BECHTEL SAIC COMPANY LLC



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# SNF Aging System Description Document

Prepared for:

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Office of Civilian Radioactive Waste Management
Office of Repository Development
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**DISCLAIMER**

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| 14. Revision No. | 15. Description of Change |
| 000 | Initial issue. This revision of the System Description Document presents a preliminary description of the system to guide the License Application design development. |
| 001 | Updated references and added design detail consistent with current design status (Spring 2004). Editorial changes throughout. Added figures and drawing list to Appendix B. Populated Appendix D with preliminary requirements satisfaction information. Clarified terminology (e.g. transfer refers to onsite, transportation refers to off-site SNF movements). Added 40,000 MTHM capacity information. |
| 002 | Complete general revision to incorporate new format per management direction using LP-3.26Q, *System Description Document*, ICN 4, and requirement updates from *Project Functional and Operational Requirements*. Change bars were applied to comply with BSC Procedures. |
| 003 | Revised to incorporate impacts from BCP-YMP-2004-122 on capacity of SNF aging, as well as PCSA and PDC requirement updates. Change bars were applied to comply with BSC procedures. |
| 004 | Revised to remove staging/aging of U.S. Department of Energy waste, include site-specific casks to hold repository site-specific canisters, incorporate source document changes to system requirements, and align the SDD with the aging system SAR section submitted November 5, 2004, for LA. This SDD revision resolves CA 4551-001 for CR 4551. |

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ALARA | as low as is reasonably achievable |
| BDBGM | beyond desing basis ground motion |
| BWR | boiling water reactor |
| CHF | Canister Handling Facility |
| CSNF | commercial spent nuclear fuel |
| DBGM | design basis ground motion |
| DCMIS | digital control and management information system |
| DOE | U.S. Department of Energy |
| DPC | dual-purpose canister |
| DTF | Dry Transfer Facility |
| FHF | Fuel Handling Facility |
| F&OR | *Functional and Operational Requirements* |
| HAM | horizontal aging module |
| HLW | high-level radioactive waste |
| HTC | horizontal transfer cask |
| ITS | important to safety |
| MCC | motor control center |
| MTHM | metric tons of heavy metal |
| NRC | U.S. Nuclear Regulatory Commission |
| PDC | *Project Design Criteria Document* |
| PCSA | preclosure safety analysis |
| PRD | *Project Requirements Document* |
| PWR | pressurized water reactor |
| SC | safety category |
| SDD | system description document |
| SNF | spent nuclear fuel |
| SRTC | site rail transfer cart |
| SSCs | structures, systems, and components |
| TBD | to be determined |
| TCRRF | Transportation Cask Receipt/Return Facility |
| TEDE | total effective dose equivalent |
| WNNRF | Warehouse and Non-nuclear Receipt Facility |
| YMP | Yucca Mountain Project |

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# 1. INTRODUCTION

The purpose of this system description document (SDD) is to establish requirements that drive the design of the spent nuclear fuel (SNF) aging system and associated bases, which will allow the design effort to proceed. This SDD will be revised at strategic points as the design matures. This SDD identifies the requirements and describes the system design, as it currently exists, with emphasis on attributes of the design provided to meet the requirements. This SDD is an engineering tool for design control; accordingly, the primary audience and users are design engineers. This SDD is part of an iterative design process. It leads the design process with regard to the flow down of upper tier requirements onto the system. Knowledge of these requirements is essential in performing the design process. The SDD follows the design with regard to the description of the system. The description provided in the SDD reflects the current results of the design process.

Throughout this SDD, the term aging cask applies to vertical site-specific casks and to horizontal aging modules. The term overpack is a vertical site-specific cask that contains a dual-purpose canister (DPC) or a disposable canister.

Functional and operational requirements applicable to this system were obtained from *Project Functional and Operational Requirements* (F&OR) (Curry 2004 [DIRS 170557]). Other requirements that support the design process were taken from documents such as *Project Design Criteria Document* (PDC) (BSC 2004 [DIRS 171599]), *Site Fire Hazards Analyses* (BSC 2005 [DIRS 172174]), and *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). The documents address requirements in the *Project Requirements Document* (PRD) (Canori and Leitner 2003 [DIRS 166275]).

This SDD includes several appendices. Appendix A is a Glossary; Appendix B is a list of key system charts, diagrams, drawings, lists and additional supporting information; and Appendix C is a list of procedures that will be used to operate the system.

## 1.1 SYSTEM IDENTIFICATION

The SNF aging system provides aging casks, aging pads, and site-specific cask transporters for commercial SNF (CSNF) from nuclear power plants. Naval SNF, DOE SNF, and DOE high-level radioactive waste (HLW) are not handled by this system. The aging system is similar in design and operation to the SNF dry storage systems that have been in use for almost 20 years at commercial reactor sites (Buchheit 2004 [DIRS 172766]) and U.S. Department of Energy (DOE) facilities.

The SNF aging system addresses thermal management for the repository and also provides flexibility for the repository by aging CSNF until it can be processed by the available facilities. Thermal management of CSNF includes placing fuel with different thermal outputs in a single waste package (blending of fuel) to meet waste package thermal limits for emplacement. Aging is needed to allow thermally hot CSNF to cool to meet the thermal limits for emplacement. The aging system returns cooler CSNF to be blended with hotter CSNF in the Fuel Handling Facility (FHF) or Dry Transfer Facility (DTF). By blending hotter CSNF with cooler CSNF, waste packages can be fully loaded within the thermal limits for emplacement.

Initially, the expected waste stream received at the repository will have the CSNF characteristics (including fuel burn-up of up to 60,000 MWd/MTU) currently in dry or wet storage systems at reactor plants. The design of initial site-specific casks for the repository will utilize existing technology modified as needed to meet repository site-specific conditions. The intent of the DOE is to design a repository disposable canister system to contain these high-burnup commercial assemblies. These canisters and their overpacks in which they are aged are expected to be similar to but not bounded by any known commercial design. Eventually, some fuel having burnups greater than 60,000 MWd/MTU may be discharged by the reactors and delivered to the repository. The aging cask systems for these higher burnup assemblies will be addressed at a future time and may require significant redesign of existing systems or development of new designs.

The SNF aging system is needed to temporarily hold, or age, CSNF that cannot proceed through normal repository processes and emplacement operations because the necessary facilities are unavailable or due to thermal management considerations. Aging at the aging pads or staging in the process buildings for thermal management considerations is the holding of CSNF until it has cooled to a suitable decay heat or is needed to provide optimal blending of the various CSNF assemblies for loading into a waste package. Transportation casks containing CSNF dual-purpose canisters and casks containing failed CSNF could be received at the repository before the appropriate dry transfer facilities are available. SNF DPCs can be received at the FHF or Canister Handling Facility (CHF), but these facilities are only equipped to transfer the DPCs to site-specific casks for aging on the aging pads. Neither the FHF nor the CHF is equipped to process failed CSNF. Consequently, if any shipments arrive containing failed DPCs when the DTF is unavailable or before it is operational, they will be placed in an overpack and aged until the DTF can process the DPC and load the CSNF into a waste package. Other casks containing CSNF may be received when the process handling facilities are not capable of emplacement rates that match the receipt rates, and again this CSNF would be aged in site-specific casks or repository canisters within an appropriate overpack to provide repository operational flexibility and to decouple receipt and emplacement.

The capacity of the aging system is 21,000 metric tons of heavy metal (MTHM). The initial capacity will be a 1,000 MTHM aging pad and will be available when the repository opens to support FHF operations. The plan is to continually assess the need for additional capacity, starting with initial repository operations, in order to minimize the number of aging pads actually constructed. The additional capacity will only be added as required by repository operations. This additional capacity is designed as four aging pads, each with a capacity of 5,000 MTHM. The first 5,000 MTHM aging pad will be built concurrent with the initial operations of the CHF. As required, additional aging pads will be built to accommodate the waste stream and support repository operations. It is anticipated (based upon *Repository Alternative Operating Scenarios System Study: Pre-Decisional Study*, Cotton and Gillespie 2003 [DIRS 163502]) that a 21,000 MTHM capacity will be sufficient to address the necessary aging requirements for the repository. However, locations for up to three additional 5,000 MTHM aging pads and one additional 4,000 MTHM aging pad have been identified as contingency.

The SNF aging system consists of the following subsystems: aging pad, cask transfer, and aging cask. Aging casks are of two distinct types (vertical casks and horizontal aging modules) as defined in Section 2.3.3. There are no anticipated unique or first-of-a-kind material applications for the aging system structures, systems, and components (SSCs).

The SNF aging system interfaces with repository systems that perform or support process-handling operations. The following systems and facilities that are not covered by this SDD have been identified as having an interface with the SNF aging system:

- Balance of plant facilities
- Canister Handling Facility
- Cask receipt/return system
- Cask/site-specific cask/waste package preparation system
- Transportation Cask Receipt/Return Facility
- Communications system
- Digital control and management information system
- Dry Transfer Facility
- Electrical power system
- Electrical support system
- Environmental/meteorological monitoring system
- Fuel Handling Facility
- Non-nuclear handling system
- Plant services system
- Radiation/radiological monitoring system
- Remediation system
- Safeguards and security system
- Site-generated radiological waste handling system
- SNF/HLW transfer system
- Warehouse and Non-nuclear Receipt Facility.

## 1.2 LIMITATIONS OF THIS SYSTEM DESCRIPTION DOCUMENT

This SDD may include assumptions, preliminary information, and to be verified values, as appropriate, to the current level of design development. Additionally, requirements or descriptions that are stated as to be determined (TBD) or are expected at a later phase of the design will be described as such.

This revision of the SDD introduces a disposable site-specific or repository canister that could be loaded with CSNF in the FHF or DTF utilizing a handling cask during loading, closure, and transfer to an overpack. The remaining repository systems and supporting preclosure safety analysis (PCSA) have not considered or included features to account for and handle repository canisters.

When this version was approved, the design status was such that the conceptual design had been completed and the preliminary design was in progress, but only limited engineering and supporting safety analysis have been completed. As design documents (e.g., calculations, drawings, and specifications) are completed, this SDD will be updated. Currently, there has been limited work completed on the design of the site-specific cask transporters and site-specific casks. However, the codes and standards expected to be used in the design of the aging system are consistent with those used in the nuclear power industry for the design of similar facilities and with those accepted by the U.S. Nuclear Regulatory Commission (NRC).

## 1.3 OWNERSHIP OF THIS SYSTEM DESCRIPTION DOCUMENT

The Mechanical group of Design and Engineering owns this SDD and is responsible for its technical content and for considering proposed changes to the document.

# 2. OVERVIEW

This section lists the functions of the SNF aging system that are traceable to the requirements in the F&OR. This section also presents a determination of the system classification and provides a brief overview of the system operation.

## 2.1 STRUCTURE, SYSTEM, AND COMPONENT FUNCTIONS

The SNF aging system functions are:

2.1.1 The SNF aging system provides areas at the repository to age CSNF. [F&OR 1.1.5-1, F&OR 1.1.5.1-1, F&OR 1.1.5.1-3, F&OR 1.1.5.1-4]

2.1.2 The SNF aging system transfers SNF between repository facilities and the aging areas. [F&OR 1.1.5.1-1, F&OR 1.1.5.1-2, F&OR 1.1.5.1-3, F&OR 1.1.5.1-5, F&OR 1.1.5.1-6]

2.1.3 The SNF aging system provides vertical site-specific casks and horizontal aging modules (HAMs). [F&OR 1.1.5.1-1, F&OR 1.1.5.1-2]

## 2.2 STRUCTURE, SYSTEM, AND COMPONENT CLASSIFICATION

This system consists of SSCs important to safety (ITS) since there are event sequences that credit the system to prevent Category 1 or Category 2 event sequences and is, therefore, classified as safety category (SC). Additional information regarding system classification is presented in *Q-List* (BSC 2005 [DIRS 171190]) and *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]).

The classifications of the aging subsystems are defined in *Q-List* (BSC 2005 [DIRS 171190], Table A-1). Table 2-1 provides a breakdown of the *Q-List* (BSC 2005 [DIRS 171190] system and subsystem classifications for the SNF aging system.

Table 2-1. Classification of Systems and Subsystems

| SNF Aging | | | | |
|---|---|---|---|---|
| **System or Subsystem** | **Component or Function** | **Important to Safety (ITS)** | **Important to Waste Isolation** | **Safety Category (SC)** |
| Cask Transfer | Cask Tractor | Yes | No | SC |
| | Horizontal Cask Transfer Trailer | Yes | No | SC |
| | Site-Specific Cask Transporter | Yes | No | SC |
| | Site-Specific Transfer Cask | Yes | No | SC |
| Aging Pad | Surface Aging Pad | Yes | No | SC |
| | Support Structures (Including utility buildings and personnel barriers) | No | No | Non-SC |
| | Aircraft Protection Barrier that Surrounds the Aging Pads | Yes | No | SC |
| Aging Cask | Site-Specific Casks | Yes | No | SC |
| | Horizontal Aging Modules | Yes | No | SC |

The three subsystems of the SNF aging system are all ITS. The subsystems are associated with each other in that the cask transfer subsystem will move site-specific casks from the repository facilities to the aging pads where the site-specific casks will rest for the aging process. The aging pads will be generally flat, fairly open areas with room for maneuvering equipment and the placement of casks. The cask transfer subsystem includes both horizontal and vertical systems including a site-specific transfer cask (also referred to as the transfer cask in this SDD) for the transfer/retrieval of DPCs from the horizontal aging modules and transfer to the DTF. The site-specific casks in the aging cask subsystem will be either oriented in a horizontal position for the case of the HAMs or vertical for the case of the site-specific casks.

The horizontal and vertical casks will be monitored during the aging process as they rest at the aging pads. Additional details on monitoring the SNF aging system are given in Section 4.1.6.

## 2.3 OPERATIONAL OVERVIEW

A simplified system diagram of the SNF aging system that depicts the system and its relationship to other interfacing systems and facilities is shown in Figure B-1. The SNF aging system will satisfy requirements on the Yucca Mountain Project (YMP) with respect to aging (thermal management). The aging system:

- Provides up to 21,000 MTHM of aging capability for the repository
- Provides the capability to place waste with high thermal power in a location where it can cool to appropriate levels
- Provides the capability to decouple the receipt of waste from emplacement of waste by creating a location to temporarily stage it until the handling facilities can accommodate it
- Provides the capability to move waste between the aging system and handling facilities.

The SNF aging system will enable the DOE to operate the Transportation Cask Receipt/Return Facility (TCRRF), DTF, CHF, and FHF with a high degree of flexibility since SNF can be transferred to and from the aging pads with relative ease. The aging pad location and layout depicted in Figure B-2 shows the layout of the aging pads, an aircraft crash barrier around the aging pads, the relative location of the aging pads to the SNF/HLW handling facilities, security fencing surrounding the repository surface facilities, and the access roads to and from SNF aging pads. The SNF aging system will facilitate management of the waste stream being emplaced in Yucca Mountain and will provide flexibility in developing loading plans as SNF and HLW is received and placed in waste packages.

Figure B-3 shows a concrete slab foundation plan and section of a typical 1,000 MTHM aging pad. Figure B-4 shows a typical 5,000 MTHM aging area pad consisting of five 1,000 MTHM capacity concrete slabs. Figure B-4 depicts a row of HAMs back-to-back and the locations for vertical placement of site-specific casks on the pad by the cask transfer subsystem.

The SNF aging system will interface with the TCRRF, CHF, DTF, or FHF whenever CSNF must be sent to an aging pad. CSNF will be placed at the 1,000 MTHM aging pad located adjacent to the North Portal, or it may be transferred to one of the more distant aging pads north of the main plant area. CSNF will be moved in either horizontal or vertical casks (Figure B-5 and Figure B-6) and will likewise be staged in either horizontal aging modules or vertical site-specific casks (as shown on Figures B-7, B-8, and B-9). Because cask details have not yet been established, it is not certain whether or not it will be necessary to anchor the aging casks to the pad to preclude cask tip over. Existing facilities have not had to anchor the HAMs and only the Diablo Canyon Independent Spent Fuel Storage Installation has anchored vertical storage casks. If it is determined that anchoring is required, Figure B-10 shows a proposed anchoring system concept for securing vertical site-specific casks to the concrete aging pads. The subsystems of the SNF aging system are further explained below. Section 4.0 provides further details on the SNF aging system, its components, and its operation.

### 2.3.1 Aging Pad Subsystem

The aging pad subsystem includes the concrete pads and associated SSCs necessary for aging CSNF. The aging pad subsystem accommodates both site-specific casks for vertical aging and HAMs for horizontal aging.

### 2.3.2 Cask Transfer Subsystem

The cask transfer subsystem consists of equipment capable of (1) moving vertical metal site-specific casks for bare SNF assemblies, (2) moving vertical concrete site-specific casks containing a DPC or repository canister, and (3) moving a transportation cask or a transfer cask containing a horizontal DPC between the handling facilities and the aging pads. Operations for moving casks in vertical and horizontal orientations are similar to those performed at commercial nuclear plants. This subsystem includes a site-specific cask crawler transporter for transporting the site-specific cask in a vertical orientation as well as a horizontal cask transfer trailer and tractor for moving casks in a horizontal orientation. Vertical transfer may occur between the DTF, FHF, and CHF to the aging pads. A specially designed tractor towed horizontal cask transfer trailer will be used to transfer casks containing a DPC designed for horizontal aging between the TCRRF and a HAM on an aging pad.

### 2.3.3 Aging Casks Subsystem

The aging cask subsystem provides casks for aging CSNF in five types of vertical site-specific casks and one horizontal aging module:

1. Concrete site-specific casks (or overpacks) for DPCs
2. Metal site-specific casks (or overpacks) for DPCs
3. Metal site-specific cask for uncanistered CSNF assemblies
4. Concrete site-specific casks (or overpacks) for repository canisters
5. Metal site-specific casks (or overpacks) for repository canisters
6. Horizontal aging modules for DPCs.

The DPCs and repository canisters provide waste containment of CSNF and are completely closed and sealed to prevent radioactive materials from reaching the environment. The DPCs are designed to hold CSNF assemblies and are loaded, dried, inerted, and sealed at their point of origin. Repository canisters are loaded, sealed, closed, and inerted at the repository in the FHF or DTF. The canisters contain a basket assembly to hold and position CSNF while providing structural support. The SNF basket assembly maintains a subcritical configuration for normal conditions, off-normal events, and credible event sequences. Site-specific casks that contain CSNF in sealed canisters are commonly referred to as overpacks.

### 2.3.4 Operations Summary

The following paragraphs are intended to give a very high level summary of the aging system operations to help understand the Section 3 requirements. A more complete description of system operations is given in Section 4.2.

Typically, SNF stored in metal/concrete casks or horizontal storage modules at commercial nuclear power plant sites is removed from these structures, placed in transportation casks, and shipped to the repository. SNF stored in metal casks that are licensed for transportation are shipped directly to the repository. Higher heat content SNF can be transferred to an aging pad for continued aging until it is suitable for emplacement. Non-disposable dual-purpose canisters (DPCs) approved for aging in vertical site-specific casks are removed from transportation casks at the SNF/HLW handing buildings and are placed in site-specific casks designed to contain canisters. The functional operations performed by the SNF aging system are summarized on the block flow diagram shown in Figure B-11.

Transportation casks for horizontal DPCs can accommodate direct canister transfer into horizontal aging modules at the aging pad area. When a transportation cask containing a DPC that requires aging in a HAM is received at the repository, the cask is taken to the TCRRF where its impact limiters are removed and the cask is transferred to a horizontal transfer trailer. Figure B-5 shows this special 32-wheeled trailer that is equipped with a hydraulic ram. A tractor to an aging pad then tows the cask/trailer, and the DPC inside the transportation cask is inserted and secured inside a concrete vault called a HAM. The operational sequences are shown on Figure B-12. When scheduled for processing, the DPC is retrieved, taken to the DTF and processed and the CNSF loaded into a waste package for emplacement. The DPC/HAM retrieval operations are the reverse of the DPC insertion and HAM closure operations, but because a transportation cask is not likely to be available on-site when needed, a special shielded site-specific transfer cask mounted on a horizontal transfer trailer will be used to take aged DPCs to the TCRRF for delivery to the DTF. These DPC retrieval operations from a HAM are shown on Figure B-13.

When a transportation cask has bare SNF assemblies or DPCs that require aging in a vertical orientation, the transportation cask is directed to a handling facility where the SNF or DPC is placed in a site-specific cask. After all site-specific cask closure operations are completed in the handling facility, the site-specific cask is moved to a suitable location to interface with the site-specific cask transporter. System operations to place a site-specific cask on an aging pad and return it after it has been scheduled for processing are shown in Figure B-14.

# 3. REQUIREMENTS AND BASES

This section lists the requirements that are necessary to ensure that the functions in Section 2.1 are satisfied. Each derived requirement is traceable to a specific function in Section 2.1. This relationship is shown in a bracketed trace [F 2.1.x]. Performance requirements, where applicable, accompany functional requirements in Section 3 and are traceable to the PDC, F&OR, or another originating requirements source, or are derived during the design process.

Design criteria (e.g., specific codes, standards, laws, regulations, general discipline design criteria, event sequences, and hazards) that shall be used as a basis of design for the areas listed below are contained in applicable sections of the PDC.

References are made to numerous source documents throughout Section 3. In each case, PRD refers to the *Project Requirements Document* (Canori and Leitner 2003 [DIRS 166275]), PDC refers to the *Project Design Criteria Document* (BSC 2004 [DIRS 171599]), and F&OR refers to the *Project Functional and Operational Requirements* (Curry 2004 [DIRS 170557]) document. The PCSA requirements pertaining to the SNF aging system from *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]) have also been cited.

All requirements referencing *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]) are classified as 10 CFR Part 63 [DIRS 173164] requirements and are presented in Section 3.1.1.1. The remaining requirements and associated bases are classified as engineering unless noted otherwise at the end of the requirement statement. Source document information is provided in Section 5.

## 3.1 GENERAL REQUIREMENTS

Some of the requirements listed below have been developed to ensure that the system functions are satisfied. Where this is the case, the requirement statement references the Section 2 function that is supported by the requirement. Some requirements listed below result from the need to satisfy a code, standard, or good engineering practice and do not directly support the accomplishment of a system function.

