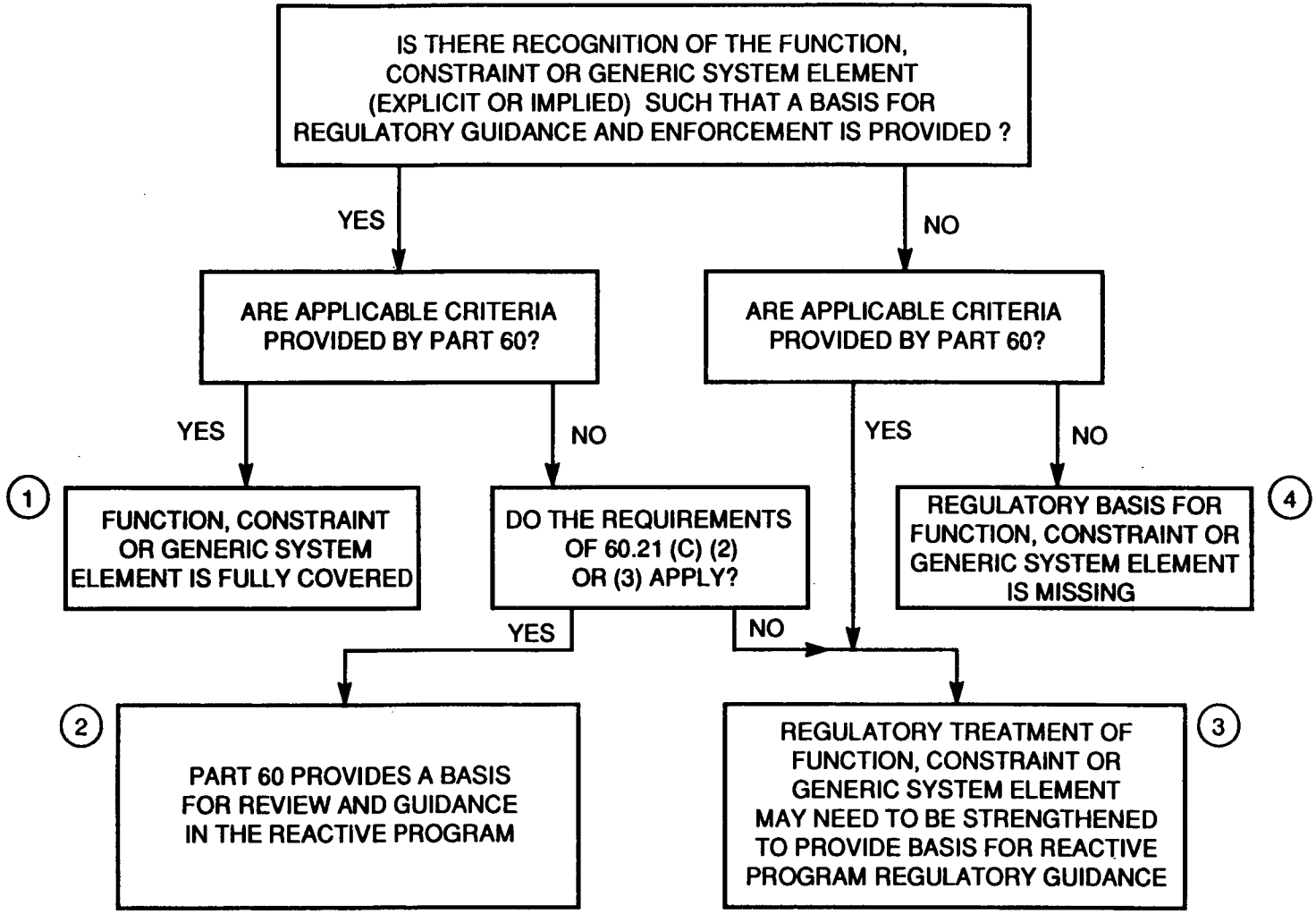

Figure 1. 10 CFR Part 60 Correlation Criteria

As seen by the leftmost path of Figure 1, if both the recognition and applicable criteria were judged to be present, the subject function, constraint or generic system element was assigned to Correlation Category 1.

If recognition of the item was evident but criteria were not, another test was required. This test was based on the following rationale. Paragraphs 60.21(c)(2) and 60.21(c)(3) require as part of the Safety Analysis Report (i) a description and discussion of the geologic repository operations area design and (ii) a description and analysis of the design and performance of structures, systems and components important to safety, respectively. These are the only SAR content requirements that have general application to the system design. It is important to also recognize that 10 CFR Part 50, Appendix B, includes procedures, instructions and processes within the scope of "design control". Thus, 60.21(c)(2) and (3) provide an avenue for preapplication review of any or all aspects of the system design and the provision of appropriate clarification or other regulatory guidance. As a result, in cases where there is recognition but applicable criteria may be incomplete or not in evidence, review of 60.21(c)(2) and 60.21(c)(3) design and performance descriptions prepared prior to license application was judged to provide a basis for guidance in the reactive program. Functions, constraints and generic system elements that follow this path were assigned to Correlation Category 2.

Functions, constraints and generic system elements (i) that are recognized by Part 60, (ii) for which criteria are incomplete or missing, and (iii) to which neither 60.21(c)(2) nor 60.21(c)(3) apply, require at a minimum an examination of their regulatory treatment (specifically, in this case, the applicable criteria) in the ROC or RIC studies. Strengthening of those criteria may be necessary in order to provide a basis for guidance in the reactive program. In such cases, the subject function, constraint or generic system element was assigned to Correlation Category 3.

The two remaining possible paths of the correlation analysis stem from an absence of regulatory recognition of the subject function, constraint or generic system element. In cases where general criteria of Part 60 were considered to be potentially applicable, Correlation Category 3 was assigned, indicating that regulatory recognition may need strengthening.

Thus, the two possible paths to a Correlation Category 3 assignment indicate that the regulatory treatment of the safety function needs to be examined and possibly strengthened due to one of two conditions:

- Part 60 recognition (explicit or implicit) is evident, but applicable criteria (general and specific) are incomplete or missing;

OR

- Part 60 contains general criteria that would be considered to be applicable, but the safety function is not recognized in the regulation.

In cases where neither recognition nor applicable criteria were to be found in Part 60, the subject function, constraint or generic system element was assigned to Correlation Category 4. 6

4.4 INTEGRATED REVIEW OF THE FUNCTIONAL ANALYSIS AND THE CORRELATION ANALYSIS

The integrated results of the functional analysis and the Part 60 correlation analysis were examined by independent CNWRA reviewers to verify that the results were (i) complete, (ii) correct, and (iii) clearly stated.

Those who performed the review and verification of the functional analysis and correlation analysis were held to two qualification standards: (i) they possessed the capability in terms of training and experience to have conducted, or to have effectively contributed to the conduct of, the analyses whose results they were reviewing, and (ii) they had not participated in the conduct of those particular analyses that were the subject of their review.

The repository functions were reviewed for the following additional properties:

- Adherence to the requirements of the ground rules described in sections 3.1 and 3.3.2;
- Independence from pre-existing regulatory criteria;
- Generic functions; i.e., independent of site-specific conditions and free of design-specific assumptions or approaches;
- Appropriate consideration of the candidate functions provided in the checklist;
- Necessity for the repository; i.e., the operating preclosure and postclosure physical system that will perform the waste disposal mission (not for the program that will create or license that system);
- Completeness to the level at which NRC would be expected to provide formal regulatory guidance.

Specific correlation analysis features examined by reviewers included, but were not limited to: (i) comprehensive and clearly stated criteria for safety functions and correlation criteria, (ii) consistent application of the criteria for safety functions and correlation criteria, and (iii) complete and correct correlation of safety functions with 10 CFR Part 60 and assignment of correlation categories.

4.5 IDENTIFICATION OF SAFETY FUNCTIONS FOR FOLLOW-ON STUDIES

Safety functions assigned to Correlation Category 1 or 2 are not of concern since these categories indicate that coverage is provided by 10 CFR Part 60. As a result, the only correlation categories of concern relative to potential regulatory uncertainties in Part 60 are categories 3 and 4. Again, these categories indicate that:

Correlation Category 3	The regulatory treatment (i.e., recognition OR criteria) of the subject function, constraint or generic system element needs to be examined in the ROC or RIC study and may need to be strengthened to provide a basis for reactive program regulatory guidance.
Correlation Category 4	A regulatory basis (i.e., recognition AND criteria) for the subject function, constraint or generic system element is missing.

Several observations were made as a result of the correlation analysis relative to functions, constraints and generic system elements assigned to Correlation Categories 3 and 4. These observations will be examined further in the ROC and RIC studies, first with respect to criteria that define the "level of regulatory concern"; i.e., the lowest level of system design or operational detail to which the NRC intends to provide guidance to the DOE. Some of the observations made in this analysis are at design and operations levels that are likely to be below the level of regulatory concern. Those items that are at or above that level are candidates for regulatory uncertainties. Subsequently, potential regulatory uncertainties related to the repository preclosure period will be analyzed and reported as part of the ROC study. The potential regulatory uncertainties associated with postclosure safety functions will be analyzed in a separate RIC report.

The following general observation was made as a result of the Part 60 correlation analysis:

- A number of crucial functions, constraints and generic system elements rely for their primary regulatory recognition and criteria on Appendix B of 10 CFR Part 50. All but one of these were assigned to Correlation Categories 1 or 2 with the overwhelming majority assigned to 1. This judgment derives from the fact that a quality assurance program "based on the criteria of Appendix B of 10 CFR Part 50" is implemented for the repository program by 10 CFR 60.152. In addition, the scope of quality assurance and the applicability of the QA program are prescribed by 60.150 and 60.151, respectively.

Nonetheless, such reliance on the quality assurance regulation points up the continuing need for (i) staff familiarity with the specific requirements of Part 50, Appendix B and (ii) sensitivity in the reactive program to the character of the DOE implementation of those requirements.

The following observations were made with respect to functions, constraints and generic system elements assigned to Correlation Category 3:

- The treatment of waste disposal package components (other than the waste form) prior to assembly into complete disposal packages is not explicitly recognized in Part 60. Certain existing general criteria would clearly be applicable to many functions, constraints and generic system elements related to disposal package components. However, there are also many functions, constraints and generic system elements for which the applicability and/or correlation of general criteria are questionable. All of these were assigned to category 3.

- Regulatory criteria for the waste preparation (packaging) process were found to be incomplete. The safety functions have to do with (i) the physical handling of waste, disposal package components, and assembled waste disposal packages prior to and during the packaging process; and (ii) the repair, overpack, or repackaging of damaged waste disposal packages. The design criteria of 60.135(a)(2) related to mechanical strength and mechanical stress were assumed to apply to the dynamic loading caused by such in-process handling. This assumption should be examined further as part of the ROC uncertainty analysis.

- Paragraph 60.21(c)(12) recognizes the potential for retrieval and "alternate storage". However, the regulation does not provide criteria for the preparation of the waste for off-site shipment, if required.

- The process of transfering waste intrafacility includes several functions that are essentially independent of the system design and, thus, not subject to review in accordance with 60.21(c)(2) or (3). No criteria are provided for these functions which include such activities as authorizing transfer, loading and off-loading the waste disposal package, and protecting it from physical damage. Essentially the same situation exists regarding waste to be removed (retrieved) from the underground facility, and waste (high-level or secondary) to be shipped off-site.

- Monitoring and warning for nonradiological hazardous conditions (e.g., nonradiological air contamination) that could impact safety are not recognized by the rule.

- Backfill emplacement is widely recognized throughout the regulation. However, no criteria are provided, relative to either requirements or constraints on its performance.

The following general subject areas are lacking both recognition and criteria in Part 60 (i.e., have been assigned correlation category 4):

- Consolidation of spent fuel;
- Waste disposal package repair or overpack;
- Repair or replacement of secondary and/or high-level waste shipping cask;
- Waste emplacement opening/location interface with emplacement equipment;
- Relocation of waste within the underground facility;
- Limiting secondary effects of industrial hazards that could adversely affect safety or isolation;
- Delay of the onset of waste disposal package degradation (postclosure) through control of the disposal package condition when emplaced;
- Limiting the quantity and rate of fluids contacting the waste form (postclosure).

5 REFERENCES

Center for Nuclear Waste Regulatory Analyses (CNWRA). 1990. *Identification and Evaluation of Regulatory and Institutional Uncertainties in 10 CFR Part 60. Volume 2 - Identification.* CNWRA 90-003. San Antonio, Texas: CNWRA.

Center for Nuclear Waste Regulatory Analyses (CNWRA). 1991. *Procedure for High-Level Waste Management System Functional Analysis.* TOP-001-07. San Antonio, Texas: CNWRA.

Nuclear Waste Policy Act. 1987. *Public Law 97-425, as amended, 42 USCS 10101,* Washington, D.C.: U. S. Government Printing Office.

Attachment A

HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY FUNCTIONAL ANALYSIS

HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY FUNCTIONAL ANALYSIS

This attachment presents the results of the functional analysis of the geologic repository segment of the high-level waste management system. The analysis began with a statement of the system mission and progressed in accordance with CNWRA TOP-001-07, the procedure for High-Level Waste Management System Functional Analysis. The reader is referred to that procedure (or to section 1.2 of the body of this report) for definitions of terms used in this analysis. The criteria for the Safety Categories and the Correlation Categories shown to the right of the functions list are as follows.

SAFETY CATEGORIES

One of the following four safety categories is assigned to each "item" of the functional analysis (i.e., each function, constraint and generic system element) whose loss or significant degradation would:

1 Directly and adversely affect postclosure waste isolation; e.g., shorten or cause loss of postclosure containment; increase release rate to the geologic setting; increase, or reduce retardation of, radionuclide transport in the geologic setting.

2 Directly and adversely affect preclosure radiological safety; e.g., potential release-producing damage during waste handling including receipt, packaging, storage, intra-facility transfer, relocation and retrieval; containment of radionuclides in, and control of releases from, facilities; mitigation of the consequences of an accident/event.

3 Directly and adversely affect radiation exposures (radiation control); e.g., radiological monitoring and alarm; control of contamination; control of radiation exposures; control of secondary radioactive waste materials; control of access to radiation areas.

4 Indirectly (i.e., as a secondary effect) cause the loss of one or more items important to isolation, radiological safety, or radiation control; e.g., some aspects of fire control, mine safety, industrial safety, operating procedures and contingency planning.

Category 5 ("Non-Safety Functions") applies to those items necessary for the system mission, but with no potential impact on isolation, radiological safety, or radiation control; e.g., maintenance facilities, nonradiological environmental protection, control of hazardous (nonradioactive) effluents; administration.

CORRELATION CATEGORIES

The degree to which 10 CFR Part 60 correlates with each function and constraint is indicated. The correlation is based on a determination of the extent to which the rule (i) recognizes the need for the function or constraint and (ii) provides criteria applicable to the function or constraint. The four correlation categories are defined as follows:

1 Function, constraint or generic system element is fully covered.

2 10 CFR Part 60 provides a basis for review and guidance in the reactive program.

3 Regulatory treatment of function, constraint or generic system element may need to be strengthened to provide a basis for reactive program regulatory guidance.

4 Regulatory basis for function, constraint or generic system element is missing.

SYMBOLOGY

The appearance throughout this analysis of one of the following symbols after an item or Part 60 citation indicates that:

\# It is the lowest level generic item definable, i.e., lower-level items are design- or site-specific.

* It is the lowest level item of that branch of the functional analysis for which the provision of formal NRC regulatory guidance is expected.

** None of the subfunctions (i.e., daughters of this function, constraint or generic system element) are in any way important to radiation control or radiological health and safety. Consequently, the RFA branch is terminated at this point.

@ The rule contains language that in the judgment of the Center would be interpreted by a "reasonable engineer or scientist" (i) to be an implied recognition of the need for the subject function, constraint or generic system element and/or (ii) to provide applicable siting or design criteria or performance objectives. (See explanation in Sections 4.2 and 4.3.1 of the body of this report.)

MISSION: Permanent Disposal of High-Level Radioactive Waste in Order to Protect the Public Health and Safety and the Environment.

