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Yucca Mountain Repository Concept of Operations

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Change History

11. Revision No.	12. Description of Change
000	Initial issue (50% draft).
001	This is a total revision to the document. It also supersedes and incorporates the pertinent parts of 800-30R-MGR0-00500-000, *Subsurface Concept of Operations*. Since the document now addresses both surface and subsurface operations, the title changed from *Geologic Repository Operations Area Surface Facilities Concept of Operations* to *Yucca Mountain Repository Concept of Operations*.
002	This revision resolves inconsistencies between the draft License Application Safety Analysis Report and this document regarding the safeguards and security concept of operations. Additionally, changes are made that reflect updates to referenced documents.

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ACRONYMS

ARM	area radiation monitor
BOP	Balance of Plant
CRCF	Canister Receipt and Closure Facility
CCCF	Central Control Center Facility
CTT	cask transfer trailer
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPC	dual-purpose canister
EDG	emergency diesel generators
ES&H	Environmental, Safety, and Health
GROA	Geologic Repository Operations Area
HAM	horizontal aging module
HEMF	Heavy Equipment Maintenance Facility
HLW	high-level radioactive waste
ICA	item control area
IHF	Initial Handling Facility
INPO	Institute of Nuclear Power Operations
ISMS	Integrated Safety Management System
ITS	important to safety
ITWI	important to waste isolation
LLW	low-level radioactive waste
LLWF	Low-Level Waste Facility
MC&A	material control and accounting
NRC	U.S. Nuclear Regulatory Commission
OCRWM	Office of Civilian Radioactive Waste Management
PCSA	preclosure safety analysis
PDC	*Project Design Criteria Document*
PFO	protective force officer
PIDAS	perimeter intrusion detection and assessment system
PM	preventive maintenance
PPE	personal protective equipment
QA	quality assurance

ACRONYMS (Continued)

RCM	reliability-centered maintenance
REMY	rail equipment maintenance yard
RF	Receipt Facility
RWP	Radiological Work Permit
SNF	spent nuclear fuel
SNM	special nuclear material
SSC	structure, system, or component
TAD	transportation, aging, and disposal
TEV	transport and emplacement vehicle
TID	tamper-indicating device
WHF	Wet Handling Facility
WNNRF	Warehouse and Non-Nuclear Receipt Facility
YMP	Yucca Mountain Project

1. INTRODUCTION

1.1 PURPOSE/METHOD

The purpose of this concept of operations is to describe operational philosophies, organization, operations activities, and processes for the following:

- Receiving and delivering packages containing nuclear wastes to the Geologic Repository Operations Area (GROA) surface facilities
- Processing and moving nuclear wastes between surface facilities
- Returning transportation packaging (i.e., casks) to National Transportation for reuse after their unloading
- Delivering waste packages to emplacement drifts
- Handling low-level radioactive and other waste byproducts.

Where enough information is available, processes are presented step-by-step (see appendices) to provide a clear and methodical description of the activity. The step-by-step tables are followed by a detailed discussion of each step that may include personnel interfaces, interlocks, special requirements, and other information needed to understand fully how and by whom the step will be accomplished. Narratives are provided for those areas for which the concept can be described, but the level of detail to present a step-by-step process does not yet exist. Examples of these areas include performance confirmation and facility closure.

This document provides design information only to the extent necessary to understand facility operations, minimizing duplication of and possible conflicts with design details contained in other project documents.

Since the project employs a phased construction and operations approach, this document will address the operations and construction interfaces. Doing so necessitates discussion of some startup activities as well. A description of startup is not an explicit purpose of this document; therefore, startup activities are discussed at a high level, deferring to the yet-to-be-developed startup plan for details.

This document serves as guidance for the development of functional and operational interfaces. However, the data and engineering values presented are estimates or summaries of the current design and may change over time. The referenced analyses or supporting documents must be utilized if the data or engineering values are used for design inputs. The references listed may contain existing data or data that need to be verified. The data and engineering values obtained from those sources, and presented in this report, however, do not impact the concepts described. For the purpose of this report, the data and engineering values are not being tracked as data to be verified.

1.2 EXPECTATION FOR REVISION AND REFINEMENT

As the detailed design of the facilities, equipment, and processes described in this document progresses, refinements in the layout, adaptations to the design and operation of the facilities and equipment, and minor operational revisions from those described herein are expected. This maturation of site and facilities physical features and operations are expected to lead to further revisions to this concept of operations document.

1.3 QUALITY ASSURANCE

This document was developed in accordance with *Quality Management Directive* (BSC 2007 [DIRS 184673]) and is subject to quality assurance (QA) program requirements because the processes are applicable to items classified as important to safety (ITS) as defined in 10 CFR 63.2, Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada [DIRS 180319]. This document was developed in accordance with PA-PRO-0313, *Technical Reports*. The record version of this report is designated as QA: QA.

The QA organization will carry out its functions in accordance with the requirements of the QA program controls established for repository nuclear operations. Examples of QA functions supporting operations activities include surveillance, audit, inspection, and review of selected operations documents.

1.4 ASSUMPTIONS

This report contains no assumptions, since its purpose is to describe a concept and no value or quantitative information is relied upon to make critical decisions about the concept of operations.

2. OVERVIEW

2.1 OPERATING PHILOSOPHY

Yucca Mountain will be operated in a manner that protects the public, project personnel, and the environment; promotes radiological safety; and meets the applicable safety bases described in the Yucca Mountain license application.

2.1.1 Use of Industry Best Practices and Guidance

Although the Yucca Mountain Project (YMP) as a whole is unique, many of the activities within the project have long histories of analogous activities in the commercial nuclear industry and within the U.S. Department of Energy (DOE) complex. As applicable, the operating organization at YMP will take full advantage of operating experience, lessons learned, U.S. Nuclear Regulatory Commission (NRC) regulatory guides, and Institute of Nuclear Power Operations (INPO) guidance and best practices.

2.1.2 Sealed Canister Concept

Receiving and processing the majority of nuclear wastes in sealed transportation, aging, and disposal (TAD) canisters, naval canisters, and DOE canisters minimizes the handling of individual spent nuclear fuel (SNF) assemblies, improves facility throughput, and reduces the overall programmatic and site contamination footprint.

2.2 NUCLEAR WASTE

Nuclear wastes arrive in NRC-certified casks. Most waste will be prepackaged in sealed canisters, including TAD, naval, and DOE canisters. Uncanistered wastes include individual DOE and commercial SNF assemblies, and commercial canisters not approved for disposal (i.e., approved for storage and transportation only). Specific nuclear waste cask types include:

- Rail casks delivering up to 90% of commercial SNF in TAD canisters
- Rail and truck casks delivering sealed canisters of DOE SNF or high-level radioactive waste (HLW) (i.e., glass logs)
- Naval (M-290) rail casks delivering sealed canisters of SNF
- Site-only shielded transfer casks and aging overpacks
- Rail and truck casks delivering uncanistered commercial SNF assemblies, including those delivered in dual-purpose canisters.

2.3 SITE OVERVIEW AND GOVERNING AUTHORITY

As required under the Nuclear Waste Policy Act of 1982 [DIRS 101681], the DOE will apply for an NRC license to receive, process, and dispose of nuclear wastes in a permanent geologic repository located within the Basin and Range Province of the western United States on federal lands in Nye County, Nevada. The DOE exercises authority over the owner-controlled area (i.e., site), which establishes the boundary for site safety analyses. Within this area is the GROA and all nuclear activities conducted therein are subject to the strict limitations of the licensing basis, including license conditions and technical specifications, imposed in the license issued by the NRC. Prior to waste operations, all facilities, equipment, and processes will be tested and validated against their safety bases and design performance specifications. No nuclear processing activities will occur without explicit authorization and approval from the NRC.

2.4 GEOLOGIC REPOSITORY OPERATIONS AREA

The boundaries of the GROA are defined by: (1) the area within the perimeter intrusion detection and assessment system (PIDAS) fences and the subsurface operations and construction interface barriers, and (2) the radiologically restricted areas that extend beyond the PIDAS fence.

The transfer of accountability of nuclear materials to YMP personnel occurs at the GROA entry point.

2.5 NUCLEAR SURFACE FACILITIES

The GROA houses five major nuclear waste processing surface facilities designed for the receipt, processing, and preparation for emplacement of all nuclear wastes received at Yucca Mountain:

- Initial Handling Facility (IHF)
- Canister Receipt and Closure Facilities (CRCFs)
- Receipt Facility (RF)
- Wet Handling Facility (WHF)
- Aging Facilities (for vertical aging overpacks and horizontal aging modules).

To meet waste throughput goals, multiple CRCFs are envisioned. Depending on the final amount of uncanistered commercial SNF received, the number of CRCFs and WHFs may be adjusted.

Other surface facilities that provide ITS or important to waste isolation (ITWI) functions for the purpose of event prevention or mitigation are:

- Emergency Diesel Generator Facility
- Emergency diesel generator fuel oil tanks.

2.6 BALANCE OF PLANT FACILITIES

Key Balance of Plant facilities that support the YMP mission include:

- Central Control Center Facility (CCCF)
- Low-Level Waste Facility (LLWF)
- Heavy Equipment Maintenance Facility (HEMF)
- Warehouse and Non-Nuclear Receipt Facility (WNNRF)
- North Portal control point
- Buffer areas (rail and truck transporter parking and queuing prior to unloading)
- Ventilation shaft fan enclosures.

2.7 SUBSURFACE FACILITIES

The subsurface facility provides space and layout for disposal of approximately 70,000 metric tons of heavy metal equivalent of SNF and HLW. The subsurface facility includes the transport and emplacement vehicle (TEV) rail tracks leading from the North Portal access into the underground area, the mains that connect the surface with the emplacement drifts, ventilation shafts and exhaust main tunnels, the emplacement drifts, alcoves, and performance confirmation areas. Intake and exhaust shafts and electrically powered exhaust fans provide ventilation and additional waste package cooling. Drifts will continue to be constructed while wastes are being emplaced until the final drift is completed.

Key subsurface facilities linked to the North Portal include:

- North Ramp
- Access main
- Turnouts
- Subsurface emplacement drifts.

Subsurface facilities are prepared to emplace packaged nuclear wastes, and individual emplacement drifts are off-limits to workers once emplacement begins due to high radiation dose rates.

3. ORGANIZATION

NOTE: The composition, roles, and responsibilities of key positions within the YMP are being specifically defined by a DOE committee chartered for this purpose. The following discussion reflects the current concept for operations but is expected to be refined.

3.1 EXECUTIVE AND MANAGERIAL ORGANIZATION

The organization at the YMP and within the Operations department will reflect the key management positions and organization as structured in the license application.

3.2 PROPOSED SHIFT COMPOSITION

The site operations manager is responsible for all site activities inside and outside of the GROA. The operations manager reports to the site operations manager and is responsible for activities at the GROA. The key operations management representative is the waste handling manager who reports to the operations manager and is primarily responsible for the activities and operations at the GROA surface and subsurface facilities. Table 1 represents an initial view of the relationship between overall site management and the functional management of operating activities.

Although many personnel will report to a functional manager, routine ongoing operations at individual facilities will be managed under direction of the shift manager and supervised by an individual facility supervisor, as outlined in Table 1. A description of the duties and interfaces associated with the operating shift personnel is found in Section 3.4. It is expected that about 100 personnel will report to and be responsible to the shift manager and facility supervisors per operating shift. Operations at the IHF and LLWF are assumed to take place only one shift per day, Monday through Friday. Operations in the remaining facilities are assumed to continue 24 hours per day, 7 days per week.

It is expected that, through cross training and alignment of personnel resources, some personnel will fill roles in multiple facilities, thus providing staffing flexibility to meet processing and throughput needs. During the day shift, additional personnel inside and outside of the GROA will manage and perform licensing, engineering, administration, planning, logistics, and other associated YMP requirements and needs.

Table 1. Proposed Matrix Operating Shift Organization of Yucca Mountain Waste Operations and Processing Personnel

Functional Mgmt.	**Facility Management and Supervision**					
Waste Handling Manager	CCCF (24/7)					
	Shift Manager/Incident Commander (1)					
	Shift Technical Advisor (2)					
	Central Control Center Operators (3)					
	Initial Handling Facility (day shift)	**Canister Receipt and Closure Facility (24/7)**	**Receipt Facility (24/7)**	**Wet Handling Facility (24/7)**	**Aging Facility (24/7)**	**Low-Level Waste Facility (day shift)**
Waste Handling Manager	GROA Outside Operations Supervisor (1)					
	Utilities Tech (as needed)			Utilities Tech (1)	Utilities Tech (1)	Utilities Tech (as needed)
	GROA Yard Techs (as needed)				GROA Techs (4)[a]	Yard Tech (as needed)
	IHF Supervisor (1)[b]	CRCF Supervisor (1)[b]	RF Supervisor (1)[b]	WHF Supervisor (1)[b]	AF Supervisor (1)[b]	LLWF Supervisor (1)[b]
	Operators (5)[a]	Operators (7)[a]	Operators (5)[a]	Operators (8)[a]	Operators (5)[a]	Operators (5)
Maintenance Manager	Mech. Maint. (as needed)	Mech. Maint. (1)	Mech. Maint. (1)	Mech. Maint. (2)	Maint. Tech (as needed)	Maint. Tech (as needed)
	Elec. Maint. (as needed)	Elec. Maint. (1)	Elec. Maint. (as needed)	Elec. Maint. (1)	Elec. Maint. (as needed)	Elec. Maint. (as needed)
	Inst. Tech (as needed)	Inst. Tech (1)	Inst. Tech (as needed)	Inst. Tech (1)	Inst. Tech (2)	Inst. Tech (as needed)
	IMT (2) per shift					
Physical Protection Manager	Officers (as needed)				Officers (2)	Officers (as needed)
Waste Material Control Manager (MC&A)	Criticality Engineer (as needed)					
	Accountability Tech (as needed)	Accountability Tech (1)	Accountability Tech (as needed)	Accountability Tech (1)	Accountability Tech (1)	NA
	Item Control Area Rep (as needed)	Item Control Area Rep (1)	Item Control Area Rep (as needed)	Item Control Area Rep (1)	Item Control Area Rep (1)	NA
Licensing Manager	Licensing Support (as needed)					
Manager, Radiation Protection	HP Tech (1)	HP Techs (2)[a]	HP Tech (1)	HP Techs (3)[a]	HP Tech (1)	HP Techs (2)
	Chem. Tech (as needed)			Chem. Tech (1)	Chem. Tech (as needed)	
Environmental Safety and Health Manager	ES&H Tech (as needed)	ES&H Tech (1)[a]	ES&H Tech (as needed)	ES&H Tech (as needed)	ES&H Tech (1)[a]	ES&H Tech (as needed)
Quality Assurance Manager	QA Tech (1)	QA Tech (1)	QA Tech (1)	QA Tech (1)	QA Tech (as needed)	QA Tech (as needed)
Emergency Preparedness Manager	Fire Brigade (6)[a]					
	Emergency Medical (2)[a]					
Personnel / Shift	8 (single shift)	17 (per CRCF)	9	21	18	8 (single shift)
Facilities Personnel	8	204	36	84	72	8
Total Fac. Pers.	484 (does not count "as needed" personnel)					

[a] Forty-one on-shift personnel have emergency response support responsibilities.
[b] Facility supervisors would become incident commanders in the event of an accident or incident affecting the facility.

AF = Aging Facility; HP = health physics; IMT = instrument maintenance technician.

3.3 TRAINING AND LICENSURE OR CERTIFICATION

Operations training and certification is self-administered at Yucca Mountain with no formal NRC licensing of system or facility operators envisioned. During the process of facility and equipment acceptance and initial procedure development, the training organization will use the procedures as fundamental inputs to employee skills-based training. As operators progress through the training program, they will be evaluated and tested. Operators will complete the associated training, pass the test, and demonstrate acceptable on-the-job performance before he or she is authorized to perform the function. Additionally, the QA organization will provide routine surveillance of key operations to verify that the operations are performed according to procedure and that the outcome is acceptable and within any limitations or performance-based specification.

3.4 OPERATING SHIFT PERSONNEL

Key shift personnel at the GROA include management, supervision, operators, technicians, and security personnel as described in Table 2.

Table 2. Geologic Repository Operations Area Operations Duties and Interfaces

GROA Operator Groups	GROA Operations Duties and Interfaces
Utilities Technician (UT)	Ensure that electrical power, compressed air, and other utilities are available to support operations and emergency event mitigation; UT may also support and perform YT and GROA FT duties. Support wastewater treatment operations, including WHF pool water cleanup.
GROA Facilities Technician (FT)	Operate facility equipment in receiving and processing waste for emplacement; may be restricted to a single facility or may be cross-trained and authorized to work in multiple facilities. Document and record actions and provide for communications to operator groups. Ensure that equipment is appropriately isolated and administer site lock-out/tag-out program.
Yard Technician (YT)	Accept and move transporters (GROA rail switch engine, GROA yard tractor, and GROA site transporters) to move and productively place loaded and empty casks, aging overpacks, and other vehicles as directed. May also include UTs and GROA FTs. May include portable crane operations in support of waste receipt and aging activity.
Electrical Maintenance Technician (ET)	Inspect, maintain, and repair electrical equipment, including overhead crane drives, canister transfer machines, and other electrical maintenance work as directed. Inspect and maintain communications systems including public address systems and alarm systems.
Mechanical Maintenance Technician (MMT)	Inspect, maintain, and repair mechanical devices, including overhead cranes and GROA yard equipment (e.g., tractors, site transporters, TEVs). Operate out of the site shops and HEMF as directed.
Instrument Maintenance Technician (IMT)	Inspect, maintain, and repair instrument systems, including electronic, digital, and air-operated as necessary. Inspect and test interlock systems for function. Information technology and computer systems technicians may be a subset of the IMT group responsible for maintaining interconnected computer systems.

Table 2. Geologic Repository Operations Area Operations Duties and Interfaces (Continued)

GROA Operator Groups	GROA Operations Duties and Interfaces
Protective Force Officer (PFO)	Inspect all incoming personnel and vehicles to minimize the threat potential to the GROA, its facilities, and personnel. Provide visible security protection and response to potential threats to divert or disperse radioactive and fissile materials. May escort noncleared personnel making deliveries and pickups or other support contractors as requested. Other operation groups may also provide escort support.
Accountability Technician (AT)	Record the exact amounts of special nuclear materials received against the amounts shipped and maintain tracking and control over the materials against unlawful use, diversion, or dispersion. May also provide other operations support.
Health Physics Technician (HPT)	Conduct radiological surveys in support of operations, including verifying the absence of radiation or contamination in uncontrolled areas. Provide oversight and monitoring of worker radiation doses and administer the repository radiation protection program. Evaluate work areas and provide worker radiological job coverage and restrictions on work in the area. Calibrate and service radiation detectors and continuous air monitors.
Chemical Technician (CT)	Obtain and analyze samples of received wastes and other environmental samples in order to provide confidence of waste canister containment. May support HPTs and ES&HTs.
Environmental, Safety and Health Technician (ES&HT)	Observe and support operations involving physical, chemical, natural, and human hazards and ensure that hazard mitigations, including personal protective equipment, is available, suitable, and is used in conformance with procedures and policies. When needed, generate special work permits such as welding and burning permits or special processes.
QA Technician (QAT)	Provide independent oversight of operations and activities, including surveillances and audits in accordance with QA program requirements. Observe and detect operating trends and support overall programmatic goals.
Fire Brigade (FB)	Respond to fire alarms and other events, such as chemical spills. Support operations inside and outside of the GROA.
Emergency Medical Technician (EMT)	Respond to medical emergencies and direct first response activities, medical intervention, and transportation.
Central Control Center Operator (CCCO)	Monitor ongoing GROA activities in relation to planned activities; direct and redirect operators and groups in an effort to meet production and safety goals.
Specialty Contractor (SC)	As needed to perform contracted work. Normally, specialty contractor work would be overseen on a one-to-one basis by a knowledgeable group to ensure safety and functionality.

4. SCHEDULE—PHASED CONSTRUCTION AND OPERATION

4.1 OVERVIEW

There are five facets to the life of the repository:

- Site characterization
- Construction
- Operations (waste emplacement and postemplacement)
- Closure
- Postclosure.

Site characterization is not in the scope of this document. Postclosure is also out of the scope of this document. Construction and operations will take place in phases, starting with the facilities required to conduct initial operating capability. More facilities will be constructed and brought on-line to achieve full operating capability eventually. Then facilities will be removed from service as waste receipt ramps down. Nuclear operations will run concurrent with construction activities for several years and will continue several years after completion of the construction phase. Facility closure begins when waste emplacement operations and the ventilation period are complete.

Inherent to construction and operations is the startup of facilities. Startup includes startup of individual systems and verification of the interaction of systems to achieve the desired process outcome.

This document is not intended to address construction and so construction is addressed only as it relates to operational interfaces. Description of startup is not an explicit purpose of this document either; therefore, startup activities will be discussed at a high level, deferring to the yet-to-be-developed startup plan for details.

4.2 CONSTRUCTION INTERFACES

Specific interface agreements between the construction and Operations organizations have not yet been developed; however, they include (but are not limited to) the following areas:

- Isolation barrier removal and relocation
- Construction blasting
- Offsite deliveries
- Emergency response
- Site-generated waste management
- Safeguards and security
- Startup.

When emplacement and construction are concurrent, the construction portion of the subsurface facility will be under control of the subsurface construction manager and the emplacement portion will be under control of the operations manager.

On the surface, operations and construction are physically separated by the PIDAS fence and by any radiologically restricted area fences that extend beyond the PIDAS fence. Subsurface activities for construction and for operations utilize different portals. When the first phase of facilities and emplacement drifts are turned over from construction to operations for hot startup, all subsequent construction activities will be conducted at or through either the South Portal or North Construction Portal. All emplacement activities will be conducted at or through the North Portal. In the subsurface, moveable isolation barriers with PIDAS fence and isolation zones provide for physical separation and protection as construction of emplacement drifts progresses.

The ultimate authority on shift for resolution of construction and operations issues, as well as for emergency response direction, is the shift operations manager.

4.3 STARTUP

There are two stages of structure, system, or component startup. For cold startup, systems and processes are tested using a surrogate. For hot startup, waste forms (canisters or waste packages) are used. In concept, cold startup will take place as part of construction (using nuclear operators) and hot startup will take place as part of operations. The methodology for getting heavy GROA equipment (e.g., TEV) to a facility for cold startup, which will take place external to the GROA boundary, has not yet been defined. Likewise, the methodology for expanding or contracting the GROA boundary—to encompass new facilities, then to subsequently exclude those facilities if necessary to mitigate any major construction defect found during hot startup—has not yet been defined.

4.3.1 System Functional Testing

System functional tests will be performed once the startup organization has accepted a structure, system, or component. These tests are the responsibility of the startup organization with assistance from the operations organization so that operations personnel can become familiar with equipment and systems. System tests will be performed after the turnover of a system, or portions of a system, and all necessary component tests have been successfully completed. These tests include:

- End-to-end testing of electrical and instrumentation runs, such as continuity testing, insulation resistance testing, line calibrations, and terminations
- Bumping of motors and motor run-in tests
- Logic verification
- Ventilation (including air balancing)
- Equipment load tests

- Equipment functional tests
- Integrated system tests
- Safeguard and security system tests
- Subsurface barrier interlocks
- Access controls for high and very high radiation areas
- Radiological monitoring system tests.

4.3.2 Cold Integrated System Testing

The cold integrated tests verify the overall functionality and operating procedures of a facility using simulated waste forms. Shipping casks containing the simulated waste forms will be received at the facility; the simulated waste forms will be transferred to a prototype waste package; the waste package will be closed and loaded onto the TEV.

4.3.3 Surface Facilities

Surface facilities startup will be detailed in the startup plan, which is yet to be developed.

4.3.4 Subsurface Facilities

4.3.4.1 Emplacement Drift Commissioning

A commissioning plan will be developed prior to the start of construction. Emplacement drift commissioning will be undertaken in the following series of steps.

4.3.4.1.1 Ground Support Inspection

After drift excavation and initial ground support installation, the drifts will undergo an initial inspection. During this time, the entire drift will be visually inspected, geologically mapped in detail, and photographed. Installed temporary monitoring and test equipment will be removed prior to installing the permanent ground support or any waste emplacement infrastructure. Any observed water seepage areas will be noted. Water seepage areas indicate local groundwater sources that should be evaluated as to size and chemical characteristic to prevent future adverse effects on ground support components. Drift degradation areas and any ground support component defects will also be noted. On the basis of the direct observations, a determination will be made of any required repairs. All required repairs will be completed prior to the installation of the waste emplacement infrastructure as described in *Ground Support Maintenance Plan* (BSC 2008 [DIRS 185043], Section 6). A contingency emplacement capacity has been provided in the repository that can be made available for use in the event that a portion of an emplacement drift is determined to be not usable due to unacceptable ground conditions (e.g., unstable ground associated with a fault or perhaps infiltrations of water through a fractured zone). The criteria for abandoning a portion of an emplacement drift with offsets described have not yet been developed.

As part of the inspection, and prior to installation of the permanent invert ballast, steel, and rails, the drifts will be cleaned of any muck in the invert and friable (and possibly organic) material on the walls. All criteria pertaining to tracers, fluids, and materials will be met prior to installing the permanent ground support or other engineered features.

Geologic mapping of drifts and installation of convergence monitoring or other test equipment in support of the performance confirmation program will be coordinated with the construction department through the test coordination office.

After installation of the waste emplacement infrastructure, the drifts will undergo a final inspection for possible failure of any ground support components or indications of drift degradation or instability. If the visual inspection indicates a condition that requires repair, then the repair will be made at that time (BSC 2008 [DIRS 185043], Section 6.1.1).

4.3.4.1.2 Emplacement Drift Systems Turnover

The complete emplacement drift systems or subsystems will be turned over from the construction organization to the startup organization. The turnover takes place when the construction organization has completed construction of the emplacement drifts, installed the components needed for the start of waste emplacement, and completed component testing. The turnover acknowledges that the construction, installation, and inspection have been performed in conformance with approved engineering drawings, codes, and specifications.

4.3.4.1.3 Emplacement Drift System Functional Testing

Emplacement drift system functional tests are the responsibility of the startup organization with assistance from the operations organization so that operations personnel can become familiar with equipment and systems. At a point during construction when appropriate, and agreed to by the construction and startup organizations, the focus will change from construction by area to completion by system. The startup organization will complete system functional testing in accordance with the testing plan and procedures.

4.3.4.1.4 Emplacement Drift Cold Integrated System Testing

The Phase 1 emplacement drift cold integrated tests (using actual operating procedures) are the final tests prior to receiving a license to receive and possess nuclear material. These tests will verify the overall functionality and operating procedures of the emplacement drift using surrogate (i.e., nonradioactive) waste forms. The TEV containing a surrogate waste package will be moved to an emplacement drift and the waste package will be emplaced in the drift. The ability to retrieve a surrogate waste package will also be verified during this phase.

4.3.4.1.5 Emplacement Drift Hot Testing (Initial Startup Operations)

Once a license to receive and possess SNF and HLW is received from the NRC, hot testing or initial startup operations will begin. Hot testing will demonstrate the ability, using actual operating procedures, to emplace waste. Hot testing will be performed in accordance with a testing program plan and will include the following elements:

- Confirmation of facility operating procedures
- Safeguards and security system tests
- Access controls for high and very high radiation areas
- Safety systems and refuge areas
- Shield confirmation surveys
- Confirmation of emplacement times
- Confirmation of shielding adequacy
- Confirmation of controls during emplacement
- Confirmation of capability to emplace waste packages at a 10 cm (4 in.) spacing end-to-end, within the prescribed tolerance
- Capability to recognize waste package and pallet by their respective unique markings
- Confirmation of facility ventilation systems operating procedure.

4.3.4.1.6 Subsurface Panel 1, Phase 1 System Turnover

Subsurface Panel 1, Phase 1, is unique in that it marks the turnover of the North Portal and the emplacement support systems from construction to operations. Acceptance takes place when the construction organization has completed construction of the subsurface openings and installation of those components needed for the start of waste emplacement. The turnover acknowledges that the construction, installation, component testing, and inspection have been performed in conformance with all approved engineering drawings, codes, procedures, and specifications and with the conditions and requirements appropriate to the license application. The systems or subsystems associated with Panel 1, Phase 1, that are part of the initial turnover include:

- North Ramp and North Ramp Access Facility
- Sections of the Panel 1 access main
- Turnouts to Emplacement Drifts 1-1 through 1-3
- Emplacement Drifts 1-1 through 1-3

- Sections of the Panel 1 exhaust main
- Exhaust Shaft #1
- Observation drift
- Inverts, rail, and ballast (North Ramp, access main, three turnouts, and three emplacement drifts)
- Ground support
- Electrical power and lighting
- Instrumentation, communications, and alarms
- Fire detection and suppression systems
- Exhaust fan and associated surface facility
- Isolation barriers
- Emplacement access doors
- Access control system
- Material control and accounting (MC&A) system
- Subsurface radiological monitoring and alarm.

5. INTEGRATED SAFETY MANAGEMENT

5.1 OVERVIEW

In the conduct of work activities, the Integrated Safety Management System (ISMS) ensures that all work is performed safely and in a manner that provides adequate protection for the employees, public, and environment. Safety, as related to ISMS, pertains not only to safety and health, but also to each aspect of the Environmental Management System, including pollution prevention and waste minimization. The program applies to work conducted by all employees, contractors, and subcontractors working at the repository.

5.2 IMPLEMENTATION

The management of environmental, safety, and health (ES&H) functions and activities is an integral, visible part of all work planning and execution. Activities are conducted utilizing a degree of care commensurate with the work and associated hazards (i.e., work activities are graded appropriately for risk).

All personnel are tasked with the responsibility and accountability to ensure success of the ISMS. Personnel at all levels throughout the organization will actively support and participate in work planning, hazard identification and control, and continuous improvement processes. The products of these activities are integrated throughout the organization to achieve ISMS principles and functions.

The conduct of activities will strictly adhere to requirements and procedures. All work is subject to the controls of the ISMS and will be performed in accordance with identified governing procedures. Procedures and work orders used to perform work will be controlled and used at the work location.