### 3.1.1 System Functional Requirements

This section describes the system safety requirements, environmental requirements, mission-critical requirements, and general requirements.

#### 3.1.1.1 Safety Requirements

The safety requirements presented in this section are nuclear safety design bases from *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). Other requirements that address safety issues, such as personnel protection from process industrial hazards, are contained in the special requirements section or other topical sections below.

Due to their importance in terms of obtaining a construction license from the NRC and in accordance with DOE-STD-3024-98 [DIRS 164472], *Content of System Design Descriptions*, safety requirements are covered up front in Section 3.1.1.1. To avoid repetition, the basis for the following requirements is the same and is only presented once after the first requirement [3.1.1.1.1] below. Additional information on safety functions (e.g., no runaway, no significant cracking or displacement, no slap down, or no tip over) is contained in *Nuclear Safety Design Bases for License Application* [BSC 2005 [DIRS 171512], Appendix B).

**Cask Tractor**

**3.1.1.1.1 Requirement**: The design of the cask transfer tractor shall limit the potential damage caused by collisions. Supports Function 2.1.2.

**Basis**: This safety requirement and the following requirements under Section 3.1.1.1 were credited in the PCSA to ensure an adequate safety basis, and are provided here in the same manner as in *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512], Table A-II), and specifically address F&OR 1.1.6-1, F&OR 1.1.6-2, F&OR 1.1.2.2-9, or PDC 4.2.2.2.

**3.1.1.1.2 Requirement**: Loss of power events shall be precluded. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.3 Requirement**: Tip over during transfer shall be precluded by ensuring that minimum tip over resistance and standards are maintained consistent with roadway design. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.4 Requirement**: The design of the cask transfer tractor shall provide reliable means to stop and maintain stability. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.5 Requirement**: The cask tractor system shall be designed to prevent runaway of the tractor under loading conditions associated with a Design Basis Ground Motion (DBGM)-2 seismic event. In addition, an analysis shall demonstrate that the cask tractor system has sufficient seismic design margin to ensure that a no runaway safety function is maintained for loading conditions associated with a Beyond Design Basis Ground Motion (BDBGM)-level seismic event. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**Horizontal Cask Transfer Trailer**

**3.1.1.1.6 Requirement**: The design of the hydraulic ram shall ensure that it cannot fail or be operated in a manner that can cause DPC loss of function through excess force or ram over-travel. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.7 Requirement**: The horizontal cask transfer trailer system shall be designed for stability and shall retain the waste container and prevent a runaway for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the horizontal cask transfer trailer has sufficient seismic design margin to ensure that no slap down and no runaway safety functions are maintained for loading conditions associated with a BDBGM-level seismic event. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**Comment:** The term waste container in the above requirement is the confinement barrier of the CSNF. In this case, the CSNF is contained inside a sealed DPC, which is transported in a transportation cask.

**3.1.1.1.8 Requirement**: The design of the horizontal cask transfer trailer shall limit the maximum potential drop height. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.9 Requirement**: The design of the horizontal cask transfer trailer shall limit potential damage to a loaded SNF cask caused by collisions. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.10 Requirement**: The design of the horizontal cask transfer trailer shall preclude tip over during transfer by ensuring that the transfer equipment design precludes failure modes that could result in tip over under design basis load handling conditions and by ensuring that minimum tip over resistance and stability standards are maintained consistent with roadway design. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**Site-Specific Cask Transporter**

**3.1.1.1.11 Requirement**: The site-specific cask transporter system shall be designed for stability to retain the waste container and prevent a runaway for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the site-specific cask transporter system has sufficient seismic design margin to ensure that no slap down and no runaway safety functions are maintained for loading conditions associated with a BDBGM-level seismic event. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**Comment**: The term waste container above is the site-specific cask or overpack with canister.

**3.1.1.1.12 Requirement**: A speed limit for the site-specific cask transporter shall be established such that a collision with shield or airlock doors or other heavy objects does not overturn the site-specific cask transporter or cause it to drop its load. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.13 Requirement**: The cask transporter shall prevent lifting the aging and transfer casks above their maximum handling height. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.14 Requirement**: The design of the site-specific cask transporter shall limit the maximum potential drop height. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.15 Requirement**: The design of the site-specific cask transporter shall limit potential damage to a loaded SNF cask caused by collisions. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.16 Requirement**: The design of the site-specific cask transporter shall preclude tip over during transfer by ensuring that the transfer equipment design precludes failure modes that could result in tip over under design basis load handling conditions and by ensuring that minimum tip over resistance and stability standards are maintained consistent with roadway design. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.17 Requirement**: The design of the site-specific cask transporter shall provide reliable means to stop and maintain stability. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.18 Requirement**: Loss of power events shall be precluded. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.19 Requirement**: Upon loss of power, the transporter shall be designed to stop, retain the load, and enter a locked mode. Upon restoration of power, the transporter shall stay in the locked mode until operator action is taken. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**Site-Specific Transfer Cask**

**3.1.1.1.20 Requirement**: The design of the site-specific transfer casks shall ensure that they can withstand a drop from the maximum handling height of a horizontal cask transfer trailer without loss of function. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.21 Requirement**: The design of the site-specific transfer casks shall ensure that they can withstand a drop of heavy objects handled during transfer operations (e.g., access cover plate) from the maximum handling height without adverse effects. Supports Function 2.1.2.

**Basis**: Same as for Section 3.1.1.1.1.

### Surface Aging Pads

**3.1.1.1.22 Requirement**: The aging pad shall be designed to preclude inundation during the maximum probable flood. Supports Function 2.1.1.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.23 Requirement**: The aging pad shall be located to avoid placement directly over Quaternary faults with a potential for significant displacement. Supports Function 2.1.1.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.24 Requirement**: The surface aging pad system shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the surface aging pad system has sufficient seismic design margin to ensure that a no significant cracking or displacement safety function is maintained for loading conditions associated with a BDBGM-level seismic event. Supports Function 2.1.1.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.25 Requirement**: The structure shall be designed for the loads associated with precipitation intensity as specified in *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). Supports Function 2.1.1.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.26 Requirement**: A barrier shall be provided surrounding the aging pads as specified in *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). Supports Function 2.1.1.

**Basis**: Same as for Section 3.1.1.1.1.

### Site-Specific Cask

**3.1.1.1.27 Requirement**: The site-specific cask system and other vertical aging systems shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the site-specific cask system and other vertical aging systems have sufficient seismic design margin to ensure that no tip over and no breach safety functions are maintained for loading conditions associated with a BDBGM-level seismic event. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.28 Requirement**: Tip over of site-specific casks as a result of extreme wind or tornado events shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.29 Requirement**: The design of site-specific casks shall ensure that they can withstand the differential pressure associated with a passing tornado without loss of function. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.30 Requirement**: Tip over of site-specific casks as a result of being struck by a design basis tornado missile shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.31 Requirement**: The design of site-specific casks shall ensure that they can withstand being struck by a design basis tornado missile without loss of function. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.32 Requirement**: The design of the site-specific casks shall ensure that they can withstand a drop from the maximum handling height of a site-specific cask transporter without loss of function. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**Comment**: Drop heights are specified in the lift height limits for casks and canisters section of the *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512], Appendix C).

**3.1.1.1.33 Requirement**: The design of the site-specific casks shall ensure acceptable thermal design performance during extreme temperature events as specified in *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.34 Requirement**: Short-duration vent blockage events (involving ventilated casks) shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.35 Requirement**: The casks shall not lose their intended function under conditions involving the maximum snow, sand, or ash loads. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.36 Requirement**: The design of the casks shall ensure that welded closure casks and canister confinement system designs preclude loss of confinement following closure of the casks to meet life cycle operations. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**Comment**: The above requirement should be restated as follows: The design of canister and cask closure systems shall preclude loss of confinement for life cycle operations. The repository canister design has not been finalized and its closure seal could be bolted as apposed to welded. Note: The site-specific casks and HAMs are not welded closed.

**3.1.1.1.37 Requirement**: The design of the site-specific cask shall ensure that the bolted closure cask design protects seals from damage following closure to maintain its primary confinement boundary function to meet life cycle operations. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.38 Requirement**: Site-specific casks shall be designed to ensure nuclear criticality safety with optimum moderation and the most reactive waste forms despite any geometric rearrangements due to a drop or other handling incident. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.39 Requirement**: In the credible event of a fire, the wall temperature of a loaded site-specific cask, being handled or at rest, shall not exceed its allowable operating range. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.40 Requirement**: In the event of a credible fire, the wall temperature of a loaded site-specific cask with docking ring installed shall not exceed its allowable operating range. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.41 Requirement**: The site-specific cask shall not breach as a result of the credible fire. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.42 Requirement**: Not used

**Horizontal Aging Module**

**3.1.1.1.43 Requirement**: The HAMs shall be designed for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the HAMs have sufficient seismic design margin to ensure that a no collapse safety function is maintained for loading conditions associated with a BDBGM-level seismic event. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.44 Requirement**: Tip over of HAMs as a result of extreme wind or tornado events shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.45 Requirement**: The design of HAMs shall ensure that they can withstand the differential pressure associated with a passing tornado without loss of function. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.46 Requirement**: Tip over of HAMs as a result of being struck by a design basis tornado missile shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.47 Requirement**: The design of HAMs shall ensure that they can withstand being struck by a design basis tornado missile without loss of function. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.48 Requirement**: The design of the HAMs shall ensure acceptable thermal design performance during extreme temperature events as defined in *Nuclear Safety Design Bases for License Application* (BSC 2005 [DIRS 171512]). Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.49 Requirement**: Short-duration vent blockage events (involving ventilated HAMs) shall be precluded. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.50 Requirement**: The HAMs shall not lose their intended function under conditions involving maximum snow, sand, or ash loads. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

**3.1.1.1.51 Requirement**: The design of the HAMs shall ensure that welded closure cask and canister confinement system designs preclude loss of confinement following closure of the casks to meet life cycle operations. Supports Function 2.1.3.

**Basis**: Same as for Section 3.1.1.1.1.

### 3.1.1.2 Environmental Requirements

Specific environmental protection requirements for the system have not been identified at this stage of the design. Environmental requirements for addressing land disturbance from system construction, system emissions, water use, or pollution prevention requirements will be added to the SDD when these requirements are developed. See Section 3.2.7.3 for additional environmental protection program requirements.

#### 3.1.1.3 Mission-Critical Requirements

**3.1.1.3.1 Requirement**: The aging system shall have sufficient capacity to accommodate the CSNF and a total capacity of 21,000 MTHM with space to accommodate an additional 19,000 MTHM available on the site layout plan as a contingency. Supports Function 2.1.1.

**Basis**: This requirement is needed to prevent interruption of the repository facility operations and to ensure that the aging system has the capacity required for aging based on the volume of SNF received at the repository that exceeds the allowable thermal limits. The repository shall at all times have the capability to place casks into the aging area. [F&OR 1.1.5.1-3]

**Comment**: Aging study results indicate that this aging capacity would be sufficient to cover expected and other waste receipt scenarios (Cotton and Gillespie 2003 [DIRS 163502], Tables 7 and 8) and also hold up to 40,000 MTHM as required by the F&OR. Currently, the pad is designed to accommodate 20 percent HAMs and 80 percent site-specific casks. This allocation will be evaluated after more information is available from the throughput analysis.

**3.1.1.3.2 Requirement**: The SNF aging system shall be designed for an operational life of 50 years, which is consistent with the preclosure period for the surface facilities. Mechanical handling equipment shall satisfy this requirement directly or be maintainable or easily replaced over the system lifetime. Supports Functions 2.1.1, 2.1.2, and 2.1.3.

**Basis:** The specification of a system operational lifetime is required to ensure that the system can fulfill system functions. Additionally, this requirement is necessary for the system to satisfy its functional requirements during the preclosure period (50 years) of the repository. [PDC 4.7.1.2]

#### 3.1.1.4 General Requirements

**3.1.1.4.1 Requirement**: Repository surface facilities shall be capable of accommodating a range of storage and transportation technologies, including multi-purpose, dual-purpose, and single-purpose canisters, as well as uncanistered SNF assemblies.

**Basis**: This requirement is a design input that implements the market-driven approach to waste acceptance and transportation. The design and engineering organization must incorporate these technologies into the design of the repository. The system must be compatible with all the possible types of canisters that will be received by the repository. [PRD-014/T-014, F&OR 1.1.5.1-2]

**3.1.1.4.2 Requirement**: The aging system shall be capable of aging higher heat output CSNF to support thermal management strategies. Supports Function 2.1.1.

**Performance Acceptance Criteria**:

1. The aging system shall be capable of aging CSNF. Aging will be in site-specific casks or HAMs. [F&OR 1.1.5-1, F&OR 1.1.5.1-3, F&OR 1.1.5.1-4]

2. The aging system shall be designed to preserve the physical and mechanical integrity of SNF so that the handling characteristics are not degraded from the arrival condition during aging. [10 CFR 72.122(h) [DIRS 171253]]

**Basis**: This requirement is needed to support thermal management and ensure that cladding remains in the acceptable temperature range and that SNF maintains mechanical integrity. The aging system must have the capability to age any SNF that would result in a fully loaded waste package with a thermal output greater than 11.8 kW.

**Comment**: Only general functional statements are given in this section for quantitative fuel assembly and cask heat output requirements (Section 3.1.2.3.3).

**3.1.1.4.3 Requirement**: The aging system design shall be capable of processing and returning transportation casks containing a horizontal DPC to the TCRRF for turnover to the National Transportation System within seven days of initial receipt at the repository.

**Basis**: This is an operational constraint imposed on the project in the F&OR. The requirement is based on the need to ensure that transportation casks are returned in a timely manner to the National Transportation System. [F&OR 1.1.1-6]

**Comment**: The standard contract stipulates that shippers will notify DOE 60 days prior to commencing activities that are related to shipping SNF to the repository (10 CFR 961.11 [DIRS 171309], Article IV). Planning and scheduling will be executed by the repository operator. This requirement is for capability only. Transportation casks may be retained for longer periods to accommodate scheduling, remediation needs or other operational needs.

**3.1.1.4.4 Requirement**: Equipment designs with proven operational performance shall be used where possible. Similarly, existing technology, where available and suitable from other nuclear establishments, shall be used in the design of facilities and systems in preference to untried technology. Supports Functions 2.1.2 and 2.1.3.

**Basis**: This requirement is needed to specify readily available design technologies and is based on good engineering practice taken directly from the PDC. The intent of these approaches is to minimize lifecycle costs. [PDC 4.7.1.2]

**3.1.1.4.5 Requirement**: The cask transfer subsystem transporter equipment shall provide, if appropriate, overload limit sensing, collision avoidance, and alarming capabilities to automatically stop handling operations and warn operators of unsafe conditions. Supports Function 2.1.2.

**Basis**: This requirement is based on good engineering practice taken directly from the PDC. The requirement applies to specific SSCs as required by the PCSA or other operational requirements. [PDC 4.7.1.2]

**3.1.1.4.6 Requirement**: The aging system shall include provisions for inspection, testing, and maintenance of system equipment.

**Basis**: This requirement is based on good engineering practice taken directly from the PDC. The provisions above shall be in accordance with applicable DOE and industry standards and Occupational Safety and Health Administration requirements.

**3.1.1.4.7 Requirement**: The aging system SSC design shall include provisions for decontamination and decommissioning.

**Performance Acceptance Criteria**:

1. Selection of materials and processes to minimize waste production
2. Minimization of the mass of shielding materials subject to neutron activation
3. Use of modular design and inclusion of lifting points to facilitate removal and dismantlement
4. Selection of materials for compatibility with projected closure and decontamination, or decontamination and dismantlement, or waste processing procedures
5. Use of minimum surface roughness finishes that have the potential for contamination
6. Use of coatings that preclude penetration into porous materials by radioactive gas, condensate, deposited aerosols, or spills to permit decontamination by surface treatment
7. Incorporation of features to contain leaks and spills
8. Incorporation of waste minimization techniques
9. Incorporation of features that would maintain occupational and public radiation doses as low as is reasonably achievable (ALARA) during decommissioning.

**Basis**: This requirement is based on good engineering practice taken directly from the PDC and on NUREG 1804 (NRC 2003 [DIRS 163274] and Regulatory Guide 8.8 [DIRS 103312].

### 3.1.2 Subsystems and Major Components

Subsystem and major component requirements driven by PCSA are included in Section 3.1.1.1.

#### 3.1.2.1 Aging Pad Subsystem Functional Requirements

**3.1.2.1.1 Requirement**: The aging pad subsystem shall have sufficient capacity to meet operational requirements. Supports Function 2.1.1.

**Performance Acceptance Criteria**:

1. The aging pad at the North Portal shall have the capability to hold 1,000 MTHM. [F&OR 1.1.5.1-3]
2. The aging pads shall have a capacity to accommodate 21,000 MTHM (see basis and comment for Section 3.1.1.3.1).
3. The aging pads shall be built in increments as required and approved. [F&OR 1.1.5.1-3]
4. The aging pad subsystem shall have a design life of 50 years.

5. The aging pad shall be designed to absorb the energy of a vertical flat bottom drop of an site-specific cask from a 12 inch maximum transport height without resulting in loss of pad function.

6. The maximum single-loaded site-specific cask weight (with any associated lifting fixtures) shall not exceed 400,000 lb. The maximum weight of the site-specific cask transporter shall not exceed 200,000 lb. The maximum gross weight of the transporter and cask shall not exceed 300 tons.

**Basis**: This requirement is needed to ensure that the aging system has the capacity required for aging based on the volume of SNF received at the repository that exceeds the allowable thermal limits. The above performance acceptance criteria were derived and are consistent with those driven by the F&OR, PDC, and static and dynamic loads of the aging cask based on the weight of heaviest cask, as well as throughput conclusions. The transporter weight is based on *Docket No. 72-26, Diablo Canyon Independent Spent Fuel Storage Installation, License Application for Diablo Canyon Independent Spent Fuel Storage Installation* (Womack 2001 [DIRS 168036], Section 4.3.2.1.1), which approximates the site-specific cask transporter weight at 85 tons (170,000 lbs).

**Comment**: The aging system capacity is under evaluation as part of the repository throughput and thermal management analysis. Currently the pad is designed to accommodate 20 percent HAMs and 80 percent site-specific casks. This allocation will be evaluated after more information is available from the throughput analysis. Initially, enough site-specific casks and HAMs will be procured to accommodate the 1,000 MTHM aging pad.

**3.1.2.1.2 Requirement**: The aging pad concrete slabs and embedment and cask anchorage steel shall be designed in accordance with ACI 349-01, *Code Requirements for Nuclear Safety Related Concrete Structures* (ACI 349-01 [DIRS 158833]). Supports Function 2.1.1.

**Basis**: This requirement is needed to specify appropriate and readily available design technologies and is based on good engineering practice taken directly from the PDC. [PDC 4.2.2]

**3.1.2.1.3 Requirement**: Bolts used as part of the anchoring design (if required) shall be coated or fabricated of a material that will resist corrosion and must meet the requirements of ASME Section III, Subsection NF, and Appendix F [DIRS 171846]. Supports Function 2.1.1.

**Basis**: This requirement is needed to specify appropriate and readily available design technologies and is based on good engineering practice. [PDC 4.2.2]

### 3.1.2.2 Cask Transfer Subsystem Functional Requirements

**3.1.2.2.1 Requirement**: The cask transfer subsystem shall be capable of safely transferring site-specific casks between the DTF, CHF, and FHF and the aging pads. Transferring operations shall not exceed one working shift. Supports Function 2.1.2.

**Basis**: This requirement is needed to define the transfer of site-specific casks to and from aging pads, since the aging pads are separated from the process handling facilities. The requirement supports and responds to the overall arrangement of the handling facilities and their distance and relationship from the SNF aging pads [F&OR 1.1.5.1-1].

**3.1.2.2.2 Requirement**: The cask transfer subsystem shall be capable of safely transferring a DPC in a transportation cask or horizontal transfer cask to and from the TCRRF and a HAM on an aging pad. Transferring operations shall not exceed one working shift. Supports Function 2.1.2.

**Basis**: This requirement is needed to define the transfer of horizontal casks to and from the aging pads since the aging pads are separated from the TCRRF. The requirement supports and responds to the overall arrangement of the handling facilities and their distance and relationship from the SNF aging pads. [F&OR 1.1.5.1-1]

**3.1.2.2.3 Requirement**: The maximum speed of the site-specific cask transporter shall be limited to 0.5 miles per hour and shall be capable of traveling on a maximum slope of 5 percent.

**Basis**: The requirement is based on preliminary vendor information as documented on the drawing *SNF Aging System MSC Transporter Mechanical Equipment Envelope*. The slope is based on the site layout as shown on *Geologic Repository Operations Area Aging Site Plan*. The slope is conservatively established to bound the current site plan, which has a maximum slope of three percent, specified. This requirement is needed to provided preliminary design information to be used for analyzing site-specific cask transporter designs.

### 3.1.2.3 Aging Cask Subsystem Functional Requirements

**3.1.2.3.1 Requirement**: The site-specific casks and HAMs shall have the capability to age CSNF. Supports Function 2.1.3.

**Performance Acceptance Criteria**:

1. The aging cask subsystem shall have the capability to age SNF in either site-specific casks or HAMs. [F&OR 1.1.5-1, F&OR 1.1.5.1-4]

2. The aging cask subsystem shall be designed for the expected extremes of environmental conditions at the Yucca Mountain site. [Derived]

3. The design of aging cask subsystems shall comply with 10 CFR Part 63 [DIRS 173164]. [10 CFR 63]

4. The metal site-specific casks, overpacks, and HAMs shall have unique identification numbers assigned to loaded casks. [F&OR 1.1.5.1-2]

5. The aging cask subsystem components shall have a design life of 50 years. [Derived based on paragraph 3.1.1.3.2.]

6. The site-specific aging casks shall be capable of absorbing the energy of a flat bottom drop from a 12-inch maximum height without resulting in loss of cask containment or shielding. [Derived]

**Basis**: This requirement is needed to define the functions and criteria of the vertical and horizontal aging components. The derived performance criteria are needed to ensure that the aging casks will not deteriorate over the life of the aging system because of ambient environmental and operating conditions. The aging system must be capable of aging SNF so that waste packages will not have a thermal output greater than 11.8 kW. The above statements are consistent with those driven by the F&OR and PDC.