		SAFETY CATEGORY	10CFR60 PRIMARY	10CFR60 SUPPORTING	CORRELATION CATEGORY
1.	PLAN OVERALL HLW MANAGEMENT PHYSICAL SYSTEM OPERATIONS *	4	21(c)(4) thru 21(c)(12) 21(c)(15)	21(b)(1) thru 21(b)(4) (Subpart I)	1
2.	SECURE AND SAFEGUARD RADIOACTIVE WASTES	4	21(b)(3) 21(b)(4)	41(c)@	1
	FUNCTIONS				
2.1	Plan nuclear security and safeguards operations	4	21(b)(4) 21(b)(3)	41(c)@ 31(b)@	3
2.1.1	Plan normal security and safeguards operations *	4	21(b)(4) 21(b)(3)	41(c)@ 31(b)@	1
2.1.2	Plan for security and safeguards contingencies *	4	21(b)(4) 21(b)(3)	41(c)@ 31(b)@	3
2.2	Screen/qualify candidate security and safeguards trainees *	4	162 21(b)(3)	41(c)@ 21(c)(15)(iii)@	1
2.3	Train and certify security and safeguards personnel *	4	161	21(b)(3) 41(c)@	1
2.4	Monitor personnel reliability *	4	162 151	21(b)(3) 41(c)@	1
2.5	Conduct periodic training exercises *	4	161	21(b)(3) 41(c)@	1
2.6	Periodically recertify security and safeguards personnel *	4	161	21(b)(3) 41(c)@	1
2.7	Conduct investigations and issue long-term authorizations for access to operations areas and specific facilities *	4	21(b)(3)	46(a)(3)@	1
2.8	Prevent unauthorized access to (and activities in) operations areas	4	21(b)(3) 21(c)(8)	41(c)	1
2.8.1	Account for access and egress of authorized visitors #	4	21(b)(3) 21(c)(8)	41(c)	1
2.8.2	Control temporary individual authorizations for access to operations areas and specific facilities #	4	21(b)(3) 21(c)(8)	41(c)	1
2.8.3	Detect and respond to intrusions and other unauthorized activities *	4	21(b)(3) 21(c)(8)	41(c)	1
2.9	Prevent theft, sabotage, or terrorism in waste management facilities *	4	21(b)(4) 21(b)(3)	41(c) 31(a)(6)@	1
2.10	Account for and maintain inventories of nuclear materials in the waste management system #	4	71(b)	21(c)(10)@	1
2.11	Limit human intrusion into the area of the repository following permanent closure (see 7.4, Limit postclosure intrusion into the area of the repository) #				
2.12	Maintain and secure security and safeguards records and reports #	4	21(b)(3)	---	1

2.13	Implement a quality assurance program for security and safeguards *	4	152	150 151	1
CONSTRAINTS					
2.14	Ensure operability of security and safeguards equipment important to safety *	2	131(b)(6)	21(c)(15)(v)@	2
2.15	Ensure fitness for duty of personnel certified for security and safeguards operations that are important to safety *	2	162 21(c)(15)(iii)	160	1
2.16	Control configuration of operational security and safeguards facilities, equipment, software and procedures *	4	44 46(a)(5)	Part 50, App B, Criterion III	1
2.17	Ensure the stability of security and safeguards facilities under local foundation conditions *	4	131(b)(1)	---	1
2.18	Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) *	4	131(b)(1)	---	1
2.19	Ensure the ability of security and safeguards facilities and equipment to perform their intended functions under conditions and events induced by human activities *	4	21(b)(3)@ 21(b)(4)@ 131(b)(6)@	31(a)(6)@ 41(c)@	1
GENERIC SYSTEM ELEMENTS					
2.20	Security and safeguards generic system elements	4	21(b)(3) 21(b)(4)	41(c)@ 31(b)@	2
2.20.1	Facilities for security and safeguards	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.1.1	Facilities for security and safeguards operations (e.g., administrative, investigatory, computer, guard stations, armory) *	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.1.2	Physical barriers to operations area(s) access #	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.1.3	Training facilities for security and safeguards *	4	21(b)(3) 21(b)(4)	161 41(c)@	1
2.20.1.4	Facilities for maintenance of security and safeguards facilities and equipment *	4	131(b)(6)@ 21(c)(15)(v)@	---	2
2.20.2	Equipment for security and safeguards	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.2.1	Operations area surveillance equipment for security and safeguards *	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.2.2	Detection equipment for unauthorized entry of emplacement opening/location #	4	21(b)(4)	41(c)@	1
2.20.2.3	Computational capability for security and safeguards (e.g., monitor intrusion, access/egress control) *	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.2.4	Communications network for security and safeguards #	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.2.5	Vehicles, armaments, and personal equipment for security and safeguards #	4	21(b)(3) 21(b)(4)	41(c)@	1
2.20.2.6	Equipment for preparation and retention of security and safeguards records and reports #	4	21(b)(3)	---	1

2.20.2.7	Training equipment for security and safeguards *	4	21(b)(3) 21(b)(4)	161 41(c)@	1
2.20.2.8	Equipment for security and safeguards unsafe/emergency conditions *	4	131(b)(4)(ii)@ 131(a)(6)	21(c)(9)@	2
2.20.2.9	Equipment, spares, and materials for security and safeguards facilities and equipment maintenance *	4	131(b)(6)@ 21(c)(15)(v)@	---	2
2.20.3	Software for security and safeguards *	4	21(b)(3) 71(b)	41(c)@ 21(c)(10)@	1
2.20.4	Trained and certified personnel for security and safeguards	4	161 21(b)(3)	160 41(c)@	1
2.20.4.1	Trained and certified personnel for security and safeguards unsafe/emergency conditions *	4	161@	160@ 21(c)(15)(iii)@ 21(c)(9)@	1
2.20.4.2	Trained and certified personnel for security and safeguards facility and equipment maintenance *	4	131(b)(6)@	21(c)(15)(v)@	2
2.20.5	Procedure(s) for security and safeguards	4	21(b)(3)	31(a)(6)@ 43(b)(6)@	1
2.20.5.1	Procedure(s) to screen/qualify candidate security and safeguards trainees *	4	21(b)(3) 162	31(a)(6)@ 43(b)(6)@ 21(c)(15)(iii)@	1
2.20.5.2	Procedure(s) to train and certify security and safeguards personnel *	4	21(b)(3) 161	31(a)(6)@ 43(b)(6)@	1
2.20.5.3	Procedure(s) to monitor personnel reliability *	4	21(b)(3)	31(a)(6)@ 43(b)(6)@	1
2.20.5.4	Procedure(s) to conduct periodic training exercises *	4	21(b)(3) 161	31(a)(6)@ 43(b)(6)@	1
2.20.5.5	Procedure(s) to periodically recertify security and safeguards personnel *	4	21(b)(3) 161	31(a)(6)@ 43(b)(6)@	1
2.20.5.6	Contingency procedure(s) for the event of loss or theft of special nuclear material *	4	21(b)(4) 21(b)(3)	31(a)(6)@ 43(b)(6)@	3
2.20.5.7	Procedure(s) for security and safeguards unsafe/emergency conditions *	4	131(b)(4)(ii) 21(b)(3)	31(a)(6)@ 43(b)(6)@	1
2.20.5.8	Procedure(s) for security and safeguards facility and equipment maintenance *	4	131(b)(6)@	21(c)(15)(v)@	2

3. TRANSPORT WASTE BETWEEN MAJOR FACILITIES (e.g., source to disposal site)
[Analysis of this function is deferred.]

4. STORE HIGH-LEVEL WASTE (Applicable to interim storage or long-term storage)
[Analysis of this function is deferred. This would apply to facilities such as an MRS.]

5.	PREPARE WASTE FOR DISPOSAL	2	131(b)(7) 132(b)	43(b)(1)@ 43(b)(2)@ 135@	1
	FUNCTIONS				
5.1	Plan waste preparation operations	4	21(c)(15)(v)	21(c)(9) (Subpart I)	1
5.1.1	Plan normal waste preparation operations *	4	21(c)(15)(v)	---	1
5.1.2	Plan for accident/emergency contingencies in waste preparation operations including any unforeseen loss or potential loss of containment within waste preparation facilities *	4	21(c)(9)	---	1
5.1.3	Plan for emergency evacuation of workers and the public during waste preparation operations *	4	21(c)(9)	(Subpart I)	1
5.1.4	Plan waste preparation facility decommissioning *	4	21(c)(15)(vi)	132(e)@ 21(c)(11)@	1
5.2	Receive waste from off-site for preparation for disposal (see 6.2, Receive waste at repository from off-site)				
5.3	Receive waste disposal package components for waste preparation	4	135@ 113(a)(1)(ii)(A)@	132(a)@	2
5.3.1	Verify transportation vehicle condition and absence of sabotage devices (e.g., explosives) upon receipt of waste disposal package components #	4	21(b)(4) 21(b)(3)	---	1
5.3.2	Off-load waste disposal package components #	4	21(c)(15)(v)@	---	2
5.3.3	Inspect and test waste disposal package components #	4	152	10CFR50, App B, Criterion VII	2
5.3.4	Update inventory of waste disposal package components received for waste preparation operations **	5			
5.3.5	Load waste disposal package components for intra-facility transfer #	4	21(c)(15)(v)@	---	2
5.3.6	Protect waste disposal package components from damage during receiving	1	152 10CFR50, App B, Criterion V, X, XIII	135(a)(2)@	1
5.3.7	Inspect, test and maintain waste disposal package component receiving facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
5.4	Temporarily store waste during operations to prepare waste for disposal; i.e., lag (surge) storage (if required)	2	132(a)	31(a)(1)(ii)@	2
5.4.1	Receive waste at lag storage facility #	2	21(c)(15)(v)@ 132(a)@	31(a)(1)(ii)@	2
5.4.2	Off-load waste for lag storage #	2	21(c)(15(v)@ 132(a)@	31(a)(1)(ii)@	2
5.4.3	Update inventory of waste in lag storage *	4	71(b)	21(c)(10)@	1
5.4.4	Store waste pending packaging for disposal *	2	21(c)(15)(v)@ 132(a)@	31(a)(1)(ii)@	2
5.4.5	Load waste for transfer from lag storage #	2	21(c)(15)(v)@ 135(b)(3)@	---	2
5.4.6	Dispatch waste from lag storage *	2	21(c)(15)(v)@ 13(b)(3)@	---	2

	5.4.7	Inspect, test and maintain waste lag storage facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
5.5		Temporarily store waste disposal package components in lag (surge) storage during operations to prepare waste for disposal	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.5.1	Receive waste disposal package components at lag storage facility #	4	132(a)@	21(c)(15)(v)@	2
	5.5.2	Off-load waste disposal package components for lag storage #	4	132(a)@	21(c)(15)(v)@	2
	5.5.3	Inventory waste disposal package components in lag storage #	4	71(b)	21(c)(10)@	1
	5.5.4	Store waste disposal package components pending packaging of waste for disposal *	4	132(a)@	21(c)(15)(v)@	2
	5.5.5	Load waste disposal package components for transfer from lag storage #	4	132(a)@	21(c)(15)(v)@	2
	5.5.6	Dispatch waste disposal package components from lag storage #	4	132(a)@	21(c)(15)(v)@	2
	5.5.7	Inspect, test and maintain waste disposal package components lag storage facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
5.6		Transfer waste during preparation operations (intra-facility) (see 6.5, Transfer waste (intra-facility) during repository operations)				
5.7		Transfer waste disposal package components (intra-facility) *	4	132(b)@ 21(c)(15)(v)@	132(a)@	2
5.8		Package waste for disposal	2	135(c)(1) 113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.8.1	Consolidate spent fuel rods (as required) *	2	---	---	4
	5.8.2	Consolidate particulate waste forms (as required) *	2	135(c)(2)	---	1
	5.8.3	Process secondary waste for packaging (as required) *	3	132(d)@	---	1
	5.8.4	Process GTCC waste for packaging (as authorized) *	2	135(d)	102(b)(4)	3
	5.8.5	Package waste in waste disposal package #	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.8.6	Assemble waste disposal package #	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.8.7	Inspect and/or test waste disposal package #	4	152 10CFR50, App B, Criterion X	43(b)(4)@ 131(b)(6)@	1
	5.8.8	Repair/overpack waste (if applicable) #	2	---	---	4
	5.8.9	Repackage waste (if required) #	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.8.10	Containerize secondary waste (if required) *	3	132(d)@	---	1
	5.8.11	Decontaminate waste disposal package surface areas during/following waste packaging (as required) *	3	131(b)(4)(i)@ 111(a)@	21(c)(7)@	2
	5.8.12	Apply unique waste disposal package identification #	4	135(b)(4)	---	1
	5.8.13	Maintain waste disposal package functional capabilities during preparation for disposal #	2	152 10CFR50, App B, Criteria V, X, XIII	131(b)(1)@ 31(a)(6)@ 21(c)(15)(v)@	1

5.8.14	Load waste disposal package for intra-facility transfer (if required) #	2	21(c)(15)(v)@	135(b)(3)@	2
5.8.15	Prepare waste disposal package for off-site shipment (if required) #	2	132(b)@ 135(b)(3)@	71(b)@	3
5.8.16	Inspect, test and maintain waste disposal packaging facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
5.9	Monitor waste preparation conditions that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety during repository operations)				
5.10	Contain and dispose of any hazardous (nonradioactive) effluents resulting from waste preparation operations #	4	31(c)	32(a)	4
5.11	Account for (maintain inventories of) nuclear materials during waste preparation for disposal *	4	71(b)	21(c)(10)@	1
5.12	Perform periodic inspection, test and maintenance of waste preparation facilities and equipment *	4	131(b)(6)	---	2
5.13	Manage the configuration of waste preparation facilities, equipment, software and procedures *	4	10CFR50, App B, Criterion III	46(a)(5)@ 44(b)	1
5.14	Implement a quality assurance program for waste preparation operations *	4	152	150 151	1
5.15	Maintain and secure waste preparation records and reports *	4	71	---	1
CONSTRAINTS					
5.16	Limit personnel radiation exposure during preparation of waste for disposal	2	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.1	Limit personnel radiation exposure during normal waste preparation operations *	2	111(a) 131(a) 132(c)	21(c)(15)(v)@	1
5.16.2	Limit radiation level of waste contained in waste preparation operations #	2	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.3	Limit external radiation level of waste preparations operations #	2	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.4	Attenuate radiation from waste preparations operations #	2	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.5	Limit personnel time and proximity to radiation sources #	3	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.6	Limit personnel radionuclide ingestion during waste preparations operations #	2	111(a) 131(a) 132(c)	21(c)(7)@ 21(c)(9)@	1
5.16.7	Limit personnel radiation exposure during waste preparation unsafe/emergency conditions	2	111(a) 131(b)(4)	131(a)(6)@	1
5.16.2.1	Stop releases at the source during waste preparation operations #	2	21(c)(3)(ii)	31(a)(6)@	2
5.16.2.2	Limit spread of contamination during waste preparation operations #	3	131(a)(4) 132(b)	132(c)	1

