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DOE-STD-1120-2005
Volume 2 of 2

DOE STANDARD

INTEGRATION OF ENVIRONMENT, SAFETY, AND HEALTH INTO FACILITY DISPOSITION ACTIVITIES

Volume 2 of 2: Appendices

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INTRODUCTION

This volume contains the appendices that provide additional environment, safety and health (ES&H) information to complement Volume 1 of this *Standard*. Volume 2 of the *Standard* is much broader in scope than Volume 1 and satisfies several purposes. Integrated safety management expectations are provided in accordance with facility disposition requirements contained in DOE O 430.1B, *Real Property Asset Management.* Additionally, the collection of appendices in Volume 2 provides guidance that supplements various safety basis practices described in Volume 1. Since Volume 2 has a broader focus than safety basis requirements, it applies to all phases of facility disposition (i.e., facility deactivation, surveillance and maintenance, and decommissioning).

Appendix A provides a set of candidate DOE ES&H directives and external regulations, organized by hazard types that may be used to identify potentially applicable directives to a specific facility disposition activity. Appendix B offers examples and lessons learned that illustrate implementation of ES&H approaches for facility disposition and environmental restoration. Appendix C contains Integrated Safety Management System (ISMS) performance expectations to guide a project team in developing and implementing an effective ISMS and in developing specific performance criteria for use in facility disposition and environmental restoration. Appendix D provides guidance on Inactive Waste Site (IWS). Appendix E discusses nuclear safety risk ranking and control selection. Appendix F presents a sample readiness evaluation checklist.

Appendix D and E were not covered in the Volume 2 of DOE-STD-1120-98. Additionally, some appendices from DOE-STD-1120-98 have been deleted in the current revision of the standard. A synopsis of appendices that were removed or consolidated with another appendix is provided in the following table.

TOPICS	DOE-STD-1120-98 COVERAGE	CURRENT VERSION
CERCLA/ES&H Integration	Appendix D	Removed. No longer relevant to the scope of Volume 1. Topic retained in Volume 2.
DOE Office of Nuclear Safety Policy and Standards Guidance Memoranda	Appendix G	Removed. No longer has official bearing on 10 CFR 830 requirements
Hazard Analysis Techniques	Appendix H	Removed. Topic is adequately covered in existing references (e.g., AICHE handbook)
Hazard Baseline Documentation	Appendix I	Topic adequately described in 10 CFR 830, Subpart B and supporting standards
Identification of ARARs for Decommissioning Activities	Appendix D	Removed. Topic adequately covered in existing DOE directives and environmental regulations
Privatization	Appendix E	Removed. Not widely used at DOE field sites
Work Smart Standards Process	Appendix F	Removed. Methodology adequately covered in other DOE directives. Appendix A retained as a supporting tool.

Appendix A

Environment, Safety and Health Directives Applicable to Facility Disposition Activities

ENVIRONMENT, SAFETY, AND HEALTH DIRECTIVES APPLICABLE TO FACILITY DISPOSITION ACTIVITIES

As directed by DOE P 450.2A, *Identifying, Implementing and Complying with Environment, Safety and Health Requirements,* and 48 CFR 970.5204-78 (DEAR clause on laws, regulations, and DOE directives), information resulting from planning and hazard identification activities should be used to determine the set of ES&H directives applicable to a facility disposition and environmental restoration project. Applicable requirements should be conveyed within project plans, which are required for disposition projects in accordance with DOE 430.1B, *Real Property Asset Management*.

This appendix provides a compilation of ES&H requirements that are potentially applicable to facility disposition and environmental restoration projects. Candidate requirements are considered from DOE regulations and directives, and Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations. This compilation will assist DOE project managers, contractors, and subcontractors in identifying the applicable ES&H requirements that must be considered to ensure the protection of workers, the public, and the environment during facility disposition and environmental restoration activities. This Appendix may be a source of input for determining Applicable or Relevant and Appropriate Requirements (ARARs) for projects subject to the CERCLA process (note: it should not be considered an exhaustive list of all possible potential ARARs). Additionally, RCRA corrective actions may be underway at facilities undergoing environmental restoration activities and, in some cases, both statutes may be applicable. Appendix A may also be used as a tool to help in tailoring specific requirements such as those uses in Work Smart Standards or similar other approaches.

Table A-1 lists mandatory and nonmandatory ES&H directives and briefly summarizes the intent for each directive. This list is not intended to represent the set of directives that should be applied to all disposition and environmental restoration activities. The specific directives applicable to a facility or work activity depend upon the facility's or activity's work scope and associated hazards. For example, the set of directives applicable to deactivating a plutonium processing facility may differ entirely from the set for decommissioning a guard house containing asbestos.

As shown in Figure A-1, the list of directives is organized by type of hazard. This is intended to facilitate the identification of hazard-specific requirements. For example, if the work involves interaction with lead and radiological materials, the table provides reference(s) to the specific directive(s) that need to be considered for each of these hazards. Directives that are not strictly driven by hazard type are identified as "crosscutting" directives, which are applicable regardless of the hazards and work scope.

Figure A-1. Organization of ES&H Directives Applicable to Facility Disposition and Environmental Restoration

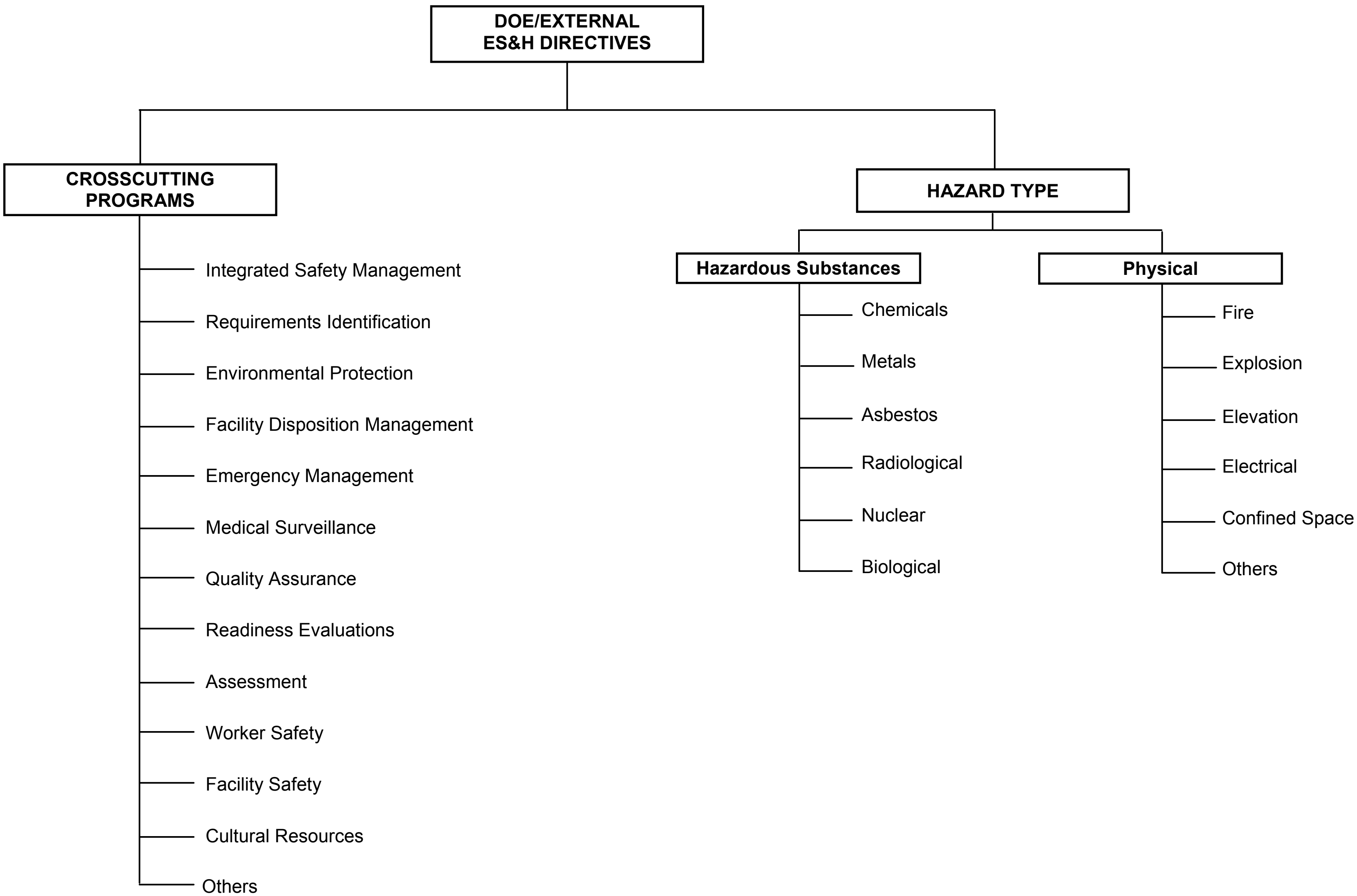

Table A-1, Environment, Safety, and Health Directives Applicable to Facility Disposition and Environmental Restoration Activities

(Directives with an asterisk (*) are mandatory when the disposition or environmental restoration activity's work scope and hazards are subject to the directive. DOE Orders are also mandatory when listed in a contract that has been negotiated with DOE to address the disposition activity.)

Category	Directive	Intent
CROSSCUTTING PROGRAMS		
Integrated Safety Management	DOE P 450.4 * Safety Management System Policy	Establishes the components necessary for a Safety Management System to provide a formal, organized process whereby people plan, perform, and improve the safe conduct of work. The system encompasses all levels of activities and documentation related to safety management throughout the DOE complex.
	DOE G 450.4-1B Integrated Safety Management System (ISMS) Guide	Provides guidance to meet the tenets of P 450.4, Safety Management System Policy.
Requirements Identification	DOE P 450.1 ES&H * Policy for DOE Complex	Specifies the goals and guiding principles for the DOE ES&H policy.
	DOE P 450.2A * Identification, Implementation, and Compliance with ES&H Requirements	Sets forth the framework for identifying, implementing, and complying with ES&H requirements so that work is performed in the DOE complex in a manner that ensures adequate protection of workers, the public, and the environment. This framework is an integral part of the Department's commitment to a standards-based management system.
	DOE P 450.3 * Authorizing the Use of the Necessary and Sufficient Process for Standard-Based ES&H Management	Sets forth the framework for the Necessary and Sufficient Process. The process can be applied at any organizational level and by any organization within the DOE complex, and can be used to establish contractual commitments between the Department and its contractors.
	DOE M 450.3-1 Necessary and Sufficient Closure Process	Describes the six elements established for the "Closure Process for Necessary and Sufficient Sets of Standards," and summarizes lessons learned from the pilots
Environmental Protection	DOE O 450.1 (1/15/03) * Environmental Protection Program	Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable Federal, State, local, environmental protection laws and regulations, Executive Orders, and internal Departmental policies.
	40 CFR 61, National Emission Standards for Hazardous Air Pollutants	Sets forth the limits and activities applicable to generators of hazardous air pollutants, including monitoring, testing, recordkeeping and reporting requirements.

Category	Directive	Intent
Environmental Protection	Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) *	Sets forth requirements for protecting human health and the environment where releases or threats of releases of hazardous substances, pollutants, or contaminants have been identified.
	Clean Air Act (CAA) *	Sets forth requirements for regulating emissions into the air from stationary and mobile sources. Controls are implemented through combined Federal, State, and local programs.
	Clean Water Act (CWA) *	Sets forth requirements for regulating point source and nonpoint source discharges into surface waters and requires the establishment of criteria and standards to protect water quality and achieve national performance standards as well as establishment of a regulatory permitting program (i.e., National Pollutant Discharge Elimination System [NPDES] permits) to enforce CWA standards.
	Safe Drinking Water Act * (SDWA)	Sets forth requirements for EPA to establish regulations to protect human health from contaminants in drinking water through the establishment of maximum contaminant levels (MCLs) and secondary maximum contaminant levels (SMCLs).
	Toxic Substances Control Act (TSCA) * (Polychlorinated Biphenyls and asbestos)	Sets forth requirements for the establishment of specific regulations for existing and new chemical substances and mixtures.
	Resource Conservation and Recovery Act (RCRA) *	Sets forth standards and requirements for ensuring that wastes are managed in a manner protective of human health and the environment and conserving of energy and natural resources. RCRA addresses the management of hazardous wastes through a program of standards and requirements for the generation, transport, treatment, and disposal of hazardous wastes and through a corrective action program to address releases of hazardous wastes and hazardous waste constituents.
	DOE O 451.1B (9/28/01)* National Environmental Policy Act (NEPA) Compliance Program	Sets forth responsibilities for the DOE implementation of NEPA. The purpose of NEPA is to provide a valuable planning tool to improve the quality of decision-making for government-sponsored proposed actions. NEPA ensures that environmental information is available to public officials and citizens before decisions are made or actions taken.
	DOE O 5400.5 Change 2 (1/7/93) * Radiation Protection of the Public and Environment.	Establishes radiation standards and requirements to be met by DOE facilities and operations in order to protect the environment and members of the public
	Pollution Prevention Act of 1990 (PPA)	The PPA of 1990 institutionalizes pollution prevention practices by encouraging voluntary reduction of hazardous waste and other pollutants resulting from industrial operations.

Category	Directive	Intent
Environmental Protection	Emergency Planning and Community Right to Know Act (EPCRA)	The EPCRA requires facility operators to notify the local emergency planning districts regarding substances stored at and released from sites. The emergency planning aspect requires local communities to prepare plans to deal with emergencies relating to hazardous substances, including: Emergency Planning and Notification, Reporting Requirements, and General Provisions.
	Endangered Species Act (ESA) and the Fish and Wildlife Coordination Act (FWCA)	The ESA provides for designation and protection of invertebrates, wildlife, fish, and plant species in danger of becoming extinct and conserves the ecosystems on which such species depend. The act mandates cooperation between Federal and State governments, especially concerning land acquisitions and management. DOE should consult with the FWS and/or NMFS before engaging in activities that might disrupt any endangered species. The FWCA assures that fish and wildlife resources receive equal consideration with other values during the planning of development projects that affect water resources. The act requires all Federal agencies to consult with the U.S. Fish and Wildlife Service whenever an agency plans to conduct, license, or permit an activity involving impoundment, diversion, deepening, control, or modification of a stream or body of water.
	National Historic Preservation Act (NHPA)	The Antiquities Act of 1906 protects historic and prehistoric remains on Federal lands. The Historic Sites Act of 1935 preserves for public use sites, buildings, and objects of national significance, extending this protection to Federal and non-Federal lands. The Archeological Recovery Act of 1960 protects archeological data from Federal dam construction; this act was amended in 1974 to protect same from any Federally related land modification activities. The NHPA includes the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, etc. NHPA requires Federal agencies to consider the effect of their projects on historical and archeological resources and allows the Council on Historical Preservation to comment on such effects.
	Executive Order 11988 Flood Plains Management	Directs Federal agencies to provide leadership and take action to minimize the risk of flood loss, and to restore and preserve the natural and beneficial values served by flood plains when carrying out its responsibilities for: (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use.

Category	Directive	Intent
Environmental Protection	Executive Order 11990 Protection of Wetlands	Directs Federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands when carrying out its responsibilities for: (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use.
	Executive Order 12580, Superfund Implementation	Establishes roles and responsibilities of EPA and other Federal agencies, including DOE, for implementing Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial and removal programs. Included are Federal agency roles and responsibilities relative to DOE facility decommissioning activities conducted as CERCLA non-time critical removal actions
	Executive Order 12856 Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements	Directs Federal agencies and their facilities to comply with the provisions of EPCRA as well as the Pollution Prevention Act of 1990. Specifically, requires Federal agencies to develop and implement pollution prevention strategies and Federal facilities to develop and implement pollution prevention plans. The goal of these efforts is to ensure that Federal agencies conduct their facility management and acquisition activities so that the quantities of toxic chemicals that may potentially enter a waste stream are reduced through source reduction; any waste that is generated is recycled and that any remaining waste is stored, treated, and disposed of in a manner protective of public health and the environment.
	Executive Order 12843 Procurement Requirements and Policies for Federal Agencies for Ozone Depleting Substances	Directs Federal agencies to minimize the use and procurement of ozone-depleting substances by conforming their regulations and procurement practices to Title VI of the CAA, maximizing the use of safe alternatives to ozone-depleting substances, and evaluating present and future needs of ozone-depleting substances. For DOE, this Executive Order is implemented by DOE/EH - 0511, *Guidance on the DOE Facility Phaseout of Ozone Depleting Substances.*
	Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Directs Federal agencies to create an Interagency Working Group on Environmental Justice to provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations, as well as developing interagency model projects on environmental justice.

Category	Directive	Intent
Facility Disposition Management	DOE O 430.1B and Associated DOE Guides (9/24/03) Real Property Asset Management	Provides requirements for the control (planning, acquiring, maintaining, leasing, and disposal) of the Department's physical assets, implemented through a graded approach to life-cycle asset management and referenced guidance and technical standards.
Emergency Management	DOE O 151.1B (10/29/03)* Comprehensive Emergency Management System	Provides requirements for the establishment of an Operational Emergency Base Program that provides the framework for response to serious events involving health and safety, the environment, safeguards, and security. Also requires an operational emergency hazardous material program to supplement the Base Program.
	DOE G 151.1-1Emergency Management Guide	Provides guidance for the establishment of an Operational Emergency Base Program that meets the requirements of DOE O 151.1B.
	DOE-HDBK-5504-95 Guidance for Evaluation of Operational Emergency Plans	Provides guidance for evaluating emergency plans.
Medical Surveillance	DOE O 440.1A (3/27/98) * Worker Protection management for DOE Federal and Contractor Employees	Applies to Federal employees not covered under the occupational medical program requirements for contractors in DOE O 440.1. This Order requires Heads of DOE Field Elements with Delegated Personnel Authority to develop, establish, provide, and maintain a Federal Employee Occupational Medical Program.
	29 CFR 1910.120(f) or (q)(9)* Medical Surveillance for Hazardous Waste Operations and Emergency Response	Paragraph (f) contains specific medical surveillance program requirements for employees conducting hazardous waste operations and whose potential exposure levels exceed specified limits. Paragraph (q)(9) requires a medical surveillance program for members of organized and designated HAZMAT teams and for hazardous materials specialists, as defined in this regulation.
	DOE G 440.1-4 Contractor Occupational Medical Program Guide for Use with DOE O 440.1 (6/27/97)	Provides guidelines for establishing an occupational medical program which meets the requirements of DOE O 440.1A.
Quality Assurance	DOE O 414.1B (4/29/04) * Quality Assurance	Ensures that the quality of DOE products and services meet or exceed customers' expectations.
	DOE G 414.1-1A (5/31/01) Management Assessment and Independent Assessment Guide	Provides guidance on performing management assessments in accordance with the requirements of 10 CFR 830 Subpart A, and DOE O 414.1. Also provides guidance on retaining information from canceled orders and conveying current trends in assessment methodology to ensure assessments are performed efficiently.