Each individual is expected to perform work safely. If work cannot be completed safely, the worker will suspend work until the safety issue is resolved. In addition, if an individual observes an unsafe act or condition of another individual, he or she will stop work until the issue is resolved.

Implementation of ISMS is a line management responsibility with each employee accountable for the safety of his or her work. The program is implemented through the incorporation of core functions and guiding principles into work planning and execution processes, procedures, and work orders. The ISMS core functions are:

- Defining the scope of work
- Identifying and analyzing associated hazards
- Developing and implementing hazard controls
- Performing work within controls
- Providing feedback for continuous improvement.

The core functions are supported by the following eight guiding principles that establish conditions for the performance of work:

- Line management responsibility for safety
- Clear roles and responsibilities
- Competence commensurate with responsibilities
- Balanced priorities
- Identification of safety standards and requirements
- Hazard controls tailored to work performed
- Operations authorization
- Worker involvement.

5.2.1 Radiation Dose as Low as Is Reasonably Achievable

NOTE: Unless otherwise identified, radiological control activities and processes discussed in this document reflect initial and generic concepts for radiological control requirements as they relate to and impact operating work processes. Radiological control activities referenced in this document will be updated as the radiological control program is further developed and as the radiological work requirements are further defined.

Controlling worker radiation dose is a significant operating challenge for the YMP. Due to the high radioactive source terms for the waste canisters and packages and the limitations on shielding that result from accommodating reasonable transportation and handling, as multiplied by the large number of waste canisters and packages handled, administrative controls must at times be relied upon for as low as is reasonably achievable exposure. A robust operational radiation protection program and associated training is required but not yet developed. This program will implement the requirements of 10 CFR Part 20, Energy: Standards for Protection against Radiation [DIRS 181962], as well as appropriate NRC regulatory guides and industry good practices. As experienced by commercial and DOE nuclear operations, the as low as is reasonably achievable program at Yucca Mountain is expected to be enhanced as greater proficiency and improvements to operations are implemented based on actual operating experience.

5.2.2 Human Factors

Human factors will be considered in design, equipment labeling, procedure development, and worker schedules. The Operations department will implement, as applicable, INPO guidance and other industry good practices related to human factors for the prevention of errors.

5.2.3 Procedures

Initial operating procedures will be developed during facility construction and commissioning activities. Operators and management will verify mechanical drawings and design documents, follow equipment pathways, trace out and label equipment and services (e.g., utilities), test interlocks, operating, and movement limits, and measure performance of equipment and systems against procurement specifications. During this time, initial operating procedures will be developed with key input from operators and operations supervision and management. As equipment and facilities construction is completed, facility and equipment functions are verified by using noncontaminated equipment such as casks, aging overpacks, waste packages, and other structures, systems, and components. In some cases, scale and full-size models and mockups will be used to demonstrate facility and equipment functions. Final procedures will be reviewed by an independent technical reviewer and sent on for approval by the site approval committee and validation by the operating unit. The process of procedure validation is an important training tool.

Operations will be performed in accordance with approved procedures following the format and requirements as provided in policies and instructions for conduct of operations prepared in accordance with INPO guidelines, as appropriate, and following the principles of the Performance Document Management System. General procedures will cover all YMP activities; local, facility, equipment-specific, and work control procedures may be limited to specific operations and activities within a single facility. Formal management approval of procedures will include independent technical reviews by QA, health and safety, radiological protection, licensing, maintenance, and security as appropriate. Procedures will be placed under document administrative controls such that only the latest revisions are used to conduct current operations. It is expected that procedures will be developed, administered, and maintained in electronic format, thereby minimizing the volume of paperwork generated and integrating procedure compliance, configuration control, and records administration.

To the extent that it is deemed necessary, equipment and facilities are designed to prevent unsafe conditions resulting from power failures or equipment malfunction. System operators are trained to recognize and to respond to indications of unexpected or off-normal conditions. Abnormal operating procedures are written to address these situations.

The following discussion reflects the current concept of procedure types that will be used for repository operations and maintenance.

1. **General Procedures**—Documents that provide guidance, general requirements, and limitations for controlling work throughout the repository site, including work outside of the GROA.

2. **Equipment Operating Procedures**—Documents that provide specific operating instructions for equipment and processes used, such as site transporter operations or electrical switching. This category includes abnormal operating procedures.

3. **Work Control Procedures**—Documents that provide detailed step-by-step sequence of operations; applicable sign-off requirements for Process-Production, Quality Control, Radiation Protection, and Environmental, Safety and Health; and the location and requirements for recording any special process or data. Required surveillances and testing will be performed per work control procedures.

Some examples of the procedures in each category are summarized in Tables 3 through 5:

Table 3. General Procedures (Examples)

Example Procedures	Purpose
Fissile Materials Accountability Procedure(s)	Instructions for identifying individual SNF assembly and canisters (including TAD canisters) and tracking its ultimate location within the facility for licensing and fissile material accountability control purposes Fissile material decay reports each quarter to delist ^{241}Pu as it decays
NRC Notification Procedure(s)	Provide criteria and instructions for notifying the NRC about reportable events such as: – Cask radiological survey data exceeds NRC reporting thresholds – Personnel contamination or overexposure – Off-normal events within the facility per or as referenced by 10 CFR 63.73.3 [DIRS 180319]
Vehicle Security Inspection Procedure(s)	Security inspection instructions for vehicles entering the protected area Appropriate handling instructions for vehicles meeting or failing (rejection) vehicle acceptance criteria To whom and what is to be done with incoming (receipt) shipment paperwork Direction for operating vehicles , including traffic controls and postings.
Emergency Management Procedures	Emergency reporting Incident classification and notification Activation of emergency response facilities Conduct of drills and exercises.

Table 4. Equipment Operating Procedures (Examples)

Example Procedures	Purpose
Critical Lifting and Hoisting Procedure(s)	Defines inspection, acceptance, and rejection criteria for slings, chains, connectors, and other lifting devices Provides general guidance and requirements for lifting and rigging operations involving critical and noncritical lifts Provides general guidance and documentation of daily, monthly, quarterly, and annual crane performance including range-of-motion, interlock, and shut-off switch function
Mobile Access Platform Operating Procedure	Defines inspection and acceptance requirements for any permanent and temporary scaffolding used to access casks Provides general guidance and requirements for relocating and use of mobile access platforms
Vehicle Movement and Parking Procedure(s)	Defines actions and limits for coupling and uncoupling motive power units (e.g., locomotives or road tractors) to vehicles on site Requires that landing gears are used to support trailers and wheel chocks are applied to prevent vehicle movements Railcar coupling will be done without energizing air brakes but under control of power unit or switch engine (i.e., no humping)

Table 5. Work Control Procedures (Examples)

Example Procedures	Purpose
Transportation Cask Survey Procedures	Provide detailed instructions for performing radiation and nonfixed contamination surveys of incoming (i.e., loaded) transportation casks and transport and outgoing (i.e., empty) transportation casks to assess compliance with 49 CFR 173.441, 49 CFR 173.443, and 10 CFR 71.47 interstate transportation requirements
Lockout/Tagout Procedure	Provides processes for ensuring that electrical power or stored-energy hazards are blocked off before equipment or systems are opened for repair

5.3 ENVIRONMENTAL, SAFETY, AND HEALTH PROGRAMS

ES&H considerations are a deciding factor in the concept of operations for all phases of the repository. These considerations are embedded in the design, construction, and operation. The ES&H electronic manual is a virtual compilation of ES&H program elements and procedures, and other ES&H-related documents and program information that implement ES&H requirements of federal and state laws, regulations, standards, and DOE directives applicable to the Office of Civilian Radioactive Waste Management (OCRWM) YMP.

The ES&H manual provides functional, organized access to current ES&H requirements, program documents, and related information. It contains a table of contents organized by program elements. Each program element contains content summaries to assist the user in locating the appropriate requirements for the desired subject matter.

The ES&H manual supports the DOE commitment to ensuring that each employee is provided with a safe and healthy work environment. It incorporates integrated safety management principles and functions contained in *Integrated Safety Management Plan* (DOE 2007 [DIRS 185206]) and *Safety Management Functions, Responsibilities, and Authorities Manual* (DOE 2003 [DIRS 176028]).

A worker safety and health program will implement 10 CFR Part 851, Energy: Worker Safety and Health Program [DIRS 182868].

5.4 RADIATION MONITORING

5.4.1 Effluent Monitoring

The air exhaust from the subsurface facility will be sampled for radioactivity per *Subsurface Emplacement Ventilation and Instrumentation Diagram Exhaust Shaft 1 Fans* (BSC 2007 [DIRS 184018]) and *Subsurface Emplacement Ventilation and Fan Instrumentation Table Exh Shaft 2, 3N, 3S, 4 & ECRB* (BSC 2007 [DIRS 184019]). With respect to effluent monitoring and controls, and in accordance with *Regulatory Guidance Agreement, Agreement for Regulatory Guide 1.21, Rev. 1 - Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and*

Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants (BSC 2007 [DIRS 182077]), the project has adopted Regulatory Guide 1.21 with clarification from *Basis of Design for the TAD Canister-Based Repository Design Concept* (BSC 2008 [DIRS 185025], Section 28.2.1.4). Subsurface exhaust air sampling will be implemented in accordance with applicable sections of ANSI/HPS N13.1, *American National Standard Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities* [DIRS 152380] and *Project Design Criteria Document* (PDC) (BSC 2007 [DIRS 179641], Section 4.6.2.6.2).

A graded approach to sampling and sample system design will be followed during the detailed design phase that is consistent with the guidance in ANSI/HPS N13.1 [DIRS 152380].

5.4.2 Area Radiation Monitoring

The project has adopted design guidance with respect to area radiation monitors (ARMs) as follows:

- ARMs will be provided in the IHF, CRCFs, RF, WHF, and other repository facilities, as necessary. The monitors shall be designed to detect changes in radiation levels above the expected levels and produce alarm signals in order to alert personnel to take protective action. (BSC 2008 [DIRS 185025], Section 28.2.1.3).
- ARMs will be provided where required throughout the surface facilities in areas that require entry, exit, or both, which are normally accessible as required by ANSI/ANS-HPSSC-6.8.1-1981, *Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Nuclear Reactors* [DIRS 159434]. This criterion is required to ensure adequate coverage of areas where there is potential for significant personnel radiation dose rates. ARMs are not required for subsurface facilities, as adequate administrative controls will be imposed where entry to high radiation areas is required (BSC 2007 [DIRS 179641], Section 4.6.2.3.1).

The YMP has adopted ANSI/ANS-HPSSC-6.8.1-1981 [DIRS 159434] within the PDC (BSC 2007 [DIRS 179641]) with respect to coverage of areas and locations of ARMs. The PDC (BSC 2007 [DIRS 179641]) excludes the need for ARMs in the subsurface facility.

The purpose of ARM measurements is personnel protection in compliance with ANSI/ANS-HPSSC-6.8.1-1981 ([DIRS 159434], Section 4.5). Detectors for monitoring and controlling occupational radiation exposure will be located in normally accessible areas which require entry, exit, or both, and where changes in plant conditions can cause significant increases in the personnel exposure rate above that expected for the area in accordance with ANSI/ANS-HPSSC-6.8.1-1981 ([DIRS 159434], Section 4.2). Per Section 5.4 of ANSI/ANS-HPSSC-6.8.1-1981 [DIRS 159434], "The locations and ranges of area radiation monitors shall be chosen to satisfy the requirements of ANSI/ANS-HPSSC-6.8.1-1981, Section 4.2 and 4.3."

The expected radiation levels in the subsurface facility have been adequately described and characterized. The subsurface facility radiation zone classifications for the license application are given in Table 6.

Table 6. Radiation Zone Classifications for Major Subsurface Facility Locations

Major Subsurface Facility Locations	Radiation Zone Classification	Dose Rate Range (mrem/hr)	Classification Description
Ramps, access mains, access main emplacement drift turnout intersection outside bulkhead, other nonemplacement openings not specifically identified	R2	0.05 to 2.5	Routine occupancy possible, less than or equal to 2000 hrs/year possible
During TEV movement in the subsurface facility: Ramps, access mains, access main emplacement drift turnout intersection outside bulkhead, other nonemplacement openings not specifically identified **when TEV is present**	R4	>15 to 100	NA
Emplacement drift, emplacement drift turnout inside bulkhead, exhaust mains and shafts	R5	>100	Limited or no occupancy. Access is restricted. Occupancy is not normally allowed

Sources: *Subsurface Facility and Transport and Emplacement Vehicle Preliminary ALARA Design Review* (BSC 2007 [DIRS 183393], Table 5) and *Subsurface Facility Radiation Zone Classification* (BSC 2007 [DIRS 183349]).

Occupancy is not normally allowed or expected in emplacement drifts, emplacement drift turnouts inside bulkheads, and exhaust mains and shafts. These areas are not normally accessible. Therefore, ARMs are not required by design within these locations because the areas do not meet the location criteria of ANSI/ANS-HPSSC-6.8.1-1981 ([DIRS 159434], Section 4.2).

Ramps, access mains, access main emplacement drift turnout intersections outside the bulkheads, and other nonemplacement openings not specifically identified allow for routine occupancy. The radiation zone classification for the license application for these areas is R2 (0.05 to 2.5 mrem/hr) when the TEV is not present, and R4 (>15 to 100 mrem/hr) when the TEV is present. By design requirements, the TEV dose rate is limited to less than 100 mrem/hr at 30 cm based on the PDC (BSC 2007 [DIRS 179641], Section 4.10.1.3, Table 4.10.1-1). Supporting calculations indicate that TEV dose rates meet design requirements when transporting 21 PWR design basis fuel assemblies based on *Dose Rate Calculation for Transport and Emplacement Vehicle* (BSC 2007 [DIRS 183768], Section 7.3). There is no credible Category 1 or 2 event sequence identified in the subsurface facility. No scenario exists where changes in plant (i.e., subsurface facility) conditions can cause significant increases in personnel exposure rates above those expected for these areas. Therefore ARMs are not required by design within these locations because the areas do not meet the location criteria of ANSI/ANS-HPSSC-6.8.1-1981 ([DIRS 159434], Section 4.2).

As stated previously, the purpose of ARM measurements is personnel protection in accordance with ANSI/ANS-HPSSC-6.8.1-1981 ([DIRS 159434], Section 4.5). There is no readily quantifiable or qualifiable justification with respect to improvements in personnel protection that would result from including ARMs in the subsurface facility design. Furthermore, including ARMs in the subsurface facility design may have an opposite and potentially detrimental impact by increasing personnel occupancy and exposure time in the subsurface facility due to time required for calibration, response testing, and maintenance of installed ARMs.

It should be noted that current TEV design includes an ARM based on *WP Transport & Emplacement Vehicle Process & Instrumentation Diagram (Sheet 1 of 2)* (BSC 2007 [DIRS 183780]). This will allow operator monitoring of TEV dose rates during transport.

6. SITE SECURITY

NOTE: Due to the classification of security information, site security details are limited in this document.

6.1 SECURITY OVERVIEW

The physical protection program is designed to protect SNF and HLW against internal and external threats that could cause loss of control over the GROA protected area, theft or diversion of special nuclear materials, radiological sabotage, and compromising classified documents. Physical protection includes physical barriers such as building walls, a waste package or cask body, fences and vehicle barriers; the presence of protective force officers; detection, surveillance, and alarm system; access control system; and the communications system. Personnel and vehicle entry into the protected area is only permitted at entry and exit control points and only after personnel and vehicles have been searched for prohibited items. Detection and assessment systems will be positioned at designated facilities within the GROA protected area, along the protected area boundary fence, and at protected area entry and exit control points. These alarms will annunciate in the primary and secondary alarm stations, prompting an immediate assessment and response by the security force. The primary and secondary alarm stations provide site-wide security oversight; are located inside the protected area; and are protected against unauthorized access. Security communications will be via redundant radio network and telephone. Backup auxiliary power and uninterruptable power supplies are provided to the base stations communications systems, detection and assessment systems, the primary alarm station HVAC system and the alarm communications and display system in the event of a power outage. Designated offsite response personnel including local law enforcement agencies will be contacted to support security response actions if necessary.

Security for the subsurface facility includes physical barriers, access control, and detection and assessment systems. The entrance to each emplacement drift has an access door that is used to prevent personnel access. The exit of each emplacement drift opens to the exhaust mains that have isolation barriers to control the ventilation flow and that also serve as physical barriers to prevent human access. Detection and assessment occurs at all portals, ventilation shafts, and at various locations underground, including physical barriers and isolation zones and emplacement drift doors.

A key subsurface security issue is the isolation of emplacement operations activities from construction. Moveable isolation barriers with PIDAS will provide for physical separation and protection as construction of the emplacement drifts progresses.

6.2 MATERIAL CONTROL AND ACCOUNTABILITY

The MC&A program is implemented to control and account for special nuclear materials to protect against loss, theft, or diversion. Nuclear materials are tracked from the shipping location through emplacement. Each loadedcanister that is not welded closed will be equipped with a tamper-indicating device (TID). Upon receipt, two independent individuals at the repository verify integrity of the TID and prepare nuclear material accountability records, material transfer reports, material status reports, and inventory reports based on shipper-supplied values. For uncanistered SNF, the individual SNF assembly data is checked against the original manufacturing data provided by the origin site. In addition, two individuals will independently verify that data provided by the origin site is accurate and complete. Once a waste package is emplaced, the drift access doors are closed and two TIDs are installed so that routine inventory management can be accomplished through the records system and through remote monitoring, if required.

7. EMERGENCY MANAGEMENT

7.1 OVERVIEW

The site emergency plan will be developed according to the requirements and guidance provided by the NRC in 10 CFR 63.21 [DIRS 180319]; 10 CFR 72.32(b) [DIRS 181968]; NUREG-1567, *Standard Review Plan for Spent Fuel Dry Storage Facilities* [DIRS 149756] (as modified by NRC Spent Fuel Project Office Interim Staff Guidance-16); NUREG-0696, *Functional Criteria for Emergency Response Facilities, Final Report* [DIRS 104098]; and NUREG-1804, *Yucca Mountain Review Plan, Final Report* [DIRS 163274]. The emergency plan covers detection of situations, incidents, and accidents that could lead to an emergency; responsibilities for notifying, communicating, and responding; and restoration of safe conditions. The discussion in this section is intended to achieve an understanding of the concept of operations for emergencies, whereas the emergency plan provides detailed information.

Due to the lack of significant energy sources that could drive an offsite release (beyond the owner-controlled area), the highest level of emergency considered credible for repository operations is a site area emergency, consistent with 10 CFR 72.32(b) [DIRS 181968]. A site area emergency does not necessitate offsite emergency mitigation actions. Onsite emergency response activities for a site area emergency will include shelter-in-place and evacuation.

Site personnel, including those in nonnuclear functions and facilities, will be trained to respond appropriately to emergencies and to take protective actions. Periodic exercises and drills will be conducted to ensure appropriate and timely personnel responses and accountability.

Security-related actions will be governed by the physical protection plan, not the emergency plan.

7.2 AGREEMENTS

As a part of emergency planning, agreements are required with state and local organizations that may be needed to respond on site, as well as the Nevada Test Site and possibly the United States Air Force. These agreements address mutual support and establish hierarchies of control. Arrangements with outside agencies, such as county fire departments, law enforcement, and local hospitals, are formalized to establish capabilities and identify responsibilities.

7.3 EMERGENCY FACILITIES

The central point for the management of the repository response to an incident will be the Technical Support Center located in the CCCF. The CCCF will be staffed continuously. A backup to the Technical Support Center will be provided in the Administration Building. These facilities provide, with modifications appropriate to a repository, capabilities consistent with the guidance contained in NUREG-0696 [DIRS 104098]. The CCCF will have a digital control and management information system, telephone, radio, and video capability to aid in incident assessment. It will also have alarm and public address systems to notify onsite and offsite personnel of an emergency.

The Emergency Operations Facility, with capabilities consistent with the guidance provided in NUREG-0696 [DIRS 104098], will be collocated with OCRWM offsite offices. The Joint Information Center will be collocated with the Emergency Operations Facility.

An area for the Operational Support Center has been identified in the WNNRF. A nonaffected handling facility will be used as an alternate location. Additional assembly areas will be identified for nonessential personnel within nonnuclear facilities in and near the GROA sufficient to accommodate the expected staffing.

Some emergency equipment will be stored in the WNNRF in support of the primary Operational Support Center. Other locations for the storage and stockpiling of emergency equipment have not yet been determined.

7.4 CONCEPT OF OPERATIONS FOR EMERGENCY RESPONSE

7.4.1 Identification and Activation

Emergencies are initially recognized through direct observation, alarms, or process indications. Once recognized, the individual detecting the condition informs other individuals in the area of the situation and then notifies the shift manager located in the CCCF. The shift manager is the senior management representative on shift; this position is staffed at all times. The shift manager has the responsibility and authority to classify the incident, make offsite notifications, initiate site protective actions, and activate the Emergency Response Organization.

Once the decision is made to activate the Emergency Response Organization, the shift manager will notify the Emergency Response Organization to activate the Technical Support Center (located in the CCCF), the Operational Support Center (located in the WNNRF), the Emergency Operations Facility (located at the OCRWM general office), and the Joint Information Center (located in close proximity to the Emergency Operations Facility).

The Technical Support Center staffing is comprised of senior site management and operating staff necessary to direct emergency response personnel to manage the site response. Once the Technical Support Center is staffed, command authority for the overall site response and responsibility for initiating site protective actions will transfer from the shift manager to the Technical Support Center director.

The Emergency Operations Facility staffing is comprised of senior OCRWM management personnel necessary to interface with DOE Headquarters and NRC Headquarters, and to provide oversight of the OCRWM response to the incident. Once the Emergency Operations Facility is staffed and operational, the responsibility for event classification and offsite notifications will formally transfer from the shift manager located in the CCCF to the OCRWM emergency director. The Joint Information Center will be staffed with the necessary personnel to provide OCRWM interface with the public and media on matters related to incident response. While there are no specific requirements for response times for the response facilities (i.e., Technical Support Center, Emergency Operations Facility, and Operational Support Center), it is expected that the Technical Support Center, Emergency Operations Facility, and Joint Information Center will be fully staffed and operational within about 2 hours of the initial classification of the incident.

Operating personnel not directly involved with the incident response at the affected facility will assemble at the Operational Support Center. The Operational Support Center staff will be dispatched to assist the affected facility as directed by the shift manager or as requested by the facility supervisor. Once the Technical Support Center is staffed, the responsibility for dispatching emergency response personnel from the Operational Support Center will transfer to the Technical Support Center. The Technical Support Center will also be responsible for any callouts of additional emergency response staff necessary to respond to the incident at the site. Additional emergency response personnel may augment the affected facility staff, the Technical Support Center staff, or the Operational Support Center staff.

7.4.2 Direction and Coordination

The repository has established an Emergency Response Organization that has the authorities and responsibilities to direct and implement any necessary actions to respond to an incident at, or affecting, the repository. For each position within the Emergency Response Organization, a member or organization from the normal organization is assigned primary responsibility for the position. Along with this assignment is the responsibility for the primary organization to provide suitable candidates for alternates to the Emergency Response Organization position, such that at least three individuals are fully trained and qualified for each position within the Emergency Response Organization at all times. For Emergency Response Organization positions not staffed during off-normal working hours (i.e., nights, weekends, and holidays), a duty roster will be established and maintained that provides reasonable assurance that trained and qualified personnel will be available for call in at all times to staff the Emergency Response Organization.

The shift manager is the designated management representative on shift at all times with the authority and responsibility to implement and direct any emergency response. The shift manager initially assumes the role of emergency director and may not delegate the decision-making responsibility for the classification, escalation, or termination of the emergency. This responsibility transfers as the Technical Support Center and Emergency Operations Facility are activated as described in Section 7.4.1. Facility and systems operation remain within the control of the facility operating staff as directed by the facility supervisor throughout the response to any incidents or events.

The Emergency Response Organization operates from the specific emergency response facilities previously described.

7.5 FIRE BRIGADE

NOTE: This section is not written to support construction activities and facilities. Changes to fire department staffing may be driven by construction phase needs assessments.

There is a dedicated fire department for the repository. It will be staffed as required to provide expertise in fire fighting supervision, fire equipment maintenance, fire code compliance, and fire fighting training. The repository will not have a full-time dedicated group of firefighters that can, without assistance, respond and suppress all site fires. Instead, a fire brigade that is comprised of plant operators trained and certified in fire fighting and rescue will supplement the fire department. This model is analogous to that of nuclear power plants and military facilities.

Additionally, it is expected that agreements will be made with local fire departments and the Nevada Test Site fire department that will provide supplementary firefighters and equipment for fires occurring outside of the GROA.

The responding fire brigade will contain at least one operations supervisor who is knowledgeable in nuclear safety to ensure fire fighting is conducted in a manner that does not jeopardize the health and safety of site personnel or the public. For example, water is a neutron moderator that, if used improperly on uncanistered nuclear fuel, could result in an inadvertent nuclear criticality. Similarly, it is important to be knowledgeable of the physical locations and arrangement of redundant nuclear safety systems so that the act of fighting a fire does not inadvertently defeat a safety function by removing both redundant trains of safety equipment from service.

The fire brigade will be structured and trained to meet a response time to be determined.

8. OPERATIONS

This section provides a general overview of GROA operations. Operations are performed in accordance with NRC, licensing, and design safety basis limitations. Operations are established to meet programmatic throughput goals, with the result being waste packages prepared in accordance with requirements such that they function along with the emplacement drifts to prevent uncontrolled release of radioactivity to the environment.

8.1 RESTRICTIONS AND LIMITATIONS

Operations described are limited to those related to the receipt of nuclear wastes prepared off site and processing of the wastes, including aging and emplacement. All operations are restricted by the explicit NRC-issued licensing basis, including Technical Specifications, License Conditions, and federal regulations related to waste disposal, radioactive materials handling, dose to workers, and packaging and transportation of wastes for disposal. Continuous improvements to the processes and operations are expected but will not exceed those authorized and approved by the NRC.

8.2 OVERVIEW

Conduct of operations includes a formalized system that stresses rigid conformance to documented policies and procedures conducted in a predictable and professional manner. Conduct of operations at Yucca Mountain will follow the applicable guidelines of the INPO. Communications of instructions and system status are written or otherwise permanently documented. Personnel not meeting critical fitness for duty standards will not be allowed GROA access or be allowed to operate equipment or systems therein. Unescorted access to nuclear facilities and critical equipment will be restricted to only approved and authorized personnel. Worker doses will be tracked to confirm that repository administrative dose limits are not exceeded.

Activities and operations will be performed according to approved plans and schedules, and their completion documented in approved logs and other site records. Turnover between shifts and work groups will include both face-to-face and written instructions and systematic communications about the status of operations, structures, systems, and components (SSCs). The operating staff is trained to recognize situations and symptoms of equipment or process fault and what corrective actions to take. Access to systems, equipment, or facilities undergoing maintenance, repair, or modification may be restricted under a robust lockout/tagout system designed to protect personnel, facilities, and equipment from potential damage.

8.3 APPENDICES

Sections 8.4 through 8.6 provide information to promote a general understanding of site-wide operations. Detailed information related to specific facilities and some key concepts (e.g., abnormal operations) is provided in the appendices to this document. The appendices are written as stand-alone documents, allowing the reader to understand, as fully as possible at this stage of design and operating philosophy development, how each facility will be operated. The appendices will mature with the design, and it is expected that additional appendices will be produced. This maturation will be reflected in future revisions to this document. Eventually, the appendices will serve as a basis for the development of operating procedures.

8.4 NUCLEAR FACILITIES

8.4.1 Overall Yucca Mountain Operating Concept

Nuclear wastes, including naval SNF, commercial SNF, and DOE SNF and HLW, will arrive at the site in NRC-approved and certified casks. After completing incoming security and radiological surveys, casks will be staged and ultimately unloaded; empty transportation casks will be reassembled and returned to service. Nuclear wastes not suited for immediate disposal are transferred for temporary cooling and process staging at site Aging Facilities. Surface movements of nuclear wastes, such as movements between surface and Aging Facilities, will be performed using site-only aging overpacks moved by site transporters operated according to site safety limits and restrictions. Wastes meeting disposal criteria will be loaded into waste packages and, after seal welding, will be moved to an emplacement drift location using a TEV. The TEV will also have the capability to retrieve waste packages from an emplacement drift for return to surface facilities if required. Although not anticipated, this entire process could be reversed to send wastes off site. The multiple layers of packaging and suitable environmental conditions within Yucca Mountain combine to ensure that radioactivity is not released to the environment from the contents of the waste packages.

8.4.2 General Description of Nuclear Surface Facilities

Nuclear surface facilities are equipped to unload casks, transfer wastes, and load and seal waste packages in the vertical orientation, although waste packages are ultimately emplaced in the horizontal position. Within each surface facility, shielded transfer rooms provide worker radiation protection. Aging overpacks are used to accommodate receipt rates above the waste packaging processing rate and for contents that do not meet thermal requirements for disposal. Each surface facility has rooms or locations to conduct necessary operations. A discussion of each facility's layout, equipment, and processes is provided in the documents referenced in Appendices C, D, E, and F.

8.4.3 Commonalities

Many key waste handling processes and equipment features are used in multiple surface facilities, thereby simplifying designs and operations. The IHF allows for dry transfer of sealed canisters and placement in waste packages. The CRCF likewise allows for the receipt and transfer of sealed canisters to waste packages using the same essential design scaled up to promote throughput. The RF uses the same design for transferring canistered wastes, but has no waste package capability. The WHF, where a deep water-filled pool allows handling of uncanistered SNF and remediation, if necessary, uses some of the standard designs and features but departs due to differences in operations from the canister-only facilities.

8.5 BALANCE OF PLANT

Central Control Center Facility

The CCCF is a reinforced concrete building that supports the shift manager in monitoring and supervising overall GROA operations and that is suitable for occupancy during any GROA emergency condition. The shift manager monitors and directs normal site operations and allocates resources as needed from the CCCF. Features and functions of the CCCF may include:

- GROA security primary alarm station
- GROA fire alarm panel station (primary or secondary)
- GROA remote facility radiation and contamination alarm station
- GROA interlock alarm station
- GROA remote facility closed-circuit television monitoring.