	5.16.2.3	Decontaminate in event of release during waste preparation operations *	3	131(b)(4)(i)@	21(c)(7)@ 2
	5.16.2.4	Limit radiation level during waste preparation unsafe/emergency conditions *	2	111(a) 131(a)(6) 131(b)(4)	21(c)(9)@ 1
	5.16.2.5	Implement worker evacuation plan as appropriate during waste preparation operations *	4	131(b)(4)(i)	(Subpart I) 1
5.17	Limit releases of radionuclides to the general environment during waste preparation operations		2	111(a) 132(b)	132(c) 1
	5.17.1	Limit planned radionuclide release rate during waste preparation operations	2	132(c)(1) 111(a)	--- 1
	5.17.1.1	Monitor radionuclide releases during waste preparation operations *	4	132(c)(2)	21(c)(7)@ 2
	5.17.1.2	Reduce radionuclide releases during waste preparation operations if excessive *	2	131(b)(8) 132(c)(1)	132(b)@ 1
	5.17.2	Minimize likelihood of accidental releases of radionuclides during waste preparation operations *	2	132 131(b)	21(c)(7)@ 21(c)(9)@ 1
	5.17.3	Limit consequences of accidental radionuclide releases during waste preparation operations	2	111(a)	21(c)(7)@ 21(c)(9)@ 1
	5.17.3.1	Reestablish control of radioactive material at the source in event of accidental release during waste preparation operations *	4	21(c)(3)(ii)	31(a)(6)@ 2
	5.17.3.2	Limit spread of contamination in event of accidental release during waste preparation operations (if possible) *	4	131(a)4 132(b) 131(b)(4)(i)@	132(c) 1
	5.17.3.3	Decontaminate in event of accidental release during waste preparation operations (if possible) *	4	21(c)(7)@	--- 2
	5.17.3.4	Implement worker/public evacuation plan as appropriate in event of accidental release during waste preparation operations *	4	131(b)(4)(i)	(Subpart I) 1
5.18	Limit radiation level in the unrestricted area due to waste preparation operations #		2	111(a) 132(b) 132(c)(1)	131(b)(4)@ 21(c)(7)@ 21(c)(9)@ 1
5.19	Prevent nuclear criticality during waste preparation #		2	131(b)(7)	--- 2
5.20	Limit secondary effects of industrial hazards during preparation of waste for disposal that adversely affect safety or isolation **		4	131(b)(9)	133(a)(2)@ 2
5.21	Ensure operability of general purpose (non-waste handling) waste preparation facilities and equipment *		4	21(c)(15)(v)@	--- 2
5.22	Ensure the stability of general purpose (non-waste handling) waste preparation surface facilities under local foundation conditions #		4	131(b)(1)	--- 2
5.23	Ensure the ability of general purpose (non-waste handling) waste preparation facilities to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) #		4	131(b)(1)	--- 2
5.24	Ensure the ability of general purpose (non-waste handling) waste preparation facilities to perform their intended functions under conditions and events induced by human activities #		4	31(a)(6) 21(b)(4)	--- 2

5.25	Ensure operability of waste disposal package component equipment *	4	135@ 113(a)(1)(ii)(A)@	131(b)(6)@ 21(c)(15)(v)@	2
5.26	Ensure the stability of waste disposal package components facilities under local foundation conditions *	4	131(b)(1)	---	1
5.27	Ensure the ability of waste disposal package component facilities important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) #	2	131(b)(1)	---	1
5.28	Ensure the ability of waste disposal package component facilities important to safety to perform their intended functions under conditions and events induced by human activities #	2	21(c)(3)@ 31(a)(6)@	131(b)(6)@ 21(b)(3)@ 21(b)(4)@	2
5.29	Ensure fitness for duty of personnel certified for waste disposal package component handling and preparation *	4	162 21(c)(15)(iii)	160	1
5.30	Ensure operability of waste preparation equipment important to safety *	2	131(b)(6)	21(c)(15)(v)@	2
5.31	Ensure the stability of waste preparation facilities under local foundation conditions *	2	131(b)(1)	---	1
5.32	Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic) *	2	131(b)(1)	---	1
5.33	Ensure the ability of waste preparation facilities and equipment important to safety to perform their intended functions under conditions and events induced by human activities *	2	21(c)(3)@ 31(a)(6)@	131(b)(6)@ 21(b)(3)@ 21(b)(4)@	2
5.34	Ensure fitness for duty of personnel certified for waste preparation operations that are important to safety *	2	162 21(c)(15)(iii)@	160	1
GENERIC SYSTEM ELEMENTS					
5.35	Waste preparation generic system elements				
5.35.1	General purpose (non-waste handling) waste preparation generic system elements	4	131	---	1
5.35.1.1	Aqueous and non-aqueous fire protection facilities and equipment for waste preparation operations #	4	131(b)(3)(iii) 131(b)(3)(iv)	131(b)(4)(ii)	1
5.35.1.2	General purpose support buildings (e.g., lab, administrative, computer) for waste preparation operations **	5			
5.35.1.3	Utilities for waste preparation operations	4	131(b)(5)	---	1
5.35.1.3.1	Interface with utilities from off-site sources #	4	131(b)(5)@	---	1
5.35.1.3.2	On-site utility distribution facilities and equipment for waste preparation operations #	2	131(b)(5)	---	1
5.35.1.3.3	Standby electrical power sources and power distribution facilities and equipment for waste preparation operations important to safety #	2	131(b)(5)(ii) 131(b)(5)(iii)	---	1
5.35.1.3.4	Uninterruptable power source(s) (e.g., for repository instrumentation, alarms, communications, and lighting important to safety) #	2	131(b)(5)(iii)@	---	2

		5.35.1.3.5 Emergency lighting for waste preparation operations *	4	131(b)(5)@	---	2
		5.35.1.3.6 Repository surface-subsurface water distribution facilities and equipment *	4	131(b)(5)(i)	---	1
		5.35.1.3.7 Repository sewage collection, treatment, and disposal facilities and equipment **	5			
	5.35.1.4 Communications for waste preparation operations		4	131(b)(4)(ii)@	---	2
		5.35.1.4.1 Interface with communications from/to off-site sources for waste preparation operations *	4	131(b)(4)(ii)@	131(b)(5)@	2
		5.35.1.4.2 On-site communication network facilities and equipment for waste preparation operations #	4	131(b)(4)(ii)@	---	2
	5.35.1.5 Ventilation and air conditioning for general purpose surface waste preparation facilities *		5			
	5.35.1.6 Facilities and equipment for industrial waste disposal during waste preparation operations **		5			
	5.35.1.7 Surface facilities, equipment spares and material for general purpose waste preparation facility and equipment maintenance during waste preparation operations *		4	131(b)(6)@	21(c)(15)(v)@	2
5.35.2	Waste disposal package component receiving generic system elements		4	135@ 113(a)(1)(ii)(A)@	132(a)@	2
	5.35.2.1 Facilities for receiving waste disposal package components for waste preparation		4	135@ 113(a)(1)(ii)(A)@	132(a)@	2
		5.35.2.1.1 Facilities for external inspection of complete off-site transportation vehicle (e.g., railcar, truck) during disposal package component receiving #	4	135@ 113(a)(1)(ii)(A)@	132(a)@	2
		5.35.2.1.2 Repository demurrage area for railcars/trucks during disposal package component receiving #	5			
		5.35.2.1.3 Facility for off-loading waste disposal package components from transportation vehicle during disposal package component receiving #	4	135@ 113(a)(1)(ii)(A)@	132(a)@	2
		5.35.2.1.4 Facility for receiving, inspection and test of waste disposal package components during disposal package component receiving #	4	135@ 113(a)(1)(ii)(A)@	132(a)@ 152@	2
		5.35.2.1.5 Repository holding facility and yard for off-loaded railcars/trucks during disposal package component receiving *	5			

	5.35.2.1.6	Facility for loading waste disposal package components for intra-facility transfer during disposal package component receiving #	4	135@ 113(a)(1)(ii)(A)@	---	2
	5.35.2.1.7	Ventilation and air conditioning for waste disposal package component receiving facilities *	5			
	5.35.2.1.8	Facility for maintenance of waste disposal package component receiving facility and equipment #	4	21(c)(15)(v)@ 131(b)(6)@	---	2
5.35.2.2	Equipment for receiving waste disposal package components during waste preparation receiving operations		4	135@ 113(a)(1)(ii)(A)@	---	2
	5.35.2.2.1	Equipment for external inspection of complete off-site transportation vehicle (e.g., railcar, truck) #	4	135@ 113(a)(1)(ii)(A)@	21(b)(3)	2
	5.35.2.2.2	Equipment for off-loading waste disposal package components from transportation vehicle #	4	135@ 113(a)(1)(ii)(A)@	---	2
	5.35.2.2.3	Equipment for inspecting waste disposal package components upon receipt #	4	152 131(b)(6)	---	2
	5.35.2.2.4	Computational capability for receiving waste disposal package components *	5			
	5.35.2.2.5	Equipment for loading waste disposal package components for intra-facility transfer *	4	135@ 113(a)(1)(ii)(A)@	---	2
	5.35.2.2.6	Equipment for response to waste disposal package components unsafe conditions *	4	131(b)(4)(ii)@ 131(a)(6)	21(c)(9)@	2
	5.35.2.2.7	Equipment, spares, and materials for receiving facility and equipment maintenance waste disposal package components *	4	131(b)(6) 21(c)(15)(v)@	---	2
5.35.2.3	Software for waste disposal package components receiving operations (e.g., inventory) *		4	21(c)(15)(v)@	---	2
5.35.2.4	Trained and certified personnel for waste disposal package components receiving operations		4	161	160	1
	5.35.2.4.1	Trained and certified personnel for waste disposal package components handling in receiving operations *	4	161	160	1
	5.35.2.4.2	Trained and certified inspection and testing personnel for waste disposal package components receiving operations *	4	161	160 152@	1

		5.35.2.4.3 Trained and certified personnel for response to waste disposal package component receiving unsafe conditions *	4	161 131(b)(4)(ii)	160 21(c)(9)@	1
		5.35.2.4.4 Trained and certified personnel for waste disposal package components receiving facility and equipment maintenance *	4	161	160	1
	5.35.2.5	Procedure(s) for waste disposal package components receiving operations	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
		5.35.2.5.1 Procedure(s) for waste disposal package components handling in receiving operations *	4	152 10CFR50, App B Criterion V	43(b)(6)@ 31(a)(6)@	1
		5.35.2.5.2 Procedure(s) for inspection and test of waste disposal package components in receiving operations *	4	152 10CFR50, App B, Criterion V, VII and X	43(b)(6)@ 31(a)(6)@	1
		5.35.2.5.3 Procedure(s) for response to unsafe conditions during receiving operations *	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 131(b)(4)(ii) 21(c)(9)@	1
		5.35.2.5.4 Procedure(s) to ensure fitness for duty of personnel certified for waste disposal package component receiving *	4	152 10CFR50, App B, Criterion V 162	43(b)(6)@ 31(a)(6)@	1
		5.35.2.5.5 Procedure(s) for waste disposal package components receiving facility and equipment maintenance #	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 131(b)(6)@	1
5.35.3	Waste lag storage generic system elements for waste preparation operations		2	132(a)	31(a)(1)(ii)@	2
	5.35.3.1	Facility for waste lag storage during preparation operations	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.1.1 Off-load/load facilities for waste preparation lag storage *	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.1.2 Facility to temporarily store waste during preparation operations #	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.1.3 Ventilation and air conditioning for waste lag storage facilities *	2	132(b)	131(a)(1)@ 131(a)(4)@	1
		5.35.3.1.4 Facility for maintenance of waste preparation waste lag storage facility and equipment #	4	21(c)(15)(v)@ 131(b)(6)@	---	2
	5.35.3.2	Equipment for waste lag storage during preparation operations	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.2.1 Equipment to off-load/load waste to/from transfer conveyance in waste preparation lag storage #	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.2.2 Handling equipment for waste preparation lag storage #	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2

		5.35.3.2.3	Equipment to support waste disposal packages in lag storage #	2	132(a)@	31(a)(1)(ii)@ 74(a)(4)@	2
		5.35.3.2.4	Monitoring equipment for waste in lag storage #	4	132(c)(2)@ 21(c)(7)@	131(b)(8)@	2
		5.35.3.2.5	Computational capability for waste lag storage operations #	2	71(b)@	21(c)(10)@	2
		5.35.3.2.6	Equipment for waste lag storage unsafe/emergency conditions *	4	131(b)(4)(ii)@ 131(a)(6)@	21(c)(9)@	2
		5.35.3.2.7	Equipment, spares, and materials for waste lag storage facilities and equipment maintenance *	4	131(b)(6) 21(c)(15)(v)@	---	2
	5.35.3.3	Software for waste lag storage (e.g., inventory, process control, management) *		2	71(b)@	21(c)(10)@	2
	5.35.3.4	Trained and certified personnel for waste lag storage		2	161	160 21(c)(15)(iii)@	1
		5.35.3.4.1	Trained and certified personnel for waste handling in lag storage *	2	161@	160@ 21(c)(15)(iii)@	1
		5.35.3.4.2	Trained and certified personnel for inspection of waste received for lag storage *	4	161@	160@ 21(c)(15)(iii)@	1
		5.35.3.4.3	Trained and certified personnel for waste lag storage unsafe/emergency conditions *	4	161@	160@ 21(c)(15)(iii)@ 21(c)(9)@	1
		5.35.3.4.4	Trained and certified personnel for waste lag storage facility and equipment maintenance *	4	161@	160@ 21(c)(15)(iii)@	1
	5.35.3.5	Procedure(s) for waste lag storage operations		2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
		5.35.3.5.1	Procedure(s) for waste handling in lag storage *	2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
		5.35.3.5.2	Procedure(s) for inspection of waste received for lag storage #	4	152 10CFR50, App B, Criterion V, X	43(b)(6)@ 31(a)(6)@	1
		5.35.3.5.3	Procedure(s) for waste lag storage unsafe/emergency conditions *	4	152 Part 50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 21(c)(9)@	1
		5.35.3.5.4	Procedure(s) for waste lag storage facility and equipment maintenance #	4	131(b)(6) 21(c)(15)(v)@	152 10CFR50, App B, Criterion V	1
		5.35.3.5.5	Procedure(s) to ensure fitness for duty of personnel certified for waste lag storage operations #	4	152 10CFR50, App B, Criterion V 162	43(b)(6)@ 31(a)(6)@	1
5.35.4	Waste disposal package components lag storage generic system elements for waste preparation operations			4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.1	Facility for waste disposal package components lag storage during preparation operations		4	132(a)@ 21(c)(15)(v)@	135@	2

	5.35.4.1.1	Waste disposal package components lag storage off-load/load facility #	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.1.2	Facility for waste disposal package components lag storage during preparation operations #	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.1.3	Ventilation and air conditioning for waste disposal package components lag storage facilities *	5			
	5.35.4.1.4	Facility for maintenance of waste preparation waste lag storage facility and equipment #	4	21(c)(15)(v)@ 131(b)(6)@	---	2
5.35.4.2	Equipment for waste disposal package components lag storage during preparation operations		4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.2.1	Equipment to off-load/load waste disposal package components to/from transfer conveyance at lag storage #	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.2.2	Handling equipment for waste disposal package components in lag storage #	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.2.3	Equipment to support waste disposal package components in lag storage #	4	132(a)@ 21(c)(15)(v)@	135@	2
	5.35.4.2.4	Computational capability for waste disposal package components lag storage *	5			
	5.35.4.2.5	Equipment for response to waste disposal package components lag storage unsafe conditions *	4	131(b)(4)(ii)@ 131(a)(6)	21(c)(9)@	2
	5.35.4.2.6	Equipment, spares, and materials for waste disposal package components lag storage facilities and equipment maintenance *	4	131(b)(6) 21(c)(15)(v)@	---	2
5.35.4.3	Software for waste disposal package components lag storage (e.g., inventory) *		5			
5.35.4.4	Trained and certified personnel for waste disposal package components lag storage		4	161	160 21(c)(15)(iii)@	1
	5.35.4.4.1	Trained and certified personnel to off-load/load waste disposal package components in lag storage *	4	161@	160@ 21(c)(15)(iii)@	1
	5.35.4.4.2	Trained and certified personnel to handle waste disposal package components in lag storage *	4	161@	160@ 21(c)(15)(iii)@	1
	5.35.4.4.3	Trained and certified personnel for inspection of waste disposal package components received for lag storage *	4	161@	160@ 21(c)(15)(iii)@	1