Category	Directive	Intent
Readiness Evaluations	DOE O 425.1C (3/13/03)* Startup and Restart of Nuclear Facilities	Provides requirements for startup of new nuclear facilities and for the restart of nuclear facilities that have been shutdown.
	DOE-STD-3006-95 (6/2000) Planning and Conduct of Operational Readiness Reviews	Provides guidance on the planning and conduct of Operational Readiness Reviews (ORRs). This standard also provides guidance for requesting exemptions. The requirements for ORRs and readiness assessments (RAs) apply both to responsible contractors and to DOE. This standard addresses the requirements and suggests methods and approaches for ORRs and RAs.
	DOE O 231.1A Change 1 (6/13/04)* Environment Health and Safety Reporting	Ensures timely collection, reporting, analysis, and dissemination of ES&H issues as required by law or regulations on a timely basis.
Assessment	DOE-STD-7501-95 (12/1999) Development of DOE Lessons Learned Programs	Defines the framework for development of a lessons learned program. When specifically referenced and required to be implemented, this technical standard applies to all DOE Headquarters and field organizations, management and operating contractors, and laboratories establishing a lessons learned program. For organizations with existing lessons learned programs, this technical standard will facilitate self-assessment to determine whether existing structures contain the essential elements for consistency and compatibility.
	DOE O 225.1A (11/26/97) * Accident Investigations	Prescribes requirements for investigating certain accidents occurring at DOE operations and sites to improve ES&H for DOE, contractors, and the public and to prevent the recurrence of such accidents.
	DOE G 225.1A-1 Implementation Guide for DOE O 225.1 Accident Investigations	Explains the requirements addressed in DOE O 225.1 and provides guidance regarding acceptable methods for implementing those requirements. The approach to investigations described in the guide is similar to, and consistent with, methods used by other government agencies and private industry.
	DOE P 450.5 Line Environment, Safety and Health Oversight	Provides expectations for Department of Energy line management ES&H oversight and for the use of contractor self-assessment programs
Worker Safety	DOE O 440.1A (3/27/98) * Worker Protection Management for DOE Federal and Contractor Employees	Establishes the framework for an effective worker protection program that will reduce or prevent accidental losses, injuries, and illnesses by providing DOE Federal and contractor workers with a safe and healthy workplace.
	DOE G 440.1-1 (7/10/97) Worker Protection Management for DOE Federal and Contractor Employees Guide for use with DOE O 440.1	Provides implementing guidance in support of DOE O 440.1A, covering topics such as management commitment, employee involvement, hazard identification, evaluation and control, and worker protection training. Pertinent guidelines are provided that support DOE-1120-98 discussions regarding task-level hazard analysis activities and worker controls.

Category	Directive	Intent
Worker Safety	DOE G 440.1-2 (6/26/97) Construction Safety Management Guide for use with DOE O 440.1	Provides S&H guidelines pertinent to construction activities. Since some disposition activities, such as demolition, have similar hazards to construction, this guide may be useful in obtaining further S&H guidance on topics such as task-level hazard analysis and health and safety plans.
	DOE G 440.1-3 (3/30/98) Occupational Exposure Assessment	Provides implementing guidance in support of DOE O 440.1A, covering the topic of occupational exposure assessment. The guidance states that exposure assessment should be included in the DOE and contractor written worker protection program and that the exposure assessment documentation should describe the methods and rationale a site uses to characterize and monitor worker's potential and actual exposures to hazardous agents.
	29 CFR 1910.120(l) or (q) * Hazardous Waste Operations and Emergency Response	Paragraph (l) contains requirements to ensure worker health and safety during emergency response for hazardous waste operations, including projects conducted under CERCLA. Paragraph (q) contains requirements to ensure worker health and safety during emergency release of hazardous substances wherever they occur.
	DOE-EM-STD-5503-94 EM Health and Safety Plan (HASP) Guidelines	Provides guidance for developing "site-specific HASPs" for EM-40 facilities that meet or exceed the requirements of 29 CFR 1910.120. Guidance may be used in developing HASPs as discussed in Section 3.3.4 of DOE-STD-1120-98.
	29 CFR 1910 Subpart I * Personal Protective Equipment	Provides requirements for the selection, use, and maintenance of eye and face protection, respiratory protection, head protection, foot protection, and electrical protective equipment.
	29 CFR 1926 Subpart E * Personal Protective and Life- Saving Equipment	Provides requirements for construction operations for the selection, use, and maintenance of foot protection, protective clothing; respiratory protection for fire brigades; head, hearing, eye, and face protection; respiratory protection; and detailed requirements for working over or near water.
	29 CFR 1910 * S&H Regulations for General Industry	Sets forth the S&H standards promulgated by OSHA for general industry.
	29 CFR 1926 * S&H Regulations for Construction	Sets forth the S&H standards promulgated by OSHA for construction, alteration, and/or repair, including painting and decorating.
Facility Safety	DOE O 420.1A (5/20/02) * Facility Safety	Establishes facility safety requirements related to fire protection and natural phenomena hazards mitigation.

Category	Directive	Intent
Cultural Resources	American Indian Religious Freedom Act (AIRFA)	AIRFA clarifies U.S. policy pertaining to the protection of Native Americans' religious freedom. The act established a policy of protecting and preserving the inherent right of individual Native Americans (including American Indians, Eskimos, Aleuts, and Native Hawaiians) to express and exercise their traditional religious beliefs.
	Native American Graves Protection and Repatriation Act." (NAGPRA)	Establishes a means for American Indians, including members of Indian Tribes, Native Hawaiian organizations, and Native Alaskan villages and corporations, to request the return or "repatriation" of human remains and other cultural items presently held by federal agencies or federally assisted museums or institutions. Contains provisions regarding the intentional excavation and removal of, inadvertent discovery of, and illegal trafficking in Native American human remains and cultural items.
Other Crosscutting Programs	DOE 433.1 (6/1/01)* Maintenance Management Program for DOE Nuclear Facilities	Provides general policy and objectives for the establishment of programs for the management and performance of cost-effective maintenance and repair of DOE property. Contains guidelines for establishing and conducting a maintenance program.
	DOE O 231.1A (6/3/04)* ES&H Reporting	Ensures the collection and reporting of information on ES&H required by law or regulation to be collected, or that is essential for evaluating DOE operations and identifying opportunities for improvement needed for planning purposes within the DOE.
	DOE M 231.1-2 (8/19/03) ES&H Reporting Manual	Provides detailed requirements to supplement DOE O 231.1, *Environment, Safety, and Health Reporting*, which establishes management objectives and requirements for reporting ES&H information.
	DOE M 232.1-2 (8/19/03) Occurrence Reporting and Processing of Operations Information	Provides detailed information for categorizing and reporting occurrences at DOE facilities. It complements DOE O 232.1, and its use is required by that Order.

HAZARD TYPES			
Hazardous Substances	Chemicals	29 CFR 1910.120 * Hazardous Waste Operations and Emergency Response (HAZWOPER)	Requires a S&H program and site-specific S&H plan for cleanup operations involving hazardous substances; operations involving hazardous wastes conducted at treatment, storage, and disposal (TSD) facilities; and emergency response operations for releases of, or substantial threats of release of, hazardous substances.
		29 CFR 1926.65 * HAZWOPER	Requires a S&H program and site-specific S&H plan for cleanup operations involving hazardous substances; operations involving hazardous wastes conducted at TSD facilities; and emergency response operations for releases of, or substantial threats of release of, hazardous substances.
		DOE/EH-0535 (June 1996) Handbook for Occupational Safety and Health During Hazardous Waste Activities	Provides guidance for establishing and implementing comprehensive, cost-effective, hazard-based worker health and safety programs that meet the requirements of DOE and DOE-adopted OSHA health and safety directives for hazardous waste activities.
		29 CFR 1910.1000 * OSHA "Z Tables" within Subpart Z	Provides permissible exposure limits (PELs) for most air contaminants regulated by OSHA and stipulates a hierarchy of controls to achieve compliance.
		29 CFR 1926.55 * Gases, Vapors, Fumes, Dusts, and Mists (comparable to "Z Tables")	Provides PELs for most air contaminants regulated by OSHA and stipulates a hierarchy of controls to achieve compliance.
		29 CFR 1910.1001—1050 * Substance-Specific Standards within Subpart Z	Provides worker S&H requirements for exposures to specific chemicals, primarily carcinogens. Includes requirements such as exposure monitoring, worker training, exposure controls, regulated areas, and medical surveillance of workers who are potentially exposed to specific hazardous substances. Includes standards for substances often involved in facility disposition activities such as asbestos, lead, and cadmium.
		29 CFR 1926 Subpart Z * Substance-Specific Standards	Contains worker S&H requirements for exposures to specific chemicals, primarily carcinogens. Includes requirements such as exposure monitoring, worker training, exposure controls, regulated areas, and medical surveillance of workers who are potentially exposed to the specific hazardous substances. Includes standards for substances often involved in facility disposition activities such as asbestos, lead, and cadmium.
		DOE-HDBK-1100-96 (February 1996) Chemical Process Hazard Analysis	Provides guidance for performing chemical process hazards analysis required by 29 CFR 1910.119.

Hazardous Substances	Chemicals	DOE-HDBK-1101-96 (February 1996) Process Safety Management for Highly Hazardous Chemicals	Provides information necessary to determine if a chemical process is covered by the Process Safety Management Rule (29 CFR 1910.119).
		29 CFR 1910.1200 * Hazard Communication	As it applies to facility disposition, requires that information concerning hazards and appropriate protective measures for chemical substances in the workplace are transmitted to personnel through appropriate labeling, Material Safety Data Sheets (MSDSs), signs, and training.
		29 CFR 1926.59 * Hazard Communication	As it applies to facility disposition, requires that information concerning hazards and appropriate protective measures for chemical substances in the workplace are transmitted to personnel through appropriate labeling, MSDSs, signs, and training.
		29 CFR 1910.1450 * Occupational Exposure to Hazardous Chemicals in Laboratories	Potentially applicable during deactivation and surveillance & maintenance. If laboratory use of hazardous chemicals is occurring during facility disposition activities, this standard may apply. Where it applies, it generally supersedes OSHA's Subpart Z health standards. Refer to this standard for specific qualifications on scope and applicability.
Hazardous Substances	Metals	29 CFR 1910.1025 * Lead	Contains requirements for employee exposure to lead including PELs, exposure monitoring, hazard controls and protective equipment, medical surveillance, worker training, and record keeping. It does not cover construction workplaces.
		29 CFR 1926.62 * Lead	Contains requirements for employee exposure to lead in construction workplaces including PELs, exposure monitoring, hazard controls and protective equipment, medical surveillance, worker training, and record keeping.
		29 CFR 1910.1027 * Cadmium	Contains requirements for employee exposure to cadmium including PELs, exposure monitoring, regulated area establishment, hazard controls and protective equipment, written emergency plan, medical surveillance, worker training, and record keeping. It does not apply to construction workplaces.
		29 CFR 1926.1127 * Cadmium	Sets requirements for employee exposure to cadmium in construction workplaces including PELs, exposure monitoring, regulated area establishment, hazard controls and protective equipment, written emergency plan, medical surveillance, worker training, and record keeping.

Hazardous Substances	Asbestos	29 CFR 1910.1001 * Asbestos	Applies to all occupational exposures to asbestos in all industries covered by OSHA, except for construction work, and includes requirements for PELs, exposure monitoring, methods of compliance, regulated areas, respiratory protection, protective work clothing and equipment, hygiene facilities and practices, communication of hazards to employees, housekeeping, medical surveillance, record keeping, and observation of monitoring practices.
		29 CFR 1926.1101 * Asbestos	Applies to all construction work and includes requirements for PELs, exposure monitoring, regulated areas, methods of compliance, respiratory protection, protective clothing and equipment, hygiene facilities and practices, communication of hazards to employees, housekeeping, medical surveillance, and record keeping.
Hazardous Substances	Radiological	10 CFR 820 * Procedural Rules for DOE Nuclear Activities	Provides procedures to govern the conduct of persons involved in DOE nuclear activities and, in particular, to achieve compliance with DOE nuclear safety requirements by all persons subject to those requirements. This part sets forth the procedures to implement the provisions of the Price-Anderson Amendments Act of 1988, which subjects DOE contractors to potential civil and criminal penalties for violations of DOE rules, regulations, and Orders relating to nuclear safety.
		DOE-STD-1083-95 Requesting and Granting Exemptions to Nuclear Safety Rules	Provides guidance for requesting exemptions to nuclear safety rules
		DOE P 441.1 * DOE Radiological Health and Safety Policy	Sets forth DOE’s approach to radiological health and safety.
		10 CFR 835 * Occupational Radiation Protection	Provides the regulations for occupational radiation protection of workers at DOE facilities. The provisions of 10 CFR 835 provide nuclear safety requirements, which, if violated, will provide the basis for the assessment of civil and criminal penalties under the Price-Anderson Amendments Act of 1988.
		DOE G 441.1-1A (10/23/03) Radiation Protection Program	Provides an acceptable methodology for documenting the development of an occupational radiation protection program that will comply with DOE requirements.
		DOE G 441.1-2 (3/17/99) Occupational ALARA Program Guide	Provides an acceptable methodology for establishing and operating an occupational ALARA (as low as reasonably achievable) program that will comply with DOE requirements as in 10 CFR 835.

Hazardous Substances	Radiological	DOE G 441.1-3 (3/17/99) Internal Dosimetry Program	Provides an acceptable methodology for establishing and operating an internal dosimetry program that will comply with DOE requirements as in 10 CFR 835.
		DOE G 441.1-4 (3/17/99) External Dosimetry Program	Provides an acceptable methodology for establishing and operating an external dosimetry program that will comply with DOE requirements as in 10 CFR 835.
		DOE G 441.1-5 (4/15/99) Radiation-Generating Devices (RGD) Guide	Provides an acceptable methodology for establishing and operating a RGD control program that will comply with DOE requirements. This also applies to radiography sources. Section IV.B.8 covers RGD decommissioning.
		DOE G 441.1-6 (4/29/99) Evaluation and Control of Fetal Exposure	Provides an acceptable methodology for establishing and operating a program to evaluate and control radiation exposure to the embryo/fetus of pregnant female workers that will comply with DOE requirements.
		DOE G 441.1-7 (6/17/99) Instrument Calibration Guide for Portable Instruments	Provides an acceptable methodology for establishing and operating a program for calibrating portable radiological survey instruments that will comply with DOE requirements.
		DOE G 441.1-8 (3/17/99) Air Monitoring Guide	Provides an acceptable methodology for establishing and operating an air monitoring program that will comply with DOE requirements.
		DOE G 441.1-10 (5/24/99) Posting and Labeling for Radiological Control Guide	Provides an acceptable methodology for establishing and operating a radiological posting and labeling program compliant with DOE requirements.
		DOE G 441.1-11 (5/20/99) Occupational Radiation Protection Record Keeping and Reporting Guide	Provides an acceptable methodology for establishing and operating an occupational radiation protection record keeping and reporting program compliant with DOE requirements.
		DOE G 441.1-12 (3/17/99) Radiation Safety Training Guide	Provides an acceptable methodology for establishing and operating a radiation safety training program compliant with DOE requirements.
		DOE O 5400.5 Change 2 (1/7/93) * Radiation Protection of the Public and Environment	Establishes radiation standards and requirements to be met by DOE facilities and operations in order to protect the environment and members of the public.
		DOE O 435.1 Change 1 (8/28/01) * Radioactive Waste Management	Provides DOE policies, guidelines, and requirements for the management of DOE radioactive waste, mixed waste, and contaminated facilities.
		DOE G 441.1-13 (4/15/99) Sealed Radioactive Source Accountability and Control Guide	Provides an acceptable methodology for establishing and operating a sealed radioactive source accountability and control program compliant with DOE requirements, applicable also to radiography sources.

Hazardous Substances	Radiological	DOE O 5480.20A Change 1 (7/12/01) * Personnel Selection, Qualification, and Training Requirements for DOE Facilities	Provides requirements for establishing and implementing personnel selection, qualification, and training requirements.
		DOE-STD-1107-97 Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities	Provides detailed qualification criteria for contractor key radiation protection personnel.
Hazardous Substances	Nuclear (Hazard Category 3 or above)	10 CFR 830 * Nuclear Safety Management	Provides requirements for the conduct of the DOE management and operating contractors and other persons at DOE nuclear facilities. This part establishes requirements for the safe management of DOE contractor and subcontractor work at the Department's nuclear facilities. The current rule adopts the sections that make up the general applicable provisions and also adopts the specific section on provisions for developing and implementing a formalized quality assurance program.
		10 CFR 830 Subpart A * Quality Assurance Requirements	Provides requirements for the development of a quality assurance program for nuclear facilities.
		DOE O 5480.19 Change 2 (10/23/01) * Conduct of Operations Requirements for DOE Facilities	Provides requirements for establishing and implementing a conduct of operations program.
		DOE O 5480.20A Change 1 (7/12/01) * Personnel Selection, Qualification, and Training Requirements for DOE Facilities	Provides requirements for establishing and implementing personnel selection, qualification, and training requirements.
		10 CFR 830.203 * Unreviewed safety question process	Provides requirements for performing USQ determinations process.
		10 CFR 830.205 * Technical safety requirements	Establishes the requirement to have TSRs prepared for DOE nuclear facilities and delineates the criteria, content, scope, format, approval process, reporting, and revision requirements of these TSRs.
		10 CFR 830.204 * Documented safety analysis	Establishes requirements for developing safety analyses that establish and evaluate the adequacy of the safety basis of the facilities.
		DOE-STD-1104-96 Review and Approval of Non-Reactor Nuclear Facility Safety Analysis Reports	Provides guidelines for conducting reviews of DOE SARs.

Hazardous Substances	Nuclear (Hazard Category 3 or above)	DOE-STD-1027-92 Hazard Categorization and Accident Analysis Techniques for Compliance with 5480.23	Provides guidance for the preparation and review of hazard categorization and accident analyses techniques as required by DOE.
		DOE-STD-3009-94, Change Notice 2 (4/04) Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis	Provides format and content of DSAs for non-reactor nuclear facilities. Chapter 3 provides specific guidance for hazards analysis.
		DOE-STD-3011-94 Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans	Specifies format and content for developing bases of interim operation (BIOs).
		DOE-HDBK-3010-94 Release Fractions and Respirable Fractions for Nuclear Facilities	Provides airborne release fraction (ARF) and respirable fraction (RF) values for use when performing hazard/safety analysis.
		DOE-EM-STD-5502-94 Hazard Baseline Documentation	Provides a methodology for classifying facilities under EM's purview.
		DOE O 420.1A (1/23/03) * Facility Safety	Establishes facility safety requirements related to nuclear safety design, criticality safety, fire protection, natural phenomena hazards and a system engineer program.
		DOE-STD-3007-93 Guidelines for Preparing Criticality Safety Evaluations at DOE Non-Reactor Nuclear Facilities	Provides guidance for preparing nuclear criticality safety analysis of DOE operations.
		DOE O 425.1C (3/13/03) * Startup and Restart of Nuclear Facilities	Provides requirements for startup of new nuclear facilities and for the restart of nuclear facilities that have been shutdown.
		DOE-STD-101-92 Nuclear Safety Criteria for Potential Application to Non-Reactor Nuclear Facilities	Provides a listing of nuclear safety criteria that may be applicable to non-reactor nuclear facilities.
		DOE-STD-3013-96 Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage	Provides guidance for assuring safe storage of plutonium metals and oxides for 50 years or final disposition.