Multiple closed-circuit television capability allows for remote monitoring of many of the waste and processing activities at the surface facilities and buildings, such as waste package and TAD canister welding, TEV movement and progress, and Aging Facility activities.

Low-Level Waste Facility

The LLWF is a building where low-level radioactive wastes (i.e., solid radioactive or radioactively surface-contaminated wastes generated during processing activities at the surface facilities and that qualify for near-surface disposal) are warehoused, characterized, repackaged as necessary, and prepared for offsite shipment and disposal. Although mostly mildly contaminated cloth and personal protective equipment, low-level wastes also include surface-contaminated commercial dual-purpose canister shells emptied of SNF at the WHF.

Multiple rooms or cells that are physically separated from adjacent rooms or cells by shielding walls allow for storage and processing operations to continue without causing unreasonable personnel doses. WHF pool water is maintained optically and radioactively clean by use of a recirculating water filtering system. This system's filter canisters may be transferred to the LLWF before offsite disposal or may be processed and packaged at the WHF. High-efficiency particulate air filters from the surface nuclear facilities, exhibiting the presence of radioactivity, would also be packaged and prepared for offsite shipment at the LLWF.

Low-level radioactive waste disposal would be done only at facilities specifically authorized to accept and dispose of such wastes. Wastes destined for one disposal facility may be segregated from wastes destined for another. Low-level radioactive wastes prepared for transportation and disposal would be transported by truck or rail to the authorized low-level waste disposal facility.

Heavy Equipment Maintenance Facility

This building houses the TEVs for inspection, testing, maintenance, and repair when they are not in use transferring loaded waste packages to emplacement drifts. Each TEV is dispatched for loaded waste package pickup from the HEMF to the IHF or CRCF and, after placing a waste package in the assigned emplacement drift, the TEV returns to the HEMF if maintenance or decontamination is required. TEV maintenance is expected to focus on routine lubrication, inspection for defects, and testing and reprogramming of the logic control program functions, including self-diagnosed logic faults or defects. The need to perform decontamination on internal or external TEV surfaces would prompt an investigation as to the source and type of contamination. Any such decontamination would occur at the HEMF. Maintenance, servicing, or repairs to other site heavy-duty equipment such as site transporters may also be performed at the HEMF.

Warehouse and Non-Nuclear Receipt Facility

New equipment, such as empty waste packages, TAD spacers, and TAD canisters, are delivered to the warehouse for inspection, inventory control, and staging prior to being placed in use. Incoming inspections confirm item quality and conformance to purchase specifications in accordance with applicable QA requirements. Equipment and commodities are dispatched from the WNNRF to the various surface facilities by using fork trucks, site trailers, or site-only site transport vehicles.

8.6 EXTERNAL FACILITIES

Outside the GROA are GROA-associated administrative offices where planning, scheduling, management, engineering, and other technical and administrative support are housed. Personnel would enter and leave the protected area through entry exit and control points. Facilities located outside the PIDAS fence are expected to include, but not be limited to, the following:

- Visitors Center
- Administration Facility (including alternate Emergency Operations Facility and alternate Technical Support Center)
- Utilities (e.g., electric substations and distribution, deionized water, potable water, water for fire control, steam)
- Warehouses
- Security facilities
- Fire, Rescue, and Medical Facility
- Shops, storage areas, and general maintenance
- Motor pool and employee parking areas.

Designs and operations at these facilities are discussed in other appropriate documents and reports.

The rail equipment maintenance yard and Cask Maintenance Facility, operated by National Transportation, are located nearby but outside of the GROA. Details concerning operations and activities at these facilities are described in other documents as well.

9. MAINTENANCE

9.1 OVERVIEW

The primary purpose of the maintenance program is to ensure that the functional requirements assumed by the preclosure safety analysis (PCSA) and the postclosure performance assessment are met.

The maintenance function will be performed in accordance with written, validated, and approved procedures, documented instructions, checklists, design and vendor drawings that conform to applicable codes and standards, specifications, and other appropriate criteria. The implementation of these processes and procedures will establish specific performance expectations based on the topical areas that follow.

9.2 PHYSICAL PLANT MAINTENANCE PHILOSOPHY AND STRATEGY

Reliability-centered maintenance (RCM) is a systematic process by which SSCs are properly identified and specific maintenance activities are assigned and performed at the proper frequency to ensure reliability goals are achieved and maintained. The RCM process consists of the following steps:

Step 1. Mission Critical SSCs—Identify ITS and ITWI SSCs based on 10 CFR 63.102(f) and (h) [DIRS 180319].

Step 2. Boundary Definition—Define the interfaces with other systems that have been or will be analyzed as part of this process.

Step 3. Data Collection—Collect SSC performance data as applicable for the repository and data based on operating experience from similar components in other projects. Pertinent SSC configuration and safety analysis documentation will be used to conduct an effective RCM analysis.

Step 4. SSC Functional Failure Identification and Failure Modes and Effects Analyses—Identify the possible failures that each SSC could experience.

Step 5. Preventive Maintenance (PM) Task Recommendations—Identify and select an effective and applicable PM task. PM tasks do not address every component failure mode; therefore, careful consideration will be applied to ensure that the appropriate task is selected to address failure modes and effects analyses output.

Step 6. PM Task Comparison—After the PM task has been selected, compare and reconcile the new PM with any vendor-recommended PM. This step represents the optimization step by ensuring the proper PM elements are in place and task redundancy or inefficiencies are addressed.

The RCM methodology is the primary analytical tool in the development of the repository basis for maintenance, ensuring that ITS and ITWI SSCs are maintained to the required degree of performance and reliability assumed by the PCSA and the postclosure performance assessment.

In order to establish a comprehensive approach toward protecting the repository design bases, a proactive maintenance philosophy will be developed to prevent or mitigate Category 1 or Category 2 event sequences, as well as to maintain non-ITS or non-ITWI SSCs.

The Yucca Mountain maintenance philosophy will reflect a condition-based maintenance strategy that represents the optimization of traditional PM programs through the application of RCM. A condition-based maintenance strategy consists of the following distinct elements. By applying the RCM process, the correct PM task and frequency will be applied.

- Run to Failure Maintenance—SSCs that, if operated until failure occurs, will not significantly affect safety, operation, or generate any significant loss or increased risk other than repair costs.

- Time-Based (i.e., Routine) Maintenance—Consists of periodically inspecting, testing and surveillance, servicing, cleaning, replacing, or overhauling components based on vendor recommendations.

- Predictive Maintenance—Used to trend and monitor equipment performance and predict the need to perform corrective maintenance before failure occurs. The following are examples of predictive maintenance:

  - Vibration analysis
  - Lubricant analysis
  - Thermography.

- Corrective Maintenance—The restoration of equipment or components affecting personnel safety or facility reliability that have failed, are degraded, or do not conform to their original design, configuration, or performance.

9.3 MAINTENANCE PROGRAM IMPLEMENTATION

To ensure maintenance activities, tests, surveillances, and modifications comply with safety analyses, the maintenance program will provide administrative controls for maintenance planning, work control, equipment control, measuring and test equipment, and special process controls.

9.3.1 Maintenance Activities

Maintenance activities are focused on maintaining or restoring SSCs to their as-designed condition, including activities that implement engineering design changes. Maintenance activities include troubleshooting, inspections, surveillances, calibration, refurbishment, maintenance-related testing, replacements, housekeeping, and similar activities that do not permanently alter the design (unless approved by engineering), performance requirements, and operation or control of SSCs.

9.3.2 Maintenance Facilities, Tools, and Equipment

One key element of the maintenance program will be the focus on repository facilities, tools, and special equipment. Specific processes and supporting procedures will identify the applicable maintenance requirements and tool control protocols, and establish the appropriate protocols in support of controlling and monitoring measuring and test equipment.

9.3.3 Maintenance Management and Leadership

Processes, procedures, and training will be developed and implemented in support of a culture and organizational behavior that reflect the following maintenance leadership core values:

- Strong leadership
- Pervasive safety focus
- Operational focus, facility wide
- Continuous improvement, through assessment and corrective action
- Organizational health
- Excellent human performance
- Sound business practices
- Effective work practices.

9.3.4 Equipment Controls

Any maintenance performed on either isolated equipment or energized operating equipment is performed in accordance with applicable procedures and work controls.

9.3.4.1 Equipment Tagging and Isolation

Operations department personnel hang the appropriate tags and manipulate equipment to isolate it for maintenance. Personnel to whom tags are issued are responsible for verifying proper tagging. Equipment tagging and isolation are implemented in accordance with equipment tagging and isolation procedures as administered by the Operations department.

9.3.4.2 Housekeeping and Material Condition

Housekeeping activities at the repository help ensure personnel and operational safety is maintained. Specific housekeeping requirements are stipulated during the preparation and execution of work control documents and procedures. Inspections are performed during and after maintenance activities to ensure that equipment is returned to service only when it meets applicable postmaintenance testing and material condition criteria.

9.3.4.3 Foreign Material Exclusion

The maintenance function will develop and implement the applicable processes and procedures to control the inadvertent introduction of foreign objects that could have a negative impact on the safe and reliable operation of repository SSCs. The Foreign Material Exclusion Program is a component of the work planning and maintenance functions.

9.3.4.4 Postmaintenance Testing

Processes and procedures will be developed and implemented in support of component and system testing following certain maintenance activities to verify that the equipment operates as designed. Examples are:

- Time Based—Maintenance instructions and procedures will identify when and what postmaintenance testing is required. The testing requirements should normally be part of, and controlled by, the work order package.

- Corrective Maintenance—The work order package will specify the postmaintenance testing required after corrective maintenance has been completed to verify operability.

9.3.4.5 Configuration Management

The maintenance function includes configuration controls to specify and control data in support of the design basis, design requirements, operational configuration, reliability requirements, and other attributes associated with ITS and ITWI SSCs.

9.3.4.6 Equipment Performance Monitoring

ITS SSCs will be operated and maintained in accordance with the PCSA to ensure the required degree of performance and reliability is established and sustained. Similarly, if required, ITWI SSCs will be operated and maintained in accordance with the postclosure performance assessment. To ensure compliance, applicable processes and procedures will establish standards, provisions, and approaches for monitoring and assessing equipment performance. Performance monitoring will address all applicable facets of the system down to the component level. Establishing effective performance metrics and the process of trending and analyzing these metrics will be critical elements of overall performance monitoring. Key components of effective performance monitoring consist of:

- System Walkdowns—Procedures will be established in support of conducting walkdowns to assess the material condition of SSCs as part of the performance monitoring process. Implementing procedures will provide guidance on how to identify and report areas of concern and establish an overall trending and tracking process for system material conditions. The results of system walkdowns will be inputs to the SSC health report process. Walkdowns are intended to reinforce the standards for aggressiveness and thoroughness in identifying and evaluating conditions and deficiencies prior to their imposing any negative effect on the SSCs.

- SSC Health Reports—Procedures will be established to develop SSC health reports, which will provide management with an effective tool to focus attention and resources on SSCs that indicate degrading trends in performance or are not meeting established performance goals.

- Operating Experience—Industry events will be evaluated with respect to applicability to the facility.

9.3.5 Maintenance Personnel Knowledge, Skills, and Training

Procedures will establish maintenance function requirements in support of developing and implementing maintenance personnel training and qualifications requirements. These activities will establish requirements for maintenance personnel training schedules, methods for the retention of qualifications, and program record keeping. In addition, these activities will identify who provides training program approval and will establish methods for determining maintenance training effectiveness and feedback evaluations, management and supervisory training protocols, and direct control of contractor and other personnel not normally assigned to the work area.

9.3.5.1 Training

Training and qualifications of maintenance personnel are controlled, conducted, and documented.

9.3.5.2 Job Assignments

The qualifications and training of maintenance personnel are considered when maintenance activities are assigned. Minimum attributes used when determining specific job functions are:

- Familiarity of personnel with the maintenance activity
- Complexity of the maintenance activity
- Requirements for special training and specific qualifications.

Personnel assigned to assist in performance of a task are not required to be qualified maintenance personnel and may be permitted to perform work under the supervision of a qualified person.

Personnel who perform job briefings, assign hold points, or directly supervise staff or contractors during the performance of maintenance or modification activities on facility SSCs will maintain a supervisor qualification.

Special processes, such as welding, heat treating, and nondestructive examination, are performed in accordance with appropriate procedures.

9.3.6 Maintenance Procedures

Maintenance of SSCs will be performed in accordance with written procedures, documented instructions, and drawings appropriate to the circumstances.

9.3.6.1 Use, Development, and Approval

Protocols will be formally established for procedure development, check of procedures prior to use, procedure approval, procedure use, adherence requirements to procedure controls, and performance of periodic reviews and revisions to procedures.

9.3.6.2 Selective Use of Content

Maintenance procedures will be written and approved with the intent that applicable portions of a procedure may be utilized for corrective maintenance of limited scope.

9.3.7 Calibration and Testing

The maintenance function includes the development, implementation, and control of activities and procedures in support of the following:

- Calibration of installed equipment
- Measuring and test equipment used to test and calibrate installed equipment
- Calibration of standards used to calibrate installed equipment.

Processes and procedures will be developed to maintain and store records of calibration for each piece of designated measuring and test equipment.

9.3.8 Special Process Controls

Use of special processes will incorporate the following attributes:

- Process qualifications will be established for special processes when the required level of quality cannot be measured by direct visual inspection. Such processes include, but are not limited to:
  - Welding
  - Heat treatment
  - Nondestructive examination
  - Specialty cleaning.
- Special processes, equipment, and personnel will be qualified in accordance with approved procedures.
- Special processes will be performed in accordance with approved procedures, processes, travelers, standards, or equivalent documents.
- Special processes will be completed under controlled conditions and in accordance with applicable codes, standards, and specifications.
- Processes, equipment, and personnel qualifications will be maintained and updated.

9.4 WORK MANAGEMENT PROCESS

Work management implementing procedures are intended to ensure operational and personnel safety by providing timely identification, selection, planning coordination, and execution of work necessary to maximize the availability and reliability of repository SSCs. In addition, work management activities are intended to manage risk, identify the impact of the work on the facility and repository, and maximize the efficiency and effectiveness of staff and resources. Processes and procedures will be developed to implement work management activities.

9.5 SUBSURFACE FACILITY AND SYSTEMS MAINTENANCE

9.5.1 Overview

In addition to stationary and mobile equipment, the facility will have a wide range of monitoring and control systems. To the maximum extent practical, these systems will be designed in a modular fashion. This design will allow maintenance to unplug modules, such as radiation or thermal sensors, programmable logic controllers, input or output circuit cards, video cameras and their pan and tilt units, and quickly replace them with operational units. The failed components will be taken to the surface shops for repair or sent off site to vendor repair facilities if needed.

To minimize down time, the extensive scheduled maintenance program will ensure that all systems and equipment are given adequate PM. Intake shafts, ramps, and access drifts that do not have high temperature or radiation levels during normal operations will receive periodic, planned maintenance.

In addition, maintenance capability involving major system malfunctions will be supported by the surface maintenance facilities. A staff of mechanics, electricians, and supervisors will react to and repair unplanned equipment outages. Equipment that can be moved will be taken to one of the surface maintenance facilities for evaluation and repair.

9.5.2 Ground Support Maintenance

A preliminary maintenance plan for the ground support system provides plans for monitoring and inspecting both emplacement drifts and nonemplacement openings, and for maintenance operations.

Many details regarding specific procedures and techniques are not developed at this time. Maintenance techniques in nonaccessible areas (e.g., emplacement drifts and exhaust mains) involving remotely operated vehicles and robotics are yet to be developed. A more detailed ground support maintenance plan will be developed as the design evolves from the preliminary design to final design.

Emplacement Drifts

Postemplacement inspection will be performed remotely because the emplacement drifts will be inaccessible due to temperature and radiation levels. This activity will be conducted to detect indications of rockfall, drift degradation, or instability that may require unplanned maintenance.

Off-Normal Emplacement Drift Ground Support Maintenance—In the event that monitoring and inspection activities indicate that an unacceptable level of ground support deterioration or drift degradation has occurred, a decision will be made to make necessary ground support repairs. If this event occurs after some or all of the waste packages have been emplaced in the drift, then the repairs will be considered an off-normal activity. The following sequence of maintenance activities will be implemented according to *Ground Support Maintenance Plan* (BSC 2008 [DIRS 185043], Section 6.1.2):

- Drift cooling by ventilation
- Waste package recovery
- Ground support repairs
- Waste package reemplacement.

Nonemplacement Openings—Accessible openings will be periodically inspected by direct observation for the deterioration of ground support components and drift degradation effects. For the ventilation intake shafts, an inspection gantry or cage may be utilized. Additionally, geotechnical instrumentation will provide in situ measurements of rock deformation and opening stability.

Nonaccessible openings (e.g., ventilation exhaust mains, exhaust shafts, and turnout drifts) may require remote monitoring and inspection. They will be monitored for drift and shaft degradation and ground support deterioration.

9.5.3 Ventilation System Maintenance

Emplacement Drift Ventilation Equipment—Maintenance of the emplacement access doors, regulators, and instrumentation will occur on a periodic basis. While the design of this equipment is in a preliminary stage, the following points should be considered:

- The gasket on the emplacement access door will be made of material with a high radiation rating so that it will last the lifetime of the repository.

- An option is to have no planned maintenance on the emplacement access door actuator. The actuator will have the capability to be remotely tested to see whether it is operational. If not operable, then it will be replaced when access is required.

- The only planned maintenance will be on the regulator. The regulator will be a bolt on, modular item and will be changed out in its entirety, if required.

Main Fan Maintenance—The main fans are located on the surface at the exhaust shafts. Specific maintenance requirements have not yet been established. The fans are standard mining industry fans and will be maintained in accordance with manufacturer recommendations. The primary difference from standard practice is the possibility that some radiological contamination may exit the shaft and become deposited on the fan blades and housing. Prior to any maintenance operations, the fan will need to have a radiological survey. If contamination is present, a radiological work plan will be prepared prior to any work being initiated.

There are typically monthly, semiannual, and annual maintenance requirements for the main fans. The main fan motor, fan bearing oilers, starter, and assorted sensors are located outside the exhaust air stream and can be serviced without entering the ductwork. To service accessories or components located inside the ductwork, the fan will be shut down, isolated from the adjacent unit, and locked out. Spare component monitoring sensors will be warehoused on site.

Louvers located at each fan inlet will be used for isolation during maintenance operations and not for airflow regulation. Fan and motor maintenance requirements will follow manufacturer recommendations. Release of activated air and potentially contaminated dust to the environment is considered part of normal subsurface operations, and these contaminants may settle out on the shaft collar ductwork and main fan components. Though contamination releases will be within regulated limits, maintenance activities need to be conducted while considering the potential for contamination for both personnel access and disposal of material.

With a program of maintenance, repair, and replacement, the ventilation fans will be available for the 100 year preclosure period. The ventilation system design has not evolved enough to determine operational readiness, but based on historical industry applications and a conceptual operating strategy, this program will provide a ventilation system with a high inherent availability.

Main Fan Failure Mode—With multiple ventilation shafts, each having two fans, a single fan out of service due to maintenance or failure will not have a major impact on repository air volume. The two fans are physically separated and a mechanical failure of one fan will not cause failure of the adjoining fan. Though quantities have not been specified, at least one spare fan and motor will be warehoused locally for change out. Based on historical industry use, a fan or components of a fan could be changed out in less than 1 week. In a parallel fan installation, if one fan fails or is off-line for maintenance, then the second fan will remain operational and will produce approximately 70% of the original air volume. The 70% value is for 26 ft diameter shafts. For each of the 16 ft diameter shafts, a single fan will provide 100% airflow. With an approximate exhaust shaft volume of 800,000 cfm, if one fan is off-line, then 70% of the normal air volume, or 560,000 cfm, will be maintained in the shaft.

The ventilation system must respond to emergency and off-normal events. Each shaft has two 13.8 kV power supply lines that can be powered from the standby diesel generators. Additionally, there are provisions for deployment of local backup diesel generators. The access and exhaust mains between the panels are interconnected so that the air can flow between panels if necessary.

9.5.4 Electrical

Not yet developed.

9.5.5 Instrumentation and Controls

Not yet developed.

9.5.6 Access Main Rail Track and Inverts

Not yet developed.

10. REFERENCES

10.1 DOCUMENTS CITED

BSC (Bechtel SAIC Company) 2007. *Access & Exhaust Mains Isolation Barrier Bulkheads & Airlocks*. 800-S0C-SSD0-00700-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070531.0045. [DIRS 183354]

BSC 2008. *Basis of Design for the TAD Canister-Based Repository Design Concept*. 000-3DR-MGR0-00300-000-002. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080229.0007; ENG.20080306.0007; ENG.20080307.0009. [DIRS 185025]

BSC 2008. *Canister Receipt and Closure Facility Event Sequence Development Analysis*. 060-PSA-CR00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080221.0008. [DIRS 180761]

BSC 2007. *Closure Design Calculation*. 800-KMC-MGR0-00200-000-00D. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070925.0083; ENG.20080129.0001. [DIRS 183206]

BSC 2007. *Dose Rate Calculation for Transport and Emplacement Vehicle*. 800-MQC-HE00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071101.0012; ENG.20071203.0046. [DIRS 183768]

BSC 2007. *Drip Shield and Waste Package Emplacement Pallet Design Report*. 000-00C-SSE0-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070810.0008; ENG.20080305.0004. [DIRS 179636]

BSC 2008. *Ground Support Maintenance Plan*. 800-30R-SSD0-00100-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080215.0001. [DIRS 185043]

BSC 2007. *IED Performance Confirmation*. 800-IED-MGR0-00801-000 REV 00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070716.0009. [DIRS 183106]

BSC 2007. *IED Subsurface Facilities Ground Support Committed Materials*. 800-IED-WIS0-01501-000 REV 00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071022.0026. [DIRS 180940]

BSC 2008. *Initial Handling Facility Event Sequence Development Analysis*. 51A-PSA-IH00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080207.0005. [DIRS 180086]

BSC 2007. *Isolation Bulkhead and Airlock Calculation*. 800-KVC-VU00-00600-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070718.0001. [DIRS 182025]

BSC 2008. *Mechanical Handling Design Report: Waste Package Transport and Emplacement Vehicle*. 000-30R-HE00-00200-000 REV 002. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080307.0006. [DIRS 184959]

BSC 2007. *Performance Confirmation Facilities*. 800-KMC-MGR0-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070725.0003. [DIRS 179638]

BSC 2007. *Portals Design Layout and General Arrangement*. 800-KMR-SS00-00200-000 REV 00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070731.0041; ENG.20080304.0020. [DIRS 183760]

BSC 2007. *Project Design Criteria Document*. 000-3DR-MGR0-00100-000-007. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071016.0005; ENG.20071108.0001; ENG.20080305.0002; ENG.20080305.0011; ENG.20080305.0012; ENG.20071220.0003; ENG.20080107.0001; ENG.20080107.0002; ENG.20080107.0016; ENG.20080107.0017; ENG.20080131.0006; ENG.20080306.0009. [DIRS 179641]

BSC 2007. *Quality Management Directive*. QA-DIR-10, Rev. 2. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20080103.0002. [DIRS 184673]

BSC 2008. *Receipt Facility Event Sequence Development Analysis*. 200-PSA-RF00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080211.0006. [DIRS 180088]

BSC 2007. *Regulatory Guidance Agreement, Agreement for Regulatory Guide 1.21, Rev. 1 - Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants*. REG-CRW-RG-000015 Rev. 1. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20070718.0004. [DIRS 182077]

BSC 2008. *Subsurface Construction and Emplacement Ventilation*. 800-KVC-VU00-00900-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080124.0010. [DIRS 184870]

BSC 2007. *Subsurface Emplacement Ventilation and Fan Instrumentation Table Exh Shaft 2, 3N, 3S, 4 & ECRB*. Engineering drawing. 800-KV0-VUE0-00211-000 REV 00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071004.0042. [DIRS 184019]

BSC 2007. *Subsurface Emplacement Ventilation and Instrumentation Diagram Composite*. 800-KV0-VUE0-00201-000 REV 00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070723.0001; ENG.20080103.0010. [DIRS 182105]

BSC 2007. *Subsurface Emplacement Ventilation and Instrumentation Diagram Exhaust Shaft 1 Fans*. Engineering drawing. 800-KV0-VUE0-00205-000 REV 00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071004.0041. [DIRS 184018]

BSC 2007. *Subsurface Emplacement Ventilation System Design Analysis*. 800-KVC-VUE0-00400-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071210.0009. [DIRS 184313]

BSC 2007. *Subsurface Facility and Transport and Emplacement Vehicle Preliminary ALARA Design Review*. 800-30R-SS00-00500-000 REV 000. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071025.0003. [DIRS 183393]

BSC 2007. *Subsurface Facility Radiation Zone Classification*. 800-U00-SSD0-00101-000 REV 00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070927.0037. [DIRS 183349]

BSC 2007. *Subsurface Repository Fire Hazard Analysis*. 800-M0A-FP00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070928.0001; ENG.20071101.0014. [DIRS 180306]

BSC 2007. *Underground Layout Configuration for LA*. 800-KMC-SS00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070727.0004; ENG.20071214.0002; ENG.20080304.0021. [DIRS 179640]

BSC 2008. *Wet Handling Facility Event Sequence Development Analysis*. 050-PSA-WH00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080225.0010. [DIRS 180087]

BSC 2007. *WP Transport & Emplacement Vehicle Process & Instrumentation Diagram (Sheet 1 of 3)*. 800-M60-HE00-00101-000 REV 00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071128.0041. [DIRS 183780]

CRWMS M&O 1999. *Monitored Geologic Repository Concept of Operations*. B00000000-01717-4200-00004 REV 03 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000313.0295; MOL.19990916.0104. [DIRS 147632]

DOE M 411.1-1C. 2003. *Safety Management Functions, Responsibilities, and Authorities Manual*. Washington, D.C.: U.S. Department of Energy. ACC: MOL.20060117.0211. [DIRS 176028]

DOE 2002. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*. DOE/EIS-0250. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20020524.0314; MOL.20020524.0315; MOL.20020524.0316; MOL.20020524.0317; MOL.20020524.0318; MOL.20020524.0319; MOL.20020524.0320. [DIRS 155970]

DOE 2007. *Integrated Safety Management Plan*. DOE/RW-0523, Rev. 2. Las Vegas, Nevada: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20071012.0001. [DIRS 185206]

10.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

10 CFR 20. 2007. Energy: Standards for Protection against Radiation. Internet accessible. [DIRS 181962]

10 CFR 63. 2007. Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. Internet accessible. [DIRS 180319]

10 CFR 71. 2007. Energy: Packaging and Transportation of Radioactive Material. ACC: MOL.20070829.0114. Internet accessible. [DIRS 181967]

10 CFR 72. 2007. Energy: Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste. Internet Accessible. [DIRS 181968]

10 CFR 851. 2007. Energy: Worker Safety and Health Program. Internet Accessible. [DIRS 182868]

49 CFR 173. 2006. Transportation: Shippers—General Requirements for Shipments and Packagings. Internet Accessible. [DIRS 181975]

ANSI/ANS-HPSSC-6.8.1-1981. *Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Nuclear Reactors*. La Grange Park, Illinois: American Nuclear Society. TIC: 253112. [DIRS 159434]

ANSI/HPS N13.1. 1999. *American National Standard Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*. McLean, Virginia: Health Physics Society. TIC: 248835. [DIRS 152380]

National Environmental Policy Act of 1969. 42 U.S.C. 4321 et seq. Internet Accessible. [DIRS 160261]

NRC (U.S. Nuclear Regulatory Commission) 1981. *Functional Criteria for Emergency Response Facilities, Final Report*. NUREG-0696. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 102319. [DIRS 104098]

NRC 2000. *Standard Review Plan for Spent Fuel Dry Storage Facilities*. NUREG-1567. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 247929. [DIRS 149756]

NRC 2003. *Yucca Mountain Review Plan, Final Report*. NUREG-1804, Rev. 2. Washington, D.C.: U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards. TIC: 254568. [DIRS 163274]

Nuclear Waste Policy Act of 1982. 42 U.S.C. 10101 et seq. Internet Accessible. [DIRS 101681]

PA-PRO-0313, Rev. 6. *Technical Reports*. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20070726.0006.

APPENDIX A
WASTE RECEIPT FROM TRANSPORTATION, GEOLOGIC REPOSITORY OPERATIONS AREA YARD, AND SUPPORT LOCATIONS CONCEPT OF OPERATIONS

A1 OVERVIEW

High-level radioactive waste and spent nuclear fuel (SNF) casks arrive at the Geologic Repository Operations Area (GROA) via rail and truck. Accountability is transferred from transportation personnel to Yucca Mountain Project personnel. The casks and their conveyances are checked by security and radiological controls prior to entering through the perimeter intrusion detection and assessment system fence via the sally port at Gate 30B. Upon entering the GROA, a cask may be taken directly to a handling facility or may be staged and put in the queue for processing in the rail yard buffer area 33A or the truck buffer area 33B. The following is a general discussion of the process.

GROA surface facilities are locations where nuclear waste contents are unloaded and packaged for aging or emplacement. To support the processing of nuclear wastes, the receipt, commissioning, and placement of new components, such as waste packages, aging overpacks, and other support commodities, use the same processes or similar transport equipment over the same roads and rail lines as do the nuclear wastes. To support continuous operations and security-system limitations, outside lighting and necessary support and response services, such as fire protection and vehicle servicing and refueling, will be available.

A2 GENERAL ARRANGEMENT

Some of the facilities and locations include:

- Preliminary inspection area
- Detailed inspection area and cask receipt security station (i.e., sally port)
- GROA rail line and roads
- GROA rail yard, truck parking, and staging areas
- Warehouse and Non-Nuclear Receipt Facility
- Low-Level Waste Facility (LLWF)
- Transport and emplacement vehicle (TEV) rail tracks.