		5.35.4.4.4	Trained and certified personnel for response to waste disposal package components lag storage unsafe conditions *	4	161@	160@ 21(c)(15)(iii)@ 21(c)(9)@	1
		5.35.4.4.5	Trained and certified personnel for waste disposal package components lag storage facility and equipment maintenance *	4	161@	160@ 21(c)(15)(iii)@	1
	5.35.4.5	Procedure(s) for waste disposal package components lag storage operations		4	152 10CFR50, App B, Criterion V	43(b)(6)@	1
		5.35.4.5.1	Procedure(s) for waste disposal package components off-loading/loading to/from transfer conveyance at lag storage *	4	152 10CFR50, App B, Criterion V	43(b)(6)@	1
		5.35.4.5.2	Procedure(s) for inspection of waste disposal package components received for lag storage #	4	152 10CFR50, App B, Criterion V, X	43(b)(6)@	1
		5.35.4.5.3	Procedure(s) for waste disposal package components handling in lag storage *	4	152 10CFR50, App B, Criterion V	43(b)(6)@	1
		5.35.4.5.4	Procedure(s) for response to waste disposal package components lag storage unsafe conditions *	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 21(c)(9)@	1
		5.35.4.5.5	Procedure(s) for waste disposal package components lag storage facility and equipment maintenance #	4	131(b)(6) 21(c)(15)(v)@	152 10CFR50, App B, Criterion V	1
		5.35.4.5.6	Procedures to ensure fitness for duty of personnel certified for waste disposal package components lag storage operations #	4	162 10CFR50, App B, Criterion V	160 93(b)(6)@	1
5.35.5	Waste packaging generic system elements			2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.35.5.1	Facilities for waste packaging		2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
		5.35.5.1.1	High-level waste consolidation facility (if required) *	2	132(c)(2)@	---	2
		5.35.5.1.2	Waste disposal package assembly facility *	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
		5.35.5.1.3	Waste disposal package repair/overpack facility (if applicable) #	2	---	---	4
		5.35.5.1.4	Waste disposal package inspection and test facility #	4	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@ 152@	2
		5.35.5.1.5	Facility for repackaging waste (e.g., damaged, defective) #	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2

	5.35.5.1.6	Facility to prepare for disposal those secondary wastes generated during packaging of high-level waste #	3	132(d)	---	1
	5.35.5.1.7	Facility to package Greater-Than-Class-C (GTCC) waste for disposal (if applicable) *	2	135(d)@	---	3
	5.35.5.1.8	Facility for waste packaging facility and equipment maintenance #	4	131(b)(6)@ 21(c)(15)(v)@	---	2
	5.35.5.1.9	Ventilation and air conditioning for waste packaging facilities *	2	132(b)	131(a)(1)@ 131(a)(4)@	1
5.35.5.2	Equipment for waste packaging		2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.35.5.2.1	Waste disposal package components #	4	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.35.5.2.2	Containers for secondary wastes (if required) #	3	132(d)@	---	2
	5.35.5.2.3	Equipment for high-level waste consolidation (if required) #	2	135(c)(2)@	---	2
	5.35.5.2.4	Equipment for the movement of waste, waste disposal package components, and assembled waste disposal packages in the waste packaging process #	2	74(a)(4)@	132(a)@	2
	5.35.5.2.5	Equipment for waste disposal package assembly #	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.35.5.2.6	Equipment for waste disposal package repair/overpack (if applicable) *	2	---	---	4
	5.35.5.2.7	Equipment for waste disposal package inspection and test during/following packaging #	4	113(a)(1)(ii)(A)@ 135(a)@ 152@	132(b)@ 131(b)(7)@	2
	5.35.5.2.8	Equipment for waste repackaging (if required) *	2	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
	5.35.5.2.9	Equipment for preparation of secondary waste for disposal #	3	132(d)@	---	2
	5.35.5.2.10	Equipment for packaging of GTCC waste for disposal (if applicable) #	2	135(d)@ 102(b)(4)@	---	3
	5.35.5.2.11	Computational capability for waste packaging operations *	2	71(b)@	21(c)(10)@	1
	5.35.5.2.12	Equipment for waste packaging unsafe/emergency conditions *	4	131(b)(4)(ii)@ 131(a)(6)@	21(c)(9)@	2
	5.35.5.2.13	Equipment, spares, and materials for waste packaging facility and equipment maintenance #	4	131(b)(6)@ 21(c)(15)(v)@	---	2
5.35.5.3	Software for waste packaging operations (e.g., inventory, process control, monitoring) *		2	71(b)@	21(c)(10)@	2

5.35.5.4	Trained and certified personnel for waste packaging operations		2	161	160 21(c)(15)(iii)a	1
	5.35.5.4.1	Trained and certified personnel for waste packaging operations *	2	161	160 21(c)(15)(iii)a	1
	5.35.5.4.2	Trained and certified inspection and testing personnel for waste packaging operations *	4	161	160 21(c)(15)(iii)a	1
	5.35.5.4.3	Trained and certified personnel for waste packaging unsafe/emergency conditions *	4	161	160 21(c)(15)(iii)a 21(c)(9)a	1
	5.35.5.4.4	Trained and certified personnel for waste packaging facility and equipment maintenance #	4	161	160 21(c)(15)(iii)a	1
5.35.5.5	Procedure(s) for waste packaging operations		2	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a	1
	5.35.5.5.1	Procedure(s) for waste disposal package assembly actions and processes *	2	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a	1
	5.35.5.5.2	Procedure(s) for inspecting and testing waste disposal packages during and following packaging operations #	4	152 10CFR50, App B, Criterion V, X	43(b)(6)a 31(a)(6)a	1
	5.35.5.5.3	Procedure(s) for waste packaging unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a 21(c)(9)a	1
	5.35.5.5.4	Procedure(s) for waste packaging facility and equipment maintenance #	4	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a 131(b)(6)a	1
	5.35.5.5.5	Procedure(s) to ensure fitness for duty of personnel certified for waste packaging operations #	4	152 10CFR50, App B, Criterion V 162	43(b)(6)a 31(a)(6)a	1

6.	CONDUCT GEOLOGIC REPOSITORY WASTE DISPOSAL OPERATIONS	2	31(a)@ 31(a)(1)(ii)@ 71(b)@	21(c)(15)(v)@ 21(c)(15)(vii)@ 102(b)(3)@ 102(d)@	1
	FUNCTIONS				
6.1	Plan repository operations	4	21(c)(4)-(12) 21(c)(15)	21(b)(1)-(4) (Subpart I)	1
6.1.1	Plan normal repository disposal operations *	4	21(c)(15)(v)	21(b)(2) 21(b)(3) 21(b)(4)	1
6.1.2	Plan for emergency repository operations contingencies including unforeseen loss or potential loss of containment *	4	21(c)(9)	131(b)(4)@	1
6.1.3	Plan for possible removal of waste from repository and alternative storage *	4	21(c)(12)	111(b)	1
6.1.4	Plan for emergency evacuation during disposal operations *	4	21(c)(9)	131(b)(4)(i)@ (Subpart I)	1
6.1.5	Plan repository post-emplacement operations *	4	21(c)(9) 21(c)(8)	21(c)(11)@	1
6.1.6	Plan repository closure and decommissioning *	4	21(c)(15)(vi) 51	---	1
6.1.7	Plan repository postclosure activities *	4	51(a)(1) 51(a)(2)	21(c)(8)	1
6.2	Receive waste at repository from off-site	2	21(b)(2)@ 21(c)(5)@	71(b)@ 132(a)@	2
6.2.1	Inspect waste upon receipt at the repository	4	152 10CFR50, App B, Criterion X	131(b)(6)@	2
6.2.1.1	Verify railcar/truck condition and absence of sabotage devices (e.g., explosives) upon receipt #	4	21(b)(4)	21(b)(3)	1
6.2.1.2	Survey transportation package external dose rate upon receipt #	3	111(a)@ 131(b)(4)(i)@	21(c)(7)@	2
6.2.1.3	Inspect physical condition of waste upon receipt #	4	152	10CFR50, App B, Criterion X	1
6.2.1.4	Verify type, amount, and source of waste received #	4	71(b)	21(c)(10)@ 51(a)(2)(ii)@	2
6.2.2	Off-load transportation package from transportation vehicle upon receipt (if required) #	2	21(b)(2)@ 21(c)(5)@	132(a)@	2
6.2.3	Decontaminate transportation package/waste surface areas in receiving (if required) #	3	21(b)(2)@ 21(c)(5)@	132(a)@	2
6.2.4	Remove waste from transportation package in receiving *	2	21(b)(2)@ 21(c)(5)@	132(a)@	2
6.2.5	Inspect and test waste received for disposal to verify condition and content *	4	21(c)(5)@	152 43(b)(4)@ 10CFR50, App B, Criteria VIII & X	1
6.2.6	Update inventory of waste received for disposal *	4	71(b)	21(c)(10)@	1

6.2.7	Monitor waste receiving conditions that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety) *					
6.2.8	Load waste disposal package for intra-facility transfer #	2	132(a)@ 21(c)(15)(v)@	31(a)(1)(ii)@	2
6.2.9	Inspect, test and maintain receiving operations facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.3	Prepare waste for disposal (see 5, Prepare waste for disposal)				
6.4	Temporarily store waste during repository operations -- lag (surge) storage (if required)	2	132(a)	21(c)(12)@ 31(a)(1)(ii)@	1
6.4.1	Receive waste disposal package at repository lag storage facility #	2	21(c)(15)(v)@ 132(a)	21(c)(12)@ 31(a)(1)(ii)@	2
6.4.2	Off-load waste disposal package for repository lag storage #	2	21(c)(15)(v)@ 132(a)	21(c)(12)@ 31(a)(1)(ii)@	2
6.4.3	Update inventory of repository lag storage waste disposal packages * *	4	71(b)	21(c)(10)@	1
6.4.4	Load repository lag storage waste disposal package for transfer #	2	21(c)(15)(v)@ 132(a)@	21(c)(12)@ 31(a)(1)(ii)@	2
6.4.5	Dispatch waste disposal package from repository lag storage #	2	21(c)(15)(v)@ 132(a)@	21(c)(12)@ 31(a)(1)(ii)@	2
6.4.6	Inspect, test and maintain repository lag storage facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.5	Transfer waste (intra-facility) during repository operations	2	132(b)@ 131(b)(7)@ 135(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
6.5.1	Prepare for individual waste disposal package transfer	4	135(b)(3)@	---	3
6.5.1.1	Select individual waste disposal package to be transferred (if required) *	4	43(b)(3) 71(b)@	135(b)(3)@	3
6.5.1.2	Authorize transfer of individual waste disposal package	4	71(b)@	21(c)(10)@	3
6.5.1.2.1	Authorize transfer of waste disposal package to lag storage *	4	71(b)@	21(c)(10)@	3
6.5.1.2.2	Authorize transfer of waste disposal package to preparation-for-disposal facility (if required) *	4	71(b)@	21(c)(10)@	3
6.5.1.2.3	Authorize transfer of waste disposal package to emplacement location *	4	71(b)@	21(c)(10)@	3
6.5.1.3	Coordinate transfer of individual waste disposal package *	5			
6.5.2	Verify identity of individual waste disposal package for intra-facility transfer *	4	135(b)(4)@	---	1
6.5.3	Ensure integrity of waste disposal package prior to transfer *	4	152 131(b)(6)@	10CFR50, App B, Criterion X	2

6.5.4	Load waste disposal package on transfer conveyance during transfer operations #	2	135(b)(3)@	---	3
6.5.5	Dispatch waste disposal package during transfer operations #	4	135(b)(3)@	---	3
6.5.6	Update inventory of waste disposal packages for transfer operations #	4	71(b)	21(c)(10)@	1
6.5.7	Move waste disposal package to next repository station during transfer operations *	2	135(b)(3)@	---	3
6.5.8	Off-load waste disposal package from transfer conveyance during transfer operations (if required) #	2	135(b)(3)@	---	3
6.5.9	Protect the waste disposal package from physical damage in transfer during transfer operations *	2	135(b)(3)@	---	3
6.5.10	Return damage protection device to storage area after transfer operations (if required) #	5			
6.5.11	Inspect, test and maintain receiving operations facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.6	Emplace waste disposal package in geologic repository	2	21(b)(2)@ 111(b)@ 132(a)@	122(b)(5)@ 135(b)(3)@	2
6.6.1	Ensure integrity of waste disposal package at start of emplacement *	4	152 10CFR50, App B, Criterion X	131(b)(6)@	2
6.6.2	Transfer waste disposal package to intended emplacement opening/location *	2	132(b)@	132(a)@	2
6.6.3	Verify and record identification of each waste disposal package and its intended emplacement opening/location *	4	135(b)(4) 152 71(b)	10CFR50 App B, X	3
6.6.4	Transfer waste disposal package to emplacement equipment (if required) #	2	111(b)@	135(b)(3)@	2
6.6.5	Align waste disposal package with emplacement opening/location #	2	111(b)@	135(b)(3)@	2
6.6.6	Place waste disposal package in position in emplacement opening/location #	2	111(b)@	135(b)(3)@	2
6.6.7	Emplace emplacement opening packing or backfill (if required) #	1	111(b)(2)	41(a)(4)@	2
6.6.8	Install monitoring equipment for waste emplacement (as required) #	4	131(a)(6) 131(b)(8)	131(a)(4) 51(a)(1)	2
6.6.9	Verify integrity of waste disposal package and, if used, emplacement opening backfill during waste emplacement operations #	4	152	10CFR50 App B,X	2
6.6.10	Verify and record identification of emplaced waste disposal package and emplacement opening location number #	4	135(b)(4)	71(b)	1
6.6.11	Authorize and sign-off emplacement opening closure #	4	43(b)(6)@	---	3
6.6.12	Close emplacement opening/location following waste emplacement (i.e., install cover or plug) #	4	111(a)@	131(a)(3)@ 131(a)(5)@	2
6.6.13	Prevent tampering with emplaced waste disposal package #	4	21(b)(4)	---	1
6.6.14	Update inventory of emplaced waste *	4	71(b)	21(c)(10)	1

6.6.15	Close and backfill selected drifts as authorized during waste emplacement operations (see 6.11.1, Close underground facility)	5			
6.6.16	Monitor waste emplacement conditions that affect radiological health and safety during waste emplacement operations (see 6.8, Monitory repository conditions that affect radiological health and safety) *				
6.6.17	Inspect, test and maintain receiving operations facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.7	Relocate waste within underground facility (as required)	4	---	---	4
6.7.1	Remove waste from emplacement location (see 6.9.1 - 6.9.12, Remove any/all waste from underground facility (as required))				
6.7.2	Transfer waste within underground facility (see 6.5, Transfer waste (intra-facility) during repository operations				
6.7.3	Reemplace waste (see 6.6, Emplace waste disposal package in geologic repository)				
6.7.4	Update inventory of emplaced waste *	4	71(b)	21(c)(10)	1
6.8	Monitor repository conditions that affect radiological health and safety or isolation during repository operations	4	131(b)(8) 132(c)(2)	21(c)(7)	2
6.8.1	Continuously monitor conditions that may impact personnel safety (radiological & non-radiological) during repository operations	4	131(a)(4) 131(a)(6) 131(b)(8) 132(c)(2)	21(c)(7)@	2
6.8.1.1	Continuously monitor radiation levels during repository operations #	4	131(a)(4) 131(a)(6) 132(c)(2)	21(c)(7)@	2
6.8.1.2	Monitor environmental conditions to provide warning of potentially hazardous conditions or events during repository operations (e.g., air contamination, seismic event) *	4	131(b)(1)@	---	3
6.8.1.3	Continuously monitor personnel radiation exposure levels during repository operations *	4	131(a)(2) 21(c)(7)@	111(a)@	2
6.8.1.4	Monitor fitness for duty of personnel performing safety-related work *	4	162	160	1
6.8.2	Continuously monitor conditions that may impact radiological exposures, releases and/or containment during repository operations *	4	131(b)(8)	---	2
6.8.3	Inspect, test and maintain monitoring facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.8.4	Verify geologic repository and engineered barrier design data and assumptions during repository operations *	4	137	Subpart F	1
6.9	Remove any/all waste from underground facility during repository waste handling operations (as required)	2	111(b) 131(b)(7)@ 132(a)@ 133(c)@	21(c)(12)@ 46(a)(1)@ 135(b)(3)@	2
6.9.1	Obtain authorization to remove waste from emplacement location and/or from underground facility *	4	43(b)(6)@	21(c)(12)@	2
6.9.2	Identify location of waste to be removed *	4	71(b)	21(c)(10)@	1

