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1.2 SURFACE FACILITY STRUCTURES, SYSTEMS, AND COMPONENTS AND OPERATIONAL PROCESS ACTIVITIES

The introduction to Chapter 1 summarizes the measures taken to ensure the safety of operational aspects of the Yucca Mountain repository site prior to permanent closure. Sections 1.2.1 through 1.2.8 present the details of how the structures, systems, and components (SSCs) of the surface facilities, as well as the related operational activities, implement this safety approach. Safety considerations that are addressed in these sections include protection of SSCs from the effects of natural phenomena; safe handling of transportation casks, canisters, uncanistered spent nuclear fuel, and waste packages; implementation of prevention features to reduce the probability of event sequences; and implementation of mitigation features to reduce the consequences of event sequences.

Sections 1.2.1 through 1.2.8 focus on SSCs that the safety analyses have determined to be important to safety (ITS) or important to waste isolation (ITWI); describe the ITS and ITWI SSCs; identify operating processes; state the safety category classification; identify procedural safety controls; present the design bases and design criteria; discuss design methodologies; identify materials of construction; provide the selection of codes and standards along with any clarifications; and list the load combinations, as applicable. This specific information for ITS and ITWI SSCs identifies the safety functions and demonstrates the ability to perform the safety functions when required with the necessary reliability. General information is provided for SSCs that are neither ITS nor ITWI to complete the description of the repository and its operations.

An overview of the surface facility and operations is presented in Section 1.2.1. The design approach and analytical methodology for structures, mechanical handling, and heating, ventilation, and air-conditioning in the design of the surface facilities are presented in Section 1.2.2. Sections 1.2.3 through 1.2.6 present the general and specific information for the Initial Handling Facility, the Canister Receipt and Closure Facilities, the Wet Handling Facility, and the Receipt Facility. The first subsection in each section addresses the physical arrangement of the facility and the flow of materials within the facility. The second subsection addresses the mechanical handling equipment used in the facility. The third subsection addresses process systems that are associated with the handling of casks and canisters, and closure of canisters and waste packages. The fourth subsection presents the heating, ventilation, and air-conditioning systems servicing the facility. Sections 1.2.7 and 1.2.8 present the Aging Facility and the balance of plant facilities.

An aspect of the design is use of similar systems and components in the various handling facilities. To eliminate repetition of information, the Canister Receipt and Closure Facility (Section 1.2.4) is treated as a lead facility with the detailed description of systems and components. The sections for the other facilities refer to Section 1.2.4 as appropriate for detailed descriptions of similar components. Facility-specific applications are addressed in the individual sections for the handling facilities.

Sections 1.2.1 through 1.2.8 present general information that addresses the requirements of 10 CFR Part 63 and the acceptance criteria in NUREG-1804, including HLWRS-ISG-02 (Section 2.1.1.2.3: Acceptance Criteria 2(2)), by providing a general description of the SSCs and the operational process activities of the geologic repository operations area. Sections 1.2.2 through 1.2.8 also present specific information for surface facility ITS SSCs as required by 10 CFR 63.21(c) and address the acceptance criteria of NUREG-1804, including HLWRS-ISG-02 (Section 2.1.1.2.3: Acceptance Criteria 2(2)). The following table lists Sections 1.2.1 through 1.2.8 and the corresponding regulatory requirements and acceptance criteria from NUREG-1804 addressed in each section.

SAR Section	Information Category	10 CFR Part 63 Reference	NUREG-1804 Reference (and Changes to NUREG-1804 from HLWRS ISGs)
1.2.1	Surface Operations Overview	63.21(c)(2) 63.21(c)(5) 63.112(a)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2
1.2.2	Surface Facilities Structural, Mechanical Handling Equipment, and Heating, Ventilation, and Air-Conditioning System Design	63.21(c)(2) 63.21(c)(3) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(8) 63.112(e)(10) 63.112(f)(2)	Section 2.1.1.1.3: Acceptance Criterion 5 Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.6.3: Acceptance Criterion 1 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 3 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2
1.2.3	Initial Handling Facility	63.21(c)(2) 63.21(c)(3) 63.21(c)(6) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(5) 63.112(e)(8) 63.112(e)(10) 63.112(e)(12) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2

SAR Section	Information Category	10 CFR Part 63 Reference	NUREG-1804 Reference (and Changes to NUREG-1804 from HLWRS ISGs)
1.2.4	Canister Receipt and Closure Facility	63.21(c)(2) 63.21(c)(3) 63.21(c)(6) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(5) 63.112(e)(8) 63.112(e)(10) 63.112(e)(12) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2
1.2.5	Wet Handling Facility	63.21(c)(2) 63.21(c)(3) 63.21(c)(6) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(5) 63.112(e)(8) 63.112(e)(10) 63.112(e)(12) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2

SAR Section	Information Category	10 CFR Part 63 Reference	NUREG-1804 Reference (and Changes to NUREG-1804 from HLWRS ISGs)
1.2.6	Receipt Facility	63.21(c)(2) 63.21(c)(3) 63.21(c)(6) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(5) 63.112(e)(8) 63.112(e)(10) 63.112(e)(12) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2

SAR Section	Information Category	10 CFR Part 63 Reference	NUREG-1804 Reference (and Changes to NUREG-1804 from HLWRS ISGs)
1.2.7	Aging Facility	63.21(c)(2) 63.21(c)(3) 63.112(a) 63.112(e)(8) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2
1.2.8	Balance of Plant Facilities	63.21(c)(2) 63.21(c)(3) 63.112(a) 63.112(e)(1) 63.112(e)(4) 63.112(e)(5) 63.112(e)(8) 63.112(e)(10) 63.112(e)(11) 63.112(e)(12) 63.112(f)(2)	Section 2.1.1.2.3: Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 6 Section 2.1.1.6.3: Acceptance Criterion 1 Acceptance Criterion 2 Section 2.1.1.7.3.1: Acceptance Criterion 1 Section 2.1.1.7.3.2: Acceptance Criterion 1 Section 2.1.1.7.3.3(I): Acceptance Criterion 1 Acceptance Criterion 2 Acceptance Criterion 4 HLWRS-ISG-02 Section 2.1.1.2.3: Acceptance Criterion 2

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1.2.1 Surface Operations Overview

[NUREG-1804, Section 2.1.1.2.3: AC 1, AC 2, AC 6; HLWRS-ISG-02, Section 2.1.1.2.3: AC 2]

This section provides an overview of surface operations and identifies the major surface facility structures. The repository surface facilities are located on the east side of Exile Hill in Midway Valley at the eastern margin of Yucca Mountain. The surface facilities include the handling facilities, a surface transportation network, and balance of plant facilities and support systems necessary to safely receive, buffer, age, stage, transfer, and package spent nuclear fuel (SNF) and high-level radioactive waste (HLW) for disposal. The layout of the surface facilities is shown in Figures 1.2.1-1 and 1.2.1-2. Figure 1.1-1 shows the location of the surface geologic repository operations area (GROA) and the repository layout in relation to the site boundary and the distance from the site boundary, which is the closest point of approach for a member of the general public. The GROA surface facilities are approximately 6.8 mi from the site boundary to the west. Figure 1.2.1-3 presents an overview of the activities involved in the handling of SNF and HLW, and Figure 1.2.1-4 shows the normal physical movement of SNF and HLW between the major surface facility structures and to the interface with the subsurface facilities at the North Portal.

Section 1.2.1.1 summarizes the casks, canisters, and waste packages used at the repository. Section 1.2.1.2 provides a brief description of the major surface facilities and systems. Section 1.2.1.3 presents an overview of surface facility operations. Loading plans that will be used to control the placement of waste forms into canisters and waste packages are described in Section 1.2.1.4. An overview of the barriers and procedural controls used to prevent construction activities from adversely affecting the surface facility operations is provided in Section 1.2.1.5.

The following paragraphs summarize the principal regulatory framework for the repository.

The primary regulation governing the design, construction, and operation of the repository is 10 CFR Part 63.

The transportation casks received at the repository will be certified under 10 CFR Part 71. Transportation casks will contain the following types of wastes:

- Transportation, aging, and disposal (TAD) canisters of commercial SNF
- Dual-purpose canisters (DPCs) of commercial SNF
- Individual commercial SNF assemblies
- Naval SNF canisters
- U.S. Department of Energy (DOE) SNF canisters
- HLW canisters.

The transportation casks enter the GROA at the Cask Receipt Security Station (Area 30B). Transportation casks will be taken directly to a handling facility or remain in a buffer area (Areas 33A and 33B) until the appropriate handling facility is available. The impact limiters are only removed while the casks are inside the handling facilities. The transportation casks are only opened while they are inside the Initial Handling Facility (IHF) (Area 51A), Canister Receipt and Closure Facility (CRCF) (Areas 60, 70, and 80), Wet Handling Facility (WHF) (Area 50) or Receipt Facility (RF) (Area 200), or at the Aging Facility (Area 17) for a transportation cask containing a horizontal DPC. Transportation casks while within the GROA are considered in the repository preclosure safety analysis (PCSA). At each facility, the transportation cask is opened, and its contents are removed for management at the repository. After the contents have been transferred, the cask is inspected and released from the GROA.

The repository PCSA demonstrates that canister systems and DPC systems, including overpacks, meet the repository safety requirements and perform adequately when exposed to the external and internal hazards specific to the repository location and operations. The canister systems will use components consistent with the thermal, neutronic, and shielding characteristics of the SNF inventory in pools and independent spent fuel storage installations. Sealed, internally dried and inerted canisters are designed to accommodate commercial pressurized water reactor (PWR) or boiling water reactor (BWR) SNF, DOE SNF, or naval SNF. HLW is also received in canisters, but they do not require internal drying and inerting. The performance basis for canisters and DPCs is addressed in Section 1.5.1. The performance basis for shielded transfer casks is addressed in Section 1.2.5.

Some components received at the repository may have been certified for use at other sites under a 10 CFR Part 72 general license. Such components will be evaluated and determined to be suitable for use at the repository in accordance with 10 CFR Part 63 prior to receipt and use. The preclosure performance objectives of 10 CFR Part 63 invoke 10 CFR Part 20 for the control of occupational exposure of workers and onsite public for normal operations and Category 1 event sequences and the performance requirements of 10 CFR 63.111(b)(1) for members of the public in the general environment. For Category 2 event sequences, the PCSA demonstrates that the exposure of the public on or beyond the site boundary meets the objectives of 10 CFR 63.111(b)(2).

1.2.1.1 Overview of Transportation Casks, Waste Packages, and Canisters
[NUREG-1804, Section 2.1.1.2.3: AC 6(1)]

SNF and HLW waste forms arrive at the repository in a variety of types and sizes. The waste is transported in various casks and is emplaced in appropriate waste package configurations.

The majority of commercial SNF received at the repository is expected to be received in TAD canisters that have been loaded, sealed, internally dried, and inerted by the commercial nuclear utilities. TAD canisters are received at the repository in rail-based transportation casks. Upon receipt, the TAD canisters are transferred into aging overpacks for transport to the Aging Facility or into waste packages for emplacement.

Approximately 10% of the commercial SNF may arrive in transportation casks as uncanistered PWR and BWR SNF assemblies. The WHF will be used for uncanistered commercial SNF handling. The processing of uncanistered commercial SNF received in transportation casks will be performed only underwater in the WHF pool. The assemblies will be transferred into TAD canisters, sealed, internally dried, and inerted. Then, the TAD canisters will be loaded into aging overpacks and sent to the Aging Facility or sent to the CRCF for loading into waste packages for emplacement.

The repository surface facilities include an Aging Facility. The Aging Facility facilitates the implementation of the repository thermal management strategy and efficient use of the handling facilities by safely maintaining an inventory of TAD canisters and DPCs with varying thermal powers. Only TAD canisters and DPCs suitable for use at the repository will be placed in the Aging Facility.

Commercial SNF may also arrive in sealed DPCs. DPCs currently used in independent spent fuel storage systems do not meet the internal basket material requirements for emplacement at the repository. Consequently, DPCs will be opened in the WHF and their contents repackaged into TAD canisters at the repository prior to emplacement. The unloaded DPCs will then be disposed of as low-level radioactive waste.

HLW, DOE SNF, and naval SNF arrive at the repository in canisters. These canisters are designed, manufactured, loaded, sealed, internally dried (except for HLW canisters), inerted (except for HLW canisters), and transported from various waste generation and storage sites for emplacement in the repository. Naval SNF canisters are removed from their transportation casks and transferred to waste packages in the IHF. HLW canisters are removed from their transportation casks and transferred to waste packages in either the IHF or CRCF. DOE SNF canisters are removed from their transportation casks and transferred to waste packages in the CRCF.

Because of the variety of waste forms to be received at the repository, the repository is designed to accommodate multiple configurations of transportation casks and waste packages. The types of transportation casks, waste forms, and waste packages are discussed below. Figure 1.2.1-3 shows the repository handling facilities, identifies the waste forms processed by each facility, and indicates the conveyance on which the transportation casks are received.

1.2.1.1.1 Transportation Casks

Transportation casks used for shipping SNF and HLW to the repository are shielded, mechanically sealed metal containers that are certified by the U.S. Nuclear Regulatory Commission (NRC) in accordance with 10 CFR Part 71. They provide shielding from radiation and protection from hazards to ensure public health and safety during transportation. The performance basis for transportation casks received at the repository is described in Section 1.2.8.4.5.

1.2.1.1.2 Waste Forms

The repository will receive and emplace no more than 70,000 MTHM of SNF and vitrified HLW. Commercial SNF constitutes about 90%, or 63,000 MTHM, of the waste to be received at the repository. The PCSA considers the expected number of operations during the lifetime of the repository associated with 12,068 waste packages. The PCSA includes the expected onsite transfers of 33,104 uncanistered commercial SNF assemblies into TAD canisters within the pool of the WHF. For the purpose of assessing normal occupational exposures, the staffing and handling activities are based upon a throughput in 1 year of 3,000 MTHM of commercial SNF and HLW, up to 24 naval SNF canisters, 179 DOE SNF canisters, and 763 HLW canisters. Table 1.2.1-1 lists the analyzed numbers of items handled during the lifetime of the various handling facilities, which exceed the expected numbers of items to be emplaced. The PCSA is summarized in Sections 1.6 through 1.9, including the quantification of event sequences. Section 1.5.1 identifies the types, characteristics, and quantities of the waste forms to be handled and emplaced at the repository.

Various types of PWR or BWR commercial SNF assemblies are received at the repository. These assemblies have been out of the reactor for at least 5 years. It is expected that approximately 90% of commercial SNF assemblies will be received in TAD canisters that are directly loaded into waste packages for emplacement or loaded into aging overpacks and moved to the Aging Facility. The remaining 10% of commercial SNF that is in a DPC or uncanistered is transferred into a TAD canister in the WHF. The filled TAD canister is closed, sealed, internally dried, and inerted. The TAD canister is then placed in an aging overpack and transferred to either the CRCF, where it is loaded into a waste package for emplacement, or the Aging Facility. Commercial SNF is further described in Section 1.5.1.1.

HLW is produced by reprocessing SNF from commercial, naval, materials production, and test reactors, as well as from research programs. HLW arrives in welded and sealed canisters suitable for emplacement. These canisters are transferred to a waste package for emplacement. For the purpose of repository inventory, each HLW canister is defined as containing 0.5 MTHM with the exception of a West Valley HLW canister, which contains 2.3 MTHM. The repository is analyzed for an inventory of 4,667 MTHM of HLW, as shown in Table 1.5.1-1. HLW and HLW canisters are described in Section 1.5.1.2.

DOE standardized canisters containing DOE SNF are received at the repository. In addition, SNF from the Hanford site is received in multicanister overpacks (MCOs). The sealed and inerted DOE SNF standardized canisters and DOE MCOs are transferred into a waste package for emplacement. The repository is analyzed for an inventory of 2,268 MTHM of DOE SNF, as shown in Table 1.5.1-1. DOE SNF and DOE SNF canisters, including MCOs, are described in Section 1.5.1.3.

Canisters containing naval SNF are received at the repository. These sealed and inerted canisters are transferred directly to waste packages for emplacement. The repository is analyzed for an inventory of 65 MTHM of naval SNF, as shown in Table 1.5.1-1. Naval SNF and naval SNF canisters are described in Section 1.5.1.4.

1.2.1.1.3 Waste Packages

There is a single waste package design with multiple configurations. There is one waste package configuration for commercial SNF (commercial SNF will be placed in a TAD canister and then placed in a waste package), three for HLW and DOE SNF, and two for naval SNF. The fundamental design of the waste package configurations is the same. Each configuration includes a corrosion-resistant outer corrosion barrier of restricted Alloy 22 (UNS N06022), a structural inner vessel of Stainless Steel Type 316 (UNS S31600) that is inerted with helium after loading, and two closure lids. The waste package configurations are described in more detail in Section 1.5.2.

1.2.1.1.4 Transportation, Aging, and Disposal Canister System

TAD canisters are used to transport commercial SNF from nuclear power plants to the repository and result in a uniform process for loading waste packages for emplacement. TAD canister and appurtenance designs will be licensed by the NRC under 10 CFR Part 72 for dry cask storage and/or certified under 10 CFR Part 71 for transportation, as required. These TAD canisters and ancillary equipment will be demonstrated to meet the preclosure and postclosure safety requirements of the repository prior to use at the repository. Section 1.5.1 describes the performance requirements and designs for TAD canisters. Once a TAD canister has been loaded with commercial SNF, the TAD canister and its contents will not be repackaged for emplacement. TAD canisters are also used to thermally age commercial SNF or otherwise match the incoming waste stream and the availability of handling facilities and waste packages. The internal basket assembly of the TAD canister can be configured to accept a variety of commercial SNF assemblies. The basket assembly maintains the commercial SNF in a subcritical configuration for normal conditions, off-normal events, and credible event sequences. The TAD canisters are metallic components providing confinement and geometry control. The TAD canister basket assembly will accommodate damaged-fuel cans to provide the appropriate confinement of damaged SNF assemblies. Section 1.5.1 describes the TAD canister and its performance requirements.

1.2.1.2 Major Surface Facility Structures and Systems
[NUREG-1804, Section 2.1.1.2.3: AC 1(1), AC 2(3)]

The following paragraphs provide a brief overview of the major surface facilities and systems. The numbers in parentheses are the area numbers identified in Figure 1.2.1-2.

Initial Handling Facility (Area 51A)—The IHF is designed to receive transportation casks containing only disposable naval SNF canisters or disposable HLW canisters, to prepare the casks for unloading, to transfer the canisters into waste packages, to close the waste packages, and to transfer the completed waste packages to a transport and emplacement vehicle (TEV) for movement to the subsurface. The IHF is the only facility capable of receiving and handling the naval SNF canister transportation cask. The IHF is an important to safety (ITS) structure with ITS mechanical handling systems and components. The cask receipt and canister preparation areas of the IHF are constructed primarily of structural steel. The cask unloading, waste package loading, waste package closure, and waste package loadout areas of the IHF are constructed primarily of reinforced concrete. The IHF and the structures, systems, and components (SSCs) contained within the facility are described in Section 1.2.3.

Canister Receipt and Closure Facility (Areas 60, 70, and 80)—There are three CRCFs of identical design. The CRCF is designed to receive transportation casks containing disposable canisters, to prepare the casks for unloading, to transfer the canisters into waste packages, to close the waste packages, and to transfer the completed waste packages to a TEV for movement to the subsurface. The disposable canisters are TAD canisters, HLW canisters, and DOE SNF canisters. The CRCF also is designed to receive TAD canisters in aging overpacks or to place TAD canisters into aging overpacks for movement to the Aging Facility. The CRCFs are ITS structures with ITS mechanical handling systems and components. The CRCFs also have ITS heating, ventilation, and air-conditioning (HVAC) systems to mitigate Category 2 event sequences. The CRCFs are constructed primarily of reinforced concrete. Other than the naval SNF waste packages and a limited number of HLW-only waste packages produced in the IHF, all other waste packages are produced in the CRCFs. The CRCF and the SSCs contained within the facility are described in Section 1.2.4.

The canistered approach to waste handling permits a similar approach to operations and equipment in the IHF and CRCF. The handling equipment and SSCs for cask sampling, waste package inerting, and waste package closure are functionally equivalent with the exception of local and physical differences resulting from layout considerations. This similarity contributes to operability, maintainability, and reliability of repository SSCs.

Wet Handling Facility (Area 50)—The WHF is designed to receive transportation casks containing uncanistered commercial SNF assemblies, to prepare the casks for unloading, to transfer the assemblies into TAD canisters underwater in the pool, to close the TAD canisters, and to load the TAD canisters into aging overpacks for transfer to a CRCF or the Aging Facility. The WHF also is designed to receive DPCs in transportation casks, aging overpacks, or shielded transfer casks; transfer the DPCs into a shielded transfer cask; open the DPCs; and transfer the commercial SNF assemblies into TAD canisters underwater in the pool. The WHF contains the systems and components to maintain the pool water clarity and chemistry associated with both PWR and BWR SNF assemblies. The WHF is an ITS structure with ITS mechanical handling systems and components. The WHF also has ITS HVAC systems to mitigate Category 2 event sequences. The WHF is constructed primarily of reinforced concrete, and the reinforced concrete pool is lined with stainless steel. The commercial SNF that is received at the repository not in TAD canisters will be packaged into TAD canisters in the WHF. The WHF and the SSCs contained within the facility are described in Section 1.2.5.

Central Control Center Facility (Area 240)—The Central Control Center Facility (CCCF) (Area 240) contains the Central Control Center and the Primary Alarm Station. The Central Control Center provides the overall supervision of repository operations. It consists of monitoring and alarm panels and human–machine interface consoles. The general philosophy for repository operations is local control from operating stations adjacent to the physical activity in the handling facilities. There is an operations room in each handling facility responsible for operations in the respective facility and is subject to the supervision of the Site Operations Manager. In the case of emplacing the waste package by the TEV in the emplacement drift, the operator in the Central Control Center remotely controls the operation of the TEV. The Central Control Center provides controls for non–waste handling equipment and facilities. The Primary Alarm Station supports the repository safeguards and security system and is addressed in separate physical protection documents. The CCCF is described in Section 1.2.8, and the operating philosophy for the repository and the control systems is addressed in Section 1.4.2.

Receipt Facility (Area 200)—The RF is designed to receive transportation casks containing TAD canisters or DPCs, to prepare the casks for unloading, and to transfer the canisters into aging overpacks on a site transporter for movement to a CRCF or the Aging Facility. For transportation casks containing horizontal DPCs, the transportation casks are placed on a cask transfer trailer before movement from the RF to the Aging Facility. The RF is an ITS structure with ITS mechanical handling systems and components. The RF is constructed primarily of reinforced concrete. The RF allows the receipt rate of commercial SNF to be decoupled from its emplacement rate. The RF and the SSCs contained within the facility are described in Section 1.2.6.

Cask Receipt Security Station (Area 30B)—The Cask Receipt Security Station is the point of receipt of all nuclear and direct nuclear support related shipments. It is at this point that the waste forms are transferred from the transportation system to repository operations. Waste forms are received in transportation casks borne on railcars or truck trailers. The transportation system prime mover (locomotive or tractor) moves the railcars or trailers into the Cask Receipt Security Station and the transportation system prime mover is withdrawn. Once in the Cask Receipt Security Station, receipt inspections, including security inspections, are performed, and the manifest for the shipment is checked. The facility provides security, health physics, and material control and accounting functions and is the point of receipt for items entering the protected area. Personnel access is limited at this facility. The Cask Receipt Security Station is described further in Section 1.2.8.

Surface Transportation and Buffer Areas (Areas 33A and 33B)—HLW and SNF are received at the repository at the Cask Receipt Security Station (Area 30B). Once the shipment is accepted, a site prime mover (locomotive or tractor) is brought into the Cask Receipt Security Station, and the railcars are moved to the railcar buffer area (Area 33A), and the truck trailers are moved to the truck buffer area (Area 33B).

The surface transportation system consists of standard gauge rail, special gauge rail for the TEV, and roads. The standard gauge rail runs from the Cask Receipt Security Station through the railcar buffer area to the surface handling facilities and to other facilities such as the Warehouse and Non-Nuclear Receipt Facility (Area 230) and Heavy Equipment Maintenance Facility (Area 220). The special gauge rail runs from the IHF and the three CRCFs to the North Portal and to the Heavy Equipment Maintenance Facility. Paved roads run from the Cask Receipt Security Station to the facilities inside the security fence, including the Aging Facility and the truck buffer area. Additional roads are provided between the surface handling facilities and the Aging Facility. These additional roads are designed to accommodate movement of the site transporters.

The railcar and truck buffer areas provide space (up to 25 railcars and 5 trucks) to temporarily locate waste forms in their transportation overpacks and to position the waste forms to accommodate the needs of the handling facilities. The balance of plant facilities, including surface transportation, are described in Section 1.2.8.

Emergency Diesel Generator Facility (Area 26D)—The Emergency Diesel Generator Facility (EDGF) is designed to provide ITS electrical power to ITS systems and components in the surface handling facilities. The EDGF is a structure that houses two ITS diesel generators and their ITS supporting systems, including electrical switchgear, engine controls, starting air, combustion air, and engine cooling. The ITS fuel system includes two trains of equipment with the fuel storage in underground tanks adjacent to the EDGF. The EDGF is constructed primarily of reinforced concrete. The mechanical systems associated with the EDGF are addressed in Section 1.2.8, and the electrical characteristics of the ITS power system are addressed in Section 1.4.1.

Aging Facility (Areas 17P and 17R)—The repository surface layout includes an Aging Facility that can accommodate up to 21,000 MTHM of commercial SNF in TAD canisters or DPCs with overpacks. The Aging Facility areas are located approximately 0.5 mi from the handling facilities. The Aging Facility has a total of 2,500 aging spaces, including 100 spaces for horizontal aging modules. The design of the aging pads, aging overpacks, and TAD canisters is similar to existing dry cask storage systems used at nuclear utilities. The aging pads and aging overpacks are ITS and are further described in Section 1.2.7.

Low-Level Waste Facility (Area 160)—The Low-Level Waste Facility is designed to accept, manage, and store dry active waste until bulk shipment off site, and store liquid radioactive waste until processed. The facility is constructed with a concrete wall base and a steel skin located above the concrete. Four separate, part-height, concrete walled, shielded storage bays are located inside the building. These four bays provide for the storage of boxes and drums, filters, high-integrity containers, and unloaded DPCs. A concrete pad for storage outside the facility is located adjacent to the four storage bays.

The dry active waste is expected to be transported on site from the surface and subsurface nuclear facilities using appropriate packaging and shielded containers in accordance with the repository Operational Radiation Protection Program.

Low-level liquid radioactive waste is collected at the WHF and other handling facilities and transferred to the liquid low-level waste collection tanks. Periodically, the liquid in the collection tanks will be processed and returned to the process water tank. The processing media will be shipped off site for recycling or disposal. There are three 25,000-gal tanks located outside the facility, adjacent to one of the storage bays.

The Low-Level Waste Facility is further described in Section 1.2.8. The low-level radioactive waste management system is described in Section 1.4.5. The Operational Radiation Protection Program is described in Section 5.11.

Support Structures and Systems—The following list identifies the structures and systems that support the operation of the repository:

- Electrical power (described in Section 1.4.1)
  - Switchyard (Area 27A)
  - Switchgear Facility (Area 27B)
  - Standby Diesel Generator Facility (Area 26B)
  - Electrical distribution system
- Service gases (described in Section 1.4.4)
- Utilities Facility (Area 25A) (described in Sections 1.2.8 and 1.4.4)
- Fire water facilities (Areas 28A, B, and E) (described in Sections 1.2.8 and 1.4.3)
- Heavy Equipment Maintenance Facility (Area 220) (described in Section 1.2.8)
- Warehouse and Non-Nuclear Receipt Facility (Area 230) (described in Section 1.2.8).

1.2.1.3 Overview of Operations
[NUREG-1804, Section 2.1.1.2.3: AC 6(1)]

Figure 1.2.1-3 illustrates the overall operations conducted in the surface facilities. Figure 1.2.1-4 shows the normal movement of loaded transportation casks, waste packages, canisters, aging overpacks, and shielded transfer casks between the major surface facility structures and the North Portal.

The following descriptions are overviews of the operations performed in the handling facilities. Sections 1.2.3 through 1.2.8 present detailed descriptions of the handling processes accompanied by figures representing the general arrangement of the facilities and the associated SSCs.

SNF and HLW arrive at the repository by railcar or truck. The shipments enter the GROA at the Cask Receipt Security Station (Area 30B). The personnel barriers are removed from the transportation casks. The transportation casks undergo a security entry inspection in accordance with 10 CFR 73.51 and a radiological survey in accordance with 10 CFR 20.1906 before the casks are passed into either the railcar buffer area or the truck buffer area. The transportation casks may remain in these buffer areas pending the availability of the waste handling facilities for processing.

Once a transportation cask, its contents, and its transportation vehicle (railcar or truck trailer) have been accepted into the repository at the Cask Receipt Security Station (Area 30B), a site prime mover is attached to the cask transportation vehicle. A standard gauge, rail-based site locomotive moves railcars to the railcar buffer area (Area 33A), and a truck-based site tractor moves truck trailers to the truck buffer area (Area 33B). When a handling facility is ready to unload a cask, the appropriate site prime mover is attached to the transportation vehicle, and the cask is delivered to the facility. The transportation casks are maintained on the transportation vehicle with their impact limiters in place until they are inside the designated handling facility. Loaded transportation casks only travel from the buffer areas to a handling facility for a series of steps within a single handling facility. The one exception is for a transportation cask containing a horizontal DPC, which first goes to the RF to be transferred to a site trailer before going to the Aging Facility (Area 17R).

After a loaded transportation cask enters one of the handling facilities, the transportation cask is prepared for unloading. The process is slightly different, but functionally equivalent, for each transportation cask and handling facility design. The general process to prepare a transportation cask for unloading includes (1) removing impact limiters, (2) surveying and decontaminating the transportation cask exterior if needed, (3) upending (i.e., moving the cask to a vertical orientation) the transportation cask, (4) transferring the transportation cask to a trolley, (5) removing the outer lid, (6) sampling the transportation cask internal atmosphere and depressurizing the transportation cask internal volume, and (7) unbolting the inner lid and installing a lifting fixture.

The transfer of canisters from transportation casks into waste packages is performed after preparation for unloading. For the IHF and CRCF, the handling operations and handling equipment are similar. The transportation cask and the receiving waste package are positioned in appropriate rooms. A remotely controlled shielded canister transfer machine is used to transfer the TAD canisters, DOE SNF canisters, HLW canisters, and naval SNF canisters into waste packages. Transfer is performed inside concrete rooms where radiation shielding, ventilation, cooling, and confinement are provided. TAD canisters and canisters of HLW and DOE SNF can also be moved to in-process staging inside the CRCF only.

After a cask is unloaded and before it is removed from the transfer room, an internal survey is performed remotely to determine if any fissile material or other waste form remains in the cask. The material control and accounting procedures will define and identify requirements for investigating, resolving, and reporting anomalies. Examples of typical anomalies include missing items, broken tamper-indicating devices, and compromised container integrity. The anomaly resolution process will require that anomalies be investigated and resolved promptly, provide for the determination of the cause so that remedial action can be taken, and protect against diversion, loss, or other misuse. Existing grapples and handling equipment or portable tools will be used to ensure that the unloaded transportation casks meet at least one of the paragraphs (a) through (f) of 10 CFR 71.15 such that unloaded transportation casks to be returned to the transportation system are exempt from the fissile material classification and package standards of 10 CFR 71.55 and 10 CFR 71.59.

After a transportation cask is unloaded, it is restored to a condition that allows it to exit the handling facility and return to the transportation system. The general process necessary to prepare a transportation cask for return includes (1) replacing lids, (2) removing lid-lifting fixtures, (3) downending (i.e., moving the cask to a horizontal orientation) the transportation casks, (4) replacing impact limiters and personnel barriers and loading the transportation cask onto a shipping conveyance, and (5) surveying the transportation cask exterior and decontaminating if needed to meet the contamination control levels for nonfixed (removable) radioactive contamination on the external surfaces that are stated in 10 CFR 71.87(i), and to ensure that the external radiation levels around the vehicle do not exceed the limits stated in 10 CFR 71.47.

Waste packages are loaded and closed only in the IHF and in the three CRCFs. The processes are the same in these facilities with some variations in the physical configuration of the IHF, as compared to the CRCFs, to accommodate the transportation cask used for the naval SNF canister.

Empty waste packages and emplacement pallets are delivered to the IHF or CRCF using a waste package transfer truck. The waste package is inspected for damage prior to placement in the waste package transfer trolley. With the waste package transfer trolley in the down position and the waste package transfer carriage extended, the waste package and emplacement pallet assembly is positioned on the carriage and drawn into the trolley. Pedestals are used with the waste package transfer trolley to bring the waste packages to a uniform level. Then the trolley is upended. The waste package transfer trolley shield ring is installed and the wheel-mounted waste package transfer trolley is actuated to move the empty waste package into the appropriate room to receive a canister. The matched waste package inner and outer lids are moved into position using auxiliary overhead cranes. Inspections are performed to ensure no foreign material is introduced into the waste package prior to loading.

After the waste package is loaded, the limited portion of the waste package that extends above the shielded enclosure of the waste package transfer trolley is surveyed for loose surface contamination, and is decontaminated if necessary. Then, the waste package is closed by installing the inner lid (including the internal shield plug for codisposal waste packages), installing the inner lid spread ring, seal welding the spread ring in place, backfilling the inner vessel with helium, leak testing the inner lid weld, closing and sealing the inner lid purge port, installing the outer lid, welding the outer lid with nondestructive examinations after each weld pass, applying stress mitigation to the surface of the completed outer lid weld, and performing nondestructive examination of the outer lid weld.

Once the waste package closure is completed and accepted, the waste package is ready for loadout. First, the TEV is brought into the loadout area, its doors are opened, and its baseplate is extended. Next, the shield door between the loadout area and the closure area is opened and the waste package transfer trolley translates the waste package to the loadout area. At this point, personnel leave the loadout area and further operations are performed remotely. The waste package handling crane then removes the shield ring from the waste package transfer trolley and the waste package transfer trolley downends the waste package. The carriage inside the shielded enclosure of the waste package transfer trolley is drawn out of the trolley, carrying the waste package and its emplacement pallet, and into a position where the emplacement pallet can be engaged by the TEV. During the transition of the waste package from the waste package transfer trolley to the TEV, a remotely operated inspection device inspects the exterior surface of the waste package. This surface inspection is performed to identify any nonconformance that might have occurred to the waste package during handling in the waste loading process. Appropriate actions are taken to evaluate and repair or rework, as necessary, any potential nonconformance that is identified.

After waste package inspection is complete, the TEV engages the waste package emplacement pallet and lifts the pallet and waste package, the waste package transfer carriage is driven back into the shielded compartment of the waste package transfer trolley, the baseplate of the TEV is retracted, and the doors of the TEV are closed and secured. At this point, the completed waste package is fully shielded. A contamination survey of the TEV exterior is performed, and the TEV is decontaminated, if necessary, prior to moving out of the handling facility. Exterior doors of the loadout area are then opened, and the TEV leaves the loadout area with the waste package on its emplacement pallet. The TEV moves on rails from the handling facility to the North Portal, where it enters the subsurface facility. Descriptions of the TEV and its movements are provided in Sections 1.3.3.5 and 1.3.4.8.

The repair or rework philosophy for the repository is to provide a safe work environment in which to perform activities involving radioactive components using a variety of cranes, grapples, handling equipment, and tools that can perform a wide range of tasks. The anticipated repair or rework activities include:

- Decontaminating exterior surfaces of casks, waste packages, and canisters
- Decontaminating interior surfaces of casks
- Removing and replacing damaged studs/bolts
- Repairing waste package closure welds
- Opening waste packages with unacceptable closure welds or other nonconformances
- Cleaning SNF assembly/canister identifiers
- Cutting and grinding.

Each of the handling facilities has the capability to perform minor repair or rework of nonconforming items in a dry environment, and the WHF includes a pool to perform activities that are required to be performed underwater. In the IHF and CRCF, repair or rework may be performed in the cask preparation rooms or closure rooms. These rooms are surrounded by shield walls, are equipped with cranes and handling equipment, and are serviced by the confinement zones of the nuclear HVAC systems. These features give the capability to safely conduct repair or rework activities and to filter any radioactive releases resulting from repair or rework. These rooms, or contiguous rooms, are also the storage rooms for grapples, tools, other portable equipment, and consumables that are used during normal operations and can be used for repair or rework activities or programs.

The WHF pool area is within the confinement zones of the WHF ITS nuclear HVAC system to ensure filtration of any airborne radioactive releases during handling activities. The area is surrounded by shield walls, and the water within the pool is maintained at a minimum depth over the commercial SNF assemblies or other waste to provide radiation protection for the workers. The pool water is borated to a minimum concentration of 2,500 mg/L to provide criticality control during SNF transfer operations in the pool. Pool water treatment and cooling systems maintain the clarity and temperature of the pool water. Cranes, grapples, trolleys, and handling equipment provide flexibility to accomplish repair or rework activities.

It is expected that the repair or rework of some nonconforming items will require special tools and procedures to supplement the installed features, normal tools, and consumables. Special tools and procedures will be developed through safety evaluations and implemented through the safety review process described in the management system for the repository.

The normal waste handling operations performed in the facilities will be conducted in accordance with procedures that are controlled by the repository management systems described in Chapter 5. These normal operating procedures will include prerequisites, cautions, warnings, and ordered steps to ensure that the facilities are in the correct configuration for waste handling operations, activities are performed in the proper order for the waste forms and equipment involved, and operations are consistent with the operations and residence times modelled in the PCSA. From time to time, it is anticipated that systems and components may not perform as designed. To restore the repository systems and components from off-normal conditions (i.e., those that do not lead to significantly elevated radiological exposures) to normal conditions, the operators will utilize off-normal operating procedures that are also controlled by the repository management systems.

Procedural safety controls are actions that ensure repository operations are within the analyzed conditions of the PCSA and TSPA.

Maintenance of the SSCs needed to support PCSA requirements will be performed in accordance with the reliability-centered maintenance program described in Section 5.6. Maintenance activities will be performed by trained personnel using appropriate procedures and instructions. The maintenance activities will be based upon original equipment manufacturer recommendations, nuclear industry experience, and repository equipment history. In addition, maintenance intervals and acceptance criteria will be established consistent with the PCSA. The maintenance activities will monitor ITS SSC performance to ensure it bounds the capacity and reliability credited in the safety analysis. The reliability-centered maintenance program will conduct the tests, inspections, part replacements, and equipment overhaul and adjustments to ensure that the ITS SSCs are available to perform their safety functions with the required reliability.

As shown in Section 1.7, there are no Category 1 event sequences associated with the operation of the repository facilities and consequently there are no specific recovery actions that have been identified.

Section 1.9.3 describes the process for identifying the procedural safety controls. Table 1.9-9 lists the postclosure analysis control parameters, and Table 1.9-10 lists the preclosure procedure safety controls. Tables 1.2.1-2 and 1.2.1-3 describe the implementation of the postclosure analysis control parameters and preclosure procedural safety controls that are applicable to intrasite and nonfacility-specific operations.

1.2.1.4 Loading Plans
[NUREG-1804, Section 2.1.1.2.3: AC 6(1)]

Prior to SNF or HLW arriving at the repository, a number of notifications are exchanged between the repository and the waste generators. These notifications allow the repository operators to prepare for the incoming material. Prior to receiving waste at the repository, loading plans are prepared that address the handling activities, buffering and staging of waste packages, TAD canisters, SNF assemblies, and canisters for the transfer of SNF and HLW.

If repository operations are interrupted for an extended period, shipments already in progress are expected to continue to the Yucca Mountain site and no new shipments will be initiated. The rail equipment maintenance yard located outside the GROA provides space for cask railcars, buffer railcars, and security railcars, as well as cask truck trailers, that might be in transit at the time of the interruption of service until such time as processing at the GROA is resumed. Physical security measures to protect the loaded casks at the rail equipment maintenance yard will be in accordance with the transportation requirements.