Hazardous Substances	Biological	29 CFR 1910.1030 * Bloodborne Pathogens	Contains requirements to control occupational exposure to blood and other potentially infectious substances. Stipulates methods to comply with exposure control, hazard communication procedures, and record keeping requirements.
		29 CFR 1910.141 * Sanitation	Includes requirements for water supply, housekeeping, waste disposal, insect and vermin control, and other provisions that reduce the potential spread of infectious agents, including rodent- and insect-borne hazards.
Physical	Fire	29 CFR 1926.51 * Sanitation	Includes requirements for water supply, housekeeping, waste disposal, insect and vermin control, and other provisions that reduce the potential spread of infectious agents, including rodent- and insect-borne hazards.
		29 CFR 1910 Subpart L * Fire Protection	Contains requirements for fire brigades; all portable and fixed fire suppression equipment; fire detection systems; and fire or employee alarm systems installed to meet the fire protection requirements of 29 CFR 1910.
		29 CFR 1926 Subpart F * Fire Protection	Contains requirements for fire protection, including a fire protection program, flammable and combustible liquids, LP-gas, heating devices, fire suppression equipment, and employee alarm systems.
		29 CFR 1910 Subpart Q * Welding, Cutting, and Brazing	Provides requirements for gas welding and cutting, arc welding and cutting, fire prevention and ventilation, and protection for welding operations.
		29 CFR 1926 Subpart J * Welding and Cutting	Provides requirements for construction operations for gas welding and cutting, arc welding and cutting, fire prevention and ventilation, and protection for welding operations. This subpart would typically apply only during decommissioning.
		DOE G-440.1-5 (9/30/95) Fire Safety Program for Use with DOE O 420.1 and DOE O 440.1	Provides guidance to facilitate the development, implementation, and maintenance of a comprehensive fire protection program that meets the requirements of DOE 0 420.1 and DOE O 440.1.
		DOE-HDBK-1062-96 DOE Fire Protection Handbook	Provides guidance on how to achieve the fire protection requirements of DOE O 420.1.
		DOE-STD-1088-95 Fire Protection for Relocatable Structures	Provides guidance on meeting fire protection requirements for relocatable structures.
		DOE/EH-0196 Bulletin 91-3 (Revised) Fire Prevention Measures for Cutting, Welding, and Related Activities	Contains requirements, standards, and guidelines governing fire safety for "hot work" activities. Among other things, requires task hazard analysis for Deactivation and Decommissioning (D&D) work, fire retardant clothing, and fire watch to protect personnel.

Physical	Explosion	DOE M 440.1-1 (3/28/00) Non-nuclear and Explosives Safety Criteria Guide for use with DOE O 420.1 Facility Safety	Provides safety standards and procedures used to implement the requirements of DOE O 440.1 for operations involving explosives, pyrotechnics, and propellants, or assemblies containing these materials.
		29 CFR 1910.109 * Explosives and Blasting Agents	Primarily applicable only during decommissioning. This regulation contains requirements for handling, storing, transporting, and using explosives and blasting agents in general industry operations.
		29 CFR 1926 Subpart U * Blasting and the Use of Explosives	Primarily applicable only during decommissioning. This section contains requirements for the use, transportation, and storage of explosives, blasting agents, and equipment in construction operations.
Physical	Elevation	29 CFR 1926 Subpart L * Scaffolding	Provides requirements for the construction and use of various types of scaffolds for construction.
		29 CFR 1926 Subpart M * Fall Protection	Sets forth requirements and criteria for fall protection in construction workplaces covered under 29 CFR 1926.
		29 CFR 1926 Subpart N * Cranes, Derricks, Hoists, Elevators, and Conveyors	Covers the use, employee protection and hazard control, maintenance, testing, and equipment associated with cranes, derricks, hoists, elevators, and conveyors used for construction.
		DOE-STD-1090-04 Hoisting and Rigging	Provides guidance for safely performing hoisting and rigging activities.
Physical	Electrical	29 CFR 1910 Subpart S * Electrical	Addresses electrical safety requirements necessary for the practical safeguarding of employees in their workplaces. Includes design safety standards for electrical systems, safety-related work practices and maintenance requirements, and safety requirements for special equipment.
		29 CFR 1926 Subpart K * Electrical	Addresses electrical safety requirements necessary for the practical safeguarding of employees involved in construction work. Includes installation safety requirements, safety-related work practices, safety-related maintenance and environmental considerations, and safety requirements for special equipment.
		29 CFR 1910.333 * Selection and Use of Work Practices	Details requirements to prevent electric shock or other injuries from work on or near electrical equipment. Includes provisions for locking and tagging out circuits.
		29 CFR 1926.417 * Lockout and Tagging of Circuits	Provides requirements and procedures for locking and tagging controls and circuits when an employee is exposed to contact with deactivated electric equipment or circuits.

Physical	Electrical	DOE-STD-1030-96 Guide to Good Practices for Lockouts and Tagouts	Provides guidance on good practices associated with lockouts and tagouts.
Physical	Confined Space	29 CFR 1910.146 * Permit-required Confined Spaces	Contains requirements for practices and procedures to protect employees in general industry (excluding construction) from the hazards of entry into permit-required confined spaces. Requirements include a Permit Space Program.
		29 CFR 1926 Subpart P * Excavations	Primarily applicable only during decommissioning. Contains requirements for the protection of employees working in and around all open excavations (including trenches) and requirements for protective systems (e.g., sloping, shield systems, etc.).
Physical	Other Physical Hazards	29 CFR 1910 Subpart Q * Welding, Cutting, and Brazing	Provides requirements for gas welding and cutting, arc welding and cutting, fire prevention and ventilation, and protection for welding operations.
		29 CFR 1926 Subpart J * Welding and Cutting	Provides requirements for construction operations for gas welding and cutting, arc welding and cutting, fire prevention and ventilation, and protection for welding operations.
		29 CFR 1910.94 * Ventilation	Provides requirements for ventilation for abrasive blasting, grinding, polishing and buffing operations, spray finishing operations, and open surface tanks.
		29 CFR 1926.57 * Ventilation	Provides requirements for ventilation for abrasive blasting, grinding, polishing and buffing operations, spray finishing operations, and open surface tanks.
		29 CFR 1910.95 * Occupational Noise Exposure	Establishes allowable noise levels and the protection requirements when those levels are exceeded.
		29 CFR 1926.53 * Occupational Noise Exposure	Establishes allowable noise levels and the protection requirements when those levels are exceeded.
		29 CFR 1910 Subpart O * Machinery and Machine Guarding	Details requirements for the use, maintenance, and guarding of machinery, including mechanical power-transmission apparatus.
		29 CFR 1926 Subpart I * Tools—Hand and Power	Provides requirements for the use, maintenance, and guarding of hand and power tools, including mechanical power-transmission apparatus.

Physical	Other Physical Hazards	29 CFR 1910.147 * Control of Hazardous Energy (Lockout/Tagout)	Covers the servicing and maintenance of machines and equipment in which the unexpected energization or startup of the machines or equipment or the release of stored energy could cause injury to employees. Minimum performance requirements for the control of such hazardous energy are established. It does not cover construction employment or exposure to electrical hazards in electric utilization installations.
		29 CFR 1910 Subpart N * Materials Handling and Storage	Contains safety requirements for mechanized materials handling and storage.
		29 CFR 1926 Subpart N * Cranes, Derricks, Hoists, Elevators, and Conveyors	Covers the use, employee protection and hazard control, maintenance, testing, and equipment associated with cranes, derricks, hoists, elevators, and conveyors used for construction.
		DOE-STD-1090-04 Hoisting and Rigging	Provides guidance for safely performing hoisting and rigging activities.
		29 CFR 1926 Subpart O * Motor Vehicles, Mechanized Equipment, and Marine Operations	Addresses safety requirements related to off-highway motor vehicles, earthmoving equipment, excavating and other equipment, pile driving equipment, site clearing, and marine operations and equipment.
		29 CFR 1926 Subpart P * Excavations	Primarily applicable only during decommissioning. Contains requirements for the protection of employees working in and around all open excavations (including trenches) and requirements for protective systems (e.g., sloping, shield systems, etc.).
		29 CFR 1926 Subpart T * Demolition	Primarily applicable only during decommissioning. Contains requirements for demolition preparatory operations, floor, wall, material, and steel construction removal, waste transport, and storage. It does not include demolition by explosives, which is in Subpart U.

Appendix B

Examples of Applying DOE-STD-1120 Concepts

EXAMPLES OF APPLYING DOE-STD-1120 CONCEPTS

The purpose of this appendix is to provide examples that illustrate concepts discussed in Volume 1 of this *Standard*, as well as integrated safety management lessons learned that apply to all phases of facility disposition and environmental restoration. The following examples are based on actual practices and experiences from around the DOE complex. Examples are organized by Integrated Safety Management (ISM) core functions as shown in Table B-1.

Actual field implementation of these concepts may involve work or hazards that deviate from individual examples. Therefore, it should not be assumed that examples are entirely representative of all aspects of an actual decommissioning or environmental restoration activities.

Links to lessons learned and best practice resources related to all DOE operations can be found at: http://www.eh.doe.gov/ll/links.html.

Table B-1. Organization of Examples

NO.	EXAMPLE TITLE	KEY TOPICS
WORK PLANNING/HAZARD IDENTIFICATION		
1	Integration of Worker Hazard Considerations into Work Planning	Hazards identification, planning
2	Utilizing a Multidisciplined Team during Job Planning	Characterization, team, planning
3	Using Historical Information to Supplement Facility Characterization	Characterization, historical information, employee experience
4	Using a Multidisciplined Team for Hazard Identification	Historical information, site characterization
HAZARD ANALYSIS		
5	Final Hazard Categorization of Environmental Restoration Activity	Final hazard categorization
6	Using Inactive Waste Site (IWS) Information to Support Hazard Categorization	Inactive Waste Sites, hazard categorization
7	Consideration of Facility Disposition Impacts on Adjacent Facilities	Safety controls, hazard analysis
8	Hazard Screening Tools used to Support Graded Task Hazard Analysis	Preliminary Hazard Screening and Assessment, Task Hazard Analysis
9	Screening Task Hazard Analysis Against Existing Safety Basis	Task hazard analysis, worker safety, hazard analysis
HAZARD CONTROL		
10	Administrative Controls for a Non-nuclear Facility	Administrative controls
11	Mitigating the Effects of an Earthquake	Administrative controls, safety controls, hazard analysis
12	Applying Hold Points in TSRs During Decommissioning	TSRs, hold points
WORK EXECUTION		
13	Tailoring of Unreviewed Safety Question Process to Environmental Restoration Activities	Tailoring, Unreviewed Safety Question, environmental restoration
14	Lessons Learned from a Readiness Evaluation Process	ORR, readiness evaluation
15	Ensuring Adequate Task Hazard Analysis and Pre-Job Briefing to Fully Identify Hazards	Task hazard analysis, lessons learned
FEEDBACK AND IMPROVEMENT		
16	Self-Assessments Lead to Discovery of Deficiency	Self-assessment, worker safety controls

EXAMPLES OF APPLYING DOE-STD-1120 CONCEPTS

WORK PLANNING/HAZARD IDENTIFICATION

Example 1: Integration of Worker Hazard Considerations into Work Planning

As part of the task to remove useable process equipment during a facility decommissioning, a welder was using a cutting torch to cut out large cylindrical sections. The work was similar in many ways to work performed in another building at the site during the past year, as well as to extensive equipment replacement activities necessary to support operations in the past. Because of these similarities, the operating contractor classified the work as routine maintenance, thereby eliminating the requirement for a task-specific work plan.

During the cutting operation, a spark or piece of hot metal ignited the welder's coveralls below the left knee. The welder was wearing multiple layers of clothing, radiological protective equipment, and a welder's mask that severely limited his ability to detect and extinguish the flames. Since the welder was working alone, the flames spread undetected until they were beyond his ability to extinguish them without assistance. By the time a co-worker responded to the emergency, the flames had totally engulfed the welder's body. He received third-degree burns on more than 95 percent of his body and died the following day.

The Type A Accident Investigation Board Report notes several deficiencies that contributed to the fatality—failure to identify a fire watch with appropriate personnel safety responsibilities and training; failure to plan the work adequately; failure to react to numerous clothing fires during welding prior to the accident because of a failure to foster an atmosphere that encouraged reporting of incidents; use of protective equipment that exacerbated the fire hazard; disregard of a formal lessons-learned report from an identical activity the prior year; inadequate provisions for emergency egress; and failure to notify the Industrial Hygiene (IH) Department for surveying the working conditions/controls as required by the work permit. None of these activities required the elaborate or extensive analysis usually associated with a SAR—just adherence to normal industrial safety practices, plant procedures, and the presence of an effective safety culture emphasized by management.

Example 2: Utilizing a Multi-disciplined Team during Job Planning

A project involved decontamination and demolition of a manufacturing facility with a floor space of 120,000 ft^2 that included metallurgical processing and fabrication of uranium metal components. An initial inspection showed the potential for chemical, radiological, and asbestos contamination throughout the building where the structural integrity was suspect. Of major importance for decontamination within the structure and the eventual demolition of the structure was the condition of the roof.

For decommissioning planning purposes, it was necessary to characterize the roof and associated support structures, particularly for radiological contamination and asbestos composition of insulation. This would require access to the roof. Before initiating characterization activities, a licensed structural engineer completed a structural inspection and evaluation. This evaluation determined that 70 percent of the roof area and associated structures were not sufficient to support personnel egress. The evaluation identified pathways that were sound, and structural supports that could be used to attach personnel fall protection. Access control was established for entry onto the roof. This was coordinated with the radiation protection and industrial hygiene specialist to ensure that adequate access would be available to complete the additional characterization activities necessary to support decommissioning planning.

As a result of the integrated approach, with an emphasis on structural integrity as being significant to worker safety, the characterization and subsequent decontamination and structural demolition activities were planned and executed with no worker injuries or lost time accidents and without releases of hazardous substances into the environment.

Example 3: Using Historical Information to Supplement Facility Characterization

During the planning of characterization activities for the decommissioning of a surplus test reactor building, a historical research effort into past hot cell programmatic operations revealed the following key information:

(1) Inspections and handling of nuclear fuel containing significant quantities of fission products and loose alpha contamination were of major concern. Historical reports provided information on the nature of the materials inspected in the hot cells.

(2) Facility descriptions and operational procedures highlighted the use of an underground hot waste catch tank fed from hot cell drains.

(3) Interviews with programmatic personnel who had worked in the area more than 10 years ago identified the use of hazardous cleaning solvents on hot cell materials and the routine practice of flushing liquids and debris down the hot cell drains to the hot waste catch tank.

This information was critical in the planning and execution of the survey and sampling activities. It ensured that the difficult sampling of the catch tank was sufficient to support the waste disposal issues of remote-handled, transuranic-mixed waste and ensured adequate planning and preparation for the health and safety of the workers performing characterization. Without the historical information, it is likely that a limited survey and sampling effort would have missed the mixed waste issue initially and failed to quantify the significant quantities of transuranic materials in the underground storage tank. This would have resulted in a schedule delay of at least 3 months to re-plan, re-sample, and analyze the catch tank inventory, as well as additional costs and increased potential for worker risk.

Example 4: Using a Multidisciplined Team for Hazard Identification

A project team was assembled to address the removal of enriched uranium deposits in shutdown process equipment. An initial hazard analysis had been performed to identify the generic hazards associated with these activities. Further planning and hazard identification were to be conducted for each task associated with specific equipment and material removal activities.

The tasks that were identified included the saw-cutting of pipe sections, scraping, vacuuming and collecting uranium in geometrically safe containers, and welding seals in process openings. A multidisciplined team, comprising craft personnel, supervisors, health and safety representatives, and project personnel, was assembled. The team discussed a detailed draft work plan, line-by-line, to determine its adequacy. Workers suggested modifications to ease or clarify the tasks discussed, and health and safety personnel provided recommendations on worker protection or removal of unnecessary requirements. As a result of these discussions, the project had a completed work plan in a minimal amount of time. Additional hazards were identified and addressed based on facility walkdowns and subsequent changes were made to the work plan. This information was then used to incorporate health and safety requirements into the work scope, perform the task hazard analysis, and prepare the subsequent special permits (i.e., safety work permits, radiological work permits, hot work permits, etc.).

HAZARD ANALYSIS

Example 5: Final Hazard Categorization of Environmental Restoration Activity

A former active disposal site that was operated from 1943 to 1970 is currently planned for soil excavation and offsite disposal. The area consists of 15 acres. Burning and disposal of debris, including radioactive wastes from Y-12 are known to have occurred within unlined trenches that were eventually covered with soil.

Soil and groundwater sample results from remedial and field investigations were used to estimate a 95 percent upper confidence level of radioactive material inventory. A preliminary hazard categorization was performed in accordance with DOE-STD-1027-92 and considered the sum of multiple radionuclide fractions to their respective threshold quantity values. This concluded that inventory was 49 times higher than the threshold for Hazard Category 3 (HC3) and 90% of the Hazard Category 2 thresholds. Therefore, the site was initially categorized as HC3.

A simple hazard evaluation was prepared and documented, which considered the presence of available energy sources (e.g., fires, vehicle collisions, impacts from aircraft crash, high winds, localized flooding). No dispersive mechanisms were identified to exist, except when material was exhumed in preparation for transport via dump trucks which exposed material to several release mechanisms. The maximum quantity of material expected to be removed at any one time was limited because of excavation capabilities and the number of dump trucks that could physically transport materials.

The credible release fractions for each event were determined using DOE-HDBK-3010-94. These values were then compared with the bounding release fraction from DOE-STD-1027-92, which is 1E-3, and a ratio of the two numbers calculated. The release fraction of 1E-3 is used as a basis for Hazard Category 2 determinations in DOE-STD-1027-02 for non-volatile solids, powders and liquids, and was also confirmed to be the baseline value in EPA Technical Background document that supported Hazard Category 3 threshold quantities. Any decrease in this release fraction will result in an increase in the DOE-STD-1027 TQ value, proportional to the ratio mentioned above.

The most limiting release fraction was associated with a vehicle accident and was modeled after a free-fall spill of powder in accordance with DOE-HDBK-3010 (Airborne Release Fraction of 2E-03 and Respirable Fraction of 0.3). This value is 60% of the baseline value, and for the sum of all isotopes in question results in a total adjusted HC3 TQ of approximately 7.0 curies. The inventory of one dump truck is estimated at 0.074 Ci (20yd^3) of mixed isotopes. Over 90 dump trucks would need to concurrently spill their contents, along with inventory of 5 waste drums located onsite (0.744 Ci total), in order to exceed the revised HC3 TQ. This is not plausible.

A simple Hazard Analysis Document was submitted to DOE for approval and the facility was downgraded below Hazard Category 3.

Example 6: Using Inactive Waste Site (IWS) Information to Support Hazard Categorization

The Department of Energy Environmental Management (EM) program office is responsible for a large number of inactive waste sites. The DOE EM program office provided guidance for categorizing these inactive waste sites in the September, 2002 Memorandum, *Hazard Categorization of EM Inactive Waste Sites as Less Than Category 3*, Jessie Hill Roberson to Distribution, September 17, 2002. Analyses that identified key assumptions and considerations that provided the basis for the downgraded categorization of these sites were included in the guidance. The categorization (below Category 3) remains valid as long as the key assumptions and considerations remain valid.

Remediation of the inactive waste sites may result in one or more of the key assumptions becoming invalid. It still might be beneficial to use the IWS assumptions and conditions that remain valid to assist in performing a final hazard categorization for the environmental restoration (ER) activity. The categorization of the ER activity would summarize the valid IWS assumptions showing how they remain applicable under the ER activity allowing the majority of the effort to focus on the one or two conditions that do not meet the IWS guidance.

An example of this is an IWS designated below grade liquid disposal site that is identified as a RCRA cleanup site or subject to a CERCLA Record of Decision (ROD) as a site requiring remediation. The decision in the ROD requires that contaminants to be immobilized in place. The contractor elected to perform the immobilization by grouting the infiltration media (crushed rock) and waste using permeation grouting techniques (low pressure flowable grout). The technique will require the installation of injection piping to deliver the grout above, below, and throughout the waste matrix (clearly an intrusive activity).

The hazard analysis document described the site and techniques to be used to accomplish the immobilization. The description specified that there are no above ground structures, no below grade structures with human access or services, no tanks, and the process did not add explosives or reactive chemicals capable of generating sufficient energy to cause a significant release. The description also summarized and referenced analyses showing that a criticality event is not credible. The description of the grouting process clearly specified that the technique does not bring the waste material to the surface as a "pump and treat" condition eliminating that IWS prohibition. The only remaining IWS assumption/condition is the intrusive activity of installing the piping and injecting the grout. The intrusive activity of installing the piping and injecting the grout is evaluated using the unmitigated allowances of DOE-STD 1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,* section 3.1.2, Final Hazard Categorization.