6.9.3	Prepare emplacement drifts for reentry to underground facility for waste removal operations (e.g., cool, stabilize (if required)) *	4	21(c)(12)@	---	3
6.9.4	Verify access entry point location before providing access to waste in underground facility during waste removal operations #	4	21(c)(12)@	---	3
6.9.5	Provide access to waste disposal package opening/location in underground facility during waste removal operations *	4	21(c)(12)@	---	3
6.9.6	Remove physical impediments to waste disposal package removal from underground facility (e.g., debris, cover or plug) *	4	21(c)(12)@	---	3
6.9.7	Verify identity of waste to be removed from underground facility #	4	135(b)(4)	71(b)@	1
6.9.8	Determine condition of waste disposal package prior to removal from underground facility during waste removal operations #	2	152 10CFR50, App B, Criterion X	---	1
6.9.9	Survey waste disposal package external dose rate prior to removal from underground facility during waste removal operations #	3	111(a)@ 133(c)@	21(c)(7)@	2
6.9.10	Remove waste from emplacement location during waste removal operations *	2	133(c)@	---	2
6.9.11	Decontaminate waste disposal package surface area(s) during waste removal operations (if required) #	3	131(b)(4)(i)@ 111(a)@	21(c)(7)@	2
6.9.12	Prepare waste for intra-facility transfer during waste removal operations *	2	21(c)(15)(v)@	135(b)(3)@	2
6.9.13	Transfer waste to surface facility [see 6.5, Transfer waste (intra-facility) during repository operations]				
6.9.14	Off-load waste from transfer conveyance #	2	21(c)(15)(v)@ 132(a)@	21(c)(12)@	2
6.9.15	Temporarily store waste during waste removal operations (if required) (see 6.4, Temporarily store waste during repository operations (if required))		---	---	-
6.9.16	Update inventory of emplaced waste during repository waste removal operations *	4	71(b)	21(c)(10)@	1
6.9.17	Close waste emplacement opening following waste removal (if required) #	5			
6.9.18	Close waste access opening following waste removal operations (if required) #	5			
6.9.19	Monitor waste removal conditions that affect radiological health and safety during waste removal operations (see 6.8, Monitor repository conditions that affect radiological health and safety)				
6.9.20	Inspect, test and maintain waste removal operations facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.10	Prepare waste for off-site shipment during repository waste handling operations (as required)	2	132(d) 21(c)(12)@	71(b)@ 135(b)(3)@ 132(b)@	2
6.10.1	Inspect shipping cask to ensure functional capability in preparation for off-site shipment #	4	152	10CFR50, App B, Criterion X	2

6.10.2	Repair/replace shipping cask (as necessary) for off-site shipment #		4	---	---	4
6.10.3	Prepare shipping cask for shipment *		4	21(c)(12)@	132(d)@	2
6.10.4	Unload waste from intra-facility transfer conveyance *		2	21(c)(15)(v)@ 132(a)@	21(c)(12)@	2
6.10.5	Inspect and test waste in preparation for off-site shipment *		4	152	10CFR50, App B, Criterion X	1
6.10.6	Refurbish waste, as required, in preparation for off-site shipment *		2	132(a)@	132(d)@	3
6.10.7	Assemble transportation package (shipping cask with waste) in preparation for off-site shipment #		2	132(a)@	132(d)@	3
6.10.8	Load transportation package onto transportation vehicle for off-site shipment (if required) #		2	132(a)@	132(d)@	3
6.10.9	Conduct external inspection/survey of complete off-site transportation vehicle *		2	152 10CFR50, App B, Criterion XIII	21(c)(7)@ 111(a)@	1
6.10.10	Monitor conditions during preparation for off-site shipment that affect radiological health and safety (see 6.8, Monitor repository conditions that affect radiological health and safety)					
6.10.11	Update inventory of geologic repository waste upon off-site shipment *		4	71(b)	21(c)(10)@	1
6.10.12	Inspect, test and maintain receiving operations facilities and equipment *		4	131(b)(6)@	21(c)(15)(v)@	2
6.11	Close and decommission repository		1	21(c)(11)@ 21(c)(15)(vi)@ 132(e)@	51(a)(1)@ 51(a)(2)@ 51(a)(4)@	1
6.11.1	Close underground facility (as authorized)		1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.1	Decontaminate underground facilities and equipment (if required) *	3	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.2	Remove underground facilities (plumbing, HVAC, etc.) and equipment (as appropriate) *	4	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.3	Remove hazardous and potentially corrosive materials from the underground facility *	4	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.4	Install, calibrate and test subsurface postclosure monitoring equipment (as applicable) *	4	51(a)(1) 21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.5	Examine performance capability of seals/backfills and monitoring equipment previously emplaced *	1	152	10CFR50, App B, Criterion X	1
	6.11.1.6	Repair/replace previously emplaced seals and/or backfill and monitoring equipment (as required) *	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.7	Emplace emplacement opening/location packing, backfill and/or cover (or plug as required) #	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.8	Verify readiness for final closure #	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
	6.11.1.9	Seal and/or backfill drifts and rooms (if required) #	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2

	6.11.1.10	Emplace drift seal(s) (if required) #	1	21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
6.11.2		Close shafts, ramps, boreholes, and other access openings	1	134a 21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
	6.11.2.1	Install, calibrate, and test subsurface postclosure monitoring equipment (as applicable) *	4	51(a)(1) 134a 51(a)(1) 21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
	6.11.2.2	Seal unused piping or conduits to underground facility (if required) #	1	134a 21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
	6.11.2.3	Backfill and close shafts, ramps, and other access openings, and emplace seals *	1	134a 21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
	6.11.2.4	Emplace closure seals for boreholes and other openings *	1	134a 21(c)(11)a 21(c)(15)(vi)a	51(a)(4)a	2
6.11.3		Decontaminate and dismantle surface facilities	3	132(e)	21(c)(11)a 21(c)(15)(vi)a	1
	6.11.3.1	Decontaminate surface facilities (as necessary) #	3	132(e)	21(c)(11)a 21(c)(15)(vi)a	1
	6.11.3.2	Install, calibrate, and test surface postclosure monitoring equipment (as applicable) *	4	51(a)(1) 132(e)	21(c)(11)a 21(c)(15)(vi)a	1
	6.11.3.3	Dismantle and dispose of unneeded surface facilities (when decontamination is complete) #	5			
	6.11.3.4	Consolidate and transfer contaminated equipment and materials #	3	132(e)	132(d)	2
	6.11.3.5	Dispose of contaminated equipment and materials during closure operations (as authorized) *	3	132(d)	---	2
	6.11.3.6	Erect surface monuments/markers *	4	51(a)(2)(i)	21(c)(8)a	2
	6.11.3.7	Return site to natural ecological system following closure and decommissioning *	5			
6.11.4		Inspect, test and maintain closure and decommissioning facilities and equipment *	4	131(b)(6)a	21(c)(15)(v)a	2
6.12		Perform configuration management for waste disposal operations system elements #	4	10CFR, App B, Criterion III	46(a)(5)a 44 (b)	1
6.13		Implement a quality assurance program for waste disposal operations *	4	152	150 151	1
6.14		Maintain and secure geologic repository waste disposal records and reports *	4	71	21(c)(10)	1
6.15		Contain and dispose of any hazardous (nonradioactive) effluents resulting from waste disposal operations #	5			

CONSTRAINTS

6.16	Limit personnel radiation exposure during waste disposal operations	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1	Limit personnel radiation exposure during normal waste disposal operations	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1.1	Limit radiation level of waste contained in waste disposal package #	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1.2	Limit external radiation level of waste disposal package #	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1.3	Attenuate radiation from waste or disposal package #	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1.4	Limit personnel time and proximity to radiation sources #	3	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.1.5	Limit personnel radionuclide ingestion during waste disposal operations #	2	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.2	Limit personnel radiation exposure during waste disposal unsafe/emergency conditions	4	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.2.1	Stop releases at the source (during waste disposal operations) #	4	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.2.2	Limit spread of contamination during waste disposal operations #	4	111(a) 131(a) 132(c) 133(g)(1)	21(c)(7)a 21(c)(9)a	1
6.16.2.3	Decontaminate in event of release during waste disposal operations #	4	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.2.4	Limit radiation level during waste disposal unsafe/emergency conditions #	4	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.16.2.5	Implement worker evacuation plan as appropriate #	4	111(a) 131(a) 132(c)	21(c)(7)a 21(c)(9)a	1
6.17	Limit releases of radionuclides to the general environment during waste disposal operations	2	111(a) 132(b)	132(c)	1
6.17.1	Limit planned radionuclide release rate during waste disposal operations	2	111(a) 132(b)	132(c)	1
6.17.1.1	Monitor radionuclide releases during waste disposal operations #	4	111(a) 132(b)	132(c)	1
6.17.1.2	Reduce radionuclide releases during waste disposal operations if an unsafe condition exists #	4	111(a) 132(b)	132(c)	1

6.17.2	Minimize likelihood of accidental releases of radionuclides during waste disposal operations #	2	111(a) 132(b) 131(b)(1)-(10)	132(c)	1
6.17.3	Limit consequences of accidental radionuclide releases during waste disposal operations	4	111(a) 132(b)	132(c)	1
6.17.3.1	Reestablish control of radioactive material at the source in event of accidental release #	4	111(a) 132(b)	132(c)	1
6.17.3.2	Limit spread of contamination in event of accidental release (if possible) #	4	111(a) 132(b) 133(g)(1)	132(c)	1
6.17.3.3	Decontaminate in event of accidental release (if possible) #	4	111(a) 132(b)	132(c)	1
6.17.3.4	Implement worker/public evacuation plan as appropriate in event of accidental release #	4	111(a) 132(b)	132(c)	1
6.18	Limit radiation level in the unrestricted area due to waste preparation operations #	2	111(a) 132(b) 132(c)(1)	131(b)(4)@ 21(c)(7)@ 21(c)(9)@	1
6.19	Prevent nuclear criticality during waste disposal operations *	2	131(b)(7)	---	1
6.20	Protect waste disposal package from damage during repository operations #	2	135(a)(2) 10CFR50 App B, IX,XIII	135(b)(3)	2
6.21	Maintain chemical and physical properties of emplacement opening backfill during repository operations (if used) #	1	133(a)@ 133(h)@	133(i)@	2
6.22	Maintain emplacement opening/location mechanical stability during repository operations #	1	133(e)	131(b)(9)	1
6.23	Maintain the stability of the underground access facilities and emplacement openings/locations during waste removal operations #	4	133(e)	131(b)(9)	1
6.24	Protect waste disposal package from potentially damaging stress during removal (e.g., thermal shock, excessive force) *	2	21(c)(12)@	---	3
6.25	Maintain chemical and physical properties of waste emplacement packing/backfill/seal(s) during closure *	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
6.26	Maintain chemical and physical properties of closure backfill/seals during closure *	1	134@ 21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	3
6.27	Limit secondary effects of mine and industrial hazards during repository waste disposal operations, closure and decommissioning that adversely affect safety or isolation *	4	131(b)(9)	133(a)(2)@	2
6.28	Isolate underground waste operations air from construction areas during concurrent operations #	4	133(g)(3)	---	1
6.29	Ensure operability of repository general purpose (non-waste handling) facilities and equipment *	4	131(b)(6)	21(c)(15)(v)@	2
6.30	Ensure the stability of repository general purpose (non-waste handling) surface facilities under local foundation conditions *	4	131(b)(1)	---	1
6.31	Ensure the ability of repository general purpose (non-waste handling) facilities and equipment to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) *	4	131(b)(1)	---	1

6.32	Ensure the ability of repository general purpose (non-waste handling) surface facilities and equipment to perform their intended functions under conditions and events induced by human activity *	4	21(c)(3)@ 31(a)(6)@	131(b)(6)@ 21(b)(3)@ 21(b)(4)@	2
6.33	Ensure operability of repository facilities and equipment important to safety or isolation *	1	131(b)(6)	21(c)(15)(v)@	2
6.34	Ensure the stability of repository surface facilities important to safety or isolation under local foundation conditions *	1	131(b)(1)	---	1
6.35	Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under naturally induced conditions and events (e.g., weather, seismic activity) *	1	131(b)(1)	---	1
6.36	Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity *	1	112 21(c)(3)	133(a) 133(e)(1) 21(b)(3)@ 21(b)(4)@	2
6.37	Ensure fitness for duty of personnel certified for repository operations that are important to safety or isolation #	4	162	160 21(c)(15)(iii)@	1
6.38	Ensure stability of underground access facilities #	4	133(e) 131(b)(1)	133(a) 131(b)(9)	1
6.39	Limit alterations of the geologic media that adversely affect performance	1	133(f)	133(b)	1
6.39.1	Limit alterations of existing discontinuities that adversely affect performance (preferential pathways to or between aquifers) *	1	133(f)	133(b)@ 133(h)@	1
6.39.2	Limit creation of new discontinuities that adversely affect performance (preferential pathways to or between aquifers) *	1	133(f)	133(b)@ 133(h)@	1
6.39.3	Limit proximity of openings to preferential pathways *	1	21(c)(1)(i)@	133(b)@ 133(h)@	2
6.39.4	Limit adverse effects on geochemistry *	1	21(c)(1)(i)(E)@ 21(c)(1)(i)(F)@	---	2
6.40	Limit proximity of waste emplacement openings/locations to fault or fracture zones #	1	21(c)(1)(i)(A)@	---	2

GENERIC SYSTEM ELEMENTS

6.41 Waste disposal operations generic system elements

6.41.1	General purpose (non-waste handling) facilities and equipment for repository disposal operations			4	131(b)@ 21(c)(15)(v)@	152@ 161@	2
	6.41.1.1	Surface general purpose (non-waste handling) facilities and equipment for repository operations		4	131(b)@ 21(c)(15)(v)@	152@ 161@	2
		6.41.1.1.1	Aqueous and non-aqueous surface fire protection facilities and equipment for disposal operations *	4	131(b)(3)(iii) 131(b)(3)(iv)	131(b)(4)(ii)	1
		6.41.1.1.2	Surface facilities and equipment for emergency surface/subsurface escape/rescue during disposal operations *	4	131(b)(9)	---	2
		6.41.1.1.3	General purpose facilities and equipment (e.g., administrative, training, computer, lab) for disposal operations **	4	152@ 161@	21(c)(15)(i)@	2
		6.41.1.1.4	Repository surface facilities and equipment for vehicle service and maintenance **	5			
		6.41.1.1.5	Ventilation and air conditioning for general purpose repository surface facilities **	5			
		6.41.1.1.6	Emergency lighting for general purpose repository surface facilities #	4	131(b)(5)@	---	2
		6.41.1.1.7	Surface facilities, equipment, spares and material for repository general purpose facility and equipment maintenance during disposal operations *	4	131(b)(6)@	21(c)(15)(v)@	2
	6.41.1.2	Underground general purpose (non-waste handling) facilities and equipment for repository operations		4	131(b)@ 21(c)(15)(v)@	152@ 161@	2
		6.41.1.2.1	Personal air supply(ies) for underground emergencies #	4	133(g)(2) 131(b)(9)	131(b)(4)(ii)@	2
		6.41.1.2.2	Underground emergency escape/rescue routes and refuges #	4	131(b)(9)	---	1
		6.41.1.2.3	Equipment for underground emergency escape/rescue #	4	131(b)(9)	131(b)(4)(ii)@	1
		6.41.1.2.4	Aqueous and non-aqueous underground fire protection facilities and equipment *	4	131(b)(9) 131(b)(3)(iii)	133(a)(2)	1
		6.41.1.2.5	Mine water control (if required)	4	133(d)	131(b)(9)	2
			6.41.1.2.5.1 Underground facility mine water control (if required) #	4	133(d)	131(b)(9)	2
			6.41.1.2.5.2 Mine water handling in access openings (if required) #	4	133(d)	---	2