The objective of the loading plans is to determine appropriate loading sequences for waste forms into waste packages and subsequently into emplacement drifts. Loading sequences that meet the applicable technical requirements and are compatible with facility capabilities will be determined for forecast and actual arrival schedules. Loading plans and detailed operating procedures will be documented prior to receipt of specific shipments (rail or truck) so that appropriate equipment (cranes, trolleys, and rigging) will be readied for waste transfer. Facilities will be prepared in advance for incoming waste forms. The appropriate waste packages, TAD canisters, and overpacks will be readied for waste transfer and disposition of waste to buffering, staging, or aging locations or to emplacement.

Key physical limitations considered in the loading plans include the number of basket cells in each TAD canister and waste package, the number of canisters that can be placed in staging, the number of SNF assemblies or canisters that can be placed in the WHF pool, the number of canisters that can be located in the Aging Facility, and the number and lengths of operable repository drifts. Loading plans will be used to optimize waste package loading and drift emplacement while maintaining inventory control and ensuring that the controlling parameters of the safety analyses are satisfied.

Waste will be shipped to the repository under approved U.S. Department of Transportation procedures in NRC-licensed transportation casks. The records provided with each shipment will be sufficient to demonstrate that the waste acceptance criteria are satisfied and to determine the appropriate waste package and emplacement drift loading. The parameters in the records will include, as applicable, assembly identifier, canister identifier, enrichment, burnup, date of removal from the reactor, thermal power, type of assembly, and cladding condition. Each canister, TAD canister, or commercial SNF assembly will be identified by its unique identifier on loading records maintained at the repository, and the initial shipping information for each canister, TAD canister, or SNF assembly will be maintained from receipt to final closure of the repository. Records will be maintained as described in Section 5.2.

Waste package and TAD canister loading will be controlled by a unique calculation for each waste package and TAD canister. The calculation will utilize a set of standard algorithms based on representative SNF assemblies and TAD canisters to assess each SNF assembly and TAD canister. The standard algorithms address thermal power, criticality, and shielding. The standard algorithms identify a set of acceptable loading arrangements for each waste package and TAD canister configuration. Each received SNF assembly and TAD canister will be compared against the representative SNF assemblies and TAD canisters. If the received SNF assembly or TAD canister is within the range of applicability of the standard algorithms, the SNF assembly or TAD canister will be placed in an assigned waste package or TAD canister location based on a standard loading pattern. Otherwise, a unique assessment will be performed for the SNF assembly or TAD canister, and a specific acceptable waste package or TAD canister location will be determined. Prior to moving a transportation cask out of the rail and truck buffer areas, the loading plan for each SNF assembly or TAD canister in the transportation cask will be reviewed and approved in accordance with established procedures.

An emplacement drift loading plan will be prepared and maintained for each emplacement drift. Prior to moving a waste package out of a handling facility, the emplacement drift loading plan for the destination emplacement drift will be reviewed and approved in accordance with established procedures. Section 1.3.1 provides further information on the emplacement drift loading plan.

1.2.1.4.1 Waste Package and Transportation, Aging, and Disposal Canister Loading Plan

Waste forms arriving at the repository will be placed in the appropriate waste package configuration. HLW and DOE SNF canisters will be placed in long or short codisposal waste packages. MCOs will be placed in a waste package configuration designed for codisposal with HLW canisters. Naval SNF canisters will be placed into Naval Long or Naval Short waste package configurations. TAD canisters will be placed in TAD canister waste packages. Each waste package and each location within the waste package will be assigned a unique identifier.

With respect to HLW and DOE SNF canisters, selecting a location within a waste package will be based solely on the type of canister. The waste acceptance criteria for the canisters will ensure that the shipper loads each canister such that its thermal, shielding, and criticality characteristics are within the range of applicability for the standard loading algorithms.

With respect to commercial SNF assemblies, each commercial SNF assembly is placed in a specific location within a TAD canister by the shipping utility or placed at the repository. The choice of each location is made to optimize utilization of TAD canisters within prescribed thermal, criticality, and shielding requirements.

Waste Form—Only SNF and HLW that satisfy the repository waste acceptance criteria will be placed in DOE, naval, and TAD canisters, and only approved DOE, naval, and TAD canisters will be placed in waste packages. Prior to waste package loading, compliance with the waste acceptance criteria will be confirmed.

Thermal—The maximum thermal power for TAD canisters at receipt is 22 kW. The maximum thermal power limits for waste packages at emplacement are: 18 kW for waste packages containing TAD canisters and 11.8 kW for waste packages containing naval SNF canisters. Section 1.3.1 provides an explanation of the thermal management of the repository.

The loading pattern will be compared to standard loading patterns that have been analyzed to demonstrate that temperatures in a sealed and inerted TAD canister or waste package do not exceed any waste form temperature limits during handling in the surface facilities.

Staging capability within the CRCF or WHF will be used to efficiently load a TAD canister or waste package. In the CRCF are staging racks that can safely hold a small number of HLW, DOE SNF, and TAD canisters. The staging capacity in the CRCF permits loading of HLW and DOE SNF canisters in the codisposal waste packages in the correct HLW and DOE SNF configuration for a particular waste package. The WHF pool contains racks similar to spent fuel racks currently in use in spent fuel pools that rely upon spacing and poison material to safely hold PWR and BWR SNF assemblies. The staging racks within the WHF pool permit blending of commercial SNF assemblies as they are loaded into TAD canisters.

The Aging Facility allows the repository the flexibility to manage the incoming TAD canisters and DPCs. In particular, the Aging Facility provides a safe location for TAD canisters and DPCs to lower their thermal power and offers a selection of TAD canisters and DPCs that can be coordinated with the availability of other waste forms and handling facilities.

The loading of each TAD canister will be determined by a unique loading plan. Subsequently, a waste package loading plan will utilize staged HLW or DOE SNF canisters, staged or aged TAD canisters, or naval SNF canisters.

The TAD canister thermal loading limitations will be similar to those for 10 CFR Part 72.

Criticality—For commercial SNF, criticality loading criteria take the form of criticality loading curves. A criticality loading curve gives the minimum average assembly burnup as a function of initial fuel enrichment at which it is acceptable to load a commercial SNF assembly in a particular TAD canister configuration. The loading of commercial SNF assemblies that are not within the range of applicability of the criticality loading curves will be controlled by unique calculations that will demonstrate the acceptability of other forms of critical mass and critical geometry controls.

The criticality loading criteria for codisposal waste packages containing HLW or DOE SNF or both are dependent on the physical size of the DOE SNF canister. For the bulk of the DOE SNF canisters (18 in. diameter), a single canister will be installed in the center position of either a 5-DHLW/DOE Short Codisposal or 5-DHLW/DOE Long Codisposal waste package along with five HLW canisters. For any 24-in.-diameter DOE SNF canisters, a single DOE SNF canister will be installed in one of the radial positions along with four HLW canisters in a 5-DHLW/DOE waste package; the center position will remain vacant. For the MCOs, two MCOs are codisposed with two HLW canisters in a single 2-MCO/2-DHLW waste package. In all cases, criticality safety is addressed by demonstrating that the effective neutron multiplication factor (k_{eff}) remains below established limits based on analysis of a canister loaded with a representative fuel inside a codisposal waste package for each of the nine DOE SNF groups.

Sections 1.14.2.3 and 2.2.1.4.1.1 describe the criticality evaluation process and methodology.

The criticality loading criterion for naval SNF is that a single naval SNF canister is loaded in a single Naval Short or Naval Long waste package. The methodology used to address criticality control of the naval SNF loaded into a naval SNF canister is described in Section 1.14 of the Naval Nuclear Propulsion Program Technical Support Document.

Shielding—Waste package and TAD canister loading will meet the shielding performance objectives by limiting the calculated dose rates on the external surfaces to satisfy the repository radiation zoning and Operational Radiation Protection Program requirements. The representative SNF assembly can be placed in a TAD canister without any restriction. For assemblies with greater levels of direct radiation, selective positioning that takes advantage of shielding by other assemblies will be used to meet the dose rate limits.

Fuel Condition—Commercial SNF that is received in TAD canisters does not require any special handling and may be placed directly into a waste package. Approximately 10% of commercial SNF may be handled as uncanistered SNF assemblies and placed into a TAD canister at the repository. Reactor records and visual observation will be used to identify failed SNF assemblies that require additional confinement prior to placement in a TAD canister or storage rack. Such elements will receive special handling. The special handling is intended to provide adequate confinement (e.g., a damaged-fuel can for damaged fuel) for thermal and criticality control and to minimize the potential spread of contamination within the facilities.

HLW, DOE SNF, and naval SNF will be received in sealed canisters that do not require any special handling of the SNF or HLW. Some DOE SNF is uncanistered SNF of commercial origin and will be handled as uncanistered commercial SNF.

1.2.1.4.2 Loading Options

The following paragraphs describe the various loading options available.

1.2.1.4.2.1 Transportation Cask Type

Transportation Casks Containing Uncanistered or Single-Element Canned Waste Forms—Transportation casks containing uncanistered or canned waste forms will be moved into the WHF and the assemblies transferred individually to a TAD canister or staging racks.

Transportation Casks Containing Canistered Waste Forms—Transportation casks containing naval canisters will be moved to the IHF and opened, and the canister will be transferred to a waste package. There is no option to stage or age naval SNF canisters.

Transportation casks containing HLW canisters will be moved to either the IHF or CRCF and opened, and the canister will be transferred to a waste package. There is no option to age HLW canisters.

Transportation casks containing DOE SNF canisters will be moved to the CRCF and opened, and the canister will be transferred to a waste package for codisposal with HLW canisters. There is no option to age DOE SNF canisters.

Transportation casks containing TAD canisters will be (1) moved to the CRCF or RF for placement of the TAD canisters in aging overpacks and movement to the Aging Facility or (2) moved to the CRCF for transfer of the TAD canisters to waste packages.

Transportation casks containing DPCs will be (1) moved to the CRCF or RF for placement of the DPC in an aging overpack and movement to the Aging Facility, (2) moved to the RF where the horizontal cask is placed on a transfer trailer and moved to the Aging Facility equipped with horizontal modules, or (3) moved to the WHF for opening of the DPC and transfer of the SNF assemblies to a TAD canister.

1.2.1.4.2.2 Waste Form Type

Commercial SNF—Commercial SNF that is received in a TAD canister is disposed of in a waste package. Uncanistered SNF assemblies and SNF assemblies received in DPCs will be transferred to TAD canisters and disposed of in waste packages. There is one waste package configuration for commercial SNF.

Naval SNF—Naval SNF canisters can only be transferred to a waste package. There are two waste package configurations for naval SNF: one to accommodate a single Naval Short canister and one to accommodate a single Naval Long canister.

HLW and DOE SNF—HLW canisters, DOE SNF canisters, and MCOs can be staged or transferred to a waste package. There are multiple codisposal HLW and DOE SNF waste package configurations for HLW and DOE SNF. The various waste package configurations are described in Section 1.5.2.

1.2.1.4.2.3 Waste Form Criticality Control

Criticality control for emplacement of the majority of the waste forms is provided by the canister designs. Canistered DOE SNF, HLW, and naval SNF have criticality controls internal to the canister, if required. No additional criticality controls for emplacement are necessary at the repository. TAD canisters with absorber plates have sufficient criticality control such that the majority of commercial SNF assemblies will be accommodated. A small percentage of PWR SNF assemblies have insufficient burnup and, therefore, require additional criticality control inside the TAD canisters (e.g., disposable control rod assemblies). Other commercial SNF outliers include damaged and consolidated SNF. These elements will be analyzed on a case-by-case basis to demonstrate compliance with the preclosure and postclosure waste form criticality control criteria as described in Sections 1.14 and 2.2, respectively.

1.2.1.4.2.4 Waste Form Thermal Power

HLW, DOE SNF, and naval SNF waste forms will be received in canisters with sufficiently low thermal power that they can be directly placed into a waste package. TAD canisters with thermal power greater than the waste package limits will be aged until the thermal power decreases to an acceptable value for emplacement.

TAD canisters may have a higher thermal power capacity than the waste package thermal power limit in order to promote efficient and timely loading of TAD canisters at the nuclear power plant.

The surface facilities include staging racks and an Aging Facility that provide the flexibility to queue the received TAD canisters and match them with the thermal limitations of the waste packages.

1.2.1.4.2.5 Waste Form Condition

The operating strategy of the repository is to ensure adequate confinement of the SNF prior to transfer between transportation casks, waste packages, TAD canisters, other suitable containers, and the staging racks, while limiting the number of handling steps and reducing the likelihood of a drop or collision involving waste. Adequate confinement of the DOE SNF, HLW, and naval SNF is provided by their respective canisters. Similarly, TAD canisters provide adequate confinement for commercial SNF shipped to the repository in TAD canisters. Adequate confinement for uncanistered commercial SNF assemblies means that gross fuel particles cannot escape during transfer and that the volume of the fuel is known for effective implementation of the waste package thermal and criticality loading requirements. The objective is to provide the SNF assembly with adequate confinement so it can be transferred to a TAD canister and emplaced in a configuration that meets the repository thermal and criticality control requirements. The repository uses the definitions and failed fuel classes of 10 CFR 961, Appendix E, when evaluating the handling options for commercial SNF.

Commercial SNF assemblies not received in a TAD canister but without previously documented or visual evidence of gross cladding failure are considered to have adequate integrity and may be transferred directly from the transportation cask or DPC to a TAD canister or a staging rack. This includes commercial SNF identified as standard whether intact or Failed Fuel Class F-2. Standard SNF assemblies that are placed in a damaged-fuel can are considered to have adequate confinement. The damaged-fuel cans may be transferred to a TAD canister or a staging rack.

Commercial SNF assemblies that have documented or visual evidence of gross cladding failure (Failed Fuel Class F-1) are handled as an off-normal operation in the WHF pool. Furthermore, when any SNF assembly is suspected to have lost adequate confinement, the SNF assembly is handled as off-normal. Any commercial SNF assembly that does not conform with the design or analysis will be treated as a nonconforming item. The nonconformance will be evaluated and dispositioned in accordance with the repository management system. Based upon the results of the evaluation, the SNF assembly is transferred to a TAD canister or is placed in a damaged-fuel can specifically designed and certified for the receiving TAD canister before it is transferred. Then, the TAD canister is transferred to a waste package. The layout of the WHF provides sufficient flexibility in conjunction with appropriately staged TAD canisters so that undamaged SNF assemblies can be transferred normally to a TAD canister.

In the event that a canister is found to be damaged, it will be identified as a nonconforming item. The damaged canister will be evaluated to determine the capability to safely continue waste handling operation and its suitability for emplacement. Based upon the safety evaluation, the canister will be used as is, repaired or reworked until acceptable, or rejected. In the unlikely event that the canister is rejected, a special procedure will be developed to control the opening of the rejected canister and transfer of the contents to an alternative canister.

1.2.1.4.3 Loading Records

Loading records will be maintained at the repository with a backup copy located off site, as described in Section 5.2. The records include the databases and operations records described below:

- Shipping records
- Total inventory database
- Facility databases
- Waste package/TAD canister databases
- Emplacement drift databases.

The total inventory database records contain entries for each canister and commercial SNF assembly received at the repository. Canister type, unique identifier, and thermal power derived from reactor records are recorded. Enrichment, burnup, date of removal from the reactor, type of assembly, assembly identifier, and any special features are recorded for SNF assemblies. The current location of each canister or commercial SNF assembly at the repository with a history of movement is maintained. The history of movement will include shipping records, date of arrival, dates of transfers, and specific locations from which and to which the transfers are made.

Facility databases will be maintained for each handling facility. These databases cross-reference the total inventory database and will be linked such that local databases cannot be changed without updating the total inventory. The facility databases are used by operations to ensure facility capacities and technical limits will not be exceeded.

The waste package and TAD canister loading plans will be maintained for each individual waste package and TAD canister, and the emplacement drift loading plan will be maintained for each emplacement drift in the repository.

As operations proceed, real-time changes will be made to keep the inventory properly updated. Operating procedures will ensure each change in the physical location of waste forms, waste packages, or canisters is entered into the proper database. An independent checker will verify each entry to a database. The records in the databases will enable material custodians to maintain control and accounting of the fissile materials at the repository.

1.2.1.4.4 Controls

Operating procedures will reference the waste package, TAD canister, and emplacement drift loading plans. Each waste transfer will be independently verified by a unique identifier to be in conformance with the applicable loading plan. Waste transfers will be videotaped or otherwise visually documented. Loading plans, Onsite Safety Committee participation, and procedural safety controls will be used to enhance the reliability of loading activities. Operating procedures will include steps that ensure handling and operations can be completed within the capacity of the equipment used. Identification of canisters and assemblies will be checked to ensure they are appropriate for the loading positions assigned.

1.2.1.5 Phased Operation and Construction Activities
[NUREG-1804, Section 2.1.1.2.3: AC 6(1)]

The surface facilities will be constructed in phases. Barriers and procedural controls will prevent construction activities from interacting with the operating facilities.

The initial operating capability for the surface facilities will be provided by the IHF, CRCF 1, WHF, and EDGF. It will be supported by the CCCF, Cask Receipt Security Station, railcar and truck buffer areas, switchyard, Standby Diesel Generator Facility, Aging Facility, Heavy Equipment Maintenance Facility, and utilities. The surface facilities will then be expanded until the full operational capacity is in place. The first expansion will add the RF. The second expansion will add CRCF 2 and additional Aging Facility areas as needed up to a maximum aging capacity of 21,000 MTHM. The final phase of expansion adds the third CRCF; at that time, the surface facilities will be capable of the maximum throughput. At the completion of each expansion of operating capability, safe operations can be performed in the operational facilities without any reliance on facilities under construction. The protected area will be enlarged at each expansion of operating capability to provide the appropriate separation between operations and construction. Figure 1.1-3 shows the changes in the protected area during phased repository development.

1.2.1.5.1 Separation of Construction Work Areas from Operating Areas

The construction of the surface facilities is planned to allow the GROA to be developed in phases to include facilities as they are completed and turned over to operations. Figure 1.1-2 shows the GROA at the completion of construction. The protected area will be protected by a barrier that expands as the additional facilities are completed. The barrier physically separates construction areas from operating areas. Construction areas have temporary access and parking areas that are separate from the permanent operating areas. Construction areas have separate security and access procedures. Construction personnel do not have access to restricted or protected areas of the operating facilities and are considered to be nonoccupationally exposed individuals. Cranes and other construction equipment are placed to physically prevent extension over barriers and operating facilities.

1.2.1.5.2 Geologic Repository Operations Area—Area-Wide Systems

Certain systems are designed to service the entire GROA. These include electrical distribution, electrical support, digital control and management information, service utilities, and fire protection systems and are described in Sections 1.4.1 through 1.4.4. These systems will be required to support initial operations while construction activities continue. The design includes provisions to extend piping, tubing, ducting, and cabling through the barrier separating the construction areas from the operations areas before the barrier is expanded so that the barrier will not be affected by construction activities. The operating systems have isolation points on both sides of the barrier that will be administratively controlled and routinely checked by security and/or operations personnel. Construction plans and activities will be reviewed against the PCSA to ensure that no activity on the development side of the barrier affects the operating area. Temporary construction systems will be provided separately and solely on the development side of the barrier.

1.2.1.5.3 Startup and Operations

Once construction is completed on a surface facility, the barrier is expanded to include the completed facility within the protected area as appropriate. Construction turns over systems, rooms, and areas to startup in accordance with approved startup plans as described in Section 5.5. Initially, electrical systems are turned over following connection to permanent plant power. Next, after utility systems have been flushed and/or purged, they are turned over to permanent plant services under the supervision of plant operations. Common systems are operated by startup, under oversight of plant operations, until startup turnover to operations. Once an area has been turned over to operations, punchlist cleanup activities are conducted under operations supervision and direction.

1.2.1.5.4 Construction-Related Hazards

Hazards analyses are conducted prior to commencement of construction activities that could potentially impact operating portions inside the protected area of the GROA. Based on these analyses, barriers or other physical devices are provided to ensure that a construction-related initiating event cannot generate a Category 1 or Category 2 event sequence for the operating facilities.

1.2.1.6 General References

BSC (Bechtel SAIC Company) 2008a. *Postclosure Modeling and Analyses Design Parameters*. TDR-MGR-MD-000037 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080108.0002.

BSC 2008b. *Preclosure Procedural Safety Controls*. 000-30R-MGR0-03600-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080313.0002.

NRC (U.S. Nuclear Regulatory Commission) 1997. *Standard Review Plan for Dry Cask Storage Systems*. NUREG-1536. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20010724.0307.

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Table 1.2.1-1. Surface Facility Analyzed Throughput over Preclosure Period

Item Type	Facility	Number of Items
TAD Canisters	IHF	0
	CRCF	8,143
	WHF	1,165
	RF	6,978
DPCs	IHF	0
	CRCF	346
	WHF	346
	RF	346
HLW Canisters	IHF	1,000
	CRCF	9,801
	WHF	0
	RF	0
DOE SNF Canisters	IHF	0
	CRCF[a]	3,751
	WHF	0
	RF	0
Naval SNF Canisters	IHF	400
	CRCF	0
	WHF	0
	RF	0
Uncanistered Commercial SNF Assemblies	IHF	0
	CRCF	0
	WHF	33,104
	RF	0

Table 1.2.1-1. Surface Facility Analyzed Throughput over Preclosure Period (Continued)

Item Type	Facility	Number of Items
Waste Packages	IHF	600
	CRCF	11,668
	WHF	0
	RF	0
	Total[b] to Subsurface	12,068

NOTE: [a]Includes MCO.
[b]200 waste packages involving HLW can be loaded in either the IHF or CRCF. The total number of waste packages has been adjusted by 200 to account for this handling flexibility.

Table 1.2.1-2. Postclosure Procedural Safety Controls for Intrasite and Non-Facility Specific Controlling Parameters

Structure, System and Component	Postclosure Control Parameter		Relevant to ITWI	Design Criteria/Configuration[a]	Postclosure Procedural Safety Control[b]
	Parameter Number and Title	Values, Ranges of Values or Constraints			
Waste Package	03-20 Materials Contacting the Waste Package	After fabrication final cleaning, the waste package shall be prepared for shipment. Materials or objects contacting the waste package outer surfaces during transportation, loading, and emplacement will be evaluated to ensure that any physical degradation and contamination are within allowable limits.	No	The fabrication specification for the waste package will contain requirements to establish acceptable surface conditions of the waste packages. Witness and hold points will be incorporated into the specification to ensure that surface conditions conform to the specifications. Handling equipment will be designed to minimize such occurrences as part of normal handling.	The waste package storage, preparation, canister transfer, closure, loadout and emplacement procedures will be developed and include handling requirements to limit activities that could physically degrade or contaminate the surface of the waste package. Operating procedures will require identification and evaluation of physical degradation or contamination or exposure to adverse substances. Warehouse procedures will require visual receipt inspection of the waste packages. Waste package preparation procedures will require visual inspection of the empty waste package before it is placed into the waste package transfer trolley. Waste package loadout procedures will require visual inspection of the loaded waste package as it moves to the TEV from the waste package transfer trolley.

Table 1.2.1-2. Postclosure Procedural Safety Controls for Intrasite and Non-Facility Specific Controlling Parameters (Continued)

Structure, System and Component	**Postclosure Control Parameter**		**Relevant to ITWI**	**Design Criteria/Configuration**[a]	**Postclosure Procedural Safety Control**[b]
	Parameter Number and Title	**Values, Ranges of Values or Constraints**			
Waste Package (Continued)	03-21 Waste Package Handling	The waste package shall be handled in a controlled manner during fabrication, handling, transport, storage, emplacement, installation, operation, and closure activities to minimize damage; surface contamination; and exposure to adverse substances.	Yes	The fabrication specification for the waste package will contain requirements to establish acceptable surface conditions of the waste packages, including damage, surface contamination and exposure to adverse substances. Witness and hold points will be incorporated into the specification to ensure that surface conditions conform to the specifications. Handling equipment will be designed to minimize such occurrences as part of normal handling.	The waste package storage, preparation, canister transfer, closure, loadout and emplacement procedures will be developed and include handling requirements to limit activities that could physically degrade or contaminate the surface of the waste package. Operating procedures will require identification and evaluation of damage, surface contamination, or exposure to adverse substances. Warehouse procedures will require visual receipt inspection of the waste packages. Waste package preparation procedures will require visual inspection of the empty waste package before it is placed into the waste package transfer trolley. Waste package loadout procedures will require visual inspection of the loaded waste package as it moves to the TEV from the waste package transfer trolley.
	03-26 Waste Package Moisture Removal and Inerting	Waste packages shall be vacuum dried and backfilled with helium in a manner consistent with that described in NUREG-1536, *Standard Review Plan for Dry Cask Storage Systems* (NRC 1997, Section 8.V.1).	Yes	(Background Information: Equipment to inert the waste package is described in Section 1.2.4.2.3.)	The waste package closure procedure will be based upon the accepted methods for cask loading described in Section 8.0, V of NUREG-1536, *Standard Review Plan for Dry Cask Storage Systems* (NRC 1997), including inerting. The waste package will be evacuated to less than or equal to 3.0 mm Hg or Torr. The waste package will be backfilled with helium as the cover gas and leak tested. Two operators will independently confirm the evacuation, pressure check, backfill, and leak test of the waste package.

Table 1.2.1-2. Postclosure Procedural Safety Controls for Intrasite and Non-Facility Specific Controlling Parameters (Continued)

Structure, System and Component	Postclosure Control Parameter		Relevant to ITWI	Design Criteria/Configuration[a]	Postclosure Procedural Safety Control[b]
	Parameter Number and Title	Values, Ranges of Values or Constraints			
Waste Package (Continued)	03-22 Waste Package Handling and Emplacement	Waste package handling and emplacement activities shall be monitored through equipment with resolution capable of detecting waste package damage. An operator and an independent checker shall perform the operations. Records demonstrating compliance shall be maintained	No	(Background Information: Equipment used for inspection of the waste package transfer is addressed in Section 1.2.4.2.4.2.)	Waste package preparation procedures will require visual inspection of the empty waste package before it is placed into the waste package transfer trolley and documentation of inspections. Waste package loadout procedures will require visual inspection of the loaded waste package as it moves to the TEV from the waste package transfer trolley and require documentation of the inspections. These inspections will be performed independently by two operators. Sufficient lighting and cameras with adequate resolution will be available in the waste package loadout rooms to perform the inspections.
Waste Form and TAD Canister	04-06 Maximum Temperature of HLW Glass Canisters Waste Form	The maximum HLW glass temperature shall be less than 400°C.	No	The handling facility HVAC systems are designed to maintain the HLW glass temperature below 400°C during normal and off normal conditions as described in Sections 1.2.3.4 and 1.2.4.4. As part of the design development, off-normal operating procedures will be developed to restore HVAC as soon as possible after it is lost.	NA

Table 1.2.1-2. Postclosure Procedural Safety Controls for Intrasite and Non-Facility Specific Controlling Parameters (Continued)

Structure, System and Component	**Postclosure Control Parameter**		**Relevant to ITWI**	**Design Criteria/Configuration**[a]	**Postclosure Procedural Safety Control**[b]
	Parameter Number and Title	**Values, Ranges of Values or Constraints**			
Waste Form and TAD Canister (Continued)	04-07 Waste package capacities	5-HLW/DOE SNF codisposal waste packages: Either 5 HLW glass canisters (including no more than 1 lanthanide borosilicate glass canister) and 1 DOE SNF canister in the center position (short loading allowed), or 1 24-in. DOE SNF canister and 4 HLW canisters (center position empty and no lanthanide borosilicate glass canisters) (short loading allowed).	Yes	The cask port, waste package port, and TAD canister slide gates of the canister transfer subsystem are equipped with interlocks as described in Section 1.2.4.2.2.	The canister transfer operating procedures will identify the acceptable loading configurations for the codisposal waste packages, including the acceptable number and location in the waste package of the HLW and DOE SNF canisters. A unique warning will address the limitations imposed on HLW canisters containing lanthanide borosilicate glass.
	04-08 Handling of waste forms	Waste form handling operations shall be performed in a standard industry fashion to limit damage. An operator and an independent checker shall perform the operations.	No	NA	The operating procedures for the repository will be prepared in accordance with nuclear industry standards for operations procedures. The operating procedures will include appropriate prerequisites, cautions, and warnings. Operations will be conducted by trained operators. As appropriate, critical steps in the handling processes will be independently verified.

Table 1.2.1-2. Postclosure Procedural Safety Controls for Intrasite and Non-Facility Specific Controlling Parameters (Continued)

Structure, System and Component	Postclosure Control Parameter		Relevant to ITWI	Design Criteria/Configuration[a]	Postclosure Procedural Safety Control[b]
	Parameter Number and Title	Values, Ranges of Values or Constraints			
Waste Form and TAD Canister (Continued)	04-09 Waste Package and TAD Canister Excluded Materials	Materials that have not been previously analyzed shall not be placed in the waste package, nor in the TAD canister that will be placed into the waste package.	Yes	NA	Procedures for TAD canister loading and canister transfer procedures will specifically identify the items that are allowed to be placed inside a TAD canister (PWR or BWR SNF assemblies or damaged fuel cans) or waste package (TAD canister, naval SNF canister, DOE SNF canister, or HLW canister). The procedures will also identify steps to exclude foreign material. The loading plans prepared before a particular waste package or TAD canister is loaded will uniquely identify the canister, TAD canister, or commercial SNF assembly to be placed in the waste package or TAD canister by the items' unique identifiers. Controls and accountability logs combined with closeout inspections, as appropriate, will be established to limit unauthorized materials entry into the canister or waste package.

NOTE: [a]Design Criteria Configuration—This column provides the design criteria, specification or configuration, as applicable, of the design that implements the subject Postclosure Control Parameter in the GROA. If the design criteria, specification or configuration is to be implemented by procurement of manufactured goods, then this is identified in the table as such.
[b]Procedural Safety Control—This column provides a description of the procedural safety control that must be performed operationally on the GROA that is necessary to implement the subject postclosure parameter.
ITWI = important to waste isolation; NA = not applicable.

Source: BSC 2008a.

Table 1.2.1-3. Preclosure Procedural Safety Controls

Item	Facility/ Operations Area	SSC	Procedural Safety Controls	Basis	Implementation Description
PSC-10	IHF, CRCF, RF, WHF, Subsurface, Intra-Site	ITS SSCs	The amount of time that a waste form spends in each process area or in a given process operation, including total residence time in a facility, is periodically compared against the average exposure times used in the PCSA. Additionally, component failures per demand and component failures per time period are compared against the PCSA. Significant deviations will be analyzed for risk significance.	PCSA uses residence times and reliability data to calculate the probability of an initiating event. This control ensures that the average exposure times and reliability data are maintained consistent with those analyzed in the PCSA.	Waste handling procedures for each facility will include the collection of waste form residence time data and ITS SSC reliability data. An administrative program will be developed that collects the residence time and reliability data and provides for the periodic assessment of the consistency with the PCSA.
PSC-19	Aging facility	TAD canisters and DPCs	The surface contamination on TAD canisters and DPCs sent to the Aging Facility is less than 1.0×10^{-4} μCi/cm^2 for beta-gamma emitters and low-toxicity alpha emitters and 1.0×10^{-5} μCi/cm^2 for all other alpha emitters.	This control is to ensure that the dose consequences from airborne releases of contamination from the canisters on the aging pads are within the calculated values presented in Tables 1.8-25, 1.8-28, 1.8-29, 1.8-32, and 1.8-36.	The canister transfer operating procedures for the CRCF, RF, and WHF will include a warning that the surface contamination levels of loaded TAD canisters and DPCs to be sent to the Aging Facility are an important constraint in the preclosure safety analysis. The canister transfer operating procedures will require swipe surveys of the exterior surface of loaded TAD canisters and DPCs prior to transfer into an aging overpack. The swipe surveys will be performed in accordance with the practices in the Operational Radiation Protection Program. The surface contamination measured will be required to comply with the limits established for TAD canisters and DPCs prior to leaving the CRCF, RF, or WHF.

Table 1.2.1-3. Preclosure Procedural Safety Controls (Continued)

Item	Facility/ Operations Area	SSC	Procedural Safety Controls	Basis	Implementation Description
PSC-23	LLWF	NA	Dose rate measurements and associated conversions are performed to confirm that the following conditions are maintained in the LLWF: • Total radionuclide inventory on WHF pool resins and pool filters is at or below 2.3×10^3 Ci. • Total radionuclide inventory on the WHF stage 1 ITS HEPA filters is at or below 6,600 Ci. • Radionuclide concentration in the low-level liquid waste tanks is limited to dose equivalents of 1×10^{-3} Ci/m^3 of ^{60}Co and 1.5×10^{-3} Ci/m^3 of ^{137}Cs.	This control is to ensure that the dose consequences from Category 2 event sequences involving these waste forms are within the values presented in Table 1.8-30 and Table 1.8-31. Table 1.8-6 and Table 1.8-7 provide the bases for the numerical values.	The LLWF operating procedures will include a warning that the radionuclide inventory in the LLWF is an important constraint in the preclosure safety analysis. The LLWF operating procedures will include a procedure for maintaining a running inventory of the radionuclide content of the following solid and liquid low-level radioactive waste streams stored at the LLWF until processed for offsite disposal: • Pool water treatment and cooling system ion exchanger resins. • Pool water treatment and cooling system filters (underwater, vacuum unit, roughing and polishing). • WHF secondary confinement exhaust HEPA filters. • Liquid in low-level waste collection tanks. The radionuclide inventory of these waste streams will be determined following the practices in the Operational Radiation Protection Program.
PSC-24	IHF, CRCF, RF, WHF, Intra-site, Subsurface	Cranes and handling equipment	When not in use, cranes, mobile platforms, and handling equipment are maintained in a location such that they cannot fall on a waste form.	The seismic analysis credits the exposure time of components over waste forms. This control ensures that the exposure time is limited to the time necessary to complete waste handling operations.	Operating procedures will include a warning that minimizing the time that cranes, mobile platforms, and handling equipment are located over waste forms is an important constraint in the preclosure safety analysis. The operating procedures will provide instructions to move the cranes, mobile platforms, and handling equipment to a location away from the waste form when not in use.

NOTE: LLWF = Low-Level Waste Facility; NA = not applicable.

Source: BSC 2008b, Table 1.