**3.1.2.3.2 Requirement**: The aging cask subsystem shall accommodate uncanistered SNF, and canistered SNF. Naval SNF, DOE SNF/HLW, or multi-canister overpacks are not aged or handled by the system. Supports Function 2.1.3

**Performance Acceptance Criteria**:

1. Uncanistered SNF characteristics to be accommodated by the aging system are listed in *DOE and Commercial Waste Package System Description Document* (BSC 2005 [DIRS 172035], Section 3.1.2.2) and *Inventory and Characteristics of Potential Repository Wastes* (BSC 2004 [DIRS 167441]). The quantity of uncanistered SNF that the aging system must accommodate has not been established.

2. Canistered SNF characteristics that may be accommodated by the aging system will be listed in *DOE and Commercial Waste Package System Description Document* (BSC 2004 [DIRS 172035], Section 3.1.2.4) and *Inventory and Characteristics of Potential Repository Wastes* (BSC 2004 [DIRS 167441]). No qualified information for canistered SNF is available at this time. The quantity of canistered SNF that the aging system must accommodate has not been established.

**Basis**: This requirement establishes the characteristics and quantities of CSNF that the SNF aging system will accommodate consistent with that of the waste package SDD [PRD-014/T-001, PRD-014/T-002, PRD-014/T-003, PRD-014/T-004, PRD-014/T-014].

**Comment**: The comment under Requirement 3.1.1.3.1 established that an aging system that will hold 21,000 MTHM, plus have contingency space for an additional 19,000 MTHM, is adequate to address a wide range of waste receipt scenarios.

**3.1.2.3.3 Requirement**: The aging cask subsystem shall accommodate metal site-specific casks for aging uncanistered CSNF for two aging configurations.

**Performance Acceptance Criteria**:

1. 32 pressurized water reactor (PWR) fuel assemblies (except South Texas Long) assigned to the repository having up to 60,000 MWd/MTU burnup, four percent initial enrichment, and ten-year out-of-reactor cooling time or the equivalent (i.e., assemblies with various combinations of burnup, enrichment, and cooling time that provide an equivalent source term/dose rate as the bounding fuel assemblies). The maximum thermal power shall not exceed 1,185 watts per PWR assembly or 38 kw for the PWR site-specific cask.

2. 68 boiling water reactor (BWR) fuel assemblies assigned to the repository having up to 60,000 MWd/MTU burnup, four percent initial enrichment, and ten-year or greater out-of-reactor cooling time or the equivalent (i.e., assemblies with various combinations of burnup, enrichment, and cooling time that provide an equivalent source term/dose rate as the bounding fuel assemblies). The maximum thermal power shall not exceed 435 watts per BWR assembly or 30 kw for the BWR site-specific cask.

**Basis**: This requirement establishes the characteristics and quantities of CSNF that the SNF aging system will accommodate consistent with the F&OR. PWR performance acceptance criteria are derived from data contained in *PWR Source Term Generation and Evaluation* (BSC 2004 [DIRS 169061], Attachment X) and are consistent with engineering and operating practices at comparable nuclear facilities licensed by the NRC. BWR performance acceptance criteria are derived from data contained in *BWR Source Term Generation and Evaluation* (BSC 2003 [DIRS 164364], Attachment X) and are consistent with engineering and operating practices at comparable nuclear facilities licensed by the NRC.

**Comment**: The South Texas Long assemblies will be placed into a waste package and directly emplaced when received. Use of spacers to configure the cask baskets for short fuels will be employed if necessary.

**3.1.2.3.4 Requirement**: The aging cask subsystem shall provide site-specific metal and/or concrete ventilated overpacks for vertical aging of repository canisters that are loaded with CSNF, sealed and inerted in the FHF or DTF.

**Performance Acceptance Criteria**:

1. A repository canister with a 210.5 in. length and 66.0 in. diameter weighing up to 49 tons fully loaded for 21 PWR fuel assemblies (except South Texas Long) assigned to the repository having up to 60,000 MWd/MTU burnup, 4 percent initial enrichment, and 10 year out-of-reactor cooling time or the equivalent (i.e., assemblies with various combinations of burnup, enrichment, and cooling time that provide an equivalent source term/dose rate as the bounding fuel assemblies). The maximum thermal power shall not exceed 1,185 watts per PWR assembly or 25 kw for the 21 PWR repository canister.

2. A repository canister with a 210.5 in. length and 66.0 in. diameter weighing up to 49 tons fully loaded for 44 BWR fuel assemblies assigned to the repository having up to 60,000 MWd/MTU burnup, four percent initial enrichment, and ten year or greater out-of-reactor cooling time or the equivalent (i.e., assemblies with various combinations of burnup, enrichment, and cooling time that provide an equivalent source term/dose rate as the bounding fuel assemblies). The maximum thermal power shall not exceed 435 watts per BWR assembly or 19.2 kw for the 44 BWR repository canister.

**Basis:** This requirement establishes the characteristics and quantities of CSNF that the SNF aging system will accommodate consistent with the F&OR. PWR performance acceptance criteria are derived from data contained in *PWR Source Term Generation and Evaluation* (BSC 2004 [DIRS 169061], Attachment X) and are consistent with engineering and operating practices at comparable nuclear facilities licensed by the NRC. BWR performance acceptance criteria are derived from data contained in *BWR Source Term Generation and Evaluation* (BSC 2003 [DIRS 164364], Attachment X) and are consistent with engineering and operating practices at comparable nuclear facilities licensed by the NRC.

**Comments**:

1. Materials of construction for the canister basket will be the same as used for the similar CSNF basket for the waste package.

2. Longer SNF, such as the CE System 80 and South Texas Long assemblies, will be placed directly into a waste package.

**3.1.2.3.5 Requirement**: The aging cask subsystem shall provide metal site-specific casks or ventilated concrete overpacks for the vertical aging of commercial dual-purpose canisters (DPCs) assigned to the repository. The bounding dimensions, weight, and decay heat of the DPCs that must be accommodated by the casks or overpacks are:

- Diameter–66.00 in. to 70.64 in.
- Length–122.50 in. to 192.30 in.
- Maximum Weight–89,765 lb
- Maximum Decay Heat–28.7 kW.

**Basis**: This requirement establishes the characteristics and quantities of CSNF that the aging cask subsystem must accommodate consistent with the F&OR. The DPC characteristics given were based on data from Table 4-1, which were derived from previously developed engineering and operating practices at comparable nuclear facilities licensed by the NRC. [Derived]

**Comment**: The bounding parameters for vertical DPCs are given in Table 4-1.

**3.1.2.3.6 Requirement**: The aging cask subsystem shall provide horizontal aging modules for aging commercial DPCs specifically designed for horizontal aging assigned to the repository. The bounding dimensions, weight, and decay heat of the DPCs that must be accommodated by the HAMs are:

- Diameter–67.25 in.
- Length–186.50 in. to 199.67 in.
- Weight–88,390 lbs
- Heat output–15.9 kW.

**Basis**: This requirement establishes the characteristics and quantities of CSNF that the SNF aging system will accommodate consistent with the F&OR. The DPC characteristics given were based on data from Table 4-2, which were derived from previously developed engineering and operating practices at comparable nuclear facilities licensed by the NRC. [Derived]

**Comment**: The bounding parameters for transportable horizontal DPCs are given in Table 4-2.

**3.1.2.3.7 Requirement**: The aging cask subsystem shall provide adequate cooling to protect the integrity of the SNF cladding material.

**Performance Acceptance Criteria**:

1. For all fuel burnups (low and high), the maximum calculated fuel cladding temperature should not exceed 400°C (752°F) for normal conditions of storage and short-term loading operations (e.g., drying, backfilling with inert gas, and transfer of the cask to the aging pad). However, for low burnup fuel, a higher short-term temperature limit may be used if it can be shown by calculation that the best estimate cladding hoop stress is equal to or less than 90 MPa (13,053 psi) for the temperature limit proposed.

2. During loading operations, repeated thermal cycling (repeated heatup/cooldown cycles) may occur but should be limited to less than 10 cycles, with cladding temperature variations that are less than 65°C (117°F) each.

**Basis**: This requirement establishes limiting temperature performance criteria to protect the integrity of the SNF cladding as defined by *Interim Staff Guidance-11, Revision 3, Cladding Considerations for the Transportation and Storage of Spent Fuel* (NRC 2003 [DIRS 170332]). PDC 6.3.2 also gives limits of 400°C for normal operations and 570°C during off-normal accident conditions.

**3.1.2.3.8 Requirement**: The nominal radiation level from the surface of any single site-specific cask or horizontal aging module at a distance of one meter shall not exceed 60 mrem/hr. For normal and Category 1 event sequences, the dose a real member of the public located beyond the site boundary receives shall not exceed 15 mrem total effective dose equivalent (TEDE) in one year. For Category 2 events, no individual located on or beyond the site boundary shall receive a dose of more than five rem TEDE per event.

**Basis**: This requirement is needed to define the bounding radiation levels from vertical and horizontal aging systems that are consistent with existing systems licensed under 10 CFR Part 72 [DIRS 171253], and that are expected to ensure that occupational and public radiation doses are kept ALARA in accordance with 10 CFR Part 20 [DIRS 173165]. The design requirement was derived from previously developed engineering and operating practices at comparable nuclear facilities licensed by the NRC. Dose rates at the site boundary are explained in *Preclosure Consequence Analyses for License Application* (BSC 2005 [DIRS 171607], Tables 1 and 2).

### 3.1.3 Boundaries and Interfaces

Boundaries and interfaces are identified in Tables 3-1, 3-2, 3-3, and 3-4, and show functional interfaces. System interfaces (i.e., CHF, TCRRF, DTF, and FHF) are shown on Figure B-1, Surface Aging System Interface Relationship Chart, and are further explained in Section 4.1.2.

Table 3-1. Interfaces among the Subsystems of the SNF Aging System

| System 1 | System 2 | Interface Function |
|---|---|---|
| Aging Pad Subsystem | Cask Transfer Subsystem | Transfer site-specific cask to aging pad |
| Aging Pad Subsystem | Aging Cask Subsystem | Contains the site-specific cask |
| Transfer Subsystem | Aging Cask Subsystem | Lift and transfer site-specific cask and transport and transfer DPCs into HAMs |

Table 3-2. Interfaces between SNF Aging System and Handling Systems

| System 1 | System 2 | Interface Function |
|---|---|---|
| SNF Aging System | Non-nuclear Handling System | Receive new site-specific casks |
| SNF Aging System | Cask/Site-Specific Cask/Waste Package Preparation System | Prepare site-specific cask for transfer, closure, and inerting prior to aging |
| SNF Aging System | SNF/HLW Transfer System | Transfer SNF to the site-specific cask |
| SNF Aging System | Cask Receipt/Return System | Transfer new aging casks to CHF and DTF |
| SNF Aging System | Remediation System | Receive damaged site-specific cask |

Table 3-3. Interfaces between SNF Aging System and Infrastructure Systems

| System 1 | System 2 | Interface Function |
|---|---|---|
| SNF Aging System | Digital Control and Management Information System | Provide temperature or pressure monitoring |
| SNF Aging System | Radiation/Radiological Monitoring System | Provide radiation/radiological monitoring |
| SNF Aging System | Electrical Power System | Provide electrical power |
| SNF Aging System | Electrical Support System | Distribute electrical power; provide lighting and lightning protection |
| SNF Aging System | Environmental/Meteorological Monitoring System | Provide seismic monitoring of the aging pads |
| SNF Aging System | Plant Services System | Provide plant services |
| SNF Aging System | Communications System | Provide communications |
| SNF Aging System | Site-generated Radiological Waste Handling System | Provide gas sample transportation cask prior to removing access cover plate for hydraulic ram. |
| SNF Aging System | Safeguards and Security System | Provide safeguards and security |

Table 3-4. Interfaces between SNF Aging System and Facilities

| System 1 | System 2 | Interface Function |
|---|---|---|
| SNF Aging System | DTF | Receive the site-specific cask (loaded and unloaded)<br>Receive damaged site-specific cask requiring remediation |
| SNF Aging System | CHF | Receive the site-specific cask (unloaded and loaded with repository canister) |
| SNF Aging System | FHF | Receive the site-specific cask (loaded and unloaded) |
| SNF Aging System | Warehouse/Non-nuclear Receipt | Receive new site-specific casks |
| SNF Aging System | Transportation Cask Receipt/Return | Receive/return the transportation casks with horizontal DPCs |
| SNF Aging System | Balance of Plant | Maintenance of mobile equipment, pad access roads |

#### 3.1.3.1 Aging Pad Subsystem Boundaries and Interface Requirements

**3.1.3.1.1 Requirement**: The aging pad subsystem interfaces with the cask transfer subsystem and aging cask subsystem. Supports Function 2.1.1.

**Performance Acceptance Criteria**:

1. Aging pads shall provide the space required for the maneuvering of cask transfer equipment and for vertical site-specific casks and HAMs. [F&OR 1.1.5.1-1, 1.1.6-1]

2. Aging pads shall provide anchorage for the vertical casks (if analysis shows it is required). [10 CFR Part 63]

3. Aging pad HAMs shall have a storage configuration compatible with the NRC approved configurations. [Derived]

**Basis**: Design interfaces must be identified and controlled. These requirements are needed to ensure that the aging pad subsystem is fully compatible with other aging subsystems as defined in the F&OR and 10 CFR Part 63.

### 3.1.3.2 Cask Transfer Subsystem Boundaries and Interface Requirements

**3.1.3.2.1 Requirement**: The cask transfer subsystem interfaces with the aging pad subsystem, aging cask subsystem, TCRRF, DTF, CHF, and FHF. Supports Function 2.1.2.

**Performance Acceptance Criteria**:

1. The horizontal cask transfer trailer and cask tractor shall interface with the transfer operations in the TCRRF for transfer of the transportation and transfer casks to the transfer trailer.

2. The horizontal cask transfer trailer shall be capable of securing and supporting the transportation cask or a transfer cask during transfer operations.

3. The cask transporter (crawler) shall interface with the handling operations at a designated area outside the DTF, CHF, and FHF.

4. The cask transfer subsystem components shall have sufficient capacity and necessary features to prevent damage to the site-specific cask during transfer operations. [PRD-022/P-001]

**Basis**: These requirements are needed to ensure that the cask transfer subsystem is fully integrated with other aging subsystems and other plant facilities. They are primarily derived requirements, specified in a manner to clearly define major interfaces. Design interfaces must be identified and controlled.

**Comments**: Space and lifting requirements for site-specific casks and space requirements for cask transfer equipment are being developed to ensure adequate space and support equipment are available in the TCRRF, DTF, CHF, and FHF to interface with aging system components.

### 3.1.3.3 Aging Cask Subsystem Boundaries and Interface Requirements

**3.1.3.3.1 Requirement**: The aging cask subsystem interfaces with the aging pad subsystem, cask transfer subsystem, Warehouse and Non-nuclear Receipt Facility (WNNRF) for new site-specific casks, TCRRF for the transfer of transportation casks that must go directly to a HAM, and processing facilities (FHF, CHF, and DTF) that provide or receive loaded site-specific casks with the aging pad. Supports Function 2.1.3.

**Performance Acceptance Criteria**:

1. The transportation casks shall interface with the operations in the TCRRF for processing transportation cask containing horizontal DPCs. [PRD-022/P-001]

2. The site-specific casks shall interface with the loading and unloading operations of SNF within the DTF, CHF, and FHF, and within the remediation area of the DTF for site-specific casks whose post-aging gas sampling indicate a problem with the internal contents. [PRD-022/P-001]

**Basis**: These requirements are needed to ensure that the aging cask subsystem as defined in the PRD is fully integrated with other aging subsystems and plant facilities. Design interfaces must be identified and controlled.

### 3.1.4 Codes, Standards, and Regulations

Codes, standards, and regulations that pertain to the SNF aging system are found in the PDC (BSC 2004 [DIRS 171599]). Design of the aging pads and roads leading to it will be subject to the criteria for civil, structural, and architectural design in the PDC, Section 4.2. The PDC mechanical handling criteria are in Section 4.7. Specific criteria for SNF aging are in the PDC, Section 4.7.1.8. Nuclear design criteria are found in the PDC, Section 4.9.

### 3.1.5 Operability

This section will provide the operability requirements for the system. This will include technical specification requirements, if applicable, and other operating requirements from modes and conditions such as startup, normal operations, shutdown, emergency operation, and other system operations. Operability functional requirements will be prepared during detailed design.

## 3.2 SPECIAL REQUIREMENTS AND BASES

Preliminary hazards analysis has not identified any safety concerns. This section will be updated for each hazard with information on applicability and non-applicability, mitigating and/or fail safe performance requirements, environments, monitoring, alarms, and interfaces. See *Preliminary Hazards Analysis for License Application Study* (BSC 2004 [DIRS 167313]) for additional information.

### 3.2.1 Radiation and Other Hazards

**3.2.1.1 Requirement**: The aging system shall be designed and operated to withstand the effects of radiation and to minimize radiation exposures.

**Performance Acceptance Criteria**:

1. The aging system shall provide radiological protection in accordance with the requirements specified in 10 CFR Part 20 [DIRS 173165]. [10 CFR 63.111(a)(1)]

2. Aging system components shall withstand the effects of radiation as they perform their intended function to shield and protect against radiation. [10 CFR 63.112(e)(3), PDC 4.7.1.2]

3. Aging system components shall be surveyed and decontaminated as necessary to remain within prescribed limits. (Surface contamination limits are TBD.) [F&OR 1.1.5.1-6]

4. The dose rate at the aging areas, around the casks (site-specific casks and HAMs), during cask transfers, and during other system work activities shall be ALARA and within prescribed limits. Site-specific cask and HAM dose rates are TBD. [F&OR 2.3-1]

**Basis**: This is needed to meet the radiological protection requirements and to comply with 10 CFR Part 63 [DIRS 173164] and F&OR (Curry 2004 [DIRS 170557]) requirements.

### 3.2.2 As Low As Is Reasonably Achievable (ALARA)

**3.2.2.1 Requirement**: The aging system shall be designed to meet ALARA principles in accordance with 10 CFR Part 63 [DIRS 173164] and 10 CFR Part 20 [DIRS 173165].

**Basis**: This is needed to meet the radiological protection and ALARA requirements and to comply with 10 CFR Part 20 and Part 63 requirements.

### 3.2.3 Nuclear Criticality Safety

**3.2.3.1 Requirement**: The aging system shall be designed and operated to prevent any credible criticality event from occurring. [10 CFR 63.112(e)(6)]

**Basis**: This is needed to meet the nuclear criticality safety requirements and to comply with 10 CFR Part 63 [DIRS 173164] requirements.

### 3.2.4 Industrial Hazards

**3.2.4.1 Requirement**: The aging system industrial hazards shall be established from the evaluation performed per AP-ESH-004, *Occupational Safety and Health Program*, to comply with hazards common to industry. Supports Function 2.1. [External compliance]

**Basis**: The aging system is required to comply with federal and state laws, regulations, standards, and DOE directives applicable to safety and health, and ensure compliance with federal and State of Nevada regulatory requirements for hazardous material use and storage. [PRD-015/P-020]

**3.2.4.2 Requirement**: The aging system shall be designed and operated to comply with federal and state laws, regulations, standards, and DOE directives applicable to safety and health. [External compliance]

**Basis**: The aging system is required to comply with federal and state laws, regulations, standards, and DOE directives applicable to safety and health. [PRD-015/P-020]

**3.2.4.3 Requirement**: The aging system shall be designed and operated in a manner to ensure that it is safe from possible events from high-energy sources. [External compliance]

**Basis**: The design should be reviewed for the presence of high-energy sources. [PRD-015/P-020]

**3.2.4.4 Requirement**: The aging system shall be designed and operated to minimize fire hazards consistent with *Site Fire Hazards Analysis* (BSC 2005 [DIRS 172174], Section 6.8.1.5).

**Performance Acceptance Criteria**:

1. There shall not be any exposed combustible materials on the aging pads (BSC 2005 [DIRS 172174], Section 6.8.1.5.7).

2. Aging casks shall be designed to withstand the effects of a postulated vehicle fire (BSC 2005 [DIRS 172174], Section 6.8.1.5.10).

3. The design of the aging system shall consider mitigation features as identified in the *Site Fire Hazards Analysis* (BSC 2005 [DIRS 172174], Section 6.8.1.5).

**Basis**: This requirement is needed to address fire protection goals. A fire hazard analysis for the SNF aging system is part of the overall *Site Fire Hazards Analysis* (BSC 2005 [DIRS 172174]). [PRD-002/T-013, PRD-015/P-020]

**Comment**: A vehicle fire is assumed to be limited to 50 gallons of diesel fuel and lasts for eight minutes.

**3.2.4.5 Requirement**: The aging system shall be designed and operated to ensure compliance with explosives hazard requirements.

**Basis**: This requirement is needed to preclude explosive hazards. Explosives hazards associated with or potentially affected by the aging system will be evaluated as part of the integrated safety assessment. [PRD-015/P-021]

**3.2.4.6 Requirement**: The aging system shall be designed and operated to limit and control employee exposures to crystalline silica (including quartz, cristobalite, and tridymite) consistent with the risk.

**Basis**: This requirement is needed to comply the applicable procedures. The requirements to limit and control employee exposures to crystalline silica (including quartz, cristobalite, and tridymite) are defined in LP-ESH-019-BSC, *Silica Protection*. [PRD-015/P-020]

**3.2.4.7 Requirement**: The aging system shall be designed to operate and/or fail safe in the normal, anticipated abnormal, and event sequence environments to which it will be exposed, consistent with its ITS classification, for the duration of its installed life.

**Basis**: This requirement is need to ensure that the system is adequate to operate in a fail-safe manner. PRD-002/T-013 requires analysis of the performance of SSCs ITS to ensure the availability of safety systems. [PRD-002/T-013]

**3.2.4.8 Requirement**: The aging system shall be designed and operated in coordination with *Emergency Management Plan* (DOE 2003 [DIRS 167254]).

**Basis**: The aging system will be evaluated for appropriate information to be included in the *Emergency Management Plan* (DOE 2003 [DIRS 167254]).