		6.41.1.2.5.3	Mine water disposal facilities and equipment (if required) **	5			
	6.41.1.2.6	Underground ventilation and air conditioning		4	133(g)	---	1
		6.41.1.2.6.1	Ventilation and air conditioning for underground waste operations *	4	133(g)(2)	---	1
		6.41.1.2.6.2	Ventilation and air conditioning for underground caretaker and waste retrieval operations *	4	133(g)(2)	---	1
		6.41.1.2.6.3	Ventilation and air conditioning for underground facility closure operations *	4	133(g)	---	2
	6.41.1.2.7	Underground administrative facility **		5			
	6.41.1.2.8	Underground general purpose support facilities and equipment **		5			
	6.41.1.2.9	Emergency lighting for general purpose underground facilities #		4	131(b)(5)@	---	2
	6.41.1.2.10	Surface facilities, equipment, spares and material for repository general purpose facility and equipment maintenance during disposal operations *		4	131(b)(6)@	21(c)(15)(v)@	2
6.41.1.3	Surface-subsurface common general purpose (non-waste handling) facilities and equipment for repository operations			4	131(b)@	21(b)(1)@ 21(c)(15)(v)@	2
	6.41.1.3.1	On-site repository utility and communications facilities and equipment		4	131(b)(5)	---	1
		6.41.1.3.1.1	Interfaces with utilities from off-site sources *	4	131(b)(5)@	---	1
		6.41.1.3.1.2	Repository on-site normal electrical power distribution facilities and equipment #	4	131(b)(5)(i)	---	1
		6.41.1.3.1.3	Standby electrical power sources and power distribution facilities and equipment for repository operations important to safety #	2	131(b)(5)(ii) 131(b)(5)(iii)	---	1

			6.41.1.3.1.4	Uninterruptable power source(s) (e.g., for repository instrumentation, alarms, communications, and lighting important to safety) #	2	131(b)(5)(iii)@	---	2
			6.41.1.3.1.5	Emergency lighting for repository surface-subsurface common facilities #	4	131(b)(5)@	---	2
			6.41.1.3.1.6	Repository surface-subsurface water distribution facilities and equipment *	4	131(b)(5)(i)	---	1
			6.41.1.3.1.7	Repository sewage collection, treatment, and disposal facilities and equipment **	5			
			6.41.1.3.1.8	Interfaces with communications from/to off-site sources *	4	131(b)(4)(ii)@	131(b)(5)@	2
			6.41.1.3.1.9	On-site repository communications network facilities and equipment *	4	131(b)(4)(ii)@	131(b)(5)@	2
		6.41.1.3.2	Facilities and equipment to verify geologic repository design data and assumptions *		4	137	Subpart F@	2
		6.41.1.3.3	Facilities, equipment, spares and material for surface-subsurface common facility and equipment maintenance during disposal operations *		4	131(b)(6)@	21(c)(15)(v)@	2
	6.41.1.4	Industrial waste disposal for the geologic repository **			5			
6.41.2	Repository generic system elements to receive waste				2	21(b)(2)@ 21(c)(5)@	71(b)@ 132(a)@	2
	6.41.2.1	Repository facilities for waste receiving operations			2	21(b)(2)@ 21(c)(5)@	71(b)@ 132(a)@	2
		6.41.2.1.1	Repository facilities for complete external inspection/survey of off-site transportation vehicle (e.g., railcar, truck) #		4	21(b)(4)@	---	2
		6.41.2.1.2	Repository demurrage area for railcars/trucks carrying waste #		5			

	6.41.2.1.3	Repository facility for off-loading transportation package/waste from transportation vehicle #	2	132(a)@	---	2
	6.41.2.1.4	Repository holding facility and yard for off-loaded railcars/trucks *	5			
	6.41.2.1.5	Radiation-controlled repository facility for removing waste from transportation package *	2	132(a)@	---	2
	6.41.2.1.6	Radiation-controlled repository facility for waste inspection and test in receiving operations *	3	152 131(b)(6)@	132(a)@ 43(b)(4)@	2
	6.41.2.1.7	Repository facility for loading waste for intra-facility transfer from receiving *	2	132(a)@	---	2
	6.41.2.1.8	Ventilation and air conditioning for repository waste receiving facilities *	3	132(b)	---	1
	6.41.2.1.9	Facility for maintenance of repository waste receiving facility and equipment #	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.2.2	Equipment for repository waste receiving operations		2	21(c)(5)@ 21(b)(2)@ 74(a)(4)@	132(a)@ 71(b)@	2
	6.41.2.2.1	Repository equipment for off-site transportation vehicle maintenance (e.g., railcars, trucks) #	4	21(b)(4)@	---	2
	6.41.2.2.2	Repository equipment for off-loading transportation package/waste from off-site transportation vehicle #	2	132(a)@	---	2
	6.41.2.2.3	Repository equipment for removing waste from transportation package in receiving operations #	2	132(a)@	---	2
	6.41.2.2.4	Repository equipment for waste inspection and test during receiving #	4	152@ 10CFR50 App B, X	131(b)(6)@	2
	6.41.2.2.5	Repository equipment for loading waste for intra-facility transfer from receiving #	2	132(a)@	---	2
	6.41.2.2.6	Computational capability for repository waste receiving operations *	4	21(b)(2)@ 21(c)(5)@	71(b)@ 132(a)@	2
	6.41.2.2.7	Equipment for repository waste receiving radiological unsafe/emergency conditions *	4	131(b)(4)	---	2
	6.41.2.2.8	Equipment, spares and material for maintenance of receiving operations facilities and equipment **	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.2.3	Software for repository waste receiving operations (e.g., inventory, process control, monitoring) *		4	71(b)@	21(c)(10)@	2

6.41.2.4	Trained and certified personnel for repository waste receiving operations *		2	161	160 21(c)(15)(iii)@	1
	6.41.2.4.1	Trained and certified personnel for handling and decontamination of waste in repository receiving *	2	161	160	1
	6.41.2.4.2	Trained and certified personnel for inspection and testing of waste in repository receiving #	4	161	160 152@	1
	6.41.2.4.3	Trained and certified personnel for repository waste receiving radiological unsafe/emergency conditions *	4	161 131(b)(4)(ii)	160 21(c)(9)@	1
	6.41.2.4.4	Trained and certified personnel for repository waste receiving facility and equipment maintenance #	4	161	160	1
6.41.2.5	Procedure(s) for repository waste receiving operations		2	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.2.5.1	Procedure(s) for waste handling in receiving operations *	2	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.2.5.2	Procedure(s) for inspecting and testing of waste (upon repository receipt) #	4	152 10CFR50, App B, Criteria V, VII, X	31(a)(6)@ 43(b)(6)@	1
	6.41.2.5.3	Procedure(s) for repository waste receiving radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@ 131(b)(4)(ii) 21(c)(9)@	1
	6.41.2.5.4	Procedure(s) to ensure fitness for duty of personnel certified for waste receiving operations *	4	162 152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.2.5.5	Procedure(s) for repository waste receiving facility and equipment maintenance *	4	152 10CFR50, App B,Criterion V	31(a)(6)@ 43(b)(6)@ 131(b)(6)@	1
6.41.3	Waste lag storage generic system elements for repository operations		2	132(a)	21(c)(12)@ 31(a)(1)(ii)@	1
	6.41.3.1	Facility for waste lag storage during repository operations	2	132(a)	21(c)(12)@ 31(a)(1)(ii)@	1
		6.41.3.1.1 Waste lag storage off-load/load facility for repository operations #	2	132(a)@	21(c)(12)@ 31(a)(1)(ii)@	2
		6.41.3.1.2 Facility to temporarily store waste during repository operations *	2	132(a)@	21(c)(12)@ 31(a)(1)(ii)@	2
		6.41.3.1.3 Ventilation and air conditioning for repository waste lag storage facilities *	3	132(b)	---	1
		6.41.3.1.4 Facility for maintenance of repository waste lag storage facility and equipment #	4	21(c)(15)(v)@ 131(b)(6)@	---	2

6.41.3.2	Equipment for waste lag storage during repository operations		2	132(a) 74(a)(4)@	21(c)(12)@ 31(a)(1)(ii)@	2
	6.41.3.2.1	Equipment to off-load/load waste to/from transfer conveyance in repository waste lag storage #	2	132(a)@ 74(a)(4)@	31(a)(1)(ii)@	2
	6.41.3.2.2	Handling equipment for waste lag storage #	2	132(a)@ 74(a)(4)@	31(a)(1)(ii)@	2
	6.41.3.2.3	Equipment to support waste disposal packages in repository lag storage #	2	132(a)@ 74(a)(4)@	31(a)(1)(ii)@	2
	6.41.3.2.4	Monitoring equipment for waste in repository lag storage #	4	132(c)(2)@ 21(c)(7)@	131(b)(8)@	2
	6.41.3.2.5	Computational capability for waste lag storage operations *	4	71(b)@	21(c)(10)@	1
	6.41.3.2.6	Repository equipment for waste lag storage radiological unsafe/emergency conditions *	4	131(b)(4)(ii)@ 131(a)(6)@	21(c)(9)@	2
	6.41.3.2.7	Equipment, spares and material for maintenance of repository lag storage operations facilities and equipment	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.3.3	Software for waste lag storage (e.g., inventory, process control, monitoring) during repository operations *		4	71(b)@	21(c)(10)@	2
6.41.3.4	Trained and certified repository personnel for waste lag storage		2	161	160 21(c)(15)(iii)@	1
	6.41.3.4.1	Trained and certified personnel for waste handling in repository lag storage *	2	161@	160@ 21(c)(15)(iii)@	1
	6.41.3.4.2	Trained and certified personnel for inspection of waste received for repository lag storage *	4	161	160 21(c)(15)(iii)@	1
	6.41.3.4.3	Trained and certified personnel for waste lag storage radiological unsafe/emergency conditions during repository operations *	4	161	160 21(c)(15)(iii)@ 21(c)(9)@	1
	6.41.3.4.4	Trained and certified personnel for repository lag storage facility and equipment maintenance #	4	161	160 21(c)(15)(iii)@	1
6.41.3.5	Procedure(s) for repository lag storage		2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
	6.41.3.5.1	Procedure(s) for waste handling in repository lag storage *	2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
	6.41.3.5.2	Procedure(s) for inspection of waste disposal package received for repository lag storage *	4	152 10CFR50, App B, Criteria V, X	43(b)(6)@ 31(a)(6)@	1
	6.41.3.5.3	Procedure(s) for waste lag storage radiological unsafe/emergency conditions during repository operations *	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 21(c)(9)@	1

	6.41.3.5.4	Procedure(s) for waste lag storage facility and equipment maintenance during repository operations #	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 131(b)(6)@	1
	6.41.3.5.5	Procedure(s) to ensure fitness for duty of personnel certified for waste lag storage operations *	4	152 10CFR50, App B, Criterion V 162	43(b)(6)@ 31(a)(6)@	1
6.41.4	Waste transfer generic system elements for repository operations		4	132(b)@ 131(b)(7)@ 135(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
	6.41.4.1	Repository facilities for waste transfer	4	132(b)@ 131(b)(7)@ 131(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
		6.41.4.1.1 Repository on-site waste transfer network (e.g., roads, railways, traffic controls) #	4	---	---	4
		6.41.4.1.2 Repository parking/staging area for waste transfer conveyances #	5			
		6.41.4.1.3 Ventilation and air conditioning for repository waste transfer facilities *	3	132(b)	---	1
		6.41.4.1.4 Repository facility for maintenance of waste transfer facilities and equipment #	4	131(b)(6)@	21(c)(15)(v)@	2
	6.41.4.2	Waste transfer equipment	2	132(b)@ 131(b)(7)@ 131(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
		6.41.4.2.1 Waste transfer conveyance(s) #	2	132(b)@ 131(b)(7)@ 131(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
		6.41.4.2.2 Equipment for loading waste disposal package components for intra-facility transfer *	4	135@ 113(a)(1)(ii)(A)@	---	2
		6.41.4.2.3 Computational capability for waste transfer *	4	71(b)@	21(c)(10)@	1
		6.41.4.2.4 Equipment for waste transfer radiological unsafe/emergency conditions *	4	131(b)(4)(ii)@ 131(a)(6)@	21(c)(9)@	2
		6.41.4.2.5 Equipment, spares and material for maintenance of waste transfer equipment #	4	132(b)@ 131(b)(7)@ 131(b)(3)@ 111(b)@ 122(b)(5)@ 21(c)(15)(v)@	132(a)@ 21(c)(12)@	2

		6.41.4.2.6	Equipment, spares and material to maintain waste transfer network #	4	132(b)@ 131(b)(7)@ 131(b)(3)@ 111(b)@ 122(b)(5)@	132(a)@ 21(c)(12)@	2
	6.41.4.3	Software for waste transfer operations (e.g., inventory, monitoring) *		4	71(b)@	21(c)(10)@	2
	6.41.4.4	Trained and certified personnel for waste transfer		2	161	160 21(c)(15)(iii)@	2
		6.41.4.4.1	Trained and certified waste transfer conveyance operators *	2	161@	160@ 21(c)(15)(iii)@	1
		6.41.4.4.2	Trained and certified personnel for radiological emergency conditions during waste transfer *	4	161@	160@ 21(c)(15)(iii)@ 21(c)(9)@	1
		6.41.4.4.3	Trained and certified personnel for waste transfer facility and equipment maintenance #	4	161@	160@ 21(c)(15)(iii)@	1
		6.41.4.4.4	Trained and certified personnel for waste transfer network maintenance #	4	161@	160@ 21(c)(15)(iii)@	1
	6.41.4.5	Procedure(s) for waste transfer		2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
		6.41.4.5.1	Procedure(s) for waste transfer conveyance operation *	2	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
		6.41.4.5.2	Procedure(s) for waste transfer radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 21(c)(9)@	1
		6.41.4.5.3	Procedure(s) for waste transfer equipment maintenance #	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 131(b)(6)@	1
		6.41.4.5.4	Procedure(s) for waste transfer network maintenance #	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@ 131(b)(6)@	1
		6.41.4.5.5	Procedure(s) to ensure fitness for duty of personnel certified for waste transfer operations *	4	152 10CFR50, App B, Criterion V	43(b)(6)@ 31(a)(6)@	1
6.41.5	Waste emplacement generic system elements			2	21(b)(2)@ 111(b)@ 132(a)@	122(b)(5)@ 135(b)(3)@	2
	6.41.5.1	Facilities for waste emplacement operations		2	21(b)(2)@ 111(b)@ 132(a)@	122(b)(5)@ 135(b)(3)@	2
		6.41.5.1.1	Access to waste emplacement opening/location (e.g., shafts, ramps, drifts) *	4	122(b)(5) 133(e)	---	1
		6.41.5.1.2	Waste emplacement openings/locations *	1	135(b)(3)@	122(b)(5)@ 131(b)(7)@ 132(a)@	2

	6.41.5.1.3	Waste emplacement opening/location interface with emplacement equipment #	2	---	---	4
	6.41.5.1.4	Administrative facility for waste emplacement operations **	5			
	6.41.5.1.5	Ventilation and air conditioning for waste emplacement facilities (surface and subsurface) #	4	133(g)(2) 132(b)@	---	1
	6.41.5.1.6	Facility for maintenance of waste emplacement facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.5.2	Equipment for waste emplacement operations		2	132(a)@ 135(b)(3)@	---	2
	6.41.5.2.1	Equipment to move waste disposal package from transfer conveyance to emplacement equipment (if required) #	2	132(a)@ 135(b)(3)@	---	2
	6.41.5.2.2	Equipment to align waste disposal package with emplacement location/opening #	2	132(a)@ 135(b)(3)@	---	2
	6.41.5.2.3	Waste disposal package emplacement equipment #	2	132(a)@ 135(b)(3)@	---	2
	6.41.5.2.4	Emplacement opening/location packing and/or backfill (if required) #	1	111(b)(2)	41(a)(4)@	2
	6.41.5.2.5	Emplacement opening/location backfill emplacement equipment (if required) #	4	111(b)(2)@ 142(a)@	51(a)(4)@ 142(c)@	2
	6.41.5.2.6	Emplacement opening/location cover (or plug) #	4	111(a)@	131(a)(3)@ 131(a)(5)@	2
	6.41.5.2.7	Equipment to close emplacement opening/location after emplacement #	4	111(b)(a)	---	3
	6.41.5.2.8	Computational capability for waste emplacement operations *	4	71(b)@	21(c)(10)@	1
	6.41.5.2.9	Equipment for waste emplacement radiological unsafe/emergency conditions *	4	131(b)(4)@ 131(a)(6)@	21(c)(9)@	2
	6.41.5.2.10	Equipment for waste emplacement facility, equipment and process inspection and testing #	4	152@ 10CFR50, App B, Criterion X @	131(b)(6)@	2
	6.41.5.2.11	Equipment, spares and material for maintenance of emplacement facilities and equipment **	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.5.3	Software for waste emplacement operations (e.g., inventory, process control, monitoring) *		4	71(b)@	21(c)(10)@	2
6.41.5.4	Trained and certified personnel for waste emplacement operations		2	161	160 21(c)(15)(iii)@	1
	6.41.5.4.1	Trained and certified personnel for waste emplacement *	2	161@	160@ 21(c)(15)(iii)@	1