A2.1 PRELIMINARY INSPECTION AREA

This is an enclosed fenced area located just outside of the protected area security fence and adjacent to the protected area. Derailers located outside of the preliminary inspection area prevent runaway railcars from entering or escaping the preliminary inspection area. Gates at the entrance to the preliminary inspection area may be used to exclude noncritical personnel and other shipping and receiving activity while casks are being in-processed. Inside the preliminary inspection area each rail track is sufficiently long to hold up to four cask railcars and a Nevada rail line switch engine. Paved access roads in the preliminary inspection area support truck cask activities including uncoupling, trailer parking, and personnel barrier storage. Removable personnel barriers will be removed prior to inspection and stored until the unloaded cask returns, or they will be lifted to conduct the incoming inspection and radiological survey and then replaced. The preliminary inspection area is sized to also accommodate a portable crane and the storage of multiple removed cask personnel barriers. Sufficient lighting is provided to support 24-hour-per-day, 365-day-per-year operations.

A2.2 DETAILED INSPECTIONAREA AND VEHICLE PORTAL (SALLY PORT)

The detailed inspection area is located within the cask receipt security station (Building 30-B) at the interface between the preliminary inspection area and the protected area. All incoming vehicles and any personnel entering the protected area at this location are searched and inspected prior to entry. Details of the incoming security and radiological inspections will be provided in respective operating or department procedures. Selected emergency vehicles may be authorized to enter the protected area without first undergoing the detailed security inspections, but they would be escorted by security personnel. Large canopies cover both the rail and truck inspection and survey positions to accommodate conducting all-weather incoming and outgoing security inspections and radiological surveys. All vehicles departing the protected area are subject to an outbound radiological survey to verify the absence of radioactivity or nonfixed contamination. Lighting is provided in this area to support 24-hour-per-day receipt and outbound inspections, including under-vehicle lighting as necessary. Normal personnel entry and exit is performed at central security station (Building 30-A).

A2.3 GEOLOGIC REPOSITORY OPERATIONS AREA RAIL LINE AND ROADS

Rail lines and roads located within the protected area of the GROA provide for the delivery and pick up of casks and other commodities from the surface facilities. Site roads and rail lines extend to all nuclear processing surface facilities, warehouses, and parking and staging areas. Rail lines and roads are constructed to prevailing industrial standards and provide the necessary capacity to carry large and weight-concentrated loads and accommodate vehicles having turning radii larger than normal highway or railroad traffic. Strict speed limits and suitable traffic controls are imposed to protect workers and to prevent cask and facility damage. All vehicles are required to stop and yield to rail traffic at railroad grade crossings. Nonsecurity vehicles and rail traffic stay more than 20 ft from the protected area fencing. Sufficient lighting is provided within the GROA for road and rail operations, including in parking areas, to meet minimum physical security and industrial health and safety requirements.

A2.4 GEOLOGIC REPOSITORY OPERATIONS AREA RAIL YARD, TRUCK PARKING, AND STAGING AREAS

The GROA rail yard includes multiple rail spurs for queuing and staging incoming loaded casks and staging outbound emptied casks and other commercial vehicles. Rail spurs are accessed through positioning of various switches; switch operation may be automatic or manual and is controlled by GROA rail yard operators. Casks in queuing and storage have impact limiters attached that meet transportation safety requirements of 10 CFR Part 71, Energy: Packaging and Transportation of Radioactive Material [DIRS 181967]. To the greatest practical extent, loaded casks would be positioned away from normally occupied work areas in an effort to lower worker doses. Transporters (i.e., trailers or railcars without casks) would be operated and moved in the same fashion as those carrying casks. On occasion, transporters without casks may be sent off site for maintenance, inspection, or repairs at the rail equipment maintenance yard (REMY) or local commercial repair shops. They would be subject to the same outbound survey requirements as other vehicles departing the GROA and the same incoming vehicle security inspection upon reentering the GROA.

A2.5 WAREHOUSE AND NON-NUCLEAR RECEIPT FACILITY

New equipment, such as empty waste packages, transportation, aging, and disposal (TAD) spacers, and TAD canisters, are delivered to the warehouse for inspection, inventory control, and staging prior to being placed in use. Items received on railcars and commercial truck trailers follow the same security inspection protocol and routine. Incoming inspections confirm item quality and conformance to purchase specifications in accordance with applicable quality assurance (QA) requirements.

Equipment and commodities are dispatched from the Warehouse and Non-Nuclear Receipt Facility to the various surface facilities using fork trucks, site trailers, or site-only site transport vehicles. Prior to tranfer, each container is verified to be uniquely marked.

A2.6 LOW-LEVEL WASTE FACILITY

The LLWF includes truck shipping and receiving docks and has multiple shielded rooms to provide for solid radioactive waste storage and processing capability. Liquid radioactive wastes generated at the Wet Handling Facility are piped to the LLWF for characterization and preparation for offsite transportation. A larger volume includes the estimated 1,250 to 1,300 emptied stainless steel dual-purpose canisters (DPCs) (shells). DPC low-level radioactive waste (LLW) is delivered to the LLWF using onsite trailers, fork lifts, or site transporters.

After characterizing, packaging, and obtaining approval for disposal, LLW would be shipped off site by over-the-road, vendor-supplied trucks or commercial railcars (i.e., not transportation system railcars). Vendor-supplied trucks may or may not have supplemental radiation shielding. The LLWF would have no fewer than two truck docks to allow for simultaneous receipt and shipping activity. If no rail track goes into the LLWF, boxes and containers of LLW could be transported out of the building onboard a truck trailer for transfer to a rail box car or flat car for transportation.

A2.7 TRANSPORT AND EMPLACEMENT VEHICLE RAIL TRACKS

The TEV is unmanned, operating autonomously via programmable logic controllers and hard-wired safety controls. An operator in the Central Control Center Facility sends signals to the programmable logic controllers to execute sets of commands for the TEV. The TEV operates over a 132 in. (11 ft) gauge, 171 pound per yard crane rail track meeting American Crane Manufacturers Association standards. Inside the surface facilities, power may be provided by a plug-in electrical umbilical cord or by an energized third rail; outside of those surface facilities, an energized third rail or insulated conductor provides electrical power to the TEV. The TEV has power pickups on both ends, allowing it to bridge the gaps at switches and junctions. The third rail may be covered in some locations to protect against weather and personnel contact, and may be uncovered in other places. The three rails run the length of the North Ramp, the access main, and into each turnout and emplacement drift. The loaded TEV proceeds from the surface facility to the selected emplacement drift. The TEV proceeds into the turnout only after the operator in the Central Control Center Facility actuates the rail switch and opens the emplacement access doors. With the TEV inside the turnout, the emplacement access doors close and the TEV continues into the emplacement drift to deliver the waste package.

A3 INTERFACES

Key interfaces and personnel groups at the Yucca Mountain GROA relative to the receipt, processing, and return of nuclear waste casks and transporters include:

- Nevada rail line, REMY, and GROA rail yard operators
- Site physical security, protective forces, and personnel
- Site health physics personnel
- Site quality assurance and quality control personnel
- Site industrial safety personnel
- GROA heavy equipment operators
- Crane operators and load controllers
- GROA surface facility operators
- Low-level radioactive waste vendor, contractor, or both
- Material control and accounting personnel.

A3.1 NEVADA RAIL LINE, RAIL EQUIPMENT MAINTENANCE YARD, AND GEOLOGIC REPOSITORY OPERATIONS AREA RAIL YARD OPERATORS

The REMY will be located between the owner-controlled area boundary and the GROA. Upon arrival of a shipment of nuclear wastes at the REMY, the Nevada rail line operators separate noncask railcars from the rest of the shipment. These railcars include buffer cars, line locomotives, and escort vehicles which remain and are staged at the REMY for inspection, servicing, and staging on outbound train queuing rail spurs. The REMY operators notify protected area security and deliver the loaded cask railcars to the location inside of the preliminary inspection area. As needed or on a regular schedule, the REMY operators pick up unloaded casks and other emptied railcars that have been set outside of the protected area in the preliminary inspection area.

Prior to any delivery or following any pick up, the REMY operators or protected area security would set the derailer to the appropriate position to allow for derail-free delivery or pick up. GROA rail operators will operate GROA switch engines to move railcars into and out of the preliminary inspection area from the GROA. GROA rail yard operators could also include qualified REMY or Nevada rail line operators explicitly authorized to conduct railcar operations within the GROA. Nevada rail line switch engines carry a larger fuel volume than GROA switch engines and are not routinely allowed inside of the GROA.

A3.2 SITE PHYSICAL SECURITY, PROTECTIVE FORCES, AND PERSONNEL

Security for loaded casks after their arrival in the land withdrawal area and the REMY is coordinated and controlled under the Yucca Mountain site security plan. Shipment escorts provide protection for each arriving shipment until it enters the protected area at Gate 30B.

Protected area security conducts an inspection in the sally port at Gate 30B in accordance with procedures and requirements in the site physical protection plan. Protected area security will provide constant visual surveillance during GROA switch engine and yard tractors movement into and out of the protected area, thus eliminating multiple inspections and improving vehicle inbound and outbound processing.

Enhanced security measures are taken to ensure that adequate physical security is provided against malevolent acts or other threats that could coincide with inbound and outbound vehicle movements. Vehicle movements within the GROA are under the control of GROA personnel following appropriate procedures and controls as specified by the conduct of operations and specific procedures. Protected area security personnel may escort or accompany commercial vehicles making deliveries within the GROA. Protected area security may also escort emergency response or outside law enforcement agency vehicles within the GROA.

A3.3 SITE HEALTH PHYSICS TECHNICIANS

Site health physics technicians are responsible for completing all necessary radiological (i.e., radiation and contamination) surveys of incoming (i.e., loaded) and outgoing (i.e., empty) transportation casks and their carrier systems to ensure compliance with U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission requirements for the transportation of radioactive materials.

Appropriate radiological surveys will be conducted at all nuclear facilities to ensure the radiation protection of workers. Radiological surveys will be conducted at nonnuclear facilities and areas of the GROA to ensure that radioactive materials and potential contamination are properly assessed and controlled. Radiological surveys will be completed for all vehicles and equipment/materials exiting the GROA to ensure all applicable radiation protection criteria for offsite release are met.

Site health physics technicians will administer and coordinate the implementation of a Radiological Work Permit program to control all radiological activities to ensure worker protection and compliance with U.S. Nuclear Regulatory Commission radiation protection requirements (10 CFR 20, Energy: Standards for Protection against Radiation [DIRS 181962]) including a comprehensive as low as is reasonably achievable program to minimize worker dose.

Site health physics technicians will ensure that all necessary personal dosimetry, operation and calibration of radiation detection and monitoring systems (including portable and fixed instruments for radiation, criticality, and air monitoring), radiological personal protective equipment, and appropriate radiological training are provided to workers.

A3.4 QUALITY ASSURANCE PERSONNEL

QA personnel would provide for review and oversight of all nuclear waste material activities in the GROA. A site QA plan meeting the appropriate criteria required by 10 CFR Part 63, Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada [DIRS 180319] would be developed and administered to describe activities and oversight processes related to cask and licensed operations. QA hold points would be identified during each cask unloading and waste package loading evolution where QA or quality control personnel would verify conditions or requirements of the site license, technical specifications, cask certificate of compliance requirement, or administrative hold point. QA and quality control personnel would coordinate with operations to minimize unnecessary hold ups during these oversight activities.

A3.5 QUALITY CONTROL PERSONNEL

Quality control is a QA function conducted as a routine part of daily operations by documenting that required inspections and instructions are completed and documented in the due course of operations. Typical quality control hold points would be included in procedures along with proposed personnel actions upon acceptance or rejection at that point in time.

A3.6 WORKER HEALTH AND SAFETY PROGRAM

A worker health and safety program will implement 10 CFR Part 851, Energy: Worker Safety and Health Program [DIRS 182868], and will identify roles and responsibilities. Site Environmental, Safety and Health (ES&H) professionals monitor activities related to cask and transporter operations. ES&H would develop and administer special work permits that specify limits on activities, necessary personal protective equipment such as gloves, safety glasses, or other equipment, and specific training or certification requirements for special site activities. ES&H would also monitor the administration of an operation lock-out and tag-out program.

A3.7 GEOLOGIC REPOSITORY OPERATIONS AREA HEAVY EQUIPMENT OPERATORS

Heavy equipment operators remove and replace cask personnel barriers, couple and uncouple railcars and trailers, set and release vehicle hand brakes, actuate trailer landing gears, and operate GROA rail yard switch engines and yard tractors. They operate the site-only, heavy-duty site transporters to deliver and productively position shielded transfer casks and aging overpacks indoors and outdoors. They operate other site heavy equipment in compliance with site procedures and follow traffic speed or routing restrictions. Heavy equipment operators inspect equipment prior to use during each operating shift to ensure that equipment is safe to operate. Equipment they find to be out of compliance or service is tagged out and not used until the out-of-service condition is repaired. Heavy equipment operators move equipment to and from the Heavy Equipment Maintenance Facility as needed. Because of the relative hazards inherent in coupling and moving loads on railcars, trailers, or fork trucks, heavy equipment operators are trained and certified in truck and rail switching, forklift operations, and vehicle load securement (i.e., chocking) as detailed in the worker safety and health program.

A3.8 CRANE OPERATORS AND LOAD RIGGERS

Only individuals that are trained and qualified are authorized to operate portable and overhead cranes. They are responsible to inspect and perform necessary functional equipment tests and ensure that critical loads are secured and rigged per procedure during lifting and transfers. Crane operators from one surface processing facility may operate the cranes at other surface facilities only after receiving building and facility-specific instructions on crane operations and other load-lifting and moving limitations. Crane operators ensure that wherever a critical load is positioned is a location where it is safe (i.e., close to ground where there is a low damage potential from a drop accident). Crane operators would follow hand instructions or directions only from trained and authorized riggers and spotters. Details on duties and responsibilities are more fully explained in the hoisting and rigging section of the worker health and safety program.

A3.9 GEOLOGIC REPOSITORY OPERATIONS AREA SURFACE FACILITY OPERATORS

The GROA surface facility operators direct the delivery and outbound movement of transportation casks, shielded transfer casks, and aging overpacks to the various surface facilities. They operate transportation cask systems in conformance to cask certificate(s) of compliance, facility-specific cask and waste operating procedures, conduct necessary incidental cask maintenance, report any damage and make necessary minor repairs to cask systems, and return casks to their transporters and reassemble them such that they are prepared for transportation in-commerce. They operate shielded transfer casks and aging overpacks in accordance with site-developed safety bases. Surface facility operators also operate locally controlled systems and transfer equipment to unload radioactive wastes and process them into waste packages.

Within each facility, they coordinate the activities of other work groups including, but not limited to, radiological protection, material control and accounting, and quality control. GROA surface facility operators would also coordinate the operation of site services and utilities within the surface facilities, including electrical, compressed air, operation and control of the air pallet air compressor systems, and building heating, ventilation, and air-conditioning. Operators would provide primary input in the development of surface facility operating procedures in accordance with the site operations plan. GROA operators trained for one surface facility may be moved to conduct operations at other surface facilities only after receiving a facility-specific briefing about any specific limitations on operations in that facility.

A3.10 LOW-LEVEL RADIOACTIVE WASTE CONTRACTOR

An LLW contractor would be responsible for ensuring that any LLW prepared, packaged, and delivered from GROA operations to the LLWF would be suitable for commercial or U.S. Department of Energy disposal (i.e., LLW meets disposal facility waste acceptance criteria). Key interfaces for the LLW contractor include obtaining the requisite data and determining the radionuclides, concentrations, form, and volumes of wastes for disposal. The LLW contractor may conduct additional radiological surveys to confirm the conditions and data provided by the surface facility operator. Solid low-activity wastes, such as cleaning rags and used personal protective equipment, would accumulate at each surface facility and the LLW operator would pick up the wastes and safely transfer them to the LLWF for analysis against disposal site acceptance criteria. The method for transporting emptied DPCs and lids from the Wet Handling Facility to the LLWF is being studied. One possibility is that emptied DPCs and lids would be overpacked in drums or boxes before movement to the LLWF. Another solution is for the DPC to be delivered to the LLWF in the shielded transfer cask.

Characterization of emptied commercial SNF DPCs could require additional radiological analyses by the LLW contractor to verify that emptied canisters meet disposal site criteria. This may be performed, in part, at the Wet Handling Facility or at the LLWF. Filters used to maintain pool water clarity and radioactivity levels may be analyzed against disposal site criteria at the Wet Handling Facility or may be packaged and transported to the LLWF for analysis against disposal site acceptance criteria. Suitable shielded packaging could be required for onsite and offsite transportation of exhausted pool filter cartridges. Dry high-efficiency particulate air filters from the surface facilities would be analyzed against the disposal acceptance criteria and would be transferred from the surface facility to the LLWF for offsite packaging and disposal preparations by the LLW operator.

A3.11 MATERIAL CONTROL AND ACCOUNTING PERSONNEL

MC&A personnel will obtain the appropriate Nuclear Material Transaction Reports and will maintain them as official records of the contents under the Yucca Mountain possession and operating license. Although operating data may be available well in advance of the arrival of nuclear material at the GROA, the Nuclear Material Transaction Report is the official record. MC&A personnel will verify that the information on the Nuclear Material Transaction Report is in agreement with the data associated with the cask received. This independent verification process is key to ensuring that the data received and entered into the accounting system is correct. MC&A personnel are responsible for accounting for and providing for up-to-date data on the quantities and locations of nuclear material including accounting for the radioactive decay of SNM. Multiple item control areas (ICAs) will be used to facilitate materials accountability.

A4 OPERATIONS

A4.1 TRANSFER OF CASKS TO THE GEOLOGIC REPOSITORY OPERATIONS AREA

For rail conveyances, trains arriving at the protected area must go through several steps prior to the cask cars entering the GROA rail car buffer area for storage. Following is the current concept of transfer of accountability.

1. Train arrives at the receiving tracks of the REMY adjacent to the Cask Maintenance Facility. The train will have two to three locomotives followed by a buffer car, the cask cars, another buffer car, and finally, the escort car.

2. The locomotives and front buffer car will be separated from the cask cars and taken to the REMY.

3. A REMY locomotive will connect to the back of the train and push the remaining cars consisting of the cask cars, the rear buffer car, and the escort car to the sally port adjacent to Building 30B.

4. The escort car and rear buffer will be uncoupled from the cask cars. This will leave the cask cars at the protected area gate. The escort crew and protected area security will complete hand-off paperwork at this point. The cask cars will become the responsibility of protected area security at this time.

5. The cask cars will be blue flagged and inspected. (No rail activity is allowed on spurs or track displaying a blue flag, indicating that personnel are working on or nearby railcars or the track.)

6. The GROA yard locomotive will bring the cars into the GROA through Building 30B and place them in the GROA railcar buffer area to await processing.

The process for truck conveyances is analagous.

A4.2 COMMON GEOLOGIC REPOSITORY OPERATIONS AREA OPERATING PRACTICES AND ACTIVITIES

This section provides generic descriptions and overviews of activities that are common regardless of the GROA surface facility or process used. A key principle of GROA and surface facility cask operations is to not proceed beyond any analyzed condition or administrative hold point. For example, a cask or transporter may not be washed down until the incoming radiological survey results were found to be acceptable. Washing a cask before then would negate efforts to assess survey wipe efficiency, locate specific contamination areas, or perform large-area averaging. Also, casks and equipment would be placed into a safe condition prior to leaving a cask or equipment unattended. Any remediation would only require repeating one step, rather than many steps. GROA common operating practices include:

- Incoming safeguards and security inspections
- Incoming cask radiological surveys
- Detailed transporter radiological surveys
- Railcar parking practices
- Railcar coupling and uncoupling practices
- Railcar movements within the GROA
- Trailer coupling and uncoupling practices
- Trailer parking practices
- Overhead and portable crane use
- Vehicle survey prior to departing surface facility
- Vehicle surveys for site rail power unit, highway (yard) tractor, site transporter, and TEV
- Satellite low-level waste accumulation

- Cask outgoing survey, prior to returning cask and transporters, at the nuclear facility from which it is being transported, and, if required, at canopied sally port adjacent to Building 30-B

- GROA road and rail traffic rules and limitations.

A4.2.1 Incoming Safeguards and Security Inspections

Except for authorized vehicles re-entering the protected area that are under constant security surveillance, all vehicles entering the protected area undergo a thorough security inspection. Prior to an incoming security inspection, the security force reviews accompanying paperwork to assess and authenticate the shipment. Before entering the protected area, all accessible vehicle internal and external surfaces, including undercarriage, are visually inspected for the presence of contraband or undeclared materials. This security inspection may be assisted by closed-circuit television and imaging software. All personnel from off site are also subjected to incoming security screening.

The validity of the content and integrity of each shipment of SNF and HLW to the GROA will be checked by MC&A personnel to confirm that it was received intact, that the integrity of its content was maintained, and that overall receiver findings are consistent with shipping documentation. This inspection provides visual verification of the unique identity of nuclear material receipts, using serial numbers affixed or engraved on transportation casks.

A4.2.2 Incoming Cask Radiological Surveys

Loaded incoming casks are subjected to fixed and nonfixed radiological assessments in accordance with 10 CFR 20.1906 [DIRS 181962]. Incoming casks are positioned under the inspection canopy at the cask receipt security station (Building 30-B) with portable or fixed scaffolding or a cask mobile access service platform. This platform and scaffolding allow safe personnel access to the transporter to support opening or retracting personnel barriers as necessary and in performing direct radiation and nonfixed contamination surveys.

Fixed gamma and neutron radioactivity readings are obtained at a distance of 2 m from the edge of the vehicle with the personnel barrier (if so equipped) closed or in place. Gamma readings may be obtained using a meter with a telescopic probe. Portable cask and transporter access platforms, similar to those used in the surface facilities, may provide workers necessary access to obtain 2 m neutron readings.

In addition to cask direct radiation readings, a radiological survey to detect nonfixed radioactivity will also be performed.

A4.2.3 Detailed Transporter Radiological Surveys

To ensure compliance with 10 CFR 20.1906 [DIRS 181962] requirements, receipt radiological surveys will be conducted on each incoming (i.e., loaded) transportation cask upon delivery to the nuclear facility that will process the transportation cask. These detailed receipt radiological surveys will be conducted after the personnel barrier and impact limiters have been removed to allow access to the entire exterior surface of the incoming loaded transportation cask.

Using the same instrumentation and steps described in Section A4.2.2, health physics technicians will obtain wipes from representative areas of the railcar or trailer after the TAD overpack or cask has been upended and removed. This same process is also used to survey any previously inaccessible vehicle and cask interior, such as the inside surfaces of the impact limiters. If significant nonfixed radioactive contamination, as defined in 49 CFR 173.443(a), Transportation: Shippers—General Requirements for Shipments and Packagings [DIRS 181975], is detected, such areas would be decontaminated prior to returning the cask to the transporter. Transporters exhibiting significant nonfixed contamination, as detailed in 49 CFR 173.443(a) [DIRS 181975], would be decontaminated before departing the GROA for any repair work.

A4.2.4 Railcar Parking Practices

Railcars parked outside of surface facilities in staging areas before unloading or prior to offsite shipment may be coupled together. While parked and during surface facility handling of railcars, the hand brakes will be engaged and at least one set of railcar wheels will be chocked during upending or down ending of transportation casks on their transporters. Additional railcar securement processes may be used per facility-specific procedures.

A4.2.5 Railcar Coupling and Uncoupling Practices

Each rail yard crew will include at least two trained and rail-qualified workers, one of whom is qualified in switch engine operations and the other who acts as a rail yard worker. If multiple rail crews are operating simultaneously, they will maintain visual and radio contact with each other. All railcar coupling and movement will be done using the GROA switch engine; no humping or free rolling of railcars is allowed within the GROA. After the switch engine engages the coupler and before releasing any brakes, the coupling is tested by reversing the switch engine and ensuring that the coupling is secured. Depending on how many railcars are included in a cut, the rail yard employee will engage the air hose glad hands to the switch engine air supply. Once the brakes are charged, and before any cars are moved, any wheel chocks are removed and then each railcar hand brake is released. In a string of cars coupled together, the rail yard worker will pull the coupler-disengage lever at the end of the last railcar in the cut. If necessary, before disengaging from the cut, the rail yard worker will install wheel chocks on the railcar string left behind.

A4.2.6 Railcar Movements within the Geologic Repository Operations Area

No rail activity is allowed on spurs or tracks displaying a blue flag, indicating that personnel are working on or nearby railcars or the track. Bringing railcars into the GROA is normally done by pulling the cars using the GROA switch engine. Railcar movements within the GROA would be done at slow speed and would be coordinated under the control of the shift manager.

Switching will be directed by the switch engine operator, and each switch position will be visually confirmed by the rail yard worker. At grade crossings, crossing safety will be confirmed by the rail yard worker prior to entering the grade crossing.

A4.2.7 Trailer Coupling and Uncoupling Practices

Two individuals will be involved in any trailer coupling and movement activity, one of whom must be certified in the operation of the yard tractor and the other a yard worker trained in safe coupling and parking safety activities. Only one trailer can be moved at a time using any GROA yard tractor. Trailer air brakes would be energized during each movement; the yard worker will connect any air brake hoses. Parking air brakes would be set and at least one of the two wheel chocks would be placed during parking and active trailer loading or unloading operation. Further trailer stabilizing may be imposed by each facility during cask upending or down ending. Trailers are parked with the landing gear sufficiently extended to allow the GROA tractor to disengage and reengage the trailer king pin. Any height adjustment needed to the landing gear to affect safe coupling and uncoupling is performed by the yard worker. After the yard tractor engages the trailer fifth wheel coupling mechanism, with the trailer brakes set, the tractor would test the coupling by engaging forward gear; a properly coupled trailer will not allow the tractor to move forward. The GROA yard tractor driver will follow prevailing GROA onsite traffic rules.

A4.2.8 Trailer Parking Practices

Trailer parking is done in the following sequence. Trailer is spotted in an approved, level parking area and the trailer parking brake is set. The yard worker installs one of the two wheel chocks and actuates the landing gear to extend the legs. In soft or unpaved areas, the trailer landing gear legs will be placed on a load-spreading support. Once the weight of the trailer is on the landing gear, the yard worker pulls the uncoupling lever and the tractor can pull forward, uncoupling from the trailer. When trailers are parked for cask processing or unloading operations and the tractor is uncoupled from the trailer, the trailer fifth wheel will be supported using a support stand and at least one of the two tandem wheels will be secured against trailer movement; additional securement would be specified in operating procedures.

A4.2.9 Overhead and Portable Crane Use

Prior to the first operation of any overhead or portable crane during a single work shift, the crane functions and motions are tested by the crane operator to ensure that the crane and controls are functioning correctly. Specific checks will include crane hoist, trolley, and bridge movements. The crane hoist will be capable of holding a load without any hoist down-drifting upon hoist power shut off. Connections between the crane and the load (i.e., below-the-hook) will be inspected for full engagement and signs of any damage or defect. The crane operator will cease any crane operations if a defect in function or load capacity is noted and will not continue until such defect is corrected.

A4.2.10 Surveys Prior to Departing a Surface Facility

All vehicles, equipment, and materials exiting from the potentially contaminated areas of a nuclear facility will have appropriate radiological (i.e., radiation and contamination) surveys completed prior to that item exiting from the facility. These surveys are completed to ensure that all radioactive material or contamination is properly controlled and that all requirements for the release or offsite shipment of such items are met.

For example, wipes will be obtained from representative areas of the railcar, cask transport skid, or trailer after the cask has been upended and removed from the transporter. A section of the outer flange and rim of one or more wheels will also be wiped and analyzed. If significant nonfixed radioactive contamination, defined as exceeding 49 CFR 173.443(a) [DIRS 181975] criteria, is detected, such areas will be decontaminated prior to exiting the surface facility.

A4.2.11 Vehicle Survey for Geologic Repository Operations Area Yard Tractor, Highway (Yard) Tractor, Site Transporter, and Transport Emplacement Vehicle

As described in Section A4.2.10, a sufficient number of wipes of representative areas using moderate pressure will be obtained from any vehicles departing surface facility buildings. At a minimum, the surface of selected tires or rail wheel flanges will be surveyed to demonstrate the absence of nonfixed surface contamination, as determined by site limits (established by the operational radiation protection program).

A4.2.12 Satellite Low-Level Waste Accumulation Areas

Solid LLW such as wiping cloths and rags would be placed in clearly marked drums or boxes located within each surface facility. Each loaded drum or box would be collected by the LLW contractor and delivered to the LLWF and would be replaced by an empty box or drum. LLW would remain at the LLWF until a truck load or other amount acceptable to the disposal facility was accumulated.

A4.2.13 Cask Outgoing Survey prior to Returning Cask and Transporters

A few wipes obtained using moderate pressure from representative areas prior to any exit of a cask or cask transporter will be used to confirm that any previous surveys were acceptable and that no “weeping” has occurred during outbound staging or storage. Nonfixed contamination levels will not exceed the limits established in 49 CFR 173.443(a) [DIRS 181975]. Casks or transporters where nonfixed contamination levels exceed the applicable DOT limits will be decontaminated to levels that ensure that the DOT limits will not be exceeded upon arrival at the destination. Decontamination, if necessary, could be performed outside, inside one of the surface facilities, or at the Cask Maintenance Facility with prior approval for offsite movement.

A4.2.14 Geologic Repository Operations Area Road and Rail Traffic Rules and Limitations

GROA rail and road traffic will not exceed posted site limits in order to prevent site accidents and provide adequate room for stopping.

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APPENDIX B
CENTRAL CONTROL CENTER FACILITY CONCEPT OF OPERATIONS

B1 INTRODUCTION

The Central Control Center Facility (CCCF) is divided into three sections and serves four primary functions. The three sections are:

1. Central control center
2. Primary alarm station
3. Central communications room.

The following are the four functions of the facility:

1. The central control center is the area from which the entire repository is monitored, selected systems are controlled, and other systems are controlled on a supervisory level.

2. The primary alarm station will maintain continuous monitoring of the site security systems including other security stations, the PIDAS, vital and controlled access areas, and alarm status.

3. The central communications room provides capability to communicate with offsite locations, including emergency response facilities, U.S. Department of Energy facilities, and the U.S. Nuclear Regulatory Commission.

4. The central control center and the central communications room serve as the primary Technical Support Center in the event of a declared emergency.