**3.2.4.9 Requirement**: As changes are made to the aging system, these changes shall be evaluated for impact on the safety basis. The safety basis shall be updated to reflect new information on existing hazards, new hazards, and changes in inventory of radiological and chemical inventories.

**Basis**: This requirement is needed to address changes per the PRD. [PRD-002/T-007]

**3.2.4.10 Requirement**: The activities involving tracers, fluids, and materials (TFMs) shall be evaluated in accordance with LP-SA-001Q-BSC, *Determination of Importance and Site Performance Protection Evaluations*.

**Basis**: The activities involving TFMs are evaluated in accordance with LP-SA-001Q-BSC. Performance assessment has considered all applicable features, events, and processes that are related to the TFM use and calculates limiting (i.e., in quantity or location) the use of certain TFMs at the site. [PRD-002/P-024, PRD-002/T-017]

### 3.2.5 Operating Environment and Natural Phenomena

**3.2.5.1 Requirement Text**: The aging system components shall be designed to withstand environmental temperatures, wind, precipitation, and other natural phenomena.

**Performance Acceptance Criteria**:

1. The system components shall be designed to withstand and operate in the temperature environment in which they are exposed (BSC 2004 [DIRS 171599] Tables 4.8.2-1, 4.8.2-2, 4.8.2-3, and Section 6.1.1). [PDC 4.7.1.2]

2. The system components shall be designed for extreme winds, as defined in Section 3.1.1.1. [PDC 4.2.2.3.6, PDC 6.1.1.2]

3. The system components shall be designed to withstand a precipitation intensity of 2.15 in./hr. [PDC 4.2.2.3.13, PDC 6.1.1.1]

4. The system components shall be designed to withstand a maximum monthly snowfall of 6.6 in. [PDC 4.2.2.3.3, PDC 6.1.1.1]

5. The system components shall be designed to withstand a frost line depth of 10 in. [PDC 6.1.1.7]

**Basis**: This requirement is needed to ensure that external loads are addressed in the design of the system in accordance with the PDC.

**3.2.5.2 Requirement**: The aging system SSCs must be designed for seismic events per Section 3.1.1.1. The aging system must be designed such that design basis seismic events will not initiate a Category 1 or Category 2 event sequence with consequences that exceed the performance objectives of 10 CFR 63.111(b)(1) or (b)(2) [DIRS 173164], respectively.

**Basis**: This requirement is needed to comply with PDC 4.7.1.2.

**3.2.5.3 Requirement**: SNF aging system components classified as ITS shall be designed to withstand the site design basis tornado per Section 3.1.1.1. The site-specific casks and HAMs must withstand a design basis extreme wind of 90 mph, a design basis tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 psi, a rate of pressure drop of 0.3 psi per second, and Spectrum II tornado missiles.

**Basis**: This requirement is needed to comply with PDC 6.1.1.2 and PDC 6.1.1.3.

**3.2.5.4 Requirement**: The aging system shall be designed and operated to minimize radon exposure to personnel.

**Basis**: This requirement is needed to comply the applicable procedures. The aging system will be evaluated against LP-ESH-071-BSC, *Protection Program for Radon*. Workers associated with the aging system may be exposed to radon while performing normal and event sequence functions. The maintenance and replacement activities on this system will consider radon exposure in the design, maintenance and replacement activities. [PRD-015/P-020, F&OR 2.1-1]

**3.2.5.5 Requirement**: The cask transfer subsystem equipment must be constructed to allow the operator clear visibility while operating in the travel direction and not expose the operator to elevated radiation levels, noise, dust, or other constituents above the threshold limits.

**Basis**: This requirement is needed to comply with PDC 4.7.1.8.

**3.2.5.6 Requirement**: The cask transfer subsystem equipment shall sound a auditable signal to warn people in the vicinity when moving backwards.

**Basis**: This requirement is needed to comply with PDC 4.7.1.8.

**3.2.5.7 Requirement**: The cask transfer subsystem equipment track/wheel design shall not damage the aging pad surfaces or other concrete floors.

**Basis**: This requirement is needed to comply with PDC 4.7.1.8

### 3.2.6 Human Interface Requirements

No human interface requirements for the aging system have been currently identified. However, human interface requirements for the various subsystems (e.g., cask transfer) will be established as the design evolves.

### 3.2.7 Specific Commitments

**3.2.7.1 Requirement**: The aging system shall be designed and operated in compliance with land access agreements, applicable permits, and applicable environmental, regulatory, monitoring, and mitigation requirements.

**Basis**: This requirement is needed to comply with the applicable procedures. Environmental hazards (impacts) associated with the aging system will be evaluated and controlled in accordance with the *Environmental Management Plan* (YMP 2000 [DIRS 154039]). AP-EM-002, *Land Access and Environmental Compliance*, will be utilized to establish compliance with land access agreements and support compliance with applicable environmental regulatory, monitoring, and mitigation requirements. AP-EM-010 will review the aging system design against the environmental baseline established by the *Final Environmental Impact Statement for a Geological Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250 (DOE 2002 [DIRS 155970]). The aging system is required to comply with federal and state laws, regulations, standards, and DOE directives applicable to AP-EM-002 and LP-EM-008-BSC, *Pollution Prevention Assessments and Sustainable Design.* [PRD-014/P-038, PRD-015/P-075, PRD-002/T-004]

**3.2.7.2 Requirement**: The aging system shall be designed and operated to meet LP-EM-008-BSC and decommissioning goals.

**Basis**: This requirement is needed to comply with applicable procedures. Pollution prevention and sustainable design assessments associated with the aging system will be evaluated and controlled in accordance with LP-EM-008-BSC. PRD-018/P-017 and DOE O 413.3 [DIRS 152047] require the identification of requirements to meet sustainable design principles and PRD-018/P-021 provides requirements for a sustainable design. [PRD-018/P-017, PRD-018/P-021]

**3.2.7.3 Requirement**: The repository shall be designed with pollution prevention systems to control air emissions and effluents, minimize water use, and reduce or eliminate discharges to the environment. [External compliance]

**Basis:** This requirement is needed to address pollution prevention. DOE O 450.1 [DIRS 161567], *Environmental Protection Program,* establishes DOE policy to conduct its operations in an environmentally safe and sound manner and perform its activities in compliance with applicable environmental protection requirements. The design shall comply with applicable environmental requirements set forth by federal and state regulations, executive orders, and DOE Directives, and requirements derived from environmental permits and corresponding permit conditions. [PDC 4.1.1.9]

**3.2.7.4 Requirement**: The repository shall be designed with a goal to reduce energy and water consumption while increasing the use of clean energy sources.

**Basis**: This requirement is needed to meet or exceed the goals of the laws, executive orders, and federal regulations for energy efficiency, use of renewable energy, and water conservation at DOE facilities. This requirement pledges compliance with 10 CFR Part 435, Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings. [DIRS 156267]. This requirement also ensures conformance with DOE O 430.2A, *Departmental Energy and Utilities Management* [DIRS 158913], and 64 FR 30851 [DIRS 104026], Executive Order 13123, that provides the goals for the reduction of greenhouse gas emissions attributed to the energy use of federal buildings. [PDC 4.1.1.1]

## 3.3 ENGINEERING DISCIPLINARY REQUIREMENTS AND BASES

### 3.3.1 Civil and Structural

#### 3.3.1.1 System Civil and Structural Requirements

**3.3.1.1.1 Requirement**: The aging pad and HAMs are designated as ITS structures. Accordingly, the structural design of reinforced concrete and structural steel, including load factors, load combinations, acceptance criteria, stability criteria, deflection limits, anchorage, story drift, and foundation design, shall meet the criteria identified in the PDC, Section 4.2.2.4.

**Basis**: Structural parameters need to be established to properly design the system in accordance to applicable design criteria [PDC 4.2.2.4].

**Comment**: The aging system has been determined to be ITS as stated in Section 2.2.

**3.3.1.1.2 Requirement**: The aging cask subsystem shall be designed to withstand the tornado missiles as specified in Design of Structures, Components, Equipment, and Systems, Chapter 3, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 1987 [DIRS 138431], Section 3.5.1.4).

**Basis**: This requirement is based on the definition of tornado missiles as specified in the PDC, Section 4.2.2.3.7. The requirement is needed to ensure that the aging cask subsystem is designed to adequately protect the SNF during severe weather.

### 3.3.2 Mechanical and Materials

Unique mechanical or materials requirements for the system have not been identified. However, design criteria, codes, and standards in the PDC, Section 4.4, govern fabrication and materials used in the design of the system.

### 3.3.3 Chemical and Process

Specific SNF aging system requirements regarding chemical and process issues have not been fully developed at this time. The site-specific cask will be inerted with helium. As detailed design evolves, specific requirements will be written and then implemented in technical specifications.

### 3.3.4 Electrical Power

**3.3.4.1 Requirement**: Continuous electrical power will be provided to the aging pads for lighting, permanent sensors, and gate and door controllers. [PRD-022/P-001] Supports Function 2.1.1.

**Basis**: This requirement is needed to define the electrical power supply. Electrical power at the aging pads will be utilized for illumination, an intrusion alarm system (Section 3.5.1.2), and other subsystems. Additional details will be provided during detailed design.

**Comment**: At this time, electrical engineering has established that each aging pad location (17A to 17E) will be equipped with a 480 VAC motor control center. Each of these motor control centers will be able to accommodate all anticipated loads.

### 3.3.5 Instrumentation and Control

**3.3.5.1 Requirement**: Aging pad conditions will be continuously monitored via the digital control and management information system (DCMIS). Supports Function 2.1.1.

**Performance Acceptance Criteria**:

1. The DCMIS will monitor the temperature of ventilated site-specific casks and HAMs. [PRD-022/P-001]

2. The DCMIS will include interspace overpressure monitoring of bolted metal casks. [PRD-022/P-001]

3. The DCMIS will include video monitoring of the aging pads. [PRD-022/P-001]

4. The DCMIS will include radiation monitoring of the aging pads. [PRD-022/P-001]

**Basis**: This requirement is needed to define DCMIS support functions. The DCMIS will be utilized to continuously monitor conditions with the SNF aging system. Additional details will be provided during detailed design.

### 3.3.6 Computer Hardware and Software

There are no computer hardware and software requirements for the system identified at this stage of the design. Computer and software requirements will be developed as the design progresses and will be added to the SDD.

### 3.3.7 Fire Protection

**3.3.7.1 Requirement**: The SNF aging system components will be constructed from fire resistant materials to minimize fire hazards and shall comply with the fire protection design criteria from the PDC. Supports Function 2.1.1.

**Basis**: Design of the SNF aging system must include an examination of fire protection criteria to ensure the protection of life and property from fire hazards. Additional details will be provided during detailed design. [PDC 4.8.1]

**Comment**: The aging system is not protected with a dedicated fire sprinkler system, but it will be serviced by an onsite fire station or other fire fighting equipment.

### 3.3.8 Communication

Specific requirements for the communication system have not yet been developed. Requirements will be developed during detailed design and may specify features, such as a telephone, at the aging areas and radio communication in the transfer vehicles.

## 3.4 TESTING AND MAINTENANCE REQUIREMENTS AND BASES

### 3.4.1 Testability

There are no testability requirements for the system identified at this stage of the design. Requirements will be developed as the design progresses and will be added to the SDD.

### 3.4.2 Safety-Required Surveillances

No requirements have been developed for this section at this time.

### 3.4.3 Non-Safety Inspections and Testing

No requirements have been developed for this section at this time.

### 3.4.4 Maintenance

Specific requirements for maintenance of the SNF aging system will be developed during detailed design. The aging pad areas may require occasional maintenance to remove weeds, repair fencing, or conduct other relatively minor upkeep. The aging cask subsystem will require some maintenance, and those maintenance requirements will be developed in conjunction with developing the technical specifications for the subsystem. The cask transfer subsystem will require the most maintenance of the three subsystems and requirements for its maintenance will be developed during detailed design. The Balance of Plant Facility includes a heavy equipment maintenance building that could be used to maintain the cask transfer subsystem equipment.

## 3.5 OTHER REQUIREMENTS AND BASES

### 3.5.1 Security and Special Nuclear Material Protection

**3.5.1.1 Requirement**: The aging system will receive and return nuclear materials from the TCRRF, DTF, CHF, and FHF and will include a program that accounts for material balance, inventory, records requirements, reporting of personnel exposure, or loss of nuclear material. [Licensing Requirement]

**Basis**: This requirement supports the tracking of waste as required to maintain nuclear material inventories, which is part of PRD-002/P-009. [PRD-002/P-009]

**Comment**: Requirement originates in 10 CFR 63.78.

**3.5.1.2 Requirement**: The safeguards and security plan shall evaluate the aging system for appropriate features and capabilities. [Licensing Requirement]

**Performance Acceptance Criteria**:

1. The aging system will be included in the safeguards and security plan and will include contingency plans to ensure compliance. [PRD-005/T-008, PRD-005/P-010]

2. The aging cask subsystem shall be designed to satisfy the requirement in 10 CFR 73.51(d)(1) [DIRS 103192] in that the site-specific casks and HAMs must present a barrier offering substantial resistance to penetration. This performance requirement combined with a barrier (security fence) at the perimeter of the protected area will meet the requirements of 10 CFR 73.51(d)(1). [PRD-005/T-008, 10 CFR 73.51(d)(1)]

3. The aging pads must be within the protected area at the repository. [PRD-005/T-008, 10 CFR 73.51(d)(1)]

4. The aging pads must be adequately illuminated to permit assessment of unauthorized activities. [PRD-005/T-008, 10 CFR 73.51(d)(2)]

5. The aging pads, which border the protected area, must be under continual surveillance with an active intrusion alarm system. [PRD-005/T-008, 10 CFR 73.51(d)(3)]

**Basis**: Safeguards and security requirements are contained in PRD-002/T-004, PRD-005/T-008, and PRD-005/P-010. The primary source requirement for security and safeguards is from 10 CFR 73.51 [DIRS 103192], which is invoked by 10 CFR 63.21(b)(3) [DIRS 173164].

**Comment**: Additional safeguard and security requirements will be added as the design moves forward. Also, see the latest available safeguards and security description documentation for further details.

### 3.5.2 Special Installation Requirements

No requirements have been developed for this section at this time.

### 3.5.3 Reliability, Availability, and Preferred Failure Modes

No requirements have been developed for this section at this time.

### 3.5.4 Quality Assurance

The minimum quality assurance requirements for the Office of Civilian Radioactive Waste Management Program are established in the *Quality Assurance Requirements and Description*, DOE/RW-0333P [DIRS 171539].

**3.5.4.1 Requirement**: The design of the system shall be in accordance with project design control procedures and Section 3 of the *Quality Assurance Requirements and Description* document (DOE 2004 [DIRS 171539]).

**Basis**: This requirement is based upon compliance with Section 3 of the *Quality Assurance Requirements and Description* document (DOE 2004 [DIRS 171539]).

### 3.5.5 Miscellaneous Requirements

Miscellaneous requirements include requirements that do not fit well within other categories. At this stage of the design, no miscellaneous requirements have been identified.

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# 4. SYSTEM DESCRIPTION

The objective of Section 4 of this SDD is to describe the current system design and provide relevant information related to supporting figures included in Appendix B. This section provides a description of the SNF aging system design features currently under development to meet the requirements identified in Section 3. The SNF aging system consists of above ground, reinforced concrete pads where CSNF will be placed for aging until it is scheduled for waste packaging and underground emplacement. The system includes vertical and horizontal cask systems that contain SNF and the heavy equipment components needed to transfer the cask configurations.

Section 4 will be expanded and updated in future revisions as the design evolves. When requirement satisfaction is part of the description here in Section 4, a parenthetical trace to the satisfied requirement is also included. For example, when Section 3.x.x.x is noted, the intent is to indicate that the description satisfies the parenthetical requirement.

## 4.1 CONFIGURATION INFORMATION

The primary subsystems and components of the SNF aging system are the aging pads, site-specific casks, HAMs, and cask transfer subsystem equipment. CSNF requiring aging will be transferred to the aging pads by transfer equipment specifically designed to transfer site-specific casks and transfer casks between the aging pads, TCRRF, DTF, FHF, and CHF. Aging will take place in site-specific casks (in a vertical orientation) and in the HAMs (in a horizontal orientation). When the aging process is completed and the SNF is scheduled for waste package loading, the SNF will be transferred to an appropriate handling facility (FHF or DTF) for packaging prior to underground emplacement. Disposable canisters such as the YMP canister, if aged in an overpack, can be taken to the CHF for transfer of the canister to a waste package prior to emplacement. A description of the primary aging system components is provided below.

### 4.1.1 Description of System, Subsystems, and Major Components

The following is a description of the aging pad, cask transfer, and aging cask subsystems.

#### 4.1.1.1 Aging Pad

The proposed locations of the aging pads are shown on Figure B-2. A 1,000 MTHM capacity pad is located adjacent to the handling buildings, while four 5,000 MTHM capacity pads are located to the northwest of the handling buildings. Each aging pad slab is a reinforced concrete mat that is supported on grade. The pads are designed to withstand loads and load combinations imposed by natural phenomena such as earthquakes, extreme winds, and tornado winds (Sections 3.1.1.1 and 3.2.5.3). The combined capacity of these five pads will enable the repository to eventually reach a capacity of 21,000 MTHM (Section 3.1.1.3.1). Space to accommodate an additional 19,000 MTHM will be made available on the site layout plan as a contingency. Figure B-4 shows a typical 5,000-MTHM module layout consisting of five 1,000-MTHM slab units. Each aging pad unit has space for accommodating both site-specific casks and HAMs. No dimensions are given since the design of the HAMs and site-specific casks and transfer equipment is the early stages of design development and subject to change. Currently, the slab layout accommodates 20 percent HAMs and 80 percent site-specific casks as stated earlier in Section 3.1.1.3.1. Twenty HAMs arranged in two back-to-back rows of ten HAM units. The vertical site-specific casks are represented by two rows of forty casks. The aging pad will include space to maneuver the transfer equipment around the site-specific casks, HAMs, and other support systems required for the safe operation and maintenance of each aging pad. The aging pads will be equipped with cask anchoring systems, if required, for the vertical casks to comply with seismic and missile requirements at the pads (Sections 3.1.1.1 and 3.2.5.2). Since it has not been shown by analysis at this time that unanchored site-specific casks are precluded from tip over for all credible seismic and missile events, a conceptual anchoring system was devised. The anchoring concept is shown in Figure B-10. The HAMs will be designed and configured to meet seismic and other natural phenomena requirements at the pads.

The concrete aging pads will be designed and constructed to provide support for the aging casks during credible design events. Flood drainage channels will surround the aging pads that are sized to carry away water from a design basis flood (Figure B-15). This precludes the possibility that site-specific casks could be subject to the probable maximum flood. Figure B-15 also shows the inner boundary location of the aircraft barrier in relation the aging pads. The distance of the aging pads from up-slope hillsides and the location of the drainage channel and aircraft barrier precludes soil from sliding onto the concrete aging pads and contacting the aging casks. Each pad is a conventionally reinforced concrete mat providing for water runoff, and each is designed to consider thermal loading and transport equipment accessibility. Each pad unit accommodates 1,000 MTHM (Figure B-3). The aging area configuration (Figure B-4) will accommodate a range of storage technologies (which will be further evaluated during the detailed design phase) (Section 3.1.1.4.1). They are also located at a reasonable distance from the process handling facilities and other heavily visited areas to satisfy ALARA and radiation protection goals (Sections 3.2.1.1 and 3.2.2.1). The areas are within the protected area (Section 3.5.1.1) and will be constructed of concrete and steel to ensure fire resistance (Section 3.3.7.1). A nuisance barrier, security fence, and aircraft crash barrier will surround the areas.

Each aging pad includes a utility building, which is a single story structure used for terminating utility leads, small tool storage, and other support equipment. The utility buildings are classified as non-ITS and are designed in accordance with the International Building Code and/or other applicable industry codes and standards.

The aging pad will require only minimal fire protection features to provide a defense in depth approach to the fire protection of the facility. This defense in depth will result in a fire being quickly detected and suppressed, thus limiting fire-induced damage.

The design separation of the aging pads and combustible vegetation is a minimum of 33 ft (10 meters) from the natural vegetation. The aging pads are also separated no less than 400 ft from other repository surface structures. This distance ensures there will be minimum damage to the aging facilities from a wild fire. Should wildfire occur, a fully staffed, completely equipped, and adequately trained site fire department will respond to a fire alarm and conduct fire suppression activities, as required.

There are no internal hazards associated with the storage of aging casks. There are no in situ ignition sources or exposed combustible materials proposed for the aging pad. The aging casks are to be transported to and from the aging pad by the diesel-powered vehicles, which represent the only identified exposure fire threat to the casks. These vehicles will have a maximum fuel tank capacity of 50 gallons. The design basis fire would be an exposure fire as a result of the failure of a diesel powered transport vehicle. A sudden rupture of the fuel tank could result in a fire that would burn at up to 800°C for no more than eight minutes. No other combustible materials have been identified in the aging pad. Thus, the fire would be confined to the area of the vehicle and cask it is carrying, or near by cask, and represent an exposure threat to the cask or casks.

The aging areas will be designed and constructed to withstand thermal loads and loads imposed by environment and natural phenomena, such as earthquakes, extreme winds, and tornado winds. Figure B-3 shows a typical aging reinforced concrete mat that is 3 ft thick at the outer aprons and approximately 7 ft thick under the site-specific casks to resist moment loads from anchored casks caused by tornado forces and missiles or design basis earthquakes. Figure B-10 shows a conceptual anchoring system for the site-specific casks, if required. The site-specific casks are placed on the aging pad in an array that must be maintained. In addition, these casks must also remain stable against tipover, drop, or slapdown from imposed seismic loads resulting from DBGMs.

Preliminary analyses have shown that sufficient rigidity can be achieved with the following tie-down features:

1. The site-specific casks are provided with an extended 2-in. thick bottom plate to form a relatively narrow external flange that requires no holes for bolting.

2. The aging pad is provided with a 1-in. thick embedded ring plate that mates with 24 threaded couplings equally spaced in a bolt circle slightly larger than the cask's flange.

3. The threaded couplings are attached to an embedded, number 14 (2¼ in. thick) threaded rebar anchor (4 ft 6 in.) that is part of the concrete mat rebar system.