		6.41.5.4.2	Trained and certified personnel for waste emplacement facility, equipment and process inspection and testing #	4	161a	160a 21(c)(15)(iii)a	1
		6.41.5.4.3	Trained and certified personnel for waste emplacement radiological unsafe/emergency conditions *	4	161a	160a 21(c)(15)(iii)a 21(c)(9)a	1
		6.41.5.4.4	Trained and certified personnel for waste emplacement facility and equipment maintenance #	4	161a	160a 21(c)(15)(iii)a	1
	6.41.5.5	Procedure(s) for waste emplacement operations		2	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a	1
		6.41.5.5.1	Procedure(s) for waste emplacement #	2	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a	1
		6.41.5.5.2	Procedure(s) for waste emplacement radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a 21(c)(9)a	1
		6.41.5.5.3	Procedure(s) for inspection and testing of waste emplacement facilities, equipment and process #	4	152 10CFR50, App B, Criterion V, X	43(b)(6)a 31(a)(6)a	1
		6.41.5.5.4	Procedure(s) for waste emplacement facility and equipment maintenance #	4	152 10CFR50, App B, Criterion V	43(b)(6)a 31(a)(6)a 131(b)(6)a	1
		6.41.5.5.5	Procedure(s) to ensure fitness for duty of personnel certified for waste emplacement operations *	4	152 10CFR50, App B, Criterion V 162	43(b)(6)a 31(a)(6)a	1
6.41.6	Repository monitoring generic system elements (radiological and non-radiological)			4	131(b)(8)a 132(c)(2)a	21(c)(7)	2
	6.41.6.1	Facilities for monitoring during repository operations *		4	131(b)(8) 132(c)(2)a	21(c)(7)	2
	6.41.6.2	Equipment for monitoring and alarm during repository operations *		4	131(b)(8) 132(c)(2)a	21(c)(7)	2
	6.41.6.3	Software for monitoring during repository operations *		4	71(b)a	21(c)(10)a	2
	6.41.6.4	Trained and certified personnel for monitoring during repository operations *		4	161 131(b)(8)	160 132(c)(2)	1
	6.41.6.5	Procedure(s) for monitoring during repository operations *		4	31(a)(6)a	43(b)(6)a	2
6.41.7	Waste removal generic system elements			2	111(b)a 131(b)(7)a 132(a)a 133(c)a	21(c)(12)a 46(a)(1)a 135(b)(3)a	2
	6.41.7.1	Facilities for waste removal operations		2	111(b)a 131(b)(7)a 132(a)a 133(c)a	21(c)(12)a 46(a)(1)a 135(b)(3)a	2
		6.41.7.1.1	Access to waste emplacement openings/locations (e.g., shafts, ramps, drifts) *	4	133(e)	122(b)(5)a 131(b)(9)a	2

	6.41.7.1.2	Interface between emplacement opening/location and waste removal equipment *	2	21(c)(12)@	---	2
	6.41.7.1.3	Surface storage facility for waste removed from the underground facility *	2	132(a)	---	1
	6.41.7.1.4	Ventilation and air conditioning for waste emplacement facilities (surface and subsurface) #	4	133(g)(2) 132(b)@	---	1
	6.41.7.1.5	Administrative facility for waste removal **	5			
	6.41.7.1.6	Facility for maintenance of waste removal facilities and equipment #	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.7.2	Equipment for waste removal operations		2	111(b)@ 21(c)(12)@	133(c)@ 135(b)(3)@	2
	6.41.7.2.1	Equipment to excavate, muck, and transfer backfill (if required) *	4	111(b)@	133(c)@	2
	6.41.7.2.2	Equipment to locate and gain access to waste disposal package (if required) *	4	111(b)@	133(c)@	2
	6.41.7.2.3	Equipment to determine condition of waste disposal package *	4	111(b)@	133(c)@	2
	6.41.7.2.4	Equipment for removal of waste disposal package from emplaced location *	2	111(b)@	133(c)@	2
	6.41.7.2.5	Equipment to load/off-load waste disposal package on transfer conveyance *	2	111(b)@	133(c)@	2
	6.41.7.2.6	Equipment for inspection of removed waste disposal package #	2	111(b)@	152 10CFR50, App B, Criterion X	2
	6.41.7.2.7	Waste disposal package transfer conveyance #	2	111(b)@ 21(c)(12)@	133(c)@ 135(b)(3)@	2
	6.41.7.2.8	Computational capability for waste removal operations #	4	71(b)@	21(c)(10)@	1
	6.41.7.2.9	Equipment for waste removal radiological unsafe/emergency condition *	4	131(b)(4)@ 131(a)(6)@	21(c)(9)@	2
	6.41.7.2.10	Equipment, spares and material for maintenance of emplacement facilities and equipment **	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.7.3	Software for waste removal operations (e.g., inventory, process control, monitoring) *		4	71(b)	21(c)(10)@	2
6.41.7.4	Trained and certified personnel for waste removal operations		2	161 21(c)(12)@	160 21(c)(15)(iii)@	1
	6.41.7.4.1	Trained and certified personnel for waste removal operations *	2	161@	160@ 21(c)(15)(iii)@	1
	6.41.7.4.2	Trained and certified personnel for waste removal facility, equipment and process inspection and testing	4	161@ 152@	160@ 21(c)(15)(iii)@	1

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		6.41.7.4.3 Trained and certified personnel for waste removal radiological unsafe/emergency conditions *	4	161@	160@ 21(c)(15)(iii)@ 21(c)(9)@	1
		6.41.7.4.4 Trained and certified personnel for waste removal facility and equipment maintenance #	4	161@	160@ 21(c)(15)(iii)@	1
	6.41.7.5 Procedure(s) for waste removal operations		2	152 10CFR50, App B, Criterion V	21(c)(12)@ 43(b)(6)@ 31(a)(6)@	1
		6.41.7.5.1 Procedure(s) for removal of waste from emplacement opening/location *	2	152 10CFR50, App B, Criterion V	21(c)(12)@ 43(b)(6)@ 31(a)(6)@	1
		6.41.7.5.2 Procedure(s) for waste removal radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	21(c)(12)@ 43(b)(6)@ 31(a)(6)@ 21(c)(9)@	1
		6.41.7.5.3 Procedure(s) for waste removal facility, equipment and process inspection #	4	152 10CFR50, App B, Criteria V, X	21(c)(12)@ 43(b)(6)@ 31(a)(6)@	1
		6.41.7.5.4 Procedure(s) for waste removal facilities and equipment maintenance #	4	152 10CFR50, App B, Criterion V	21(c)(12)@ 43(b)(6)@ 31(a)(6)@ 131(b)(6)@	1
		6.41.7.5.5 Procedure(s) to ensure fitness for duty of personnel certified for waste removal operations *	4	152 10CFR50, App B, Criterion V 162	21(c)(12)@ 43(b)(6)@ 31(a)(6)@	1
6.41.8	Waste off-site shipment generic system elements		2	132(d) 21(c)(12)@	71(b)@ 135(b)(3)@ 132(b)@	2
	6.41.8.1 Off-site shipment preparation facilities		2	132(d) 21(c)(12)@	71(b)@ 135(b)(3)@ 132(b)@	2
		6.41.8.1.1 Facility for inspection of shipping cask in preparation for off-site waste shipment *	4	152 10CFR50, App B, Criterion X	43(b)(4)@ 131(b)(6)@	1
		6.41.8.1.2 Facility for repair/replacement of shipping cask in preparation for off-site waste shipment *	4	---	---	4
		6.41.8.1.3 Radiation-controlled facility for unloading waste disposal package from intra-facility transfer conveyance #	2	21(c)(12)@ 21(c)(15)(v)@	132(a)@	2
		6.41.8.1.4 Radiation-controlled facility for waste disposal package inspection and test in preparation for off-site shipment *	4	152 10CFR50, App B, Criterion X	135(c)	2
		6.41.8.1.5 Radiation-controlled facility for refurbishment of waste disposal package (as required) in preparation for off-site shipment *	4	132(a)@	132(d)@	3

	6.41.8.1.6	Radiation-controlled facility for assembling transportation package *	2	132(a)@ 132(d)@	135(b)(3)@	2
	6.41.8.1.7	Facility for loading transportation package onto waste transportation vehicle (e.g., railcar, truck) #	2	132(a)@ 21(c)(12)@	135(b)(3)@ 132(d)@	2
	6.41.8.1.8	External inspection/survey facilities for complete off-site transportation vehicle #	4	152 10CFR50, App B, Criterion XIII	21(c)(7)@ 111(a)@	1
	6.41.8.1.9	Holding facility and yard for waste transportation vehicles #	5			
	6.41.8.1.10	Ventilation and air conditioning for waste off-site shipment facilities and equipment #	2	133(g)(2) 132(b)@	---	1
	6.41.8.1.11	Administrative facility for waste off-site shipment operations **	5			
	6.41.8.1.12	Repository facility for maintenance of waste off-site shipment facilities and equipment #	5			
6.41.8.2	Off-site shipment preparation equipment		2	132(d)@ 21(c)(12)@	71(b)@ 135(b)(3)@ 132(b)@	2
	6.41.8.2.1	Equipment for inspection of shipping cask in preparation for waste off-site shipment #	4	152 10CFR50, App B, Criterion X	43(b)(4)@ 131(b)(6)@	1
	6.41.8.2.2	Equipment for shipping cask repair/ replacement (as required) #	4	---	---	4
	6.41.8.2.3	Equipment for unloading waste disposal package from intra-facility transfer conveyance #	2	21(c)(12)@ 21(c)(15)(v)@	132(a)@	2
	6.41.8.2.4	Equipment for waste disposal package inspection and test in preparation for off-site shipment #	4	152 10CFR50, App B, Criterion X	135(c)	2
	6.41.8.2.5	Equipment for refurbishment of waste disposal package in preparation for off-site shipment #	4	132(a)@	132(d)@	3
	6.41.8.2.6	Monitoring equipment for waste in preparation for off-site shipment #	4	131(a)(6)	21(c)(7)@	2
	6.41.8.2.7	Equipment for assembling transportation package #	2	132(a)@ 132(d)@	135(b)(3)@	2
	6.41.8.2.8	Equipment for loading transportation package/waste onto waste transportation vehicle for off-site shipment #	2	132(a)@ 21(c)(12)@	135(b)(3)@ 132(d)@	2
	6.41.8.2.9	Equipment for external inspection/ survey of off-site waste transportation vehicle #	4	152 10CFR50, App B, Criterion XIII	21(c)(7)@ 111(a)@	1
	6.41.8.2.10	Computational capability for off-site shipment operations *	4	71(b)@	21(c)(10)@	2
	6.41.8.2.11	Equipment for radiological unsafe/emergency conditions in off-site shipment operations *	4	131(b)(4)@	21(c)(9)@	2

	6.41.8.2.12	Equipment, spares and material for maintenance of off-site shipment facilities and equipment **	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.8.3	Waste off-site shipment operations software (e.g., inventory, process control, management) *		4	71(b)@	21(c)(10)@	2
6.41.8.4	Trained and certified personnel for off-site shipment operations		2	161	160 21(c)(15)(iii)@	1
	6.41.8.4.1	Trained and certified personnel for preparation of shipping cask for waste off-site shipment operations *	2	161	160 21(c)(15)(iii)@	1
	6.41.8.4.2	Trained and certified personnel for waste handling (e.g., load/off-load) in off-site shipment operations *	2	161	160 21(c)(15)(iii)@	1
	6.41.8.4.3	Trained and certified personnel for inspecting and testing waste disposal package in preparation for off-site shipment #	4	161	160 152@	1
	6.41.8.4.4	Trained and certified personnel for refurbishment of waste disposal package in preparation for off-site shipment #	4	161	160 21(c)(15)(iii)@	1
	6.41.8.4.5	Trained and certified personnel for off-site shipment unsafe/emergency conditions *	4	161 131(b)(4)(ii)	160 21(c)(9)@	1
	6.41.8.4.6	Trained and certified personnel for off-site waste shipment facility and equipment maintenance #	4	161	160	1
6.41.8.5	Procedure(s) for waste off-site shipment operations		2	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.8.5.1	Procedure(s) for preparation of shipping cask for waste off-site shipment *	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.8.5.2	Procedure(s) for waste handling (e.g., load/ off-load) in off-site shipment operations *	2	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.8.5.3	Procedure(s) for inspecting and testing waste disposal package in preparation for off-site shipment #	4	152 10CFR50, App B, Criteria V, VII, and X	31(a)(6)@ 43(b)(6)@	1
	6.41.8.5.4	Procedure(s) for refurbishment of waste disposal package in preparation for off-site shipment #	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1
	6.41.8.5.5	Procedure(s) for waste off-site shipment radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@ 131(b)(4)(ii) 21(c)(9)@	1
	6.41.8.5.6	Procedure(s) to ensure fitness for duty of personnel certified for waste off-site shipment operations	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@	1

	6.41.8.5.7	Procedure(s) for waste off-site shipment facility and equipment maintenance #	4	152 10CFR50, App B, Criterion V	31(a)(6)@ 43(b)(6)@ 131(b)(6)@	1
6.41.9	Generic sytem elements to close and decommission repository		4	21(c)(11)@ 21(c)(15)(vi)@ 132(e)@	51(a)(1)@ 51(a)(2)@ 51(a)(4)@	2
6.41.9.1	Repository closure and decommissioning facilities		4	21(c)(11)@ 21(c)(15)(vi)@	132(e)@	2
	6.41.9.1.1	Repository backfill material processing facility (if required) *	4	21(c)(15)(vi)@	---	2
	6.41.9.1.2	Repository seal material processing facility (if required) *	4	21(c)(15)(vi)@	---	2
	6.41.9.1.3	Facility for repository equipment decontamination *	3	21(c)(15)(vi)@	---	2
	6.41.9.1.4	Repository equipment salvaging facility *	5			
	6.41.9.1.5	Repository equipment and materials storage facility *	5			
	6.41.9.1.6	Contaminated material processing and package facility (if required) *	3	132(d)	21(c)(15)(vi)@	1
	6.41.9.1.7	Decontaminated material package and shipment facility (if required) *	5			
	6.41.9.1.8	Ventilation and air conditioning for material package and shipment facilities (surface and subsurface) #	3	133(g)(2) 132(b)@	---	1
	6.41.9.1.9	Facility for repository postclosure monitoring *	4	51(a)(1)@	---	2
	6.41.9.1.10	Repository closure and decommissioning administrative facility **	5			
	6.41.9.1.11	Facility for maintenance of repository closure and decommissioning facilities and equipment *	4	131(b)(6)@	21(c)(15)(v)@	2
6.41.9.2	Closure and decommissioning equipment and materials		1	21(c)(11)@ 21(c)(15)(vi)@	132(e)@	2
	6.41.9.2.1	Backfill bulk materials and material processing equipment (if required) *	1	21(c)(15)(vi)@	---	2
	6.41.9.2.2	Backfill emplacement equipment (if required) *	1	51(a)(4)@	21(c)(15)(vi)@	2
	6.41.9.2.3	Seal bulk materials and material processing equipment (if required) *	1	134(b)@	21(c)(15)(vi)@	2
	6.41.9.2.4	Seal emplacement equipment *	1	134(b)@	21(c)(15)(vi)@	2
	6.41.9.2.5	Decontamination equipment and	3	21(c)(15)(vi)@	---	2