B2 GENERAL ARRANGEMENT

The central control center contains human-machine interface consoles, printers, and other support equipment. A separate engineering configuration room is provided to house an engineering workstation, a printer, and other support equipment. The design of the primary alarm station is in accordance with security requirements and is not addressed in this document. The operations portion of the building is sized to accommodate the personnel that will work from the Technical Support Center in a declared emergency.

In general, the security portion and the operations portion of the CCCF are independent from one another (e.g., they have separate heating, ventilation, and air-conditioning, separate power supplies). The heating, ventilation, and air-conditioning systems will be designed for the level of habitability needed in the event of a fire or radiological event.

B3 OPERATIONS

The central control center is the supervisory operating facility for the Geologic Repository Operations Area (GROA). The following is a list of functions, activities, inputs, and outputs of the facility:

1. The operations shift manager, who is based at the central control center, has a visual of most GROA activities from his station and has a communications line to all operating facilities from his workstation.

2. The operating consoles receive data from the digital control and management information system.

3. Cameras throughout the nuclear facilities, the GROA yard, and the subsurface provide a visual view to the central control center.

4. Temperatures of all overpacks on the aging pad are either directly indicated or abnormal temperatures are annunciated in this facility.

5. Several console operators are stationed in the central control center. From these consoles, all nuclear operating activities can be monitored and many can be stopped, in the event of an abnormal situation.

6. The central control center is the operating station for the transport and emplacement vehicle (TEV). The TEV console operator provides the "go" or "no-go" command signals to the TEV onboard programmable logic controllers at each stop point for the TEV. The TEV console operator can stop TEV operations at any time.

7. Key parameters required in the event of a declared emergency are available either by read-out in the central control center or by direct dedicated communications with the operators in the control center for the affected facility.

8. From the central control center and its connected central communications room, the shift manager—or the emergency director in a declared emergency—has communications lines with state and local authorities, the U.S. Department of Energy, the U.S. Nuclear Regulatory Commission, and Nevada rail line.

9. From this facility, the operations shift manager controls the site Plan of the Day and deconflicts work activities both within the GROA and external to the GROA (for those activities that may impact operations).

Security activities from the CCCF are not addressed in this document.

APPENDIX C
INITIAL HANDLING FACILITY CONCEPT OF OPERATIONS

C1 OVERVIEW

The purpose of this section is to provide a brief description of the layout, key equipment, functions, and operations associated with the Initial Handling Facility (IHF). Naval Nuclear Propulsion Program spent nuclear fuel and U.S. Department of Energy high-level radioactive waste as glass logs in standard stainless steel canisters, delivered by rail and truck, are the only inputs to the IHF, and the only output of the IHF is fully compliant waste packages delivered for emplacement. The structural integrity of the canisters and the solid forms of nuclear wastes prevent any significant release of radioactive material under IHF conditions. Preparing and unloading of casks, transferring canistered wastes to waste packages, and final waste package sealing and preparations at the IHF are performed using a combination of contact and remote operations designed to maintain worker exposures as low as is reasonably achievable. The design and operation of the IHF is inherently safe with very little potential for unexpected radiation exposure to workers, the public, or the environment. The facility, equipment, and processes are robust in design and specified to provide highly reliable operation.

C2 FACILITY LAYOUT, EQUIPMENT, AND OPERATIONS

See the following sections of 51A-PSA-IH00-00100-000, *Initial Handling Facility Event Sequence Development Analysis* (BSC 2008 [DIRS 180086]), for a discussion of the facility and its operations.

6.1 Initiating Event Analysis

6.1.1 Introduction

6.1.2 Overview of IHF and Its Operations

Attachment A IHF Layout and Equipment Summary

Attachment B IHF Operational Summary

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APPENDIX D
CANISTER RECEIPT AND CLOSURE FACILITIES CONCEPT OF OPERATIONS

D1 OVERVIEW

The purpose of this section is to provide a brief description of the layout, key equipment, functions, and operations associated with the Canister Receipt and Closure Facility (CRCF). All commercial and U.S. Department of Energy (DOE) spent nuclear fuel (SNF) and other DOE high-level radioactive waste canisters are processed into waste packages at the canister receipt and handling facility. Inputs to the CRCF include commercial SNF in transportation, aging, and disposal canisters, including those loaded by utilities and at the Wet Handling Facility. Transportation, aging, and disposal canisters received in transportation casks or aging overpacks may be transferred to aging overpacks or to waste packages. The CRCF may also receive commercial SNF in dual-purpose canisters; all SNF received in dual-purpose canisters is transferred to aging overpacks. Finally, sealed DOE canisters containing DOE SNF and DOE and commercial high-level radioactive waste, as glass logs, may also be received and transferred to waste packages (DOE canisters are not suited to aging). Transportation casks, aging overpacks, and shielded transfer casks and canisters received and processed at the CRCFs are expected to exhibit minimal nonfixed surface contamination. Work areas in the CRCFs are expected to start and remain essentially noncontaminated.

D2 FACILITY LAYOUT, EQUIPMENT, AND OPERATIONS

See the following sections of 060-PSA-CR00-00100-000, *Canister Receipt and Closure Facility Event Sequence Development Analysis* (BSC 2008 [DIRS 180761]), for a discussion of the facility and its operations.

6.1 Initiating Event Analysis

6.1.1 Introduction

6.1.2 Overview of CRCF and Its Operations

Attachment A CRCF Layout and Equipment Summary

Attachment B CRCF Operational Summary

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APPENDIX E
WET HANDLING FACILITY CONCEPT OF OPERATIONS

E1 OVERVIEW

The purpose of this section is to provide a brief description of the layout, key equipment, functions, and operations associated with the Wet Handling Facility (WHF).

Uncanistered commercial spent nuclear fuel (SNF) and dual-purpose canisters (DPCs), including horizontal DPCs, are received into the WHF in transportation casks, including transportable storage containers (if allowed), and aging overpacks. They are unloaded from horizontal aging modules into shielded transfer casks. Commercial DPCs, including those retrieved from Aging Facility, are first transferred into shielded transfer casks in the transfer room thereby keeping the casks and aging overpacks from contacting radioactive contamination in the WHF pool. The deep water-filled pool provides a well shielded, nonoxidizing and cooling environment for handling and transferring individual commercial SNF assemblies into transportation, aging, and disposal (TAD) canisters. Ultimately, all SNF unloaded at the WHF is placed into TAD canisters that are sent to Aging Facility or to the Canister Receipt and Closure Facility.

Note that transportation casks, waste packages, or loaded TAD canisters that require repair or remediation may be directed to the WHF, where underwater handling provides a flexible and safe handling environment away from other surface facilities, where such activities could significantly disrupt waste acceptance and throughput. However, such flexibility comes at the price of limited throughput at the WHF. The WHF is expected to generate the greatest volume of low-level radioactive wastes, including emptied commercial DPCs and exhausted pool water filter cartridges.

E2 FACILITY LAYOUT, EQUIPMENT, AND OPERATIONS

See the following sections of 050-PSA-WH00-00100-000, *Wet Handling Facility Event Sequence Development Analysis* (BSC 2008 [DIRS 180087]), for a discussion of the facility and its operations.

6.1 Initiating Event Analysis

6.1.1 Introduction

6.1.2 Overview of WHF and Its Operations

Attachment A WHF Layout and Equipment Summary

Attachment B WHF Operational Summary

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APPENDIX F
RECEIPT FACILITY CONCEPT OF OPERATIONS

F1 OVERVIEW

The purpose of this section is to provide a description of the layout, key equipment, functions, and operations associated with the Receipt Facility (RF). The RF is designed to make transfers of dual-purpose canisters and transportation, aging, and disposal canisters from rail transportation casks to aging overpacks. This report also identifies a location for the transfer and movement of horizontally oriented dual-purpose canisters from their transport carrier to a horizontal positioning trailer for moving transportation casks to horizontal aging modules at the Aging Facility. The concepts and much of the equipment, specified for the RF, are similar to the concepts and equipment used at the Initial Handling Facility and at the Canister Receipt and Closure Facility. The RF provides important to safety ventilation air control to mitigate a potential dose consequence of a cask or canister drop event sequence. The likelihood of a cask or canister drop event sequence, that could result in a breach of the cask or canister, is reduced by limiting the height to which a cask or canister is lifted above a hardened surface, and by use of reliable lifting and transfer equipment.

F2 FACILITY LAYOUT, EQUIPMENT, AND OPERATIONS

See the following sections of 200-PSA-RF00-00100-000, *Receipt Facility Event Sequence Development Analysis* (BSC 2008 [DIRS 180088]), for a discussion of the facility and its operations.

6.1 Initiating Event Analysis

6.1.1 Introduction

6.1.2 Overview of RF and Its Operations

Attachment A RF Layout and Equipment Summary

Attachment B RF Operational Summary

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APPENDIX G
AGING FACILITY CONCEPT OF OPERATIONS

G1 OVERVIEW

The purpose of this section is to provide a brief description of the layout, key equipment, functions, and operations associated with the Aging Facility. The Aging Facility is needed to uncouple waste receipts from waste emplacement operations to accommodate repository temperature and thermal limits, operations workflow (differences in acceptance and emplacement rates), and maintenance outages.

The Aging Facility includes a series of specially designed concrete pads suitable for placement of vertical aging overpacks and horizontal aging modules (HAMs). Vertical aging overpacks can accept transportation, aging, and disposal (TAD) canisters loaded at commercial nuclear plants or at the Wet Handling Facility (WHF). Vertical aging overpacks can also accept dual-purpose canisters (DPCs) loaded at commercial facilities and accepted by the U.S. Department of Energy. The vertical aging overpacks, which contain DPCs or TAD canisters, are positioned on aging pads for thermal management until the canisters are ready for further processing. Aging provides for the outdoor staging and cooling of commercial spent nuclear fuel that does not meet emplacement thermal criteria and also provides for staging of DPCs destined for unloading at the WHF. Aging overpacks are delivered to and retrieved from the Aging Facility one at a time using a site transporter.

HAMs are used to accommodate staging and to transfer horizontal DPCs. Horizontal DPC transportation casks are transferred, in the horizontal position, to a site cask transfer trailer (CTT) at the Receipt Facility (RF). The CTT is then moved to the aging pad and positioned adjacent to a HAM, where the DPC is then transferred from the transportation cask into the HAM for aging. Later, the CTT is used to extract the DPC into a special site horizontal shielded transfer cask. The cask is then delivered to the WHF where the DPC is opened and unloaded in the vertical position.

G2 GENERAL ARRANGEMENT

Aging pads consist of reinforced concrete storage pads, paved access ramps leading to and from the pads, security fencing and gates, and an operations area for monitoring, managing, and maintaining operations and instrumentation. The Aging Facility is only manned during placement and removal of aging overpacks or DPCs from HAMs and for periodic surveillance activities. Radiation surveys are conducted periodically to verify the absence of nonfixed contamination. Radiation and temperature instruments are provided to allow remote monitoring and alarming. Closed-circuit television is provided for remote monitoring, and security systems provide early warning of intrusion or security violation. Multiple concrete slabs that make up the aging pads will be constructed as needed. Aging pads containing HAMs need additional room to allow for maneuvering the CTT and associated equipment, including high-capacity portable cranes. Aging pad access roads will be designed to accommodate site transporters, the CTT, and other support equipment and vehicles, such as site cask tractors.

G3 CONCEPT OF OPERATIONS

G3.1 RECEIVING

Loaded aging overpacks are moved from the WHF, RF, or Canister Receipt and Closure Facility using site transporters and delivered to an aging pad. Loaded horizontal DPCs are moved primarily from the RF using a site CTT. These site-only vehicles move very slowly (up to 2.5 mph) and may be escorted by site security and health physics technicians.

G3.2 SITE TRANSPORT EQUIPMENT

Shielded transfer casks carry aging overpacks in the vertical position. When loaded, the site transporter and aging overpack are expected to weigh nearly 300 tons. To protect concrete surfaces during maneuvering and positioning, the site transporter is equipped with wide, caterpillar-style tracks without cleats. Outside of the surface nuclear facilities, the site transporter operates via electric motor drives powered by an onboard diesel generator, whereas inside it may also operate using line electric power from the building.

The CTT is expected to weigh approximately 165 tons when loaded. A site cask tractor with a top speed of 2.5 mph is used to tow the trailer and cask to a HAM on the aging pad. The cask tractor is capable of towing the load along compacted crushed gravel roadways and up a 5% grade to the aging pad. Both the tractor and trailer include braking systems. These braking systems are designed to apply the brakes automatically on both the tractor and the trailer should they become uncoupled or exceed the 2.5 mph speed limit. The cask tractor and CTT brakes are set and cannot be released when the operator is not at the wheel. Slow movement is key to ensuring that these heavy loads remain under control at all times within the Geologic Repository Operations Area. Regular inspections and maintenance of site transporters, cask tractors, and CTTs take place at the Heavy Equipment Maintenance Facility. Portable tanker trucks refuel site transporters and tractors.

G3.3 OPERATIONS

Thermal management involves preselecting a location on the aging pad and completing preparation activities prior to the arrival of a loaded aging overpack. Typically, a radiological survey of the overpack would be performed in a noncontaminated area at the facility in which the aging overpack was loaded. Instrument lead connections are checked beforehand. Any security gates are opened just ahead of the transporter and are closed after the transporter passes. The site transporter is driven to the aging space and sets the aging overpack in proper orientation to connect instrument and monitor leads. After the aging overpack is set down, the site transporter disengages and backs away. Final instrument checkout is done on the aging overpack. Temperature monitoring instruments are connected to the aging overpack or HAM and output is monitored continuously in the Central Control Center Facility. Security systems are monitored continuously at the primary alarm station and the secondary alarm station.

Prior to the arrival of a site transporter to remove a loaded aging overpack, the appropriate instrumentation and monitoring systems are disconnected. Once positioned, the site transporter picks up the loaded aging overpack, and the security gate is opened only long enough for the site transporter to exit. Aging overpacks containing TAD canisters are returned to the Canister

Receipt and Closure Facility. Aging overpacks containing vertical DPCs are returned to the WHF.

HAMs are prepared ahead of time by removing the HAM access door and positioning the portable crane and other necessary support equipment. The crane may remain in the area or may be delivered to, and removed from, the aging pad for each such transfer. After inspecting the interior of the HAM, the CTT is dispatched. The security gate is opened long enough to allow entrance of the CTT and is closed immediately afterwards. After the CTT is positioned just outside of the HAM, the cask lid bolts are removed and the cask lid is picked up using the portable crane. The cask is then engaged and secured to the HAM. After removing the cask bottom port cover and aligning the hydraulic cylinder, the DPC is pushed out of the cask and into the HAM. After moving the cask away from the HAM and reassembling it, the HAM access door is closed. The reverse of this process is used to transfer the DPC from the HAM and transfer it to a site transfer cask.

G3.4 MONITORING

Protective Force Officers (PFOs) will observe the Aging Facility during routine inspections and patrols. On occasion, health physics technicians will perform radiological surveys for nonfixed contamination and to verify instrument accuracy. In addition, the Operations department will occasionally observe aging overpacks and HAMs to verify that air inlets and outlets remain unblocked. To minimize radiation doses to workers and the number of entries and exits from the aging pads, these activities are expected to be performed in conjunction with normal arrivals and departures from the aging pads and as prompted by an abnormal increase in overpack or HAM temperature, as monitored and observed from a remote location. MC&A personnel will monitor aging overpacks and HAMs for inventory and other item identification purposes.

G3.5 TRANSPORTABLE STORAGE CASKS

If accepted and authorized, transportable storage casks may also be temporarily placed in the Aging Facility until their contents have cooled sufficiently or until the WHF is ready to unload them. After removal from their transport railcars, such casks will be moved to and from aging pads in the vertical position using modified site transporters. Otherwise, operation and monitoring of transportable storage casks will follow the same principles and activities as aging overpacks.

G3.6 DETAILED PROCESS ANALYSES

The steps to receive and process aging overpacks, site transportation casks, and transportable storage casks (if any) at the Aging Facility are summarized in Tables G-1 through G-3, along with the personnel groups and responsibilities associated with supporting these activities. The transfer of TAD canisters or DPCs in vertical aging overpacks and transportable storage casks to and from the aging pads is covered in Appendix F. Table G-3 is organized into sections as listed in Table G-1.

Table G-1. Aging Facility Activity Sections

Section
Movement of Aging Overpacks and Shielded Transfer Casks to Aging Pads
Delivery of Vertical Aging Overpacks from an Aging Pad
Routine Aging Pad Monitoring and Inspection

Personnel groups are listed in Table G-2.

Table G-2. Aging Facility Personnel Groups

Description	Abbreviation	Description	Abbreviation
Accountability Technician	AT	Health Physics Technician	HPT
Central Control Center Operator	CCCO	Item Control Area Representative	ICAR
Chemical Technician	CT	Mechanical Maintenance Technician	MMT
Electrical Maintenance Technician	ET	Quality Assurance Technician	QAT
Emergency Medical Technician	EMT	Protective Force Officer	PFO
Environmental Safety and Health Technician	ES&HT	Specialty Contractor	SC
Fire Brigade	FB	Utilities Technician	UT
Geologic Repository Operations Area Facilities Technician	FT	Yard Technician	YT

Table G-3. Personnel Required to Support Tasks Associated with the Movement of Aging Overpacks and Transfer Casks to Aging Pads

Step	Description	Duration (hrs)	Typical Staffing	Details
Movement of Aging Overpacks and of Shielded Transfer Casks to Aging Pads				
1	Position and engage aging overpack or shielded transfer cask. Lift aging overpack or shielded transfer cask to traveling height (not more than 12 in. above grade)	0.5	1 FT to operate the site transporter 1 FT to spot and verify load engagement 1 HPT to obtain final radiation measurements1 QAT to verify completion of all prerequisites 1 ICAR to prepare ICA transfer from waste facility to Aging Pad	This assumes that the aging overpack has integral lifting slots. The site transporter engages the lift slot from below and stabilizes the load using the cask restraint system on the site transporter. The aging overpack is lifted only high enough to clear ground-level obstructions
2	Move site transporter from surface facility	0.5 to 1.0	1 FT to operate airlock doors 1 FT to operate the site transporter while inside facility 1 YT to operate the site transporter 1 ICAR to update MC&A records	Once the aging overpack departs the facility (through the airlock), operation of the site transporter is turned over to YTs and the site transporter operates under diesel power. The site transporter moves slowly (not more than 2.5 mph) to mitigate the consequences of any accident
3	Move site transporter on designated surface roads to a location just outside of the aging pad	1.0 to 2.0	1 YT to operate the site transporter 1 YT to observe and guide 1 ICAR to prepare ICA receipt transaction form waste facility to the Aging Pad	As the site transporter approaches the aging pad, the security escort authorizes the aging pad gates to be opened. As soon as the site transporter enters the aging pad area, the gates are closed. The site transporter remains under Operations control inside of the aging pad
4	Position aging overpack at the designated location and set the aging overpack on the aging pad. Disengage the site transporter	0.5 to 1.0	1 YT to operate the site transporter 1 YT to observe and guide site transporter 1 UT to position the aging overpack 1 ET to connect and verify instruments 1 HPT to verify radiation measurements 1 ICAR to update MC&A records	The aging overpack is set down and the air inlet openings are verified to be clear of debris or damage to the animal screens. The site transporter may be moved away to pick up a loaded aging overpack for delivery to a surface facility or may be removed from the aging pad. The HPT will obtain a wipe from the aging area to verify the absence of nonfixed contamination before the aging overpack is positioned. The ET will connect instrument leads to the instrument network and verify their operation with the Central Control Center Facility. Bolting down is no longer an option

Table G-3 Personnel Required to Support Tasks Associated with the Movement of Aging Overpacks and Transfer Casks to Aging Pads (Continued)

Step	Description	Duration (hrs)	Typical Staffing	Details
5	Return site transporter	0.5 to 1.0	1 YT to operate the site transporter 1 YT to observe and guide site transporter 1 UT to position the aging overpack	After the site transporter is disengaged, it is directed to another aging overpack for transfer back to a surface facility or it is moved out of the aging pad area. Once activities have been completed, the personnel and site transporter are removed from the aging pad area. Security gates are closed and surveillance duties are turned over to the Central Control Center Facility
Delivery of Vertical Aging Overpacks from an Aging Pad				
1	Move the disengaged site transporter to the aging pad vehicle gate	0.5 to 1.0	1 YT to operate the site transporter 1 YT to observe and guide site transporter 1 HPT to obtain radiation readings and survey aging pad for nonfixed contamination 1 ET to disconnect instruments 1 ICAR to prepare ICA transfer from Aging Pad to waste facility	Any instrument connections are disconnected by the ET. The site transporter engages the aging overpack. The overpack is lifted no more than 12 inches above grade level and is secured for transportation. The HPT obtains radiation measurements from the aging overpack. Once the aging overpack is moved away, HPTs survey for the presence of nonfixed contamination on the vacant spot
2	Move loaded site transporter from the aging pad location to the aging pad gate	1.0 to 2.0	1 YT to operate the site transporter 1 YT to observe and guide site transporter 1 ICAR to update MC&A records	As soon as the site transporter departs the aging pad area, the gates are closed
3	Move site transporter to the designated surface facility	0.5 to 1.0	1 FT to operate airlock doors 1 FT to operate site transporter while inside facility 1 YT to operate the site transporter 1 ICAR to prepare receipt transaction from the Aging Pad to the waste facility	The site transporter moves slowly to mitigate the consequences of any accident. Prior to arrival at a surface facility, the YT notifies the surface facility operator to open the outer facility doors. ICAR also updates MC&A records. NOTE: When outdoors, the site transporter always is operated by the diesel generator

Table G-3 Personnel Required to Support Tasks Associated with the Movement of Aging Overpacks and Transfer Casks to Aging Pads (Continued)

Step	Description	Duration (hrs)	Typical Staffing	Details
Routine Aging Pad Monitoring and Inspection (Such routine inspections will be conducted in conjunction with normal aging overpack deliveries or shipments to the greatest practical extent)				
1	Routine visual inspection	1.0 to 2.0	1 YT to conduct visual inspection 1 HPT to survey radiation and contamination	As prompted by an abnormal increase in overpack or HAM temperature, as monitored remotely, the YT will look at the aging overpacks and HAMs and verify that any air inlets and outlets are unobstructed and that animal screens are in place. The YT will also inspect for surface damages and instrument and monitoring connections. The HPT will conduct both radiation and nonfixed contamination surveys; notifications will be made if significant nonfixed contamination or radiation dose rates are found. Surface cracks in aging pads are expected. Large cracks or significant displacement will indicate a need for investigation and corrective action
2	Deleted.			
3	Routine quality assurance inspection	1.0 to 2.0	1 YT to accompany QAT 1 QAT to conduct inspection and document results	Quality assurance inspection is done as a self-assessment against aging requirements and may be on a random, rather than regularly scheduled, basis
4	Routine radiation protection inspection	1.0 to 2.0	1 YT to accompany HPT 1 HPT to obtain radiation measurements	The HPT will obtain direct radiation readings to confirm instrument output and to ascertain that aging overpacks are functioning correctly. The HPT will also conduct surveys of the aging pad and aging overpack exterior surfaces to verify the absence of nonfixed contamination. The presence of significant nonfixed contamination will trigger an investigation as to its source
5	Annual inventory	~1 week	1 ICAR 1 AT	Conduct annual nuclear materials inventory.

NOTE: Abbreviations are identified in Table G-2.

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APPENDIX H
NORTH PORTAL CONCEPT OF OPERATIONS

H1 APPLICABILITY OF DISCUSSION

This appendix describes the North Portal after turnover for emplacement. This section does not apply to construction activities that occur at or via the North Portal prior to turnover to Operations.

H2 NORTH PORTAL CONTROL POINT

The North Portal is the main access point for the subsurface repository facility. There are several activities that must take place at the North Portal surface to subsurface transition point for personnel and equipment entry and egress. A North Portal control point will be established to coordinate and control these activities, as well as to accommodate the personnel that are responsible for controlling the activities and associated equipment.

H2.1 FUNCTIONS

The required functions to be performed at the North Portal include the following.

1. **Material Control and Accounting (MC&A) (Nuclear)**—Entry into the subsurface is a change in MC&A balance areas. This function is accomplished by two custodians—one assigned to the surface ICA and one assigned to the subsurface ICA.

2. **Security**—A physical barrier for access control at the entry and exit control point for the subsurface facility is required.

3. **Personnel Accountability—**An accurate accounting of personnel in the subsurface must be kept at all times for emergency management purposes.

4. **Material Tracking (Control of Committed Materials)—**A specific accounting of materials entering the subsurface must be maintained due to the limitations on committed materials at closure. Therefore, materials (e.g., tools and lubricant) entering the subsurface must be logged and removal of those materials will be verified.

5. **Underground Worker Safety Training and Qualifications Check**—There will be required training for subsurface access (e.g., subsurface worker training, subsurface familiarity training, and first aid training). Worker qualification may be required for some subsurface tasks. A badge check must be made of each person requesting entry to the subsurface. Through barcoding or equivalent means, a badge check will reveal the status of an individual's training and qualifications.

6. **Personal Protective Equipment**—There will be a minimum set of personal protective equipment (PPE) required for subsurface access. This minimum set includes hard-toed shoes, a hard hat, safety glasses, hearing protection (not required to be used at all times), a flashlight or miner's cap light, a self-rescuer, and radiological PPE and radiation monitoring equipment as specified on the Radiological Work Permit (RWP).

Additional PPE may be required based on the task to be performed or based on subsurface environmental conditions. For typical subsurface U.S. Department of Energy facilities, a check of required PPE is performed prior to entry.

7. **Radiological Work Permit (RWP)**—Entering the subsurface is a transition from a clean area to a potentially contaminated area. Personnel access to the subsurface emplacement area will be controlled through the RWP process, which will clearly specify all radiation protection entry requirements (e.g., PPE and dosimetry) and work area radiological status information. Personnel will be made aware of any movement of the loaded transport and emplacement vehicle (TEV) and emplacement activities for their safety and radiation protection to keep doses as low as is reasonably achievable.

8. **Radiological Surveys**—Health physics technicians will complete radiological surveys of personnel, vehicles, equipment, and materials exiting the subsurface emplacement area as specified on the RWP. This may be by portal monitor or by frisking personnel. For handheld equipment, documents, and similar accessories, the survey may be by a counting chamber or frisking. For vehicles and large equipment, the survey may be by portal monitor or swipes. A health physics technician must be available to assist personnel and to survey vehicles and equipment.

   Note that a catwalk or similar type of accommodation will be considered for TEV, inspection gantry, and drip shield gantry surveys.

9. **Environmental Monitoring**—An Environmental, Safety and Health technician will perform (typically each shift) air quality monitoring and other surveys and inspections (e.g., for noise, lighting, dust, and silica) to ensure safety and health and to specify safety and health PPE requirements for subsurface workers. Results of these suveys and inspections will be documented at the subsurface entry point.

10. **Communications**—There should be at least two means of communication with personnel in the subsurface. It is expected that there will be a public address system and a handheld radio for each person. Each person entering the subsurface will be issued a radio and will be responsible for testing the handheld radio prior to entry. The public address system must be tested periodically (typically each shift).

H2.2 STAFFING

The required staffing for the North Portal control point is expected to be:

- One MC&A custodian—as needed
- Two ICA representatives—as needed
- One protective force officer—as needed
- One health physics technician—24/7
- One operator/access control coordinator—24/7
- One Environmental, Safety and Health technician—as needed.

H3 OPERATIONS

H3.1 TRANSPORT AND EMPLACEMENT VEHICLE ENTRY AND EXIT

Upon loading the waste package at one of the surface nuclear facilities, the TEV will begin to travel along the surface toward the North Portal. The TEV will be guided remotely with a digital control and management information system program and monitored by an operator in the Central Control Center Facility. Prior to arriving at the North Portal, the TEV, if necessary, will be oriented by means of passing through a series of track switches so the front doors will be facing forward when the TEV reaches the designated emplacement drift. Only emplacement of waste packages in Panel 3 East will require the TEV to be oriented so the front doors face toward the rear as the TEV enters the North Portal.

As the TEV reaches the North Portal control point, the digital control and management information system will bring the TEV to a stop at a preprogrammed point inside the gated inspection area. At this time, the ICA representatives will transfer custody of the waste package and record its entrance into the subsurface. Prior to the TEV leaving the North Portal control point, the following activities will take place:

- The TEV will undergo a system check initiated by the operator monitoring the TEV.
- A remote visual inspection will be conducted via cameras.
- The track switch settings will be verified.
- The TEV route will be cleared and confirmation verified with the subsurface tracking system that all personnel and equipment are sheltered and the right-of-way is clear.
- The waste package identity and emplacement location will be confirmed by MC&A.
- No occurrence of off-normal events, precluding emplacement, will be confirmed.

When all of these conditions are met, the Operations department will declare all clear for the scheduled emplacement and the TEV will be signaled to continue en route to the designated emplacement drift location. After off-loading the waste package, the TEV will return to the North Portal control point by reversing its route. The TEV will stop at a programmed point to be inspected for contamination by swipe or smear test by radiation control personnel before being released by the Operations department for maintenance or reloading.

H3.2 PERSONNEL ENTRY AND EXIT

All personnel accessing the subsurface repository will pass through security access control and radiological control points in the North Portal control point. Each person will pick up any additional required dosimetry at the radiological control point and check in by signing onto the RWP for his or her assigned task. The RWP is linked to a computerized system that verifies the currency of personnel training (i.e., radiation worker training) as well as work control package.

Personnel from Engineering; Operations; Environmental, Safety and Health; Health Physics; Quality Control; U.S. Nuclear Regulatory Commission; Science; Performance Confirmation; Safeguards and Security; and other department personnel supporting repository operations will routinely require access to the subsurface repository via the North Portal control point.

After turnover from construction to operations, access to the subsurface repository will also be required by personnel associated with startup of the emplacement drifts (e.g., from the departments of Engineering, Construction, Field Engineering, Quality Control, Operations, and others). All the personnel, materials, and equipment will be beyond the TEV route and will be impacted only if they require egress during TEV movement.