4. The site-specific cask is lowered into place by the site-specific cask transporter such that the cask's flange is concentric with the circle of embedded couplings.

5. Each coupling takes a 2 ½-in. threaded stud, keeper plate, and nut to tie down the cask's flange to the aging pad anchor system.

Additional features supporting the aging pads include normal and standby power supplies, lighting, and equipment for monitoring site-specific cask parameters (pressure between cask seals and outlet vent air temperatures) and the environment (area ambient temperatures, wind speed and direction, and radiation). Maintenance and support equipment for the site-specific cask subsystem includes debris removal equipment and platforms for checking site-specific cask ventilation ports and performing maintenance. The standby diesel generators provide standby power. Provisions are made at each aging pad to accommodate instrumentation to monitor the metal site-specific casks, concrete site-specific casks, and horizontal aging modules. Monitoring will enable operators to remotely read the pressure between the double O-ring seals placed between the outer lid and body of the metal site-specific casks to allow detection of a seal failure. Monitoring concrete site-specific casks or horizontal aging modules is provided to enable operators to read the temperature of the outlet cooling air. Figure B-16 shows a diagram of the monitoring system.

#### 4.1.1.2 Cask Transfer

Two types of transfers are being considered to transfer CSNF from TCRRF and the process handling facilities to and from the aging pads. They comprise a vertical system for site-specific casks in a vertical orientation and horizontal system for moving DPCs in transportation casks or transfer casks oriented horizontally. Both the vertical and horizontal cask transfer subsystems are depicted on a typical aging pad as shown on Figure B-4.

The horizontal transfer of CSNF will utilize a specially designed horizontal cask transfer trailer that is towed by a separate cask tractor. One concept for a horizontal cask transfer trailer has 32 wheels and is equipped with a ram that is used to push the horizontal DPC into the HAM. Figure B-5 illustrates this type of horizontal cask transfer trailer (Section 3.1.2.2.2). In addition to the horizontal cask transfer trailer, the repository will also require a site-specific transfer cask to retrieve DPCs from the HAMs when a suitable transportation cask is not available. This transfer cask is similar to the transportation casks that transport horizontal DPCs and will be specifically designed for retrieving DPCs from the HAMs when the DTF is ready to process the DPC and transfering SNF into a waste package.

Loaded vertical site-specific casks containing canistered waste or site-specific casks containing uncanistered waste are moved to and from the aging pad using a commercially designed and fabricated (to ITS standards) tracked or wheeled transporter shielded to minimize dose to the occupants and capable of lifting and moving the site-specific casks. The site-specific cask transporter consists of the vehicle main frame, hydraulic lifting towers, an overhead beam system that connects the lifting towers, a cask restraint system, the drive and control, and a series of cask lifting attachments that connect to the beam and permit attachment to be made to casks of different sizes and types. The site-specific casks are individually carried within the internal footprint of the vehicle between the tracks or wheels. The transporter is designed to lift a vertical site-specific cask and to lock it into position during transport. The lifting towers include a ratcheting device that prevents dropping the load more than a few inches in the event of a failure of the hydraulic lifting mechanism. The transporter is designed for operation in the full range of anticipated weather conditions at the repository. The transporter is grounded to mitigate the effects of a direct lightning strike.. A typical crawler type site-specific cask transporter is shown on Figure B-6 (Section 3.1.2.2.1).

All transfer systems will be designed to be stable, travel relatively slowly, and withstand inadvertent collisions (Section 3.1.1.1).

### 4.1.1.3 Aging Cask

As with the cask transfer equipment, two types of aging casks are being considered. The first is a site-specific cask placed in a vertical orientation on the aging pad. Aging of SNF in a vertical orientation takes place within all vertical metal (bolted) or metal/concrete casks. The metal/concrete site-specific casks are also referred to as overpacks, since they protect and provide shielding of canistered SNF.

The metal-bolted site-specific casks used to age uncanistered CSNF are thick-walled cylindrical vessels that provide shielding and physical protection against natural phenomena. These casks are sealed provide confinement for uncanistered SNF. The internal basket assembly of the cask maintains the SNF in a subcritical configuration for normal conditions, off-normal events, and credible event sequences. Heat from the SNF is conducted to the outside surface of the vertical metal cask to the atmosphere. The internal pressure of a metal cask is monitored.

Metal and concrete overpacks have features to enhance cooling and are used to age SNF that is contained within metal canisters. The canisters provide confinement for SNF and are completely closed and sealed. The configuration of the cask, internals, and SNF canister is designed to maintain the SNF in a subcritical condition for normal, off-normal, and credible event sequences. Concrete overpacks are equipped with air inlets and outlets at the tops and bottoms to permit passive removal of heat by natural convection. The inlet and outlet air temperature of these casks are monitored to alert operators of abnormal conditions in order to ensure safe heat removal.

The internal basket configuration and spacers of vertical overpacks will accommodate the dimensions and characteristics of commercial vertical DPCs now stored at reactor sites. The bounding parameters are summarized in Table 4-1.

Table 4-1. Bounding Parameters for Existing Vertical DPCs Containing CSNF

| Characteristic | Dimension/Value | Storage System Canister/Docket | Source |
|---|---|---|---|
| Smallest Diameter | 66.00” | Fuel-Solutions<br>W21 & W74 Series/71-9276, 72-1026 | [DIRS 170407], [DIRS 161778] |
| Largest Diameter | 70.64” | NAC-MPC<br>Yankee-MPC, CY-MPC/ 71-9235, 72-1025 | [DIRS 103045], [DIRS 171546] |
| Longest Length | 192.30” | Fuel-Solutions<br>W21 & W74 Series/71-9276, 72-1026 | [DIRS 170407], [DIRS 161778] |
| Shortest Length | 122.50” | NAC-MPC<br>Yankee-MPC/71-9235, 72-1025 | [DIRS 103045], [DIRS 171546] |
| Highest # of Assemblies | 68 BWR | HI-STORM<br>MPC-68/-68F/-68FF/71-9261, 72-1008 | [DIRS 172633], [DIRS 162875] |

Table 4-1. Bounding Parameters for Existing Vertical DPCs Containing CSNF (Continued)

| Characteristic | Dimension/Value | Storage System Canister/Docket | Source |
|---|---|---|---|
| Least # of Assemblies | 21 PWR | Fuel-Solutions<br>W21 Series, 71-9276, 72-1026 | [DIRS 170407],<br>[DIRS 161778] |
| Heaviest Loaded Weight | 89,765 lb | HI-STORM<br>MPC-32/-32F/71-9261, 72-1014 | [DIRS 172633],<br>[DIRS 168494] |
| Lowest Design Heat Load | 12.5 kW | NAC-MPC<br>Yankee-MPC/71-9235, 72-1025 | [DIRS 103045],<br>[DIRS 171546] |
| Highest Design Heat Load | 28.7 kW | HI-STORM<br>MPC-32/-32F/71-9261, 72-1014 | [DIRS 172633],<br>[DIRS 168494] |
| Highest Allowable Leak Rate | 8.52 × 10-6<br>CC/Sec | Fuel-Solutions<br>W21 & W74 Series/71-9276, 72-1026 | [DIRS 170407],<br>[DIRS 161778] |

The vertical site-specific casks will be arranged in an efficient manner to optimize retrieval. New site-specific casks will be received at the WNNRF for inspection and storage prior to being placed in service. Empty site-specific casks could also be transferred to the aging pads for storage prior to re-use if necessary. Vertical site-specific casks will be arranged on the aging pad by the cask transporter.

The second type of aging cask is a HAM or horizontal aging module, which is similar to the advanced horizontal storage module that has been approved by the NRC in use at nuclear power plants. The DPCs presently stored in horizontal orientation at nuclear power plants will arrive at the repository in an NRC approved transportation cask. Upon arrival at the repository, the DPCs that require aging before being sent to the DTF for processing will be transferred in their transportation casks to the aging pad using the horizontal cask transfer trailer and inserted into the HAMs. The HAMs are used solely for canistered fuel. The horizontal aging module is a box-like, thick-walled reinforced concrete structure with a removable access door in the front to permit horizontal loading of the DPC. Inside the module, the DPC rest on rails. The heavily reinforced concrete sidewalls and top provide shielding and protection against natural phenomena such as tornadoes, earthquakes, high winds, and ambient temperature extremes. The horizontal aging modules are configured with vents and flow paths to permit natural circulation airflow to transfer the heat from the DPC to the atmosphere. A typical HAM is depicted on Figure B-7.

Ventilation, in a similar manner as for the HAMs, the concrete overpacks are equipped with air inlets at the bottom and outlets at the top to permit passive removal of heat. The HAMs and the overpacks are equipped with temperature sensors. The ability to measure temperature conditions and alert operators ensures continued adequate passive cooling thermal performance.

The internal design configuration of the HAMs will accommodate the dimensions and characteristics of existing horizontal DPCs stored at reactor sites. Horizontal DPC bounding parameters are summarized in Table 4-2.

Table 4-2. Bounding Parameters for Existing Horizontal DPCs Containing CSNF

| Characteristic | Dimension/Value | Storage System Canister/Docket | Source |
|---|---|---|---|
| Smallest Diameter | 67.19” | Adv. NUHOMS<br>NUHOMS-24PT1/71-9255, 72-1029 | [DIRS 105288], [DIRS 168870] |
| Largest Diameter | 67.25” | Std. NUHOMS<br>NUHOMS-61BT/71-9302, 72-1004 | NUHOMS Dockets 71-9302, 72-1004 [DIRS 167076], [DIRS 157643] |
| Longest Length[a] | 199.67” | Std. NUHOMS<br>NUHOMS-61BT/71-9302, 72-1004 | [DIRS 167076], [DIRS 157643] |
| Shortest Length[a] | 186.5” | Adv. NUHOMS<br>NUHOMS-24PT1/71-9255, 72-1029 | [DIRS 105288], [DIRS 168870] |
| Highest # of Assemblies | 61 BWR | NUHOMS-61BT/71-9302, 72-1004 | [DIRS 167076], [DIRS 157643] |
| Least # of Assemblies | 13 PWR | NUHOMS-FF/71-9255, 72-1029 | [DIRS 105288], [DIRS 168870] |
| Heaviest Loaded Weight | 88,390 lb | Std. NUHOMS<br>NUHOMS-61BT/71-9302, 72-1004 | [DIRS 167076], [DIRS 157643] |
| Lowest Design Heat Load | 14.0 kW | Adv. NUHOMS<br>NUHOMS-24PT1/71-9255, 72-1029 | [DIRS 105288], [DIRS 168870] |
| Highest Design Heat Load | 15.86 kW | Std. NUHOMS<br>NUHOMS-61BT/71-9302, 72-1004 | [DIRS 167076], [DIRS 157643] |
| Allowable Leak Rate | $1.0 \times 10^{-7}$<br>CC/Sec | Std. NUHOMS<br>NUHOMS-61BT/71-9302, 72-1004<br>and<br>Adv. NUHOMS<br>NUHOMS-24PT1/71-9255, 72-1029 | [DIRS 167076], [DIRS 157643]<br>and<br>[DIRS 105288], [DIRS 168870] |

NOTES: [a] Includes Bottom Grapple Ring

Only the NUHOMS-24PT1 and NUHOMS-61BT are currently licensed for both transport and storage.

These two types of aging casks satisfy the requirement for aging SNF (Section 3.1.2.3.1). The quantities of materials to be aged are accommodated by the procurement of these casks in a sufficient quantity (Section 3.1.2.3.2).

### 4.1.2 Boundaries and Interfaces

This section addresses the interface requirements for the cask transfer subsystem and process handling areas (Section 3.1.3.2.1) and the aging cask subsystem interface with the DTF, CHF, FHF, and TCRRF (Section 3.1.3.3.1).

System boundaries and interfaces have been developed. The surface aging system interface relationship chart (Figure B-1) illustrates the current interfaces with other facilities (DTF, CHF, FHF, and TCRRF).

Transportation casks are received by the TCRRF and forwarded to the handling facilities for processing. In the first phase of operation the FHF will directly receive every thing it needs to function including transportation casks. The current plan for moving loaded site-specific casks to an interface point outside the FHF building involves utilizing a large gantry crane. This 200-ton crane will have the capability to move a site-specific cask in the vertical position from the vestibule to a designated location outdoors in front of the building. At that point the site-specific cask transporter or crawler can pick up the site-specific cask and move it to an aging pad. Metal site-specific casks that contain aged CSNF fuel assemblies that are scheduled for processing can be returned to the FHF or to the DTF by the site-specific cask transporter.

Whenever a transportation cask is received by the TCRRF that contains a horizontal DPC that requires aging, the transportation cask will be removed from its rail car and placed on the horizontal transfer trailer as shown on Figure B-5. DPCs in these casks will be taken to the aging pad and inserted into a HAM where they will be aged until they are scheduled for processing by the DTF. After this aging period, a transportation cask or the site-specific transfer cask mounted on the horizontal transfer trailer will be used to transfer the DPC directly to the DTF or alternately to the TCRRF, and transferred to a site rail transfer cart (SRTC) and moved to the DTF for processing and waste package loading.

The interface with the CHF involves the receipt of an overpack loaded with a vertical DPC that is carried to a designated location outside the building on an SRTC to an awaiting site-specific cask transporter crawler. The crawler straddles the SRTC, engages the overpack's lifting fixture, and lifts the overpack a few inches off the bed of the SRTC. The SRTC is moved out from under the overpack so the crawler can lower the overpack to a position 6 to 12 inches off the ground and takes it to the aging pad. After aging, overpacks with vertical DPC are returned to the DTF for processing. If disposable YMP canisters are aged, they can be retrieved and taken to the CHF and transfered to a waste package for emplacement.

The site-specific cask transporter crawler interface with the DTF is the same as described for the CHF. After site-specific casks have been loaded in the DTF, they will be placed on an SRTC and moved outside the DTF to a designed area where the site-specific cask crawler can retrieve the cask. The site-specific cask crawler/transporter would then take the site-specific cask to an aging pad. Alternatively the crawler could enter the DTF building through the vestibule to an area under the 200-ton cask crane, retrieve the site-specific cask, and take it to an aging pad. After the CSNF has been aged, the process of returning site-specific casks is just reversed.

### 4.1.3 Physical Layout and Location

The aging layout plan and potential surface aging locations (Figures B-2, B-3, and B-4) provide the locations and layout of the aging facilities. The figures include five aging locations identified as Areas 17A through 17E, and four contingency areas identified as 17F through 17J.

### 4.1.4 Principles of Operation

The primary purpose of the aging system is to provide a system wherein relatively hot CSNF contained in site-specific casks can be aged to support operations prior to waste package loading and underground emplacement. Equipment and operations involved in the process is similar to those at commercial reactor utilities sites for dry storage. See Section 4.2 for operation details.

### 4.1.5 System Reliability Features

The reliability of SNF aging subsystems, such as the vertical and horizontal transfer equipment, cask seals, and monitoring transducers, will be addressed in separate documents. The reliability of the miscellaneous SSCs, that is part of the overall SNF aging system, will be addressed during detailed design, testing, procurement, and startup operations.

### 4.1.6 System Control Features

The SNF aging system will be monitored to provide assurance that conditions at the aging pads are as expected. Most of the aging system SSCs will be controlled through manual means. Humans will operate the cask transfer subsystem, and other equipment involved in transferring CSNF to the aging pads. Programs for the automatic monitoring systems for the aging system will be developed during detailed design. The following items are currently envisioned as part of monitoring the aging system:

- Temperature monitoring of the outlet air of HAMs and ventilated site-specific casks
- Interspace overpressure monitoring of bolted metal site-specific casks
- Video monitoring of the aging pads
- Radiation monitoring at the aging pads.

The SNF aging system will utilize data from the DCMIS and other systems such as the seismic monitoring data from the environmental and meteorological monitoring system. Significant seismic events will trigger a need to inspect the aging pads for damage. Additional details regarding the monitoring needs will be developed as part of design development.

## 4.2 OPERATIONS

Operation of the SNF aging system will be coordinated by repository operations and will involve planning and operational support from the transportation organization, handling facilities (DTF, which includes remediation, CHF, FHF, and TCRRF), and site-specific cask receipt and inspection program in the WNNRF. The operation of the aging system involves preparation of site-specific casks for loading, transferring waste into the site-specific casks, and moving site-specific casks to the aging pad. Site-specific casks used by the aging system will be loaded in accordance with a cask-specific loading plan.

Each assembly or canister placed in the site-specific cask will be recorded in plant records to ensure that accurate retrieval of CSNF after aging and placement in a waste package can be performed and that traceability of waste is maintained. Procedures governing these steps will be developed and approved prior to waste receipt. Validation of these procedures will occur as part of the testing and startup program.

Processing DPCs requires opening the DPCs and transferring the SNF contents to a waste package. To accomplish this, the opened DPC will be docked with the transfer cell in the DTF, and the fuel assemblies will be moved one at a time into the waste package. In the initial years of repository operation, the DTF will be under construction. DPCs received prior to the DTF being available will have to be sent to the aging pad after they are placed in site-specific casks. The aging of these DPCs will continue until the DTF becomes available to process the DPC or in the rare case of a high heat content DPC being received, the waste has radiologically decayed to a point where the thermal nature of the assemblies permits emplacement. Following a period of time, these DPCs would be brought to the DTF and opened for processing. An overview of the process for DPCs from receipt; placement into a site-specific cask, if required; moving it to the aging pad for a period of time; and returning DPCs to DTF for cutting and loading the CSNF to waste packages for emplacement is summarized in Figure B-17. Steps that occur in the DTF are shown in dotted lines.

Procurement of SSCs for the aging system will include requiring the vendors to provide vendor data and suggested maintenance and operating procedures or recommendations. Where similar operations are performed at the commercial utilities or DOE installations, an effort to utilize the information developed in these applications will be undertaken in order to take advantage of lessons learned.

Procedures for transferring site-specific casks to and from the aging pad will be developed prior to use of the system. These procedures, like the procedures defined in the handling facility descriptions, will be prepared by the operations and start-up organizations and validated during the testing and startup phase of the project.

**Thermal Management**

Initial studies have been completed and preliminary results indicate that an aging system with a capacity of up to 21,000 MTHM will be sufficient. This capacity will be confirmed during detailed design. Thermal management is discussed in the *Geologic Repository Operations Area Waste Stream Handling Process and Facilities Study* (BSC 2003 [DIRS 166015], Section 2.5). There are a number of variables to consider in thermal management. The variables include the average age of the fuel, average burnup, and initial enrichment percent of the SNF. These data will be provided to the DOE 60 days prior to shipment (10 CFR 961.11, Article IV [DIRS 171309]). At that time, the repository operator will be able to decide if the SNF is to be transferred to the aging system.

### 4.2.1 Initial Configuration (Prestartup)

Prestartup activities will be commensurate with the safety category safety classification. The pads and roads will be constructed to specifications developed during detailed design. The storage locations will be constructed, inspected, and verified per specifications and procedures. During initial startup, the 1,000 MTHM aging pad will have empty HAMS in place and locations for an anchoring system, if required, prepared for the vertical site-specific casks.

### 4.2.2 System Startup

System startup procedures commensurate with the safety category classification of the SNF aging system will be developed during detailed design, procurement, testing, and initial startup. For example, procedures will be developed for normal operations and startup actions for the cask transfer subsystem. Normal procedures and operations may be verified using non-nuclear mockups to ensure aging systems function as intended and to help ensure smooth operations when nuclear materials are handled.

### 4.2.3 Normal Operations

The primary purpose of the aging system is to provide an interim location at the repository for SNF that is not ready to be emplaced underground. Operations of the aging system will involve transfer concepts of either horizontal or vertical movement of SNF. Operations for moving casks in vertical and horizontal orientations are similar to those performed at commercial nuclear power plants. Mechanical flow diagrams (Figures B-12, B-13, and B-14) outline the transfer process.

#### 4.2.3.1 Horizontal Transfer

Transportation casks will be received at the TCRRF. Some transportation casks may contain CSNF in horizontal DPCs that could be transported directly to the aging pads since the DPCs will be compatible with the HAMs. These casks are moved from rail cars to the horizontal cask transfer trailers (Figure B-5). The transportation casks are towed to the aging pads (no impact limiters are used during transfer) by the cask tractors (Figure B-4). The cask lid bolts and lid are removed at the pad with the aid of a mobile crane and the cask is aligned to the HAM using a hydraulic suspension and adjustable trailer bearing plates. The shielded HAM access door is removed and the cask is docked to the HAM using cask-docking collars that provide shielding. The operational steps for the transfer and insertion of DPCs into the HAMs are illustrated in Figure B-12.

Additional equipment is needed to facilitate DPC transfer to the horizontal aging modules. This includes a hydraulic ram system that inserts through a portal in the end of the transportation cask and pushes the loaded DPC into the horizontal aging module. Outriggers and jacks are used to stabilize the cask and trailer during transfer of the DPC to the HAM. A hydraulic ram and hydraulic power unit are set up behind the cask and aligned to engage the hydraulic ram to the DPC ram grapple rings. The hydraulic ram cylinder is actuated to insert the DPC into the HAM. The transfer is facilitated using rails inside the HAM. The empty cask and trailer are removed in a reverse manner and the HAM shielded access door is replaced. The empty transportation cask and the horizontal cask transfer trailer are returned to the TCRRF where the cask is unloaded from the cask transfer trailer, placed on a railcar and configured for return to the National Transportation System.

When the aging is complete, the process is reversed, using the site-specific transfer cask and horizontal transfer trailer. The site-specific transfer cask is similar in construction to the transportation cask. The horizontal transfer trailer moves the loaded cask back to the TCRRF. The process of retrieving a DPC from a HAM and withdrawing it into the site-specific transfer cask is shown in Figure B-13. The closure lids on the cask and HAM are secured and the aged DPC may be taken directly to the DTF or indirectly via the cask receipt and return system. For the case that the cask receipt and return system receives the transfer cask, it off loads the cask to a site rail transfer cart, configures the cask for transfer with impact limiters, and transfers the cask to the DTF for CSNF transfer to a waste package for emplacement in the repository.