Evaluation of the intrusive activity for Final Hazard Categorization considers the quantity (no additional inventory brought onto the site other than sealed sources required for calibration of equipment), location (waste remains below ground) and waste interaction with available energy (not capable of generating a significant release). These key assumptions and conditions were maintained as condition for approving the facility categorization as a "below Category 3" activity.

Example 7: Consideration of Facility Disposition Impacts on Adjacent Facilities

A retired tritium facility had a 200-ft.-high, 10-ft.-diameter, reinforced brick-lined concrete stack that was to be demolished using explosives. A hazard analysis was performed to identify the hazards and requisite controls related to the demolition activities. The hazard analysis also examined the stack's close proximity to several operating nuclear facilities (some of these facilities' safety class equipment was less than 300 feet away from the stack). The hazard analysis considered hazards related to stack materials and hazards introduced from the chosen work method. These hazards included seismic effects, tritium release from the stack materials on impact, propagation of pressure waves, and projectiles. Additionally, the analysis was benchmarked with another similar activity at a commercial reactor site and related lessons learned from other DOE sites were reviewed.

The hazard analysis identified safety controls, including the use of mobile SeaLand containers, as an additional measure to protect critical equipment within adjacent nuclear facilities from blast damage and potential projectiles. The stack was demolished well within the expected fall zone. Except for the estimate of the pressure wave from the base of the stack, all assumptions and designated controls in the hazard analysis were adequate and realistic, based on post-demolition monitoring data. As the stack struck the ground and collapsed, the pressure wave was larger than expected and moved two large metal SeaLand containers several feet. The containers were also damaged from small projectiles. However, the containers successfully performed their pressure-wave barrier function and prevented damage to the adjacent facilities and components.

Example 8: Hazard Screening Tools used to Support Graded Task Hazard Analysis

To support the deactivation of a plutonium processing facility, a task-based hazard screening process was implemented. Over the course of the project, two different hazard screening tools were used to assist in grading hazard analysis activities. The first tool, which was the Preliminary Hazard Screening and Assessment (PHSA), aided the project team in selecting the appropriate level of analysis based on the team's experience in conducting the task, the complexity of task activities and overall perceived risk. A PHSA checklist was organized to elicit these project characteristics and completed by the cognizant engineer and safety analyst for each major deactivation task. For example, a PHSA was completed for the task of transferring contaminated nitric acid from large tanks to tanker trucks for shipment. The results of the screening indicated that the task was complex; involved chemical, radiological, and physical hazards; and had not been conducted previously. Additionally, since the task involved handling of 48 weight percent nitric acid with uranium contamination, and failure of the coupling equipment could result in severe consequences to workers, facility management concluded that a more detailed hazard analysis was warranted.

As the project progressed, the PHSA was expanded to a computerized task hazard screening tool that accommodated self-directed work teams. The newly expanded tool served three main functions: (1) to assist work teams in identification of hazards and appropriate controls; (2) to identify the need for involvement of safety professionals to ensure that appropriate controls are established; and (3) to identify tasks that require additional analysis, such as Job Safety Analysis or Hazard and Operability Study. The computerized screening tool consisted of several screens, each addressing separate task hazards (e.g., nuclear safety, industrial safety, industrial hygiene, and radiological protection). In cases where the hazards were well known and evaluated, and work was routine (i.e., skill of the craft with approved radiological controls and no permits required, such as cutting and welding), a simple hazards checklist was all that was required.

One key to this process was the fact that the workers involved in task activities participated in the hazard screening process. Resulting information was used in the pre-job briefing to ensure that all workers were aware of the hazards and controls. Using this process, the incidents of lost work day injuries decreased significantly during the project.

Example 9: Screening Task Hazard Analysis Against Existing Safety Basis

A plutonium processing facility was entering deactivation. Although many of the activities were closely related to the operations activities, the deactivation included many one-time tasks performed under varying facility conditions that could have led to new or increased worker safety hazards. The work team's planned work task was to remove residual plutonium material from gloveboxes. As part of this process, a task hazard analysis was drafted. In order to verify that job hazards were not outside the previously identified safety envelope, the task hazard analysis results were screened against the existing hazard baseline document (e.g., facility DSA). The task hazard analysis identified potential hazards that included personnel radiological exposure, criticality considerations, and physical hazards including punctures and pinch points. Since these hazards were consistent with those encountered during glovebox operations, and the controls were identified in both training and current procedures, no additional hazard analysis was warranted for the planned activity. However, to ensure that the appropriate controls were included in the work process, the evaluation was reviewed and approved by the criticality safety representative, industrial safety representative, and radiological personnel. The work plan and final task hazard analysis were completed and used in the pre-job briefing to ensure that personnel understood the hazards and controls associated with the activity prior to beginning work.

HAZARD CONTROLS

Example 10: Administrative Controls for a Non-nuclear Facility

A non-nuclear laboratory facility with gloveboxes was to be deactivated in preparation for long-term S&M. An integrated hazard analysis was performed to identify the hazards and the requisite controls. The analysis considered hazards related to the storage of chemicals, as well as those hazards introduced from the chosen work methods.

The analysis identified three administrative controls that supported and enhanced existing programmatic health and safety controls. These controls specify that: (1) all hazardous substances be inventoried and a "living" inventory be maintained and updated on a weekly basis; (2) all hazardous substances to be brought into the facility, proposed activities, new (or changes to) procedures, and discoveries be screened and hazards analyzed as necessary, using a management of change process; and (3) all tasks have an initial hazard analysis performed the first time the activity is completed. In addition, industrial safety, IH, and health protection personnel; workers; and the facility supervisor reviewed and approved identified worker safety controls. In order to ensure proper implementation of these controls, all facility workers involved in the activity were trained (i.e., procedure review and pre-job briefing) on these safety control requirements.

Example 11: Mitigating the Effects of an Earthquake

A plutonium facility scheduled to be decommissioned within the next 10 years was to be analyzed for the effects and consequences of earthquakes. As part of the integrated hazard analysis, a seismic assessment revealed a potential for structural failure of the building during a credible seismic event. The facility was in long-term S&M, awaiting deactivation, and contained a large inventory of releasable radioactive material in its processing cells. The hazard analysis indicated that with more than two cell cover blocks removed the consequences of the seismic event would be unacceptable. The facility walkdown indicated that six cells were found without cover blocks in place.

Rather than instituting facility structural upgrades or modifying the facility to prevent or mitigate the additional release of material that could occur with numerous cover blocks out of place, a simple, cost-effective, solution involved reinstalling the cell cover blocks on these six cells. This action allowed for the facility to remain within its analyzed safety envelope. Once the cover blocks were reinstalled, a specific administrative control was established in the TSR that prohibited their removal during activities authorized within the DSA... This simple and practical approach avoided the potentially large costs associated with seismically upgrading the equipment and/or facility to address the discovered vulnerability.

This approach promoted: (1) modifying operations (i.e., no cover blocks off at any time) and (2) enhancing confinement integrity (i.e., reinstalling cover blocks), instead of requiring the facility to be structurally upgraded to meet the seismic requirements.

Example 12: Applying Hold Points in TSRs During Decommissioning

A Hazard Category 2 plutonium processing facility had been retired for more than 30 years and was being prepared for final decommissioning. The facility process systems had been flushed and deactivated to its current inventory of about 2 kg of Pu-239, much of which was determined to be held up in process systems (i.e., approximately 1.5 kg was contained within six small process vessels). The potential existed for significant uncertainty in total inventory, due to the inability to assay structure, systems, or components (e.g., the pipe trench) beyond the pipes and vessels immediately accessible.

The existing TSRs for inventory and criticality control were designed to be applied to facility modes of operation. Imbedded within the TSRs were several “hold” points that facilitated additional assays or analyses to confirm assumptions used in the derivation of TSRs and to verify inventory certainties. Once the six process vessels were removed and all required confirmations and approvals completed, the limiting conditions of operations (LCOs) contained within the TSRs that were associated only with this "mode" were no longer applicable. Additional TSRs were applicable during the subsequent "mode," including more detailed characterization of the pipe trench. Hold points were used throughout the activities to ensure that assumptions, laboratory data, analyses, and approvals were obtained prior to authorizing work.

WORK EXECUTION

Example 13: Tailoring of Unreviewed Safety Question Process to Environmental Restoration Activities

The Unreviewed Safety Question (USQ) process has retained the focus on protecting hardware that is important to safety (Equipment Important to Safety). This example provides one way that responses to the USQ questions on Equipment Important to Safety have been tailored to fit ER activities.

DOE G 424.1-1, *Implementation Guidance for Use in Addressing Unreviewed Safety Question Requirements,* identifies seven questions that are an expansion of the three general questions identified in 10 CFR 830, Subpart B. Standard questions # 3 (probability of a malfunction of equipment important to safety), # 4 (consequence of malfunction of equipment important to safety), and # 6 (malfunction of equipment important to safety of a different type) all involve the issue of change impact to hardware (equipment important to safety). These questions are focused on some form of hardware barrier mitigating an undesirable event. Environmental restoration activities typically have a stronger reliance on administrative controls and company level safety management programs as opposed to safety SSCs

Recognizing that administrative controls can provide a level of importance similar to that of safey SSCs (see DOE-1186), one DOE site expanded their responses to USQD questions to better fit ER activities. The responses address the standard "equipment important to safety" (e.g. there are none) and expand the response to cover "controls important to safety" that replace the traditional hardware reliance. A typical response to question # 3 is provided below as an example of the tailoring that has been used.

(3) Could the proposed change or as-found condition increase the probability of a malfunction of equipment important to safety previously evaluated in the facility's safety analyses? Yes ☐ No ☒

> **Justification:** No equipment is identified as important to safety in the safety basis (SB). The proposed changes do not require any equipment to be designated as important to safety. However, administrative controls and safety management program (SMP) commitments take the place of equipment important to safety (EITS) hardware in most remediation activities. The SB (chapter 5, section 5.2) and the work instruction commit to the SMPs. There are no "increases in the probability of malfunctions" to **controls important to safety** created by the proposed change to the work instruction in the form of deviations to the company approved safety management programs. Therefore, the answer to this question is "No."

The "controls" in this case are not limited to TSR level controls but include defense in depth similar to the discussion in the DOE G 424.1-1 on equipment important to safety not being limited to safety significant or safety class equipment. The controls are those administrative practices that would weaken or circumvent a safety function implicitly or explicitly identified in the Safety Basis.

Example 14: Lessons Learned from a Readiness Evaluation Process

A Hazard Category 2 nuclear facility was shutdown in 1992 and is currently planned for deactivation. The facility still contains significant quantities of uranium hexaflouride in process lines and various degraded containers. Adjoining the facility is a metal recovery operation, which is to be retained to support recycling of weapons parts. Both facilities share a common ventilation system that is contaminated with various uranium isotopes, including U-233.

After consultation with the DOE field office, it was determined that the appropriate level of readiness evaluation appropriate for the facility deactivation was an ORR. This level of readiness evaluation was selected for the following reasons:

- The facility contained significant quantities of dispersible hazardous substances, including radioactive materials, contained in aged, degraded, and non-criticality-safe containers.
- The process of removing materials from the facility was complex, since much of the material was contained in numerous process lines and in a ventilation system.
- The facility undergoing deactivation, as well as the adjoining metal recovery operation, contained classified quantities and configurations of materials.
- The deactivation project represented the first major disposition project at the site.

Example 15: Ensuring Adequate Task Hazard Analysis and Pre-Job Briefings to Fully Identify Hazards

A work task involved the installation of a temporary enclosure for asbestos abatement consisting of double plastic attached to wooden 2 inch x 4 inch framing. The enclosure consisted of panels that were glued together to form a seamless barrier. This glue produced a volatile off-gas during drying. This volatile off-gas was to be controlled by the operation of the temporary exhaust system, which was attached to the enclosure.

During the installation, the workers inside the enclosure noted that the temporary exhaust separated the plastic panel seams before the glue dried. To prevent this, the temporary exhaust was shut off. During a routine inspection, a safety technician noted that the exhaust was not operating, but worker activities were continuing, including the use of unshielded electric drills to attach wooden framing. A portable explosive gas monitor was used by the technician to determine the presence of volatile gases. The measurement was off-scale. The technician ordered an immediate cessation of activities and evacuation of the area. The temporary exhaust was restarted and the plastic seams began to separate again. A review of this event revealed the following:

(1) The task hazard analysis had addressed the volatile off-gas condition and the temporary exhaust was provided to mitigate this condition. However, the use of unshielded electric motors in this environment had not been identified.

(2) The workers had not been briefed adequately on the hazards presented by the volatile off-gas nor on the importance of maintaining adequate ventilation during the drying of the glue, resulting in a potentially explosive atmosphere.

FEEDBACK AND IMPROVEMENT

Example 16: Self-Assessments Lead to Discovery of Deficiency

A quarterly self-assessment indicated that workers were being exposed to higher than expected levels of airborne contamination when performing apparently routine decontamination of an area within a surplus plutonium facility. As part of the self-assessment, the readings from building constant air monitors (CAMs) were reviewed and the information was analyzed for trends. Although no worker had been exposed to levels above DOE limits contained within 10 CFR 835, it became apparent that the levels from this area were consistently higher than any other area within the building. Accordingly, an investigation team, comprised of the cognizant engineer, a health physicist, and a worker, assembled to determine the cause and develop an approach to bring the exposures to ALARA. The results of the investigation indicated that the building HVAC system contributed to the formation of fugitive dust by allowing contamination to be continually resuspended. Three alternatives were proposed to correct this situation: (1) discontinue activities within the area; (2) have workers wear respiratory protection equipment while performing work within the area; and (3) the preferred alternative of reducing the forced air into the area by installing an in-line damper. Option three was implemented and the CAM within the area was monitored closely for the next two weeks and was found to be within expected acceptable values.

Appendix C

ISMS Guidance

ISMS GUIDANCE

This appendix provides general guidelines on Integrated Safety Management System (ISMS) that are organized according to the five ISM core functions. This information provides a general framework for meeting facility disposition and environmental restoration related requirements in DOE 430.1B. Guidelines are provided in a checklist format to provide ease of use for project managers and their team members. It should be noted that these guidelines should flow down to all levels of contractors.

Action Completed (Yes/No)	ISMS GUIDELINES FOR FACILITY DISPOSITION AND ENVIRONMENTAL RESTORATION
DEFINE THE WORK SCOPE	
Integrating ES&H Considerations into Work Planning Activities	
	A multidisciplined project team, including Project Management, IH, Industrial Safety, Construction Safety, Health Physics, Facility Safety, Emergency Preparedness, Fire Protection, Waste Management, Environmental Protection, regulators, and workers, as appropriate, evaluates available facility data (e.g., budget, schedule, existing ES&H documents, and ORPS data) and provides input to the development of a project plan.
	The project plan defines ES&H requirements and standards, performance measures and metrics, ISM approach, ES&H authorities and responsibilities, and safety management strategy.
	Stakeholders' issues/expectations are identified, clearly understood, and reflected in project planning activities.
	The project plan specifies an approach for ensuring that subcontractor ES&H programs are adequate, in place, and monitored.
	For decommissioning projects, an evaluation is made of the CERCLA non-time-critical removal action provisions (Policy on Decommissioning Department of Energy Facilities Under CERCLA," May 22, 1995 joint memorandum from Steven A. Herman (EPA), Elliot P. Laws (EPA) and Thomas Grumbly (DOE) to U.S. EPA Regional Office and U.S. DOE Operations Offices) and a strategy is developed for integrating ES&H activities, documentation, and review and approval required by DOE directives.
	Work packages are prepared during the planning of specific work tasks, using first-line supervisors, workers, and safety personnel. Work packages provide details regarding proposed work scope and methods; identify task hazards; specify required training, necessary work permits, and appropriate controls for worker protection; and specific appropriate emergency response actions. Work packages should be screened against the approved facility safety basis.
Resource Planning	
	Resources are effectively allocated to address ES&H, programmatic, and operational considerations. Protecting the public, workers, and environment is a priority when activities are planned and performed (i.e., S&H risk of the workers, public, and the environment will not be compromised, with a high priority placed on managing and reducing risks in the workplace, as well as reducing risks to the public and the environment).
	ES&H support required for the project work scope and the associated skill mix and funding required to adequately provide this support is identified.
	Site/project ES&H issues and vulnerabilities, including personnel, skill mix, and funding issues, are identified and strategies for addressing these issues are presented.
ANALYZE HAZARDS	
Hazard Identification and Characterization	
	All relevant information describing the facility and hazards is collected. Valuable sources include existing Documented Safety Analyses, Health and Safety Plans, Environmental Impact Statements (EISs), Environmental Assessments (EAs), permits, waste management plans, waste analysis plans, contingency plans, design documents, operational records, purchasing records, MSDSs, medical and environmental reporting data, and Unusual Occurrence Reports (UORs), CERCLA preliminary assessments/site investigations and RCRA facility investigations

Action Completed (Yes/No)	ISMS GUIDELINES FOR FACILITY DISPOSITION AND ENVIRONMENTAL RESTORATION
	Current and past facility employees are interviewed, as appropriate, to gather information not evident from document reviews.
	Walkdowns are performed using a multidisciplined project team to assess and confirm existing facility conditions and inherent hazards.
	A determination is made on the need for additional characterization based on the level of uncertainty regarding knowledge of hazards (e.g. hazardous substance type, form, quantity, and locations) and data quality objectives.
	Planning assumptions, such as planned work scope and end-points, are confirmed or modified as appropriate, based on the additional information gained from facility hazard identification and characterization.
	Intrusive characterization activities are performed, as necessary.
	Provisions are in place to protect workers performing facility walkdowns and characterization activities. For decommissioning projects, a characterization HASP is prepared where required by 29 CFR 1910.120.
	A hazard categorization is performed in accordance with 10 CFR 830, Subpart B, and DOE-STD-1027-92 for facilities with radiological hazards.
Facility Hazard Analysis	
	A determination is made on whether existing hazard analyses can be used for current disposition activities based on the current scope of activities and the past safety basis.
	A hazard analysis is performed by a multidisciplined team comprising (on an as-needed basis) specialists in radiological, chemical, biological, and physical hazards, as well as facility management, safety specialists, engineers, environmental protection specialists, and facility disposition workers.
	The analysis evaluates the hazardous substance types and their related inherent harmful characteristics, quantities and concentrations, form, location, and exposure mechanisms.
	The safety basis is updated and kept current. The need for updates should be triggered by changes in facility disposition phases, new hazards or changes to energy sources, and changes to assumptions or commitments related to the safety basis. Previously conducted hazard analyses should be made available for project team use.
	The analysis is used as the common starting point for development of the appropriate hazard analysis document (e.g., DSA or HASP), as well as emergency planning strategies.
	The results of the integrated hazard analysis should be used as one of the inputs to the analysis required by the NEPA process.
Task Hazard Analysis	
	A task hazard analysis is conducted for specific disposition work tasks and uses the facility analysis information as the starting point, as well as an evaluation basis for the MOC process.