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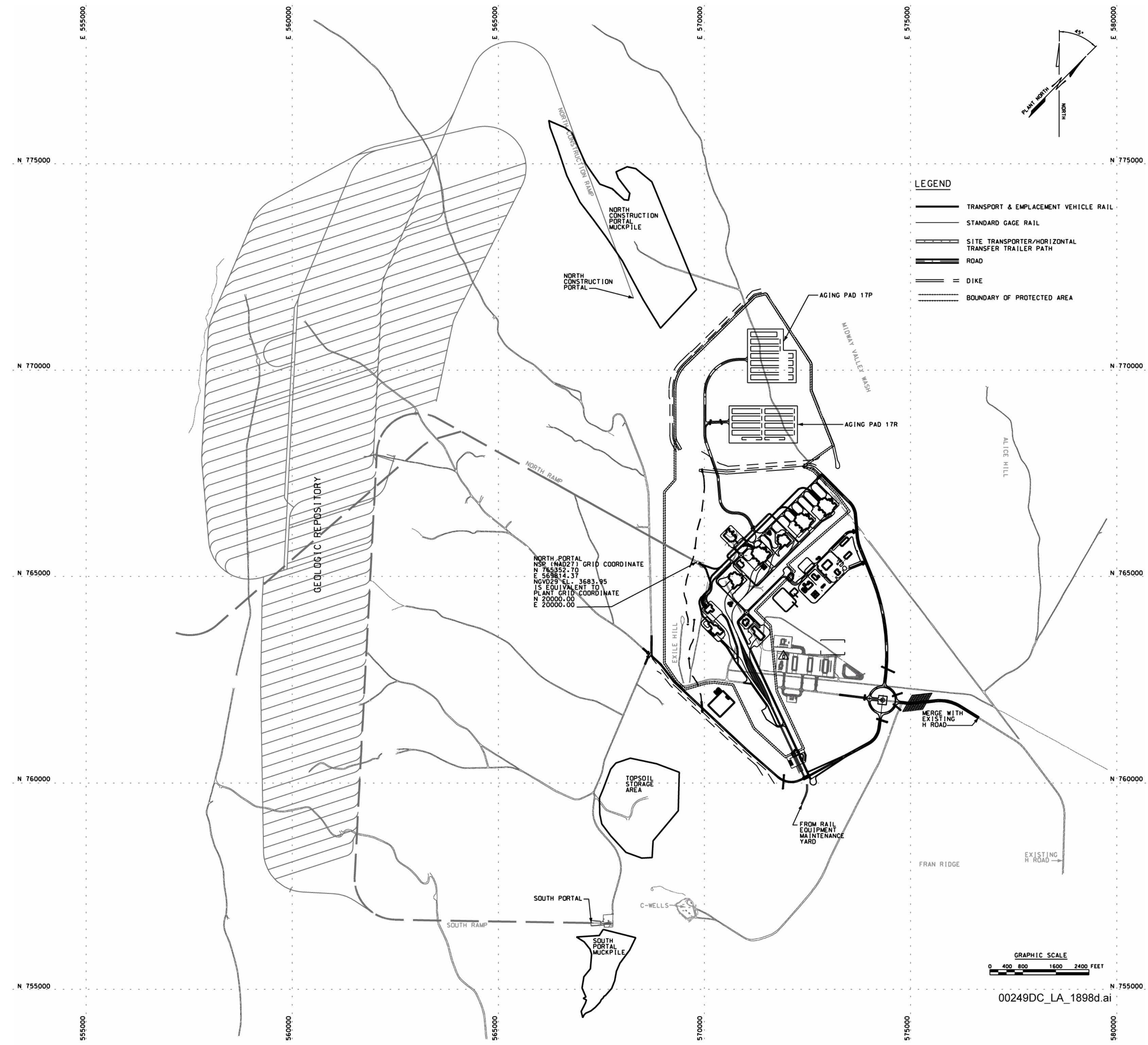

Figure 1.2.1-1. Geologic Repository Operations Area Site Plan

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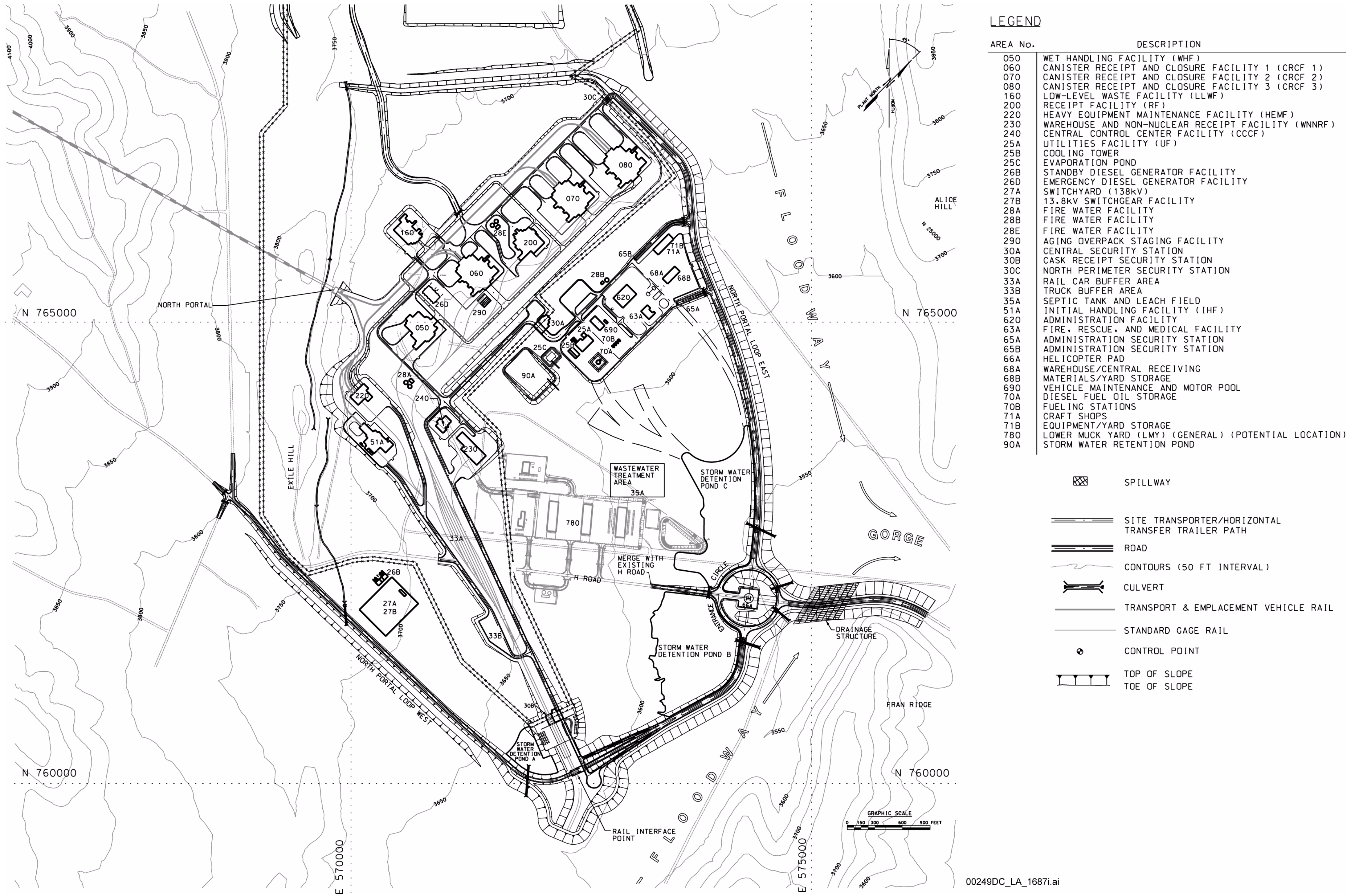

Figure 1.2.1-2. Geologic Repository Operations Area North Portal Site Plan

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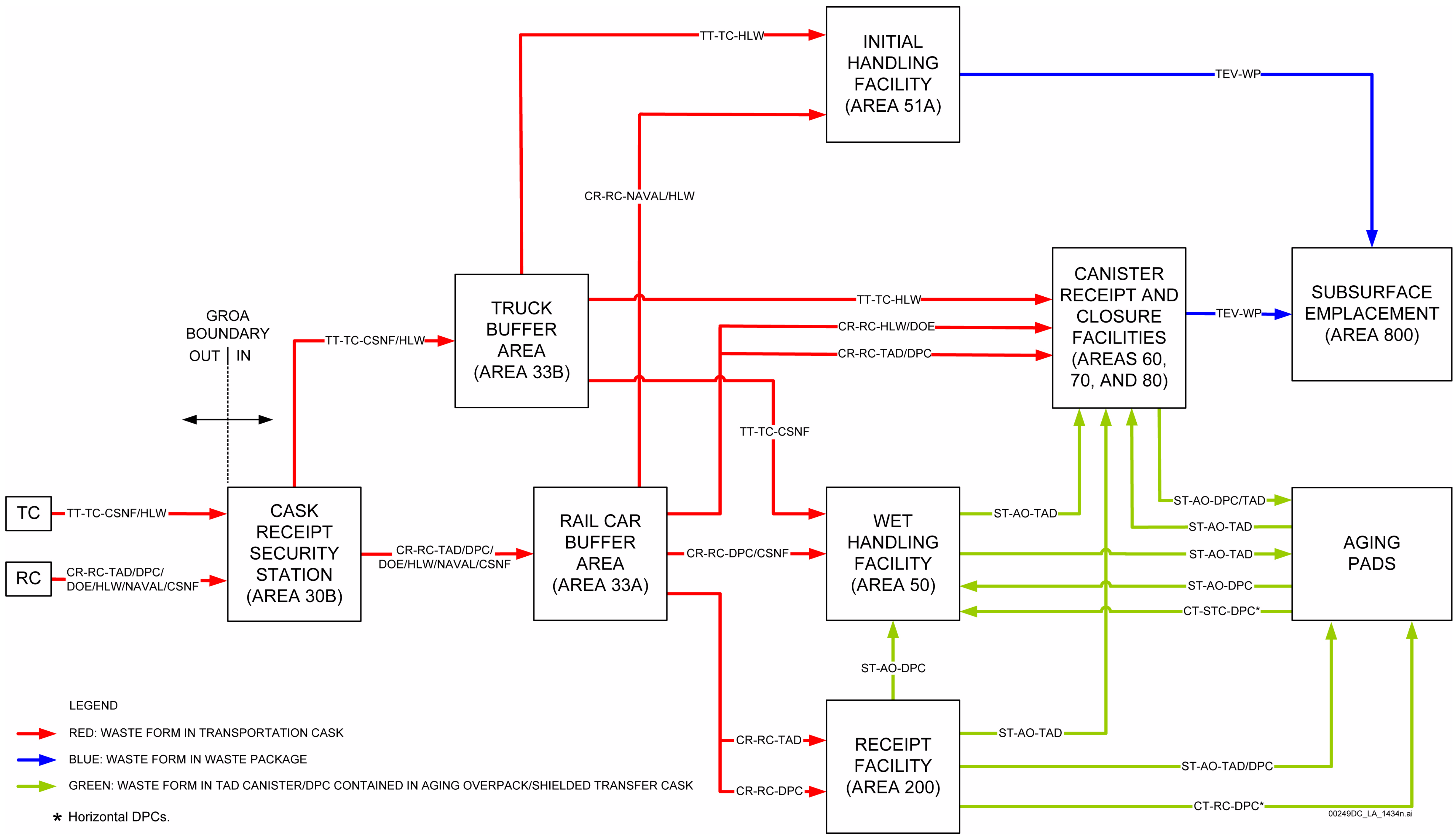

NOTE: AO = aging overpack; CR = commercial rail; CSNF = uncanistered commercial SNF; CT = cask tractor and cask transfer trailer; DOE = DOE SNF canister; HLW = HLW canister; Naval = naval SNF canister; RC = rail cask/overpack; ST = site transporter; STC = shielded transfer cask; TC = truck cask/overpack; TT = truck trailer; WP = waste package.

Figure 1.2.1-3. Overview of Surface Operations

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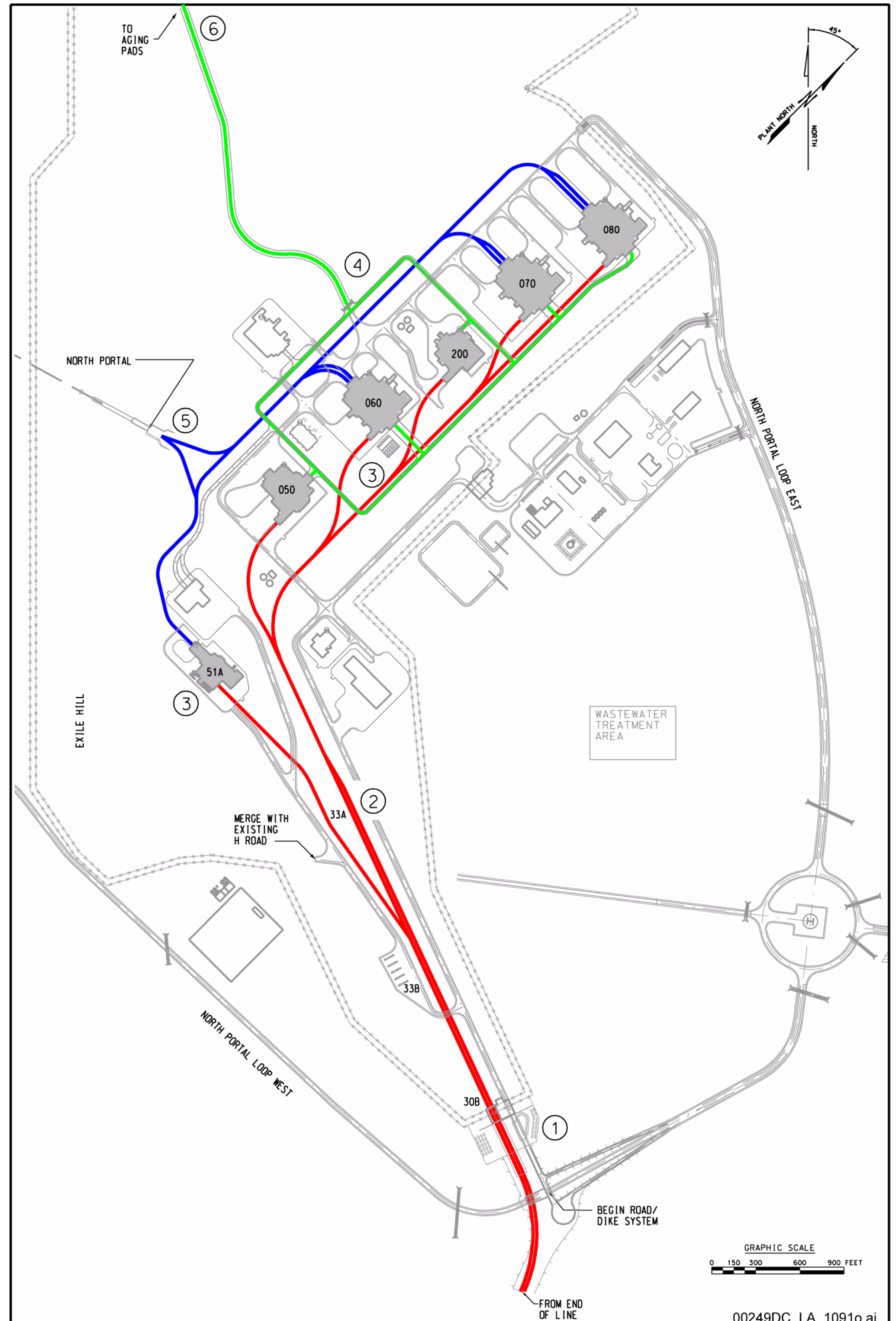

LEGEND

(1) INITIAL RECEIPT, WASTE ACCEPTANCE CRITERIA CONFIRMATION, SECURITY ENTRY INSPECTION, AND RADIOLOGICAL SURVEY.

(2) SHORT-TERM QUEUING OF TRANSPORTATION CASKS IN BUFFER AREA.

(3) RECEIPT OF TRANSPORTATION CASKS AND WASTE PACKAGES BY WASTE HANDLING FACILITY.

(4) TRANSPORT OF TRANSPORTATION, AGING, AND DISPOSAL CANISTERS AND DUAL-PURPOSE CANISTERS TO AGING PADS.

(5) TRANSPORT OF LOADED WASTE PACKAGE TO ASSIGNED EMPLACEMENT DRIFT.

(6) AGING FOR BLENDING OF WASTE PACKAGE CONTENTS.

TRANSPORTATION CASKS
WASTE PACKAGES
AGING OVERPACK/SHIELDED TRANSFER CASK

FACILITIES

050	WET HANDLING FACILITY
060/070/080	CANISTER RECEIPT AND CLOSURE FACILITY
51A	INITIAL HANDLING FACILITY
200	RECEIPT FACILITY
30B	CASK RECEIPT SECURITY STATION
33A	RAIL CAR BUFFER AREA
33B	TRUCK BUFFER AREA

Figure 1.2.1-4. Normal Movement of Transportation Casks, Waste Packages, Canisters, Aging Overpacks, and Shielded Transfer Casks

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FIGURES

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1.2.2 Surface Facilities Structural, Mechanical Handling Equipment, and Heating, Ventilation, and Air-Conditioning System Design

[NUREG-1804, Section 2.1.1.1.3: AC 5, Section 2.1.1.2.3: AC 1, AC 2; Section 2.1.1.6.3: AC 1; Section 2.1.1.7.3.1: AC 1; Section 2.1.1.7.3.2: AC 1; Section 2.1.1.7.3.3(I): AC 1, AC 2, AC 3, AC 4; HLWRS-ISG-02 Section 2.1.1.2.3: AC 2]

The design considerations, concepts, and solutions that are applicable to the repository surface facilities' structures, systems, and components (SSCs) that are important to safety (ITS), including the mechanical handling and heating, ventilation, and air-conditioning (HVAC) systems and components, are discussed in this section. The nuclear safety design bases required to meet credited safety functions performed by ITS surface facilities and SSCs are identified by the preclosure safety analysis (PCSA) and are presented in Section 1.9.

The design bases and supporting design information presented are based on the risk-informed, performance-based regulatory framework of 10 CFR Part 63. Additionally, experience from the deterministic methods employed for commercial nuclear design, industry codes and standards endorsed by the U.S. Nuclear Regulatory Commission (NRC), and proven technology in use at other NRC-licensed facilities of comparable or higher risk than the repository are incorporated as appropriate. *Project Design Criteria Document* (BSC 2007a) provides the design criteria necessary to support the development of design for repository SSCs. *Basis of Design for the TAD Canister-Based Repository Design Concept* (BSC 2008a) provides the programmatic and technical requirements that provide the basis for engineering design activities involving the transportation, aging, and disposal (TAD) canister-based repository design concept.

The design bases and supporting design information for the structural aspects of the surface facilities and the mechanical handling and HVAC components that are similar throughout the facilities are discussed in this section. Unique design bases or supporting design information applicable to a particular SSC are discussed in Sections 1.2.3 through 1.2.8.

The surface facilities are designed to receive, age, transfer, and package a variety of physical forms of spent nuclear fuel (SNF) and high-level radioactive waste (HLW) for emplacement in the repository. The surface facilities are designed for a minimum service life of 50 years.

1.2.2.1 Structural Design

[NUREG-1804, Section 2.1.1.1.3: AC 5(8); Section 2.1.1.2.3: AC 1(2), AC 2(1), (2), (4); Section 2.1.1.6.3: AC 1(2)(h); Section 2.1.1.7.3.1: AC 1(1) to (5), (9); Section 2.1.1.7.3.2: AC 1(1), (2), (4); Section 2.1.1.7.3.3(I): AC 1(1), AC 2(1) to (3), AC 3, AC 4(1) to (5)]

1.2.2.1.1 Structural Design Description

The structural design of the surface waste handling facilities and other ITS structures is addressed in Section 1.2.2.1. The layout of the facilities, processes performed in the facilities and SSCs contained in the facilities are addressed in Sections 1.2.3 through 1.2.8. The Initial Handling Facility (IHF) building consists of a multilevel, steel, braced-frame structure with both interior and exterior reinforced concrete substructures for waste handling and a reinforced concrete mat foundation. The Canister Receipt and Closure Facility (CRCF), Wet Handling Facility (WHF), and Receipt Facility (RF) buildings are multilevel, low-rise, cast-in-place, reinforced concrete structures with structural steel vestibules. These concrete structures consist of interior and exterior shear walls, reinforced concrete floors and roof slab diaphragms, and reinforced concrete mat foundations. Additionally, the WHF building contains a 52-ft-deep pool constructed of thick reinforced concrete walls and mat. The continuity between the pool structure and the basemat of the superstructure is reflected in the mathematical models used in analysis. This continuity does not permit any differential movement between the top of the pool and the base of the structure under seismic loads. As a result of this continuity, there are interface forces during a seismic event, and the interface is designed for these forces. The aging pads consist of reinforced concrete slabs on grade to support the aging overpacks.

The reinforced concrete walls, slabs, and roofs are provided with steel reinforcing bars in each direction, placed at both concrete faces with appropriate concrete cover, to provide the strength requirements to withstand the design loadings.

The foundations for the IHF, CRCF, WHF, and RF are reinforced concrete mat foundations having the thickness necessary to completely support the superstructures of each facility (BSC 2007b; BSC 2007c; BSC 2007d; BSC 2008b). The aging pads are also reinforced concrete mat foundations (BSC 2007e). The reinforced concrete mat foundations include horizontal reinforcing steel bars placed in each direction at the top and bottom surfaces with appropriate concrete cover to resist the applied moments and forces. Also, vertical reinforcing steel bars (stirrups) are provided in areas of the mat foundation where the demand shear forces require additional shear capacity to supplement the capacity provided by the concrete alone. The mat foundation and steel reinforcing bar configurations are consistent with nuclear industry practices for the design and construction of reinforced concrete structures and foundations. Typical concrete reinforcement sections are provided in Figures 1.2.2-1 through 1.2.2-4. A typical section through the IHF showing the structural steel layout is provided in Figure 1.2.2-5.

The foundations have been designed such that the bearing pressure imparted by the structures for various loading and load combinations are within the bearing capacity of the underlying soil with due consideration for settlement. In addition, foundation stability against overturning, sliding, and potential uplift due to lateral loads has been addressed in the design.

The structures are founded on alluvium or engineered fill above the alluvium layer. The engineered fill has material properties equivalent to that of the underlying alluvium. None of the structures are entirely founded on fill (Figure 1.2.2-6).

1.2.2.1.2 Operational Processes

There are no operational processes associated with the facility structures. The structures are passive components.

1.2.2.1.3 Safety Category Classification

The following structures are ITS:

- Aging pads
- CRCF
- IHF
- RF
- WHF.

The general arrangements of the facilities are presented in figures in Sections 1.2.3 through 1.2.8. Some portions of these facilities are not ITS; the figures are annotated to show the ITS portions.

1.2.2.1.4 Procedural Safety Controls to Prevent Event Sequences and Mitigate Their Consequences

There are no procedural safety controls required to achieve a particular configuration of the structures to reduce the frequency or mitigate the consequences of event sequences during waste handling.

1.2.2.1.5 Design Bases and Design Criteria

The nuclear safety design bases and their relationships to design criteria for the ITS structures of the waste handling facilities are presented in Sections 1.2.3 through 1.2.8.

1.2.2.1.6 Design Methodologies

The following paragraphs describe the types of loads and parameter values that are considered in the design of the surface structures. This includes the design considerations and methodology for design of SSCs for effects from loads, such as wind and tornado, flood, load drop, seismic, snow, and other loads.

1.2.2.1.6.1 Wind and Tornado Design

The surface facilities are designed to withstand the effects of tornado wind pressures, differential pressures, and rate of pressure drop. Additionally, these facilities are evaluated to determine the results of tornado-generated missile impacts.

Wind and tornado design criteria are provided in the following paragraphs. These evaluations demonstrate the ability of the structures to perform their intended safety functions for wind and tornado loading conditions.

1.2.2.1.6.1.1 Design Basis Wind

Wind loads (*W*) result from applied wind pressures. Wind loads are static loads calculated in accordance with *International Building Code 2000* (ICC 2003) using a wind velocity based on Yucca Mountain site-specific conditions.

The design basis wind is developed in accordance with the American Society of Civil Engineers standard ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*. It uses the minimum design 3-second (basic) wind speed of 90 mph for the Yucca Mountain area.

Structures exposed to ambient wind conditions are designed for a basic wind speed of 90 mph. This value is used for the design of both ITS SSCs and non-ITS SSCs.

1.2.2.1.6.1.2 Design Basis Tornado

Tornado loads (W_t) result from the effects of tornado wind pressure, tornado-created differential pressure, and tornado-generated missiles.

The design basis tornado characteristics are developed in accordance with Regulatory Guide 1.76 except for Table 1, Region III, to develop design parameters for the design basis tornado. NUREG/CR-4461 (Ramsdell and Andrews 1986) is used to develop the conservative design parameters for the design basis tornado. The guidance is used to establish the following parameters for the design basis tornado:

- Maximum wind speed: 189 mph
- Pressure drop: 0.81 psi
- Rate of pressure drop: 0.3 psi/s.

Tornado-generated missiles are in accordance with Spectrum II from NUREG-0800 (NRC 1987, Section 3.5.1.4). The minimum wall thickness of exterior concrete walls for ITS portions of structures is 24 in. The minimum roof slab thickness for ITS portions of structures is 18 in. Evaluations of the ITS SSCs for the effects of tornado missile impacts are performed in accordance with *Design of Structures for Missile Impact* (Linderman et al. 1974) utilizing the guidance of Regulatory Guide 1.117.

1.2.2.1.6.1.3 Determination of Forces on Structures

The design basis wind is converted to velocity pressure in accordance with ASCE 7-98 using the following formula:

$$q_z = 0.00256\, K_z\, K_{zt}\, K_d I\, V^2$$

in which

q_z = velocity pressure in psf

K_z = exposure coefficients; varies based on structure height (ASCE 7-98, Table 6-5)

K_{zt} = topographic factor = 1.0

K_d = wind directionality = 0.85

I = importance factor = 1.15 (ASCE 7-98, Table 6-1, for Category III buildings or Category IV buildings)

V = design basis wind velocity = 90 mph.

The gust factors and building pressure coefficients are in accordance with ASCE 7-98. The manner in which the design basis wind load is combined with other applicable design loads is given in Section 1.2.2.1.9.

The design basis tornado wind is converted to effective velocity pressure using the following formula:

$$q = 0.00256\ V^2$$

in which

q = velocity pressure in psf
V = tornado wind velocity in mph.

The manner in which the total tornado load is combined with other applicable loads is given in Section 1.2.2.1.9. The method of combining the three individual tornado-generated effects (wind load, differential pressure load, and missile load) is in accordance with Section 3.3.2 of NUREG-0800 (NRC 1987) as presented in the following:

i. $W_t = W_w$
ii. $W_t = W_p$
iii. $W_t = W_m$
iv. $W_t = W_w + 0.5W_p$
v. $W_t = W_w + W_m$
vi. $W_t = W_w + 0.5W_p + W_m$

in which

W_t = total tornado load
W_w = tornado wind load
W_p = tornado differential pressure
W_m = tornado missile load.

1.2.2.1.6.1.4 Missile Impact Load

Missile impact loads (Y_m) or drop loads are treated as live loads with impact. Postulated dropped loads are evaluated for local damage such as penetration, perforation, and spalling of a concrete slab, as well as structural integrity.

1.2.2.1.6.2 Water Level (Flood) Design

An external flash flood may be initiated by episodes of high-intensity rainfall. The Yucca Mountain area is located inland and has no large surface water bodies or water-control structures located near the site, so there is no potential for events such as surges, seiches, tsunamis, dam failures, or ice jams that could affect the site. There is no potential for future dam development. However, flash floods could potentially impact buildings, transportation casks, waste packages, canisters, or transporters.

1.2.2.1.6.2.1 Flood Elevations

The Yucca Mountain repository surface facility design is based on the probable maximum flood event described in Section 1.1.4. Due to the naturally sloping topography of the Yucca Mountain region, the repository surface facilities are sited at differing elevations. Therefore, the probable maximum flood level varies at different locations of the site. The probable maximum flood level in the northernmost regions of the geologic repository operations area (GROA) in the vicinity of the aging pads is approximately 3,844 ft mean sea level (National Geodetic Vertical Datum of 1929). To the east of CRCF 3, the probable maximum flood level is approximately 3,672 ft mean sea level. The probable maximum flood level near the Cask Receipt Security Station, the southernmost reaches of the GROA, is approximately 3,636 ft mean sea level.

1.2.2.1.6.2.2 Flood Protection

The ITS surface facilities are protected against the probable maximum flood by locating the structures above the probable maximum flood elevation or by engineered barriers such as dikes or drainage channels. Figure 1.2.2-7 provides the site flood protection barrier layout and sections. Engineered barriers, such as ditches and dikes, have been sized to prevent inundation of ITS structures from a flood associated with the probable maximum precipitation event. The adequacy of these engineered barriers is demonstrated by verification of available freeboard for the areas subject to inundation along the entire length of each engineered barrier. ITS structures are located at or near the highest elevations of the North Portal and Aging Facility areas that are protected by engineered barriers. Adequate slopes are provided in these areas to preclude inundation of any ITS structures. The protection against flooding is in accordance with Regulatory Guide 1.102, *Flood Protection for Nuclear Power Plants*. The probable maximum flood is defined as the hypothetical flood, with peak discharge, volume, and hydrographic shape, that is considered the most severe reasonably possible flood, based on probable maximum precipitation and other hydrologic factors favorable for maximum flood runoff such as sequential storms and snowmelt. Probable maximum floods are statistical maximum predictions that are independent of time (ANSI/ANS-2.8-1992, *American National Standard for Determining Design Basis Flooding at Power Reactor Sites*). The probable maximum flood is described in Section 1.1.4. Table 1.2.2-1 provides the precipitation values.

1.2.2.1.6.3 Seismic Design

Table 1.2.2-2 identifies the seismic design considerations of ITS structures: safety classification, input ground motion, analytical models, and principal codes and standards.

Details of the methodology for seismic design and analysis are presented in *Preclosure Seismic Design and Performance Demonstration Methodology for a Geologic Repository at Yucca*

Mountain Topical Report (DOE 2007). Seismic design inputs, including design ground response spectra and design time histories, and the methodology for development for Yucca Mountain are discussed in *Supplemental Earthquake Ground Motion Input for a Geologic Repository at Yucca Mountain, NV* (BSC 2008c). To obtain seismic design forces, seismic analyses of the structures are performed using an analytical model that incorporates soil-structure interaction. The seismic analytical modeling is in accordance with ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary,* to determine the combination of modal and spatial seismic responses.

1.2.2.1.6.3.1 Seismic Design Input

To meet the performance objectives of 10 CFR Part 63, surface facilities that are ITS are designed for site-specific seismic ground motions. As discussed in Sections 1.1.5 and 2.2.2, a probabilistic seismic hazard analysis, in which a panel of experts provided characterizations of seismic sources and ground motion in the vicinity of Yucca Mountain, determined seismic motions for a hypothetical reference rock outcrop. The ground motions at the reference rock outcrop do not include effects of the local site materials (rock and soil). To determine motions for the surface GROA, the results of the probabilistic seismic hazard analysis are used to provide the basis for inputs to a site-response model. The site-response model takes into account the effects of the site materials on the ground motion. Site-specific ground motions for the surface GROA are developed for mean annual probabilities of exceedance that correspond to design basis ground motions (DBGMs): DBGM-1 (10^{-3}) and DBGM-2 (5×10^{-4}). Surface facility area ground motions are developed for a beyond DBGM mean annual probability of exceedance (10^{-4}).

As part of the site-response modeling process, strain-compatible soil profiles are generated for use in soil-structure interaction analyses. Soil profiles consist of strain-compatible values for shear-wave velocity, compression-wave velocity, and associated damping. For the site response model, a wide range of soil property variations has been considered. The free-field ground motion time histories and response spectra for the surface facilities area are used as input motions to the soil-structure interaction analysis discussed in Section 1.2.2.1.6.3.2.1.

Two levels of seismic ground motion (DBGM-1 and DBGM-2) are defined for use in the design of the ITS SSCs (DOE 2007). The probabilities of exceedance associated with DBGM-1 and DBGM-2 are consistent with NRC-licensed nuclear facilities with comparable or higher risks to workers and the public. Similar to other nuclear facilities, the repository handles SNF and HLW using conventional means of receiving, handling, and transferring in shielded structures (i.e., cranes, trolleys, and carts surrounded by thick reinforced concrete walls and slabs).

The applicable DBGM is dependent on the functions and risk significance of the ITS SSCs, as determined in the PCSA. DBGM-1 applies to ITS SSCs if the postulated loss of function due to a seismically initiated event results in a dose to the public or workers that exceeds the performance objectives of 10 CFR 63.111(a) and (b)(1) but does not exceed those of 10 CFR 63.111(b)(2). If the postulated dose to the public exceeds the objectives of 10 CFR 63.111(b)(2), the SSC is designed for DBGM-2 ground motions. If the ITS SSC is not included in a seismic event sequence, then the SSC is designed to the appropriate *International Building Code 2000* (ICC 2003) seismic requirements. The appropriate seismic design input is utilized in the development of the seismic design loading conditions for *E* in the loading combinations defined in Section 1.2.2.1.9.2.1 for reinforced concrete and Section 1.2.2.1.9.2.2 for structural steel.

Probabilistic seismic safety analyses to demonstrate compliance with the preclosure performance objectives in 10 CFR 63.111(b)(2) are described in Section 1.7. For each seismically initiated event sequence, the probabilistic seismic analyses demonstrate (1) that the probability of the event sequence is less than one in 10,000 before permanent closure, thus allowing the event sequence to be screened out; or (2) that the radiological dose consequences of each Category 2 event sequence meet the performance objectives of 10 CFR 63.111(b)(2). To determine the probability of a seismically induced event sequence, the event sequence is quantified in terms of its expected number of occurrences over the preclosure period. The quantification includes the convolution of the site-specific seismic hazard curve with the fragility curves of the ITS structures whose seismic failures are included in the event sequence. The beyond DBGM is used to develop the fragility curve for the ITS structures.

Seismic safety is achieved through a combination of two important design aspects: (1) conservatism in design codes, standards, and acceptance criteria; and (2) fragility assessments described in Section 1.7 that demonstrate adequate capacity exists to support regulatory compliance.

1.2.2.1.6.3.1.1 Design Response Spectrum

Table 1.2.2-3 summarizes the peak ground accelerations used in the design and evaluation of ITS SSCs. Horizontal and vertical ground response spectra at mean annual probabilities of exceedance of 10^{-3} (DBGM-1) and 5×10^{-4} (DBGM-2) are shown in Figures 1.2.2-8 through 1.2.2-11, respectively. Figures 1.2.2-12 and 1.2.2-13, respectively, show the horizontal and vertical ground response spectra at annual probability of exceedance of 10^{-4} (beyond DBGM). These response spectra are used in soil-structure interaction analysis to determine seismic forces on the structure.

1.2.2.1.6.3.1.2 Design Time History

The time histories used in design analyses are developed to be compatible with design spectra. Each set of time histories consists of two horizontal component records and one vertical component record. For a given mean annual exceedance probability and location of interest, one or more sets of time histories are developed. Time histories are used in soil-structure interaction analysis to determine the seismic responses of the structures in terms of in-structure response spectra. Horizontal and vertical time history motions in terms of acceleration, velocity, and displacements are developed for 1,000-year, 2,000-year, and 10,000-year return period ground motions (i.e., developed for 10^{-3}, 5×10^{-4}, and 10^{-4} annual probability of exceedance).

1.2.2.1.6.3.1.3 Damping Values

The structural damping values are given as a function of response level in members and are provided in ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*, Section 3.4.3, as an acceptable alternative to Regulatory Guide 1.61. Table 1.2.2-4 identifies specific damping values used in the analysis of the surface facility structures. The response level 2 described in ASCE/SEI 43-05 corresponds to DBGM-2.

1.2.2.1.6.3.2 Structural Design Approach for Seismic

The seismic analysis for structural design of ITS surface facilities is conducted using either a lumped-mass, multiple-stick model or a finite element model. These analyses demonstrate that the nuclear safety design basis functions are satisfied for each of the ITS surface facilities.

1.2.2.1.6.3.2.1 Soil–Structure Interaction

The foundation model and the seismic model of the structure are combined to form the soil-structure interaction model. Soil-structure interaction analysis of each structure includes:

- The layering effects of the supporting soil layers and the radiation damping associated with soil-foundation interaction
- Soil-structure interaction analysis with best estimate, upper-bound, and lower-bound soil property profiles.

1.2.2.1.6.3.2.2 Soil Model

Soil springs (also called the foundation impedance functions) and dashpots (damping coefficients) represent the interaction between the foundation basemat and the underlying soil under seismic loads.

Equations for these springs are in accordance with ASCE 4-98, Section 3.3.4.2. Impedances are determined for the median (best estimate) and upper- and lower-bound estimates of soil properties.

The soil properties are consistent with the properties used in the development of the DBGM and beyond DBGM ground motions. The strain-compatible shear modulus and damping from the free-field soil column analysis are used in the soil-structure interaction analysis. For buildings located on varying thickness of alluvium, soil-structure interaction analysis is performed using the range of alluvium thicknesses applicable to the building location.

1.2.2.1.6.3.2.3 Structural Model for CRCF, WHF, and RF

The CRCF, WHF, and RF structural concrete models (BSC 2006a; BSC 2008d; BSC 2008i; BSC 2007g; BSC 2008e; BSC 2007h; BSC 2006b; BSC 2008f; BSC 2007i) are conventional lumped-mass, multiple-stick models with global soil springs to account for soil structure interaction effects. The WHF model incorporates a pool model as part of the structural model that has an additional set of global soil springs attached to the pool foundation base to account for the different soil properties at the depth of the pool foundation.

The mathematical lumped-mass, multiple-stick models of the CRCF, WHF, and RF are developed using the general arrangement of the building configurations as the basis. The lumped-mass, multiple-stick model for these concrete structures consists of the lateral load-carrying resisting system of reinforced concrete diaphragms and shear walls. The shear walls are linked to the floors, roofs, and basemat. The roof and floor slabs act as building diaphragms. The mass of the concrete structure along with the estimated mass of components are lumped at the center of mass of each diaphragm. The rigid basemat is connected to the ground by soil springs. Figures 1.2.2-14 through 1.2.2-16 illustrate the lumped-mass, multiple-stick models used in the analysis of the CRCF, RF, and WHF structures and foundations (BSC 2007j, Section 7.3). Figure 1.2.2-17 shows how stick elements and rigid links are used in a typical reinforced concrete shear wall seismic model.

For these concrete structures, soil-structure interactions are represented using soil springs and dashpots for horizontal and vertical translation, rocking, and torsion effects using the impedance method in accordance with ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary*, Section 3.3.4.

Seismic demand forces and appropriate static load demand forces are combined using defined load cases to determine critical load combinations for design of primary structural members. Structural members are designed according to code requirements as specified in Section 1.2.2.1.8.

The WHF pool is evaluated for sloshing of water due to a seismic event. This analysis determined water pressures imposed on the pool walls and the amount of freeboard required to prevent spilling of pool water on the WHF pool area floor.

Code capacities, based on concrete member dimensions, and number and spacing of steel reinforcing bars are determined and compared to the demand conditions to ensure adequate code compliance for the primary structural members of reinforced concrete shear walls, floor and roof slabs, and the building mat foundation. Similarly, structural steel member properties and demand stress conditions are determined and compared to the code allowable capacities to ensure adequate code compliance for the primary steel members.

In addition to the ITS concrete structure, the CRCF, RF, and WHF each include an ITS structural steel vestibule for the transportation casks. The WHF also includes an ITS structural steel vestibule for the site transporter. Each vestibule is analyzed using a three-dimensional finite element model of the steel frame structure with a fixed base. The vestibule model is separate from the concrete model. There is a seismic separation joint between the concrete structure and the structural steel vestibule.

The structural steel vestibule models for the seismic analyses are developed and analyzed using the finite element program SAP 2000. The seismic forces and moments determined by the analyses of the seismic ground motions are combined with the nonseismic forces and moments to compute the demand loads and stresses in the structural elements. Conformance with governing design code requirements is then verified by ensuring that the code capacities exceed the demand conditions.

1.2.2.1.6.3.2.4 Structural Model for IHF and Aging Pads

The analysis of the IHF utilizes a three-dimensional finite element model of the steel frame structure and both the inner and outer concrete waste package handling substructures without soil springs and dashpots (fixed base analysis) (Figure 1.2.2-18). The IHF exterior loadout area is separated from the main structure through the use of a seismic separation joint running from the foundation slab to the roof (BSC 2008; BSC 2008g; BSC 2007l; BSC 2008h).

The aging pads are modeled as finite element plates with soil springs attached to each node of the element (Figure 1.2.2-19).

Structural models for the seismic analysis are developed using the finite element program SAP 2000. Nodes are typically permitted to have six degrees of freedom each, three translations and three rotations. The concrete base mats, floor slabs, and walls are typically modeled by shell elements. Gross concrete thicknesses are typically assigned to these plate elements. The structural steel columns, beams, and braces are represented by frame elements.

The mass of heavy equipment components is included in the model. Heavy equipment components whose positions can vary such as cranes are located in the models to maximize overall structure seismic response. Lumped masses are included to represent other weights supported by the structure.

The aging pads are analyzed for each of the soil profiles (best estimate, lower-bound, and upper-bound). The use of three soil profiles accounts for uncertainties in soil properties in accordance with NUREG-0800, Section 3.7.2, Subsection II.4 (NRC 1987).

The seismic forces and moments determined by the analyses of seismic ground motions are combined with the nonseismic forces and moments to compute the demand loads and stresses in the structural elements. These demand loads and stresses are then used to determine member properties, dimensions, and spacing in accordance with the governing code requirements. Conformance with governing design code requirements is then verified by ensuring that the code capacities exceed the demand conditions (BSC 2007j).

1.2.2.1.6.3.3 Summary of Results

The analysis results are presented in this section. The results of the building analyses are used to provide the input forces in the loading combinations addressed in Section 1.2.2.1.9.2. Additionally, the structural response for each ITS structure is provided in Tables 1.2.2-5 and 1.2.2-6 and described below. The results show that the surface facilities are adequate to withstand the site-specific ground motions without loss of structural integrity or collapse.

1.2.2.1.6.3.3.1 Structural Responses

Structural responses to be described:

- **Acceleration**—Table 1.2.2-5 provides the diaphragm accelerations for the governing case soil conditions.

- **Displacement**—Table 1.2.2-6 provides the story displacements for the governing case soil conditions and shows that they are less than the acceptance criteria in ASCE/SEI 43-05.

- **Consideration of Torsion and Rocking**—The analytical models used in the seismic analyses account for the geometrical relationships between the elements of the structure and their masses. The member forces obtained from the analyses include the torsional and rocking effects from the actual eccentricities. In addition to the actual torsion, an "accidental" torsion is incorporated into the design in accordance with ASCE 4-98 (Section 3.1.1(e)).

1.2.2.1.6.3.3.2 Overall Shears

The building story shears are provided in Table 1.2.2-7. The shears are the summation of same-direction shear wall in-plane shear forces, which are subject to the same direction of horizontal ground motion spectra.

1.2.2.1.6.3.4 Seismic Analysis of Systems and Components

Seismic analysis of ITS systems and components that are relied upon for seismic event sequences are performed using a response spectrum method of dynamic analysis. Input to the seismic analysis of systems and components is the in-structure response spectra.

Other ITS systems and components that are not relied upon for seismic event sequences are designed in accordance with the seismic requirements of *International Building Code 2000* (ICC 2003).

1.2.2.1.6.4 Snow and Ice Design

Snow loads (S_N) are static loads resulting from the accumulation of snow. Surface structures are designed to withstand a maximum daily snowfall of 6 in. and a maximum monthly snowfall of 6.6 in. Snowfall and snow depth are not measured under the meteorological monitoring program at Yucca Mountain. Parameters are based on records from Desert Rock Weather Service Meteorological Observatory, Nevada, which is located approximately 45 km southeast of the repository and are representative of the site.

1.2.2.1.6.5 Volcanic Ash Design

Ash fall (A) is defined as airborne volcanic ash, such as fine pyroclastic material, falling from an ash cloud and accumulating on the surface of the earth. Ash fall may occur at the repository. As discussed in Section 1.1.6, ash fall loads are estimated at 21 lb/ft^2. Ash fall loads are considered as roof live loads, and the load combinations consider roof live loads or ash fall in the analyses (BSC 2007a, Section 6.1.11).

1.2.2.1.7 Consistency of Materials with Design Methodologies

The following are the principal materials used in the construction of ITS surface structures. As allowed by the listed applicable codes and standards, equivalent materials may be used.

Concrete Structures

- Cement
  - ASTM C 150, *Standard Specification for Portland Cement*

- Reinforcement Steel
  - ASTM A 706/A 706 M, *Standard Specification for Low–Alloy Steel Deformed and Plain Bars for Concrete Reinforcement*
- Embedments
  - ASTM A 36/A 36M, *Standard Specification for Carbon Structural Steel*.