#### 4.2.3.2 Site-Specific Cask Preparation and Loading

Prior to moving the site-specific cask from the handling facilities to the aging pads, the site-specific casks will undergo a series of events. Empty metal site-specific casks are received at the Warehouse and Non-Nuclear Receipt Facility (WNNRF), where they are inspected and staged until needed for loading at one of the handling facilities. When needed, a vertical site-specific cask is delivered to a handling facility for loading. Metal site-specific casks are taken to the CHF or DTF by an SRTC or to the FHF by railcar. If concrete overpacks are used they will be most likely stored vertically on a pad away from the WNNRF. As with the site-specific casks, overpacks will have a numbered metal plaque or other means of unique identification. Site-specific casks may also be stored at the aging pads. Separate procedures and handling processes will be in effect for site-specific casks that are reused versus site-specific casks that are brand new. Unloaded site-specific casks that once contained CSNF will not be retuned to or stored at the WNNRF.

When CHF or DTF requires a site-specific cask a site rail transfer cart will deliver an empty site-specific cask to a process handling facility for SNF transfer operations. If the site-specific cask once held SNF and was being stored at an aging pad, or is a concrete overpack it will be delivered directly by the site-specific cask crawler type transporter. DPCs that require aging are transferred to site-specific casks in the FHF, CHF, and DTF. Uncanistered CSNF is transferred to and from site-specific casks only in the DTF or FHF. At the handling facilities, vertical DPCs containing CSNF are loaded into vertical site-specific casks. Site-specific casks containing canistered SNF do not require seal monitoring or cavity inerting because the sealed DPC provides the confinement function and the DPC has been previously inerted. The loaded site-specific casks are then ready for movement to the aging pad

The transfer operations in the FHF or DTF transfer cells load assemblies into site-specific casks in a predetermined configuration that considers fuel age, enrichment percent, burn-up, and other variables. Procedures will be developed to control all steps surrounding the loading of site-specific casks. Records will be kept that detail the exact contents of each site-specific cask. Serial numbers will be recorded and checklists developed to ensure that the site-specific cask complies with the applicable technical specifications. After the site-specific casks are loaded, they will be closed and sealed, inerted, and pressure tested. Acceptance criteria and process steps for site-specific cask handling will be developed during detailed design. Once the site-specific cask has met the criteria for movement to the aging pad, it will be moved to a position that will enable the site-specific cask transporter crawler to transfer the cask.

Site-specific casks used on the YMP will most likely be developed or based on existing designs that are currently available from qualified vendors. Once the selected system is chosen, the principal task will be to qualify the casks for use at Yucca Mountain and the conditions experienced at the repository. Due to the desert climate and seismic issues, additional analyses will be conducted to qualify the selected system for repository use. Operating procedures and process steps will be developed, approved, and implemented, which are commensurate with the conditions at the repository.

#### 4.2.3.3 Site-Specific Cask Transfer

Transfer operations for the site-specific casks will occur between the DTF, CHF, and FHF and the aging pads using the site-specific cask transporter or crawler. Loaded site-specific casks are moved from the handling facilities to the aging pads using a site-specific cask transporter. After the vertical transporter has engaged and lifted the site-specific cask, the unit is moved to the aging pad. At the aging pad, the site-specific cask is lowered into place, the lifting mechanism is disengaged, and the site-specific cask transporter is moved away. When aging is complete, the process is reversed and the site-specific cask is moved from the aging pad to a handling facility using the site-specific cask transporter. The site-specific cask crawler is design to be stable to ensure that an upset will not occur during normal or off normal events. Its speed will be limited, and grades to the aging pads will be designed to ensure safe operations (Sections 3.1.1.1 and 3.1.2.2.3).

The interface with the site-specific cask and site-specific cask transporter for each of the processing facilities is described in the following paragraphs:

At the CHF, when applicable, a canister that is too hot to be loaded into a waste package will be loaded into a site-specific aging cask and brought outside the building to a transfer area on an SRTC to a waiting site-specific cask transporter. The site-specific cask transporter approaches and straddles the SRTC and engages the site-specific cask lifting trunnions or other lifting fixture and lifts it a few inches off the bed on the SRTC. The SRTC is moved out from under the aging cask and the transporter lowers the cask so that the bottom of the cask clears the ground and roadbeds by 6 to 8 in. The cask is then secured to the transporter to prevent it from swinging when the transporter is put in motion. The site-specific cask is then carried by the transporter to the aging pad at a speed of approximately 0.5 miles per hour.

At the DTF, the loaded aging cask can interface with an SRTC in the same manner as described above for the CHF. In the current design and operation plan, the transporter enters the DTF at grade and travels through the building vestibule to the cask and site-specific cask SRTC receipt area (Room 1077) to receive an aging cask under the reach of its 200-ton overhead crane. The crane is moved away from the cask and the transporter is moved forward to straddle the aging cask and to engage its lift trunnions or lift fixture. The transporter lifts the cask so that the bottom of the cask clears the floor by 6 to 8 in. and the cask is secured to the transporter to prevent it from swinging when the transporter is in motion. The transporter then carries the site-specific cask to the aging pad.

At the FHF, a loaded aging cask is brought outside the building vestibule on its 200-ton gantry crane and placed on a concrete pad in designated transfer area near a waiting site-specific cask transporter. The crane is moved away from the cask and the transporter is moved forward to engage, lift, and secure the cask and take it to the aging pad as described in the above paragraph.

### 4.2.4 Off-Normal Operations

Off-normal events range from the failure of a component of a subsystem (e.g., a flat tire on a horizontal cask transfer trailer) to events such as fire, explosion, or major earthquake. The subsystems of the SNF aging system will be analyzed for off-normal responses. Additional details will be provided when operating procedures (which will include off-normal actions) are developed for the aging pad subsystem, the transfer subsystem, and the cask subsystem.

Prior to the completion of the remediation system in the DTF, the aging pads area could be used to temporarily stage a transportation cask that failed an internal gas sample. If a transportation cask arrives at the repository and gas sampling indicates that an internal canister or spent fuel assembly is breached, the cask could be staged at the pads until the remediation system has been completed. This off-normal operation is unlikely and is only needed during the early years of repository operation prior to completion of the remediation area inside the DTF.

### 4.2.5 System Shutdown

At this stage of the design, there is no particular sequence of events or special procedure foreseen to shutdown the SNF aging system. Transfer equipment will have its own shutdown procedures.

### 4.2.6 Safety Management Programs and Administrative Controls

The safety management program in place is the integrated safety management system.

## 4.3 TESTING AND MAINTENANCE

### 4.3.1 Temporary Configurations

Separate testing and maintenance programs and temporary configurations will be developed for the SNF aging system.

### 4.3.2 Safety-Required Surveillances

Required surveillances will be based on the final system configuration and its contribution to preclosure and postclosure performance objectives. A review of these objectives will establish the set of necessary surveillances, inspections, and testing, but currently no programs have been identified. Requirements and necessary programs will be determined as the design process matures and the relationship of the SNF aging system SSCs with repository systems and facilities is defined.

### 4.3.3 Non-Safety Inspections and Testing

Procedures will be developed to define, describe, and implement non-technical safety surveillances, inspections, and testing requirements. The procedures will be based on manufacturers' recommendations and final system configuration, which will be developed after requirements have been established.

### 4.3.4 Maintenance

Aging system SSCs will be designed for ease of maintenance with a service life of 50 years. Aging system SSCs to be maintained include pressure and temperature monitoring systems for the aging casks, lighting systems and radiation monitoring at the aging pads, cask transfer equipment, site-specific cask surfaces, access roads, pad surfaces, and site-specific cask hold-down devices. The maintenance program for the SNF aging system will include the development of preventive maintenance and post-maintenance testing processes, and any post-modification testing programs. The design process needs to progress further in order to identify maintenance requirements and a maintenance program for SNF aging SSCs. Post-maintenance testing and post-modification testing programs will be developed to ensure that systems can be reliably returned to use following maintenance activities. The maintenance program for the SNF aging system will be developed as part of the repository maintenance program.

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## 5.3 DATA TRACKING NUMBERS

No data tracking numbers were issued with this document.

## 5.4 SOFTWARE CODES

No software codes were developed with this document.

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# APPENDIX A
# GLOSSARY

**Aging Cask** A generic term for a component or combination of components that confine commercial SNF and provide a heat transfer path, criticality control, radioactive shielding, and environmental protection under normal, off-normal, and accident conditions of aging. This includes:

- A cask, with integral shielding and an internal basket assembly, containing uncanistered commercial SNF.
- A dual-purpose canister (DPC) or disposable canister in a metal or concrete overpack.
- A DPC in a Horizontal Aging Module.

**Basket Assembly** The internal support and assembly positioning structure placed within a cask or canister cavity that provides a heat transfer path and criticality control under normal, off-normal, and accident conditions of storage and/or transportation and/or aging.

**Beyond Category 2 Events** Event sequences that have less than one chance in 10,000 of occurring are considered Beyond Category 2 events.

**Canister** A relatively thin walled metal vessel, with an internal basket assembly, designed to confine individual commercial SNF assemblies and provide a heat transfer path and criticality control under normal, off-normal, and accident conditions of storage, transportation and/or aging.

**Category 1 Event Sequences** Event sequences that are "expected to occur one or more times before permanent closure of the geologic repository operations area."

**Category 2 Event Sequences** Other event sequences that have at least one chance in 10,000 of occurring before permanent closure of the repository.

**Dual-Purpose Canister** A canister, loaded with commercial SNF at a utility, which is used for storage and transportation.

**Function** A statement of the purpose of a system or component.

| | |
|---|---|
| **Handling Cask** | A cask, without an internal basket assembly, designed to be used with a disposable canister and provide a heat transfer path, handling, shielding and environmental protection under normal, off-normal, and accident conditions within the FHF and DTF during canister loading operations. |
| **Horizontal Aging Module** | A concrete structure designed to contain a DPC in a horizontal orientation and provide a heat transfer path, radioactive shielding, and environmental protection under normal, off-normal, and accident conditions of storage and/or aging. |
| **Horizontal Cask Transfer Trailer** | A transfer trailer specifically designed to move the shielded transfer cask or transportation cask containing a horizontal DPC between the aging pads and the TCRRF or take an aged DPC directly to the DTF. |
| **Multi-purpose Canister** | A metal canister with an internal basket assembly containing CSNF or other forms of HLW (e.g., HLW immobilized in vitrified-glass or spent fuel assemblies) that meets all applicable regulatory requirements for handling, storage, transportation, and disposal in the geologic repository. Currently, no multi-purpose canisters have been licensed by the NRC for CSNF. |
| **Off-Normal** | A term used to define an occurrence of an event or condition outside the bounds of routine operations, but within the range of analyzed events and conditions for SSCs. |
| **Overpack** | A relatively thick walled metal or concrete vessel designed to enclose canistered commercial SNF in a vertical orientation and provide a heat transfer path, radioactive shielding, and environmental protection under normal, off-normal, and accident conditions of storage and/or aging. |
| **Performance Acceptance Criteria** | Statements that provide verifiable measures of how well the design specification has been achieved or limits against which the actual performance capability of the as-built system can be evaluated. Performance requirements show how well functional requirements must be performed and allow for verification. |

**Requirement** A specification of what the design solution must do. Requirement statements should also include a statement of how well the specification is to be achieved so as to permit verification. In some cases, there are several criteria for measuring the success of the achievement of the specification, and these would be listed as performance acceptance criteria.

**Site-Specific Cask** A radiation shielded vertical site-specific transfer and aging cask (metal or metal/concrete) to accommodate two configurations of SNF: (1) a site-specific vertical metal cask with an internal basket assembly containing CSNF assemblies that are received uncanistered, and (2) metal or concrete shielded cask containing CSNF in certified, vertical DPCs or certified, vertical disposable canisters. The site-specific cask will be licensed with the NRC per 10 CFR Part 63 [DIRS 173164].

**Site-Specific Cask Transporter**

**(Crawler Type)** A track type transporter designed to move a cask or combination of canister and overpack between the aging pads and DTF, CHF, or FHF. Note: A wheeled site-specific cask transporter is also an option.

**Transfer Cask** A cask, without an internal basket assembly, designed to be used with a Horizontal Cask Transfer Trailer and provides a heat transfer path, handling, shielding and environmental protection under normal, off-normal, and accident conditions for on-site transfer of a horizontal DPC between the TCRRF, aging pads, FHF and DTF.

**Transportation Cask** A cask, with impact limiters and personnel barriers, used for transporting SNF and HLW on the nation's highways and railroads.

- It is used, without an internal basket assembly, to transport dual-purpose canisters and provide a heat transfer path, handling, shielding, and environmental protection under normal, off-normal, and accident conditions during transport.
- It is used, with an internal basket assembly, to confine and transport uncanistered SNF and provide a heat transfer path, criticality control, radioactive shielding, and environmental protection under normal, off-normal, and accident conditions during transport.

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# APPENDIX B
# KEY SYSTEM CHARTS, DIAGRAMS, DRAWINGS, AND LISTS

## Appendix B Figures



NOTE: Additional items will be added in revisions of this SDD, as applicable

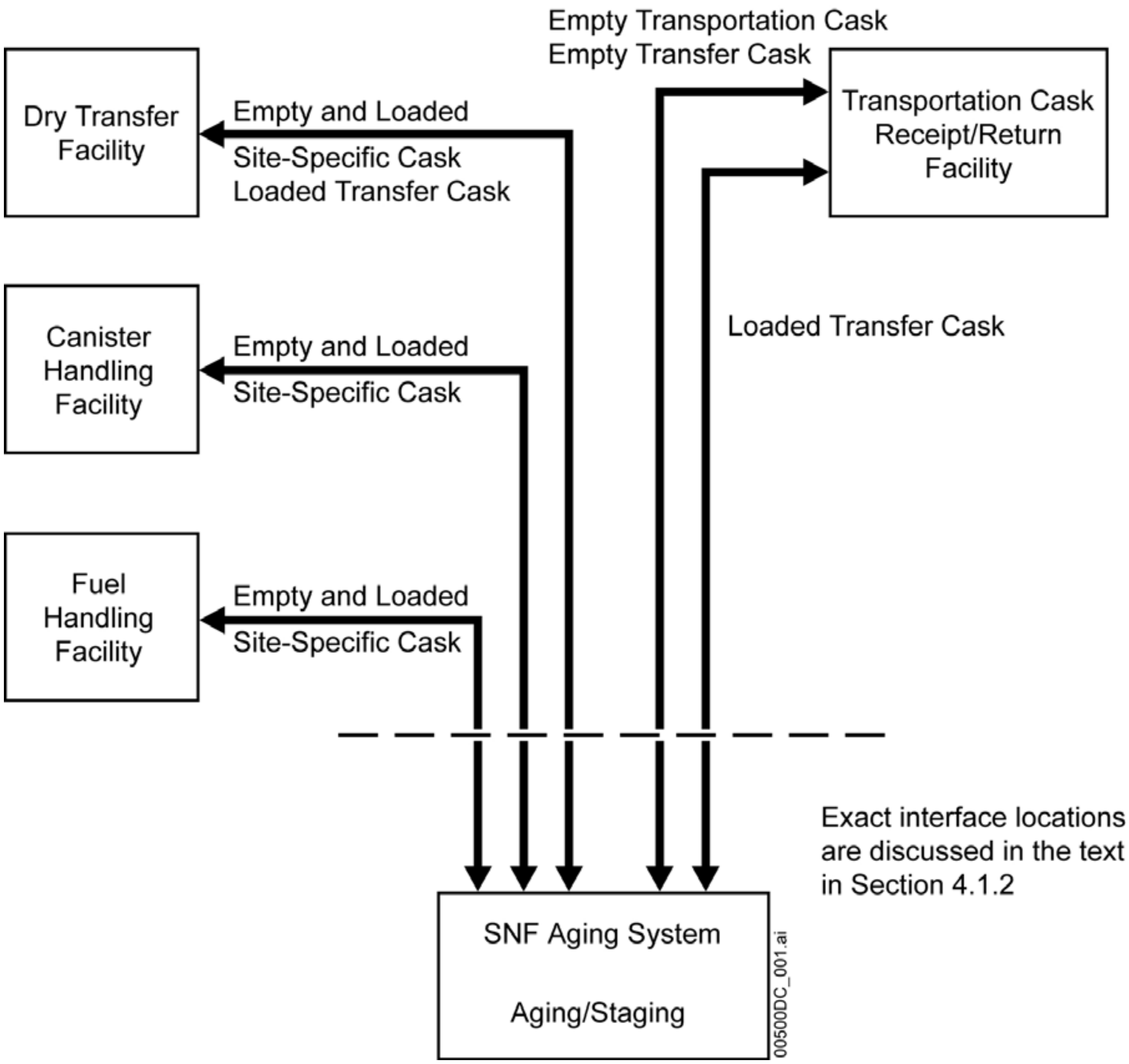


Figure B-1. SNF Aging System Interface Relationship Chart

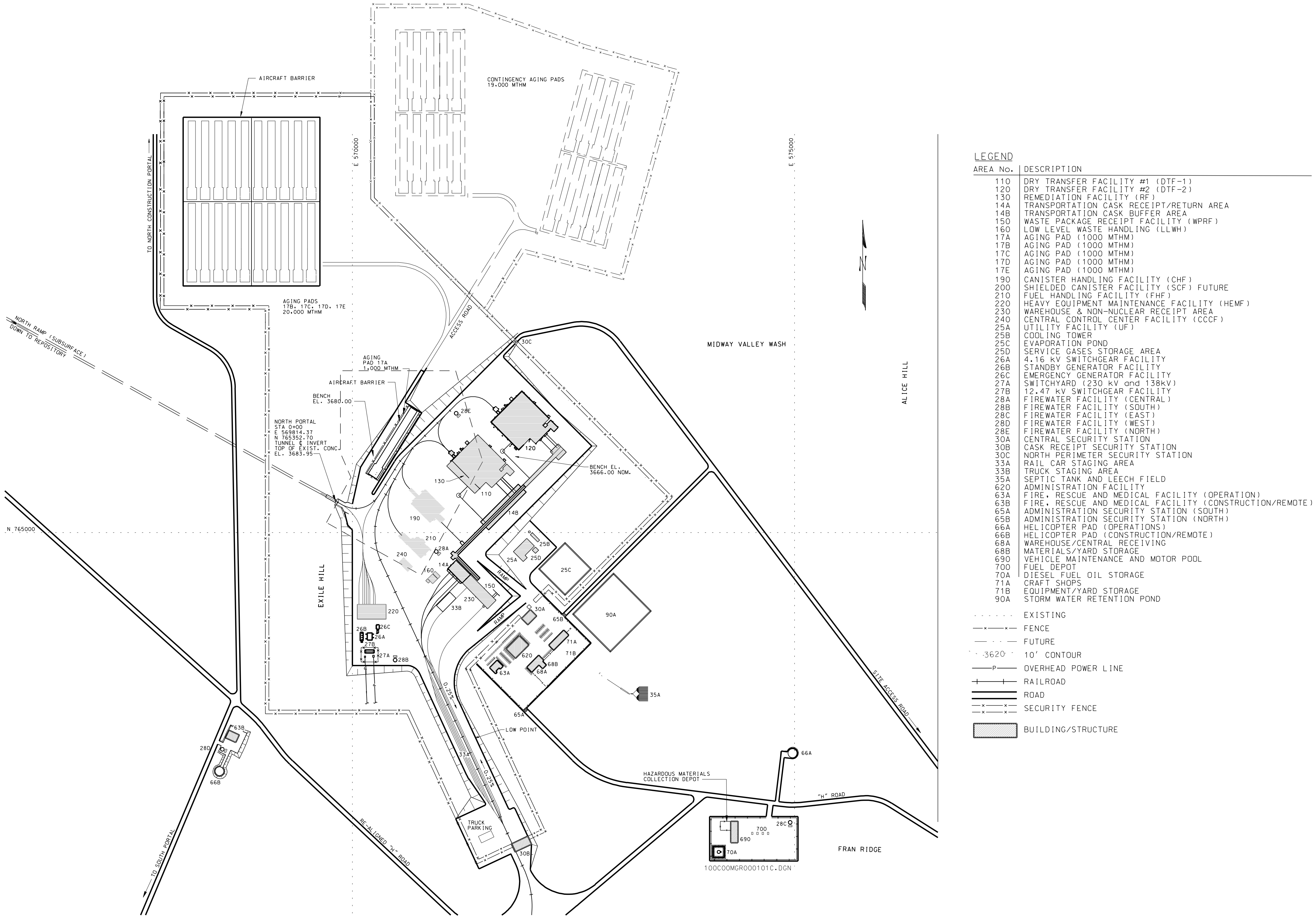


Figure B-2. Aging Pad Location and Layout

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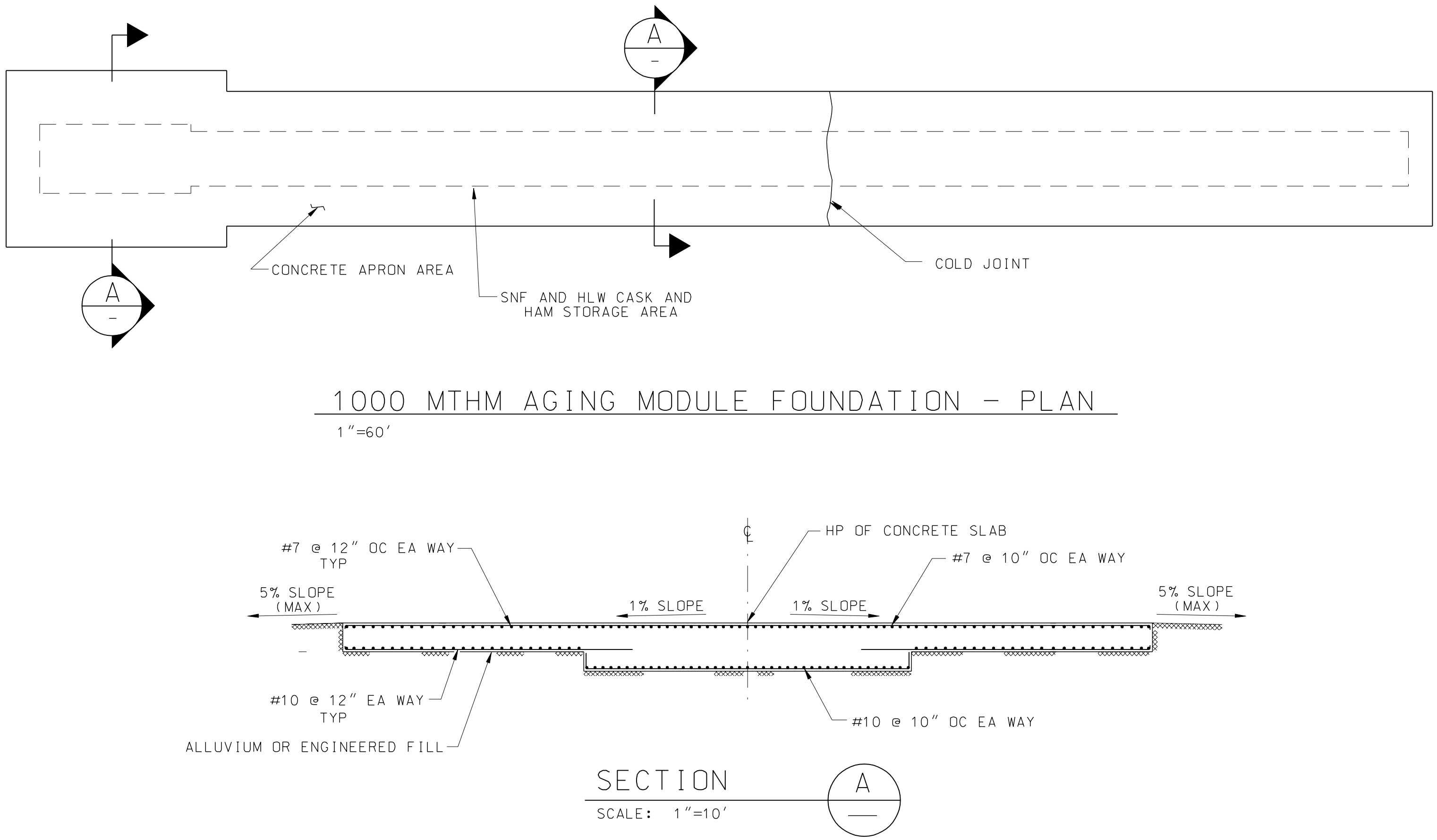


NOTE: Dimensions shown are nominal.