Action Completed (Yes/No)	ISMS GUIDELINES FOR FACILITY DISPOSITION AND ENVIRONMENTAL RESTORATION
	Workers, first-line supervisors, and safety personnel are involved in walkdowns of the work on an as-needed basis to review the steps associated with a task and to identify the hazards associated with the workplace and the chosen work methods.
DEVELOP AND IMPLEMENT HAZARD CONTROLS	
Worker Safety Controls	
	ES&H requirements/standards, including controls stemming from baseline documentation and commitments, are effectively translated into work procedures and instructions. The strategy for establishing safety controls for facility disposition workers is consistent with the hierarchy specified in DOE O 440.1.
	Operational safety commitments for each work method are clearly identified and reflected in the task work plan or package.
	Personnel qualifications and training requirements are derived from the hazard analyses and are clearly specified in work packages.
	Task sequences, prerequisites, and hold points related to ES&H are documented in the work package.
Facility Safety Controls	
	An evaluation is made based on the hazard analysis results and planning data for the facility safety controls needed during disposition activities. Existing safety controls may be retired during the course of a disposition activity when the hazardous condition being controlled is no longer present, the hazardous substances are no longer present, the substance's form has changed to a less dispersible form, or the quantity of substance has been reduced to a level where the consequences of potential exposure no longer present a concern.
	Establishment of safety controls considers uncertainties in material inventories or hazardous conditions and uses conservative assumptions in designating controls.
	Hold points are established for conducting characterization or additional analysis to determine if the condition warrants establishing or changing a safety control.
	Assumptions pertaining to location, forms, or quantities of hazardous substances are sufficiently conservative to ensure that safety is not compromised before or during characterization activities.
Safety Basis Documentation	
	Safety Basis documentation clearly reflects disposition work scope and anticipated hazards and their associated controls, including safety equipment functional and performance requirements, as well as administrative controls and programmatic commitments.
	Approval of the safety basis documents has been secured consistent with designated Program Secretarial Officer's delegation of authority protocols as well as site protocols.
	Information needed to be included in worker training related to controls, commitments, or operating limits has been clearly documented and transferred to the person or organization responsible for creating the training module(s).

Action Completed (Yes/No)	**ISMS GUIDELINES FOR FACILITY DISPOSITION AND ENVIRONMENTAL RESTORATION**
	Safety basis documents that exists from previous phases of facility or environmental restoration operation or disposition is evaluated and used only when the following information is provided: (1) a description of the site and location, including current facility and site boundaries; (2) design criteria for those safety structures, systems, or components (for nuclear facilities, safety class and safety-significant equipment are defined by DOE-STD-3009-94) needed to support safe facility disposition work; (3) normal and emergency operating procedures based on a hazard analysis that is still representative of planned future work; and (4) operational limitations to address existing facility vulnerabilities.
Environmental Permits	
	For deactivation, long-term and environmental restoration S&M projects, the need for required environmental permits (e.g., RCRA and CAA) has been determined and the needed permits have been obtained and mechanisms are in place to ensure that the work complies with the permit provisions.
	For decommissioning and environmental restoration projects, the need for required environmental permits (e.g., RCRA and CAA) has been determined and the substantive aspects of applicable permits have been incorporated into the set of ARARs that are determined for the project.
PERFORM THE WORK	
Evaluating Readiness	
	A readiness evaluation is conducted that ensures all hazards have been identified, S&H requirements have been met, and safety systems and controls are in place and functional.
	Workers are qualified to perform the required task(s) and understand the associated hazards and controls.
	Applicable environmental permits and procedures are in place and controls are operable.
	Work authorization is obtained.
	Verification of the resolution of applicable readiness assessment findings is completed.
Management of Change	
	A change control process should be employed that evaluates changes to work plans, procedures, and effects from unforeseen hazards. The process should encompass screening all changes, the evaluation of changes to hazards and controls, verification that the changes are within the existing safety basis, and specification of actions necessary if a change is outside of the safety basis.
	For category 2 or 3 nuclear facilities, tasks are screened against the seven questions defined in DOE G 4242.1-1 to determine whether they represent a potential USQ.
FEEDBACK AND EVALUATION	
	Feedback mechanisms are in place and include monitoring and self-assessment.
	Performance monitoring reflects appropriate and measurable ES&H indicators and measures that encompass integrated safety management activities.
	Self-assessment of the ES&H program is performed periodically and includes an evaluation of both management commitments and worker involvement.

Action Completed (Yes/No)	ISMS GUIDELINES FOR FACILITY DISPOSITION AND ENVIRONMENTAL RESTORATION
	Procedures, processes, and items that do not meet established requirements are identified, controlled, and corrected. Corrective actions include identifying the causes of problems and preventing recurrences.

Appendix D

Inactive Waste Site Criteria

INACTIVE WASTE SITE CRITERIA

This appendix provides program guidance with defined criteria on Inactive Waste Sites issued by the Office of Environmental Management. The guidance is based on results of generic hazard analysis and supporting categorization used to downgrade inactive waste sites throughout the DOE complex.

When specific criteria are satisfied, an inactive waste site may be downgraded below Hazard Category 3 and, therefore, not subject to the requirements of 10 CFR 830, Subpart B.

Department of Energy
Washington, DC 20585

September 17, 2002

MEMORANDUM FOR DISTRIBUTION

FROM: JESSIE HILL ROBERSON
ASSISTANT SECRETARY FOR
ENVIRONMENTAL MANAGEMENT

SUBJECT: Hazard Categorization of EM Inactive Waste Sites as Less Than Hazard Category 3

Environmental Management (EM) is responsible for a large number of inactive waste sites. These inactive waste sites exist primarily at the following Department of Energy (DOE) sites: Fernald, Hanford-RL, INEEL, Nevada Test Site, Oak Ridge, and Savannah River. Other sites that have, or will have, inactive waste sites as a result of decommissioning include Hanford-Office of River Protection, Rocky Flats, and some of the DOE national laboratories.

The nuclear safety rules in 10 CFR Part 830, Subpart B require hazard category 1, 2, and 3 DOE nuclear facilities to have a safety basis. Contractors responsible for such facilities are required to perform work in accordance with the safety basis and the hazard controls to ensure adequate protection of workers, the public, and the environment. DOE nuclear facilities categorized as less than category 3 are not subject to the safety basis requirements. A facility, activity, or operation can be categorized as less than hazard category 3 if it has no potential for significant off-site, on-site, or local consequences consistent with the standard DOE-STD-1027-92, Change Notice 1, as required by 10 CFR 830.202(b)(3). The standard describes a methodology for categorizing a facility, activity, or operation based on a hazard analysis that considers material inventories, material form, dispersibility, and interaction with energy sources.

At an EM workshop near the Rocky Flats Site on April 23-25, 2002, DOE and contractor representatives from EM sites studied EM's current inactive waste sites in light of the criteria for hazard categorization in accordance with the standard. The workshop participants developed a definition of an inactive waste site proposed for use in hazard categorization (Attachment 1) and described the physical features and controls common to EM inactive waste sites (Attachment 2). The workshop participants concluded that in light of their similar safety features, operational characteristics, and minimal hazard potential, most EM inactive waste sites could qualify to be categorized as less than hazard category 3. The basis for the proposed final hazard categorization is presented in Enclosure 3 and the supporting calculations and assumptions for Hanford site used to derive dose consequences are shown in Attachment 4. These attachments may only be used for the purposes of the hazard categorization in this memorandum, using site-specific assumptions in Attachment 4.

Based on the analysis from the workshop and in accordance with Section 9.3.2 of DOE M 411.1-1B, *Safety Management Functions, Responsibilities, and Authorities Manual*, which assigns the responsibility to approve the final hazard categorization to the Cognizant Secretarial Officer, I hereby categorize EM inactive waste sites as below hazard category 3 nuclear facilities provided that the following terms and conditions are verified and documented:

1) The site must meet the definition of an inactive waste site in Attachment 1;
2) The site must be regulated under currently-binding RCRA permits, orders, or agreements pertaining to mixed waste, and/or currently-binding CERCLA regulations and agreements;
3) The site must have in place hazard controls that are identified in Attachment 2;
4) The site must not have identified hazards or conditions that exceed the hazard analysis assumptions presented in Attachment 3 and 4.

The hazard categorization package developed to verify and document the above terms and conditions must be approved by you. By December 15, 2002, please notify me which of your inactive waste sites were categorized and approved according to this memorandum. The Office of Safety, Health and Security (EM-5) will work with your safety basis points of contact to provide the format for your notification.

If you have any questions, please contact me or Ms. Sandra Johnson at (202) 586-0651.

Attachments

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September 17, 2002 (2:31PM)

Attachment 1 to EM-1 Memorandum
on Inactive Waste Site Categorization

Inactive Waste Site Definition

For the purpose of this attachment, "inactive waste sites" are sites covered with a soil or other engineered barrier as required by RCRA[1] and/or CERCLA requirements and subject to physical access as required by HAZWOPER and 10 CFR 835. Hazardous or radioactive materials may be in a general soil matrix as a result of liquid discharge or spill, legacy burial grounds, or in areas that contain contaminated equipment, pipes, or other items disposed of at the waste site. Physical features preclude the introduction of an energy source capable of dispersing the radioactive material.

Intrinsic to this description are the passive and administrative features, described in Attachment 2, that preclude intrusive activities, control access, and provide barriers to the release of radioactive material to the above-ground environment. Once environmental remediation activities commence or other intrusive activities are initiated, the waste site no longer meets the description of an inactive waste site.

The following items are specifically *not* included in the definition of inactive waste sites:

1. Above ground structures or containers.
2. Below-grade facilities/structures with human access or active provision of services (e.g., electricity, ventilation, steam), including tanks.
3. Any intrusive activity of the waste site (e.g., waste sampling, acceptance or retrieval activities).
4. Above-ground remediation activities for an inactive waste site (e.g., pump and treat facilities adjacent to an inactive waste site).
5. Evaporation ponds and sludges.
6. Waste sites that could contain fissile such that there is a potential for a criticality hazard because of water intrusion or material rearrangement (see supporting rationale in Attachment 3).
7. Waste sites that could contain explosives, or chemicals that might react with sufficient energy to cause a significant release (see supporting rationale in Attachment 3), and
8. Unvented tanks, unless demonstrated that there is no potential to exceed tank bursting limits from overpressurization (see supporting rationale in Attachment 3).

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[1] While it is recognized that RCRA does not statutorily apply to radiological constituents of hazardous mixed wastes, RCRA controls applied to the regulated hazardous constituents provide the same controls for co-located radiological hazards. Therefore RCRA regulation is included as an alternative regulation in the definition of inactive waste sites. It is appropriate to consider either regulation under RCRA or CERCLA as a condition of inactive waste site.

Attachment 2 to EM-1 Memorandum
on Inactive Waste Site Categorization

Inherent Physical Features and Controls Provided at Inactive Waste Sites

Inactive waste sites (IWSs) are subject to physical features and controls that afford protection to workers, the public and environment. These protective measures are already in place for IWSs, as mandated through various statutory and regulatory requirements. As listed below, provisions include passive safety features as required by CERCLA/RCRA; safety oversight and review of proposed risk management strategies that are applied to IWSs as required by EPA and local/state regulatory agencies; worker safety controls and physical access requirements as required by 29 CFR 1910.120 (HAZWOPER); and radiation protection controls such as work permits, posting and monitoring that is required by 10 CFR 835.

1. Inherent Physical Features

The soil overburden physical characteristic of an IWS provides an inherent control from release of hazardous materials. The soil overburden either exists naturally or as an engineered barrier. Engineered barriers may consist of differing soil types (i.e., clay or sand), riprap, an asphalt or cement cap, or a combination of these features. Depending on the site, RCRA or CERCLA may indicate the need for an engineered barrier designed to protect against water or biota intrusion. These forms of cover provide the following protective measures for the public, workers, and environment.

- **Shielding.** Radiation dose reduction due to shielding. Soil overburden prevents most, if not all, significant exposure to nearby workers. Additionally, 10 CFR 835 provides a regulatory mechanism to ensure any needed additional level of protection is identified and appropriate measures taken.
- **Intrusion Barrier.** Protection from external energy sources. The wastes in the IWS are protected from impact by energy sources commonly considered for above ground structures, e.g., facility fires, electrical, hot work, range fires, local flooding, impact due to common carriers (vehicles, trains, planes), or falling objects. To expel significant levels of waste, sources of energy would need to act below the soil overburden rather than merely impacting the soil cover. The soil overburden also provides a barrier against unintentional intrusive activities. These waste sites are clearly marked. Intentional excavation is required to defeat the barrier. In addition, if an engineered barrier exists, this provides additional protection that requires extensive effort to penetrate.
- **Containment.** The soil cover provides a level of containment to prevent surface release. Normal dispersive mechanisms are not significant concerns. Wind transport is precluded and water runoff is precluded or reduced from affecting the hazardous radiological inventory.

- **Confinement**. If an accident condition is possible, the soil overburden provides a smothering effect on any dispersive events as well as filtration of gases and particulates.
- **Passive Barrier.** Soil overburden is passive. By definition, no external energy such as electrical, pneumatic, or hydraulic is required to maintain the barrier. Although this is a key feature, no worker actions are required for it to be fully effective. There is no mechanism to easily remove or distribute hazardous radiological inventory without intentional intrusive activities specifically designed to defeat the barrier. Potential migration of the waste inventory through environmental transport is addressed by RCRA/CERCLA.

2. Site Level Institutional Programs

Inactive waste sites are located on DOE property and are not readily accessible to the public. They are also subject to physical access controls as required by 29 CFR 1910.120 (HAZWOPER) and 10 CFR 835. Both regulations require identification and control of safe work zones (e.g., based on levels of hazardous/radioactive materials present). These measures provide additional buffers against potential disturbances or unauthorized intrusive activities that are required to gain access to radiological or hazardous materials.

3. Work Control Process

Workers are precluded from conducting activities that may disturb an IWS through mechanisms provided by established work control systems. These include processes for work authorization and the development and implementation of hazard controls in accordance with integrated safety management system requirements (i.e., as required by 48 CFR 970.5223-1). Using the Integrated Safety Management System, work activities (i.e., routine surveillance and maintenance) must be planned prior to personnel access, worker hazards must be identified and appropriate protective measures must be established. Additionally, work control measures invoked by 29 CFR 1910.120, 29 CFR 1926.65 and 10 CFR 835, ensure that hazardous/radiological material controls will be established to minimize potential personnel exposure, minimize the potential for release of materials to uncontrolled areas, provide for appropriate training (i.e., radiological and HAZWOPER) to personnel, and ensure that monitoring for any changes to IWS hazards is accomplished.

4. Radiation Protection Programs

The Occupational Radiation Protection Final Rule, 10 CFR 835, provides requirements and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Standards are established for personnel monitoring, area posting, entry control, radioactive contamination control, and training of personnel. These requirements and standards are implemented through management and administrative processes that control potential access and work activities within areas that meet the criteria established by 10 CFR 835. Inactive areas are posted with the identified radiological hazard using the criteria of 10 CFR 835, Subpart G, Posting and Labeling, and periodically monitored to verify radiological conditions during inactive periods. All personnel entering a Radiological Control Area receive minimum training on the potential presence of radiological conditions and basic training on radiological hazards and posting that may be present. Entry into Radiological Areas requires additional training commensurate with the radiological hazards.

Requirements that are particularly relevant to an IWS are as follows:

- Individual and area monitoring where necessary (Sections 835.402 and 835.403)
- Entry control for radiological areas (Subpart F)
- Posting and labeling requirements (Subpart G)
- Proper creation, maintenance, and final disposition of monitoring and administrative records (Subpart H)
- Training (Subpart J)
- Design and workplace controls to maintain doses ALARA (Subpart K, especially Section 835.1003)
- Requirement for routine internal audits (Section 835.102)
- Occupational dose limits (Sections 835.202, 835.206, 835.207, and 835.208)

In addition, self-discovery and reporting of potential violations of 10 CFR 835, and timely implementation of corrective actions, are prompted by Price-Anderson Amendments Act considerations in the same manner as for 10 CFR 830, since violations of 10 CFR 835 are also considered violations of nuclear safety rules.

5. RCRA/CERCLA Controls and Risk Assessment Process

The Resource Conservation and Recovery Act (RCRA) and corresponding state laws regulate the treatment, storage and disposal of listed and characteristically hazardous wastes and hazardous wastes mixed with radioactive components ("mixed wastes"). In addition, RCRA establishes "Corrective Action" requirements to respond to releases of hazardous/mixed wastes from solid waste management units. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes requirements for response to releases of hazardous substances, which include radioactive wastes. Independent regulatory oversight, that includes extensive state/EPA/local agencies, as well as public involvement, is inherent to RCRA as well as CERCLA.

Inactive waste sites as discussed herein, are subject to requirements imposed by RCRA, RCRA corrective action, and/or CERCLA. These requirements will be imposed at various stages in the life of the inactive waste site and, in general, will include the following attributes in accordance with the particular disposal or contamination circumstances of the individual site:

- Surface water monitoring;
- Ground water monitoring;
- Operation, surveillance, and maintenance of passive features such as caps, vegetative cover, slurry walls for containment, etc.

- Institutional controls to limit public access to the site and/or to limit use of the contaminated resource.

These requirements are formalized in legal commitments and agreements between the DOE facility and regulators (in some instances the contractor). These may take the form of:

- RCRA permit terms and conditions;
- RCRA corrective action orders and/or Corrective Action Decisions;
- CERCLA Records of Decision (RODs);
- Regulatory approvals of intermediate actions; and/or
- Federal Facility Compliance Agreements.

In addition, CERCLA Sec. 121(b) requires that, among other factors, both the short-term and long-term health and environmental risks be considered prior to selecting a remedy such as a long-term storage of radiological material in an inactive waste site as defined herein. This risk assessment evaluates risks to workers, the public and the environment and must include an evaluation of the threat posed by hazardous substances remaining on a site and the adequacy and reliability of any engineering or institutional control used to manage risks. (For additional detail, see the DOE Information Brief: *Assessment of Short-Term and Long-Term Risks for Remedy Selection,*" U. S. Department of Energy, CERCLA Information Brief, Office of Environmental Policy and Assistance, DOE/EH-413/9708 (August 1997).

As addressed in EPA guidance, "*Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Parts A, B and C)*," EPA/540/1-89/002, December 1989, the risk assessment process addresses potential pathways, quantification of potential radiation exposures, and quantification of risks. Such an assessment involves the identification of environmental media concern, the types of radionuclides expected at a site, areas of concern, and potential routes of radionuclide transport through the environment.

Finally, periodic reviews of the adequacy of RCRA/CERCLA controls are required. RCRA permits must be reviewed every five years. CERCLA also requires a reexamination of the selected remedy (including institutional controls) every five years.

Attachment 3 to EM-1 Memorandum
on Inactive Waste Sites Categorization

Final Hazard Categorization Summary for Inactive Waste Sites

1. Introduction

10 CFR 830, Subpart B requires that facilities with radiological inventory perform a hazard categorization in accordance with DOE-STD-1027. The standard prescribes an initial hazard categorization that is based on gross inventory comparisons to threshold quantities of Table A.1. A final hazard categorization is also permitted for refining hazard categorization results based on a hazard analysis that considers material form, dispersibility, and interaction with energy sources, but not consideration of engineered safety features (ventilation system, fire suppression, etc.)

Section 4 of DOE-STD-1027 addresses various considerations for an acceptable hazard analysis. Per the standard's guidelines for applying a graded approach, facilities that are low in complexity typically warrant simplistic, qualitative hazard analysis methods and techniques. The standard cites waste storage as a low-complexity operation for which release mechanisms are "intuitive or straightforward."

Based on these DOE-STD-1027 guidelines, a semi-quantitative hazard analysis has been developed for categorizing inactive waste sites (IWSs). Common safety features, operational characteristics, and hazard potential among inactive waste sites justifies the use of singular hazard categorization approach for inactive waste sites across the DOE complex, provided they meet the criteria of Attachments 1 and 2.

This document provides the basis for a complex-wide final hazard categorization for an inactive waste site. Supporting calculations and assumptions used to derive dose consequences are contained in Attachment 4.

2. Hazard Identification

Hazardous materials stored at inactive waste sites vary among DOE sites, but consist primarily of contaminated soils and low-level wastes (e.g., contaminated personnel protective equipment, machine parts, residuals, sludges). For the purposes of this final hazard categorization, bounding values of plutonium are estimated in some accident scenarios based on the highest concentrations that would be expected at the Hanford site. These values are much greater than that expected at the vast majority of inactive waste sites at other DOE sites. The hazard analysis results show that bounding assumptions used for radiological inventories provide a sufficient basis for determining a final hazard categorization.