		materials *				
	6.41.9.2.6	Equipment for salvaging equipment *	5			
	6.41.9.2.7	Equipment to handle bulk materials and salvaged equipment during closure *	5			
	6.41.9.2.8	Contaminated material processing and packaging equipment (if required) *	3	21(c)(15)(vi)a	---	2
	6.41.9.2.9	Decontaminated material packaging and shipment equipment (if required) *	5			
	6.41.9.2.10	Computational capability for closure and decommissioning *	4	71(b)a	21(c)(10)a	1
	6.41.9.2.11	Equipment for closure and decommissioning radiological unsafe/emergency conditions *	4	131(b)(4)a 131(a)(6)a	21(c)(9)a	2
	6.41.9.2.12	Equipment for postclosure monitoring *	4	51(a)(1)	---	2
	6.41.9.2.13	Equipment, spares and material for maintenance of closure and decommissioning equipment *	4	131(b)(6)a	21(c)(15)(vi)a	2
6.41.9.3	Closure and decommissioning software (e.g., inventory, process control, monitoring) *		4	71(b)	21(c)(10)a	2
6.41.9.4	Trained and certified personnel for closure and decommissioning		1	161 21(c)(11)a	160 21(c)(15)(iii)a	1
	6.41.9.4.1	Trained and certified personnel for backfill material processing *	1	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.2	Trained and certified personnel for backfill emplacement *	1	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.3	Trained and certified personnel for seal material processing *	1	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.4	Trained and certified personnel for seals emplacement *	1	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.5	Trained and certified personnel for emplaced backfill and seal inspection and testing *	4	161a 152	160a 21(c)(15)(iii)a	1
	6.41.9.4.6	Trained and certified decontamination personnel *	3	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.7	Trained and certified personnel for equipment salvaging *	5			
	6.41.9.4.8	Trained and certified personnel for contaminated material packaging and shipping *	3	161a	160a 21(c)(15)(iii)a	1
	6.41.9.4.9	Trained and certified personnel for decontaminated material packaging and shipping *	5			
	6.41.9.4.10	Trained and certified personnel for closure and decommissioning radiological unsafe/emergency	4	161a	160a 21(c)(15)(iii)a 21(c)(9)a	1

		conditions *				
	6.41.9.4.11	Trained and certified personnel for post-closure monitoring *	4	161@	160@ 21(c)(15)(iii)@	1
	6.41.9.4.12	Trained and certified personnel for closure and decommissioning facilities and equipment maintenance *	4	161@	160@ 21(c)(15)(iii)@	1
6.41.9.5	Procedure(s) for closure and decommissioning		1	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.1	Procedure(s) for backfill material processing (if required) *	1	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.2	Procedure(s) for backfill emplacement *	1	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.3	Procedure(s) for seal material processing (if required) *	1	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.4	Procedure(s) for seal emplacement *	1	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.5	Procedure(s) for inspection and testing of emplaced backfill and seals *	4	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.6	Procedure(s) for decontamination *	3	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.7	Procedure(s) for equipment salvaging *	5			
	6.41.9.5.8	Procedure(s) for contaminated material processing and packaging during closing and decommissioning *	3	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.9	Procedure(s) for decontaminated material packaging and shipping during closure and decommissioning *	5			
	6.41.9.5.10	Procedure(s) for closure and decommissioning radiological unsafe/emergency conditions *	4	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1
	6.41.9.5.11	Procedure(s) for postclosure monitoring *	4	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@ 51(a)(1)	1
	6.41.9.5.12	Procedure(s) for closure and decommissioning equipment maintenance *	4	152 10CFR50, App B, Criterion V	21(c)(11)@ 31(a)(6)@ 43(b)(6)@ 131(b)(6)@	1
	6.41.9.5.13	Procedure(s) to ensure fitness for duty of personnel certified for closure and decommissioning operations *	4	152 10CFR50, App B, Criterion V 162	21(c)(11)@ 31(a)(6)@ 43(b)(6)@	1

7. CONTAIN AND ISOLATE RADIONUCLIDES (POSTCLOSURE)		1	112 113	133(a)(1)@ 133(h)@ 135(a)@	1
FUNCTIONS					
7.1 Contain emplaced radionuclides (postclosure)		1	113(a)(1)(i)(A) 113(a)(1)(ii)(A)	135(a)@	1
7.1.1 Confine waste within fixed boundaries (in emplaced disposal package)		1	113(a)(1)(ii)(A)	135(a)@	1
7.1.1.1 Resist waste disposal package degradation		1	135(b)(1) 113(a)(1)(ii)(A) 135(b)(2)	135(a)@	1
7.1.1.1.1	Resist waste disposal package degradation due to chemical or electrochemical processes in emplacement environment *	1	135(b)(1) 135(b)(2) 135(c)(3)	135(a)@ 113(b)(2)@ 113(b)(3)@	1
7.1.1.1.2	Resist waste disposal package degradation due to mechanical processes in the emplacement environment *	1	133(e)(2) 133(i)	135(a)@ 113(b)(2)@	1
7.1.1.1.3	Resist waste disposal package degradation due to mechanical-chemical interactions in the emplacement environment *	1	133(e)(2) 133(i) 135(b)(1) 135(b)(2) 135(c)(3)	135(a)@ 113(b)(2)@ 113(b)(3)@	1
7.1.1.1.4	Withstand stress concentrations in waste disposal package *	1	133(e)(2)	135(a)@	2
7.1.1.2 Resist waste disposal package short-duration mechanical failure		1	135(a)@	---	2
7.1.1.2.1	Resist waste disposal package gross plastic deformation #	1	135(a)@	---	2
7.1.1.2.2	Resist waste disposal package fracturing due to static and dynamic loads #	1	135(a)@	---	2
7.1.1.2.3	Withstand waste disposal package buckling loads #	1	135(a)@	---	2
7.1.1.2.4	Limit waste disposal package residual stresses #	1	135(a)@	---	2
7.1.1.2.5	Withstand external loads on waste disposal package #	1	133(e)(2) 133(i)	113(b)(2)@	2
7.1.2 Control period of postclosure confinement in waste disposal package		1	113(a)(1)(ii)(A)	113(b)	2
7.1.2.1 Delay onset of waste disposal package degradation		1	---	---	4
7.1.2.1.1	Control condition of waste disposal package material when emplaced #	1	---	---	4
7.1.2.1.2	Control chemical composition of waste disposal package materials #	1	135(a)@	---	2

		7.1.2.1.3	Control physical properties of waste disposal package materials (e.g., crystal structure, inclusions, mechanical properties) #	1	135(a)@	---	2
		7.1.2.1.4	Limit residual stresses in waste disposal package #	1	135(a)@	---	2
		7.1.2.1.5	Control stress state of waste disposal package #	1	113(b)(2)@ 133(i)@	135(a)@	2
		7.1.2.1.6	Withstand external loads on waste disposal package #	1	133(a)(1) 133(e)(2)	51(a)(4)@ 133(i)@	2
		7.1.2.1.7	Control postclosure thermal environment of the waste disposal package #	1	113(b)(2)	133(i)@	2
		7.1.2.1.8	Control postclosure chemical environment of the waste disposal package #	1	---	---	4
	7.1.2.2	Retard rate of waste disposal package degradation		1	135(a)@	113(b)(2)@ 133(i)@	2
		7.1.2.2.1	Limit waste disposal package surface erosion #	1	135(a)@	113(b)(2)@ 133(i)@	2
		7.1.2.2.2	Control chemical composition of waste disposal package materials #	1	135(a)@	---	2
		7.1.2.2.3	Control physical properties of waste disposal package materials (e.g., crystal structure, inclusions, mechanical properties) #	1	135(a)@	---	2
		7.1.2.2.4	Limit residual stresses in waste disposal package #	1	135(a)@	---	2
		7.1.2.2.5	Control stress state of waste disposal package #	1	113(b)(2)@ 133(i)@	135(a)@	2
		7.1.2.2.6	Withstand stress concentrations in waste disposal package #	1	133(e)	135(a)@	2
		7.1.2.2.7	Control thermal environment of waste disposal package #	1	113(b)(2)@ 133(i)@	135(a)@	2
		7.1.2.2.8	Control chemical environment of waste disposal package #	1	---	---	4
	7.1.2.3	Limit number of waste disposal package degradation mechanisms #		1	---	---	4
7.2	Limit radionuclide releases to the geologic setting (postclosure)			1	133(a)(1)(i)(B) 113(a)(1)(ii)(B)	133(a)@ 133(h)@	1
	7.2.1	Limit cumulative quantity of radionuclides released to the geologic setting (postclosure)		1	---	21(c)(5)@ 43(b)(1)@ 43(b)(3)@	2
		7.2.1.1	Limit initial radionuclide inventory	1	---	21(c)(5)@ 43(b)(1)@ 43(b)(3)@	2
			7.2.1.1.1 Limit total quantity of emplaced waste *	1	21(c)(5)@	---	2

		7.2.1.1.2 Control age of emplaced waste *	1	113(b)(2)@	---	2
	7.2.1.2	Prevent migration of radionuclides to the geologic setting #	1	113(a)(1)(i)(B) 113(a)(1)(ii)(B)	134	4
	7.2.1.3	Control rate of migration within the engineered barrier(s) (e.g., such that significant radionuclide decay occurs) #	1	113(a)(1)(i)(B)@ 113(a)(1)(ii)(B)@	---	2
7.2.2	Limit rate of radionuclide release to the geologic setting		1	113(a)(1)(i)(B) 113(a)(1)(ii)(B)	133(a)@ 133(h)@ 135(c)(1)@ 135(c)(2)@	1
	7.2.2.1	Limit waste form leach rate(s) #	1	113(a)(1)(i)(B)@ 113(a)(1)(ii)(B)@	135(c)(1)@ 135(c)(2)@	2
	7.2.2.2	Limit gaseous radionuclide release rate(s) #	1	113(a)(1)(i)(B)@ 113(a)(1)(ii)(B)@	---	2
	7.2.2.3	Control length of time before fluids contact waste form #	1	135(a)@	---	2
	7.2.2.4	Control chemistry of fluids that contact waste form #	1	113(b)(3)	135(b)(1) 135(b)(2)	2
	7.2.2.5	Limit quantity and rate of fluids contacting waste form #	1	---	---	4
	7.2.2.6	Limit migration rate within the engineered barrier(s) #	1	113(a)(1)(i)(B)@ 113(a)(1)(ii)(B)@	---	2
7.3	Limit releases of radionuclides to the accessible environment		1	112	21(c)(1)(ii)(C)@ 21(c)(1)(ii)(D)@	1
	7.3.1	Ensure stability of waste emplacement opening/location #	1	122(a)(1)	122(b)(1)	1
	7.3.2	Avoid exposure of waste due to natural processes (e.g., volcanism, faulting) #	1	122(a)(1) 122(b)(1) 122(b)(5)@	122(c)(3)@ 122(c)(4)@ 122(c)(11)@ 122(c)(12)@ 122(c)(15)@	1
	7.3.3	Protect waste from adverse effects of surficial processes (e.g., weather, erosion, mass wasting) #	1	122(a)(1) 122(b)(5)	122(c)(1)@ 122(c)(3)@ 122(c)(4)@ 122(c)(11)@ 122(c)(16)@	1
	7.3.4	Obstruct human intrusion into repository #	1	51(a)(2) 121	122(b)(5)@	1
	7.3.5	Impede movement of fluids to the waste disposal package #	1	122(a)(1) 122(b)(5)@ 122(b)(8)(i) 122(b)(8)(iii)	122(c)(2)@ 122(c)(3)@ 122(c)(4)@	1
	7.3.6	Ensure geochemical environment is not conducive to radionuclide mobility #	1	122(a)(1) 122(b)(1) 122(b)(3) 122(b)(4)	122(c)(7)@ 122(c)(8)@ 122(c)(9)@ 122(c)(10)@	1
	7.3.7	Ensure hydrologic environment is not conducive to radionuclide transport #	1	122(a)(1) 122(b)(1) 122(b)(7) 122(b)(8)	122(c)(1)@ 122(c)(2)@ 122(c)(3)@ 122(c)(5)@ 122(c)(6)@	1

7.3.8	Ensure geologic environment is not conducive to gaseous radionuclide transport #	1	122(a)(1)	122(c)(24)a	2
7.4	Limit postclosure intrusion into the area of the repository	4	51(a)(2)	121	1
7.4.1	Establish a controlled area #	4	21(c)(8)a 43(b)(5) 51(a)(2)(i)	121(a)(1)a 121(b)a	1
7.4.2	Designate the boundaries of the controlled area #	4	51(a)(2)(i)	21(c)(8)a 43(b)(5) 121(b)a	1
7.4.3	Maintain government control of controlled area land and resource use #	4	121(a) 21(c)(8)a 43(b)(5)	51(a)(2)a	1
7.4.4	Maintain government control of adjacent area land and resource use #	4	121(b)	21(c)(8)a 43(b)(5)	1
7.4.5	Preserve public records about the location, boundaries and purpose of the controlled area *	4	51(a)(2)(ii)	72(b)(11) 21(c)(8)a	1
7.4.6	Preserve public records about the location, design, and contents of the geologic repository *	4	51(a)(2)(ii)	---	1
7.4.7	Monitor for drilling or excavation in or adjacent to the controlled area *	4	51(a)(1)a	---	2
7.4.8	Prevent or stop unauthorized drilling or excavation in the controlled area *	4	51(a)(2)a 121(a)	21(c)(8)a	1
7.4.9	Prevent or stop activities outside the controlled area that could adversely effect waste containment or isolation *	4	121(b) 121(c)	51(a)(2)a 21(c)(8)a	1
7.5	Conduct repository postclosure monitoring (as required) *	4	51(a)(1)a	---	2
CONSTRAINTS					
7.6	Ensure the ability of underground facilities and equipment to perform their intended postclosure functions under naturally induced conditions and events (e.g., seismic activity) *	1	112 113(a)(1)	133(a)(1) 133(e)(2)	1
7.7	Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity *	2	21(c)(3) 131(b)(1) 131(b)(6)a	134(a) 134(e)(1) 21(b)(3)a 21(b)(4)a	2
7.8	Ensure the ability of engineered barriers, shafts, boreholes and seals to perform their intended postclosure functions under naturally induced conditions and events (e.g., seismic activity) *	1	112 113(a)(1)	133(a)(1) 133(h)	1
7.9	Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity *	2	21(c)(3) 131(b)(1) 131(b)(6)a	134(a) 134(e)(1) 21(b)(3)a 21(b)(4)a	2
7.10	Ensure the ability of the geologic setting to perform its intended postclosure functions under naturally induced conditions and events (e.g., seismic activity) *	1	112 113(a)(2)	122	1
7.11	Ensure the ability of repository facilities and equipment important to safety or isolation to perform their intended functions under conditions and events induced by human activity *	2	21(c)(3) 131(b)(1) 131(b)(6)a	134(a) 134(e)(1) 21(b)(3)a 21(b)(4)a	2

GENERIC SYSTEM ELEMENTS

7.12	Waste disposal packages #	4	113(a)(1)(ii)(A)@ 135(a)@	132(b)@ 131(b)(7)@	2
7.13	Waste emplacement openings/locations #	1	135(b)(#)@	122(b)(5)@ 131(b)(7)@ 132(a)@	2
7.14	Emplacement opening cover or plug (if required) #	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
7.15	Emplacement opening backfill (if required) #	1	21(c)(11)@ 21(c)(15)(vi)@	51(a)(4)@	2
7.16	Underground facility backfill (if required) #	1	21(c)(15)(vi)@	---	2
7.17	Repository access openings (shafts and ramps) #				
7.18	Access opening backfill (if required) #	1	21(c)(15)(vi)@	---	2
7.19	Borehole backfill (if required) #	1	21(c)(15)(vi)@	---	2
7.20	Shaft, ramp and borehole seals #	1	135(b)@	21(c)(15)(vi)@	2
7.21	Postclosure monitoring facilities and equipment (as required) #	4	51(a)(1)@	---	2
7.22	Geologic setting #	1	112	122	1