Figure B-3. 1,000 MTHM Aging Pad

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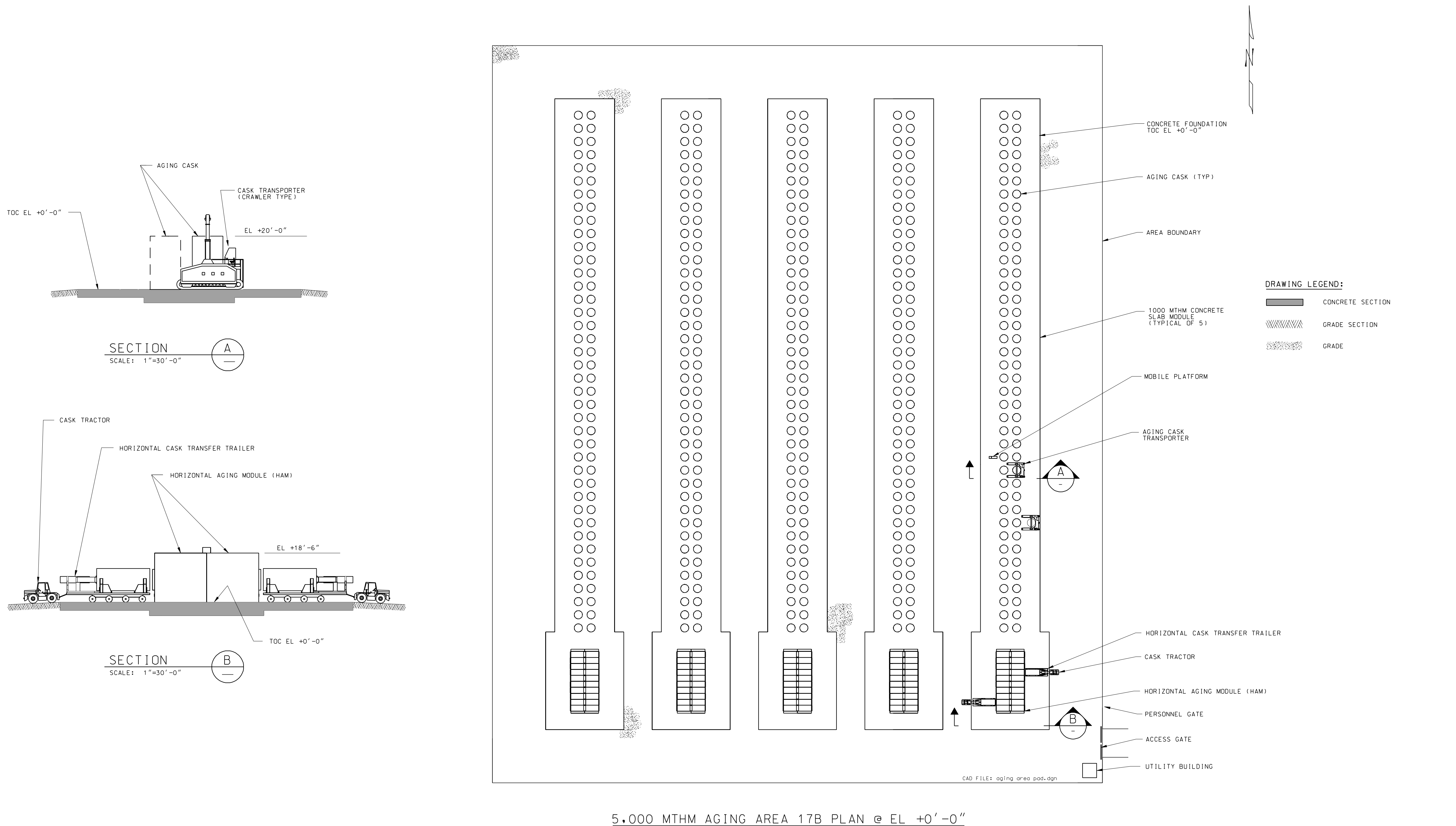


Source: Derived from BSC 2004 [DIRS 169152]

Figure B-4. Typical 5000 MTHM Aging Area Pad

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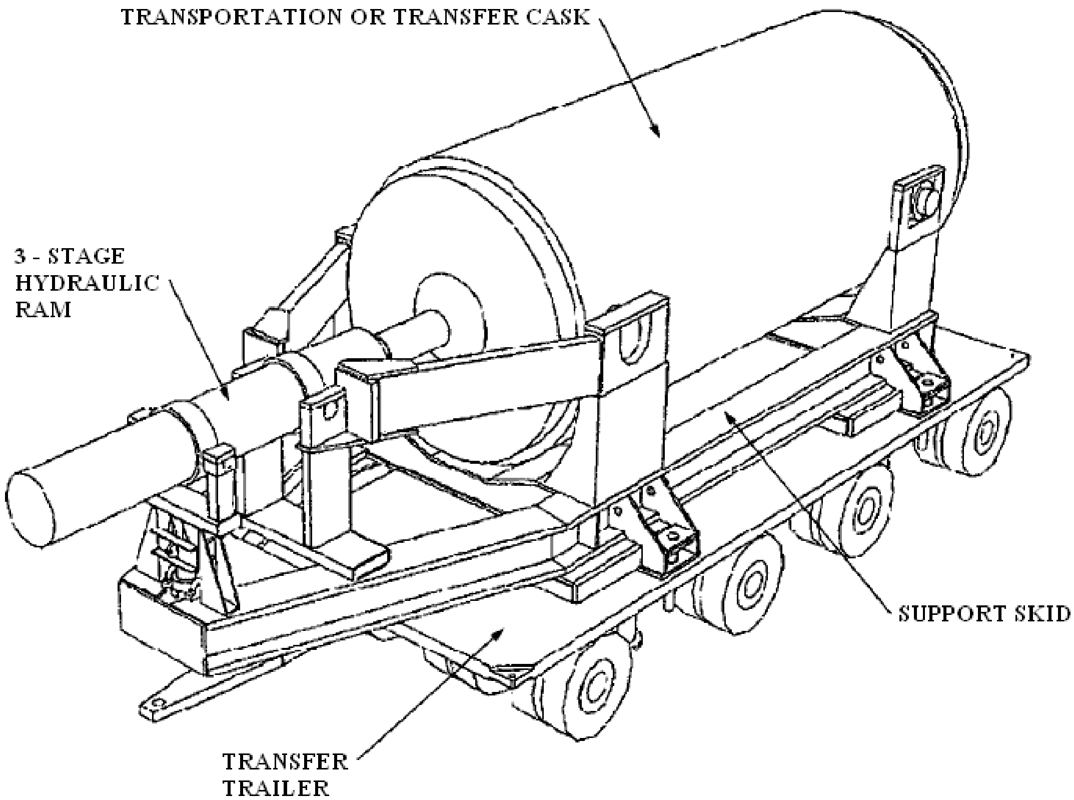
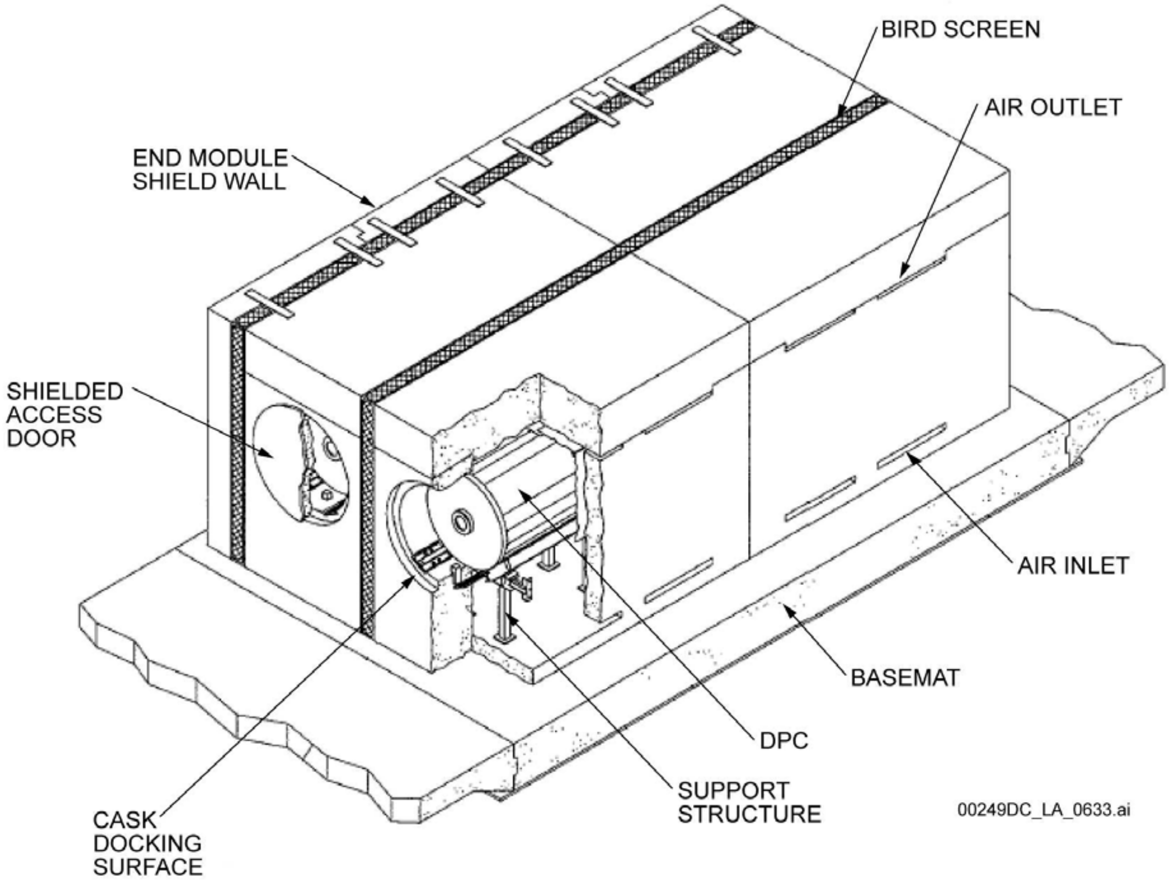



Source: Chopra 2002 [DIRS 162138]

Figure B-5. Horizontal Cask Transfer Trailer

00249DC_LA_0634a.ai

Figure B-6. Site-Specific Cask Transporter

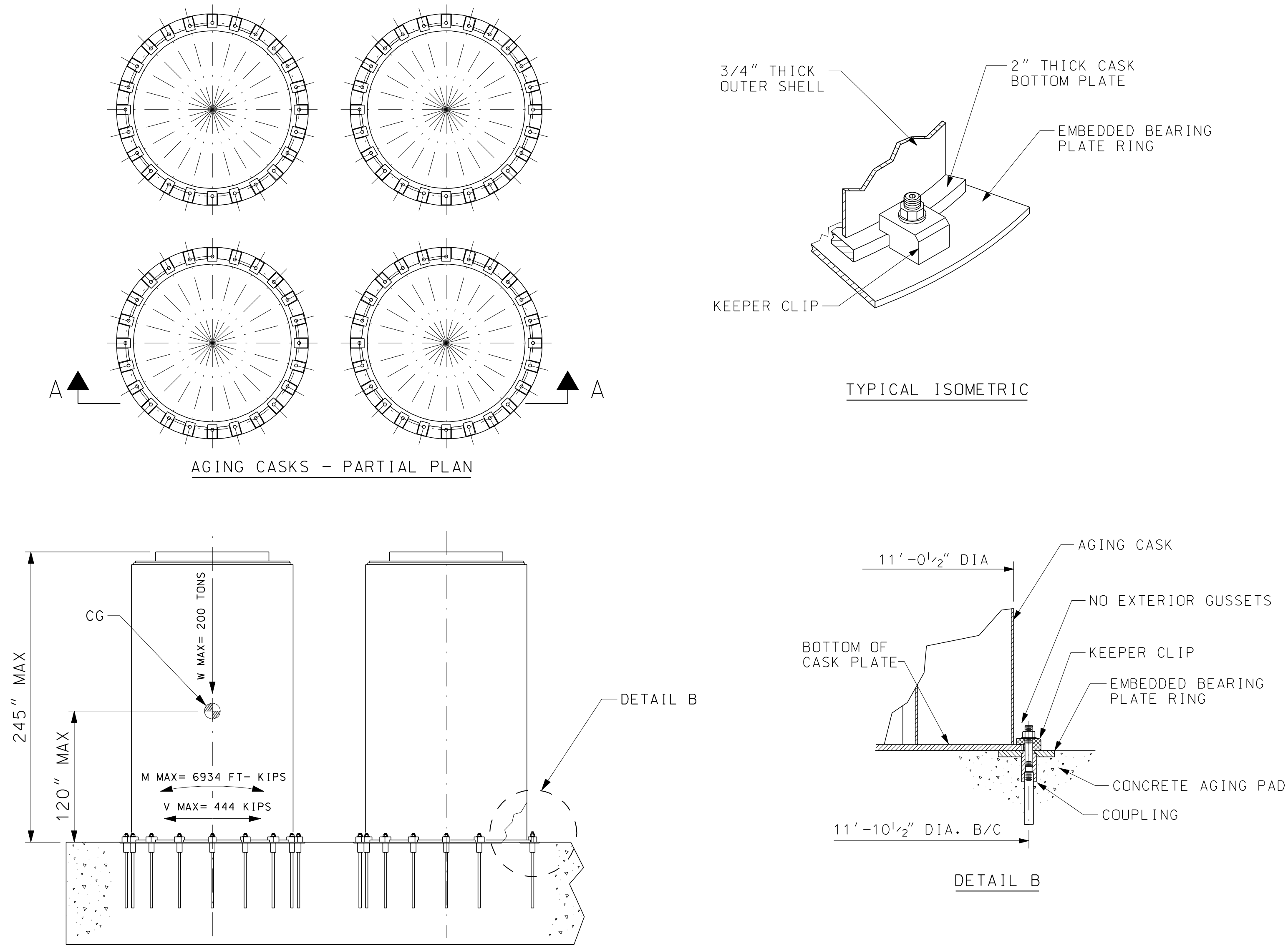



Source: Chopra 2002 [DIRS 162138]

Figure B-7. Horizontal Aging Module Configuration

Figure B-8. Typical Concrete Site-Specific Cask for CSNF in Canisters


Figure B-9. Typical Metal Cask for Uncanistered CSNF




NOTE: Dimensions shown are nominal

Figure B-10. Typical Site-Specific Cask Anchoring System

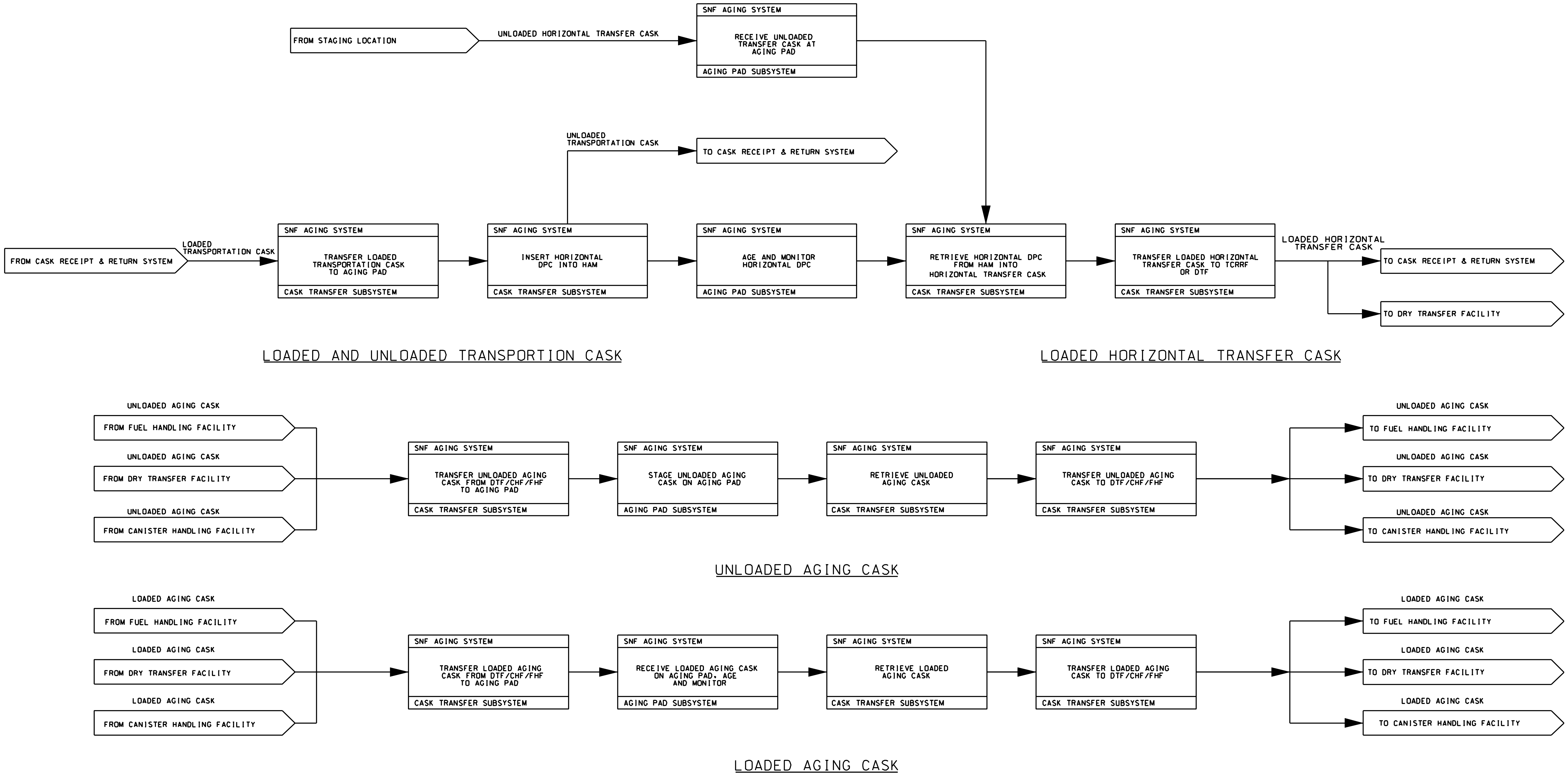



Figure B-11. Block Flow Diagram SNF Aging

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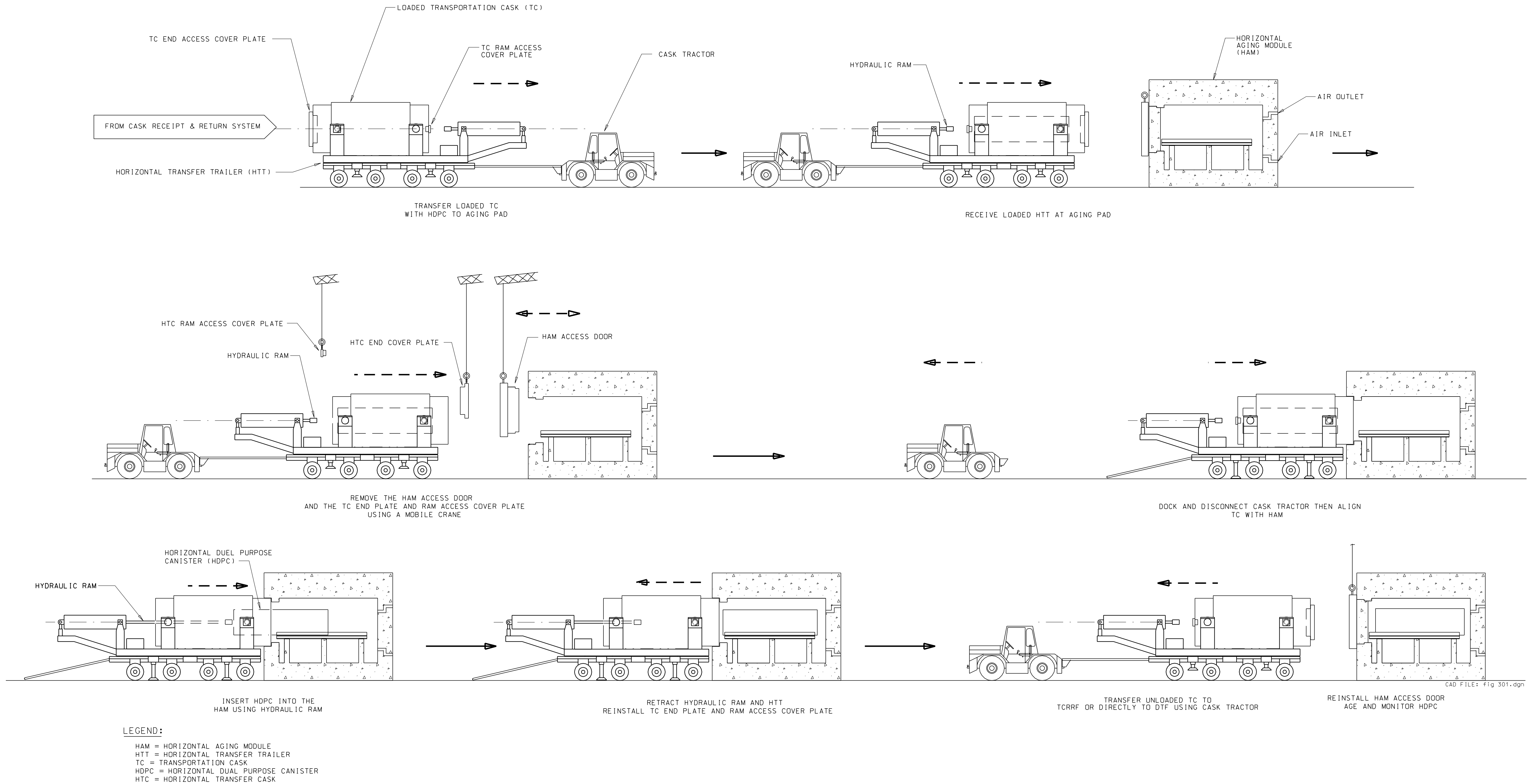