Steel Structures

- Structural Steel
  - ASTM A 36/A 36M, *Standard Specification for Carbon Structural Steel*
  - ASTM A 53/A 53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
  - ASTM A 588/A 588M, *Standard Specification for High–Strength Low–Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance*
- High-Strength Bolts
  - ASTM A 325-06, *Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*.

Material Properties

The properties of concrete used in the design analysis of the surface facilities include:

- Concrete unit weight, γ_{conc} = 150 pcf
- Concrete compressive strength, f'_c = 4,000 or 5,000 psi
- Concrete Young's modulus, E_{conc} = $E_c = 3.83 \times 10^6$ psi (for $f'_c = 4{,}000$ psi)
$E_c = 4.29 \times 10^6$ psi (for $f'_c = 5{,}000$ psi)
- Concrete Poisson's ratio, v = 0.17
- Reinforcing steel yield strength, f_y = 60,000 psi
- Reinforcing steel modulus, E_{steel} = 29×10^6 psi.

Properties of steel used in the design analysis of the surface facilities include:

- Modulus of elasticity = $E_{steel} = 29 \times 10^6$ psi
- Poisson's ratio, v = 0.3
- Density γ = 490 pcf.

Soil properties used in the design analysis of the surface facilities include:

- In-place unit weight of soil = 114 to 117 pcf
- Mohr-Coulomb soil friction angle (ϕ) = 39°
- Lateral soil coefficient for at-rest conditions = 0.37
- Lateral soil coefficient for passive conditions = 4.4
- Lateral soil coefficient for active conditions = 0.23
- Soil/concrete coefficient of friction (μ) = 0.81.

Properties of engineered backfill used in the design analysis of the surface facilities include:

- In-place unit weight of engineered fill = 127 pcf
- Mohr-Coulomb engineered fill friction angle (ϕ) = 42°
- Lateral engineered fill coefficient for at-rest conditions = 0.33
- Lateral engineered fill coefficient for passive conditions = 5.0
- Lateral engineered fill coefficient for active conditions = 0.20
- Engineered fill/concrete coefficient of friction (μ) = 0.90.

1.2.2.1.8 Structural Design Codes and Standards

The principal codes and standards applicable to the design of the structures are:

- Concrete
  - ACI 349-01/349R-01, *Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)* (for ITS)
  - ACI 318-02/318R-02, *Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02)* for concrete structures that are non-ITS
  - *International Building Code 2000* (ICC 2003) for concrete structures that are non-ITS
  - ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*
- Structural Steel:
  - *Manual of Steel Construction, Allowable Stress Design* (AISC 1997)
  - ANSI/AISC N690-1994, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities,* with Supplement No. 2

– ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*

– *International Building Code 2000* (ICC 2003)

– AWS D1.1/D1.1M:2006, *Structural Welding Code — Steel*

- Nonstructural and Miscellaneous Steel:

  – *Manual of Steel Construction, Allowable Stress Design* (AISC 1997)
  – ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*
  – *International Building Code 2000* (ICC 2003)
  – AWS D1.1/D1.1M:2006, *Structural Welding Code — Steel*.

1.2.2.1.9 Structural Load Combinations

The surface facilities are designed for loads and load combinations described below.

The ITS SSCs are designed for the applied normal loads, Category 1 event sequence loads, and Category 2 event sequence loads and loading conditions discussed in the following paragraphs. Numerical values of natural phenomena loading parameters are provided in Table 1.2.2-1.

1.2.2.1.9.1 Design Loads

Dead Loads—Dead loads (*D*) on facility structures include the static self-weight of the structure and the weight of permanently installed equipment.

Live Loads—Live loads (*L*) are those static loads produced by the use and occupancy of the building or structure. Live loads include the weight of equipment not permanently installed, lifted loads, and loads other than dead loads that might be experienced and are not separately identified and used in the applicable load combinations. These include normal and off-normal handling and impact loads from equipment. Impact loads for the crane include equipment loads imposed on the crane through supporting members of the building and loads induced by the acceleration and deceleration of the crane bridge, gantry, or trolley.

Roof live loads (L_r) are static loads resulting from maintenance on the roof, including the load of workers, equipment, and materials, and from movable objects, such as temporary equipment. Roof live loads are in accordance with the *International Building Code 2000* (ICC 2003).

Earthquake (Seismic) Load—Earthquake loads (*E*) are dynamic loads that result from the direct and secondary effects of the DBGM earthquake. Seismic analysis methods for the determination of seismic forces used in ITS building design are discussed in Section 1.2.2.1.6. Non-ITS structures are designed in accordance with *International Building Code 2000* (ICC 2003).

Lateral Earth Pressure Load—Lateral earth pressure loads (*H*) are static loads applied to buried walls resulting from soil density and depth, as well as loads based on surface surcharge loads that are applied adjacent to buried walls. The minimum surcharge load is determined to be 300 lb/ft^2 for normal vehicular traffic passing near buried walls (BSC 2007a, Section 4.2.11.3.5).

During seismic events, there are additional dynamic lateral earth pressure load increments due to DBGM-1 or DBGM-2 on buried wall structures.

The static at-rest lateral earth pressure and dynamic lateral earth pressures are used in the design of buried structures. Additionally, the dynamic lateral and static earth pressures, as appropriate, are used in the stability evaluation of structures.

Hydrostatic lateral earth pressure, corresponding to probable maximum groundwater levels, is nonexistent at the repository surface facilities because the water table is approximately 1,280 ft beneath the surface structures (Section 1.1.4.2.3).

Thermal Loads—Thermal loads (T) are loads resulting from normal operating (T_o) and event sequence (T_a) thermal conditions. Temperature distributions and thermal gradients within the SSCs are computed and applied to determine the effects of thermal conditions.

ITS structures are designed for movements resulting from the maximum seasonal temperature change and for the lags between air temperatures and the interior temperatures of massive concrete members or structures. The extreme outdoor ambient temperature ranges from 2°F to 116°F (BSC 2007a, Section 6.1.6).

Temperature effects on structural steel elements are evaluated in accordance with *Manual of Steel Construction, Allowable Stress Design* (AISC 1997, Part 6). Temperature effects on structural concrete elements are evaluated in accordance with ACI 349-01/349R-01, *Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)*, Appendix A.

Wind Loads—Wind loads (W) for structures are calculated in accordance with the *International Building Code 2000* (ICC 2003) using basic wind speed of 90 mph.

Snow and Ice Loads—Snow and ice loads (S_N) are static loads resulting from the accumulation of snow.

Ash Loads—Ash load (A). The roof of the structure shall withstand a design basis volcanic ash fall (Live Load (L and L_r)). Ash fall loads are considered as roof live loads, and the load combinations shall consider roof live loads or ash fall in the analyses.

Fluid Loads—Fluid loads (F) include loads resulting from the weight and pressure of fluids with well-defined densities and controllable maximum heights. Fluid loads include the effects of seismically induced horizontal sloshing in accordance with ASCE 4-98 (Section 3.5.4.3).

Operating Pipe Reaction Loads—Operating pipe reaction loads (R_o) include static loads resulting from piping reactions during normal, operating, and shutdown conditions.

Missile Impact Loads—Missile impact loads (Y_m) or drop loads are live loads with impact factors.

1.2.2.1.9.2 Load Combinations

The following load combinations are used in the design and analysis of surface facility structures that are ITS. These are consistent with industry codes, standards, and regulatory guidance applied to other nuclear facilities.

1.2.2.1.9.2.1 Reinforced Concrete Structures

Reinforced concrete structures are designed for seismic levels and other applied loads in accordance with the strength design method (NRC 1987). Load combinations applicable to normal, Category 1, and Category 2 event sequence conditions are defined below. These are in accordance with ACI 349-01/349R-01, Section 9.2, and NUREG-0800 (NRC 1987, Section 3.8.4, Paragraphs II.3.b(II) and II.5.a).

The calculated applied forces and moments (U) used in the strength design method for reinforced concrete in accordance with ACI 349-01/349R-01 (BSC 2007a) are as follows (the other values are defined above for each type of load):

1. $U = 1.4D + 1.7L + 1.7(L_r \text{ or } A) + 1.4F + 1.7H + 1.7R_o$
2. $U = 1.4D + 1.7L + 1.7S_N + 1.4F + 1.7H + 1.7R_o$
3. $U = 1.4D + 1.7L + 1.7L_r + 1.4F + 1.7H + 1.7R_o + 1.7W$
4. $U = 1.4D + 1.7L + 1.7S_N + 1.4F + 1.7H + 1.7R_o + 1.7W$
5. $U = 1.05D + 1.3L + 1.3(L_r \text{ or } A) + 1.05F + 1.3H + 1.05T_o + 1.3R_o$
6. $U = 1.05D + 1.3L + 1.3S_N + 1.05F + 1.3H + 1.05T_o + 1.3R_o$
7. $U = 1.05D + 1.3L + 1.3L_r + 1.05F + 1.3H + 1.3W + 1.05T_o + 1.3R_o$
8. $U = 1.05D + 1.3L + 1.3S_N + 1.05F + 1.3H + 1.3W + 1.05T_o + 1.3R_o$
9. $U = D + L + L_r + F + H + T_o + R_o + E$
10. $U = D + L + L_r + F + H + T_o + R_o + W_t$
11. $U = D + L + S_N + F + H + T_o + R_o + E$
12. $U = D + L + L_r + F + H + T_a + R_o$
13. $U = D + L + S_N + F + H + T_a + R_o$
14. $U = D + L + L_r + F + H + T_a + R_o + E + Y_m$
15. $U = D + L + L_r + F + H + T_a + R_o + W_t$
16. $U = D + L + S_N + F + H + T_a + R_o + E + Y_m$
17. $U = D + L + S_N + F + H + T_a + R_o + W_t$

1.2.2.1.9.2.2 Structural Steel Design Load Combinations

Steel structures are designed for seismic levels and other applied loads in accordance with ANSI/AISC N690-1994, *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities,* with Supplement No. 2. The load combinations applicable to normal, Category 1, and Category 2 event sequence conditions are evaluated to determine the controlling combination for the structural steel design. They are based on ANSI/AISC N690-1994, Table Q1.5.7.1, and NUREG-0800 (NRC 1987, Section 3.8.4, Paragraphs II.3.c.i(a), II.3.c.ii(a), and II.5).

The calculated applied loads (S) used to determine design stresses for design per allowable stress method are as follows (the other values are defined above for each type of load):

1. $S = D + L + (L_r \text{ or } A)$
2. $S = D + L + S_N$
3. $S = D + L + (L_r \text{ or } A) + R_o + T_o$
4. $S = D + L + S_N + R_o + T_o$
5. $S = D + L + L_r + W$
6. $S = D + L + S_N + W$
7. $S = D + L + L_r + W + R_o + T_o$
8. $S = D + L + S_N + W + R_o + T_o$
9. $1.6S = D + L + L_r + R_o + T_o + E$
10. $1.6S = D + L + S_N + R_o + T_o + E$
11. $1.6S = D + L + L_r + R_o + T_o + W_t$
12. $1.6S = D + L + S_N + R_o + T_o + W_t$
13. $1.6S = D + L + L_r + T_a + R_o$
14. $1.6S = D + L + S_N + T_a + R_o$
15. $1.7S = D + L + L_r + T_a + R_o + E + Y_m$
16. $1.7S = D + L + S_N + T_a + R_o + E + Y_m$
17. $1.7S = D + L + L_r + T_a + R_o + W_t$
18. $1.7S = D + L + S_N + T_a + R_o + W_t$

1.2.2.1.9.2.3 Overturning and Sliding

The stability of the building structure against overturning and sliding is evaluated for the conditions identified below.

1. $D + H + W$
2. $D + H + E$
3. $D + H + W_t$

The stability against overturning is verified using a static evaluation approach of comparing forces and moments versus resistance, using a factor of safety of 1.5 for load combination 1, and 1.1 for load combinations 2 and 3.

If the static approach is not possible, stability against overturning is evaluated by the methodology provided in ASCE/SEI 43-05 (Sections 7.2 and A.2), or by the energy approach. Using the energy approach, the factor of safety against overturning is calculated as the ratio of potential energy required to cause overturning about one edge of the structure to the maximum kinetic energy in the structure due to the earthquake.

The results of the building overturning analyses are provided in Table 1.2.2-8. The ITS buildings have sufficient resistance against overturning and meet the factors of safety described above.

Building sliding is evaluated by the use of the reserve energy approach recommended in ASCE/SEI 43-05 (Section 7.2), or the time history approach. The results of the sliding analyses are provided in Table 1.2.2-8 and demonstrate that the building displacements are inconsequential to the structural integrity of the building. There are no interactions between adjacent ITS structures due to sliding. ITS components, such as electrical cables, piping, or ducts routed into the building from the surrounding yard or underground, are designed with adequate flexibility so that these components withstand the results from the building displacement without loss of any credited safety function.

1.2.2.1.10 Structural Design for Construction of the Surface Facilities

Detailed structural analyses are performed to support design of the surface nuclear facilities for construction. These seismic analyses use a three-dimensional, finite element mathematical model of the structural components (i.e., concrete shear walls, floors and slabs, foundation mats, and structural steel members) of the surface nuclear facilities. The three-dimensional, finite element model is integrated with the SASSI2000 software program to perform a soil-structure interaction analysis.

The input motion for the seismic analysis using SASSI2000 consists of three simultaneous ground motion acceleration time histories, one in each of the three orthogonal directions, at a user-specified control point. To calculate the seismic response of the structure, SASSI2000 first generates transfer functions at selected frequencies. These transfer functions are convolved by the Fourier transform of the input motion resulting in the solution in the frequency domain. The time histories of the seismic response are then calculated as the inverse of the Fourier transforms of the response.

The mass of heavy equipment components is included in the SASSI2000 model. Heavy equipment components whose positions can vary such as cranes are located in the models to maximize overall structure seismic response. Lumped masses are included to represent other weights supported by the structure.

The structural damping values are given as a function of response level in members and are provided in ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*, Section 3.4.3. ITS structures are designed for DBGM-2 to satisfy code requirements.

Each structure is analyzed for each of the soil profiles (best estimate, lower-bound, and upper-bound). The use of three soil profiles accounts for uncertainties in soil properties in accordance with NUREG-0800, Section 3.7.2, Subsection II.4 (NRC 1987). Excitation input to the analysis of a particular soil stiffness case consists of the free-field earthquake acceleration time histories corresponding to that soil case. The control point for these input time histories is specified to be at the soil surface consistent with the site-response analysis. Simultaneous input is acceptable because the NUREG-0800, Section 3.7.2, Subsection II.6.b requirement on statistical independence of the three orthogonal acceleration time histories is satisfied (NRC 1987).

The results of the seismic analysis is combined with the nonseismic forces and moments to compute the demand loads and stresses in the structural elements. These demand loads and stresses are then used to determine the detailed design of member sizes, dimensions, and connection details in accordance with the governing code requirements.

In-structure acceleration time histories obtained from SASSI2000 are calculated for selected nodes where structure seismic responses are required for equipment seismic qualification. The acceleration time histories are postprocessed to obtain in-structure acceleration response spectra.

In-structure response spectra at 3%, 4%, 5%, 7%, and 10% of critical damping are calculated at the selected nodes in accordance with NUREG-0800, Section 3.7.2, Subsections II.5.b and II.9 (NRC 1987), and Regulatory Guide 1.122, *Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components*. Frequency intervals for calculation of the in-structure response spectra are equal to or less than the suggested values in Table 1 of Regulatory Guide 1.122. In-structure response spectra at a given node for the three soil stiffness cases are enveloped. The node enveloped in-structure response spectra are then broadened by ±15% on frequency to account for modeling and analysis uncertainties and is in accordance with Regulatory Guide 1.122 (refer to Table 1.2.2-9 for clarification). The design in-structure response spectra for each structure are developed by enveloping the nodal response spectra over a sufficient number of nodes to account for the in-structure response in specific areas in the building.

1.2.2.2 Mechanical Handling Equipment Design

[NUREG-1804, Section 2.1.1.2.3: AC 1(4); AC 2(1), (2), (4); Section 2.1.1.6.3: AC 1(2)(h); Section 2.1.1.7.3.1: AC 1(1) to (5), (9); Section 2.1.1.7.3.2: AC 1(1), (2), (4); Section 2.1.1.7.3.3(I): AC 1(1), AC 2(1) to (3), AC 3, AC 4(1) to (5)]

SSCs used to lift, handle, or transport SNF and HLW are ITS and incorporate design features to minimize the potential for drops, collisions, and other types of mechanical impacts to loaded waste containers and uncanistered commercial SNF. Cranes, trolleys, transporters, and other SNF- and HLW-handling equipment incorporate design features to ensure a high degree of reliability with low probability of failure. Cranes include redundant design features for load-bearing components, braking systems, and travel limit switches. Mechanical handling equipment is designed to stop and hold its load on loss of power; operator action is required to restart handling equipment after power is restored. The travel paths of SNF and HLW within surface facilities are controlled to minimize the potential for collisions. Design features incorporated into cranes and other SSCs, such as travel speed limits, interlocks, and physical stops, preclude collisions.

Canisters, waste packages, casks, and overpacks containing SNF and HLW are handled using transfer machines, cranes, trolleys, and other equipment designed in accordance with accepted codes and standards (refer to Section 1.2.2.2.8). Mechanical handling components are designed to accommodate the weight of the anticipated loads, including the heaviest load and associated lifting devices or grapples. ITS hoisting equipment is designed in accordance with ASME NOG-1-2004, *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)*.

The PCSA credits the SNF and HLW mechanical handling equipment with performing the ITS functions described in Section 1.9. The design requirements for the SNF and HLW mechanical handling equipment are established to:

- Withstand seismically induced ground motions
- Preclude tipover
- Preclude collision resulting in breach of containment
- Preclude load path failures
- Limit lift heights.

Lift-height limits are established for mechanical handling equipment to ensure that in the unlikely event of a load drop, the probability or consequences of a breach are kept below analyzed conditions. These lift-height limits are incorporated into the equipment design by physically limiting how high a load can be lifted or carried and by the use of controls and instrumentation such as hoist travel limit switches. Additionally, energy-absorbing features may be used to mitigate the effects of a potential drop.

The level of reliability required from an ITS SSC is that credited in quantification of the event sequence(s) for which the SSC performs a safety function. The development of event sequences and the associated reliability of the SSCs required is discussed in Sections 1.6 and 1.7. The identification of SSCs as ITS is discussed in Section 1.9.

1.2.2.2.1 Mechanical Handling Equipment Description

The following paragraphs describe the types of mechanical handling equipment that are common to more than one of the handling facilities. The generic design aspects of the handling equipment are addressed in this section; the functions in specific handling processes and unique features are described in facility sections where the handling equipment is physically located. Facility-specific mechanical handling equipment is also described in the applicable facility section. The process and instrumentation diagrams, logic diagrams, and mechanical equipment envelope drawings are presented in the facility Sections 1.2.3 to 1.2.8.

Each waste handling surface facility and the subsurface facility have non-ITS seismic shutdown features in the design. Seismic shutdown switches mounted at suitable locations in the facilities interrupt electrical power to the ITS mechanical handling equipment designed to ASME NOG-1-2004 requirements, thus preventing movement during and after a seismic event; power remains off to this ITS mechanical handling equipment until reset by an operator.

Cranes—Overhead bridge cranes are used in the surface facilities to lift and transport casks and overpacks containing canistered or uncanistered waste. These ITS cranes are designed in accordance with ASME NOG-1-2004 for a Type I crane and have features such as load path redundancy, conservative design factors, overload protection, redundant braking systems, overtravel limit switches, and other protective devices to make the likelihood of a load drop extremely small. These cranes are also designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3.

Overhead bridge cranes and jib cranes are used in the surface facilities to handle loads over waste containers, such as for the removal and replacement of cask lids. Where required to reduce the probability of a load drop that could breach a waste container, the cranes are classified as ITS. The overhead bridge cranes are designed in accordance with ASME NOG-1-2004 for a Type I crane, and the jib cranes are designed in accordance with ASME NUM-1-2004 for a Type IA crane. Both types of cranes have features such as load path redundancy, conservative design factors, overload protection, redundant braking systems, overtravel limit switches, and other protective devices to make the likelihood of a load drop extremely small. These cranes are also designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3.

Overhead cranes, such as maintenance cranes, that do not handle waste forms and are required to remain in place during a seismic event are classified as ITS and are designed in accordance with ASME NOG-1-2004 for a Type II crane. These cranes are designed to meet the site-specific ground motions, described in Section 1.2.2.1.6.3, to preclude an adverse seismic interaction.

Other overhead and gantry cranes in the surface facilities are non-ITS and are designed using the methods and practices of ASME NOG-1-2004 for a Type III crane. Non-ITS cranes are physically separated from waste forms or are prohibited from carrying any load over loaded casks, loaded waste packages, canisters, or SNF assemblies that could breach the waste container or damage SNF assemblies if the load were to drop. This restriction is implemented through design features or operating procedures.

Canister Transfer Machine—The canister transfer machine is used in the surface facilities to transfer a waste canister from a cask or overpack to a waste package, overpack, or shielded transfer cask. This ITS machine is a special-purpose overhead crane with two trolleys operating on a single bridge. One trolley permanently supports a shield bell assembly, which is used to provide radiation shielding for the canister during transfer operations. The second trolley houses the hoisting machinery. The canister transfer machine is designed in accordance with ASME NOG-1-2004 for a Type I crane and has features such as load path redundancy, conservative design factors, overload protection, redundant braking systems, overtravel limit switches, and other protective devices to make the likelihood of a load drop extremely small. The canister transfer machine is also designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3.

Cask Transfer Trolley—The cask transfer trolley is used in the surface facilities to move a transportation cask from the cask preparation area to the cask unloading room and back. This ITS trolley consists of a steel platform and superstructure that supports the transportation cask. Removable steel pedestals are used to position the cask at the appropriate height for unloading. The trolley platform employs air film technology to support the weight of the trolley during movement. Air modules beneath the platform are pressurized with air, raising the trolley slightly and allowing it to be readily moved from one position to another using a traction drive system. Air is supplied via an umbilical hose.

The cask transfer trolley is designed in accordance with the requirements of ASME NOG-1-2004 applicable to a Type I crane trolley, except for the unique features associated with the pneumatic components, and has features such as conservative design factors, redundant systems, speed limitations, and other protective features to make the likelihood of a tipover, collision, or uncontrolled movement extremely small.

The cask transfer trolley is designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3. The trolley will not tip over but may slide during these seismic events. The trolley is free to slide without encountering an obstruction. For beyond design basis seismic events that produce greater movements, features are provided to limit trolley movement and prevent tipover. These features incorporate energy-absorbing capabilities as required to control impact forces on the cask.

Waste Package Transfer Trolley—The ITS waste package transfer trolley is used to transfer a waste package between stations for the purpose of loading the waste package, closing the waste package, and positioning the waste package to permit transfer to the transport and emplacement vehicle. The trolley incorporates a shielded enclosure for the loaded waste package that allows access to the top of the waste package for closure activities. A pedestal of the appropriate height is used within the shielded enclosure to position the top of the waste package at the required elevation for closure. The waste package transfer trolley operates on crane rails for movement between stations. It incorporates redundant electro-mechanical assemblies that rotate the shielded enclosure containing the waste package between the vertical and horizontal positions to permit horizontal transfer of the waste package to the transport and emplacement vehicle. The waste package transfer trolley is designed in accordance with the requirements of ASME NOG-1-2004 applicable to a Type I crane trolley and has features such as conservative design factors, redundant systems, speed limitations, and other protective features to make the likelihood of a tipover, collision, or uncontrolled movement extremely small. The waste package transfer trolley is also designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3. The trolley is equipped with seismic restraints that prevent derailment that could lead to a tipover situation. The seismic restraints are designed in accordance with the requirements of ASME NOG-1-2004.

Rails for Waste Package Transfer Trolley and Transport and Emplacement Vehicle—The rails for supporting the waste package transfer trolley are classified as ITS and are designed in accordance with the requirements of ASME NOG-1-2004. The portion of the rails within the waste package loadout room for supporting the transport and emplacement vehicle are classified as ITS.

Spent Fuel Transfer Machine—The ITS spent fuel transfer machine operates over and within the WHF pool to perform underwater transfer of pressurized water reactor (PWR) and boiling water reactor (BWR) SNF assemblies from transportation casks or dual-purpose canisters (DPCs) to TAD canisters or to/from pool staging racks. The spent fuel transfer machine is designed in accordance with ASME NOG-1-2004 for a Type I crane and has features such as load path redundancy, conservative design factors, overload protection, redundant braking systems, end-of-travel limit switches, and other protective devices to make the likelihood of a load drop extremely small. The spent fuel transfer machine is also designed to meet the site-specific ground motions described in Section 1.2.2.1.6.3.

Special Lifting Devices—ITS special lifting devices, such as cask yokes, canister grapples, and lifting beams, are used with ITS cranes or with the canister transfer machine to lift and transport casks, overpacks, or canisters containing waste. These special lifting devices are designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Non-ITS special lifting devices and non-ITS slings are designed using the methods and practices of ASME B30.20-2003 and ASME B30.9-2003, respectively.

1.2.2.2.2 Operational Processes

Operational processes that are common to the mechanical handling equipment and are relied upon for normal operations are addressed in Sections 1.2.3 to 1.2.8.

Processes for safe handling of waste forms, including casks, canisters, overpacks, waste packages, and SNF assemblies, are based on the principles of controlling load movement at all times and limiting load height (potential energy) and speed (kinetic energy). Load height and speed are inherently limited by characteristics of the handling equipment, supplemented by automated controls or, where appropriate by manual controls governed by written procedure. Procedures are developed based on industry guidance such as that for crane operation from ASME B30.2-2005 and the guidance on heavy load handling from NUREG-0612 (NRC 1980).

Mechanical handling processes are also based on reducing worker radiation exposure to as low as reasonably achievable. Where the use of permanent shielding is not practical, operations involving the waste forms utilize features such as temporary shielding, shield rings or collars, standardized fittings, long-handled tooling to increase distance to the radiation source, or automated equipment to reduce exposure time and/or crew size.

1.2.2.2.3 Safety Classification

Table 1.2.2-10 lists the cranes that are located in the surface facilities. This table identifies the location for each crane, whether the crane lifts waste forms, the assigned safety classification, and the applicable American Society of Mechanical Engineers design standard and crane type. Table 1.2.2-11 lists the mechanical handling equipment in the surface facilities and identifies the location of the component, whether the component handles waste forms, the assigned safety classification, and the applicable design standard.

1.2.2.2.4 Procedural Safety Controls to Prevent Event Sequences or to Mitigate Their Consequences

There are no procedural safety controls associated with the mechanical handling equipment.

1.2.2.2.5 Design Bases and Design Criteria

The nuclear safety design bases and their relationships to design criteria for the ITS mechanical handling equipment associated with the waste handling facilities are presented in Sections 1.2.3 to 1.2.8.

1.2.2.2.6 Design Methodologies

Design methodologies for ITS mechanical handling equipment are consistent with those outlined in the applicable design standards, identified in Tables 1.2.2-10 and 1.2.2-11.

Probabilistic seismic safety analyses to demonstrate compliance with the preclosure performance objectives in 10 CFR 63.111(b)(2) are described in Section 1.7. For each seismically initiated event sequence, the probabilistic seismic analyses demonstrate (1) that the probability of the event sequence is less than one in 10,000 before permanent closure, thus allowing the event sequence to be screened out; or (2) that the radiological dose consequences of each Category 2 event sequence meet the performance objectives of 10 CFR 63.111(b)(2). To determine the probability of a seismically induced event sequence, the event sequence is quantified in terms of its expected number of occurrences over the preclosure period. The quantification includes the convolution of the site-specific seismic hazard curve with the fragility curves of the ITS mechanical handling SSCs whose seismic failures are included in the event sequence.

The equipment fragility analysis uses seismic ground motion for earthquakes ranging from the DBGM-2 level to the 500,000 year return interval to determine the demand on the equipment. For the majority of ITS mechanical handling SSCs, the beyond DBGM is used to develop the fragility curves. The selection of the ground motion and earthquake level used in the fragility analysis depends on the equipment being considered, and the seismic failure modes of that equipment.

Seismic safety is achieved through a combination of two important design aspects: (1) conservatism in design codes, standards, and acceptance criteria; and (2) fragility assessments described in Section 1.7 that demonstrate adequate capacity exists to support regulatory compliance.

For equipment and vehicles that transport waste containers, maximum travel speeds are established to limit the kinetic energy of the waste container. These speeds are often lower than those recommended by the design standard or those based strictly on operational considerations.

1.2.2.2.7 Consistency of Materials with Design Methodologies

The structural, mechanical, and electrical aspects of the ITS mechanical handling equipment utilize materials consistent with the applicable design standard.

Equipment designed in accordance with ASME NOG-1-2004 utilizes materials consistent with Section 4200, "Materials and Connections," Section 5200, "Materials," and Section 6200, "Wiring Materials and Methods (Types I, II, and III Cranes)," of ASME NOG-1-2004.

Equipment designed in accordance with ASME NUM-1-2004 utilizes materials consistent with Section NUM-I-8200, "Structural"; and the applicable portions of Sections NUM-III-8200, "Structural"; NUM-III-8300, "Mechanical"; and NUM-III-8400, "Electrical," of ASME NUM-1-2004.

Equipment designed in accordance with ANSI N14.6-1993 utilizes materials consistent with Section 4, "Design," of that standard.

1.2.2.2.8 Mechanical Handling Equipment Codes and Standards

The principal codes and standards applicable to the design and fabrication of the ITS mechanical handling equipment are:

- ASME NOG-1-2004, *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)*
- ASME NUM-1-2004, *Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)*
- ANSI N14.6-1993, *American National Standard for Radioactive Materials—Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More*.

1.2.2.2.9 Mechanical Handling Equipment Load Combinations

Mechanical handling ITS equipment is designed for loads and load combinations described below.

The design of ITS mechanical equipment considers applicable static, dynamic, and environmental loads associated with normal operation as well as those loads associated with the design bases established to prevent or mitigate Category 1 and Category 2 event sequences. The design process includes application of load combinations based on applicable industry standards and regulatory guidance listed in Table 1.2.2-9 or on standard engineering practice.

1.2.2.2.9.1 Design Loads

Dead Loads—Dead loads (*D*) include the weight of the equipment and permanently installed appurtenances.

Live Loads—Live loads (*L*) for load-handling equipment include the weights of the loads to be lifted or carried, including rated load.

Dynamic Loads—Dynamic loads (*Y*) include loads associated with starting and stopping, acceleration, and deceleration of equipment during normal operation.

Earthquake (Seismic) Loads—Earthquake loads (*E*) are loads experienced during the DBGM. ITS mechanical handling equipment in a seismic event sequence is designed for DBGM-2 and analyzed to demonstrate functionality for more severe seismic events. Other mechanical handling equipment is designed for the appropriate *International Building Code 2000* (ICC 2003) seismic requirements.

Environmental Loads—Environmental loads (nonseismic) include wind loads (*W*) and precipitation loads (*P*) that encompass rain, snow, ice, and ash accumulation. Thermal loads (*T*) are not a major consideration for mechanical handling equipment, which operates in locations near ambient temperature. Thermal design criteria include consideration of the effects of temperature on allowable stresses of components such as lifting adapters that are in contact with heat-generating waste forms.

Event Sequence Loads—Event sequence loads (*ES*) include loads associated with event sequences such as collision or tipover.

1.2.2.2.9.2 Load Combinations

The following load combinations are used in the design and analysis of ITS mechanical handling equipment.

1.2.2.2.9.2.1 Overhead Cranes, Canister Transfer Machine, and Spent Fuel Transfer Machine

The following cases apply to overhead cranes, the canister transfer machine, and the spent fuel transfer machine:

- Case 1 (normal operation, including testing and operating events): For load combination, see ASME NOG-1-2004, Sections 4140 and 5310, and Tables 5415.1-1 and 5453.1(a)-1.
- Case 2 (earthquake): The load combination is $D + L + E$ (DBGM-2).
- Case 3 (extreme wind (IHF only)): The load combination is $D + W$.
- Case 4 (collision): The load combination is $D + L + ES$ (collision).

1.2.2.2.9.2.2 Jib Cranes

The following cases apply to jib cranes:

- Case 1 (normal operation, including testing and operating events): For load combination, see ASME NUM-1-2004, Section NUM-III-8213.
- Case 2 (earthquake): The load combination is $D + L + E$ (DBGM-2).
- Case 3 (collision): The load combination is $D + L + ES$ (collision).

1.2.2.2.9.2.3 Special Lifting Devices

The following cases apply to special lifting devices:

- Case 1 (normal operation, including testing and operating events): For load combination, see ASME NOG-1-2004, Sections 4140 and 5310, and Table 5415.1-1 (as applicable to load block).
- Case 2 (earthquake): The load combination is $D + L + E$ (DBGM-2).
- Case 3 (collision): The load combination is $D + L + ES$ (collision).

1.2.2.2.9.2.4 Cask Transfer Trolley and Waste Package Transfer Trolley

The following cases apply to the cask transfer trolley and the waste package transfer trolley:

- Case 1 (normal operation, including testing and operating events): For load combination, see ASME NOG-1-2004, Sections 4140 and 5310, and Table 5453.1(a)-1 (as applicable to a crane trolley).
- Case 2 (earthquake): The load combination is $D + L + E$ (DBGM-2).

- Case 3 (extreme wind (IHF only)): The load combination is $D + L + W$.

- Case 4 (collision): The load combination is $D + L + ES$ (collision).

1.2.2.3 HVAC Systems Design

[NUREG-1804, Section 2.1.1.2.3: AC 1(4), AC 2(1), (2), (4); Section 2.1.1.6.3: AC 1(2)(a), (d), (h), (j); Section 2.1.1.7.3.1: AC 1(1) to (6), (9); Section 2.1.1.7.3.2 AC 1(1), (2), (4); Section 2.1.1.7.3.3(I): AC 1(1), AC 2(1) to (3), AC 3, AC 4(1) to (5)]

The HVAC systems provide temperature control, flow control, and filtration during normal operation. Air flow from areas of low to high potential contamination minimizes contamination in facility effluents. The surface facilities utilize multiple barriers to mitigate the potential release of radioactivity in event sequences that involve a drop or collision of a fuel assembly or cask, canister, or waste package containing HLW or SNF. ITS portions of the HVAC system ensure reliable confinement and filtration of radiological releases from event sequences involving breach of waste containers or damaged SNF assemblies and provide appropriate environmental conditions for ITS electrical and mechanical equipment that support the filtration function. Table 1.2.2-12 identifies the principal codes and standards used in the design of surface structures, mechanical handling equipment, and HVAC systems. Table 1.2.2-13 identifies the building confinement zones.

1.2.2.3.1 HVAC Description

The following paragraphs describe the HVAC system components that are used similarly throughout the surface handling facilities. The generic design and analysis aspects are addressed in this section; the functions in specific handling facilities and unique features are described in Sections 1.2.3 through 1.2.6 and Section 1.2.8, which discuss the facility where the HVAC component is physically located.

Dampers—The various dampers in the distribution network and their functions are as follows:

- **Isolation Dampers**—Where a means of isolating the system or portion of a system from a flow path is required, butterfly dampers or parallel-blade-type dampers are utilized. These dampers are designed to automatically fail in the safe position. The ITS dampers are provided with actuators to ensure a fail-safe position. The non-ITS dampers are provided with electric actuators. In some cases, manual isolation dampers are used to isolate systems for maintenance purposes.

- **Volume (Balancing) Dampers**—Opposed-blade-type dampers are utilized, as necessary, to provide a means of system balancing. In general, these dampers are manually operated with locking quadrants. These dampers are either ITS or non-ITS depending upon the application as shown on ventilation and instrumentation diagrams in Sections 1.2.3 through 1.2.6 and 1.2.8.

- **Backdraft Dampers**—Backdraft dampers are employed, where required, to maintain the proper direction of air flow or prevent reversal of air flow. Backdraft dampers are equipped with adjustable counterweight. These backdraft dampers are either ITS or non-ITS depending upon the application as shown on ventilation and instrumentation diagrams in Sections 1.2.3 through 1.2.6 and 1.2.8.

- **Tornado Dampers**—Tornado dampers are installed in the ITS outdoor air intake and exhaust ductwork that is open to the atmosphere to prevent duct collapse due to rapid depressurization during a tornado event. During a tornado event, the ITS tornado dampers automatically close to prevent the outward rush of air caused by a rapid drop in atmospheric pressure. Damper closure mitigates the damage to systems and its components that are ITS.

- **Fire/Smoke Dampers**—Heat- or smoke-activated combination fire/smoke dampers are the parallel blade-type dampers located in fire barriers, as necessary, to maintain the fire ratings of the barriers. Smoke dampers located in the discharge of air handling units are provided with electric motor actuators and are actuated by duct-mounted smoke detectors to close the damper when smoke is detected in the air stream. These dampers are non-ITS.

Ductwork—The design, materials, construction, inspection, and testing of the exhaust subsystem ductwork are in accordance with ASME AG-1-2003, *Code on Nuclear Air and Gas Treatment*, including the 2004 addenda (ASME AG-1a-2004). ITS exhaust ductwork is designed to maintain its confinement boundary during normal operation and event sequences. Ductwork is supported to remain in place so that it will not fail during an event sequence. The exhaust ducts are sized to maintain sufficient transport velocities to minimize particulate contaminants from settling out of the air stream. The exhaust ducts from the potentially contaminated areas (confinement zones) are made of stainless steel with welded construction to minimize duct leakage.

The design, materials, construction, inspection, and testing of the supply subsystem ductwork are in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004). The supply ductwork is generally constructed of galvanized steel with outside thermal insulation. ITS supply ductwork is designed to maintain its confinement boundary during event sequences.

Fans—The exhaust fans are either directly driven or belt driven, heavy-duty centrifugal-type fans with backward inclined or airfoil blades. The exhaust fans are equipped with electric motors and adjustable speed drives to provide adjustment in the system air flow to maintain the required pressures in the confinement areas and to compensate for filter loading. The exhaust fans are designed in accordance with Section BA of ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), and Article 5.7 of ASME N509-2002, *Nuclear Power Plant Air-Cleaning Units and Components*.

The supply fans associated with the HVAC air handling units are integral to the air handling units and are either directly driven or belt driven, heavy-duty centrifugal-type fans with backward inclined or airfoil blades. The fans are equipped with motors and adjustable speed drives to provide adjustment in the system air flow to maintain the air flow for cooling and to compensate for filter loading. The supply fans are designed in accordance with the Air Movement and Control Association publication, *Standards Handbook* (AMCA 1999). The fan performance testing is in accordance with ANSI/AMCA 210-99, *Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*.

HEPA Filters—Each high-efficiency particulate air (HEPA) filter cell is constructed by pleating a continuous sheet of a formed, corrugated glass fiber media back and forth upon itself (separatorless) so that it is self-supporting. The filter element is typically permanently bonded to a 14-gauge, Type 304L stainless steel case with a fire-retardant urethane sealant. The perimeter of the filter face has a channel with gel sealant to seal it to its mounting frame. The nominal dimensions of a HEPA filter cell are 24 in. in height by 24 in. in width by 12 in. in depth. The HEPA filter is designed in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004) and has a filtration efficiency of at least 99.97% for particulates 0.3 micron and larger. The HEPA filters are designed and tested to withstand up to 700°F ± 50°F. Figure 1.2.2-20 provides a typical moisture separator, prefilter, and HEPA filter arrangement.

Moisture Separators—The moisture separators/demisters in the HEPA filter plenum are used to protect the HEPA filters from damage or loss due to entrained moisture in the air stream. The demister pads are designed in accordance with ASME N509-2002, Article 5.4, and ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Section FA.

Prefilters—The prefilters are installed upstream of the first-stage HEPA filter to remove large airborne particulates. The prefilters are designed in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Section FB, and UL 900.

Moisture Separator, Prefilter, and HEPA Filter Acceptance Tests—Acceptance tests will be conducted with clean moisture separator, prefilter, and HEPA filter banks installed in the system. Visual inspection, differential pressure, and in-place leak tests will be conducted and test results verified to be within the acceptance limits of the design requirements. These test results will be documented in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Section TA-6300, and will be retained as reference values for comparison to periodic in-service test results.