All personnel, vehicles, tools, and materials coming out of the subsurface repository will be required to pass through the North Portal control point. Personnel will be subjected to a contamination check, which may range from a check of the hands and feet to a full body scan via a personnel contamination monitor. Vehicles and tools will require a swipe test. The level of contamination inspection will be driven by the actual operating conditions found at the subsurface repository.

It is reasonable to expect that the following personnel will enter the subsurface at the following frequencies:

- Two MC&A personnel for TID program and other activities (each shift)
- One safety and health technician to verify life safety conditions (each shift)
- One radiological technician for surveys and swipes (each shift)
- One operator for a rail walkdown and inspection (each shift)
- Two operators for general housekeeping and cleaning the invert (each shift)
- Four maintenance personnel for electrical and mechanical preventive maintenance (each shift)
- One operator or mining engineer for ground support inspection (each shift)
- One safety professional for observations and walkdowns (each shift)
- One supervisor for walkdowns, job inspections, and miscellaneous tasks (each shift)
- Approximately six personnel for startup of an emplacement drift (as needed)
- One quality control technician for maintenance activities verification, weld verification, and miscellaneous tasks (as needed)
- Two personnel for servicing of the portable toilets (weekly)
- One quality assurance technician for audits and observations (several times per week)

- Several personnel as allowed for tours (as defined and allowed by the U.S. Department of Energy)
- Other personnel for corrective maintenance, construction and operations barrier installation and removal, and miscellaneous tasks (as needed).

H3.3 PERSONNEL TRANSPORTATION

The specific method of mechanized transport of workers from the surface to the subsurface areas has not yet been defined. Any vehicle chosen for operation in the subsurface will be electric, either functioning from the third rail or battery powered. Rail-based vehicles, rubber-tire-based vehicles, or both may be employed. Rail-based vehicles are hampered by limited mobility, whereas rubber-tire-based vehicles introduce additional committed materials from the tires. There may also be larger vehicles to carry multiple personnel and smaller vehicles that transport only one or two personnel. It is also likely that specialized maintenance vehicles, equipped with toolkits and other maintenance supplies, will be utilized.

Personnel movement must be coordinated with TEV movement. Deconfliction of these activities will be covered in the Operations department Plan of the Day and will be controlled by the operator at the North Portal control point.

H4 SUBSURFACE MAINTENANCE OVERVIEW

Subsurface repository maintenance vehicles will also enter the repository though the North Portal control point. All vehicles and personnel will be tagged and tracked while in the subsurface by the subsurface tracking system. Maintenance activities will be completed under an RWP. All activities, with the exception of emergent events, will be scheduled and coordinated with the TEV and waste package emplacement activities. When performing maintenance tasks in the subsurface repository, all maintenance personnel and vehicles will be cleared from the TEV route prior to beginning waste emplacement operations. All maintenance materials entering the tunnel will be approved and logged. Excess, damaged, or replaced materials are returned to the North Portal control point from the subsurface repository to ensure all noncommitted materials are tracked.

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APPENDIX I
SUBSURFACE AND EMPLACEMENT CONCEPT OF OPERATIONS

I1 OVERVIEW

I1.1 WASTE HANDLING AND EMPLACEMENT OPERATIONS

Nuclear waste emplacement operations begin in Panel 1 and continue to Panels 2 through 4. Emplacement operations for the different panels are nearly identical, as described in this section.

At the access main, the turnout alignment is curved and has an emplacement access door. Waste packages are emplaced relatively far from the access main to ensure exposure to radiation for personnel working in the access main remains as low as is reasonably achievable. The curve of the turnout also provides for shielding of the access drift.

The transport and emplacement vehicle (TEV) collects a waste package, positioned on a pallet, from the Initial Handling Facility (IHF) or Canister Receipt and Closure Facility.

The TEV exits the surface facility, moving across the surface rail system, and, if necessary, is turned around so that it is correctly oriented for emplacement. The TEV then moves through the North Portal and down the North Ramp to the repository level, where it proceeds to a turnout. The emplacement access doors open and the TEV moves into the turnout. After the TEV moves through the access doors, the doors close behind the TEV. The TEV proceeds into the emplacement drift and stops at a predetermined distance from a previously emplaced waste package. The TEV shielded enclosure doors open, the rear shield door raises, the baseplate retracts from under the shielded enclosure, and the TEV moves forward to set the waste package in its required position within the emplacement drift. The shielded enclosure then lowers to its lowest position, placing the waste package and pallet on the emplacement drift invert structure. The TEV is driven back away from the waste package and pallet a predetermined distance. The TEV stops and the shielded enclosure raises to its travel height. The baseplate is retracted back under the shielded enclosure, the rear shield door lowers, the shielded enclosure front doors close, and the TEV travels back down the emplacement drift to the access doors, which open as the TEV approaches and close when the TEV has passed through. The TEV continues back to the surface facility to start another emplacement procedure.

In addition to waste emplacement, other activities (e.g., maintenance, performance confirmation activities, and inspections) will be performed in the subsurface facility on a regular basis.

I1.2 TRANSPORT AND EMPLACEMENT VEHICLE CONTROLS AND IMPORTANT TO SAFETY SWITCH

Implementation of important to safety functions to prevent inadvertent opening of the doors is accomplished by means of a hard-wired, mechanically-operated switch mounted on the TEV that interfaces with a stationary, actuating device mounted to the rails in the load out areas of the surface nuclear facilities and within the subsurface emplacement drifts. The stationary actuating device activates the switch on the TEV as it enters the load out areas or emplacement drifts, which allows control system components responsible for operating the locks of the shielded enclosure front doors to function. Activation of the mechanical switch on the TEV also permits the onboard programmable logic controller network to unlock the doors and implement the TEV functions needed to perform the prescribed operational sequence. When operations in the surface facility load out areas or the emplacement drifts are completed, the TEV leaves these areas. As the TEV exits the load out areas or emplacement drifts, the stationary actuating device again operates the mechanical switch on the TEV. This action disables unlocking of the front shield door locks and raising of the rear shield door and ensures the shielded enclosure doors cannot be inadvertently opened (BSC 2008 [DIRS 184959], Section 3.3.15).

The fixed actuator brackets are mounted to the TEV rails inside the emplacement access doors of the emplacement drifts and inside the waste package load out areas of the surface facilities. While the design for the mechanical switch mounted on the TEV is ongoing, it is anticipated that the switch is a lever-operated rotary switch of a radiation-hardened type, mounted in an enclosure within the central legs of the structural chassis with the actuating lever protruding below the bottom face of the support leg. This position would deny operation of the switch to any other device but the dedicated fixed actuator brackets mounted to the rails in the load out areas and emplacement drifts (BSC 2008 [DIRS 184959], Section 3.3.15).

I1.3 RETRIEVAL OPERATIONS OVERVIEW

If the decision is made to retrieve a waste package from the repository, normal operations will be executed using the TEV in a reverse sequence. Use of the same equipment provides a built-in capability for retrieval that can be readily implemented.

Waste retrieval operations begin by ventilation blast cooling of the emplacement drift, if required. If the decision for retrieval occurs after drip shield installation, then drip shield removal is also required. The current design does not require the installation of drip shields until a decision to close the repository is made and approved by the U.S. Nuclear Regulatory Commission. Therefore, with the exception of retrieval from the thermally accelerated test drift, drip shield removal is not anticipated.

Waste package retrieval is initiated by the TEV with the removal of the waste package emplaced nearest the emplacement drift entrance. Because the TEV is not designed to lift one waste package over another, the waste packages are removed in sequence, from the drift entrance back to the exhaust end of the drift.

All equipment returning to the surface will require special handling to address possible radiation levels and contamination control. At the surface facilities, any retrieved waste packages would be processed and moved to an alternate storage facility.

I1.4 OFF-NORMAL OPERATIONS

Off-normal is a term used to define an occurrence or condition outside the bounds of routine operations but within the range of analyzed conditions for the structure, system, or component (SSC). Off-normal operations are addressed in Appendix P; however, there is currently limited development of off-normal responses. The requirements for worker health and safety, as low as is reasonably achievable considerations, and radiation releases are not reduced during off-normal events. Handling off-normal events requires procedures and controls specific to that operation, and are developed for that specific situation. Ventilation during off-normal operations may need to be modified and will be included in off-normal response planning.

Examples of off-normal events that may occur in the subsurface facility during the emplacement phase include the following:

- Any event that results in a need to conduct a specialized operation in a loaded emplacement drift, an exhaust main, or exhaust shaft. The present concept of operations does not provide for manned operations in a loaded emplacement drift, or active exhaust mains or shafts, other than monitoring and periodic inspections.

- Loss of construction or emplacement ventilation due to fan failure or power loss.

- Recovery from a rockfall blocking an opening.

- Recovery from a subsurface fire.

- Recovery from a general power failure shutting down the ventilation system.

- Recovery from a loss of ventilation due to mechanical failure.

- Recovery from a TEV failure or accident.

I2 GENERAL ARRANGEMENT

I2.1 ENVIRONMENT

The surface environmental extremes are moderated in the subsurface facility. Because the facility is underground, there will be little or no effect from rain, snow, wind, and tornadoes. Flooding is not a problem because the portals and shafts are located outside of the probable maximum flood boundaries or are protected against flooding by barriers, if necessary. Earthquakes are a natural phenomena that have the potential to affect the subsurface facility during preclosure. In the subsurface, rock strains resulting from typical earthquake ground motions and associated long wavelengths are much smaller than those at the surface are. The ground motion and wavelengths are attenuated by the rock mass. Therefore, since tunnels are an integral part of, and move in unison with, the surrounding rock strata, the potential impacts from earthquakes are less severe in tunnels than on the surface.

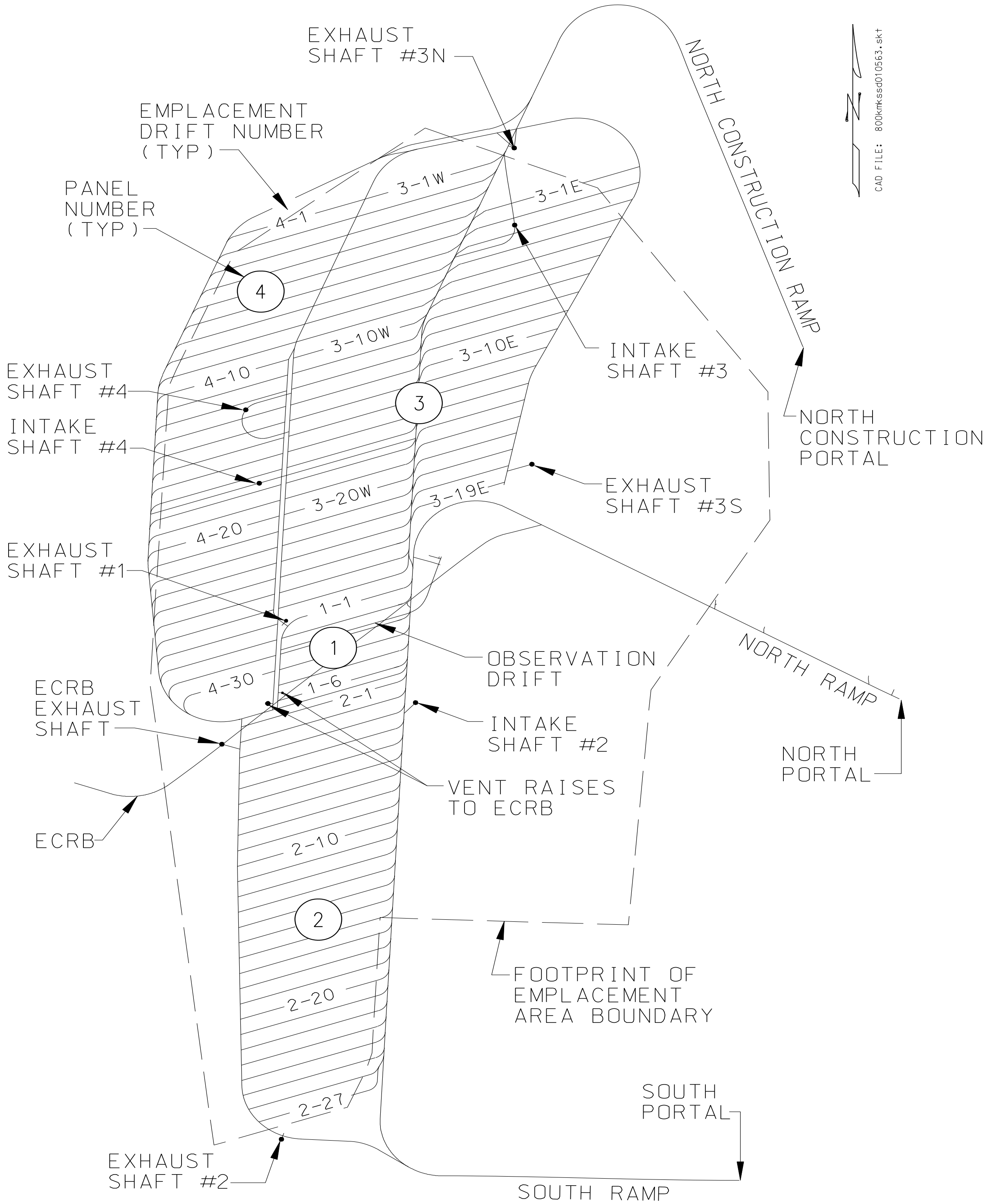
Additional subsurface hazards are radon and silica dust. Naturally occurring radon gas, released from volcanic rock, is a radioactive, colorless, and odorless gas that accumulates in unventilated areas. Radon gas can be mitigated with ventilation, administrative controls, or personal protective equipment (i.e., respirators to filter radon daughter particulates). Volcanic tuff, which is approximately one-third silica, is composed of various types of silica. Silica dust is a significant respiratory health hazard for workers and, thus, proper protective measures must be taken. Engineering controls such as dust control techniques will be used and supplemented by administrative controls and personal protective equipment, if necessary.

I2.2 SUBSURFACE LAYOUT

The current subsurface facility layout design provides for 108 emplacement drifts (maximum total) in four waste emplacement panels. The layout is shown in Figure I-1. The first emplacement panel to be constructed (Panel 1) is also the smallest, consisting of six emplacement drifts. The first drift in Panel 1 is dedicated to receiving waste packages from the IHF. One or two of these emplacement drifts will be designated as thermally accelerated test drift(s) and will be used as part of the performance confirmation program. The balance of the emplacement drifts will be developed concurrently with waste emplacement operations. Separation will be maintained between the development area and emplacement areas by the use of temporary isolation barriers, separate access portals, and administrative controls, thus providing separate access, safeguards and security, transportation, and ventilation systems for the two areas.

The subsurface facility is grouped into four waste emplacement panels as shown in Figure I-1. The subsurface facility is composed of the following major features: portals, access mains, ramps, exhaust mains, shafts, raises, turnouts, and emplacement drifts. In addition to these features, other features are included in the subsurface facility. These items include performance confirmation facilities (e.g., observation drift and alcoves), civil infrastructure, equipment, utilities, communications, safeguards and security, and miscellaneous support and safety systems (e.g., refuge stations).

The repository layout was designed to take advantage of existing subsurface Yucca Mountain Project excavations. Subsurface openings excavated during the characterization phase of the Yucca Mountain Project will become part of the permanent repository after improvements have been implemented to bring those structures up to the higher regulatory standards of the repository.



Source: Adapted from BSC 2007 [DIRS 179640], Figure 11.

ECRB = Enhanced Characterization of the Repository Block Drift.

Figure I-1. Outline of Primary Subsurface Excavations

I3 MONITORING AND CONTROL

I3.1 MONITORING

There are two general types of monitoring to be accomplished in the subsurface facility: operational monitoring (e.g., radon, radiation monitoring, and dust measurements taken for the health and safety of workers) and performance confirmation monitoring (e.g., monitoring a fault for displacement).

Some measurements, such as relative humidity, can be used for both operations and performance confirmation. Abrupt changes in relative humidity are an indication of water intrusion into the repository (performance confirmation). The amount of relative humidity is also important for determining how much heat is being removed from the emplacement drifts (operational monitoring). Performance monitoring and confirmation are addressed in Appendix M.

I3.1.1 Ventilation System Airflow Monitoring

Monitoring of the emplacement ventilation subsystem will be executed at several locations within the subsurface. The main intake, exhaust, and underground work area monitoring parameters will include airflow velocity, barometric pressure, air temperature, humidity, airborne particulates, carbon monoxide, and radioactive materials. In addition, the regulator at each emplacement drift will contain an airflow sensor. The intake airflow is monitored to provide system operation information and safety considerations, and to establish a baseline to confirm compliance with thermal management goals. The emplacement drift monitoring provides the ability to adjust the ventilation system components as repository requirements change. The exhaust shaft monitors provide the information necessary to verify the thermal performance, and monitor the exhaust airflow at the exhaust shafts (BSC 2007 [DIRS 184313], Section 6.12).

Though a monitoring program has not been designed at this time, airflow, carbon monoxide, and radon sensors in the main drift will likely operate continuously and temperature, humidity, and particulate monitors will operate intermittently. The emplacement drift airflow monitors are within the regulators, and will have the ability to provide real-time monitoring and regulation, if desired (BSC 2007 [DIRS 184313], Section 6.12).

Final monitoring of the ventilation system will occur at the exhaust shaft collars. The airflow, temperature, and relative humidity provide ventilation-related information. The ventilation system will also support radiation, environmental, and carbon monoxide monitoring at the exhaust shafts (BSC 2007 [DIRS 182105]).

Monitoring the stability of the ventilation system will also be conducted at the exhaust from the system. Revolutions per minute, vibration, and bearing temperature of the exhaust fans will be monitored to minimize the likelihood of interrupted service in accordance with *Subsurface Emplacement Ventilation System Design Analysis* (BSC 2007 [DIRS 184313], Section 7.3).

Monitoring of these parameters will be continuous throughout the duration of forced ventilation, and results will be fed back to remote equipment located on the surface. Feedback control equipment may be employed for adjustment (BSC 2007 [DIRS 184313], Section 6.12.2).

I3.1.2 Emplacement Access Door Monitoring

Monitoring parameters include the locking mechanisms and indication system, functionality, and status. The emplacement access doors must be monitored and guarded when open, and will only allow exit from inside the emplacement drift when locked. The emplacement access door emergency escape hatch will be secured but not monitored. Though an emergency hatch design has not yet been developed, it is expected the hatch design will only permit opening from the inside. No one will be able to open the doors from underground without the surface control room allowing the action (BSC 2007 [DIRS 182105]).

I3.1.3 Main Fan Installation Monitoring

The main fan installation monitoring parameters will include operating pressure, bearing temperature, vibration, status, fan pressure, power, and revolutions per minute. Main fan installations typically use continuous monitoring and recording capabilities. The main fans will also incorporate remote start and stop or speed adjustment features (BSC 2007 [DIRS 182105]).

I3.1.4 Radiation Monitoring

See Section 5.4.

I3.1.5 Ground Support Monitoring

Ground support monitoring will include deformation measurements in turnout areas and access mains. Selected emplacement drifts will be monitored for the physical conditions of the drifts (e.g., rockfall, drift degradation, or instability) using remote observation vehicles or robotic technologies in accordance with *Ground Support Maintenance Plan* (BSC 2008 [DIRS 185043], Section 6.1).

Emplacement Drift Postemplacement Inspections—During and after the emplacement of waste packages, human access to the emplacement drifts will not be permitted. During this time, as part of the performance confirmation program, the drifts will be remotely monitored and inspected for drift environmental conditions and waste package integrity. This activity will be conducted periodically, on a scheduled basis, to detect any indications of rockfall, drift degradation, or instability within the drifts that may require unplanned maintenance. The inspection frequency has not yet been established (BSC 2008 [DIRS 185043], Section 6.1.1).

Monitoring and inspecting emplacement drifts after the emplacement of waste packages may be accomplished using acoustic or seismic tomography, or both, to help detect rockfall. Remotely operated observation vehicles will be used for visual inspections and material sampling. Remote observations by video camera will be made of the drift walls for possible water seepage, drift degradation areas, and ground support component failure (indicators of ground support failure include bagged or torn stainless steel sheeting and rock particles on the invert or waste packages). The drift floors will be observed for rockfall debris. The volume of any observed rockfall debris will be estimated, and the condition of the waste packages will be assessed. This monitoring and inspection activity will be conducted on a scheduled basis, and it will provide the information necessary for evaluating drift degradation effects and ground support deterioration, and for the possible need for retrieving any damaged waste packages (BSC 2008 [DIRS 185043], Section 6.1.2).

Accessible Openings—Many nonemplacement repository openings will be safe and accessible for human entry. These openings include the portals and access ramps, access mains, ventilation intake shafts, raises, and accesses, portions of the emplacement drift turnouts, and the performance confirmation observation drift, including test alcoves. The accessible openings also include the existing Exploratory Studies Facility and the Enhanced Characterization of the Repository Block Cross-Drift.

During repository operations, qualified personnel will (subject to normal operational control procedures) periodically visually inspect these accessible nonemplacement openings, by direct observation, for the deterioration of ground support components and drift degradation effects. For the inspection of ventilation intake shafts, an inspection gantry will be used. These direct observations will be supplemented by in situ measurements of rock deformation and opening stability provided by geotechnical instrumentation. This information will form the basis for evaluating the need for repairs of the ground support system. A schedule of regular inspections by qualified personnel will be implemented, maintenance reports will be prepared, and any necessary repairs will be identified and performed (BSC 2008 [DIRS 185043], Section 6.3).

As currently envisioned for performance confirmation testing of accessible emplacement or access mains, the frequency of walkdowns for visual inspection of the drifts will be, at a minimum, weekly for the first 3 months, monthly for the next 3 months, and at 3 month intervals for the remaining period or until waste emplacement begins.

Inaccessible Openings—Nonemplacement openings that are inaccessible for human entry during the preclosure period are the exhaust mains, exhaust shafts, and turnout drifts. High temperatures and potential high-radiation levels characterize these areas. These areas will require remote monitoring and visual inspection for any degradation and ground support deterioration, using a remote observation vehicle equipped with a video camera. Visual indicators of problematic conditions include failed or buckled liner segments in exhaust shafts and failed ground support components and rockfall in exhaust mains. Ventilation airflow rates also will be monitored to determine whether any detected rockfall has resulted in an unacceptable constriction of airflow. A schedule of regular inspections will be implemented and will form the basis for determining whether any maintenance will be required in these inaccessible openings (BSC 2008 [DIRS 185043], Section 6.2).

I3.2 CONTROL

Airflow through the emplacement drifts will be remotely controlled. Control of the regulators will be automated with logic ties to the airflow sensors. To effectively evaluate and control the airflow distribution, a central data processing center will tie the regulators to both the airflow and differential pressure sensors at each turnout bulkhead. A program that monitors airflow differential pressure and regulator position, and then adjusts the regulator position based upon the airflow measurement, will establish the accuracy and reliability of each airflow sensor.

Because of the complexity of the subsurface ventilation system and the number of emplacement drifts considered, this system will be automated (BSC 2007 [DIRS 184313], Section 6.12.3) (the exception to this will be the independent control of airflow to meet performance confirmation test requirements).

The status, display, and command override functions of regulator and fan controls, and information needed for fire and worker protection, will be accessible from the fire command center.

The emplacement access doors will be locked and sealed with 2 TIDs except during periods when access is required. When a door is opened, an alarm will notify individuals in the area as to the change in position of the door. The emplacement access doors will be interlocked and operated from the remote control center. In this way, security and positive control of each emplacement drift can be maintained. The emplacement access doors are expected to be used for only several hundred open and close operations (BSC 2007 [DIRS 184313], Section 6.14).

The subsurface ventilation system will remotely operate all of the regulators. The regulators balance airflow in the emplacement drifts through a combination of remote operator controls and computer simulation.

I4 OPERATIONS

The operations phase begins when the construction organization turns over the initial portion of the facility (Panel 1, Phase 1) to the startup organization. The startup plan will detail the actual point at which turnover to the Operations department occurs, because it is a function of barrier placement and the success of cold startup testing. Startup testing will be performed in accordance with the testing program plan and procedures. A consistent process of turnover of newly commissioned emplacement drifts will be required for turnover and startup of the drifts until the construction of the repository is complete; however, licensing process requirements that will be followed for the addition of emplacement drifts to the repository are still in the development stage. When hot testing is successfully completed, waste emplacement can begin.

This sequence of construction, system functional testing, cold integrated testing and hot testing, and emplacement will take place frequently during the life of the repository, because the construction organization will turn over emplacement drifts in sets of 3 to 10 drifts at a time.

I4.1 VENTILATION OPERATIONS

I4.1.1 Subsurface Ventilation Operations Overview

The subsurface ventilation system consists of construction ventilation and emplacement ventilation. The independent ventilation systems allow concurrent construction of the repository and waste emplacement operations. The two systems have independent airflow networks and fan systems that operate simultaneously. To prevent the spread of any unlikely potential radioactive releases from the emplacement side, isolation barriers physically separate the construction ventilation from the emplacement ventilation. Air pressure on the construction side is maintained at a higher pressure (relative to the emplacement side) to prevent infiltration of emplacement air to the construction side. The construction ventilation system is operated as a positive pressure system (relative to the emplacement system), and the emplacement ventilation system is operated as a negative pressure system (relative to the construction system). In the event that one system shuts down, a pressure differential between the systems will be maintained, thus ensuring any potential radioactive releases are contained to the emplacement side.

The system ventilates the subsurface facility by circulating ambient surface fresh air throughout the subsurface construction areas, subsurface emplacement areas, and subsurface nonemplacement areas, and then removing exhaust air through shafts to the surface. The system provides fresh air for a safe work environment, and supports thermal management goals by ventilating and cooling emplacement drifts. The ventilation system also removes water from the host rock by evaporation and removes potential contaminants (e.g., silica dust, radon, blasting fumes, engine exhaust smoke, and diesel particulates) to meet air quality requirements. Ventilation volumetric flow rates for the subsurface ventilation system are based on the airflow demanded by subsurface personnel, equipment operations, thermal performance management, and air quality control. Although the system ventilates the subsurface, some of the infrastructure may be housed or located aboveground. Subsurface ventilation system components include access mains, exhaust mains, ramps, shafts, shaft access drifts, raises, ventilation fans, emplacement access doors, isolation barriers, regulators, and instrumentation for control and management of the system.

Personnel access to the exhaust mains on the emplacement side is prohibited due to potential radiation concerns and an elevated air temperature.

I4.1.2 Emplacement Ventilation

The emplacement ventilation system is discussed in *Subsurface Construction and Emplacement Ventilation* (BSC 2008 [DIRS 184870], Section 6.4). The subsurface ventilation supports the emplacement operation of the subsurface repository by providing fresh air for personnel and equipment, and supports thermal management goals by removing a portion of the waste package heat from emplacement drifts. Emplacement ventilation will start when the construction of a set of emplacement drifts is completed and handed over for startup testing.

The subsurface ventilation system is designed to operate continuously throughout the subsurface construction, operation (i.e., waste emplacement), postemplacement, and closure phases. This is accomplished by the system providing an emplacement drift intake airflow rate that has been demonstrated as satisfying thermal requirements.

In the emplacement ventilation system, the airflow is drawn through the repository by fans located at the top of the exhaust shafts. Ambient air enters the intake shafts or the North Ramp and is distributed to the access mains. The intake shafts are connected to the access mains by shaft access drifts. Fresh air from the 25 ft access mains enters the emplacement drifts via the turnouts. In an unregulated system, most of the airflow would course through the emplacement drifts closest to the intake and exhaust sources, and the drifts furthest from the intake and exhaust sources would receive little airflow. To avoid this situation, the airflow distribution is controlled by automated regulators located in the turnout of each emplacement drift. The regulator is part of the emplacement access doors bulkhead and controls the amount of air that enters an emplacement drift. The emplacement drift regulators closest to the intake and exhaust sources will be closed more often (i.e., more restrictive), and the emplacement drift regulators farther from the intake and exhaust sources will be open more often (i.e., less restrictive). The doors normally remain closed and serve as the designed barrier to restrict access to high-radiation areas.

Automated ventilation regulators will also be used to stop or regulate the airflow entering the emplacement drifts used for performance confirmation testing.

As air passes over the waste packages, it heats and expands. The emplacement drift exhaust volume is, therefore, higher than the intake volume due to thermal expansion. The air will also pick up moisture from the wall rock, if moisture is available. The airflow travels to the exhaust main, where it is then exhausted to the surface through an exhaust shaft. Exhaust shafts are also connected to the exhaust mains by shaft access drifts.

As design matures, more details regarding the specific method of operating the ventilation regulators will be defined.

I4.1.3 Isolation Barriers

The ventilation system uses fire-rated isolation barriers located in the access mains and exhaust mains to separate emplacement areas from construction areas. The following types of barriers are used in the repository (BSC 2007 [DIRS 182025], Section 6.2):

- Type A—Moveable barrier between the development and emplacement ventilation systems that does not permit emergency egress
- Type B—Moveable barrier between the development and emplacement ventilation systems that permits emergency egress
- Type C—Permanent barrier between intake airflow and exhaust airflow.

During the construction phase, Type A and Type B isolation barriers are installed in the access and exhaust mains to separate the construction ventilation from emplacement ventilation. The isolation barriers are temporary and are moved as the construction effort progresses. The Type B isolation barrier (Figures I-2 and I-3) contains an air lock door for emergency egress for escape purposes (BSC 2007 [DIRS 182025], Section 6.2). See Appendix P for discussion of emergency egress in the event of a subsurface emergency.

A Type C isolation barrier is installed between the intake and exhaust airflow paths, ensuring that access to high-radiation and high-temperature areas is not possible and that exhaust air does not recirculate. Access ports for the deployment of remotely operated vehicles may be made available at some Type C barriers. Type C barriers are permanent because they remain in place for the entire period of ventilation, both during and after final emplacement (BSC 2007 [DIRS 182025], Section 6.5.1).