3. Hazard Analysis Discussion

10 CFR 830, Subpart B provides the basic definition for a Hazard Category 3 (HC3) facility as having the potential for only "significant localized consequences." DOE-STD-1027 provides further interpretation of HC3 as "facilities that cannot have a significant radiological impact outside of the facility."

An inactive waste site is not technically a facility. However, for purposes of hazard categorization, impacts "outside" of an inactive waste site facility is interpreted to mean an event that has the capability to exhume and disperse materials above the ground. Dispersion of waste materials could conceivably be postulated through several pathways including ingestion (e.g., contamination of groundwater or vegetation), inhalation or direct exposure (e.g., where protective overburden is breached). In defining a "significant localized consequence" for Hazard Category 3 facilities, DOE-STD-1027-92 reflects these three pathways within the EPA model used to calculate threshold quantities. However, given the short-time duration (i.e., 24 hours) over which consequences are estimated, the inhalation dose typically bounds other pathways and gives the highest consequences. Therefore, this final hazard categorization document focuses primarily on those events that have potential to uncover buried wastes and disperse materials to potential receptors above ground.

In order to create a radiological release of any significance at an inactive waste site (i.e., 10 rem at 30 meters as defined for HC3), an accident event would have to take place that possesses the following characteristics:

(1) An initiator would need to be of sufficient magnitude to penetrate into the ground to a depth necessary to impact a radiological source;
(2) A significant amount of energy would need to be imparted to a highly concentrated radiological inventory; and
(3) The radiological source would need to be dispersed in a sufficient amount that results in a significant localized consequence.

Given that inactive waste sites are "inactive" and no intrusive remedial activities are being conducted, there are no operational or process-related initiators of concern that would breach the protective overburden and expose hazardous/radioactive materials. Rather, initiators are limited to a small set of internal initiators and external man-made and natural phenomena events. A summary of the categories of hazards considered is presented in Table 1.

Table 1- Consideration of Hazardous Events

Categories of Hazards	Specific Events	Considerations
Internal/Operational	Criticality due to water intrusion or contamination movement	**Not Plausible** – Concentrations of fissile materials necessary for a criticality are not found at inactive waste sites. This event is analyzed in order to establish concentration limits that can be used to support inactive waste site definitions.
	Pressurization (e.g., from explosives)	**Not Plausible** – Explosives are typically not found at an inactive waste site. This event is analyzed in order to establish limits that can be used to support IWS definitions.
	Over-pressurization of storage tanks (e.g., gas generation)	**Not Plausible** – Hazardous tanks of this nature are typically not found at an inactive waste site. This event is analyzed in order to establish limits that can be used to support inactive waste site definitions.
	Fire	**Low consequence** –Material is below surface and there is a lack of oxygen to support combustion. Major forest and brush fires have occurred at inactive waste sites throughout the complex with no appreciable impacts on contaminated waste materials
	Loss of confinement	**Low Consequence**- No process initiators. Additionally, the consequences of this event would be bounded by aircraft impact or inadvertent penetration event.
External (Man-Made)	Aircraft Impact	**Low Consequence**- General aviation aircraft crash would be the only credible event. Typical ground penetration for GAA crash is three feet or less (see discussion). This is an analyzed event.
	Inadvertent Penetration of Surface (e.g., Digging)	**Low Consequence**- Event requires excavation of significant quantity of highly concentrated waste material followed by wind dispersion of exhumed materials. This is an analyzed event.
	Vehicle Impact	**Low Consequence**- Vehicle would have to significantly penetrate surface and result in a fire. The consequences of this event would be bounded by an aircraft crash, which has more velocity and greater impact angle for penetrating ground.
Natural Phenomena	High Wind/Tornado	**Not Plausible** – Material is below the surface. Significant crater would have to be created.
	Seismic	**Not Plausible**- Event would have to create large surface void and introduce fire ignition source. The consequences of such an event are bounded by "inadvertent penetration" event.

Bounding hazardous events presented in Table 1 are discussed below.

3.1 Criticality

The potential for a criticality involving fissile or fissionable materials in a soil matrix is driven by several factors including water content in soil, density of soil, and soil type. Based on various references or studies[1] performed for both uranium and plutonium, and assuming optimum conditions for these factors, ^{239}Pu concentration in soil above 2.5 g/L can be shown to present criticality concern. For ^{235}U, this concentration threshold is approximately 1.8 g/L. Studies have shown that calculations involving just ^{239}Pu or ^{235}U are conservative relative to typical mixtures of plutonium and/or uranium isotopes from reactor fuel processing. Concentrations of this magnitude are not expected at inactive waste sites. For example, as shown in the discussion below on inadvertent ground penetration, the ^{239}Pu concentrations (i.e., 0.7 g/L) associated with that scenario is below the critical concentrations shown above.

Another criticality hazard that must be considered is the potential for a concentrated mass that could potentially occur as a result of material rearrangement (i.e., seismic event or loss of integrity of containers) or water migration within the soil. Criticality mass limits are referenced in DOE-STD-1027 that provide thresholds for various fissile materials (i.e., 700 grams for ^{235}U, 450 grams for ^{239}Pu, and 500 grams for ^{233}U). Criticality would be of concern where there is a potential to actually concentrate fissile material into a critical mass that challenges the threshold quantities (i.e., as opposed to simply considering gross inventory over a relatively large area associated with an inactive waste site).

It is not expected that fissile materials within inactive waste sites could be sufficiently concentrated into a critical mass under conceivable phenomena that would be necessary to transport the materials from their stored locations. The relative immobility of plutonium and uranium species in a soil matrix precludes concentration due simply to migration resulting from water intrusion. For example, sampling of cribs at the Hanford facility's Plutonium Finishing Plant has shown that very little plutonium migration into the soil has occurred over time, even with almost continual water washing over it. Additionally, criticality safety evaluations for plutonium and/or uranium mixtures that are to be buried show that the waste remains subcritical even with optimum water moderation and reflection (e.g., water intrusion) and with no credit taken for the drum iron (e.g., loss of integrity). The analysis is performed to show that the double contingency principle is met.

The potential for fissile or fissionable materials to exceed the above assumptions for material rearrangement/water intrusion or concentration, as cited, should be used as a basis for inactive waste site definitions of Attachment 1. This includes the potential for assembling a critical mass or fissile or fissionable materials (e.g., ^{239}PU, ^{241}Pu, ^{238}Pu,

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[1] Hanford memo of July 11, 1977 (Roecker to Elgert dealing with 241-Z-361 Tank criticality safety issue) indicates maximum subcritical concentrations of Pu in dry soil as low as 2.5 g/L. A study provided in the Proceedings of the Topical Meeting of the Nuclear Criticality Safety Division, "Criticality Safety Challenges in the Next Decade," September 7-11, 1997 indicate minimum critical concentrations of U^{235} in dry soil can be as low as 1.8 g/L (Calvin Hopper and Cecil Parks).

^{244}Cm, ^{233}U, ^{235}U, etc.). For conservatism, spent reactor fuel rods or assemblies should also be excluded in the inactive waste sites definition.

3.2 Internal pressurization

It is conceivable, but unlikely that inactive waste sites contain explosives or chemicals that could react rapidly creating a rapid pressure increase within the soil, and suspend contamination. Equations 5.23 and 5.24 of DOE/TIC-11268, *A Manual for the Prediction of Blast and Fragment Loading on Structures* show that, at 5 ft beneath the surface, it takes the ignition of 10 lbs of explosives to create a crater. Ignition of less than 10 lbs of explosives forms a camouflet (a below grade void) with little environmental release. Figure 5.15 of the stated DOE manual shows that 10 lbs of explosive ignited 5 ft below the surface results in a crater having a volume of 125 ft^3. The ignition of 40 lbs of explosive yields a crater having a volume of 400 ft^3.

The respirable release quantity is given by DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* as 0.2 times the quantity of TNT involved in the accident or 2 lbs of TNT in this case. The respirable release fraction is given by:

$$RRF = (0.2*10 \text{ lbs}) / (125 \text{ ft}^3)(106 \text{ lb/ft}^3) = 1.5 \times 10^{-4}$$

where 106 lb/ft^3 is the soil density (based on 1700 kg/m^3). While not all of the respirable release is contaminated material, the quantity released is greater than that from inadvertent excavation to be shown later. Therefore, to be conservative an inactive waste site that might have as much as 5 lbs of explosives or chemicals that might react so as to yield similar releases as 5 lbs of TNT equivalent should be excluded from consideration as an inactive waste site defined in Attachment 1.

3.3 Storage Tank Overpressurization

It is conceivable that an IWS may contain buried tanks with waste that could be generating gas. If these tanks are not ventilated, the pressure might build up to the point that the tank ruptures. It is also possible that, if the gas is flammable, an ignition source might develop and ignite the gas, causing the tank to rupture. It was shown above that the equivalent of 10 lbs of TNT ignited 5 ft below the surface could create a crater and a large respirable release. There are well known methods to determine the TNT equivalent for bursting vessels (see Section 6.3.3.1 of *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires and BLEVEs).* The equations require knowledge of the tank volume and burst pressure (which is a function of the volume, the wall thickness, and tank shape). Tanks that are vented will not pressurize to the point of bursting. Therefore non-vented tanks that have the potential to burst at conditions that generate the equivalent of 5 lbs of TNT (using similar assumptions as discussed in the internal pressurization event) should be excluded from consideration as an IWS defined in Attachment 1.

3.4 Aircraft Crash Evaluation

An aircraft crash that has the capability to penetrate an inactive waste protective overburden, create a sizeable crater, and disperse a high-octane gasoline that results in a fire is one of the most damaging events that can be postulated for an inactive waste sites. Such an event would need to involve an aircraft that has large enough mass, velocity and high impact angle to inflict significant damage.

With the exception of Rocky Flats Environmental Technology Site[2], EM's inactive waste sites are not located near airports, and therefore crashes from airport operations (i.e., takeoffs and landings) are not considered credible. For non-airport operations, Table B-15 of DOE-STD-3014-96, *Accident Analysis for Aircraft Crush into Hazardous Facilities* lists the probabilities per unit area of an air carrier, air taxi, large military craft, and small military crashes (i.e., high mass or high velocity aircraft). These values are presented for all DOE sites. The most restrictive value of any aircraft at the worst case DOE site is 2 E-06 crashes/mi^2/year. Inactive waste sites can cover large areas, so a value of 20 acres (0.03124 mi^2) was considered to be a reasonable bounding size of an inactive waste site. Multiplying this area by the crash probabilities per unit area indicates the annual probability of commercial and military crashes from non-airport operations is 6.2 E-8, and therefore is considered credible.

DOE-STD-3014-96 lists the maximum probability for a general aviation aircraft (GAA) crash per unit area for non-airport operations at a DOE site as 3 E-3 crashes/mi^2/year. These aircraft have relatively low mass and velocity when compared to commercial or military aircraft. Using the area of 20 acres, this would place the annual probability at 9.4 E-5. Therefore, this event was considered a credible, though extremely unlikely, event for an inactive waste site.

A GAA crash would have to penetrate an inactive waste site protective overburden in order to impact and disperse underground waste materials. Empirical studies or test data could not be found for modeling or predicting GAA crash damage. However, a search of the National Transportation Safety Board (NTSB) accident analysis database[3] was performed for GAA crashes involving fatalities. A sample of accidents for the five-year period between 1997 to 2002 showed that roughly 60% of GAA crashes resulted in impact craters that were one foot in depth or less. Another 33% were two feet or less and 7% of crash impacts were three feet or less. No impacts into soil were found beyond three feet in depth.

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[2] Since RFETS is near Jeffco Airport, the frequency of an aircraft crash from airport operations is higher than other sites. The only inactive waste site located at RFETS is Pad 903 (asphalted contaminated soil with Pu machining oils) which is 100 m by 100m. Using a crash rate of 1.0E-3/mi^2/yr (based on Kaiser-Hill recalculating the data for the Denver metro area), the crash rate probability is 3.2E-6/yr.

[3] NOTE: Data was based on search of GAA accidents involving a fatality for specified five-year period using search word "crater." A total of 150 accidents were identified and results were compiled from those investigations in which crater specifications were given (about 62% of accidents reported).

Inactive waste sites that meet the definitions and criteria of Attachments 1 and 2 have inherent physical barriers such as soil overburden or engineered caps which have to meet pedigrees established by CERCLA or RCRA. These features must be established in order to reduce hazardous material risks (public, environment, and workers) to acceptable levels as negotiated with EPA and local/state regulators. The depth of protective overburden/caps provided at DOE sites varies depending on risks presented by waste materials and regulatory specifications. As an illustration:

- The Savannah River Site must provide overburden protection of around six feet to ensure their caps can resist wildlife intrusion.
- The Nevada Test site must have protective overburden of between 8 to 10 feet.
- Hanford site is in the range of five feet or greater of overburden.
- Oak Ridge site is in the range of five feet or greater of overburden.

Using the general assumption that protective overburden is at a sufficient depth that meets regulatory risk goals, and assuming a maximum size crater of around three feet deep that could be created by a GAA crash, it is not expected that such an event would inflict sufficient energy on soil terrain to disperse underground waste materials. Therefore, consequences from this event are considered negligible.

3.5 Inadvertent Penetration of Ground Surface

Consideration was given to an inadvertent ground penetration associated with two possible events. For each event, scenarios were postulated for three separate contamination areas that included (1) a highly contaminated crib; (2) a large spill site (e.g., leakage from a transfer line at Hanford Tank Farms); (3) a small concentrated spill site (e.g., drum spill). The crib inventory bounds that expected from a large or small spill site and is therefore carried forward in this evaluation.

The first accident initiator considered is wind blown erosion over a contaminated site. In this accident, the site either was uncovered by some mechanism or was inadvertently not covered when the contamination occurred. The resuspension is assumed to continue for 24 hours. The large waste site and small waste site are covered by this accident. The contaminated portion of a crib is typically around 1.5 meters below the soil surface. Therefore, it is not considered credible for a crib to become entirely uncovered by wind erosion.

The second accident is inadvertent digging of a test pit into a crib for soil characterization. It should be noted that this is not an allowed activity under the definition of an inactive waste site. It is included here to provide perspective on a worst case situation. This event would typically be controlled through a new safety evaluation and associated safety basis document. However, for the purposes of this hazard categorization it is assumed that this inadvertently occurs at an inactive waste site. The pit is assumed to be 2 m in diameter and 6 m deep (typical size). The contamination starts 1.5 m below the surface and extends to 6 m. The volume of contaminated soil is

14 m^3 or 18 yd^3. The excavated material is assumed to be placed in a layer 1 m deep all around the pit. The total amount of soil brought to the surface is 19 m^3. The ring of soil is 5.3 m in diameter (22 m^2). The number of loads dumped is 18. It is assumed that the bucket of the backhoe has a 1 cubic yard capacity. [Note: typical excavation of this volume associated with a test pit would take several weeks because of regulatory oversight restrictions].

In order to determine a bounding material at risk for Scenario 2, the soil is assumed to be contaminated at a similar level to the Hanford Z-1A Crib. This represents the highest expected plutonium concentrations for inactive waste site at the Hanford site. Information from the Z-1A crib shows that the greatest concentration of ^{239}Pu was 24,000 n Ci/g at 10 ft below the surface (data from PNNL-11978, *Results of the 1998 Spectral Gamma-Ray Monitoring of Boreholes at the 216-Z-1A Tile Field, 216-Z-9 Trench and 216-Z-12 Crib*). This value equates to 4 x 10^{-4} g Pu/g soil, using a specific activity of 0.062 Ci/g or 0.66 g Pu per liter of soil using 1700 g/L as the soil density. Since this value is similar to that from the Z-9 crib, a concentration of 0.7 g Pu per liter (assumes 6% ^{240}Pu) of soil will be used in the analysis for re-suspension off of or dumping of soil excavated from a crib.

This concentration is reasonable for a crib that received waste from fuel reprocessing plants. It is overly conservative for waste sites that involved spills. By comparison, RPP-10773, *Compressed Gas Accident Parametric Consequence Analysis*, Table 3-8 (page 3-32) provides a dose factor of 1 rem/g of soil or 1700 rem/L of soil based on the worst case documented Tank Farm spill (using a soil density of 1700 g/L). That soil had a concentration of ^{239}Pu of 3300 pCi/g or 10^{-4} g/L of soil.

Using these material inventory concentrations, dose consequences were calculated using analysis assumptions built into the EPA model that is used in DOE-STD-1027 HC3 thresholds. This includes a dose receptor distance of 30 meters, 1 m/s wind speed with D stability, X/Q value of 0.07 s/m^3 (receptor is in center line of plume), and resuspension of materials over a 24 hour period.

Release fractions were adjusted using Equation 4-5 of DOE-HDBK-3010-94, which provides a correlation for ARF based on drop height, mass, and density. The soil is assumed to spill from a height of 1 m. The average value of ARF for TiO_2 (a closer surrogate for soil than UO_2) was selected and is 10^{-4} for spills from 1 m. The corresponding value for RF is 0.6. Using these assumptions, the adjusted release fraction (ARF*RF) is 6 x 10^{-5}. This value is for a very dry oxide and is inconsistent with typical soil conditions, which, even for an arid climate such as Hanford's, ranges from 3-5% moisture content. DOE/RL/12074-30-2, *Dust Mitigation Study for the Environmental Restoration Disposal Facility*, p. 27 and AP-42, *Compilation of Air Pollutant Emission Factors, Fifth Edition*, Section 13.2.4.3 provides data for releases due to dumping soil containing moisture. Using emission rates provided in this study provides for an adjusted conservative value of 10^{-6}. This value is more appropriate for this application as it accounts for soil moisture and does not include surface contamination nor intensive remediation or decommissioning activities, which are precluded from the scope of this analysis. Similarly, use of Equation 4-6 was deemed appropriate for this scenario as it represents either pneumatic transfers or spills of minute quantities of soil during earth moving operations. Dumping bulk quantities of soil would not provide similar energetics or physical phenomenon. These values and assumptions have been peer reviewed and validated, based on discussions with Jofu Mishima.

Using the above conservative assumptions, maximum expected dose consequences are approximately 7 rem at 30 meters. This value is below DOE-STD-1027 HC3 values.

4. Conclusion

The inadvertent penetration event is the bounding event analyzed for inactive waste sites. Although consequences are approaching the general range of DOE-STD-1027 for Hazard Category 3, assumptions used in the postulation of this event were extremely conservative. These assumptions include defeating physical barriers or access controls that would be in place as a result of CERCLA/RCRA, HAZWOPER and 10 CFR 835 requirements; ignoring postings, work controls and permitting requirements of 10 CFR 835; excavation of a significant amount of material in a period of time that is much shorter than standard practices; and high conservatism within dose consequence estimates.

The ^{239}Pu concentrations that are postulated in the hazard analysis are considered the highest that would be expected at the Hanford site. Additionally, these values are much greater than that expected at the vast majority of inactive waste sites at other DOE sites. Further, although the bounding scenario only looked at ^{239}Pu, this is still conservative for the types of material that would commonly be expected at various inactive waste sites. For example, the threshold quantities for ^{239}Pu stated in DOE-STD-1027 for Hazard Category 3 are 2 E+5 greater than U^{235}. Other isotopes with higher specific activity than ^{239}Pu may be encountered, but not in the quantities evaluated in the inadvertent penetration scenario.

Therefore, it can be reasonably and conservatively assumed that DOE inactive waste sites do not present a significant localized consequence as defined by HC3 thresholds.

Attachment 4 to EM-1 Memorandum
on Inactive Waste Sites Categorization

Final Hazard Categorization Basis for Inactive Waste Sites for Inadvertent Ground Penetration Scenario

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[Note: This attachment is specific to hazards and conditions found at the Hanford site and is provided to give a perspective on maximally expected consequences associated with a ground penetration event. The event as postulated requires a series of activities that are extremely conservative, beyond currently accepted practices, and in violation of the definition of work permitted at an inactive waste site.]