Instrumentation and Controls—The HVAC system is provided with the necessary instrumentation and controls such that its subsystems and components function collectively as a system capable of maintaining its safety function; providing real-time monitoring, regulating, and displaying significant facility and system parameters; and ensuring reliable equipment operation. ITS systems are provided with ITS instruments and hard-wired ITS controls. Monitoring incorporates data collection and alarm annunciation. The digital control and management information system provides instrumentation and controls, which monitor and control significant facility parameters as noted in Table 1.2.2-14.

1.2.2.3.2 Operational Processes

The HVAC system consists of supply and exhaust subsystems that provide indoor climate control for worker health and safety, heat removal, and proper equipment operation and limits the release and spread of airborne radioactive contamination in and from the surface facilities. Each of these facilities has a number of supply and exhaust subsystems with similar basic features, but varying capacities.

The confinement areas of the surface facilities are provided with a recirculating supply subsystem and an exhaust subsystem. The supply subsystem is designed to provide filtered and heated or cooled air. The majority of the supply air is recirculated air drawn from within the confinement areas. The recirculated air is augmented by filtered and heated or cooled make-up air drawn from the outdoors. The conditioned air is distributed to the appropriate areas of the facility through the distribution ductwork. Outdoor air and air from outside the confinement areas infiltrate into the confinement areas due to exhausting more air from the confinement areas than the make-up air supply. The excess air is exhausted through one or more stages of HEPA filters prior to being discharged to the atmosphere. The exhaust is monitored for radioactivity downstream of the exhaust fans. The make-up and recirculated air is filtered for particulates through one stage of HEPA filters. The make-up air for the confinement areas operates in a cascading fashion such that air flows from areas of lesser contamination potential to areas of greater contamination potential. Each facility is provided with a discharge duct that extends above the facility roofline. The discharge ductwork is sized based on maintaining a minimum discharge velocity of 3,000 ft per minute to provide adequate plume rise and jet dilution.

1.2.2.3.3 Safety Category Classification

The components of the HVAC system required to mitigate the consequences of a radioactive release following an event sequence and to provide cooling to ITS equipment are classified as ITS. Non-ITS HVAC system SSCs are designed to ensure that they will not fail during a seismic event in a manner that would prevent an ITS SSC from performing its intended safety function.

1.2.2.3.4 Procedural Safety Controls to Prevent Event Sequences or to Mitigate Their Consequences

There are no procedural safety controls associated with the operation of the HVAC systems.

1.2.2.3.5 Design Bases and Design Criteria

The nuclear safety design bases and their relationships to design criteria for the ITS HVAC system in the CRCF, WHF, and Emergency Diesel Generator Facility are presented in Sections 1.2.4, 1.2.5, and 1.2.8.

1.2.2.3.6 Design Methodologies

Structural Design—The design of the system and components of the ITS HVAC system follows standard nuclear industry practice and is in accordance with the applicable requirements of relevant codes and standards (refer to Section 1.2.2.3.8).

The HVAC ITS distribution system consists of ducts and their supports. The HVAC ducts and duct supports are designed in accordance with the *International Building Code 2000* (ICC 2003) for seismic loads.

The ITS HVAC distribution systems are adequately supported and anchored to ensure that they are capable of performing their safety functions under the design loading conditions. The distribution systems are located such that they do not interfere with the safety function of adjacent equipment or distribution systems.

The ITS exhaust ducts are made of welded stainless steel in accordance with ASTM A 240/A 240M-06c, Type 304. The ducts are designed for concurrent dead weight, seismic load, and pressure load. The duct supports are evaluated for dead weight and seismic loads. The HVAC duct supports are constructed of bolted assemblies of cold-formed sections in accordance with "Specification for Design of Cold-Formed Steel Structural Members" (AISI 1993). The supports can also be made of structural steel members in accordance with the AISC *Manual of Steel Construction, Allowable Stress Design* (AISC 1997).

The ITS duct supports are attached to concrete or structural steel members of the building by bolted connections or welding. The supports are spaced at intervals as required by engineering evaluation.

Thermal Design—Thermal performance of various waste forms and waste containers in the handling facilities is evaluated. These evaluations of commercial SNF, DOE SNF, and HLW demonstrate that thermal performance of the waste forms, canisters, and waste packages is acceptable, given various heat loads during normal and off-normal HVAC conditions. These evaluations assess normal operating conditions (normal HVAC operations) and off-normal conditions, considering reduced heat removal (ventilation provided by ITS SSCs only) or no forced convective heat removal, as appropriate.

To bound the thermal evaluation, the thermally limiting room in the surface facilities is used. For commercial SNF, DOE SNF, and HLW, the CRCF cask unloading room is determined to be the thermally limiting room, primarily because waste containers are assumed to also be present in rooms adjacent to the cask unloading room.

The solution methods include the use of one-, two-, and three-dimensional analyses using ANSYS Version 8.0 and FLUENT Version 6.0.12 to determine the temperatures in the waste packages and canisters for several cases with varying heat loads, boundary conditions, and waste container types.

For ventilation cases representing the normal operating condition (normal HVAC operations) and the off-normal condition (ventilation provided by ITS SSCs only), transient and steady-state, computational fluid dynamics, numerical solutions are performed using FLUENT Version 6.0.12. For those cases where ANSYS Version 8 is used for these analyses, bounding conditions are applied to account for convection effects. ICEM computational fluid dynamics Version 5.0 is used to generate the meshes input into FLUENT Version 6.0.12. For ventilation cases representing the off-normal condition with no forced air flow (loss of ventilation), either a 30-day transient or a steady state, finite element, numerical solution is performed using ANSYS Version 8.0.

The waste package and the waste package transfer trolley shielded enclosure are represented together as a single, homogeneous, heat-generating cylinder in three-dimensional analyses to determine boundary conditions for the one- and two-dimensional analyses for commercial SNF, DOE SNF, and HLW in the CRCF. To determine the temperatures of the waste package and canister(s) contained therein, finite element numerical solutions are performed in ANSYS Version 8.0, using one- or two-dimensional representations of the waste package inside the trolley shielded enclosure.

Of the transportation casks that contain canistered commercial SNF, the thermally limiting cask is identified through a comparison on the bases of the maximum thermal power each cask is licensed to contain, as well as the resistance to heat dissipation across each cask wall. The thermal resistance of the cask wall is determined with a one-dimensional steady-state conduction heat transfer representation. The cask is conservatively modeled using unloading conditions, with the cask in a vertical orientation with its lid removed, and air present in the gap between the canister and cask. The cask is allowed to achieve thermal equilibrium, with active cooling from ventilation in the room.

The peak cladding temperature of a commercial SNF assembly from the TS-125 transportation cask SAR (Sisley 2002) is used as a reference. The difference in canister shell temperature between the transportation conditions and unloading conditions is conservatively evaluated using a one-dimensional steady-state conduction-only calculation through the cask solid layers. For the gap between the canister and cask, a conductive and radiative heat transfer calculation is included. The difference between canister shell temperature and peak cladding temperature is conservatively modeled to be the same in both transportation and unloading conditions. The resulting peak cladding temperature during unloading conditions is compared to the established limit of 400°C for commercial SNF.

The off-normal condition for cask unloading is defined as a failure of the ventilation system, resulting in the absence of forced convection cooling. The CRCF evaluation contains a calculation of surface temperatures in the CRCF cask unloading room, in the normal condition scenario with ventilation, as well as in the off-normal scenario of a loss of ventilation for 30 days. The difference in these temperatures is applied to the cask outer surface temperature in the licensing scenario. When recalculated with the same simplified cask representation, a new canister shell temperature for the off-normal condition is approximated. Applying the difference of normal and off-normal canister shell temperatures to the peak cladding temperature yields the peak cladding temperature for the off-normal condition. The estimated peak fuel assembly cladding temperature in the off-normal condition is then compared to the established limit of 570°C.

Analyses discussed in Section 1.5.1.4 of the Naval Nuclear Propulsion Program Technical Support Document demonstrate that naval SNF structural integrity is maintained when the naval SNF canister external surface temperature remains below 400°F during a maximum 30-day period starting with detensioning of the transportation cask closure in the IHF and ending with waste package emplacement. The transport and emplacement vehicle performance requirements are described in Section 1.3.3.

An evaluation that includes multiple axial peaks representing the potential loading of naval SNF canisters (both short and long configurations) is being performed to demonstrate that the naval SNF canister surface temperatures remain within acceptable limits while in the IHF. Scenarios represent the naval SNF canister in a transportation cask, starting with the detensioning of the closure on the naval transportation cask and continuing after the closure lid is removed, in a waste package, and in a waste package in a transfer trolley. The scenarios are being evaluated for loss-of-ventilation conditions for the entire permitted duration of naval SNF canister handling in the IHF. The duration for receipt (starting with detensioning of the transportation cask closure), handling, and emplacement operations of a naval SNF canister is limited to a maximum of 30 days. During this time, the temperature of the surface of the naval SNF canister may not exceed 400°F(DOE 2008, Section 10.3.2.2). Generally accepted, steady state and transient three dimensional heat transfer equations are being used to determine the naval SNF canister surface temperatures for the scenarios in the IHF. The cask, waste package, or trolley is being modeled within an empty concrete-walled room. The objects are being modeled as floating bodies preserving their geometric characteristics.The scenarios are being evaluated for both the naval long and naval short SNF canisters. Conduction heat transfer is being modeled across the solid bodies. Free convection and radiation are being applied across the air (and helium) gaps between solid bodies.

1.2.2.3.7 Consistency of Materials with Design Methodologies

Materials of construction for the ITS SSCs are as follows:

- Ductwork—minimum 18-gauge 304L stainless steel (ASTM A 240/A 240M-06c)
- Fans—in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Article BA 3000, Table BA-3100
- HEPA filters—glass fiber with 14-gauge 304L stainless steel casing (ASTM A 240/A 240M-06c)
- HEPA filter housing—in accordance with ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004); 304L stainless steel (ASTM A 240/A 240M-06c).

1.2.2.3.8 HVAC Codes and Standards

The principal codes and standards applicable to the design and fabrication of the ITS HVAC equipment are:

- IEEE Std 484-2002, *IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*
- IEEE Std 603-1998, *IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations*
- NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*
- NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*
- NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*
- *HVAC Air Duct Leakage Test Manual* (SMACNA 1985)
- UL 586, *High-Efficiency, Particulate, Air Filter Units*
- UL 900, *Air Filter Units*

- ASME AG-1-2003, *Code on Nuclear Air and Gas Treatment*, including the 2004 addenda (ASME AG-1a-2004)
- ASHRAE DG-1-93, *Heating, Ventilating, and Air-Conditioning Design Guide for Department of Energy Nuclear Facilities*.

1.2.2.3.9 HVAC Load Combinations

HVAC ITS equipment is designed for loads and load combinations described below.

1.2.2.3.9.1 Design Loads

Dead Weight Loads—Dead weight loads include the weight of equipment or ductwork including supports, stiffeners, insulation, and all internally or externally mounted components or accessories.

Live Loads—Live loads include loads occurring during construction and maintenance.

Constraint of Free-End Displacement Loads—Loads caused by constraint of free-end displacement that results from thermal or other movements.

Pressure Differential—Pressure differential loads include maximum positive or negative pressure differential that may occur during normal operation or an event sequence.

System Operational Transient Loads—System operational transient loads include pressure transient loads due to events such as rapid damper, plenum or housing door, and valve closure, or other normal loads that result in a short duration pressure differential.

Fluid Momentum Loads—Fluid momentum loads include momentum and pressure forces due to fluid flow.

External Loads—External loads include applied loads caused by attached piping, accessories, or other equipment.

Earthquake (Seismic) Loads—Earthquake loads are loads in accordance with the *International Building Code 2000* (ICC 2003).

1.2.2.3.9.2 Load Combinations

The following load combinations are used in the design and analysis of ITS HVAC systems and equipment during normal operation and Category 1 or 2 event sequences (the only load that is unique to an event sequence is the seismic load):

- Ductwork: For load combination, see ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Article SA-4212.

- Ductwork supports: For load combination, ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Article SA-4216, Table SA-4216.
- Exhaust fans: For load combination, see ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Article BA-4131, Article AA-4212, Table AA-4212.
- HEPA filter housings: For load combination, see ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004), Article HA-4212, Table HA-4212.

1.2.2.4 Regulatory Guidance and Other Design Codes and Standards *[NUREG-1804, Section 2.1.1.7.3.3(I): AC 1]*

NRC regulatory guidance documents, addressed in the design and safety analysis, are identified in Table 1.2.2-9. Because of the unique nature of the repository, not all positions of existing regulatory guidance are directly applicable to the design, analysis, and operation of the repository. Table 1.2.2-9 also provides a discussion of repository-specific alternatives to selected regulatory guidance positions. Principal industry codes and standards used in the design of ITS surface structures, mechanical handling equipment, and HVAC systems are provided in Table 1.2.2-12.

Application of industry codes and standards, where available, provides established performance levels, accepted levels of reliability, and service factors based on equipment usage and performance and is addressed in the appropriate SAR section.

There are few industry consensus standards available for the development of SSCs used in a geologic repository facility. The DOE has chosen to adopt standards that were written to provide criteria and requirements for safety-related SSCs in commercial nuclear power generating stations to provide a proven and accepted means for the design of SSCs that are ITS and important to waste isolation. The DOE commits to applying the requirements of codes and standards identified in the license application except for requirements that obviously apply to SSCs unique to a nuclear reactor. As an example, IEEE Std 603-1998 identifies reactor trips and emergency safety feature equipment as safety system equipment, and the Yucca Mountain repository clearly does not have these types of components. However, the criteria that are provided for the design of safety systems will be used for the design for SSCs of the Yucca Mountain repository as they are directly applicable to any high-consequence, engineered system regardless of the industry. In summary, while compliance with regulatory guidance documents and other codes or standards is not required, evaluations have been performed to assess their potential applicability to the design, analysis, and operation of the repository. As a result, clarifications have been identified throughout the safety analysis report where flexibility from a specific provision of a regulatory guidance document, code, or standard has been taken. Full conformance with provisions of the regulatory guidance document, code, or standards is demonstrated by the SAR statement "in accordance with." Similarly, partial conformance with the provisions of a regulatory guidance document, code, or standard is demonstrated by the use of terms such as "using the methods and practices" or "...applicable..." in order to allow flexibility for provisions that are not appropriate to the design, analysis, or operation of a geologic repository. These points of clarification are further elaborated in the sections of the license application that directly address the design of specific SSCs to particular standards.

Most surface SSC designs are based on proven and commercially available technology. However, portions of some designs, such as trolleys, represent first-of-a-kind equipment or innovative applications of existing technology. If only partial application of an applicable code or standard is possible due to project-specific performance or functional requirements or a new application of an existing technology, it may be necessary to develop additional requirements to augment the applicable code or standard.

1.2.2.5 General References

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Table 1.2.2-1. Natural Phenomena Loading Parameters

Criterion	Value
Lightning	For aging casks: a lightning strike with a peak current of 250 kiloamps over a period of 260 microseconds and a continuing current of 2 kiloamps for 2 seconds (off-normal)
Wind load (W)	3-second wind speed: 90 mph
Tornado loads (W_t)	Maximum wind speed: 189 mph Atmospheric pressure change: 0.81 psi Rate of pressure drop: 0.30 psi/s
Tornado missile spectrum	Spectrum II missiles as defined in NUREG-0800, Section 3.5.1.4 (NRC 1987)
Frost line	Depth of 10 in.
Wind	Basic wind speed: 90 mph
Precipitation	Maximum annual precipitation: 20 in./yr Upper bound 90% confidence interval precipitation Maximum 24-hour (50 year recurrence interval) 3.30 in/d (8.4 cm/d) Maximum 24-hour (100 year recurrence interval) 3.84 in/d (9.8 cm/d) Maximum 24-hour (500 year recurrence interval) 5.25 in/d (13.3 cm/d) Maximum 1-hour (50 year recurrence interval) 1.72 in/hr (4.4 cm/hr) Maximum 1-hour (100 year recurrence interval) 2.15 in/hr (5.5 cm/hr) Local-storm Probable Maximum Precipitation North Portal: 13.2 in. 6 hours South Portal: 12.9 in. 6 hours
Ambient temperature	2°F to 116°F (–17°C to 47°C)
Humidity	Annual mean value: 30% Minimum summer monthly mean value (June): 10% Maximum winter monthly mean value (February): 59%
Snow	Maximum daily snowfall: 6 in. (15 cm) Maximum monthly snowfall: 6.6 in. (17 cm)
Groundwater	Surface facilities GROA: Land surface elevation: ~ 1,120 m (3,675 ft) above mean sea level Water table elevation: ~ 730 m (2,400 ft) above mean sea level Water table: about 390 m (1,275 ft) below the surface facilities GROA land surface
Explosions	Evaluation of safe distances from an explosion is based on a maximum no-damage overpressure of 1.0 lb/in.^{2}. At a distance equal to or greater than 5 mi, an explosion equivalent to 2.0×10^8 lb of TNT is required to generate this overpressure (Regulatory Guide 1.91). With the exception of to the east, the withdrawal area would encompass more than 5 mi from the GROA. To the east, Area 25 of the Nevada Test Site adds an additional buffer zone to the distance of more than 4 mi from the GROA to the edge of the withdrawal area.
Volcanic ash	Structural loading shall take into account volcanic ash fall with a roof live load of 21 lb/ft^2

NOTE: TNT = trinitrotoluene.

Table 1.2.2-2. Seismic Design Considerations for Surface Structures Important to Safety

Facility	Safety Class	Input Ground Motion	Lumped-Mass Multiple-Stick Model	Finite Element Model	Structural Design Codes Used
CRCF	ITS	DBGM-2	Yes	No	ACI 349-01/349R-01 for concrete; ANSI/AISC N690-1994 for steel
RF	ITS	DBGM-2	Yes	No	ACI 349-01/349R-01 for concrete; ANSI/AISC N690-1994 for steel
WHF	ITS	DBGM-2	Yes	No	ACI 349-01/349R-01 for concrete; ANSI/AISC N690-1994 for steel
IHF	ITS	DBGM-2	No	Yes	ACI 349-01/349R-01 for concrete; ANSI/AISC N690-1994 for steel
Aging pads	ITS	DBGM-2	No	Yes	ACI 349-01/349R-01 for concrete

Table 1.2.2-3. Ground Motion Peak Ground Accelerations

Ground Motion Category	Mean Annual Probability of Exceedance	Horizontal Peak Ground Acceleration (g)	Vertical Peak Ground Acceleration (g)
		Surface	Surface
DBGM-1	1.0×10^{-3}	0.33	0.22
DBGM-2	5.0×10^{-4}	0.45	0.32
Beyond DBGM	1.0×10^{-4}	0.91	0.72

Source: BSC 2008c.

Table 1.2.2-4. Damping Values Used in Analysis of Yucca Mountain Repository Surface Facility Structures

Facility	DBGM-2	Beyond DBGM	Soil Radiation Damping[a]
CRCF	7%	10%	20%
RF	7%	10%	20%
WHF	7%	10%	20%
IHF	7%	10%	NA

NOTE: [a]The eigenvalues damping coefficients are calculated in accordance with Table 3.3-3 (ASCE 4-98); however, these values have been limited to 20% of critical damping. NA = not applicable.

Source: ASCE/SEI 43-05; BSC 2007j, Appendix C.

Table 1.2.2-5. Design Basis Ground Motion–2 Surface Facility Structure Zero Period Accelerations

Elevation (ft)	East–West - Acceleration[a]		North–South - Acceleration[a]		Vertical - Acceleration[a]	
	ft/sec^2	g′s	ft/sec^2	g′s	ft/sec^2	g′s
Canister Receipt and Closure Facility[b]						
0′–0″	15.59	0.48	15.60	0.48	12.44	0.38
32′–0″	20.47	0.64	20.97	0.65	13.27	0.41
64′–0″	25.26	0.78	25.07	0.78	13.77	0.43
72′–0″	25.67	0.79	27.22	0.85	14.61	0.45
100′–0″	32.97	1.02	31.78	1.00	14.33	0.44
Receipt Facility[b]						
0′–0″	15.84	0.49	15.71	0.49	12.83	0.40
32′–0″	21.51	0.67	21.19	0.66	13.71	0.43
64′–0″	26.00	0.81	25.69	0.80	14.18	0.44
72′–0″	26.84	0.83	28.02	0.87	14.37	0.45
100′–0″	32.41	1.01	38.13	1.18	15.08	0.47
Wet Handling Facility[b]						
–52′–0″	13.37	0.42	12.96	0.40	10.50	0.33
0′–0″	17.00	0.53	15.74	0.49	13.45	0.42
32′–0″	22.02	0.68	20.47	0.64	17.60	0.55
40′–0″	22.38	0.70	21.88	0.68	15.47	0.48
80′–0″	28.96	0.90	29.34	0.91	16.16	0.50
100′–0″	35.74	1.11	41.84	1.30	20.52	0.64

Table 1.2.2-5. Design Basis Ground Motion–2 Surface Facility Structure Zero Period Accelerations (Continued)

Elevation (ft)	East–West - Acceleration[a]		North–South - Acceleration[a]		Vertical - Acceleration[a]	
	ft/sec^2	g′s	ft/sec^2	g′s	ft/sec^2	g′s
Initial Handling Facility[c]						
0′–0″	14.49	0.45	14.49	0.45	10.30	0.32
65′–0″	33.49	1.04	32.20	1.00	13.20	0.41
87′–3″	40.25	1.25	37.67	1.17	16.10	0.50
104′–6″	46.69	1.45	37.35	1.16	18.35	0.57

NOTE: [a]Square root of the sum of the squares design accelerations are based on DBGM-2.
[b]For concrete structures CRCF, RF, and WHF, the accelerations correspond to the center of mass at each elevation.
[c]For IHF, the accelerations correspond to the elevation at the column intersection grid lines H and 7. These accelerations are provided at roof level and at elevations where major equipment (such as cranes) are located.

Table 1.2.2-6. Design Basis Ground Motion–2 Surface Facility Structures Story Displacements

Elevation (ft)	**Story Displacement[a] (in.)**	
	East-West	**North-South**
Canister Receipt and Closure Facility		
0′–0″	0.11	0.10
32′–0″	0.15	0.15
64′–0″	0.18	0.17
100′–0″	0.21	0.20
Receipt Facility		
0′–0″	0.10	0.09
32′–0″	0.14	0.13
64′–0″	0.17	0.15
100′–0″	0.19	0.19
Wet Handling Facility		
–52′–0″	0.18	0.17
0′–0″	0.29	0.29
40′–0″	0.37	0.38
80′–0″	0.43	0.47
100′–0″	0.46	0.51
Initial Handling Facility		
26′–9″	0.19	0.38
37′–0″	0.28	0.57
65′–0″	0.53	1.16
87′–3″	0.64	1.20
104′–6″	0.72	1.17

NOTE: [a]Story displacements are in the same direction of ground motion spectra for DBGM-2.

Table 1.2.2-7. Design Basis Ground Motion–2 Surface Facility Structures Story Shears

Elevation (ft)	East-West[a] Kips	North-South[a] Kips
Canister Receipt and Closure Facility		
0′–0″	127862	129516
32′–0″	68657	68249
64′–0″	22115	21558
Receipt Facility		
0′–0″	77228	76733
32′–0″	37928	38252
64′–0″	8879	9946
Wet Handling Facility		
0′–0″	90398	88343
40′–0″	51443	54888
80′–0″	8470	10338
Initial Handling Facility		
0′–0″	13148	11764
26′–9″	12701	11277
37′–0″	10980	9966
65′–0″	8297	7607
87′–3″	4758	4126
97′–6″	3574	2875
104′–6″	2281	1769

NOTE: [a]Shears are the summation of the same direction in- plane shear force in the same direction of ground motion spectra.

Table 1.2.2-8. Design Basis Ground Motion–2 Surface Facility Structures Stability Analysis Results

Stability Results		
Building	**Sliding (inches)**	**Factor of Safety Overturning**
Canister Receipt and Closure Facility	0.20	3.10
Receipt Facility	0.20	2.99
Wet Handling Facility	0.13	2.70
IHF (main structure)	0.14	2.11
IHF (loadout area)	0.14	1.30

Table 1.2.2-9. Regulatory Guidance Documents Used in the Design of Structures, Mechanical Handling Equipment, and HVAC Systems

NRC Guidance Document Number	NRC Guidance Document Title	Yucca Mountain Project Position	Description of Position
Regulatory Guide 1.52, Rev. 3	*Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants*	Adopted with Clarification	ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004) is used in lieu of ASME AG-1-1997, ASME N509-2002 is used in lieu of ASME N509-1989, and DOE-HDBK-1169-2003 (DOE 2003) is used in lieu of ERDA 76-21 (Burchsted et al. 1976). Also, there are no charcoal adsorbers because short-lived (<28 day half-life) radioiodine for SNF has decayed to insignificant levels.
Regulatory Guide 1.59, Rev. 2	*Design Basis Floods for Nuclear Power Plants*	Adopted with Clarification	Cold shutdown does not apply to the repository. The design basis flood will not prevent SSCs from meeting their safety function. References within the regulatory guide to safety-related SSCs are construed to mean SSCs that are ITS. Appendix C is not applicable to the repository because it only applies to Atlantic and Gulf of Mexico coastal sites.
Regulatory Guide 1.61, Rev. 1	*Damping Values for Seismic Design of Nuclear Power Plants*	Acceptable Alternative	Damping values used in the analysis of ITS SSCs are based on the industry guidance from ASCE/SEI 43-05.
Regulatory Guide 1.76	*Design Basis Tornado for Nuclear Power Plants*	Adopted with Clarification	The repository uses the more recent design parameters from NUREG/CR-4461 (Ramsdell and Andrews 1986 instead of Table 1, or uses site-specific meteorological data that supports lower maximum wind speeds for credible tornadoes in keeping with the risk-informed licensing basis.
Regulatory Guide 1.92, Rev. 2	*Combining Modal Responses and Spatial Components in Seismic Response Analysis*	Acceptable Alternative	The methodology for combination of modal responses and spatial components is developed in compliance with ASCE 4-98.
Regulatory Guide 1.102, Rev. 1	*Flood Protection for Nuclear Power Plants*	Adopted with Clarification	References within the regulatory guide to safety-related SSCs are construed to mean SSCs that are ITS.

Table 1.2.2-9. Regulatory Guidance Documents Used in the Design of Structures, Mechanical Handling Equipment, and HVAC Systems (Continued)

NRC Guidance Document Number	NRC Guidance Document Title	Yucca Mountain Project Position	Description of Position
Regulatory Guide 1.117, Rev. 1	*Tornado Design Classification*	Adopted with Clarification	References within the regulatory guide to safety-related SSCs are construed to mean SSCs that are ITS.
Regulatory Guide 1.122, Rev. 1	*Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components*	Acceptable Alternative	The in-structure response spectra used for the seismic response analyses are developed in compliance with ASCE 4-98.
Regulatory Guide 1.140, Rev. 2	*Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants*	Adopted with Clarification	ASME AG-1-2003, including the 2004 addenda (ASME AG-1a-2004) is used in lieu of ASME AG-1-1997, ASME N509-2002 is used in lieu of ASME N509-1989, and DOE-HDBK-1169-2003 (DOE 2003) is used in lieu of ERDA 76-21 (Burchsted et al. 1976). Also, there are no charcoal adsorbers because short-lived (<28 day half-life) radioiodine for SNF has decayed to insignificant levels.
Regulatory Guide 1.142, Rev. 2	*Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)*	Adopted with Clarification	ACI 349-01/349R-01 is used. Design of members in torsion meets ACI 349-01/349R-01.
Regulatory Guide 3.18	*Confinement Barriers and Systems for Fuel Reprocessing Plants*	Adopted with Clarification	The Yucca Mountain Project will generally meet Regulatory Guide 3.18 except that the Yucca Mountain Project is a repository and not a fuel processing plant. The Yucca Mountain Project employs confinement barriers in the design of systems performing a confinement function.
Regulatory Guide 3.32	*General Design Guide for Ventilation Systems for Fuel Reprocessing Plants*	Not applicable	The Yucca Mountain Project adopts other regulatory guides to address uncontrolled release and dispersal of radioactive material. Refer to Regulatory Guides 1.140, 1.52, and 3.18.

Table 1.2.2-10. Surface Facility Cranes

Item	Crane Name	Location (Facility/ Room No)	Equipment Number	Lifts Waste Forms?	Safety Classification	Bounding Load	Capacity (tons)	ASME Standard and Type	DBGM Level
1	Cask Handling Crane	IHF/1012	51A-HM00-CRN-00001	Yes	ITS	Casks	300	ASME NOG-1-2004, Type I	2
2	Cask Handling Crane	WHF/1016	050-HM00-CRN-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
3	Cask Handling Crane	CRCF/1026	060-HM00-CRN-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
4	Cask Handling Crane	RF/1017	200-HM00-CRN-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
5	Cask Preparation Crane	IHF/1012	51A-HM00-CRN-00002	No	ITS	Cask impact limiters	30	ASME NOG-1-2004, Type I	2
6	Auxiliary Pool Crane	WHF/1016	050-HMH0-CRN-00001	No	ITS	Cask lids	10	ASME NOG-1-2004, Type I	2
7	DPC Cutting Jib Crane	WHF/1016	050-HD00-CRN-00001	No	ITS	Site transfer cask/DPC lids	10	ASME NUM-1-2004, Type IA	2
8	Preparation Station #1 Jib Crane	WHF/1016	050-HMH0-CRN-00002	No	ITS	Cask lids	10	ASME NUM-1-2004, Type IA	2
9	Preparation Station #2 Jib Crane	WHF/1016	050-HMH0-CRN-00003	No	ITS	Cask lids	10	ASME NUM-1-2004, Type IA	2
10	TAD Canister Closure Station Jib Crane	WHF/1016	050-HC00-CRN-00001	No	ITS	Cask lids	10	ASME NUM-1-2004, Type IA	2
11	Waste Package Handling Crane	IHF/1005	51A-HMP0-CRN-00001	No	ITS	Waste package with pallet and yoke	100	ASME NOG-1-2004, Type II	2

Table 1.2.2-10. Surface Facility Cranes (Continued)

Item	Crane Name	Location (Facility/ Room No)	Equipment Number	Lifts Waste Forms?	Safety Classification	Bounding Load	Capacity (tons)	ASME Standard and Type	DBGM Level
12	Waste Package Handling Crane	CRCF/1015	060-HMP0-CRN-00001	No	ITS	Waste package with pallet and yoke	100	ASME NOG-1-2004, Type II	2
13	Entrance Vestibule Crane	WHF/1001	050-HMC0-CRN-00001	No	ITS	Cask impact limiters	20	ASME NOG-1-2004, Type II	2
14	CTM Maintenance Crane	CRCF/2004	060-HTC0-CRN-00001	No	Non-ITS	Waste package shield plug	15	ASME NOG-1-2004, Type III	IBC
15	CTM Maintenance Crane	IHF/2005	51A-HTC0-CRN-00001	No	Non-ITS	Waste package shield plug	15	ASME NOG-1-2004, Type III	IBC
16	CTM Maintenance Crane	RF/2007	200-HTC0-CRN-00001	No	ITS	Maintenance loads	15	ASME NOG-1-2004, Type II	2
17	CTM Maintenance Crane	WHF/2004	050-HTC0-CRN-00001	No	Non-ITS	STC and aging overpack lids	15	ASME NOG-1-2004, Type III	IBC
18	Waste Package Closure Room Crane	IHF/2004	51A- HW00-CRN-00001	No	Non-ITS	Maintenance loads	15	ASME NOG-1-2004, Type III	IBC
19	Waste Package Closure Room Crane	CRCF/2007	060-HW00-CRN-00001	No	Non-ITS	Maintenance loads	15	ASME NOG-1-2004, Type III	IBC
20	Lid Bolting Room Crane	RF/1002	200-HMC0-CRN-00001	No	ITS	Lid bolts	10	ASME NOG-1-2004, Type II	2
21	Pool Equipment Crane	WHF/M001	050-PW00-CRN-00001	No	Non-ITS	Maintenance loads	5	ASME NOG-1-2004, Type III	IBC
22	Closure Support Room Crane North	CRCF/2003	060-HW00-CRN-00002	No	Non-ITS	Maintenance loads	5	ASME NOG-1-2004, Type III	IBC

Table 1.2.2-10. Surface Facility Cranes (Continued)

Item	Crane Name	Location (Facility/ Room No)	Equipment Number	Lifts Waste Forms?	Safety Classification	Bounding Load	Capacity (tons)	ASME Standard and Type	DBGM Level
23	Closure Support Room Crane South	CRCF/2011	060-HW00-CRN-00003	No	Non-ITS	Maintenance loads	5	ASME NOG-1-2004, Type III	IBC
24	Waste Package Closure Remote Handling System	CRCF/2007	060-HWH0-HEQ-00003	No	ITS	Stress Mitigation Tooling	3	ASME NOG-1-2004, Type II	2
25	Waste Package Closure Remote Handling System	CRCF/2007	060-HWH0-HEQ-00005	No	ITS	Stress Mitigation Tooling	3	ASME NOG-1-2004, Type II	2
26	Waste Package Closure Remote Handling System	IHF/2004	51A-HWH0-HEQ-00003	No	ITS	Stress Mitigation Tooling	3	ASME NOG-1-2004, Type II	2

NOTE: ASME = American Society of Mechanical Engineers; IBC = International Building Code 2000.

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
1	Cask Handling Yoke	CRCF	060-HM00-BEAM-00001	Yes	ITS	Casks	200	ANSI N14.6-1993	2
2	Cask Handling Yoke	RF	200-HM00-BEAM-00001	Yes	ITS	Casks	200	ANSI N14.6-1993	2
3	Cask Handling Yoke	IHF	51A-HM00-BEAM-00001	Yes	ITS	Casks	200	ANSI N14.6-1993	2
4	Cask Handling Yoke	WHF	050-HM00-BEAM-00001	Yes	ITS	Casks	200	ANSI N14.6-1993	2
5	Pool Cask Handling Yoke	WHF	050-HM00-BEAM-00002	Yes	ITS	Casks	200	ANSI N14.6-1993	2
6	Lid Lifting Grapple	WHF	050-HMH0-HEQ-00001	No	ITS	Cask lids	10	ANSI N14.6-1993	2
7	Lid Lifting Grapple	WHF	050-HMH0-HEQ-00002	No	ITS	Cask lids	10	ANSI N14.6-1993	2
8	Lid Lifting Grapple	WHF	050-HMH0-HEQ-00003	No	ITS	Cask lids	10	ANSI N14.6-1993	2
9	Lid Lifting Grapple	WHF	050-HMH0-HEQ-00004	No	ITS	Cask lids	10	ANSI N14.6-1993	2
10	Lid Lifting Grapple	WHF	050-HMH0-HEQ-00006	No	ITS	Cask lids	10	ANSI N14.6-1993	2
11	Truck Cask Lid Lifting Grapple	WHF	050-HMH0-HEQ-00007	No	ITS	Truck cask lids	1	ANSI N14.6-1993	2
12	Truck Cask Lid Lifting Grapple	WHF	050-HMH0-HEQ-00008	No	ITS	Truck cask lids	1	ANSI N14.6-1993	2
13	Truck Cask Lid Lifting Grapple	WHF	050-HMH0-HEQ-00009	No	ITS	Truck cask lids	1	ANSI N14.6-1993	2
14	West Valley Demonstration Project/Hanford HLW Canister Grapple	CRCF	060-HTC0-HEQ-00003	Yes	ITS	HLW canister	10	ANSI N14.6-1993	2
15	West Valley Demonstration Project/Hanford HLW Canister Grapple	IHF	51A-HTC0-HEQ-00003	Yes	ITS	HLW canister	10	ANSI N14.6-1993	2

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment (Continued)

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
16	Defense Waste Processing Facility/Idaho National Laboratory Canister Grapple	CRCF	060-HTC0-HEQ-00005	Yes	ITS	HLW canister	5	ANSI N14.6-1993	2
17	Defense Waste Processing Facility/Idaho National Laboratory Canister Grapple	IHF	51A-HTC0-HEQ-00004	Yes	ITS	HLW canister	5	ANSI N14.6-1993	2
18	Hanford MCO Canister Grapple	CRCF	060-HTC0-HEQ-00004	Yes	ITS	MCO canister	15	ANSI N14.6-1993	2
19	18-in. SNF Canister Grapple	CRCF	060-HTC0-HEQ-00006	Yes	ITS	DOE SNF canister	5	ANSI N14.6-1993	2
20	24-in. SNF Canister Grapple	CRCF	060-HTC0-HEQ-00007	Yes	ITS	DOE SNF canister	7	ANSI N14.6-1993	2
21	DPC Lid Adapters	CRCF	060-HMH0-HEQ-00005	Yes	ITS	DPC canister	45	ANSI N14.6-1993	2
22	DPC Lid Adapters	CRCF	060-HMH0-HEQ-00006	Yes	ITS	DPC canister	45	ANSI N14.6-1993	2
23	DPC Lid Adapters	WHF	050-HMH0-HEQ-00014	Yes	ITS	DPC canister	45	ANSI N14.6-1993	2
24	DPC Lid Adapters	RF	200-HMH0-HEQ-00001	Yes	ITS	DPC canister	45	ANSI N14.6-1993	2
25	Cask Lid Lifting Grapple	CRCF	060-HMH0-HEQ-00012	No	ITS	Cask lids	8	ANSI N14.6-1993	2
26	Cask Lid Lifting Grapple	RF	200-HMH0-HEQ-00008	No	ITS	Cask lids	8	ANSI N14.6-1993	2
27	Long-Reach Grapple Adapter	WHF	050-HMH0-TOOL-00001	No	ITS	STC lids	12	ANSI N14.6-1993	2
28	Long-Reach Grapple Adapter	WHF	050-HMH0-TOOL-00002	No	ITS	Truck cask lids	12	ANSI N14.6-1993	2

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment (Continued)

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
29	Canister Transfer Machine Canister Grapple	WHF	050-HTC0-HEQ-00001	Yes	ITS	Canisters	70	ANSI N14.6-1993	2
30	Canister Transfer Machine Canister Grapple	IHF	51A-HTC0-HEQ-00001	Yes	ITS	Canisters	70	ANSI N14.6-1993	2
31	Canister Transfer Machine Canister Grapple	CRCF	060-HTC0-HEQ-00001	Yes	ITS	Canisters	70	ANSI N14.6-1993	2
32	Canister Transfer Machine Canister Grapple	CRCF	060-HTC0-HEQ-00002	Yes	ITS	Canister	70	ANSI N14.6-1993	2
33	Canister Transfer Machine Canister Grapple	RF	200-HTC0-HEQ-00001	Yes	ITS	Canisters	70	ANSI N14.6-1993	2
34	Pool Yoke Lift Adapter	WHF	050-HM00-TOOL-00002	Yes	ITS	Casks	200	ANSI N14.6-1993	2
35	Cask Transfer Trolley	IHF	51A-HM00-TRLY-00001	Yes	ITS	Casks	265	ASME NOG-1-2004, Type I	2
36	Cask Transfer Trolley	CRCF	060-HM00-TRLY-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
37	Cask Transfer Trolley	CRCF	060-HM00-TRLY-00002	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
38	Cask Transfer Trolley	RF	200-HM00-TRLY-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2
39	Cask Transfer Trolley	WHF	050-HM00-TRLY-00001	Yes	ITS	Casks	200	ASME NOG-1-2004, Type I	2

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment (Continued)

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
40	PWR Lifting Grapple	WHF	050-HTF0-HEQ-00001	Yes	ITS	SNF	1.5	ANSI N14.6-1993	2
41	BWR Lifting Grapple	WHF	050-HTF0-HEQ-00002	Yes	ITS	SNF	1.5	ANSI N14.6-1993	2
42	Canister Transfer Machine	IHF	51A-HTC0-FHM-00001	Yes	ITS	Canister	70	ASME NOG-1-2004, Type I	2
43	Canister Transfer Machine	CRCF	060-HTC0-FHM-00001	Yes	ITS	Canister	70	ASME NOG-1-2004, Type I	2
44	Canister Transfer Machine	CRCF	060-HTC0-FHM-00002	Yes	ITS	Canister	70	ASME NOG-1-2004, Type I	2
45	Canister Transfer Machine	RF	200-HTC0-FHM-00001	Yes	ITS	Canister	70	ASME NOG-1-2004, Type I	2
46	Canister Transfer Machine	WHF	050-HTC0-FHM-00001	Yes	ITS	Canister	70	ASME NOG-1-2004, Type I	2
47	DOE Waste Package Inner Lid Grapple	IHF	51A-HTC0-HEQ-00007	Yes	ITS	Waste package lid	7	ANSI N14.6-1993	2
48	Naval Canister Lifting Adapter	IHF	51A-HTC0-HEQ-00005	Yes	ITS	Naval canister	52	ANSI N14.6-1993	2
49	Naval Waste Package Inner Lid Grapple	IHF	51A-HTC0-HEQ-00008	No	ITS	Waste package lid	1.5	ANSI N14.6-1993	2

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment (Continued)

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
50	Waste Package Transfer Trolley	IHF	51A-HL00-TRLY-00001	Yes	ITS	Waste package	100	ASME NOG-1-2004, Type I	2
51	Waste Package Transfer Trolley	CRCF	060-HL00-TRLY-00001	Yes	ITS	Waste package	100	ASME NOG-1-2004, Type I	2
52	Waste Package Transfer Trolley	CRCF	060-HL00-TRLY-00002	Yes	ITS	Waste package	100	ASME NOG-1-2004, Type I	2
53	Spent Fuel Transfer Machine	WHF	050-HFT0-FHM-00001	Yes	ITS	SNF	1.5	ASME NOG-1-2004, Type I	2
54	Naval Cask Lift Bail	IHF	51A-HMC0-BEAM-00001	Yes	ITS	Naval M-290 Cask	285	ANSI N14.6-1993	2
55	Naval Cask Lift Plate	IHF	51A-HMC0-HEQ-00005	Yes	ITS	Naval M-290 Cask	285	ANSI N14.6-1993	2
56	Horizontal Lifting Beam	RF	200-HMC0-BEAM-00001	Yes	ITS	Rail Cask	150	ANSI N14.6-1993	2
57	Truck Cask Lid Adapter	WHF	050-HMH0-HEQ-00010	No	ITS	Truck Cask Lid	1	ANSI N14.6-1993	2
58	Truck Cask Lid Adapter	WHF	050-HMH0-HEQ-00011	No	ITS	Truck Cask Lid	1	ANSI N14.6-1993	2
59	Rail Cask Lid Adapter	WHF	050-HMH0-HEQ-00012	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2
60	Rail Cask Lid Adapter	WHF	050-HMH0-HEQ-00013	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2

Table 1.2.2-11. Surface Facility Mechanical Handling Equipment (Continued)

Item	Mechanical Handling Equipment Name	Location (Facility)	Equipment Number	Handles Waste Forms?	Safety Category	Bounding Load	Capacity (tons)	Principal Design Standard	DBGM Level
61	Rail Cask Lid Adapter	CRCF	060-HMH0-HEQ-00003	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2
62	Rail Cask Lid Adapter	CRCF	060-HMH0-HEQ-00004	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2
63	Rail Cask Lid Adapter	RF	200-HMH0-HEQ-00002	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2
64	Rail Cask Lid Adapter	IHF	51A-HMH0-HEQ-00002	No	ITS	Rail Cask Lid	6	ANSI N14.6-1993	2

NOTE: MCO = multicanister overpack.