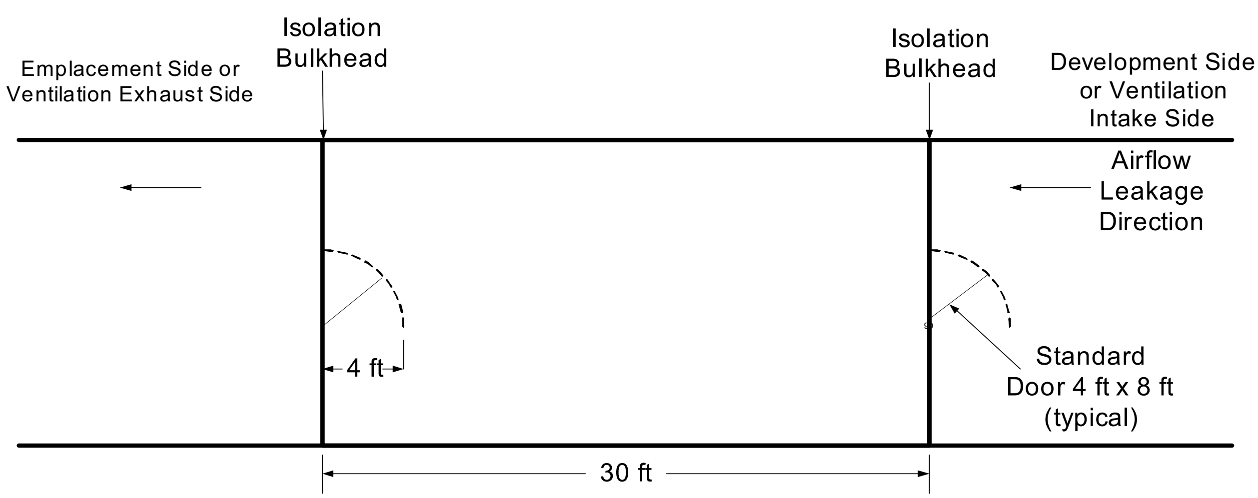
Most bulkheads for temporary and permanent barriers are of the same size and have interchangeable parts (BSC 2007 [DIRS 182025], Section 7.2).

I4.1.3.1 Isolation Bulkhead Movement

In a typical panel, each isolation barrier structure consists of a bulkhead and an air lock chamber (Figures I-2 and I-3). The length of the air lock chamber is dependent on the specific application. Location of the isolation barriers in the access mains will be coordinated with the location of the electrical equipment alcoves such that there is no impact to their intended functions. A set will typically consist of two Type A barriers in the exhaust main and two Type B barriers in the access main.

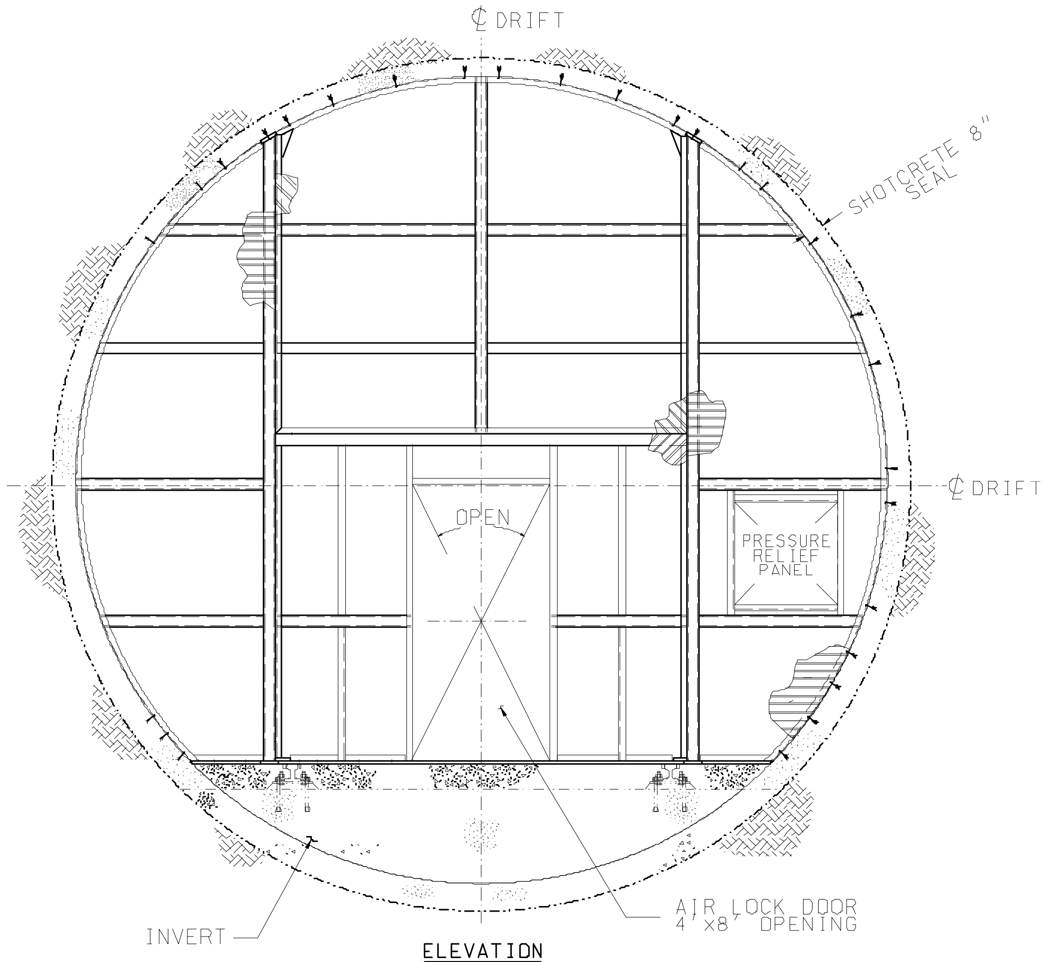
As an example, assume five emplacement drifts have been completed. The development activities for the five emplacement drifts include construction of the access main invert structure, rail installation, and installation of electrical equipment up to and past the first set of isolation barriers. The first set of isolation barriers with PIDAS separates the emplacement in the first five drifts from the development activities in the rest of this panel. Commissioning for emplacement begins when the first set of isolation barriers is in place and sealed. Emplacement drift excavation activities can continue beyond this set of barriers.

Installation of a second set of isolation barriers with PIDAS is initiated on the development side of the set of five emplacement drifts; however, this set of isolation barriers is left open or partially completed, to allow construction equipment and personnel traffic across the barriers. Similar to the case of the first five drifts, completion of the second set of emplacement drifts includes completion of the access main invert structure and installation of rail and utilities up to and past the second set of isolation barriers. This allows the second set of barriers to be closed, sealed, and made ready for commissioning of the second set of emplacement drifts. This operation will be carried out in accordance with safeguard and security requirements.



Source: BSC 2007 [DIRS 182025], Figure 1.

Figure I-2. Isolation Barrier Typical Drift Plan View



Source: BSC 2007 [DIRS 182025], Figure 2.

Figure I-3. Sample Cross Section of Isolation Bulkhead Configuration

The first set of isolation barriers is no longer needed and can be removed, reconditioned, and relocated to the intended location for the third set of barriers. Removal of the isolation barriers takes place inside a commissioned emplacement area. This activity is limited to dismantlement and includes limited, controlled demolition and dust-generating activities. The bulkheads for the isolation barriers are constructed by bolting modules together to a structural framework. There is little interaction with emplacement activities, and radiological exposure will be minimal.

After the second set of isolation barriers is sealed and the second set of emplacement drifts is commissioned for emplacement, construction activities will continue on a third set of emplacement drifts. Components from the first set of isolation barriers that are removed can then be reconditioned and reinstalled at the intended location for the third set of barriers. This process is then repeated until the panel is completed.

The bulkhead structural frame may be left in place and removed at repository closure, or it can be removed and reused during development, depending on details of final design and fabrication for these structures. The design and fabrication of the bulkheads will include features that will allow the disassembly and removal of components with minimal disruptions to the surrounding environment. This requirement is necessary because the disassembly will take place in a commissioned emplacement area. This activity will take place away from active waste package emplacement and with the appropriate radiological protection controls in place.

I4.1.3.2 Rail and Utility Extensions in the Access Mains

Rail Extensions—The rail system on the emplacement side is located in the North Ramp, the access mains, and turnouts. In developing the first set of emplacement drifts in the panel, the rail system will be constructed to extend through the first set of isolation barriers. After construction of the first set of emplacement drifts, but prior to turnover of the drifts to the startup organization, the rail system will be extended through the second set of isolation barriers. This sequence of construction will be followed until the entire panel is constructed.

Utility Extensions—The main utilities to be carried in the access mains are electric power and communications. Electric power is needed to power the TEV. It is also needed for lighting, communications, instrumentation, ventilation dampers, and doors. During construction of the first set of emplacement drifts in the panel, the utilities will be installed and activated up to the first isolation barrier. They will not penetrate the barrier (with the exception of emergency communications) so that isolation of the construction and emplacement utilities can be maintained. During this same construction period, the utilities will be installed (but not activated) between the first and second barriers. After the construction organization turns over the first set of emplacement drifts to the startup organization, and the first isolation barrier is removed, the utilities will be activated up to the remaining barrier. This sequence of construction will be followed until the entire panel is constructed.

I4.1.3.3 Construction to Emplacement Transition

This section summarizes the steps for the current concept of transition (to convert subsurface construction areas to emplacement operations). The following figures are simple schematics to help visualize the turnover sequence. Figure I-4 represents the status of the facility before turnover and Figure I-5 represents the status when turnover operations are complete.

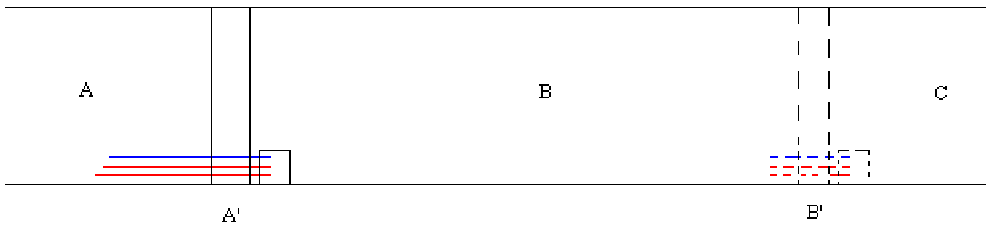


Figure I-4. Turnover Schematic—Transition Period Start

Legend: A = Operating area of the repository
A′ = Isolation barrier separating construction from operations
B = Constructed facility being readied for turnover (construction side)
B′ = Isolation barrier that will separate construction from operations after turnover
C = Construction side of the repository

= Power, third rail, communications, data, monitoring, security systems

= Termination boxes, system end points, future connection point

= Isolation bulkhead.

Figure I-5. Turnover Schematic—Transition Period End

Legend: A = Operating area of the repository
A′ = Isolation barrier separating construction from operations
C = Construction side of the repository

= Power, third rail, communications, data, monitoring, security systems

= Termination boxes, system end points, future connection point

= Isolation bulkhead.

Turnover Sequence

The following steps demonstrate the method for starting up and turning over completed areas of the subsurface facility (these steps only represent one possible solution for the turnover sequence; variations to this sequence may occur as the design and concept of operations matures):

1. Coordinate subsurface facilities to be commissioned (Figure I-4, Area B).
2. Extend electrical power through the new isolation barrier area (Figure I-4, Area B′).
3. Install communication and data systems through new isolation barrier area.
4. Complete microwave communication channel through new isolation barrier area.
5. Complete TEV rail and third rail systems through new isolation barrier area.
6. Finalize construction of heavy systems (e.g., ground support, invert, steel, rail, and concrete).
7. Complete acceptance testing of heavy systems.
8. Erect steel bulkheads at new isolation barrier location in intake mains (Figure I-4, Area B′).
9. Erect steel bulkheads in exhaust mains.
10. Complete safeguards and security and monitoring systems.
11. Transfer electrical power from construction to operations (Figure I-4, Area A′).
12. Turn over data, communications, and monitoring systems.
13. Turn over radiological monitoring system.
14. Conduct operational test of emplacement access door using Operations department SSCs.
15. Conduct operational tests of emplacement access door louvers using Operations department SSCs.
16. Coordinate startup and testing of new surface fans (if present in turnover package).
17. Activate security systems at new isolation barrier with PIDAS locations.
18. Activate new isolation barriers with PIDAS in exhaust mains.
19. Activate new isolation barriers in intake mains (Figure I-5, Area A′).
20. Test, verify, and accept security systems, camera operation, and isolation barrier with PIDAS monitors.
21. Open ventilation bulkheads at deactivated isolation barrier in intake main.
22. Verify negative pressure (i.e., flow from new area to old area) in exhaust main.
23. Remove bulkheads in exhaust main.
24. Survey and decontaminate steel bulkheads on surface, if needed.

25. Test ventilation system pressures.
26. Test ventilation controls.
27. Test and verify louver, door, and fan controls.
28. Verify ventilation system performance.
29. Test, verify, and accept radiological monitoring systems.
30. Remove remaining steel bulkhead components from intake main.
31. Survey and decontaminate steel bulkheads on surface, if needed.
32. Return bulkhead components to subsurface contractor.
33. Complete coupling of microwave communication system.
34. Energize the third rail for TEV operations.
35. Conduct cold integrated testing with TEV or equivalent vehicle.
36. Test TEV travel to all areas.

I4.1.3.4 Postconstruction Status of Construction Portals

Upon completion of construction activities, the facilities supporting the construction effort at the South and North Construction Portals will be demolished and removed, leaving in place only those facilities required to support postemplacement activities. It is anticipated that a substantial barrier will be installed at the portals that will require exerted time and effort to breech and not interfere with ventilation or other system operations (BSC 2007 [DIRS 183760], Section 5.8). The barricades will meet the requirement that any potential access point to the emplacement side of the subsurface facility will require either isolation bulkheads or barricades that prevent and detect unauthorized entry and maintain access controls (BSC 2007 [DIRS 183393], Section 4.2).

I4.2 WASTE PACKAGE EMPLACEMENT

NOTE: The waste package loading plan will be developed by nuclear engineering, geology, and national laboratory personnel to account for geological conditions and thermal load balancing. The Operations department will follow the waste package loading plan. If at any time a geologic or other anomaly is found that could impact the loading plan, waste emplacement will be secured until the anomaly is studied and the loading plan is formally revised, if a change is required.

The TEV is massively shielded to minimize surface radiation hazards to workers and is remotely operated to eliminate the need for workers to enter waste emplacement drifts. Waste packages are emplaced on the invert (i.e., flat) of the drift floor in close proximity to, but not touching, adjacent waste packages.

Personnel groups are listed in Table I-1.

The steps to emplace waste packages are summarized in Table I-2.

Table I-1. Subsurface and Emplacement Personnel Groups

Description	Abbreviation	Description	Abbreviation
Accountability Technician	AT	Health Physics Technician	HPT
Central Control Center Operator	CCCO	Item Control Area Representative	ICAR
Chemical Technician	CT	Mechanical Maintenance Technician	MMT
Electrical Maintenance Technician	ET	Quality Assurance Technician	QAT
Emergency Medical Technician	EMT	Protective Force Officer	PFO
Environmental Safety and Health Technician	ES&HT	Specialty Contractor	SC
Fire Brigade	FB	Utilities Technician	UT
Geologic Repository Operations Area Facilities Technician	FT	Yard Technician	YT

NOTE: The TEV is controlled by an operator in the central control center, who provides commands to the onboard programmable logic control system. The programmable logic control automatically performs a series of specific steps upon receiving a given command signal. Important to safety-related functions are hard-wired.

Table I-2. Waste Package Emplacement

Step	Description	Duration (hr)	Typical Staffing	Details
Waste Package Emplacement by the TEV (NOTE: The TEV is autonomous and travels at 150 ft per minute)				
1	The TEV with loaded waste package travels into air lock of IHF or Canister Receipt and Closure Facility	0.1	1 FT 1 CCCO	—
2	Inner load out room doors close and outer load out room doors open, and the TEV exits the building	0.25	1 FT 1 CCCO 1 HPT to ensure radiological controls are enforced for moving in high radiation area	If electrical power within the facility is via an umbilical cord, the cord is disconnected after the inner door is closed
3	The TEV travels through North Portal into access main to turnout for designated emplacement drift, using third rail power	1.0 to 4.0	1 CCCO 1 HPT	See Appendix H for activities that take place at the North Portal control point
4	Control operator verifies TEV position, actuates the rail access switch, and opens the emplacement access doors	0.1	1 CCCO	—
5	The TEV travels into the turnout and the access doors are closed behind it	0.1	1 CCCO	—
6	The TEV travels to within 150 feet of emplaced waste packages in drift, and slows to positioning speed	0.5 to 2.0	1 CCCO	—

Table I-2. Waste Package Emplacement (Continued)

Step	Description	Duration (hr)	Typical Staffing	Details
7	TEV rear shield door opens, shield baseplate is extended; shielded enclosure doors open, and screw jacks lower the main shielded enclosure for waste package positioning	0.5	1 CCCO	—
8	The TEV places the pallet and waste package on the steel invert and verifies placement position. The TEV then backs away from the waste package, raises the shielded enclosure, retracts the baseplate, lowers the rear shield door, closes the shielded enclosure front doors, and proceeds to the turnout	0.5	1 CCCO 1 QAT for verification of placement	—
9	The sequence is reversed, and the TEV travels to the Heavy Equipment Maintenance Facility for any required checks and maintenance	1.0 to 4.0	1 CCCO	See Appendix H for activities that take place at the North Portal control point

NOTE: Abbreviations are identified in Table I-1.

APPENDIX J
OTHER NUCLEAR AND IMPORTANT TO SAFETY FACILITIES CONCEPT OF OPERATIONS

J1 INTRODUCTION

This section discusses any nuclear facility not covered by a dedicated appendix and those important to safety (ITS) facilities for which the concept of operations is important to detail for understanding. At this point in the project, every nuclear facility is covered by a dedicated appendix. The only ITS facility not specifically covered elsewhere in this report is the ITS alternating current power supply, specifically for the emergency diesel generators (EDGs) and their auxiliaries.

The design of the ITS alternating current electrical power supply incorporates nuclear industry practices (such as redundancy, equipment qualification, physical separation, and electrical independence) by the use of applicable industry codes and standards.

J2 GENERAL ARRANGEMENT

The ITS EDGs are located in the EDG Facility. The fuel oil tanks for the EDGs are outside of the building and buried.

The ITS EDGs are electrically isolated from each other. Physical separation for fire and missile protection is maintained between the ITS EDGs, because they are housed in separate rooms of the EDG Facility. Power and control cables for the ITS EDGs and associated switchgear are routed to maintain physical separation.

J3 OPERATIONS

Other than automatically starting and tying to a deenergized bus, only local operation of the EDGs is currently presented in the design. Planned surveillance testing that requires synchronization of the EDG to the electrical power grid has not received detailed consideration. Since there are current studies ongoing regarding remote operation of the EDGs, standby diesel generators, and the switchyard, it is premature to describe operations. This section will be updated as the design matures.

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APPENDIX K
LOW-LEVEL, HAZARDOUS, AND NONHAZARDOUS WASTE MANAGEMENT CONCEPT OF OPERATIONS

K1 OVERVIEW

This section discusses the handling of low-level radioactive waste (LLW), hazardous waste, and nonhazardous waste generated at the Geologic Repository Operations Area (GROA). The generation of LLW will be minimized. Any LLW generated will be disposed of in an authorized U.S. Department of Energy, U.S. Nuclear Regulatory Commission, or Agreement State-licensed LLW disposal site, subject to the completion of appropriate reviews pursuant to the National Environmental Policy Act of 1969 [DIRS 160261]. Hazardous waste is disposed of at approved offsite facilities. Nonhazardous waste is collected and processed, or disposed of in the Nevada Test Site landfill or an offsite commercial landfill.

K2 GENERAL ARRANGEMENT

The Low-Level Waste Facility (LLWF) is a one-story building designed to accept, manage, and store dry radioactive waste and liquid radioactive waste. Dry waste will be shipped, typically in bulk, off site for disposal. As currently conceived, a waste disposal subcontractor will come to the site with truck-mounted filters and demineralizers to process the liquid radioactive waste. The waste product will then be dewatered, appropriately packaged, and shipped off site for disposal.

Four separate, part-height, walled, and shielded storage bays are located inside the building. The four bays provide for interim storage of packaged waste received on a routine basis from the waste handling facilities. Storage is provided in the LLWF for wastes contained in boxes, drums, filters, and high-integrity containers. Empty dual-purpose canisters (DPCs) are stored in the LLWF for eventual disposal at an offsite licensed LLW facility. A bridge crane is provided to access all waste storage areas within the building; it is sized to accommodate any expected waste form.

Liquid waste tanks are located outdoors adjacent to the LLWF. The current design provides for Wet Handling Facility (WHF) liquid LLW to be piped to the LLWF tanks; any liquid LLW from the other nuclear facilities will be transported to the tanks in suitable containers. Provisions will be provided for liquid LLW sampling, characterization, and processing on site by contractor mobile equipment. After processing, the waste may be transported off site for disposal. The liquids may be recycled for use at the repository.

K3 LOW-LEVEL RADIOACTIVE WASTE

K3.1 DESCRIPTION

For the purposes of the GROA, LLW includes all radioactive waste that is not high-level radioactive waste (i.e., emplacement waste forms), transuranic waste, or mixed waste (radioactive waste mixed with hazardous waste). Therefore, LLW handled within the GROA will range from very low activity (e.g., anticontamination clothing) to very high activity (e.g., fuel pool filters).

During operation of the repository, LLW is generated in the Initial Handling Facility, the Canister Receipt and Closure Facilities, the WHF, the Receipt Facility, and the LLWF. Additionally, small amounts of waste will come from routine radiological surveys conducted throughout the surface area of the GROA. Significant quantities of LLW will not routinely be generated in the subsurface.

The solid LLW streams are:

- Empty DPCs
- Dry solids, including:
  - Compactable solids, such as personal protective clothing, swipes, and miscellaneous trash and materials
  - Noncompactable solids, such as contaminated tools or activated components
  - High-efficiency particulate air filters used to remove airborne contamination.
- Wet solids, including:
  - Spent ion-exchange media, mechanical filters, and material (other than high-level waste) collected by the pool vacuum system
  - Wet cleaning products used in contaminated areas.

Liquid LLW consists of primarily:

- Equipment drain water
- Decontamination wash water
- Floor drain system water.

K3.2 CONCEPT OF OPERATIONS

Once removed from the WHF pool, a DPC carcass is drained of water and any residual fissile material is removed. The DPC is inspected and placed in a suitable container for transport to the LLWF. The lid may be tack welded back onto the DPC.

Dry solid LLW is collected, transferred to the LLWF, and stored for eventual packaging and shipment. Containers of wet solids associated with pool water treatment and decontamination water treatment are similarly transferred to the LLWF and stored until processed.

The LLWF will be designed to accept, manage, and store dry active waste and liquid radioactive waste until it is shipped (in bulk shipment) to an offsite vendor for processing and disposal. Storage is provided in the LLWF for wastes contained in boxes, drums, filters, and high-integrity containers. Empty DPCs are also stored in the LLWF for eventual disposal at a licensed offsite facility. The LLWF is equipped with a high capacity crane that can access all of the storage areas in the facility. Waste will be transported to the LLWF from the nuclear facilities via standard vehicular transport (e.g., an open flatbed truck), and radiation shielding will be provided as needed to transfer items.

The current concept is for liquid waste to be processed by a specialty subcontractor. It may be processed from each facility's liquid waste storage tank or could be consolidated at the LLWF and processed there. Typically, a subcontractor samples and characterizes the liquid waste, processes it through filters and demineralizers, then dewaters and transports the solidified waste package for offsite disposal.

K4 HAZARDOUS WASTE

K4.1 DESCRIPTION

Hazardous waste may be liquid or solid and includes medical waste, solid wastes, or a combination of wastes, which because of quantity, concentration, or physical, chemical, or infectious characteristics have to be properly treated, stored, transported, disposed of, or otherwise managed. Additional forms of hazardous wastes include spent batteries, pesticides, mercury-containing thermostats, and lamps.

K4.2 CONCEPT OF OPERATIONS

GROA personnel have the responsibility for taking hazardous wastes to satellite accumulation areas within the GROA, and for ensuring the wastes are properly labeled. From the satellite accumulation areas, a hazardous waste custodian will move the materials to the primary accumulation area, located outside of the GROA. Shipments will be made from that area to appropriate offsite disposal facilities.

K5 NONHAZARDOUS WASTE

K5.1 DESCRIPTION

Nonhazardous waste includes sanitary sewage, storm water, used tires, and sanitary and industrial waste.

K5.2 CONCEPT OF OPERATIONS

Sanitary solid waste receptacles are placed throughout the GROA but outside of potentially contaminated areas. Specially marked receptacles are placed in appropriate locations for industrial solid wastes (primarily oil-contaminated maintenance debris). Sanitary sewage is disposed of in septic tanks or a drainage field system. Storm water runoff within the GROA is directed to a retention basin and is monitored for radiological contamination. Nonhazardous wastes that can be recycled are separated when practical.

Nonhazardous waste generated in the subsurface will be packaged, surveyed at the North Portal, and processed for offsite disposal.

Solid waste collection and preparation for shipment to a landfill or recycling center is conducted by the custodial staff. This staff will also prepare and ship industrial waste to the nonradiological waste management yard located outside of the GROA.

APPENDIX L
BALANCE OF PLANT CONCEPT OF OPERATIONS

NOTE: Balance of Plant (BOP) facilities and operations are still in development and consequently they are not discussed in detail here. The material presented in this report has been condensed from other documents supporting the license application. This information will be updated as BOP design matures.

L1 OVERVIEW

The following is a current list of the BOP facilities. Some of these facilities are further discussed in facility-specific appendices.

- 138 kV switchyard
- 13.8 kV Switchgear Facility
- Administration Facility
- Administration security stations
- Cask receipt security station
- Central Control Center Facility (see Appendix B)
- Central security station
- Communications
- Cooling tower
- Craft shops
- Diesel fuel oil storage
- Standby diesel generators
- Equipment and yard storage
- Evaporation pond
- Fire, Rescue, and Medical Facility
- Fire Water Facilities
- Fueling stations
- Heavy Equipment Maintenance Facility
- Helicopter pad
- Low-Level Waste Facility (see Appendix K)
- Materials storage yard
- North perimeter security station
- Railcar staging area (see Appendix A)
- Septic tank and leach field
- Storm water retention pond
- Truck staging area (see Appendix A)
- Utilities Facility
- Vehicle maintenance and motor pool
- Warehouse and Non-Nuclear Receipt Facility
- Warehouse and central receiving.

L2 OPERATIONS

Not currently available for this section.

APPENDIX M
PERFORMANCE CONFIRMATION CONCEPT OF OPERATIONS

M1 OVERVIEW

Performance confirmation activities continue throughout the preclosure period. These activities include monitoring the performance of natural and engineered barriers to ensure that safety analyses conditions are as expected. Specific subsurface facility structures, systems, and components devoted to performance confirmation are described in *Performance Confirmation Facilities* (BSC 2007 [DIRS 179638], Section 6.0), and include the following:

- Observation drift and test alcove
- Thermally accelerated test drift
- Seepage alcoves and niches.

The initial performance confirmation activities will begin in one or two emplacement drifts in Panel 1. The number of emplacement drifts used will depend on the method selected for varying the thermal environment. The thermal environment can be altered either by modifying the density of emplaced waste or by using a second emplacement drift that has initially been loaded with the proper waste type and package configuration (i.e., spacing). Ventilation and waste package spacing will be varied in these drifts to simulate the predicted postclosure thermal environment of the emplacement drifts and to monitor their responses. Seepage alcoves and niches will be developed to monitor the flow of water within the repository host rock. The two-drift concept is currently preferred and is expected to be the concept used because it does not require removal and reloading of waste packages into the drift. An observation drift will be located parallel to these drifts and will allow monitoring of full-scale tests in these two thermally accelerated emplacement drifts. (BSC 2007 [DIRS 183106])

In *IED Performance Confirmation* (BSC 2007 [DIRS 183106], Table 1), 20 testing and monitoring activities are described as part of the performance confirmation program. Activities that interface with and require access to the subsurface facility include: mapping of underground openings during construction, collection of samples from the thermally accelerated test drift and adjacent near-field areas, seismic monitoring, construction effects monitoring, seepage testing, rock and water testing, saturated zone fault hydrology testing, and unsaturated zone testing.

M2 PERFORMANCE CONFIRMATION ACTIVITY INTERFACES

The 16 specific performance confirmation activities that interface with the subsurface facility are shown in Table M-1.

Table M-1. Performance Confirmation Activities and Facility Interfaces

Activity	ID No.[a]	Facility	Interface Description
Seepage monitoring	133	Alcoves, TD, ECRB	Access to facility, alcoves, TD, and ECRB. Sample collection, remote sensing, and point-in-time data collection. All phases.
Subsurface water and rock testing	119	Various locations	Access to facility. Drilling of test boreholes. Core collection. Construction phase.
Unsaturated zone testing	137	Alcoves	Access to facility and alcoves. Drill horizontal boreholes. Air injection. Construction through early emplacement phase.
Saturated zone monitoring	150	Various locations	Access to facility. Drilling of monitoring water level boreholes.
Saturated zone fault hydrology testing	159	Various locations	Hydraulic and tracer testing in the saturated zone.
Drift inspection	59	Emplacement drifts and TD	Access to facility, TD, and emplacement drifts. Use of remote vehicle. Emplacement through closure phase.
TD near-field monitoring	125	Observation drift and alcoves	Access to facility, observation drift, and alcoves. Remote sensing from boreholes. Operation through closure phase.
Dust buildup monitoring	52	Emplacement drifts and TD	Access to facility, TD, and emplacement drifts. Remote sample collection from drifts. Emplacement through closure phase.
TD in-drift environment monitoring	54	TD	Access to facility and TD. Remote monitoring and sample collection. Operation through closure phase.
Subsurface mapping	105	Emplacement drifts and TD	Access during construction of emplacement drifts.
Seismicity monitoring	167	Various locations	Access to facility. Observation of large magnitude fault displacements.
Construction effects monitoring	224	Emplacement drifts and TD	Access to facility and emplacement drifts. Construction phase.
TD thermal-mechanical monitoring	60	TD	Access to facility and TD. Remote monitoring during emplacement phase.
Seal testing	200	Seal test locations	Access to facility and seal test locations. Prior to closure phase.
Waste package monitoring	83	TD	Access to facility and emplacement drifts. Remote monitoring. Emplacement through closure phase.
Corrosion testing of TD samples	223	TD	Access to facility and TD. Remote collection of samples. Emplacement through closure phase.