1. Introduction and Summary

This report presents the final hazard categorization for inactive waste sites. Inactive waste sites include cribs, surface contamination areas, and below-grade contamination areas (e.g., transfer line leak). Work is not typically performed in these areas. Any intentional intrusion will be performed under an approved safety document. Waste sites undergoing active remediation and characterization efforts are not covered by this report.

These sites are contaminated with radioactive material. However, the radioactive material itself comprises a very small fraction of the contaminated area. The rest is soil. As a result, the wind entrainment (or resuspension) models are those used by the U.S. Environmental Protection Agency for similar sites. To be comprehensive, the wind entrainment models of DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, are also considered. Because the radioactive material has been present for a long time, much of it has been relocated to below grade by environmental factors or due to administrative procedures. As a result, the average concentration of radionuclides in soil is used. However, these averages were taken from bounding events.

Table 1 provides a summary of the results of the final hazard categorization of an inactive waste site. The data used in this analysis are shown in Table 2. The worst-case events involve digging a test pit into a crib.

Table 1. Summary of the Results.

Scenario Number and Description	Wind Speed, m/s	Exposure Duration, h	Site	Dose Factor, rem/L, soil	Dose at 30 m, rem
1. Wind over a contaminated site	1.0 1.0	24 24	Large Small	2×10^4 2×10^7	0.006 0.08
2. Test pit dug into a crib	1.0	24	Crib	2×10^7	7.0

Several conservatisms have been employed during this analysis:

- Dose conversion factors are based on ICRP 30 for consistency with past analyses. Use of the currently approved ICRP 68/71 values would reduce postulated doses by a factor of at least three.
- To account for uncertainty, the release fraction used has been rounded to the next nearest order of magnitude. This bounds uncertainties such as wind speed, shovel volume, and moisture content. This results in a factor of nine increase from the calculated value.
- Conservative resuspension rates are used from DOE-HDBK-3010 relative to those provided using EPA models. This results in a resuspension rate that is more than an order of magnitude greater.
- The scenarios do not address any of the features that are in place under separate regulation to prevent inadvertent intrusion, and when intrusion occurs, it is assumed that the intrusion occurs in bounding locations.
- The test pit scenario assumes that the dig was completed in one day. Test pits are normally dug over a several day period, and may take weeks to complete due to characterization data quality objectives.

Table 2. Data Used in Dose Calculations.

• Dose factors	
Crib	2×10^7 rem/L of soil
Large contaminated site	2×10^4 rem/L of soil
Small contaminated site	2×10^7 rem/L of soil
• ARF*RF due to dumping[a]	10^{-6}
• Resuspension[a]	4×10^{-3} g/m^2-h
• X/Q at 30 m	
X/Q based on Pasquill D meteorology per DOE-STD-1027-92[b]	
Dumping	X/Q = 0.07 s/m^3 based on 1.0 m/s wind
Resuspension	
Large site	0.02 based on 1.0 m/s wind
Small site	0.07 based on 1.0 m/s wind
Test pit	0.07 based on 1.0 m/s wind
• Site size	
Large site	800 m^2
Small site	7.3 m^2
Test pit	22 m^2
• Number of 1 yd^3 loads that are dumped	
Test pit dug into crib	18
• Receptor present for 24 hours according to DOE-STD-1027-92.[b]	

[a]DOE-STD-1027-92 allows use of U.S. Environmental Protection Agency models for ARF*RF and for resuspension.

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

2. Hazards

During the hazard identification phase, three types of contamination areas and two accident scenarios were identified. These scenarios address inadvertent intrusion or release of materials. The contamination areas are identified as a crib, a large spill waste site (e.g., like that from a large spill from a transfer line at the tank farms), and a small spill waste site (e.g., a drum spill).

The accident scenarios include contaminated soil dispersal from:

- Entrainment by the wind
- Inadvertent excavation for characterization (e.g., digging in the wrong place)

These last two events represent those ground penetration scenarios with the greatest likelihood of occurring. Radioactive material releases and the resulting dose consequences will be determined for these two scenarios for the three types of waste contamination.

The first accident type is wind-blown erosion over a contaminated site. In this accident, the site either was uncovered by some mechanism or was inadvertently not covered when the contamination occurred. The resuspension is assumed to continue for 24 hours. The large waste site and small waste site are covered by this accident. The contaminated portion of a crib is typically 5 ft below the soil surface. It is not considered credible for a crib to become entirely uncovered. Scenario 2 will cover the partial uncovering of a crib.

The second accident involves a test pit dug into the soil for characterization. The pit is assumed to be dug into a crib. The pit is assumed to be 2 m in diameter and 6 m deep. The contamination starts 1.5 m below the surface and extends to 6 m. The volume of contaminated soil is 14 m^3 or 18 yd^3. The excavated material is assumed to be placed in a layer 1 m deep all around the pit. The total amount of soil brought to the surface is 19 m^3. The ring of soil is 5.3 m in diameter (22 m^2). The area of contamination, assuming the top of the ring of soil that had been removed is covered with contaminated soil.

Scenario 2 also bounds a test well or borehole inadvertently sunk through contaminated soil. Assuming the well is 12 in. in diameter, the extent of contamination would have to be exceptionally long for the volume dumped by well drilling to exceed that discussed in Scenario 2.

3. Soil Contamination and Dose Factors

For the analysis involving the crib, the soil is assumed to be contaminated to the same extent as was the Z-9 Crib. The Z-9 Crib was the most highly contaminated crib, in terms of plutonium concentration, on the Hanford Site. ARH-2207, *216-Z-9 Crib History and Safety Analysis*, provides information regarding the Z-9 Crib. Liquid waste containing plutonium was discharged into this crib. Table 2 of ARH-2207 (p. 23) shows that the plutonium existed within the upper 2 to 3 ft of the soil. The maximum concentration was 25.4 g/L of soil. Below the upper 2 to 3 ft of soil, concentrations are much less (i.e., 0.06 to 1 g/L). The large concentrations of plutonium were removed from this crib, leaving soil with an average concentration of about 0.5 g Pu/L.

Information from the Z-1A Crib shows that the greatest concentration of ^{239}Pu was 24,000 nCi/g at 10 ft below the surface (data from PNNL-11978, *Results of 1998 Spectral Gamma-Ray Monitoring of Boreholes at the 216-Z-1A Tile Field, 216-Z-9 Trench and 216-Z-12 Crib*). This value equates to 4 x 10^{-4} g Pu/g soil using a specific activity of 0.062 Ci/g, or 0.066 g Pu/L of soil using 1700 g/L as the soil density. This value is similar to that from the Z-9 Crib. Therefore, a concentration of 0.7 g Pu/L of soil will be used in the analysis for resuspension off of or dumping of soil excavated from a crib.

The isotopic mix for weapons grade plutonium is taken from HNF-SD-CP-SAR-021, *Plutonium Finishing Plant Final Safety Analysis Report*. The data take into account americium buildup, which yields the following:

Isotope	Weapons-grade $6\%\ ^{240}Pu$	rem/ g (Class Y)
^{238}Pu	0.01	4.93×10^9
^{239}Pu	93.77	1.91×10^7
^{240}Pu	6.0	6.99×10^7
^{241}Pu	0.2	5.11×10^8
^{241}Am	0.14	1.52×10^9

The dose factor for weapons-grade plutonium ($6\%\ ^{240}Pu$) is 2.6×10^7 rem/g.

Weapons-grade plutonium is used in this analysis. The reason is two-fold. The data provided in HNF-SD-CP-021, Table 9-43 shows that 70% of the plutonium stored at the Plutonium Finishing Plant at Hanford is weapons-grade plutonium. This is indicative of the process history. The discharges to the crib also reflect that process history. Therefore, it is expected that the isotopic mix of plutonium in the crib is predominantly weapons-grade plutonium. Second, fuels-grade plutonium campaigns occurred later in the history of the facility. It would be expected that process improvements and increased environmental awareness would have resulted in relatively smaller discharges than would have been the case earlier in the history of the facility. This would result in the isotopic mix being even more reflective of weapons-grade plutonium. In addition, because of the conservatisms in the site size, plutonium concentration in the soil, and in the choice of ARF, the choice of a greater-than-average, but less-than-bounding, isotopic mix is reasonable.

The dose factor for cribs is found as follows:

$$\frac{0.7\,\mathrm{g\,/\,Pu}}{\mathrm{L,soil}}\left(\frac{2.6\ \times\ 10^{7}\ \mathrm{rem}}{\mathrm{g,\ Pu}}\right) = 1.8 \times 10^{7}\ \mathrm{rem\,/\,L\ of\ soil}$$

This value will be rounded up to 2×10^7 rem/L of soil.

The concentrations above are reasonable for a crib that received waste from fuel reprocessing plants; however, they are overly conservative for waste sites that involved spills. By comparison, RPP-10773, *Compressed Gas Accident Parametric Consequence Analysis*, Table 3-8 (p. 3-32) provides a dose factor of 1 rem/g of soil or 1700 rem/L of soil (using a soil density of 1700 g/L) based on the worst-case documented tank farm spill. The soil had a concentration of ^{239}Pu of 3300 pCi/g or 10^{-4} g/L of soil. This will be increased by a factor of 10 and rounded up to 2 x 10^4 rem/L of soil to bound large contaminated waste sites that do not resemble cribs. This dose factor will be used for larger contamination sites.

Smaller contamination sites could be formed. In this case, it is assumed that 200 g of plutonium (maximum allowed in a 55-gal drum) are scattered over a 10-ft-diameter area (equivalent to 55 gal of waste spread about 1 in. thick). The plutonium is assumed to be mixed in with 6 in. of soil (1:6 dilution). The plutonium concentration is

$$200\ g/[(\pi/4)\ (10\ ft)^2\ (0.5\ ft)\ (28.3\ L/ft^3)] = 0.2\ gPu/L$$

Using the crib data, the dose factor is

$$\frac{0.2\ g/Pu}{L, soil}\left(\frac{7\ x\ 10^7\ rem}{g,\ Pu}\right) = 2\ x\ 10^7\ rem/L\ of\ soil\ (rounded\ up)$$

where 7 x 10^7 rem/g is the average dose factor for all plutonium stored at PFP at the time of writing HNF-SD-CP-SAR-021 (data are from Table 9-45 of the reference).

A summary of the dose factors follows:

- Crib and like sites — 2 x 10^7 rem/L of soil
- Small contaminated sites — 2 x 10^7 rem/L of soil
- Large contaminated sites — 2 x 10^4 rem/L of soil

4. Respirable Release Due To Dumping

The respirable release is found by multiplying the mass of soil dumped by the ARF and respirable fraction (RF). ARF and RF are found in Section 4.4.3.1.2 of DOE-HDBK-3010-94. The soil is assumed to spill from a height of 1 m. While the bucket can be raised to at least 2 m and possibly more, there is no reason to believe that the operator will drop the material from more than 1 m. The average value of ARF for TiO_2 (a closer surrogate for soil than UO_2) is about 10^{-4} for spills from 1 m. The corresponding value for RF is 0.6. Equation 4-5 of the reference provides a correlation for ARF based on drop height, mass, and density. The bulk density of soil is typically 1700 kg/m^3. The mass of soil in 1 yd^3 is 1300 kg. ARF is given by

$$ARF = 0.1064(M)^{0.125}\ H^{2.37}/\rho^{1.02}$$

where

M = mass, kg
= 1300 kg
H = drop height, m
= 1.0 m
ρ = bulk density, kg/m^3
= 1700 kg/m^3.

Solving for ARF yields 1.3×10^{-4}. RF is taken to be 0.6. The value of ARF*RF is 8×10^{-5}. If 0.1 yd^3 is dropped from 1 m, ARF is 10^{-4} and the ARF*RF is 6×10^{-5}.

This value is based on very dry oxide. The contaminated soil, however, is not very dry oxide. It contains moisture, which changes the dynamics of resuspension due to dumping. DOE/RL/12074-30-2, *Dust Mitigation Study for the Environmental Restoration Disposal Facility*, p. 27 and AP-42, *Compilation of Air Pollutant Emission Factors, Fifth Edition*, Section 13.2.4.3 provides data for releases due to dumping soil containing moisture. The equation is

$$e = k(0.0016)(u/2.2)^{1.3}/(M/2)^{1.4}$$

where

e = the 10 μm particle release fraction, kg/tonne
k = 0.35 when 10 μm particles are of concern (according to AP-42)
u = mean wind speed, m/s
M = moisture content, %.

The moisture content for Hanford Site soils is 3 to 5 percent (p. 31 of DOE/RL/12074-30-2). Using a moisture content of 3 percent, the release fraction (e from above equation) for 10 μm particles for a 1 m/s wind speed is 1.1×10^{-4} kg/tonne. A wind speed of 1 m/s is used in this calculation because it is the wind speed used in DOE-STD-1027-92 to determine the threshold quantities for Category 3 facilities. Because the calculation in this report is being performed for final hazard categorization purposes, it is judged that consistency with DOE-STD-1027-92 is important.

The values of the release fraction will be rounded up to the nearest order of magnitude to bound uncertainties such as wind speed, shovel volume, and moisture content. The value used in the analysis is then 10^{-6}.

The fraction of material suspended using the EPA model is about 100 times less than that found in DOE-HDBK-3010-94. The reason is two-fold. First, the mass spilled and the equation for ARF in DOE-HDBK-3010-94 show a functional dependence on mass. However, when a large volume is dropped, the main contribution to ARF is from the edges of the volume. The material in the inner section is not subjected to stresses while falling. At impact, particles are resuspended; however, most do not escape the volume due to interception by the mass further to the outside. That is, a damage ratio should be applied to large volume drops. The second reason is moisture. The powders used in the DOE-HDBK-3010-94 experiment were drier then soil. Even a moisture percentage difference of a factor of 5 yields a factor of 10 in ARF according to the DOE dust model. As a result, the ARF*RF from DOE-HDBK-3010-94 with an appropriate damage ratio yields results similar to the equation from AP-42. Therefore, a value of 10^{-6} will be used for ARF*RF.

5. Release Rate Due To Resuspension

The release rate due to resuspension is based on data in EPA/600, *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites*, p. 34. The equation comes from studies involving highly erodible soils. It is assumed that the site fits this description. The equation is:

$$E_{10} = 0.036(1\text{-}V)(u/u_t)^3\ F(x)$$

where

E_{10} = annual average emission factor for <10 μm particles, g/m^2-h
V = fraction of site covered by vegetation
= 0 (assumed)
u = wind speed, m/s
u_t = threshold value of wind, m/s (see below)
x = 0.886 (u_t/u)
$F(x)$ = function if x>2, $F(x) = 0.18(8x^3 + 12x) * \exp(-x^2)$. For 0<x<2 see Figure 4-3 of the reference.

To find u_t,

1. Obtain mode of particle size distribution. Assume 500 μm, in accordance with the example on p. 69 of the reference.
2. Use Figure 3-4 of the reference to obtain a threshold friction velocity of 50 cm/s.
3. Obtain surface roughness from Figure 3-6 (Z_o) of the reference. Assume 1.0 cm.
4. Use Figure 4-1 of the reference to obtain u_t/friction velocity.
5. u_t/friction velocity = 16.5
6. Solve for u_t = 16.5 (50 cm) = 8.25 m/s.

Using the above data and equation:

$$\text{For 1.0 m/s winds, } E_{10}=0.036\left(\frac{1.0}{8.25}\right)^3 F(x)$$

$x = 7.3$ $F(x) = 4 \times 10^{-21}$
$E_{10} = 2.6 \times 10^{-25}$ g/m^2–h or zero

According to p. 38 of the reference:

$$R_{10} = yE_{10}\,A$$

where

R_{10} = emission rate for <10 μm particles
y = fraction of contaminant in soil (in E_{10})
= 1.0 here
A = area, m^2
= 1 m^2 (assumption).

DOE-HDBK-3010-94 provides the results of a test in which oxide and uranyl nitrate hexahydrate were spread over smooth sandy soil. The airborne resuspension rate over 24 hours for 1 m/s is as follows:

	1 m/s
UO_2	2×10^{-5}/h
Air-dried uranyl nitrate hexahydrate	3×10^{-6}/h
Uranyl nitrate hexahydrate	5×10^{-6}/h

In each of the above cases, about 50 g of the contaminant were sprinkled over the sandy soil held in a 23-in.-diameter tray. The tray area is 2.88 ft^2 or 0.27 m^2.

To compare the resuspension rates from DOE-HDBK-3010-94 to those from EPA/600 above, they must be multiplied by 50 g and divided by 0.27 m^2:

- 1 m/s wind 4×10^{-3} g/m^2-h to 6×10^{-4} g/m^2-h

The resuspension rate for 1 m/s winds from EPA/600 is much less than the values in DOE-HDBK-3010-94. There are many reasons why the EPA/600 values might be less, including upwind topography, age of deposit, particle shape, and soil particle size distribution. However, for conservatism, the resuspension rate of 4×10^{-3} g/m^2-h from DOE-HDBK-3010-94 will be used in the analysis, which, as was stated above, will use a 1 m/s wind speed.

6. Atmospheric Dispersion

The atmospheric dispersion factor is based on the equations within the GXQ code as documented in WHC-SD-GN-SWD-30002, *GXQ Program Users Guide*. The onsite individual is assumed to be 30 m from the edge of the contaminated site or operation and on the centerline of the plume. The value of X/Q for ground-level releases is given as follows:

$$X/Q = [\theta_y \theta_z u]^{-1} f(y)$$

where

θ_y = horizontal diffusion coefficient, m
= 3.17 m for Pasquill D conditions at 30 m (data from Table 1 of the reference) Pasquill D is used on p. A-7 of DOE-STD-1027-92.
θ_z = 1.58 m (same rationale as for θ_y)
u = 1.0 m/s according to DOE-STD-1027-92
f(y) = $\exp[-0.5 (y/\theta_y)^2]$ where y = 0 if centerline values are wanted.

For scenarios involving dumping, f(y) is set equal to 1.0 (i.e., y = 0). The value of X/Q is 0.07 s/m^3. This is consistent with EPA model X/Q that provides 8.4x10^{-13} day/cm^3, which equals 0.07 s/m^3. This value also is used for the test pit. The reason is that the test pit has a small areas where the wind blows along the axis of the test pit.

For wind entrainment from a large area, it is conservative to assume that the receptor is on the centerline of the plume, downwind from one end of a long rectangle with a width small enough that most of the entrained material can affect the receptor. To determine the width of this rectangle, consider horizontal distances from the centerline of a plume from a small source. The value of f(y) is 0.5 when this small source is 3.7 m from the centerline and 30 m upwind from the individual. At 8 m from the centerline, f(y) equals 0.04. Because f(y) is small, X/Q is small as compared to that evaluated on the centerline. Therefore, for horizontal distances the plume extends about 8 m on either side of the centerline. This value will set the width of the contamination that will affect the onsite individual.

Based on the above, the large (800 m^2) waste site is considered to be an area source with a width of 16 m (from 2 times the 8 m width found above). Section 4.2.2 of WHC-SD-GN-SWD-30002 shows that for area sources the virtual source is located up wind such that

$$\theta_y = W/4.3$$

where

W = width of source
 = 16 m in this case.

Solving for θ_y yields 3.72 m. Using Table 1 of the reference, θ_y equals 3.72 m at 36 m. The virtual source is located

$$30 + 36 = 66 \text{ m upwind of the individual}$$

At 66 m, θ_z equals 3.17 m and θ_y equals 6.47 m. The value of X/Q is found as above, but with the new values for θ_y and θ_z. The value of X/Q is 0.02 s/m^3 for a wind speed of 1.0 m/s.

The small site is 3 m in width. No area source correction will be performed. The X/Q is 0.07 s/m^3.

The receptor is assumed to remain for 24 hours in keeping with DOE-STD-1027-92.