Table 1.2.2-12. Principal Codes and Standards Used in the Design of Surface Structures, Mechanical Handling Equipment, and HVAC Systems

Codes and Standard	Applicability
ACI 318-02/318R-02, *Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02)*	Concrete structures
ACI 349-01/349R-01, *Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)*	ITS concrete structures
Manual of Steel Construction, Allowable Stress Design (AISC 1997)	Conventional structural steel design
Standards Handbook (AMCA 1999)	Supply fans
ANSI N14.6-1993, *American National Standard for Radioactive Materials—Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More*	Special lifting devices
ANSI/AISC N690-1994, *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*, with Supplement No. 2	ITS structural steel structures, shield doors, confinement doors, and slide gates
ANSI/AMCA 210-99, *Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*	Supply fan, exhaust fan
ANSI/ANS-2.8-1992, *American National Standard for Determining Design Basis Flooding at Power Reactor Sites*	Probable maximum floods
ANSI/ANS-57.7-1988, *American National Standard, Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)*	HVAC system
ANSI/ANS-57.9-1992, *American National Standard, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)*	HVAC system
ANSI/ASHRAE 52.1-1992, *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter*	Air filters
ANSI/AWS A5.32/A5.32M-97, *Specification for Welding Shielding Gases*	Welding
ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary*	Seismic response analysis for surface ITS facilities
ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*	ITS structures and structural components
ASME AG-1-2003, *Code on Nuclear Air and Gas Treatment*, including the 2004 addenda (ASME AG-1a-2004)	Air filters, dampers, exhaust HEPA filter plenums, demisters and prefilters, HEPA filters
ASME B30.2-2005, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)*	Crane operation
IEEE Std 484-2002, *IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*	—
IEEE Std 603-1998, *IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations*	—

Table 1.2.2-12. Principal Codes and Standards Used in the Design of Surface Structures, Mechanical Handling Equipment, and HVAC Systems (Continued)

Codes and Standard	Applicability
NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*	—
NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*	—
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*	—
UL 586, *High-Efficiency, Particulate, Air Filter Units*	—
ASME B30.9-2003, *Slings*	Standard lifting devices
ASME B30.10-2005, *Hooks*	Standard lifting devices
ASME B30.20-2003, *Below-the-Hook Lifting Devices*	Below-the-hook lifting devices
ASME N509-2002, *Nuclear Power Plant Air-Cleaning Units and Components*	Exhaust fans, exhaust HEPA filter plenums, demisters and prefilters, and HEPA filters
ASME N510-1989, *Testing of Nuclear Air Treatment Systems*	Testing of exhaust HEPA filter plenums
ASME NOG-1-2004, *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)*	Structural design of cranes, trolleys, and other mechanical handling equipment, including load and load combination requirements
ASME NUM-1-2004, *Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)*	Monorails and hoists
AWS D1.1/D1.1M:2006, *Structural Welding Code — Steel*	Welding and structures
International Building Code 2000 (ICC 2003)	Non-ITS concrete structures
HVAC Duct Construction Standards—Metal and Flexible (SMACNA 1995)	Ductwork
UL-555, *Fire Dampers*	Fire damper
UL 900, *Air Filter Units*	Air filters, demisters, and prefilters
ASCE/SEI 43-05	Seismic analysis of SSCs
ASHRAE DG-1-93	HVAC Instrumentation and control

Source: BSC 2007a.

Table 1.2.2-13. Ventilation Confinement Zoning Classifications

Contamination Characteristics	Confinement Zoning	Applicability
Areas where radioactive materials or contamination is present during normal operations (Zone C4 is used for areas that are normally contaminated and Zone C5 is for areas with high levels of contamination.)	Primary confinement	NA
Areas with a potential for airborne contamination during normal facility operation	Secondary confinement	WHF pool room only
Areas that are normally clean where airborne contamination is not expected during normal facility operation	Tertiary confinement	RF, CRCF, WHF, IHF, LLWF
Noncontaminated areas (clean)	Nonconfinement	RF, CRCF, WHF, IHF, LLWF

NOTE: Confinement zone definition is in accordance with DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook* (DOE 2003), Section 2.2.9. NA = not applicable.

Table 1.2.2-14. HVAC Instrumentation and Controls

Parameter	Location/Characteristics
Air Temperature	Indication and control of air temperature in selected areas of the nuclear facilities, including supply air temperature
Airflow Rate	Air handling units supply air flow, exhaust fans, and exhaust to atmosphere flow indication and low-flow alarms.
Differential Pressure	Filters, moisture eliminators, and selected ITS confinement areas. Includes indication and alarm of high and low differential pressure across fans, indication of high and low differential pressure across HEPA stages, indication and alarm of low differential pressure alarm in ITS confinement areas (with respect to atmosphere), and indication and alarm of high or low differential pressure across the HEPA filter plenums.
Radiation	Indication and alarm of high radiation level at the HEPA filter plenums and exhaust discharge
Smoke/High Heat	Detection located at ventilation ductwork, fan motors, air-handling units discharge, and ITS HEPA filter plenums. Alarms located at the Facility Fire Alarm Panel.
On/Off and Operational Status	All electrically powered or controlled equipment, including fan operational status indication
Damper Position Indication	All electric motor operated dampers, including damper position indication of backdraft dampers and ITS manual isolation dampers
Failure Alarms	Alarm the failure of specific equipment and components, such as fans, dampers and radiation monitors.

Source: BSC 2007a; ASHRAE DG-1-93; NFPA 90A.

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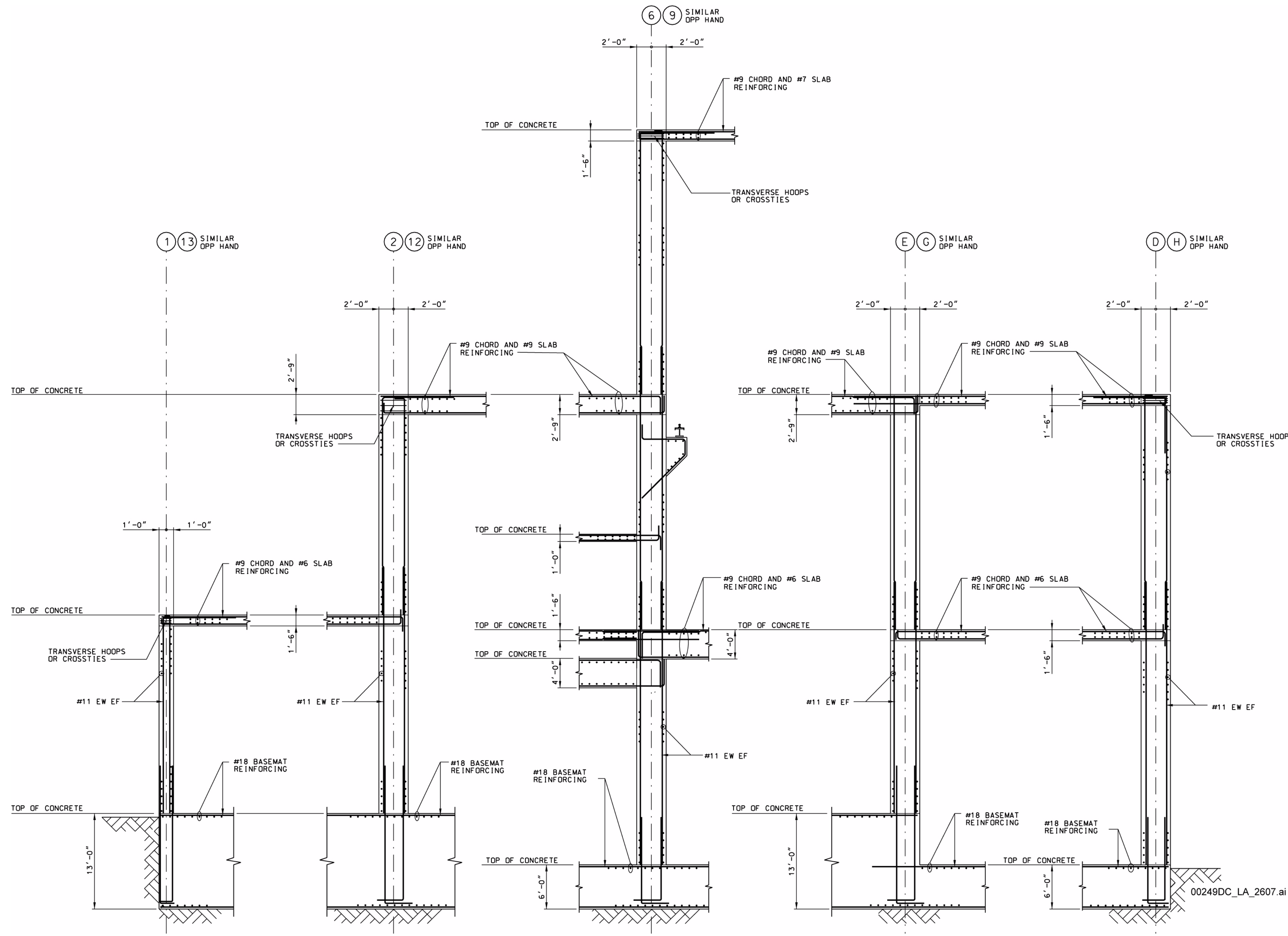

Figure 1.2.2-1. Typical Canister Receipt and Closure Facility Reinforcing Sections

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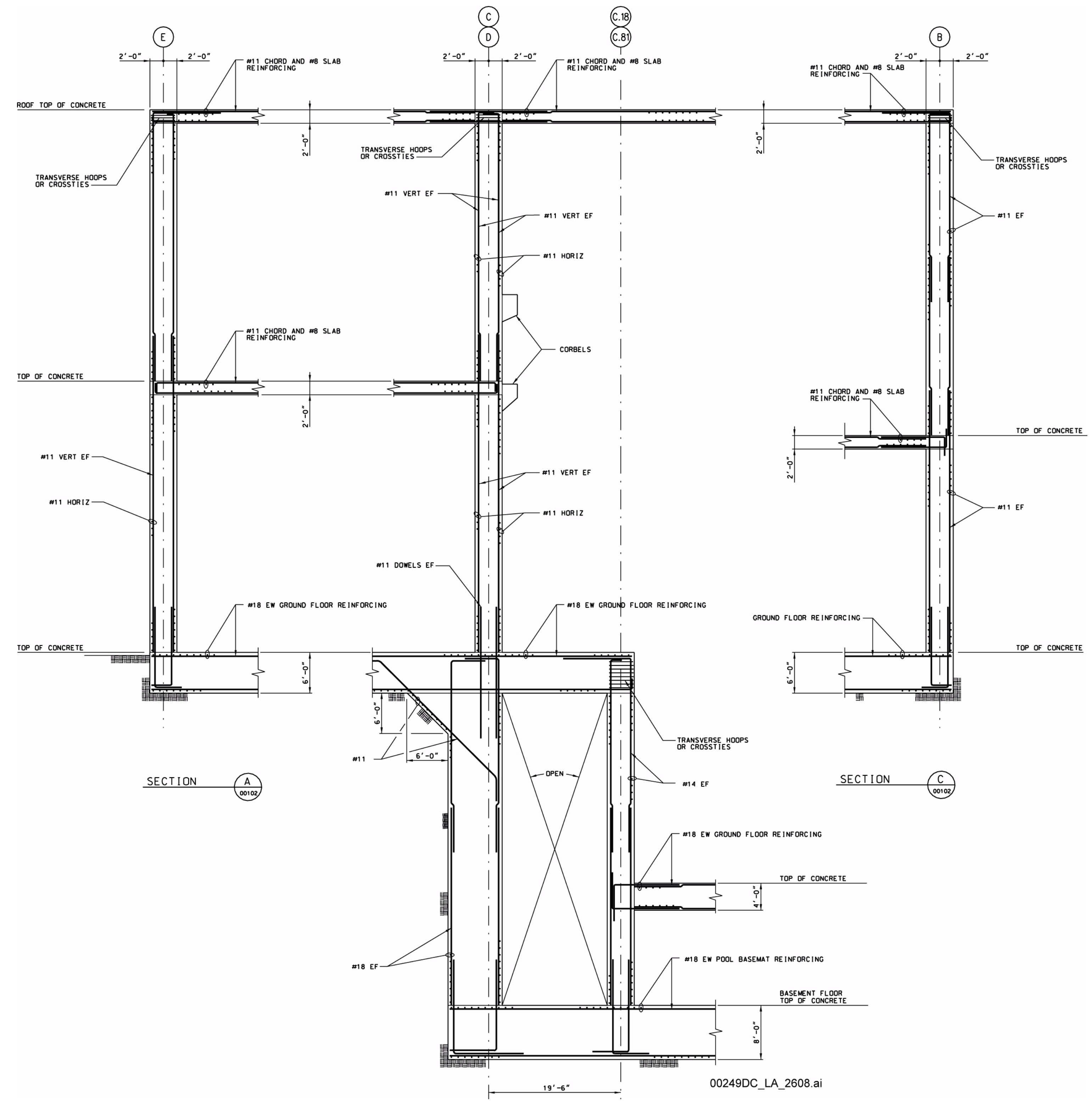

Figure 1.2.2-2. Typical Wet Handling Facility Reinforcing Sections

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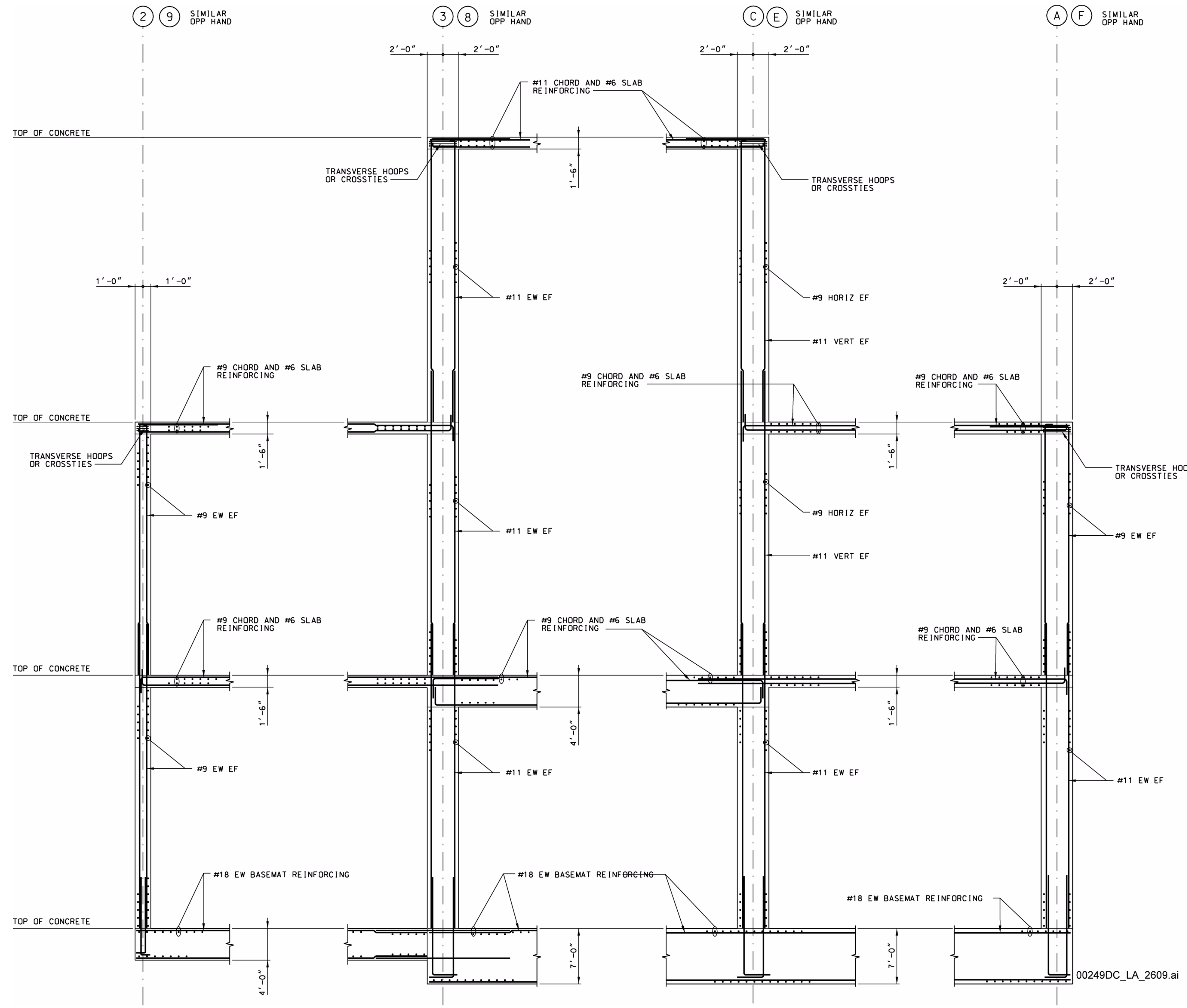

Figure 1.2.2-3. Typical Receipt Facility Reinforcing Sections

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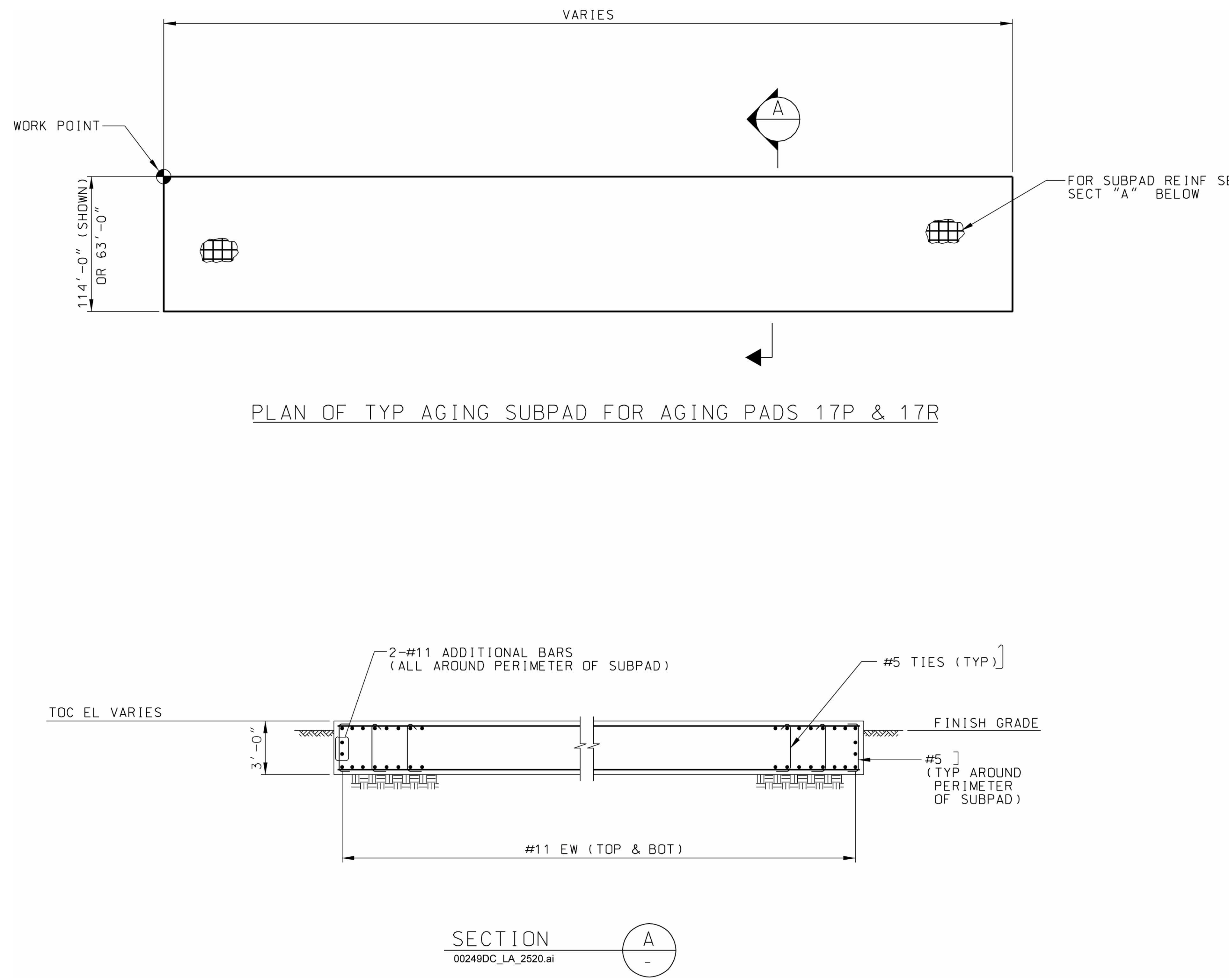

Figure 1.2.2-4. Typical Aging Pad Reinforcing Details

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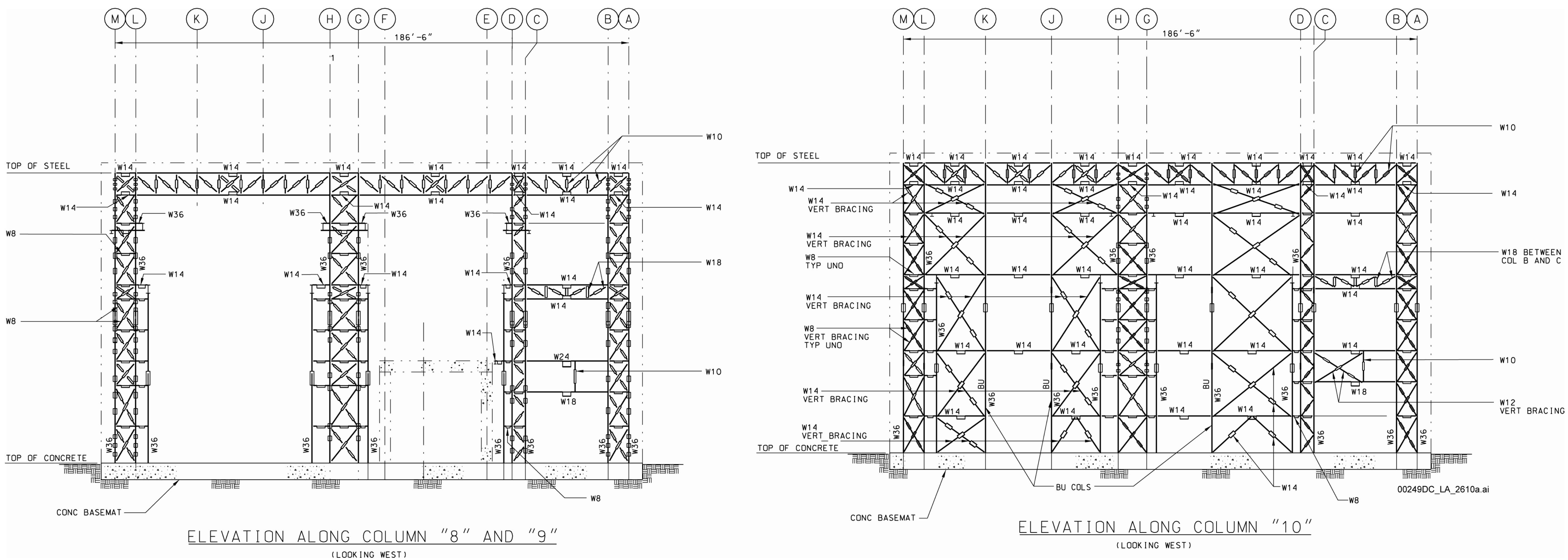

Figure 1.2.2-5. Typical Section through the Initial Handling Facility Building

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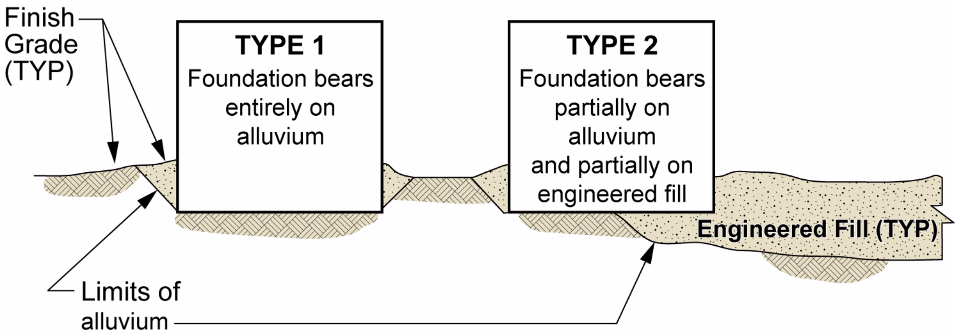

Facility	Type 1	Type 2
CRCF 1		X
CRCF 2		X
CRCF 3	X	
IHF	X	
WHF		X
RF	X	
Aging Pad		X

Figure 1.2.2-6. Extent of Alluvium and Engineered Fill for Surface Facilities

NOTE: Engineered fill will have material properties equivalent to that of the underlying alluvium.

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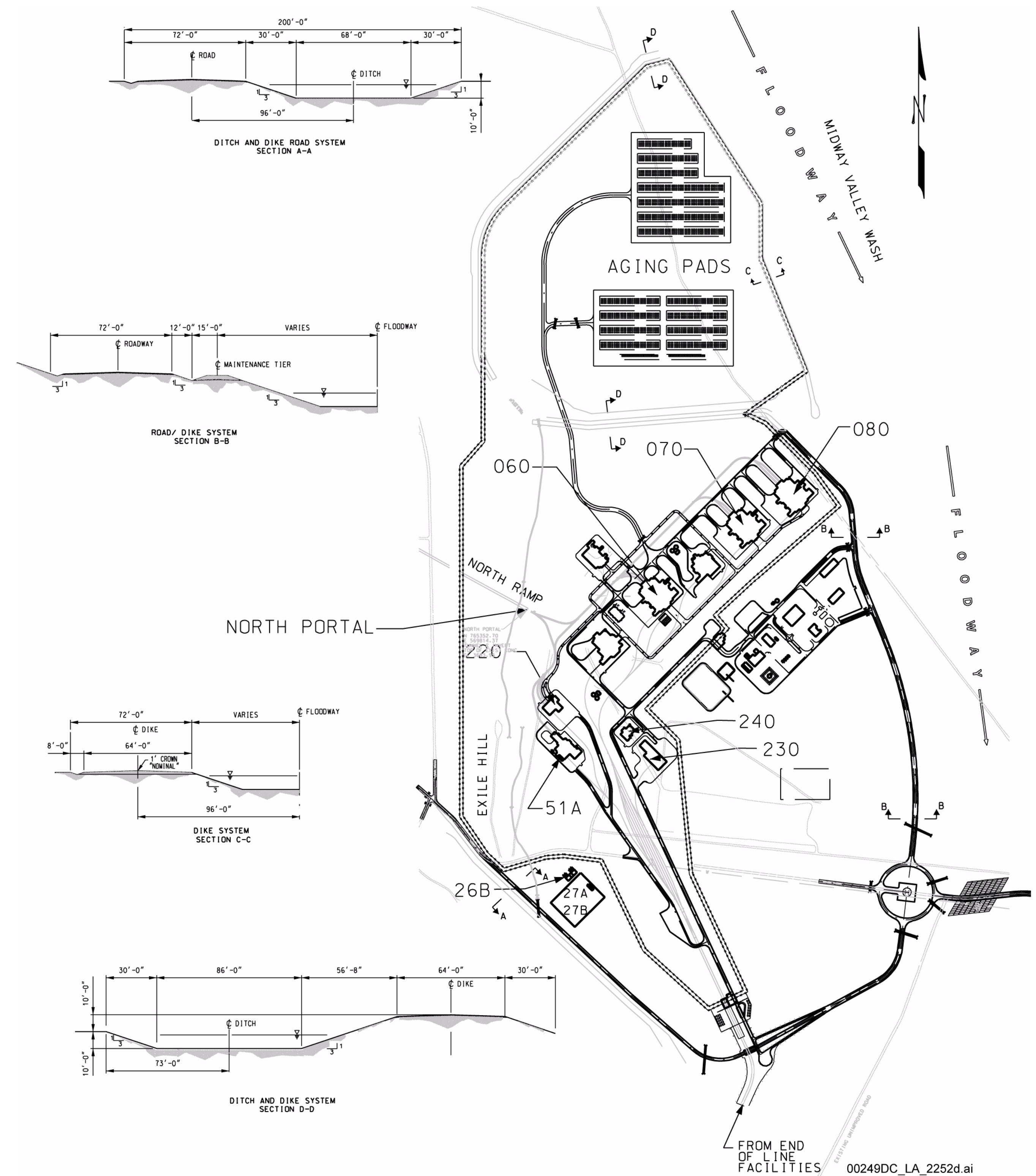

Figure 1.2.2-7. Flood Protection Plan and Sections

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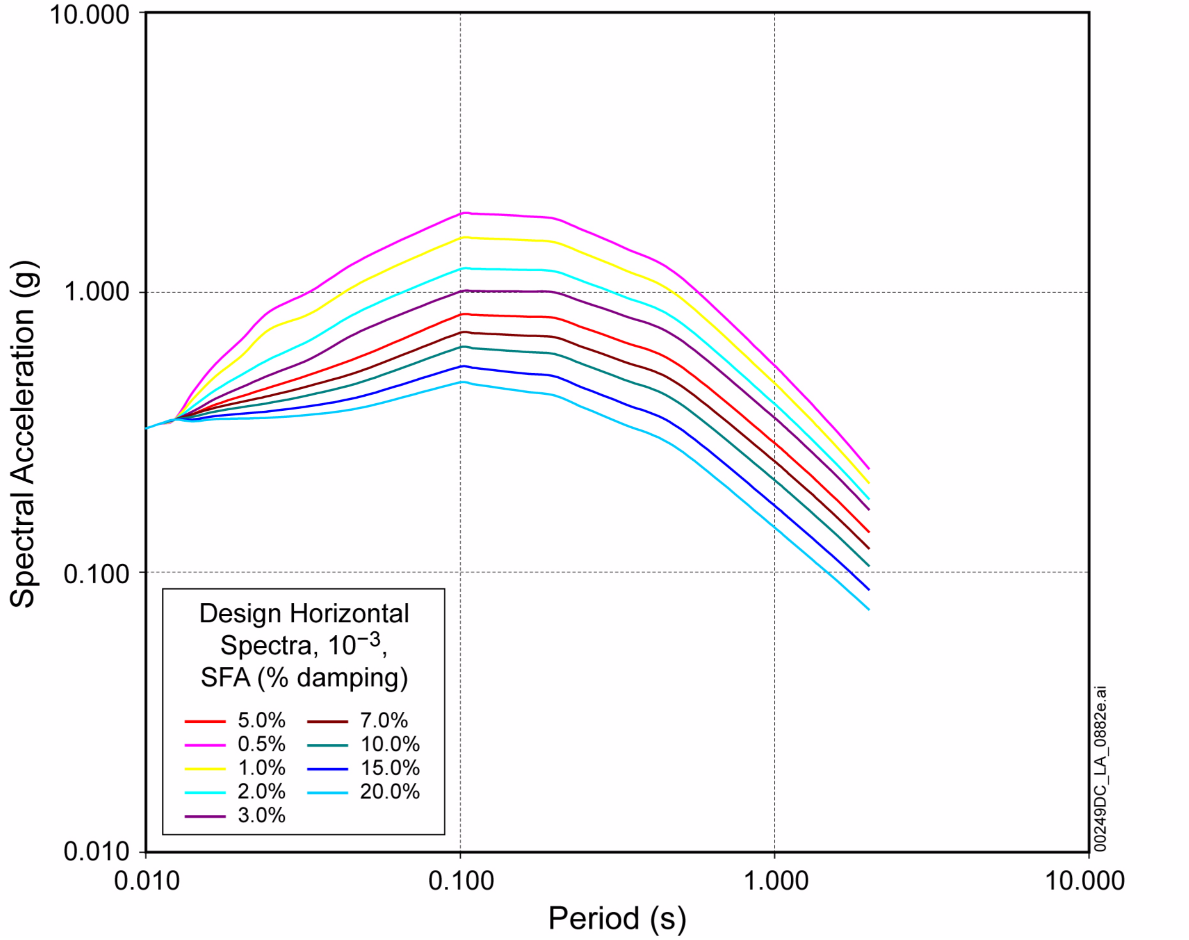

Figure 1.2.2-8. Horizontal Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 10^{-3}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

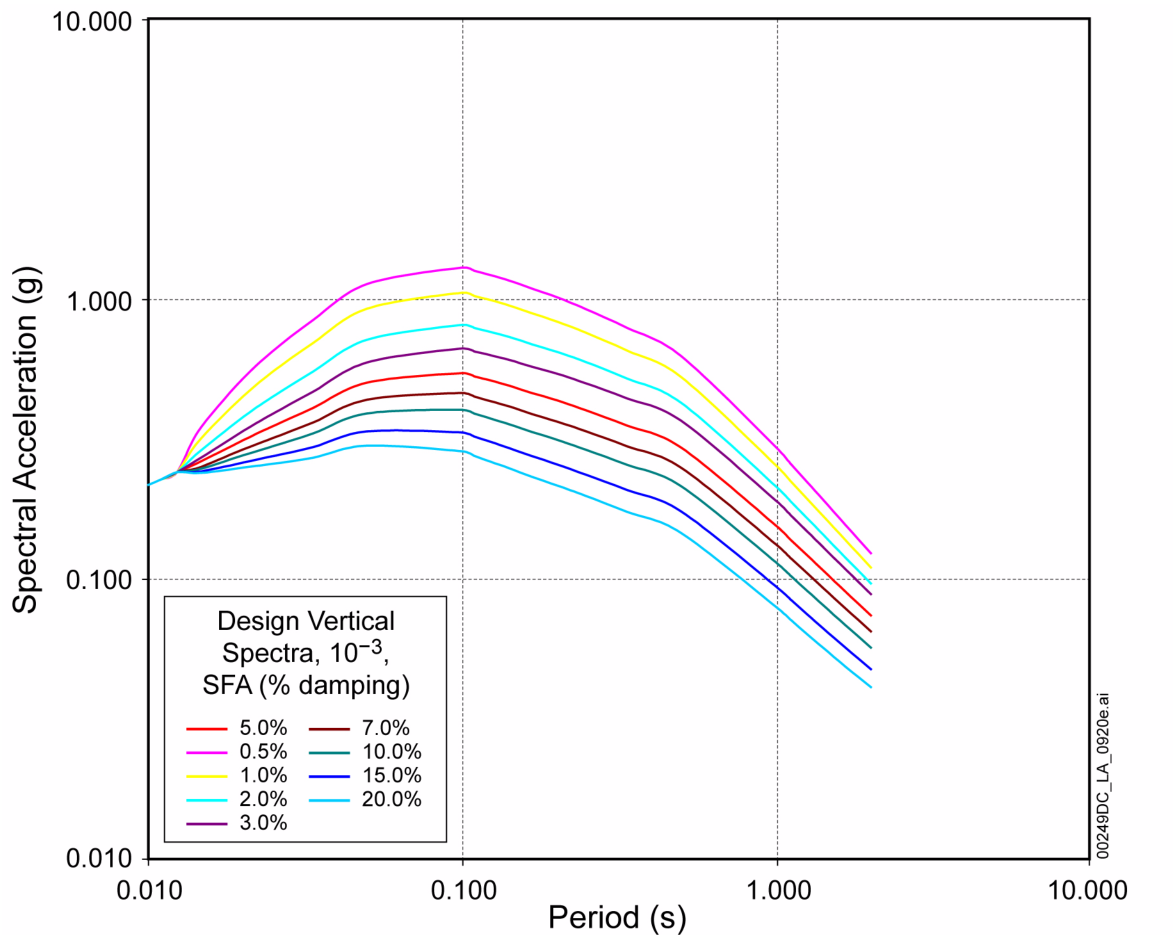

Figure 1.2.2-9. Vertical Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 10^{-3}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