[a] ID numbers are from Table 1 of *IED Performance Confirmation* (BSC 2007 [DIRS 183106]).

ECRB = Enhanced Characterization of the Repository Block Drift; TD = thermally accelerated test drift.

In addition to the interfaces described in Table M-1, there will be interfaces with the seismic monitoring program. Most of the seismic monitoring stations are outside of the subsurface facility. There are, however, three strong motion monitors within the facility. There also will be subsurface inspections following seismic events.

NOTE: Specific test plans for the performance confirmation activities listed in Table M-1 have not yet been developed; therefore, detailed operation concepts are not yet defined. Many common elements to these activities can be addressed at a general level.

M3 FACILITY ACCESS

Performance confirmation test personnel will have to access the subsurface facility at the North Portal (once emplacement has started), and possibly at the South Portal and the North Construction Portal for testing during construction. Access to the North Portal will be controlled as discussed in Appendix H.

M3.1 OBSERVATION DRIFT AND ALCOVE ACCESS

Performance confirmation test personnel must access the observation drift and associated alcoves for the conduct of performance confirmation operations. Access procedures, which have not yet been developed, will include the following steps:

1. Obtain facility access.
2. Obtain a Radiological Work Permit (RWP).
3. Coordinate with Safeguards and Security for personnel identification verification in the access control system.
4. Document plan of shift activities.
5. Coordinate plans with waste emplacement activities.
6. Obtain observation drift access.

M3.2 EMPLACEMENT DRIFT ACCESS

Access to emplacement drifts prior to emplacement is required for sample collection and monitoring activities. After emplacement, because of the extreme radiation levels in and around the emplacement drifts, these activities will be conducted by remote control. Specific plans and equipment, which have not been developed yet, needed to conduct these activities will include the following steps:

1. Obtain facility access.
2. Obtain an RWP.
3. Coordinate with Safeguards and Security for personnel identification verification in the access control system.

4. Document plan of shift activities.

5. Coordinate plans with waste emplacement activities.

6. Obtain emplacement drift access.

M3.3 THERMALLY ACCELERATED TEST DRIFT ACCESS

Access to the thermally accelerated test drift is required to conduct performance confirmation activities, monitoring, and sample collection. Because of the radiation levels in and around the thermally accelerated test drift, these activities will be performed by remote control equipment. Specific plans and equipment, which have not been developed yet, needed to conduct these activities will include the following steps:

1. Obtain facility access.
2. Obtain an RWP.
3. Document plan of shift activities.
4. Coordinate plans with waste emplacement activities.
5. Obtain emplacement drift access.
7. Coordinate plans with subsurface ventilation operations.

APPENDIX N
POSTEMPLACEMENT CONCEPT OF OPERATIONS

N1 OVERVIEW

Postemplacement begins when all the waste has been emplaced and terminates at the beginning of repository closure. Postemplacement activities include:

- Safeguarding the waste
- Maintaining the surface and subsurface facilities needed to support performance confirmation or other required test activities, responding to emergencies, and conducting maintenance
- Maintaining the capability for retrieval
- Gathering data to support predictions of the repository license for permanent closure.

The Operations department is responsible for conducting the postemplacement phase. The support operations needed during the postemplacement phase are the same as those needed during the operations phase. This phase will be terminated by a direction to retrieve the waste or an authorization to close the repository (CRWMS M&O 1999 [DIRS 147632], Section 3.1).

N2 INTERFACES

Table N-1 provides a matrix of interfaces related to specific activities in the postemplacement phase of the project. During the postemplacement phase, there will be no construction or regular emplacement activity. Primary interfaces with postemplacement processing systems are:

- Performance confirmation—maintain the performance confirmation facility and provide support for data collection and testing
- Waste emplacement and retrieval—potential to retrieve and reemplace waste packages as part of a test program or for emplacement drift repair and maintenance.

The postemplacement operations phase interfaces with the following programs and systems:

- Digital control and management information
- Environmental monitoring
- Radiation and radiological monitoring
- Nonradiological waste management
- Electrical power
- Electrical support
- Plant services
- Communications
- Fire protection
- Safeguards and security

- Subsurface ventilation
- Emplacement and retrieval
- Performance confirmation
- Thermal management.

Table N-1. Subsurface Concept of Operations Interface Summary: Postemplacement Phase

Initiating Organization	Affected Organization(s)	System or Activity	Description
Operations	Performance Confirmation ES&H Safeguards and Security	System operations and maintenance	Operation and maintenance of all active systems (e.g., subsurface ventilation)
Performance Confirmation	Operations Safeguards and Security ES&H	Waste emplacement	Performance confirmation activities
Safeguards and Security	Operations Performance Confirmation ES&H	Control of site and underground access	Physical security of plant and personnel
Safeguards and Security	Operations Performance Confirmation ES&H	Subsurface electrical, communications, facility, and ventilation systems	Compliance with safeguards and security requirements
Emergency Preparedness	Operations Performance Confirmation ES&H	Emergency response	Radiological and underground response plans
Safeguards and Security	Operations	Material control and accounting	Accountability of nuclear materials

ES&H = Environmental, Safety and Health.

N3 RADIOLOGICAL CONTROLS

Radiological controls needed during the postemplacement phase are the same as those needed during the emplacement phase.

APPENDIX O
CLOSURE CONCEPT OF OPERATIONS

O1 OVERVIEW

Once the license amendment to close the repository is accepted, the closure phase of the repository begins. At that point, the requirement for maintaining the option to retrieve waste is no longer applicable. Operations supporting waste retrieval are no longer necessary and those supporting closure are identified.

This phase includes:

- Emplacement of drip shields
- Removal of noncommitted materials
- Backfilling of shafts and ramps
- Surface reclamation
- Construction of monuments (CRWMS M&O 1999 [DIRS 147632], Section 3.1).

Support operations needed during the closure phase include many of the same support operations needed during the operations phase.

Details of closure activities have not been developed at this time and, consequently, the concepts of operation are also undeveloped. The closure and sealing activities will likely consist of the following:

- Installation of drip shields
- Removal of noncommitted material from the subsurface facility
- Placement of backfill in ramps and shafts
- Reclamation of affected surface areas and installation of surface monuments.

These activities will be coordinated and integrated with the surface facilities decommissioning. This section discusses the development of decontamination and dismantlement plans that include the following:

- Concurrent evaluations, including hazards associated with decontamination and dismantlement; facilities and equipment available for use in decontamination and dismantlement operations; and licensing requirements of decontamination and dismantlement.

- License amendment developed to include a design with supporting safety analysis and technical specifications to implement an operational decontamination plan or an operational decontamination and dismantlement plan.

The anticipated period of decontamination and dismantlement related to closure of the facility will extend from U.S. Nuclear Regulatory Commission approval to permanently close the repository until termination of the license as set forth in the approval.

O2 CLOSURE INTERFACES

Table O-1 provides a matrix of interfaces as related to specific activities in the closure phase of the project.

Detailed closure plans have not been developed at this time and closure interfaces have not been thoroughly defined. The closure phase interfaces with the performance confirmation processing system.

The closure phase interfaces with the following infrastructure systems:

- Digital control and management information
- Environmental monitoring
- Radiation and radiological monitoring
- Nonradiological waste management
- Radiological waste management
- Thermal management
- Electrical power
- Electrical support
- Plant services
- Communications
- Fire protection
- Safeguards and security
- Subsurface ventilation
- Offsite deliveries
- Surface decommissioning.

Table O-1. Subsurface Concept of Operations Interface Summary: Closure Phase

Initiating Organization	Affected Organization(s)	System or Activity	Description
Operations	Performance Confirmation ES&H Safeguards and Security	Drip shield installation	Drip shield placement in emplacement drifts
Operations	Performance Confirmation ES&H Safeguards and Security	Ventilation system	Removal of isolation barriers
Operations	Performance Confirmation ES&H Safeguards and Security	Material removal	Removal of noncommitted materials
Operations	Performance Confirmation ES&H Safeguards and Security	Backfilling operations	Backfilling of shafts and ramps

Table O-1. Subsurface Concept of Operations Interface Summary: Closure Phase (Continued)

Initiating Organization	Affected Organization(s)	System or Activity	Description
Safeguards and Security	Performance Confirmation ES&H Operations	Control of site and underground access	Physical security of plant and personnel
Safeguards and Security	Performance Confirmation ES&H Operations	Subsurface electrical, communications, facility, and ventilation systems	Compliance with safeguards and security requirements
Emergency Preparedness	Performance Confirmation ES&H Operations	Emergency response	Radiological and underground response plans
Safeguards and Security	Operations	Material control and accountability	Accountability of nuclear materials

ES&H = Environmental, Safety and Health.

O3 OPERATIONS

O3.1 INSTALLATION OF DRIP SHIELDS

Drip shields are installed over the waste packages before closure. The function of the drip shield is to divert moisture with high reliability for 10,000 years. Additionally, the drip shield protects the waste package against damage by rockfalls resulting from degradation of the drift walls, withstanding damage from rocks weighing several tons.

A drip shield gantry will transport the drip shields from the surface to their final location in the emplacement drift. The drip shields are designed to interlock and form a single, continuous barrier that runs the entire length of the emplacement drift. Drip shields are uniformly sized so that one design can be used to enclose all waste package configurations. The drip shield sections are designed to accommodate an interlocking feature to prevent separation between the contiguous segments. This feature consists of an overlapping section with connectors guided between the drip shield segments (BSC 2007 [DIRS 179636], Section 6.1.1.2). The drip shield feet will rest on the drift invert structure.

The drip shields are constructed of rigid titanium. The design of the gantry is intended to preclude the possibility of the drip shield or gantry physically touching the waste package. .

No significant rockfall is anticipated during the preclosure period. It is envisioned that special equipment or attachments to the drip shield gantry or waste packages will be used to sweep the mating surface of the emplaced drip shield on which the adjacent drip shield would interlock. Debris on the invert surface that could interfere with emplacement of the drip shields would be removed or plowed aside. These operations occur before or during drip shield emplacement. The design of such equipment will be developed as needed and as the detailed subsurface equipment designs evolve.

O3.2 REMOVAL OF NONCOMMITTED MATERIAL FROM THE SUBSURFACE

Noncommitted materials are those materials that will be removed from the subsurface prior to closure. Committed materials installed in the emplacement and nonemplacement drifts will not be removed at closure. Committed materials are predetermined by the design organization and submitted for preclosure safety analysis (BSC 2007 [DIRS 180940]). All material in the emplacement drifts is considered committed material. In the nonemplacement areas, only general categories of noncommitted material, as follows, can be identified at this stage of design:

- Mobile and fixed equipment
- Concrete inverts
- Electrical items, such as cable, wire, conduit, cable tray, and electrical equipment
- Communication items, such as antennae, feeder cable, and fiber-optic cable
- Emplacement access doors
- Ventilation equipment and structures
- Refuge chamber material
- Steel rails.

Removal of the ventilation equipment and structures, in addition to the items installed underground, includes the surface-based components, such as portions of the shaft collars, fans, ductwork, and other appurtenances located around the shaft surface openings to allow for shaft capping and surface restoration.

Ground support materials in the access and exhaust mains will not be removed because of personnel safety concerns. The concrete ground support in the shafts will be removed (from the bottom to the top) in short sections of the shaft at a time.

Radiological controls will be required during some closure activities. Practices of decontamination and dismantlement for surface facilities will also be adopted and implemented during the subsurface facility closure activities.

O3.3 PLACEMENT OF BACKFILL IN NONEMPLACEMENT OPENINGS

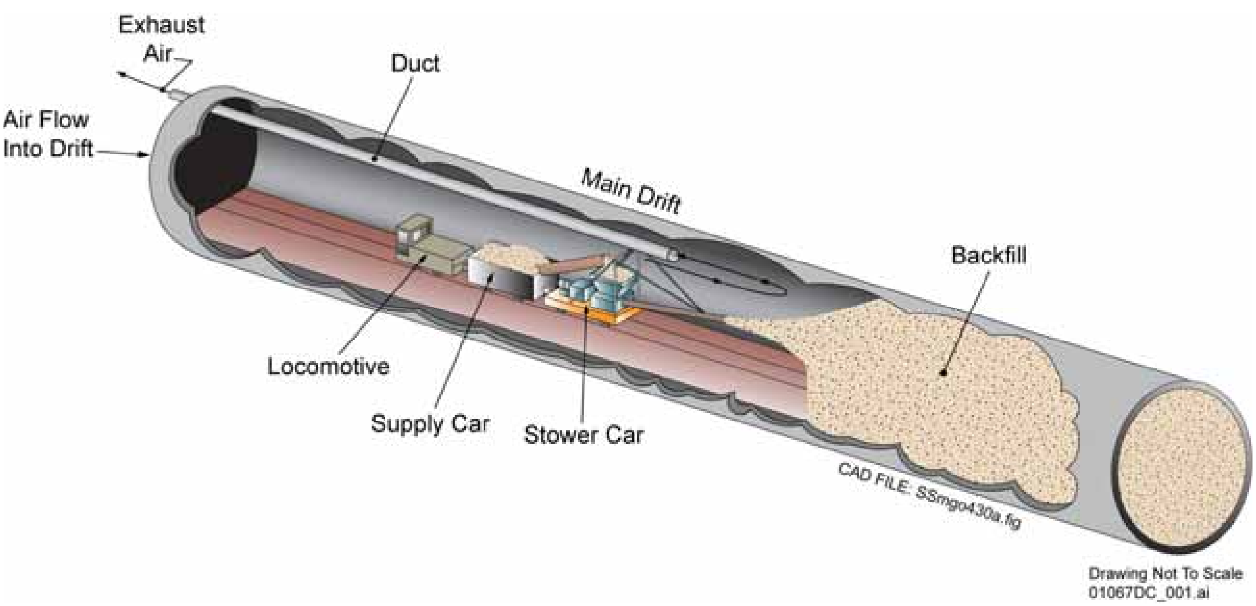
In accordance with 10 CFR 63.51 [DIRS 180319], the U.S. Department of Energy will submit an application to amend the license before permanent closure. The updated license application will include the results of tests, experiments, and other analyses relating to backfill of excavated areas pertinent to compliance with the performance objectives for the geologic repository after permanent closure. Backfill that impacts performance will require additional study to develop and will be completed as a future activity in time to support the updated license application. Backfill that does not impact performance will be accomplished by conventional means as discussed later in this section.

The drifts and ramps should have a negligible effect on water and gas movement within the repository because the host rock is highly fractured and permeable. This provides ample other pathways for fluid movement within the repository. Because no performance requirements have been identified for ramps, they can be backfilled by conventional means.

Placement of backfill in the ramps and shafts has also been proposed as a means to deter human intrusion into the waste emplacement areas after repository closure. The removal of the backfill by intruders to reach emplacement areas will require a significant commitment of resources and, therefore, constitute a significant deterrent.

Earthen materials have been recommended for use as backfill in ramps and shafts to discourage human intrusion. Properties considered desirable for backfill materials include low permeability, chemical stability in the thermal and hydrologic environment in the repository, material longevity, and availability. The selected backfill material should have the approximate hydraulic conductivity and permeability of the surrounding rock mass. Crushed tuff is readily available (from muck stockpiles) as a by-product of tunnel excavation. The muck material could be screened and crushed to enhance the characteristics useful for closure backfill.

Repository closure operations include placement of backfill throughout the ramps and shafts. Figure O-1 illustrates possible backfill placement methods for the ramps. The method illustrated in Figure O-1 consists of a pneumatic conveyance system. More conventional placement methods, however, are available that use standard underground equipment (e.g., load-haul-dump underground haulers). Pneumatic systems provide good placement control, but they require extensive dust control to maintain acceptable working conditions.



Source: BSC 2007 [DIRS 183206], Section 6.3, Figure 4.

NOTE: Repository closure activities include backfilling of the ramps and main drifts with granular material. This figure portrays a method by which these operations can be accomplished.

Figure O-1. Conceptual Arrangement for Placement of Backfill in Ramps

The placement of backfill must address the following concerns:

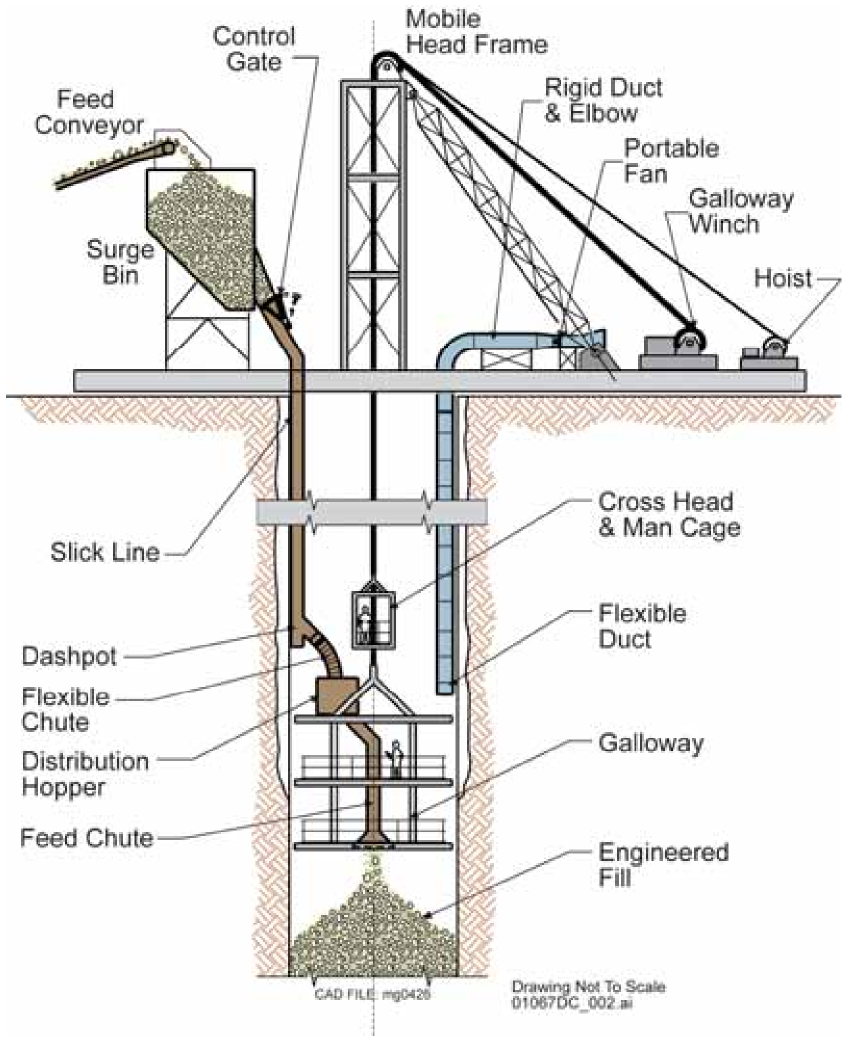
- Health and safety concerns for workers
  - Protection from radiation
  - Protection from high temperatures
  - Protection from dust.
- Performance concerns
  - Protection of waste packages from dust generated during backfill emplacement
  - Verification of backfill integrity
  - Removal of noncommitted material.

O3.4 CLOSING OF SHAFTS

In accordance with 10 CFR 63.51 [DIRS 180319], the U.S. Department of Energy will submit an application to amend the license before permanent closure. The updated license application will include the results of tests, experiments, and other analyses relating to shafts pertinent to compliance with the performance objectives for the geologic repository after permanent closure. Backfilling of shafts that impact performance will require additional study to develop and will be completed as a future activity in time to support the updated license application. Shafts that do not impact performance will be backfilled in compliance with the state and environment laws that exist at that time.

Design will mitigate the effects of surface flooding at the ventilation shafts, limiting water entry to only direct rainfall. The water flow patterns are generally vertical with little flow focusing into faults. The high porosity rock in the nonwelded Paintbrush Tuff dampens flow transients and the backfilled shafts would be more effective than faults in damping the flow because of their large porosity compared with faults. No performance requirements have been identified for backfilling the shafts but they need to be backfilled to prevent rapid transient flows from the ground surface to the repository. Specifications for the backfill have not been developed and will require future study.

A concept for backfilling the shafts has been developed as shown in Figure O-2. This figure shows that the concrete shaft liner is still in place. It is likely that these liners will be removed prior to backfilling. This will add another step to the process that has not been addressed at this time.



Source: BSC 2007 [DIRS 183206], Section 6.4, Figure 6.

NOTE: Intake and exhaust shafts also will be backfilled with granular material as part of repository closure activities.

Figure O-2. Conceptual Arrangement for Placement of Backfill in Shafts

O3.5 SURFACE CLOSURE

Specific plans for surface closure have not been developed at this time. The *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002 [DIRS 155970], p. 2-40) requires the site to be reclaimed to a condition as close to the preconstruction condition as practicable. This will involve the removal of all shaft surface facilities (e.g., head frames and ventilation fans), much of the portal structure, surface facilities, and regrading of the pads near the portals.

Surface monuments and markers will be constructed. The markers will be, at a minimum, erected at the three portals and nine shaft locations. The markers will be of sufficient size and construction that they cannot be destroyed easily by human intervention or the passage of time.

The markers will have signage that notifies future generations of the radiological danger present by intrusion into the repository. The signage will be in several languages and in pictograph format to provide a high probability that the warning will be understood far into the future.

O3.6 RADIOLOGICAL CONTROLS

The radiological controls needed during the closure phase are the same as those needed during the emplacement phase.

O3.7 VENTILATION DURING CLOSURE

During the closure phase, a variety of activities will be underway, possibly at the same time. These activities include:

- Installation of drip shields
- Normal postemplacement phase activities
- Recovery of noncommitted materials from turnouts, mains, shafts, and ramps
- Backfill of ramps and shafts.

Ventilation activities during installation of the drip shields will be similar to ventilation during waste emplacement. Ventilation activities for those portions of the facility not affected by closure activities will be conducted as normal postemplacement ventilation activities.

Specific plans for the recovery of noncommitted materials, and for backfilling of openings, have not been developed. The following concepts will assist in developing the ventilation plans for these activities:

- Recovery of noncommitted materials from radiation zones (R4 and R5) will be conducted remotely.

- Recovery of noncommitted materials from nonradiation zones will be ventilated as accomplished during the postemplacement phase. These ventilation activities may be augmented by using controls to limit worker exposure to dust that may be generated during removal.

- Removal of noncommitted material from the shafts will require augmented ventilation to provide fresh air and control dust.

APPENDIX P
ABNORMAL OPERATING CONDITIONS AND PROCEDURES

P1 INTRODUCTION

This section introduces the concept of required operator actions prescribed by procedure for abnormal conditions. These are conditions that can be reasonably expected to occur during routine operations. Such occurrences should be anticipated, and the actions to take will be detailed in a procedure. Operators must be prepared and trained to perform these specific actions. There may be cases in which the immediate actions required by the operator must be performed from memory. Such actions are of such a time-critical nature as to not allow time to read the procedure prior to taking action. In any such case, the procedure must be utilized as soon as possible, and actions taken prior to reading the procedure must be verified as correct.

At this stage of the project, it is premature to write abnormal operating procedures; however, potential events identified should be documented and actions defined if possible. This section contains this information and will serve as a basis to write abnormal operating procedures, allowing adequate time to develop, publish, and train in advance of actual repository operations.

The events presented herein are not all events identified to date. They are only the events which the Nuclear Operations department has studied and for which the department has developed rough preliminary plans.

P2 ABNORMAL EVENTS AND ACTIONS

P2.1 SUBSURFACE

P2.1.1 Emplacement Area Emergency Egress and Refuge

Escape from the repository will be the primary survival strategy for emergency off-normal events. Emergency escape from the emplacement areas of the repository will be influenced by the type and location of the life threatening off-normal event. The location of the work area(s) in relation to the event, development stage of the repository, and ventilation airflow arrangement are crucial parameters influencing emergency escape and response planning. Identified escape ways are access mains leading to intake ventilation shafts, the North Ramp and Portal, the South Ramp and Portal, and the North Construction Ramp and Portal. When there is no potential for escape, refuge will become the survival strategy.

The most serious off-normal event in the subsurface repository is fire in an access main or intake shaft. Not only would such a fire block an escape way, but it would also release smoke, heat, and toxic fumes into the fresh airstream, creating a life-threatening situation for all personnel downstream of the fire. This will likely be the only event that would require those personnel that are unable to escape to seek refuge. Protection of personnel from subsurface fire has been foremost during operation of the current Exploratory Studies Facility and the subject of several fire hazard analyses.

The *Subsurface Repository Fire Hazard Analysis* (BSC 2007 [DIRS 180306]) looked at the emplacement area of the subsurface repository and evaluated comprehensively and qualitatively the risk from fire within individual fire areas to ascertain whether the Bechtel SAIC Company, LLC Fire Protection Program fire safety objectives are being met. The Fire Protection Program and subsequent fire hazard analyses, policies, and procedures will provide the criteria for emergency escape ways and refuge to protect subsurface personnel and property. These are living documents that will require revision to account for each stage of the emplacement area development and operation.

Other credible off-normal events requiring emergency egress from the repository may be fall of ground, transport and emplacement vehicle derailment, power failure affecting ventilation or transport and emplacement vehicle movement, among others. Most off-normal events would not be life threatening but the disruption of normal system operations may be desirable to evacuate the subsurface repository. For example, power loss to the ventilation fans and subsequent ventilation loss is not an immediate threat to life for subsurface personnel; however, if the system could not be restored within a specified time frame, the subsurface would be evacuated because the ventilation operational requirements could not be met. An analysis of each structure, system, or component in the repository emplacement area to determine contributing factors concurrent with the fire hazard analysis following detailed design will help establish credible events and appropriate responses.

P2.1.2 Emergency Egress through Isolation Barriers

P2.1.2.1 Isolation Barrier Description

Three types of isolation barriers, A, B, and C, are described in *Isolation Bulkhead and Airlock Calculation* (BSC 2007 [DIRS 182025]). Type A barriers are temporary isolation barriers located in the exhaust mains that separate the main emplacement areas from the development areas. The barriers consist of two bulkheads; each has a locked access door to prevent unauthorized entry into the waste packages located on the exhaust side of the emplacement drifts. Type A isolation barriers are removable and transferable as the emplacement area expands. Type A barriers do not allow personnel emergency egress. Type B barriers are temporary isolation barriers located in the access mains that separate the emplacement areas from the development areas. The barriers consist of two bulkheads; each has an access door to allow personnel emergency egress. Type B isolation barriers are removable and transferable as the emplacement area expands. Type C barriers are permanent isolation barriers that separate the repository ventilation exhaust from the intake system during the preclosure period. The barriers consist of two bulkheads; each has a locked access door to prevent unauthorized entry into the waste packages located in the emplacement drifts. Type C isolation barriers do not allow personnel emergency egress. The bulkheads are fabricated from structural steel and their design is provided in *Access & Exhaust Mains Isolation Barrier Bulkheads & Airlocks* (BSC 2007 [DIRS 183354]).

P2.1.2.2 Emergency Egress, Shelter, or Refuge

Isolation Barrier Types A and C are, by definition, precluded from use as an escape way or refuge based on their purpose and location. Located in an exhaust main, escape from a construction area through the isolation barrier would be into a radiation area having high temperature emplacement exhaust air. The heat associated with the exhaust air also makes the isolation barrier unusable as a refuge. However, the Type B isolation barriers located in the access mains offer the opportunity for utilization as an emergency egress, shelter, or refuge. Under the current isolation barrier configuration, the emplacement-side bulkhead is the PIDAS barrier required to meet safeguards and security requirements in the subsurface repository. Further analysis of emergency egress has recognized that the isolation barriers can be modified to provide emergency egress, shelter, or refuge from both sides of the isolation barriers, enhancing safety for both construction and operations personnel. To achieve this and maintain safeguard and security requirements, a PIDAS barrier must be established between the bulkheads. Doing this will allow personnel emergency egress through the first bulkhead of the isolation barrier and allow them to take shelter or refuge in the area between the bulkhead and the PIDAS barrier.

Any emergency or off-normal event will be monitored by the Operations department and, due to installed intrusion detection and assessment equipment located between the isolation barriers, any breach of either bulkhead will be immediately annunciated to the primary alarm station and the secondary alarm station. The primary alarm station, upon detecting the emergency movement of personnel into the isolation zones, will activate the PIDAS turnstile gate to allow these personnel to exit through the PIDAS into the construction or emplacement area. The primary alarm station will direct a response by PFOs. The PFOs, along with operations or construction personnel (depending on the side of access), will establish control of those personnel who have passed through the PIDAS. The construction or operations responder's responsibility is resolution of safety, health physics, and radiological concerns regarding entrance into either side of the barrier as governed by procedure.

P2.1.2.3 Detailed Design of Isolation Barriers to Incorporate Emergency Egress, Shelter, or Refuge

Incorporating the preceding scenario into the current isolation barrier design will have a minimal impact to current design, but will require detailed design for bulkhead spacing, bulkhead doors, door alarms and controls, and the credited PIDAS barrier. The 30 ft spacing now identified in *Isolation Bulkhead and Airlock Calculation* (BSC 2007 [DIRS 182025]) is based on the room required to pass a 7 ft stretcher though the door with sufficient room to open and close the 4 ft door. There are no ventilation requirements that influence the spacing of the bulkheads. Evolution of the door design as described in *Access & Exhaust Mains Isolation Barrier Bulkheads & Airlocks* (BSC 2007 [DIRS 183354]) has progressed from a swinging door to a sliding door, which would allow a closer spacing of the bulkheads. No detailed design exists for the bulkhead door, door controls, or alarms. Ultimately, the spacing of the bulkheads will be based on the room required to provide personnel shelter or refuge and the room required for installation and operation of the PIDAS barrier. Design resolution of these and other requirements to determine bulkhead spacing to allow for emergency egress, shelter, or refuge will be provided by detailed design.

P2.2 SURFACE

Although many events have been postulated, the Operations department has not yet developed a strategy. This document will develop to include those events as the project matures.