7. Site Area

The site sizes are as follows:

- Small site -- 7.3 m^2 (based on a 10-ft-diameter area discussed in Section 3.0)
- Large site -- 800 m^2 (based on a 16 m wide area, from Section 6.0; assumed 50 m long)

8. Consequence Calculations

Data used in the calculations below are found in Table 2.

8.1 Scenario 1 – Wind Over a Contaminated Site

- Dose rate equation

Dose rate = (resuspension rate)(site area) (L/1700 g) (X/Q) (3.3×10^{-4} m^3/s) (dose factor)

Where:

3.3×10^{-4} m^3/s = breathing rate. Notably, this is conservative to the EPA model, which uses a breathing rate of 2.3×10^{-4} m^3/s.

- Consequences

Large site	2.5×10^{-4} rem/h or 6×10^{-3} rem over 24 hours
Small site	3.4×10^{-3} rem/h or 0.08 rem over 24 hours.

8.2 Scenario 2 – Test Pit Dug into a Crib

Resuspension 0.024 rem/h or 0.6 rem over 24 hours

- Dumping

Dose = (1 yd^3) (ARF*RF) (765 L/yd^3) (# dumps) (X/Q) (3.3×10^{-4}) (dose factor) =6.4 rem.

9. Analytical Conservatism

Several analytical conservatisms have been used during the preparation of this analysis:

- Dose conversion factors are based on ICRP 30 for consistency with past analyses. However, use of the currently approved ICRP 68/71 values would reduce postulated doses by a factor of at least three.
- To account for uncertainty, the release fraction used has been rounded to the next nearest order of magnitude. This bounds uncertainties such as wind speed, shovel volume, and moisture content. This results in a factor of nine increases from the calculated value.

- Conservative resuspension rates are used from DOE-HDBK-3010 relative to those provided by EPA models. This results in a resupsension rate that is more than an order of magnitude greater.
- The scenarios do not address any of the features that are in place under separate regulation to prevent inadvertent intrusion, and when intrusion occurs it is assumed that the intrusion occurs in bounding locations.
- The test pit scenario assumes that the dig was completed in one day. Test pits are normally dug over a several day period, and may take weeks to complete due to characterization data quality objectives.

10. References

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Appendix E

Risk Binning Guidelines

RISK BINNING GUIDELINES

The following Nuclear Safety Risk Ranking Process and associated Control Selection Guidelines should be used as a qualitative tool to supplement the safe harbor methods in DOE-STD-3009. It is advised that the numerical guidelines are not to be construed as either risk acceptance nor compliance criteria. Table 1 identifies Consequence Levels and Evaluation Guidelines for the maximally exposed offsite individual and maximally exposed hypothetical onsite worker. Table 2 identifies the Risk Ranking Bins. Specific guidelines for application are summarized below.

Unmitigated hazard events shall be evaluated in accordance with the Tables 1 and 2 and guidelines provided herein.

Risk Class I events must be protected with safety structures, systems, and components (SSCs) and Technical Safety Requirements (TSRs). For offsite public protection, Safety Class SSCs and TSRs are required for radiological events that challenge 25 rem TEDE offsite in accordance with Appendix A of DOE-STD-3009, Change Notice 2. Events resulting in high offsite radiological consequences must be moved forward into accident analysis for determination of safety classification, without consideration of frequency.

Risk Class II events must be considered for protection with TSRs and safety SSCs. The consideration of control(s) shall be based on the effectiveness and feasibility of the considered controls along with the identified features and layers of defense in depth (DID). Events resulting in high offsite radiological consequence must be moved forward into accident analysis for determination of safety classification, without consideration of frequency.

Risk Class III events are generally protected by the safety management programs (SMPs). These events may be considered for defense in depth SSCs in unique cases.

Risk Class IV events do not require additional measures.

For facility worker protection, significant hazardous events are evaluated for appropriate controls in accordance with DOE-STD-3009, Change Notice 2. The activity-specific controls (e.g., PPE and hot work permit) should be developed as part of a work control process, not as a specific part of the Safety Basis per 10 CFR 830. The actual implementation of work control process should be reviewed as part of the annual ISMS verification. For those events identified in the hazard analysis that require a control that is not contained in an SMP, a discrete administrative control should be established.

DID is a philosophy that ensures the facility is operated in a safe manner through multiple means. DID features include the entire suite of safety controls, encompassing Safety Class and Safety Significant SSCs, Administrative Controls (ACs), safety management programs, and other engineered controls. Only the significant contributors to DID should warrant TSR designation. Those passive features that provide significant safety benefit are covered by the TSR Design Features section. Compensatory measures should be provided for those existing TSR Design Features that do not meet functional requirements. DOE G 423.1-1 provides additional guidance for consideration.

Many important aspects of the defense in depth strategy are implemented through the safety management programs. The holistic approach embedded in the SMPs and their effective implementation as part of the ISMS must continue to optimize the intended safety benefits. The discipline imposed by the SMPs extends beyond simply supporting the assumptions made in the hazard analysis and is an essential part of defense in depth safety posture.

The radiation protection of the workers during normal operations is governed by 10 CFR 835, Occupational Radiation Protection and is discussed in the Radiation Protection chapter of the DSA.

Table 1: Consequence Levels and Risk Evaluation Guidelines

Consequence Level	Offsite Public MOI [1, 2]	Hypothetical Onsite Worker MEI[3] location not less than 100 meters or facility boundary from the point of release For elevated doses use point of highest doses	Site Facility Worker Involved worker[3] within facility boundary Use highest dose within facility boundary
High **25 rem** **100 rem**	**Considerable off-site impact on people or the environs.** **> 25 rem TEDE or** **> ERPG-2/TEEL-2**	**Considerable on-site impact on people or the environs.** **> 100 rem TEDE or** **> ERPG-3/TEEL-3**	For Safety Significant designation, consequence levels such as prompt death, serious injury, or significant radiological and chemical exposure, should be considered.
Moderate **25 rem > 1** **100 rem > 25**	**Only minor off-site impact on people or the environs.** **≥ 1 rem TEDE or** **> ERPG-1/TEEL-1**	**Considerable on-site impact on people or the environs.** **≥ 25 rem TEDE or** **> ERPG-2/TEEL-2**	
Low **< 1 rem** **< 25 rem**	**Negligible off-site impact on people or the environs.** **< 1 rem TEDE or** **< ERPG-1/TEEL-1**	**Minor on-site impact on people or the environs.** **< 25 rem TEDE or** **< ERPG-2/TEEL-2**	

Notes:

DSA: Documented Safety Analysis
MOI: Maximally-Exposed Offsite Individual
SSC: structures, systems, or components
MEI: Maximally-Exposed Collocated Worker
SMP: Safety Management Programs, Chapters 6-17 of the DSA
TSR: Technical Safety Requirements

[1] Offsite consequences that challenge 25 rem must be protected with Safety Class SSCs independent of frequency

[2] Hazard Analyses qualitatively evaluate public consequences at the shortest distance to the site boundary. Accident Analyses must utilize 95% X/Q for public consequence determination.

[3] Beyond safety-significant SSCs designated for worker safety and their associated TSR coverage, additional worker safety issues should be covered in TSRs only by administrative controls on overall safety management programs.

Table 2: Qualitative Risk Ranking Bins[4]

Consequence Level	Beyond[5] Extremely Unlikely Below 10^{-6}/yr	Extremely Unlikely 10^{-4} to 10^{-6}/yr	Unlikely 10^{-2} to 10^{-4}/yr	Anticipated 10^{-1} to 10^{-2}/yr
High Consequence	III	II	I	I
Moderate Consequence	IV	III	II	I
Low Consequence	IV	IV	III	III

[4] Industrial events that are not initiators or contributors to postulated events are addressed as standard industrial hazards in the hazard analysis.

[5] For external events, frequency of occurrence below 10^{-6}/yr conservatively calculated or 10^{-7}/yr realistically calculated are Beyond Extremely Unlikely.

Appendix F

Readiness Evaluation Checklist

READINESS EVALUATION CHECKLIST

This appendix provides a readiness evaluation checklist that can be used to support facility disposition and environmental restoration activities and may be used as a starting point for developing a project-specific readiness checklist. The checklist is organized according to the following categories:

- Safety Basis
- Project Plans
- Project Procedures Manuals
- Work Package
- Facility Preparation
- Support Facilities
- Support Equipment Preparation
- Traffic Control
- Industrial Safety and Hygiene
- Radiation Protection
- Environmental Protection
- Emergency Preparedness
- Worker Training, Testing, and Qualification
- Subcontractors
- Management of Change

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE?	
		Yes	**No**
I. Safety Basis: Confirm that Required Nuclear Safety and Environmental Compliance Documents are Complete, Reviewed, and Approved by Appropriate Parties			
1. Hazard characterization report			
2. Hazard baseline document (e.g., SAR, BIO or ASA)			
3. NEPA process (e.g., EIS, EA, or categorical exclusion)			
4. TSRs			
5. Environmental permits (e.g., NPDES/SPDES, NESHAPS, or NAAQS)			
II. Project Plans: Confirm that the Following Project Plans have been Developed, Reviewed, and Approved by Appropriate Parties and are in Place			
1. Project management plan (including project organization with responsibilities, budgets and schedules, project controls program, and reporting requirements)			
2. Health and safety plan (including asbestos abatement)			
3. Quality assurance plan (including records management and retention requirements)			
4. Procurement plan			
5. Waste management plan			
6. Emergency plan (e.g., for fires, releases or injuries)			
7. Final verification plan			
III. Project Procedures Manuals: Confirm that the Following Procedures Manuals have been Developed, Reviewed, and Approved by Appropriate Parties			
1. Engineering procedures manual			
2. Procurement procedures manual			
3. ES&H procedures manual			
a. Personnel exposure control procedures			
b. Sampling and monitoring procedures			
c. Instrument calibration procedures			
d. Hazardous substance control (including asbestos controls) procedures			

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE? Yes	No
4. Emergency procedures manual			
a. Evacuation, assembly, and personnel accounting procedures			
b. Medical emergency procedures			
c. Spill and release control procedures			
d. Decontamination procedures			
5. Material control manual (e.g., procured items)			
a. Material inspection and inventory procedures			
b. Material packaging and transport procedures			
c. Material storage and retrieval procedures			
IV. Work Package: Confirm that the Following Documents have been Developed, Reviewed, and Approved by Appropriate Parties. Confirm Support Activities have been Completed and Documented			
1. Work instructions detailing sequence of work			
a. Supporting drawings and specifications			
b. Inspection hold points			
c. Data forms			
d. Task hazard analysis of each work step in instructions			
2. Work permits			
a. Radiological work permits (with current radiological surveys)			
b. Hazardous work permits			
c. Confined space entry permits			
d. Cutting, burning, and welding permits			
e. Excavation and trenching permits			
f. Scaffolding permits			
g. Lifting and rigging permits			
h. Special equipment operating permits			
3. Material safety data sheets for all hazardous substances to be used			

READINESS CHECKLIST

PROJECT: _____________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE?	
		Yes	No
V. Facility Preparation: Confirm the Existence and Adequacy of Facility Support Features (Inspect)			
1. Space requirements			
a. Office space			
b. Restrooms			
c. Change rooms			
d. "Break" facilities			
e. Material laydown and storage space			
f. Packaged waste storage			
g. Flammable material storage			
h. Hazardous chemical storage			
i. Equipment maintenance and storage			
2. Postings			
a. Warning signs per DOE and OSHA requirements (e.g., restricted area, radiological control area, or high voltage)			
b. Evacuation routes			
c. "No smoking" signs			
3. Custodial service (e.g., cleaning and janitorial)			
4. Support utilities			
a. HVAC test complete and results documented			
b. HEPA filter DOP test complete and results documented			
c. Installed lighting			
d. Noise control and abatement			
e. Physical barriers to separate project work from other operations			
f. Utility air			
g. Electrical power			
h. Potable water			
I. Fire water			
j. Sewer			

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE? Yes	No
k. Disposal system for radioactive contaminated fluids			
5. Systems and components to be removed are tagged or identified			
6. Lock and tag requirements are completed and documented in accordance with approved procedures			
7. Breathing air system			
a. Adequate volume			
b. Equipment tested			
c. Air certified			
VI. Support Facilities			
1. Waste processing			
2. Waste packaging			
3. Decontamination (including equipment and personnel)			
4. Medical			
VII. Support Equipment Preparation: Verify the Readiness of Support Equipment (e.g., Inspections, Maintenance, and Testing Logs and Documentation Completed)			
1. Heavy equipment test, inspection, and certification			
a. Trucks			
b. Cranes			
c. Bulldozers			
d. Backhoes			
e. Forklifts			
f. Front-end loaders			
2. Waste solidification systems			
3. Volume-reduction equipment			
a. Shredders			
b. Compactors			
4. Decontamination equipment			
a. High-pressure liquid			
b. Liquid abrasive			
c. Dry abrasive			

READINESS CHECKLIST

PROJECT: _____________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE? Yes	ACCEPTABLE? No
d. Scabbling, grinding, and chipping			
e. Chemical decontamination equipment or system			
5. Hand and power tools inspect and test			
a. Proper guards			
b. Proper grounding			
6. Lifting and rigging tested and certified			
a. Wire rope			
b. Slings (including rope)			
c. Come-alongs (including block and tackle assemblies)			
d. Shackles			
e. Hooks			
7. Preventive maintenance program in place			
VIII. Traffic Control			
1. Loading, unloading, and staging zones designated and posted			
2. Traffic flow patterns established and marked			
a. Equipment			
b. Personnel			
3. Roadways, gates, doors, hallways, corridors, etc. evaluated for heavy or oversized equipment and material movement			
4. Hazardous material transport routing established			
a. Onsite			
b. Offsite			
5. Waste disposal routing established (offsite)			
a. Routing capable of supporting loads			
b. Local officials along the route are involved			
c. Permits obtained			
d. Transport routing, system upgrades, and modifications completed and approved			
6. Onsite escort requirements available (e.g., security and radiation control)			
7. Approved waste packages for radioactive or hazardous			

READINESS CHECKLIST

PROJECT: _____________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE? Yes	ACCEPTABLE? No
substances available			
a. Properly specified			
b. Proper and approved labeling			
IX. Industrial Safety and Hygiene: Ensure the Availability of Adequate Quantities and Functional Adequacy of Worker Protective Equipment and Materials			
1. Personnel protective equipment (PPE)			
a. Hard hats or other head covering			
b. Safety glasses or goggles			
c. Gloves (specific to task)			
d. Safety shoes			
e. Hearing protection			
f. Special PPE for hazardous substance handling			
g. Respirators			
h. Heat stress protection (e.g., air suits and ice vests)			
I Lifting supports			
j. Fall protection devices			
2. First-aid kits			
3. Herbicide and pesticide spray			
4. Air monitors and samplers (with alarms)			
a. Explosive gas			
b. Hazardous chemicals			
c. Asbestos			
X. Radiation Protection: Ensure Availability of Adequate Quantities and Functional Adequacy of Worker Protective Equipment and Materials			
1. Personnel protective equipment (PPE)			
a. Respirators			
b. Breathing air support			
2. Portable radiation detectors			
3. Decontamination supplies			
4. Fixed or stationary monitoring equipment			

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE?	
		Yes	No
a. High-volume air samplers			
b. Constant air monitors (CAM) with alarms			
c. Area radiation monitors (ARM)			
d. Sample counting systems			
e. Personnel and equipment frisking stations			
f. Portal monitors			
5. If fissionable material is present, criticality detection and alarm systems are in place, tested, and results documented			
6. Contamination controls in place			
a. Containments			
b. Tents			
c. Barriers			
d. Step-off pads			
e. Laundry hampers			
f. Proper postings			
g. Fixatives			
7. Temporary shielding in place			
XI. Environmental Protection			
1. Environmental surveillance program - required documents are in place with proper approvals			
2. Effluent control (e.g., filtration and water treatment)			
a. All potential effluent discharges identified			
b. Control system(s) adequate for effluent contaminant control			
c. Control system installed and tested with results documented			
3. Effluent monitoring			
a. All potential effluent discharge points identified			
b. Effluent monitors installed and tested with results documented			
c. Sample locations identified and sample systems installed and functionally verified			
XII. Emergency Preparedness: Confirm the Availability and Functioning of the Emergency Preparedness System			

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE?	
		Yes	No
1. Communications			
a. Two-way radios			
b. Pagers			
c. Telephones			
d. Public address (PA) system			
e. Alarms (e.g., fire, radiation, chemical, and criticality)			
2. Fire equipment - in place, functional, and properly labeled			
a. Sprinkler system			
b. Pull boxes			
c. Fire and smoke detectors			
d. Fire extinguishers			
e. Hydrants			
f. Stand pipes			
3. Fire exits clearly marked and unobstructed			
4. Unique fire suppression material (e.g., halon, sand, and foam)			
5. Safety showers, eye wash, and decontamination facilities in place and functional			
6. Emergency breathing air supply (e.g., SCBA)			
7. Emergency supply cabinet fully equipped and readily accessible			
8. Emergency lighting available and operable			
9. Emergency power or UPS available and operable			
XIII. Worker Training, Testing, and Qualification: Verify that Each Worker Has Completed the Following, Been Successfully Tested When Required, and a Record is Available Verifying the Worker's Qualification			
1. Basic training completed - all workers			
a. HAZWOPER			
b. Radiological			
2. Supervisor advanced training			
a. Radioactive waste supervisor			
b. HAZWOPER supervisor			
3. Specialized worker training			

READINESS CHECKLIST

PROJECT: ______________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE? Yes	ACCEPTABLE? No
a. Heavy equipment operator			
b. Welder			
c. Health physics technician (including radiological controls)			
d. Special D&D equipment operator			
e. Radioactive waste operations			
f. Waste process equipment operator			
g. Plutonium handling			
4. Site-specific hazards indoctrination			
5. Emergency response drills conducted and documented			
6. Medical examination (including fitness requirements)			
7. Respirator and breathing air testing and qualification			
8. Special PPE training and qualification			
9. "Dry-run" or demonstration successfully conducted and documented for any new technology or equipment to be utilized			
10. Mockup training is completed and documented			
11. Work package indoctrination with the workers and walkdowns are completed			
12. Other training as needed (e.g., fire watch, gas-free inspector, and rigger)			
XIV. Subcontractors: Ensure that All Subcontractors are Mobilized as Required and All Pre-Job and Mobilization Requirements are Completed			
1. Pre-job deliverables are received and accepted by the project			
a. Health and safety programs and plans			
b. QA plan/program			
c. Worker certifications (e.g., training, medical, special equipment, operator, and resume)			
d. Equipment certifications			
e. Special operating procedures			
2. Subcontractor resources			
a. All required subcontract personnel are onsite and have successfully completed site-specific qualification requirements			

READINESS CHECKLIST

PROJECT: _____________ PROJECT MGR:

	ACTION ASSIGNEE	ACCEPTABLE?	
		Yes	No
b. All required subcontractor equipment is onsite and has been successfully tested			
c. All required support materials and consumables are staged onsite and available			
XV. Management of Change: Ensure that a Change Control System is in Place and Workers are Familiar with the Requirements			
1. Pre-job meetings to discuss anticipated hazards and hazards controls conducted daily			
2. Lessons learned from work completed			
3. Response to unanticipated conditions of workplace			

DOE -STD-1120-2005

CONCLUDING MATERIAL

Review Activity: **Preparing Activity: DOE-EH-23**

Project Number: SAFT-0060

DOE	Field Offices	National Laboratories	Area Offices	External Organization
DP	AL	BNL	Amarillo	DNFSB
EE	CH	LANL	Kirtland	EFCOG
EH	Fernald	LLNL	Princeton	
EM	ID	ORNL	Rocky Flats	
ER	NV	PNNL		
FE	OAK	RF		
FM	OR	SNL		
GC	RF	WSRC		
HR	RL			
IG	SF			
NE	SR			
NN				
RW				