Figure B-12. Mechanical Flow Diagram-
Horizontal Transfer, Sheet 1

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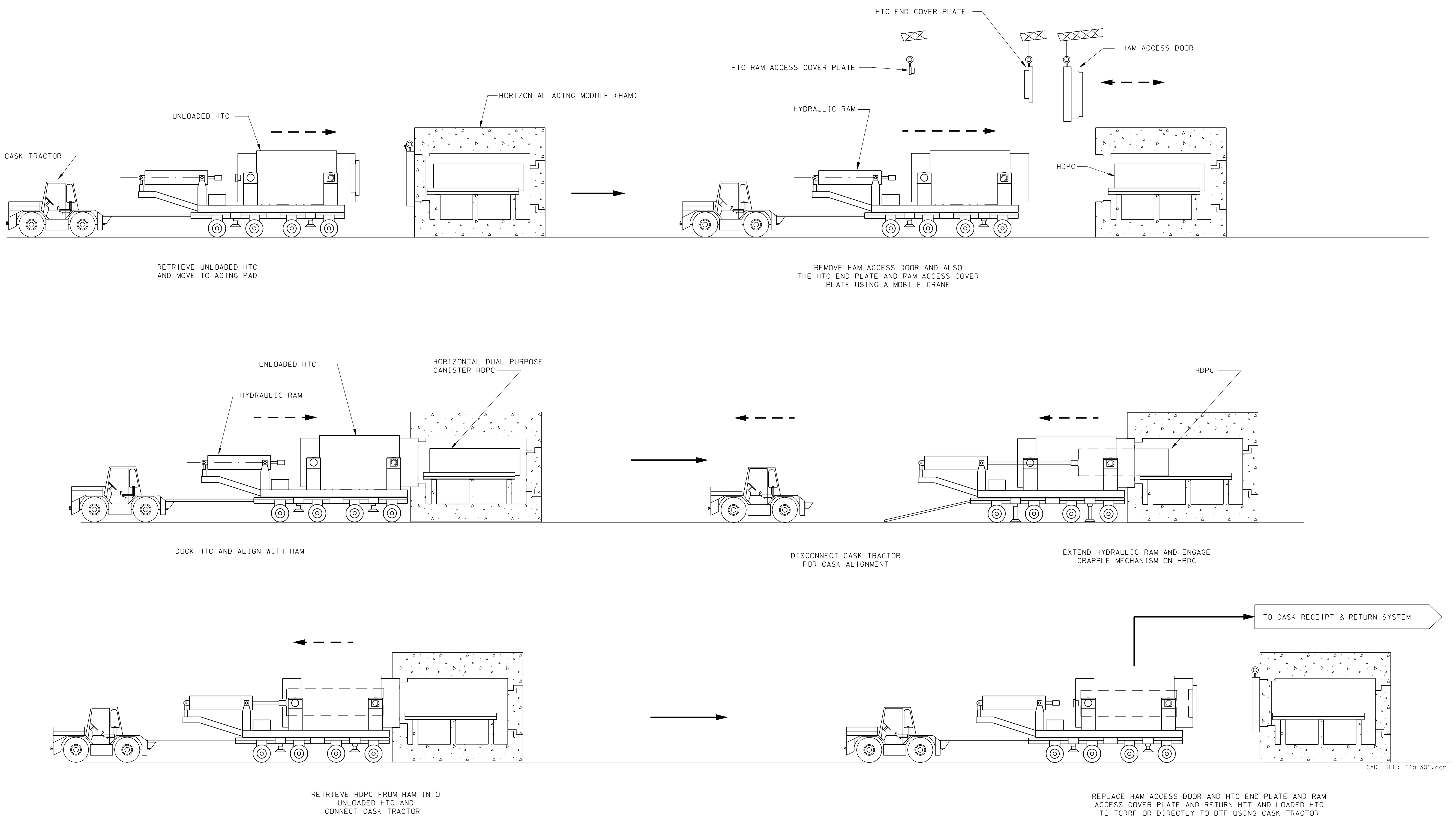


Figure B-13. Mechanical Flow Diagram-Horizontal Transfer, Sheet 2

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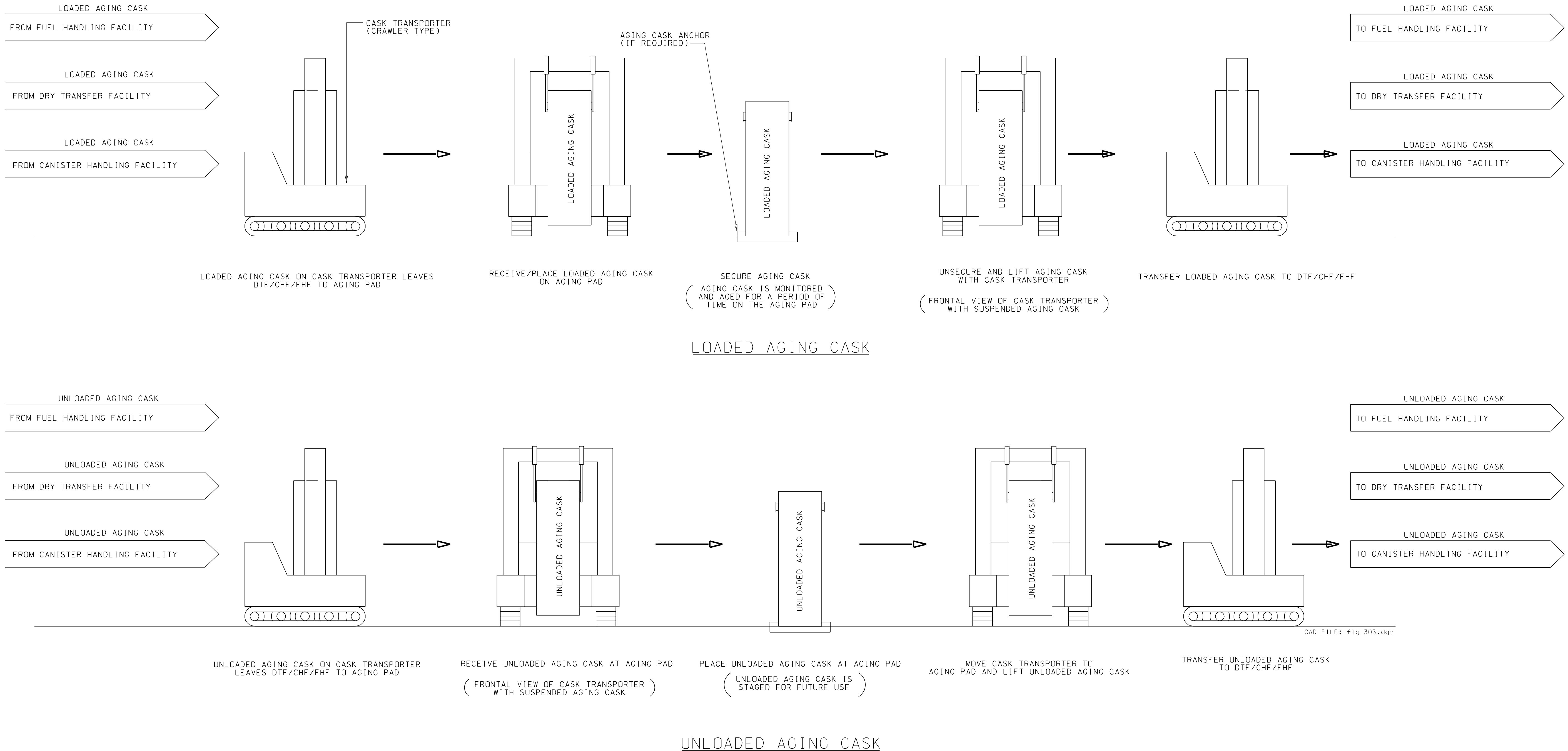


Figure B-14. Mechanical Flow Diagram-Vertical Transfer

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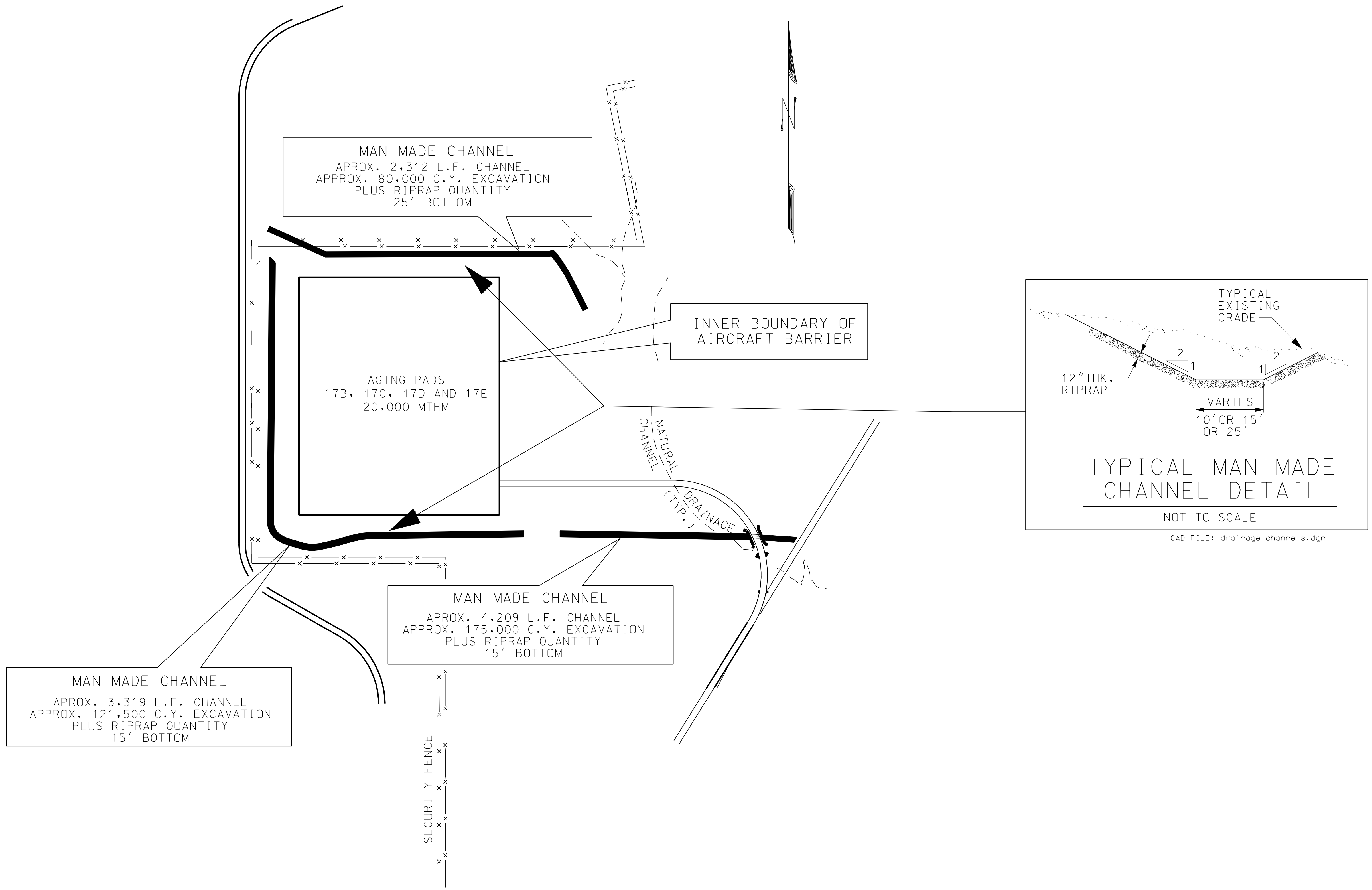


Source: Derived from BSC 2004 [DIRS 169211]

NOTE: Dimensions shown are nominal

Figure B-15. Typical Drainage Channels for Aging Pads

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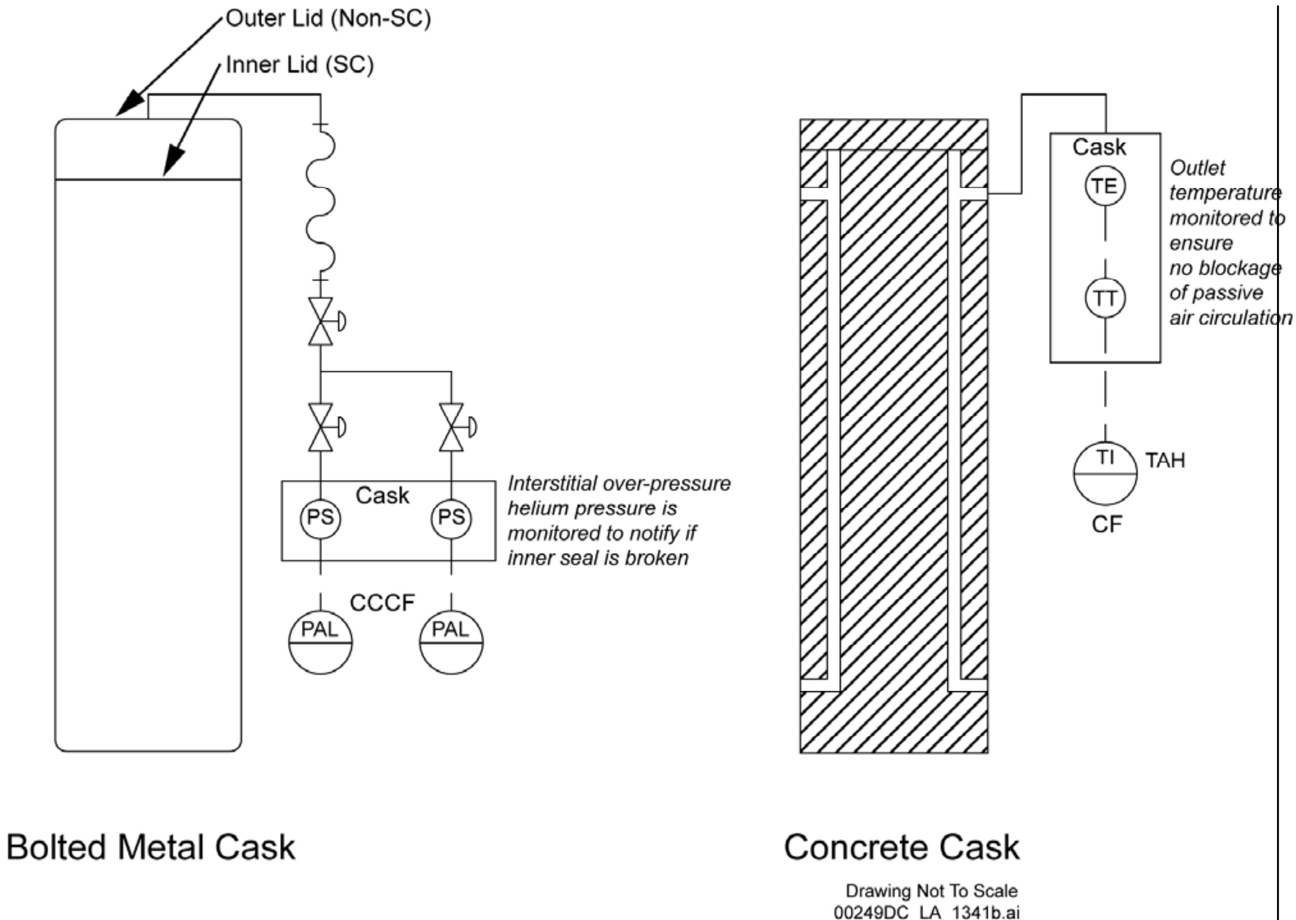


NOTE: SC=Safety Class, PS=Pressure Switch, PAL=Pressure Alarm Low, TE=Temperature Element, TT= Temperature Transmitter, TI=Temperature Indicator, TAH=Temperature Alarm High, CF=Control Facility

Figure B-16. Schematic for Site-Specific Cask Monitoring System

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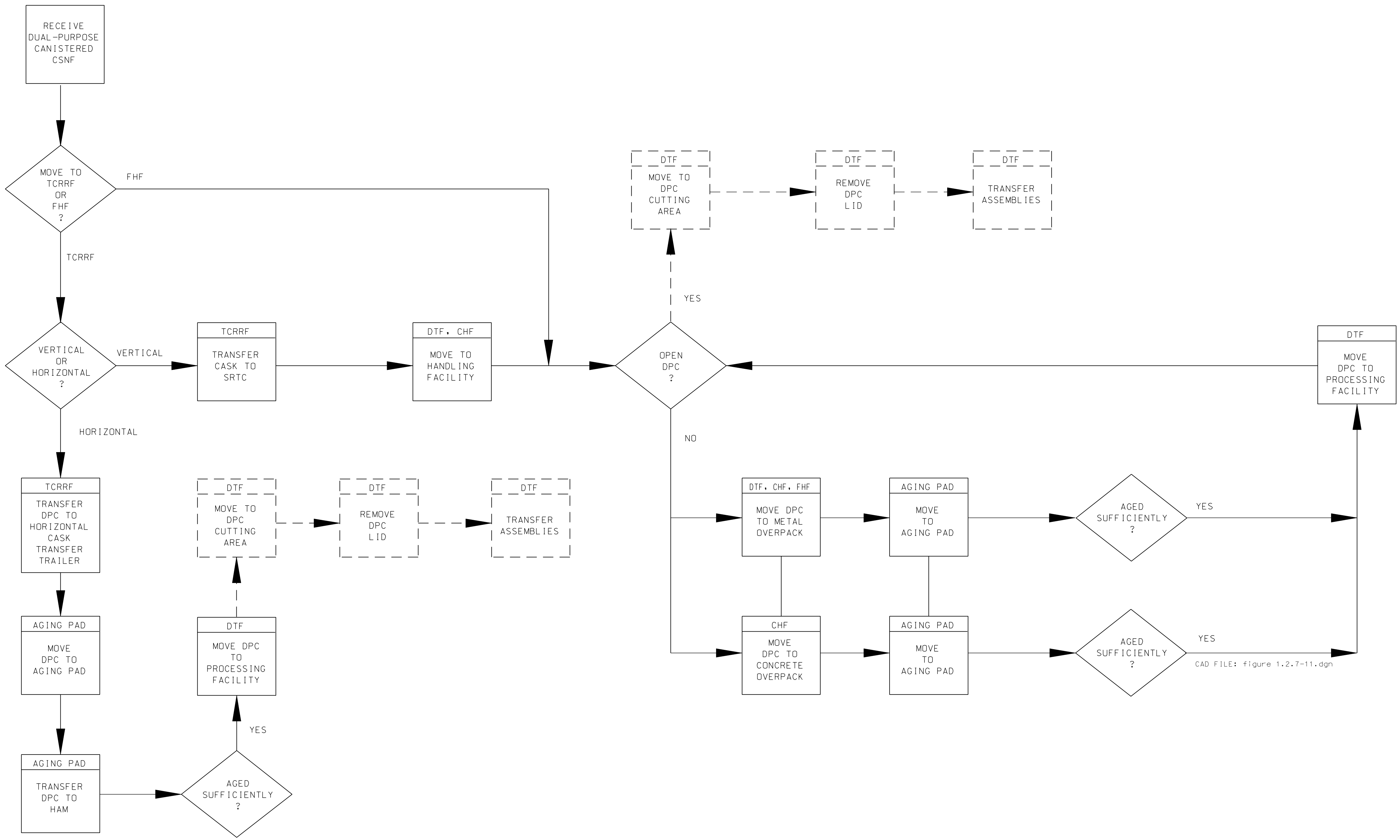


Figure B-17. DPC Processing Flowchart

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# APPENDIX C
# LIST OF SYSTEM PROCEDURES

The aging system will have general, operating, safety-required surveillance, and maintenance procedures that will affect, or be associated with, the system. As system procedures are developed, they will be included in this section.

## C1 GENERAL SYSTEM PROCEDURES

No general procedures have been identified at this time.

## C2 SYSTEM OPERATING PROCEDURES

No operating procedures have been identified at this time.

## C3 SAFETY-REQUIRED SURVEILLANCE PROCEDURES

No safety-required surveillance procedures have been identified at this time.

## C4 MAINTENANCE PROCEDURES

No maintenance procedures have been identified at this time.

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