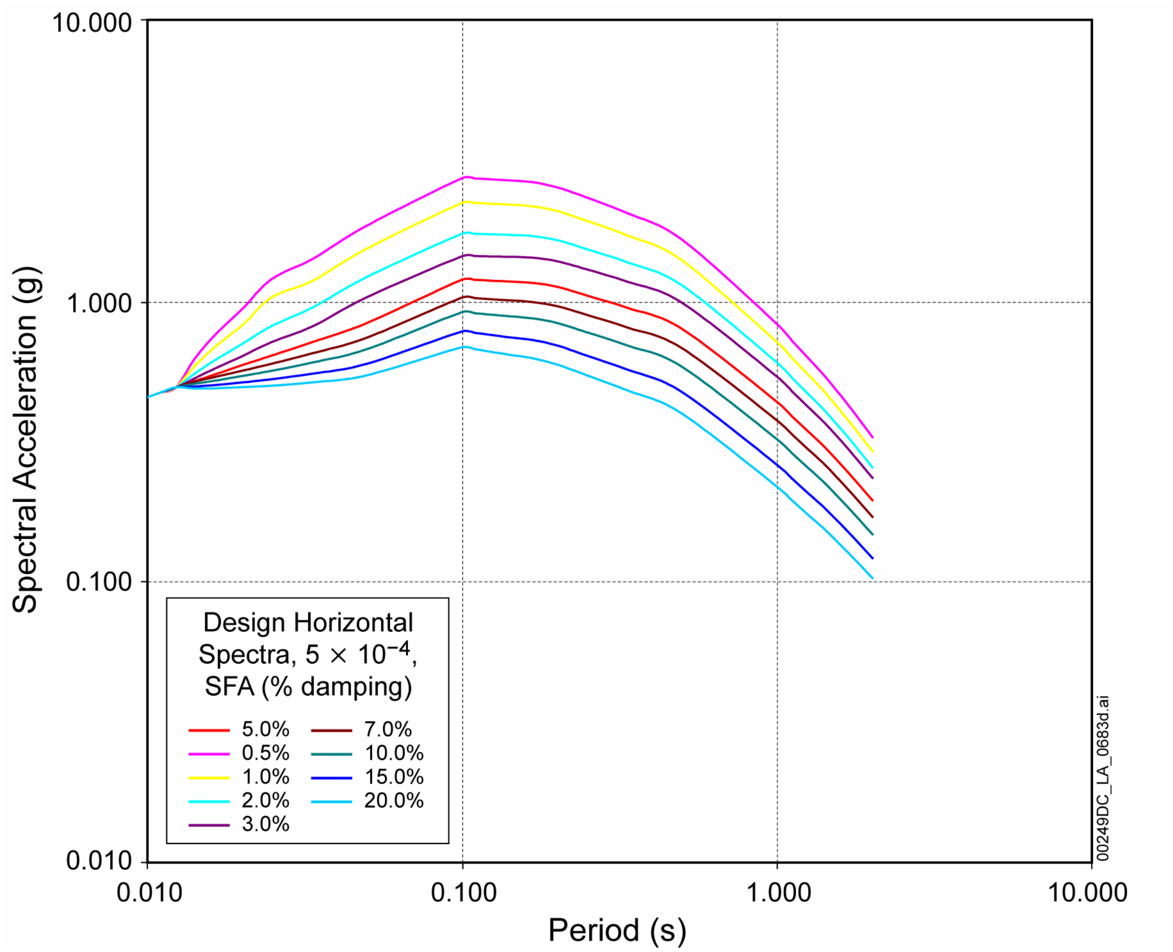

Figure 1.2.2-10. Horizontal Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 5×10^{-4}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

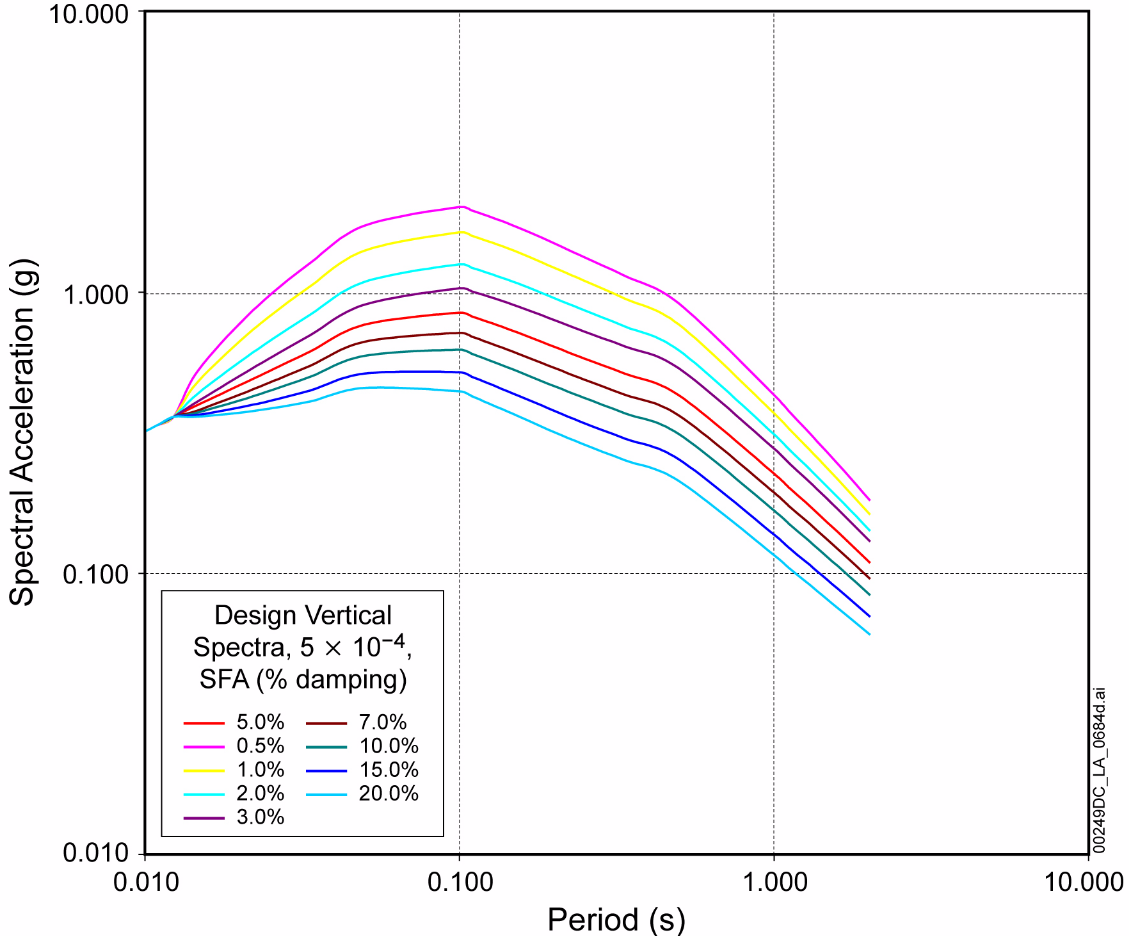

Figure 1.2.2-11. Vertical Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 5×10^{-4}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

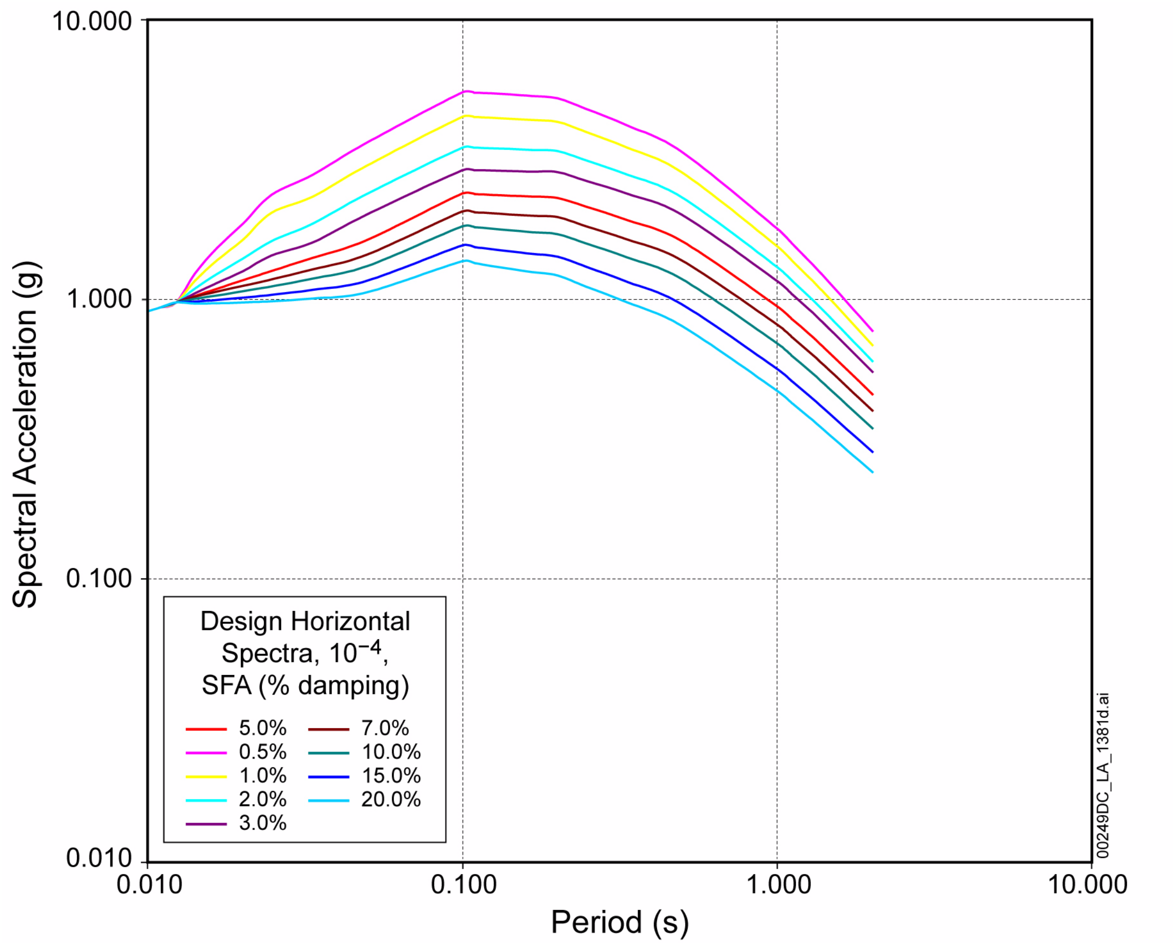

Figure 1.2.2-12. Horizontal Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 10^{-4}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

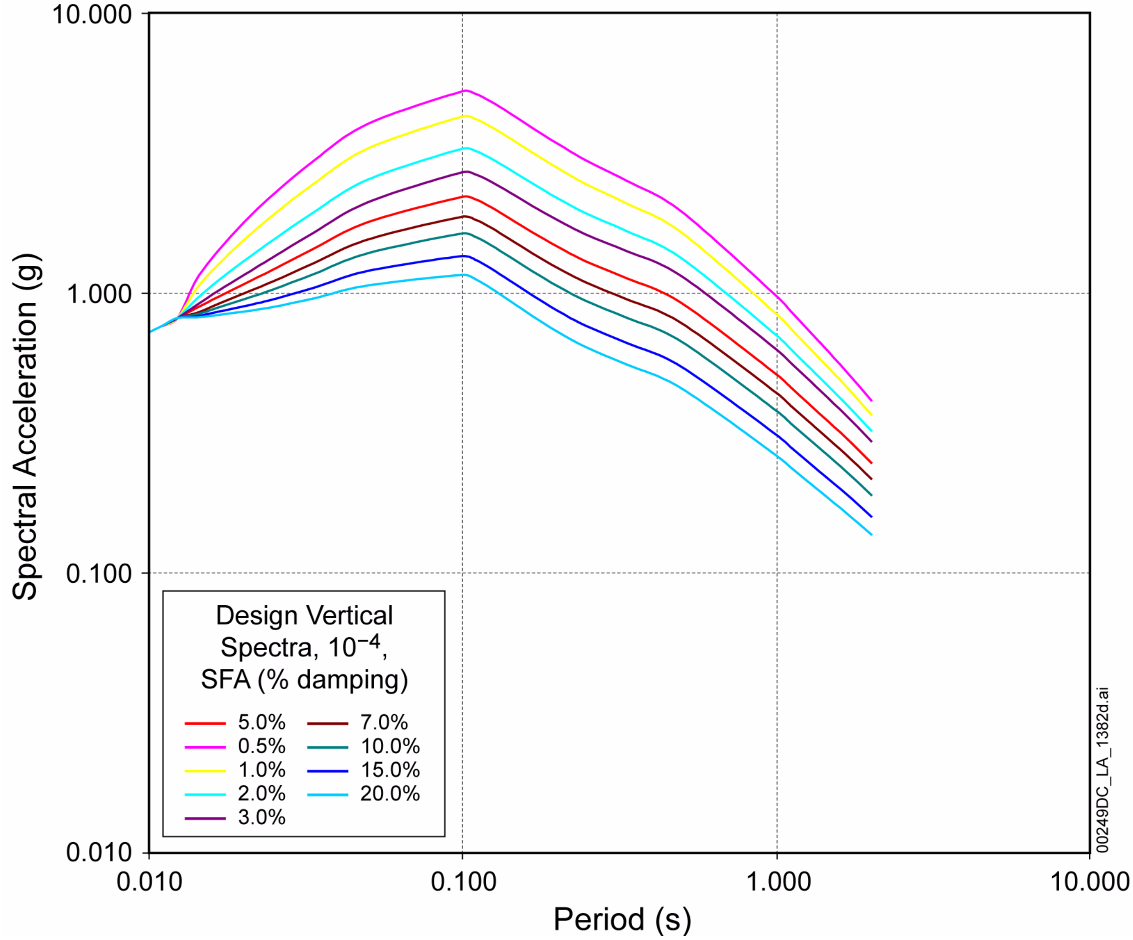

Figure 1.2.2-13. Vertical Ground Response Spectra at Multiple Dampings for a Mean Annual Exceedance Probability of 10^{-4}

NOTE: SFA = surface facilities area.

Source: BSC 2008c.

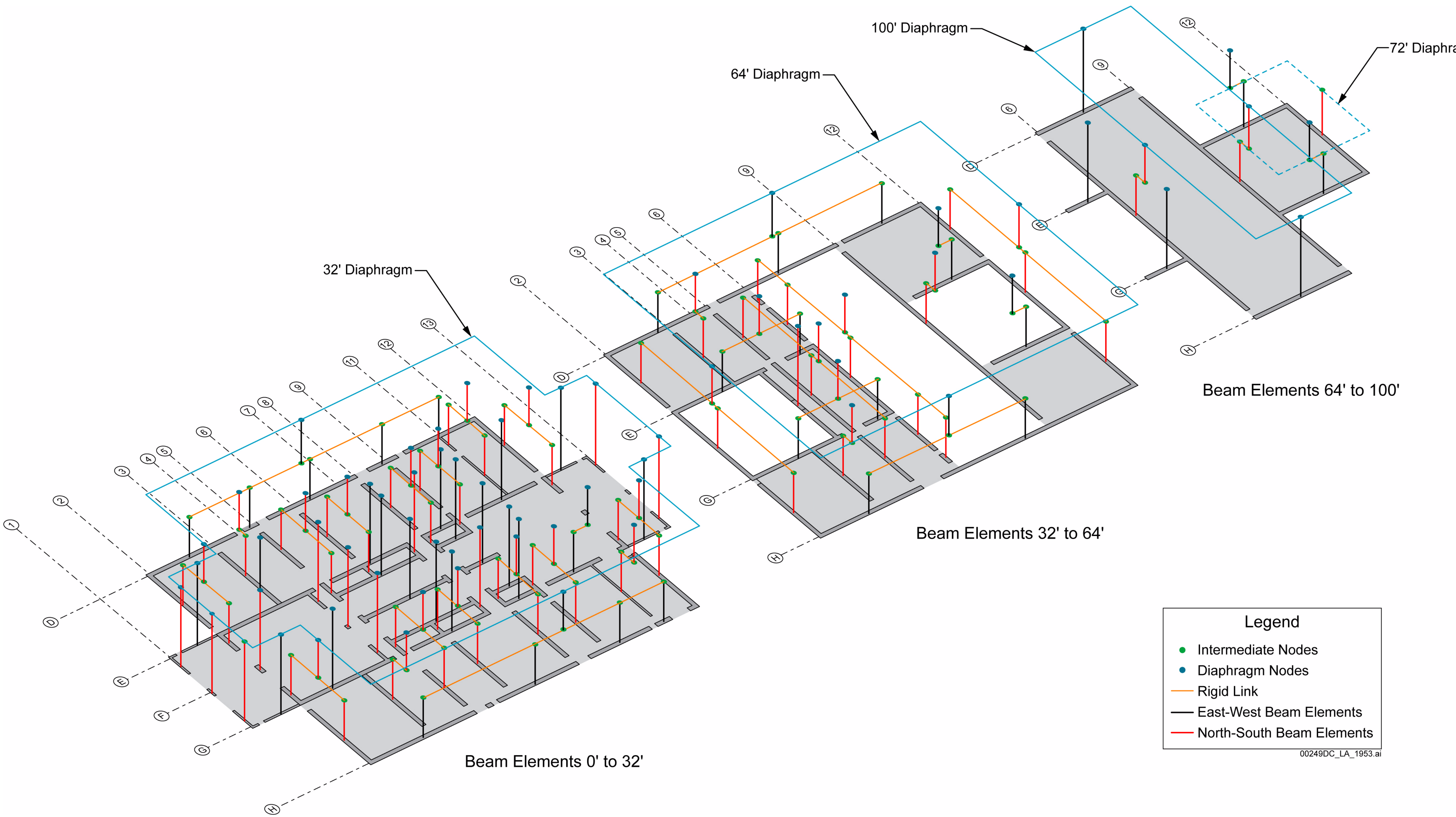

Figure 1.2.2-14. Canister Receipt and Closure Facility Lumped-Mass, Multiple-Stick Model

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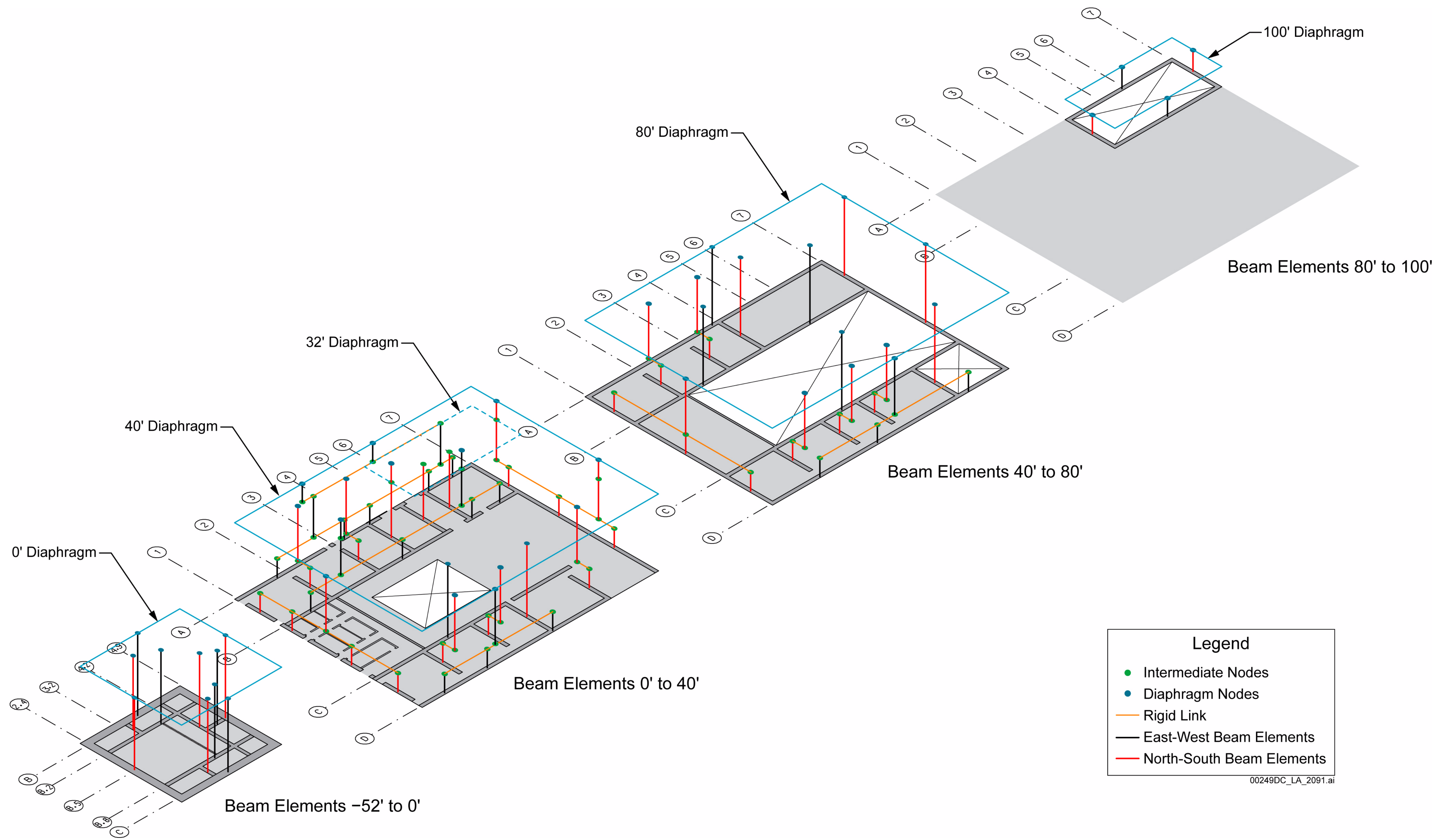

Figure 1.2.2-15. Wet Handling Facility Lumped-Mass, Multiple-Stick Model

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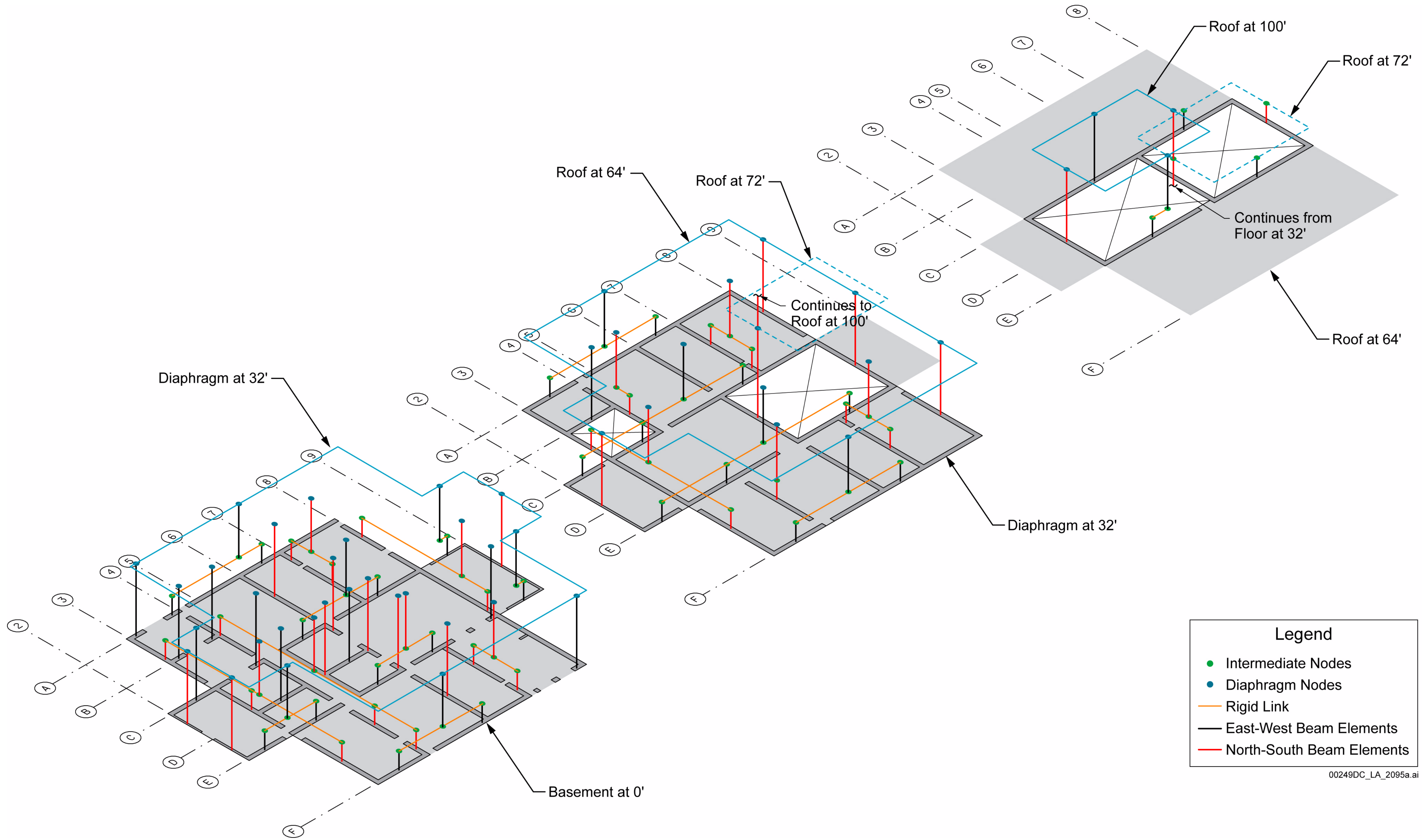

Figure 1.2.2-16. Receipt Facility Lumped-Mass, Multiple-Stick Model

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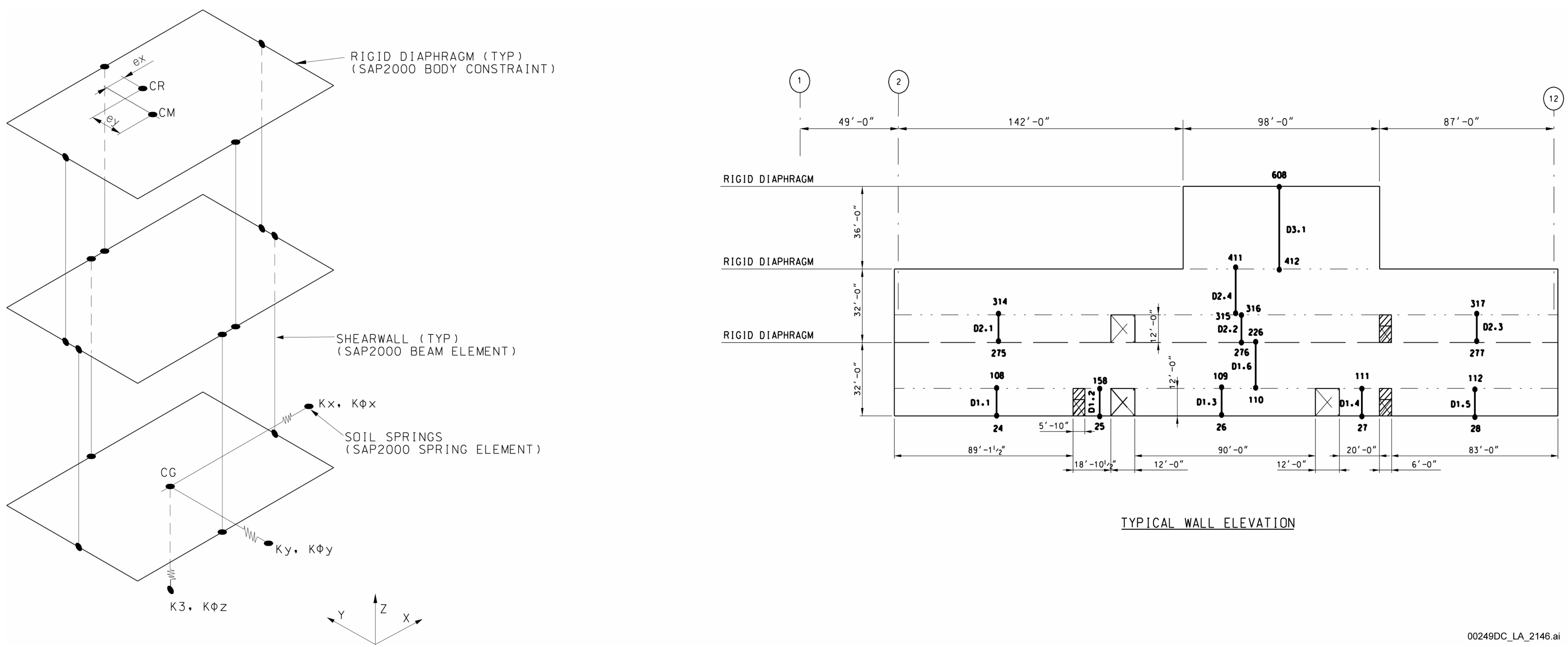

Figure 1.2.2-17. Typical Lumped-Mass Stick Model and Shear Wall Representation

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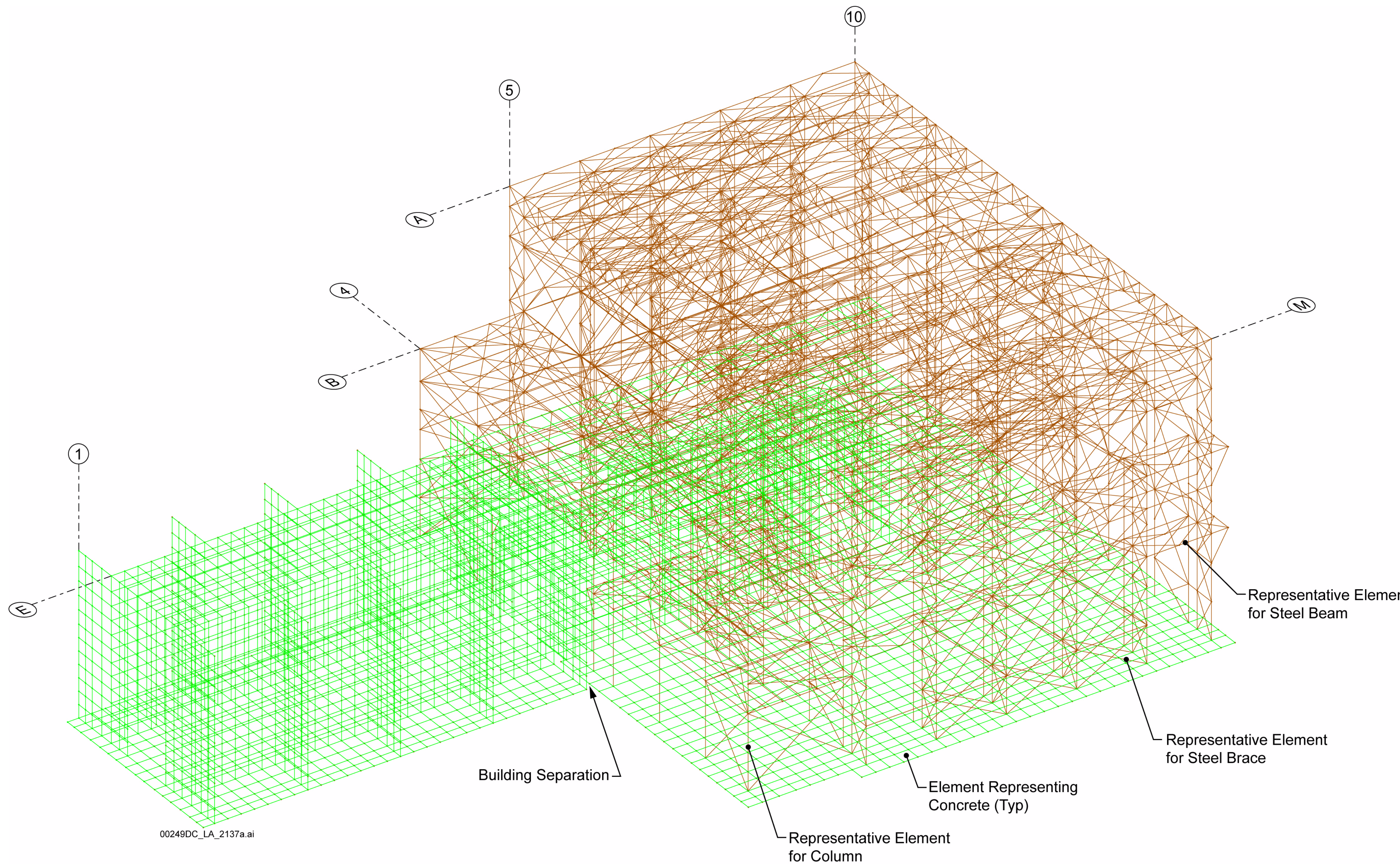

Figure 1.2.2-18. Initial Handling Facility Model

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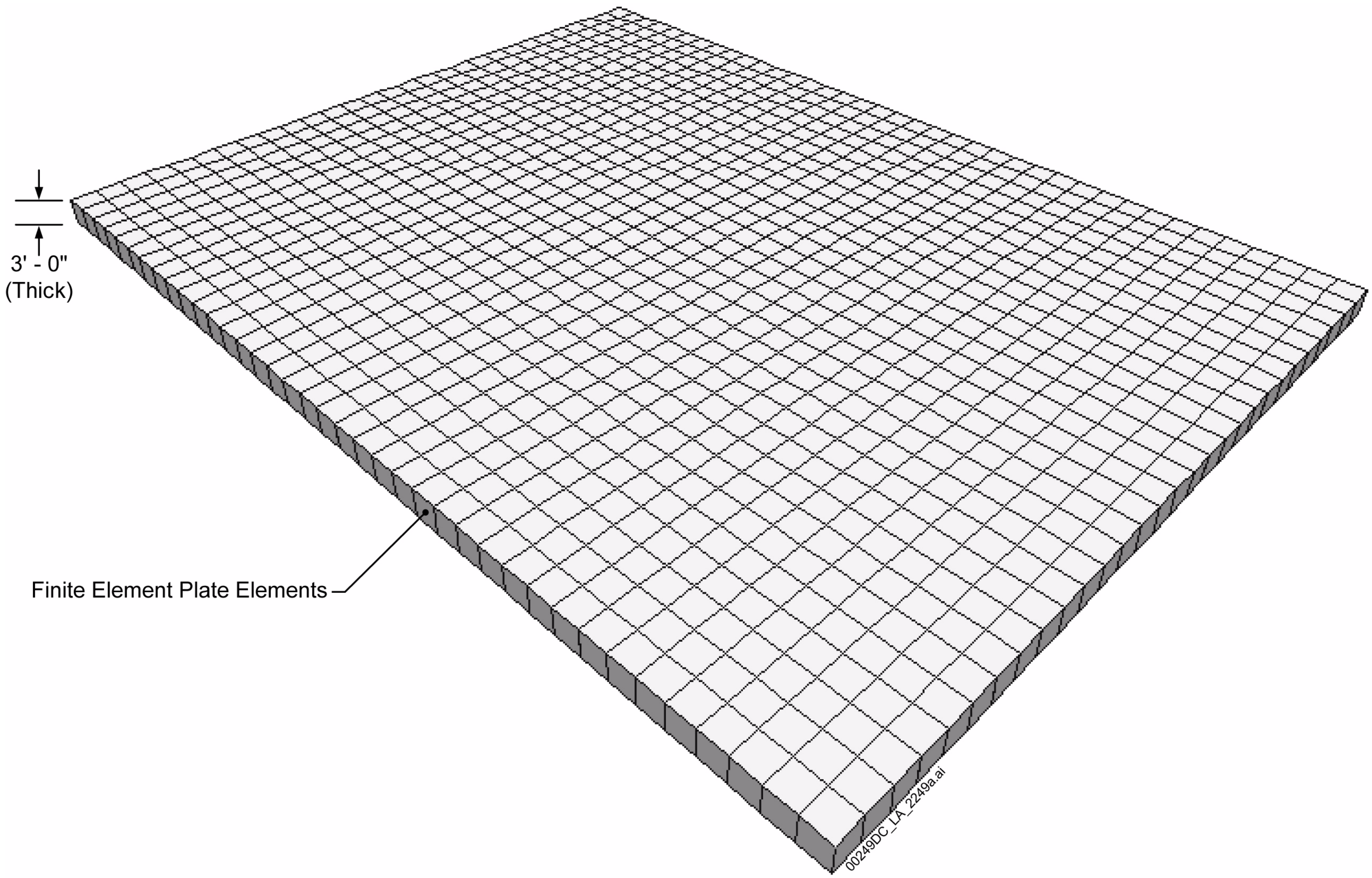

Figure 1.2.2-19. Aging Pad Model

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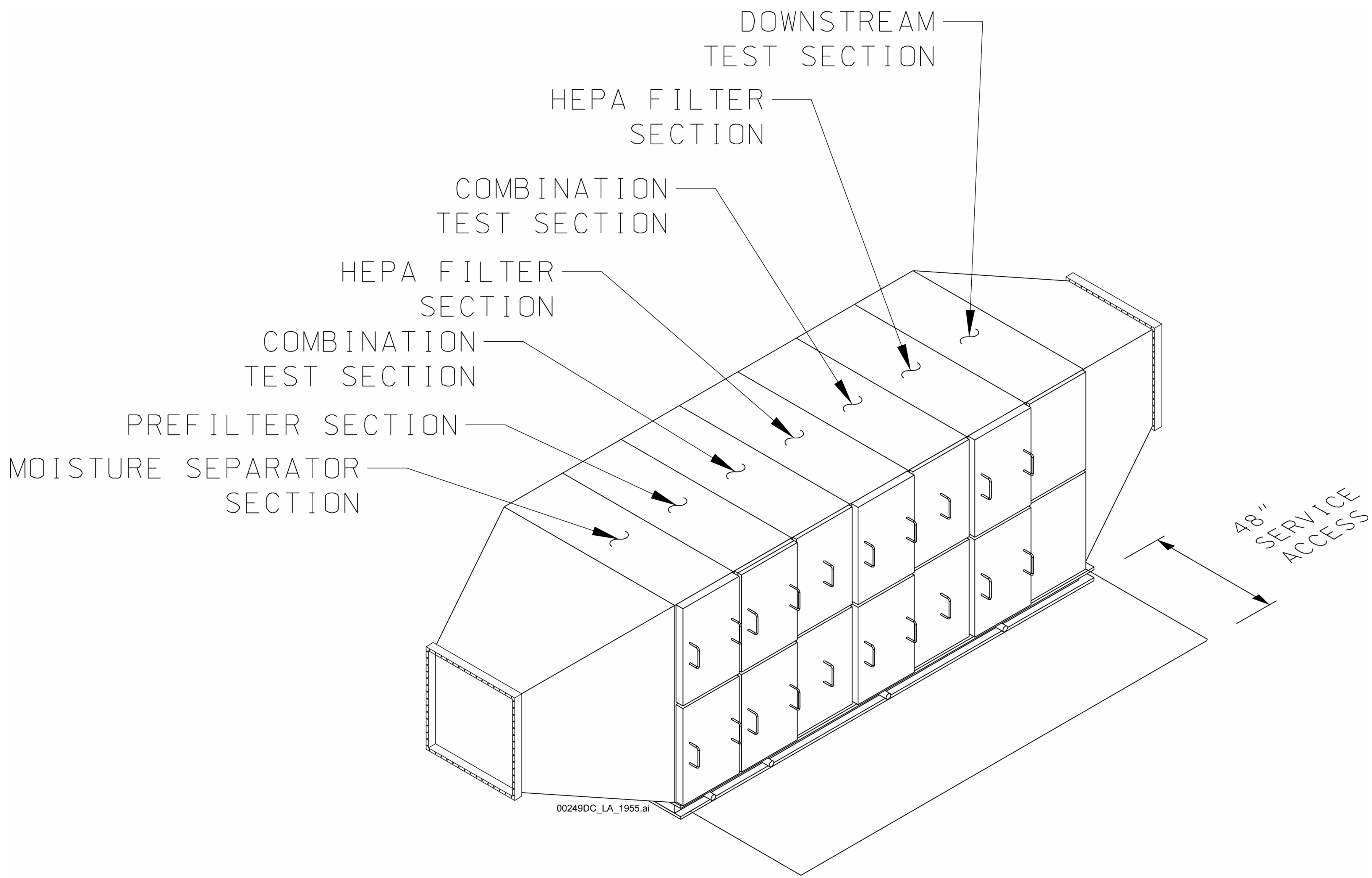

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Figure 1.2.2-20. HVAC System Filter Arrangement

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TABLES

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FIGURES

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1.2.3 Initial Handling Facility

[NUREG-1804, Section 2.1.1.2.3: AC 1, AC 2, AC 6; Section 2.1.1.6.3: AC 1, AC 2; Section 2.1.1.7.3.1: AC 1; Section 2.1.1.7.3.2: AC 1; Section 2.1.1.7.3.3(I): AC 1, AC 2, AC 4; HLWRS-ISG-02 Section 2.1.1.2.3: AC 2]

The design and operation of the Initial Handling Facility (IHF) and the systems within the facility are described in this section. Information specific to the generic features of structural design, mechanical handling design, and heating, ventilation, and air-conditioning (HVAC) design, is provided in Sections 1.2.2.1, 1.2.2.2, and 1.2.2.3. Information related to the electrical power, controls and monitoring, fire protection, plant services, and waste management is provided in Sections 1.4.1 to 1.4.5, respectively. The methodologies for shielding and nuclear criticality design are addressed in Sections 1.10.3 and 1.14, respectively. Logic diagrams for structures, systems, and components (SSCs) that are important to safety (ITS) used in facilities, including the IHF, are provided in Section 1.2.4 where the discussion of the ITS equipment is addressed.

ITS SSCs in the mechanical handling system that are used in handling facilities, including the IHF, are discussed in Section 1.2.4.2. Table 1.2.3-1 lists the non-ITS mechanical handling SSCs used in the IHF, which are similar to those in other handling facilities. IHF-specific non-ITS SSCs in the mechanical handling system are described in summary in Table 1.2.3-2. Non-ITS SSCs in the mechanical handling system that are used in handling facilities, including the IHF, are described in Table 1.2.4-1.

1.2.3.1 Initial Handling Facility Description

[NUREG-1804, Section 2.1.1.2.3: AC 1(2), (3), (4), AC 2, AC 6; Section 2.1.1.6.3: AC 1(2)(e), (2)(h), AC 2(2); Section 2.1.1.7.3.1: AC 1(1), (2), (3), (5), (6), (9); Section 2.1.1.7.3.2: AC 1(1), (2); Section 2.1.1.7.3.3(I): AC 1(1), AC 2(1), (2), (3), AC 4(1)]

1.2.3.1.1 Facility Description

The IHF provides the facility as well as necessary utilities and support systems to perform the following functions:

- Receive transportation casks containing naval spent nuclear fuel (SNF) canisters or high-level radioactive waste (HLW) canisters. No other waste forms are handled in the IHF. The naval SNF canisters are delivered via rail service. The HLW canisters are delivered by either rail service, legal-weight truck, or overweight truck.

- Prepare the transportation casks for unloading by removing impact limiters; inspecting, upending and removing casks from their conveyances; gas sampling; and unbolting the cask lid(s).

- Transfer the contents of the transportation casks into waste packages for emplacement.

- Replace the lid(s) on the unloaded transportation casks. The transportation casks are inspected, surveyed, and decontaminated prior to leaving the facility.

- Install the waste package inner lid on a loaded waste package and weld it closed; inspect and leak test the inner lid weld; evacuate the waste package inner vessel and backfill it with helium; close and seal weld the purge port in the inner lid; inspect and leak test the purge port closure; install the waste package outer lid and weld it closed; nondestructively examine the outer lid weld; and stress mitigate the outer lid weld.

- Inspect the completed waste package for compliance to emplacement requirements.

- Position the completed waste package such that the transport and emplacement vehicle (TEV) can receive it.

- Conduct maintenance, radiological surveys, minor decontamination, and low-level radioactive waste collection, as required.

- Confine and control the radioactive waste sources during normal operations and off-normal operations, and event sequences.

- Control radiation exposure, temperature, and human access, prevent criticality, and mitigate identified hazards.

- Provide adequate shielding.

- Monitor the facility operations and performance to ensure the health and safety of workers and the public.

- Withstand the effects of natural phenomena and nearby military and industrial hazards.

The IHF is an ITS surface structure that is located south of the North Portal of the repository. The IHF is physically separated from other surface buildings to isolate it from interactions with the other facilities during a seismic event. The location of the IHF relative to the other surface facilities is shown on Figures 1.2.1-1 and 1.2.1-2. The IHF is located such that it is protected from external flooding as shown in Figure 1.2.2-7. The distance of the geologic repository operations area facilities from the site boundary is shown in Figure 1.1-1.

The IHF is composed of two seismically independent ITS surface structures (the main structure and the waste package loadout room) and several adjacent non-ITS structures.

- The IHF cask handling process area main structure (Rooms 1001, 1002, 1003, 1006, 1007, 1008, 1009, 1011, 1012, and 1026) is a heavily braced-frame steel structure, with an overall size of approximately 170 ft wide, 187 ft long, and 105 ft high. The IHF main structure consists of the large, braced-frame steel structure with an internal concrete structure that provides the shielding and structural support required for the canister transfer and waste package loading/closure operations that take place within the main structure. The interior reinforced concrete structure consists of 4-ft-thick walls and roof that comprise the waste package positioning room (Room 1006), the waste package loading room (Room 1007), and the cask unloading room (Room 1008). The IHF main structure is constructed of noncombustible materials with interior and exterior bracing steel, steel frame roof structure, and internal reinforced concrete structure and waste package processing concrete rooms for those areas of the facility that will handle canisters and waste packages. Both the steel and concrete portions of the IHF main structure are supported by a common concrete mat foundation.

- The IHF waste package loadout room (Room 1005) is a reinforced concrete structure that has an overall size of approximately 41 ft wide, 140 ft long (excluding external north–south concrete buttresses), and 60 ft high. The waste package loadout room is a reinforced concrete structure made of noncombustible materials with interior and exterior shear walls, exterior concrete buttresses, concrete floor and roof slab diaphragms, and concrete mat foundation. The concrete mat foundation for the IHF waste package loadout room is structurally and seismically separate from the IHF main structure concrete mat foundation.

The IHF main structure foundation and the IHF waste package loadout room structure foundation are both reinforced concrete having the necessary thickness to adequately support the superstructures. The common mat for the IHF main structure (for both the steel structure and the internal concrete structure) is a 6-ft-thick mat. The internal shielded rooms are made up of 4-ft-thick concrete walls and common roof slab (i.e., the floor slab for the canister transfer area (Room 2005) and for the waste package closure room (Room 2004)). The mat for the waste package loadout room is also a 6-ft-thick concrete mat.

The IHF structure (main structure and the waste package loadout room structure) are designed to withstand the design basis ground motion (DBGM)–2 seismic event. Both structure foundations are reinforced concrete mats, physically separated from each other and separated from other buildings to isolate them from interactions with each other and other facilities during DBGM-2 seismic events. The loads associated with the various cask, canister, and waste package handling equipment are supported from the IHF main structure and waste package loadout room structure and transferred into the foundation. The IHF canister transfer machine, canister transfer machine maintenance crane, 300-ton cask handling crane, cask preparation crane, and the waste package closure and equipment cranes are supported from the main structure steel frame, and the loads are transferred to the concrete mat. The cask transfer trolley and waste package transfer trolley are supported directly by the basemat foundations for the IHF building.

Ancillary areas of the facility that are not categorized as ITS, including the general support area (Rooms 1200 through 1225), low-level radioactive waste sump room (Room 1027), and external fire water valve rooms, are constructed on separate slabs on grade using lighter concrete construction and/or insulated metal panels on steel framing that are attached to, but fall outside the footprint of the IHF main structure. The mat foundations for the IHF ancillary area non-ITS structures are reinforced concrete mats as necessary to adequately support the superstructures. The non-ITS portions of the IHF will not compromise the integrity of the IHF ITS main structure or waste package loadout room structure in a DBGM-2 event.

The general arrangement floor plans for the various floors of the IHF and the associated legend are shown in Figures 1.2.3-1 to 1.2.3-5. Cross-sectional views of the IHF are shown in Figures 1.2.3-6 to 1.2.3-14. The ITS and non-ITS areas of the IHF are shown in Figure 1.2.3-2.

The IHF is divided into areas for handling operations and areas to support these activities. Handling activities are performed in the following areas: cask preparation area (Room 1012), cask unloading room (Room 1008), waste package loading room (Room 1007), waste package positioning room (Room 1006), waste package loadout room (Room 1005), canister transfer area (Room 2005), and waste package closure room (Room 2004). The support areas include the facility operations room (Room 2001), HVAC (high-efficiency particulate air (HEPA) filter exhaust) room (Room 1001), electrical equipment area (normal power) (Room 1002), battery room (Room 1003), canister transfer machine maintenance area (Room 1009), cask sampling equipment area (Room 1011), waste package closure equipment room (Room 2002), and the waste package closure support room (Room 2006).

The radiation/radiological monitoring system provides for monitoring of dose rates and airborne radioactivity levels in the IHF, as described in Section 1.4.2. For airborne radioactivity monitoring, the system includes continuous air monitors and effluent monitors. The system includes area radiation monitors that measure gamma and neutron radiation levels. The system instruments include local alarms that provide audible and visible warnings if certain thresholds are exceeded. The system and alarms are monitored in the facility operations room and the Central Control Center.

The IHF is designed to provide radiation protection to workers, the public, and the environment, and to minimize occupational exposure in accordance with as low as is reasonably achievable dose principles. Features for minimization and control of radioactive contamination within the IHF are incorporated into the design. Shielded work areas, as required, are incorporated into the design. Section 1.10 addresses the design features to reduce occupational exposures to repository workers.

Interlocks on shield doors are provided to ensure that workers cannot be inadvertently exposed to high radiation.

Major mechanical handling equipment in the IHF includes overhead bridge cranes, the cask transfer trolley, canister transfer machine, waste package transfer trolley, and associated lifting fixtures and devices.

An overview of the major areas within the IHF is provided below.

1.2.3.1.1.1 Cask Preparation Area (Room 1012)

The cask preparation area is used to receive transportation casks, prepare the casks for canister unloading, and export the unloaded casks. Transportation casks are received in this area via railcar or truck carrier.

Loaded transportation casks are prepared for transfer using the cask preparation crane and mobile access platform. The casks are upended and transferred to the cask transfer trolley using the 300-ton cask handling crane. The casks are then transferred to the cask unloading room on the cask transfer trolley.

The cask preparation area is also used to receive other parts for the waste package closure process (e.g., waste package inner lids, spread rings) from the Warehouse and Non-Nuclear Receipt Facility.

1.2.3.1.1.2 Canister Transfer Area (Room 2005)

The canister transfer area connects to the cask unloading room (Room 1008) and the waste package loading room (Room 1007) through ports with slide gates. The canister transfer area is used to transfer canisters from transportation casks in the cask unloading room to waste packages in the waste package loading room. Transfer of the HLW and naval SNF canisters is carried out by the canister transfer machine.

The waste package loading room shields personnel in other rooms of the facility from radiation during canister transfer operations. Once the waste package transfer trolley positions a waste package, no other operations requiring personnel to be present are performed from inside the room.

The cask unloading room shields personnel in other rooms of the facility from radiation during canister transfer operations. Once a cask transfer trolley positions a cask, no other operations requiring personnel to be present are performed from inside the room.

1.2.3.1.1.3 Waste Package Closure Area (Rooms 2002, 2004, and 2006)

The waste package closure area includes the waste package closure room (Room 2004), waste package closure support room (Room 2006), and waste package closure equipment room (Room 2002).

The waste package closure area is used for closure of the loaded waste packages. Loaded waste packages are brought into the waste package positioning room by the waste package transfer trolley. The waste package closure room provides space for the closure operations, which include welding, nondestructive examination, inerting, and stress mitigation.

1.2.3.1.1.4 Waste Package Loadout Room (Room 1005)

The waste package loadout room is used for transferring the loaded and sealed waste package to the TEV. The waste package loadout room shields personnel external to the area from radiation during waste package loadout.

The loaded and sealed waste package is brought into the room by the waste package transfer trolley, which downends the waste package into the horizontal position. The waste package transfer carriage transfers the waste package from the waste package transfer trolley and positions it for pickup by the awaiting TEV.

This room also receives empty waste packages and emplacement pallets, and loads them into the waste package transfer trolley for subsequent movement to the waste package loading room (Room 1007).

1.2.3.1.1.5 Canister Transfer Machine Maintenance Area (Room 1009)

The canister transfer machine maintenance area is used to store different grapples for the canister transfer machine and perform periodic maintenance.

1.2.3.1.1.6 Waste Package Positioning Room (Room 1006)

The waste package positioning room shields personnel in other rooms of the facility from radiation during waste package closure operations and during translation of the loaded waste package from the waste package positioning room to the waste package loadout room. The waste package transfer trolley operates between the waste package loading room, the waste package positioning room, and the waste package loadout room.

1.2.3.1.2 Operational Processes

Figures 1.2.3-15 and 1.2.3-16 show the operational sequences and material flow through the IHF. Figure 1.2.3-17 illustrates the major waste processing functions performed in the IHF. Figure 1.2.3-18 shows the waste form inventory present within IHF at any one time.

The major operational waste processing functions are summarized in the following sections.

1.2.3.1.2.1 Cask Handling

The cask preparation area receives transportation casks containing naval SNF canisters or HLW canisters.

For naval transportation casks, a lift plate is bolted onto the upper impact limiter, and the upending adapter is secured to the bottom impact limiter. The cask is upended and lifted from the conveyance by the cask handling crane. The crane loads the cask into the cask transfer trolley. The upper impact limiter, cask lid, and restraint plate are removed. A lift adapter is bolted to the top of the naval SNF canister within the cask and to the naval shield ring. The prepared naval cask is then moved to the cask unloading room. The lower impact limiter of the naval cask is not removed.

For HLW transportation casks, impact limiters are removed. The cask is upended and lifted from the conveyance by the cask handling crane and placed in the cask transfer trolley, which is already configured with the appropriate pedestal for the transportation cask. A lid adapter is attached onto the cask lid, and the cask lid bolts are removed. The prepared HLW cask is then moved to the cask unloading room.

1.2.3.1.2.2 Canister Transfer

Canister transfer operations in the IHF occur in the cask unloading room, canister transfer area, and the waste package loading room.

Canister transfer operations are performed by the canister transfer machine. The canister transfer machine is moved to the cask port, the shield skirt is lowered, and the canister transfer machine slide gate and cask port slide gate are opened. For an HLW cask, the cask lid is removed by the canister transfer machine as described in Section 1.2.3.2.2.2. The canister guide sleeve is lowered for the naval SNF canister only. The HLW or naval SNF canister is then lifted into the canister transfer machine. The canister guide sleeve is raised, the slide gates are closed and the shield skirt is raised. The loaded canister transfer machine moves the HLW or naval SNF canister to the waste package port where the shield skirt is lowered, the canister transfer machine and waste package port slide gates are opened, the canister guide sleeve is lowered for the naval SNF canister only, and the canister is lowered into the waste package. For HLW canisters, the process is repeated to fill the waste package.

1.2.3.1.2.3 Waste Package Closure

Waste package closure operations include welding waste package lids to the waste package, inerting the waste package inner vessel, mitigating the stress associated with the welding of the outer lid, and performing nondestructive examination of the waste package closure welds. Weld defects, if found, are repaired or reworked as necessary by the waste package closure system. The waste package remains on the ground floor of the IHF during the closure process.

1.2.3.1.2.4 Waste Package Loadout

The TEV enters the facility, the TEV shield doors are opened, and the base plate is extended. The waste package transfer trolley moves the loaded and sealed waste package from the waste package positioning room to the waste package loadout room, where it engages the waste package transfer carriage docking station and is locked down. The waste package transfer trolley shielded enclosure is downended to the horizontal position.

The waste package transfer carriage, conveying the loaded waste package and emplacement pallet, is withdrawn from the waste package transfer trolley and is placed in position to be received by the TEV. The TEV lifting feature raises the waste package and emplacement pallet off of the waste package transfer carriage. The TEV base plate is retracted into a traveling position and the shield doors are closed. The waste package is inspected for surface flaws as it travels between the waste package transfer trolley and the TEV.

A contamination survey is performed on the TEV and decontamination is performed if necessary. The waste package loadout room equipment shield door is opened, and the TEV moves out of the IHF toward the North Portal and into the subsurface.

1.2.3.1.3 Safety Category Classification

The overall IHF is classified as ITS. The portion of the IHF structures that do not contain ITS SSCs are classified as non-ITS (Figure 1.2.3-2). The ITS structure provides protection of SSCs from internal and external hazards. The IHF is designed such that failure of portions, parts, subparts, or subsystems of non-ITS SSCs, cannot adversely interact with an ITS SSC and prevent the safety function from being performed. The transport and emplacement vehicle rails in the waste package loadout room and the rails for the waste package transfer trolley in the IHF main structure are categorized as ITS.

1.2.3.1.4 Procedural Safety Controls to Prevent Event Sequences or Mitigate Their Effects

There are no procedural safety controls for the structural features of the IHF.

The postclosure analyses identified one procedural requirement related to operations conducted in the IHF as identified in Table 1.9-8, Footnote e.

Operational procedures will be developed to ensure that the overall duration of handling operations for the naval SNF canister from the time of detensioning of the transportation cask closure through emplacement shall not exceed 30 days.

1.2.3.1.5 Design Bases and Design Criteria

The nuclear safety design bases for ITS and important-to-waste-isolation (ITWI) SSCs and features are derived from the preclosure safety analysis presented in Sections 1.6 through 1.9 and the postclosure performance assessment presented in Sections 2.1 through 2.4. The nuclear safety design bases identify the safety functions to be performed and the controlling parameters with values or ranges of values that bound the design.

The quantitative assessment of event sequences, including the evaluation of component reliability and the effects of operator action, is developed in Section 1.7. SSCs or procedural safety controls appearing in an event sequence with a prevention or mitigation safety function are described in the applicable design section of the SAR.

Section 1.9 describes the methodology for safety classification of SSCs and features of the repository. The tables in Section 1.9 present the safety classification of the SSCs and features. These tables also list the preclosure and postclosure nuclear safety design bases for each structure, system, or major component.

To demonstrate the relationship between the nuclear safety design bases and the design criteria for the repository SSCs and features, the nuclear safety design bases are repeated in the appropriate SAR sections for each individual ITS/ITWI SSC or feature that performs a safety function. The design criteria are characteristics of the ITS/ITWI SSCs or features that are utilized to implement the assigned safety functions.

The nuclear safety design bases and their relationship to design criteria for the IHF structure and ITS SSCs contained in the IHF are provided in Table 1.2.3-3.

1.2.3.1.6 Design Methodologies

The design methodologies for the IHF structure are in accordance with codes and standards provided in Section 1.2.2.1. The design methodologies for the transport and emplacement vehicle rails and rails for the waste package transfer trolley are in accordance with ASME NOG-1-2004.

1.2.3.1.7 Consistency of Materials with Design Methodologies

Materials of construction used in the design of the IHF structure are in accordance with codes and standards provided in Section 1.2.2.1. Materials of construction used in the design of transport and emplacement vehicle rails and the rails for the waste package transfer trolley are in accordance with ASME NOG-1-2004.

1.2.3.1.8 Design Codes and Standards

The principal codes and standards applicable to the IHF structure are provided in Section 1.2.2.1. The transport and emplacement vehicle rails and the rails for the waste package transfer trolley are designed in accordance with ASME NOG-1-2004.

1.2.3.1.9 Design Load Combinations

The design load combinations for the IHF structure are in accordance with codes and standards provided in Section 1.2.2.1. These design load combinations are applicable to steel and reinforced concrete structures. The design load combinations for the transport and emplacement vehicle rails and the rails for the waste package transfer trolley are in accordance with ASME NOG-1-2004.

1.2.3.2 Mechanical Handling Systems

[NUREG-1804, Section 2.1.1.2.3: AC 1(2), (3), (4), AC 2, AC 6; Section 2.1.1.6.3: AC 1(2)(h), AC 2(2); Section 2.1.1.7.3.1: AC 1(1), (2), (3), (5), (6), (9); Section 2.1.1.7.3.2: AC 1(1), (2); Section 2.1.1.7.3.3(I): AC 1(1), AC 2(1), (2), (3), AC 4(1)]

The mechanical handling system in the IHF is divided into four subsystems: cask handling, canister transfer, waste package closure, and waste package loadout. ITS SSCs in the mechanical handling system are designed as described in Section 1.2.2.2. ITS SSCs in the IHF mechanical handling system that are also used in the Canister Receipt and Closure Facility (CRCF) are described in Section 1.2.4.2, including figures. Non-ITS SSCs in the IHF mechanical handling system, which are also used in the CRCF, are described in summary in Table 1.2.4-1. Table 1.2.3-1 lists the non-ITS mechanical handling SSCs used in the IHF, which are similar to those in other handling facilities. The IHF-specific non-ITS SSCs in the mechanical handling system are described in summary in Table 1.2.3-2. The IHF design bases and their relationship to design criteria are provided in Table 1.2.3-3. The rated capacity of the ITS mechanical handling equipment is provided in Tables 1.2.2-10 and 1.2.2-11. Table 1.2.4-3 provides a summary-level description of (Types 1 to 5) equipment and personnel shield doors.

Logic diagrams for ITS SSCs are shown where the description of the ITS equipment is provided. Typical non-ITS logic diagrams, which show the interface with digital control and management information system (DCMIS) and programmable logic controller elements within the selected ITS logic diagrams, are shown in Figures 1.2.4-15 to 1.2.4-18.

1.2.3.2.1 Cask Handling Subsystem

1.2.3.2.1.1 Subsystem Description

The cask handling subsystem consists of the cask preparation subsystem and waste package preparation subsystem. These two systems prepare the loaded transportation casks and empty waste packages for unloading and loading operations.

1.2.3.2.1.1.1 Subsystem Functions

Cask Preparation Subsystem—The functions of the cask preparation subsystem are to:

- Receive loaded transportation casks containing naval SNF canisters by rail or HLW canisters by rail or truck.
- Prepare loaded transportation casks for canister transfer operations.

Waste Package Preparation Subsystem—The functions of the waste package preparation subsystem are to:

- Receive empty waste packages
- Prepare empty waste packages for canister transfer operations.

1.2.3.2.1.1.2 Subsystem Location and Functional Arrangement

The cask preparation subsystem and waste package preparation subsystem are located in the cask preparation area (Room 1012) and waste package loadout room (Room 1005), respectively.

These areas are shown in Figures 1.2.3-2 and 1.2.3-3.

1.2.3.2.1.1.3 Subsystem and Components

1.2.3.2.1.1.3.1 Cask Preparation Subsystem

ITS SSCs in the IHF cask preparation subsystem, which are also used in the CRCF, are listed below and described in Section 1.2.4.2, including its figures and logic diagrams, unless otherwise described below.

Cask Handling Crane—The cask handling crane is rated at 300 tons, with no auxiliary hoist. Due to the configuration of the crane in the facility, it is not possible for the cask handling crane to lift the bottom of a cask more than 40 ft above the floor. This equipment is described in Section 1.2.4.2. Figure 1.2.3-19 shows the cask handling crane specific to the IHF.

Cask Handling Yoke—This equipment handles casks containing HLW and is described in Section 1.2.4.2.

Cask Transfer Trolley—This equipment is described in Section 1.2.4.2. To handle the different sizes of casks, pedestals are used in the bottom of the cask transfer trolley. The pedestal is loaded into the cask transfer trolley using the cask handling crane and rigging. For details of this equipment, refer to Figure 1.2.3-20. The capacity of this equipment is 265 tons.

Cask Unloading Room Equipment Shield Door (Type 1)—This equipment is described in Section 1.2.4.2.

Rail Cask Lid Adapter—This equipment is described in Section 1.2.4.2 and Figure 1.2.4-40.

ITS SSCs that are unique to the IHF cask preparation subsystem are described below.

Cask Preparation Crane—The cask preparation crane is used for the cask preparation operations, with the exception of the actual lifting and relocation of the transportation cask. The crane is located in the cask preparation area, above the cask handling crane. The main hoist of the cask preparation crane is rated at 30 tons, with an auxiliary hoist rated at 10 tons. This equipment is shown on Figures 1.2.3-21 and 1.2.3-22. The logic diagram for the cask preparation crane hoist is provided in Figure 1.2.3-23.

Naval Cask Lift Bail—The naval cask lift bail is utilized by the cask handling crane and interfaces with the naval cask lift plate to upend and lift the naval cask from the railcar. This equipment is shown on Figure 1.2.3-24.

Naval Cask Lift Plate—The naval cask lift plate is bolted onto the top impact limiter of the naval cask and interfaces with the naval cask lift bail to upend and lift the naval cask from the railcar. This equipment is shown on Figure 1.2.3-25.

Cask Preparation Platform—The cask preparation platform located in the cask preparation area is a permanent, multilevel steel structure that provides operator access to the top of the transportation cask when it is supported by the cask transfer trolley. This equipment is described in Section 1.2.4.2. Figure 1.2.3-26 shows the cask preparation platform specific to the IHF.

1.2.3.2.1.1.3.2 Waste Package Preparation Subsystem

The waste package handling crane is described in Section 1.2.3.2.4 and is ITS. There are no other ITS SSCs in the IHF waste package preparation subsystem because this subsystem only handles empty waste packages.

1.2.3.2.1.2 Operational Processes

1.2.3.2.1.2.1 Cask Preparation Subsystem

Prior to moving a cask to the cask transfer trolley, a cask pedestal is installed in the cask transfer trolley using the cask handling crane and standard rigging.

The yoke for the particular cask arriving, the cask handling yoke or the naval cask lift bail, is brought into the facility. The hook for the cask handling crane is lowered into the yoke lift fixture. The yoke is lifted from its yoke stand, and is moved to make way for the incoming rail or truck carrier.

After completion of a visual inspection of the transportation cask outside the facility, the outside roll-up door is opened, and the loaded transportation cask conveyance is moved into the cask preparation area. The conveyance is secured in place.

The following is a description of the operational process for naval casks:

- The naval railcar is leveled and secured. The upending adapter (supplied with the transportation cask) is lifted from the railcar bed, using the cask preparation crane, and positioned on the bottom of the lower cask dome. The upending adapter is bolted to the lower cask dome by personnel on the mobile access platform. The naval cask lift plate (supplied with the transportation cask) is lifted from its stand, using the cask preparation crane, and positioned on the top of the upper cask dome. The lift plate is bolted to the upper cask dome by personnel on the mobile access platform. The cask handling crane lowers the naval cask lift bail into position with the naval cask lift plate. The lift bail is pinned to the lift plate.

- Once the naval cask lift bail is secured to the transportation cask, the cask cradle caps and tie-downs are unbolted from the cask by personnel on the mobile access platform. The cask shoring pads are lowered from the cask. The transportation cask is upended on the conveyance, using the cask handling crane. As the cask is upended, the upending adapter fits into the upending stand on the conveyance.

- The cask is lifted off the transportation cask conveyance by the cask handling crane, moved into position, and lowered into the cask transfer trolley. The cask restraint system of the cask transfer trolley is actuated, securing the cask in place. The upper cask dome bolts are loosened and removed by personnel on the cask preparation platform. The upper cask dome is removed from the cask by the cask handling crane, still connected by the naval cask lift bail.

- Gas sampling of the cask internals (annular space between the canister and the cask interior) is performed.

- The cask lid bolts are loosened and removed by personnel on the cask preparation platform, using common tools. The transportation cask lid is removed, by use of the cask preparation crane, and placed in the naval cask lid stand. The fasteners and bolts for the closure shear ring and the shear ring backing ring are loosened and removed by personnel on the cask preparation platform. The sections of the shear ring backing ring are removed first, and then the sections of the closure shear ring, by use of the cask preparation crane. The spent fuel canister restraint plate is then removed by use of the cask preparation crane.

- The naval canister lifting adapter is placed onto the canister inside the cask by the cask preparation crane. The device is bolted to the canister and the shield ring by personnel on the cask preparation platform.

- The cask unloading room equipment shield door is opened, and the cask transfer trolley is moved into the cask unloading room. The air hose is disconnected from the cask transfer trolley, and pulled back into the cask preparation area. The cask unloading room equipment shield door is closed.

The following is a description of the operational process for HLW casks:

- Personnel on the mobile access platform unfasten the impact limiters for the cask. The impact limiters are lifted from the cask using the cask preparation crane and stored.

- The cask handling crane moves the cask handling yoke into position over the transportation cask, and the yoke engages the lifting trunnions on the cask. Once the cask handling yoke is secured to the transportation cask, personnel on the mobile access platform remove the cask tie-downs from the cask. The transportation cask is upended on the conveyance, using the cask handling crane.

- The cask is lifted off the transportation cask conveyance, moved into position, and lowered into the cask transfer trolley. The cask restraint system of the cask transfer trolley is actuated, securing the cask in place. The lifting arms of the cask handling yoke are released from the cask trunnions, and the cask handling crane is moved out of the way.

- Gas sampling of the cask internals (annular volume between the canister and the cask interior) is performed.

- The cask lid bolts are loosened and removed by personnel on the cask preparation platform. The rail cask lid adapter, or truck cask lid adapter, is obtained from its appropriate rack, and placed onto the cask using the cask preparation crane. The adapter is bolted to the cask lid by personnel on the cask preparation platform.

- The cask unloading room equipment shield door is opened, and the cask transfer trolley is moved into the cask unloading room. The air hose is disconnected from the cask transfer trolley and pulled back into the cask preparation area. The cask unloading room equipment shield door is closed.

Once the cask is emptied, the cask unloading room equipment shield door is opened and the cask transfer trolley, carrying the empty cask, is moved from the cask unloading room. The cask transfer trolley is positioned within the cask preparation platform, the cask is loaded on the transportation cask conveyance, the outside roll-up door is opened and the loaded transportation cask conveyance is moved out of the facility.

1.2.3.2.1.2.2 Waste Package Preparation Subsystem

The waste package preparation subsystem prepares empty waste packages for naval SNF and HLW (short) canister transfer operations. The waste package handling crane is functionally a part of the waste package preparation subsystem but it also performs a waste package loadout function. The waste package handling crane is described in Section 1.2.3.2.4. The operational processes for the waste package preparation subsystem are the same as for the CRCF and are described in Section 1.2.4.2.1.2.2.

1.2.3.2.1.3 Safety Category Classification

The cask handling crane, cask handling yoke, cask transfer trolley, cask preparation crane, cask unloading room equipment shield door, rail cask lid adapter, cask preparation platform, naval cask lift plate, and naval cask lift bail in the cask preparation subsystem are categorized as ITS.

The waste package handling crane is ITS and is described in Section 1.2.3.2.4. No other components in the waste package preparation subsystem are ITS, because the waste packages do not contain any waste forms during preparation exercises.

1.2.3.2.1.4 Procedural Safety Controls to Prevent Event Sequences or Mitigate Their Effects

The preclosure safety analysis identifies three procedural safety controls related to the operation of components in the cask handling subsystem of the IHF. Table 1.9-10 identifies the unique numbering of the preclosure procedural safety controls, as well as the associated facility or operations area, SSCs, and bases.

PSC-1—To limit the spurious movement of the cask transfer trolley potentially resulting in canister impacts, the cask preparation and canister transfer operating procedures will include a warning that deflation of the IHF cask transfer trolley is an important procedural step in the preclosure safety analysis. The cask preparation and canister transfer operating procedures will require that the cask transfer trolley be on the floor of the IHF with the air pallet feature deactivated during loading of the cask onto the trolley, cask preparation activities while the cask is on the trolley, and during canister unloading activities. This requirement will be independently verified.

PSC-11—To ensure seismic stability of the transportation cask during cask preparation, the cask preparation operating procedure will include a warning that connection to the IHF cask handling crane is an important procedural step in the preclosure safety analysis. The cask preparation operating procedure will require that a loaded transportation cask remain attached to the IHF cask handling crane hoist and associated yoke until the cask is placed into the cask transfer trolley and the trolley's seismic restraints are properly engaged. The engagement of the seismic restraints will be independently verified prior to slacking the load on the IHF cask handling crane.

PSC-12—To prevent the operator from attempting to remove the cask lid with the lid bolts still in place, the cask preparation operating procedure will include a warning that the removal of loaded transportation cask lid bolts is a procedural step important to the preclosure safety analysis. The cask preparation operating procedure will include a prerequisite to confirm lid bolt removal prior to movement of the cask from the IHF cask preparation area (Room 1012) to the cask unloading room (Room 1008). The removal of the bolts will be independently verified.

1.2.3.2.1.5 Design Bases and Design Criteria

The nuclear safety design bases and design criteria for the cask handling subsystem in the IHF are addressed in Table 1.2.3-3.

1.2.3.2.1.6 Design Methodologies

The design methodologies for the ITS SSCs in the cask preparation subsystem that are similar to those in other handling facilities, including the cask handling crane, cask handling yoke, cask transfer trolley, cask preparation crane, rail cask lid adapter, and cask preparation platform, are in accordance with the codes and standards provided in Section 1.2.2.2. The methodology used in the design of the cask unloading room equipment shield door, naval cask lift plate, and naval cask lift bail is in accordance with Section Q1.2 of ANSI/AISC N690-1994.

1.2.3.2.1.7 Consistency of Materials with Design Methodologies

Materials of construction used in the design of ITS SSCs in the cask preparation subsystem that are similar to those in other handling facilities, including the cask handling crane, cask handling yoke, cask transfer trolley, cask preparation crane, rail cask lid adapter, and cask preparation platform, are in accordance with codes and standards provided in Section 1.2.2.2. The materials used in the design of the cask unloading room equipment shield door, naval cask lift plate, and naval cask lift bail are in accordance with Section Q1.4 of ANSI/AISC N690-1994.

1.2.3.2.1.8 Design Codes and Standards

The principal codes and standards applicable to the cask preparation subsystem are identified in Table 1.2.2-12.

1.2.3.2.1.9 Design Load Combinations

The load combinations used in the analysis of ITS SSCs for the cask preparation subsystem that are similar to those in other handling facilities, including the cask handling crane, cask handling yoke, cask transfer trolley, cask preparation crane, rail cask lid adapter, and cask preparation platform, are in accordance with codes and standards provided in Section 1.2.2.2. The design load combinations analyzed include normal conditions and event sequences and the effects of natural phenomena. The load combinations and applicable stress limit coefficients used in the design of the equipment shield doors, naval cask lift plate, and naval cask lift bail are in accordance with Table Q1.5.7.1 of ANSI/AISC N690-1994.

1.2.3.2.2 Canister Transfer Subsystem

1.2.3.2.2.1 Subsystem Description

The canister transfer subsystem consists of SSCs that safely transfer canisters from transportation casks into waste packages for delivery to the TEV.

1.2.3.2.2.1.1 Subsystem Functions

The functions of the canister transfer subsystem are to:

- Transfer naval SNF canisters, or HLW canisters, from transportation casks into waste packages
- Move waste packages to the waste package positioning room after loading.

1.2.3.2.2.1.2 Subsystem Location and Functional Arrangement

The canister transfer subsystem is located in the cask unloading room, waste package loading room, and canister transfer area. These areas are shown in Figures 1.2.3-2 and 1.2.3-3.

1.2.3.2.2.1.3 Subsystem and Components

ITS SSCs in the canister transfer subsystem that are similar to those used in the CRCF are listed below and described in Section 1.2.4.2, including figures and logic diagrams.

Defense Waste Processing Facility/Idaho National Laboratory HLW Canister Grapple—This equipment is described in Section 1.2.4.2 and Figures 1.2.4-43 to 1.2.4-45.

West Valley Demonstration Project/Hanford HLW Canister Grapple—This equipment is described in Section 1.2.4.2 and Figures 1.2.4-44 to 1.2.4-46.

Canister Transfer Machine—The canister transfer machine is used to transfer naval SNF canisters or HLW canisters from a transportation cask in the cask transfer trolley to a waste package in the waste package transfer trolley. Due to the configuration of the canister transfer machine in the facility, it is not possible for the canister transfer machine to lift the bottom of a canister more than 40 ft above the cavity floor of the transportation cask or waste package. This equipment is described in Section 1.2.4.2 and Figures 1.2.4-50 to 1.2.4-51. The logic diagram for the IHF canister transfer machine waste package inner lid grapples is shown in Figure 1.2.3-27.

Cask Port Slide Gate—This equipment is described in Section 1.2.4.2 and Figures 1.2.4-57 to 1.2.4-58. Figure 1.2.4-59 shows the logic diagram for the cask port slide gate.

Canister Transfer Machine Canister Grapple—The canister transfer machine canister grapple is used to lift transportation rail cask lids and naval and HLW canisters during canister transfer operations. This equipment is described in Section 1.2.4.2 and Figures 1.2.4-47 to 1.2.4-48. The logic diagram for the canister transfer machine canister grapple is shown in Figure 1.2.4-49.

Waste Package Port Slide Gate—This equipment is described in Section 1.2.4.2 and Figures 1.2.4-57 to 1.2.4-58. Figure 1.2.4-59 shows the logic diagram for the waste package port slide gate.

ITS SSCs that are unique to the IHF canister transfer subsystem are described below.

U.S. Department of Energy Waste Package Inner Lid Grapple—The U.S. Department of Energy (DOE) waste package inner lid grapple is used by the canister transfer machine to place a waste package inner lid with integral shield plug into a codisposal waste package loaded with HLW canisters. The grapple lifting feature interfaces with the canister transfer machine canister grapple. The grapple uses three lifting jaws, equally spaced, to engage the lid. The grapple has a pneumatic jaw actuation with a fail-safe mechanical lock. The grapple is provided with remote and local control capabilities to engage or disengage the canisters. Raising or lowering the grapple is possible only if the grapple is either fully engaged or disengaged with the load. The grapple with a suspended waste package inner lid is prevented mechanically from unintentional disengagement. The DOE waste package inner lid grapple is identical to the 24-in. SNF canister grapple used in the CRCF. For details of this equipment, refer to Figures 1.2.3-28 and 1.2.3-29.

Naval Waste Package Inner Lid Grapple—The naval waste package inner lid grapple is used by the canister transfer machine to place a waste package inner lid into a waste package loaded with a naval SNF canister. The grapple lifting feature interfaces with the canister transfer machine canister grapple. The grapple uses three lifting jaws, equally spaced, to engage the lid. The grapple has a pneumatic jaw actuation with a fail-safe mechanical lock. The grapple is provided with remote and local control capabilities to engage or disengage the canisters. Raising or lowering the hoist is possible only if the grapple is either fully engaged or disengaged with the load. The grapple with a suspended waste package inner lid is prevented mechanically from unintentional disengagement. For details of this equipment, refer to Figures 1.2.3-29 and 1.2.3-30.

Naval Canister Lifting Adapter—The naval canister lifting adapter is attached to the top of naval SNF canisters and associated shield rings so that naval SNF canisters can be lifted by the canister transfer machine. The adapter is placed on the top of the naval SNF canister by the cask preparation crane, and then bolted on by personnel. When not in use, the adapter rests in the naval adapter stand. For details of this equipment, refer to Figure 1.2.3-31.

Waste Package Positioning Room Equipment Shield Doors (Type 3)—The waste package positioning room equipment shield doors control equipment and personnel access to the waste package positioning room (Room 1006) and the waste package loading room (Room 1007). The equipment shield door has dual-hinged panels, which swing open. Each door panel is operated by an electric motor with a worm-gear assembly attached to the door hinges. The door panels overlap the aperture on the top and both sides to prevent streaming. A staggered door panel edge provides shielding between the mating door panel seam. A shield bar mounted to the front of the door panels, close to the bottom, is actuated when the door panel is closed. When actuated, the bar rests on the ground, providing shielding at the bottom of the door panel.

The equipment shield doors are controlled from the facility operations room. A local emergency open button is provided. The equipment shield door between the waste package loading room and the waste package positioning room is interlocked with the waste package port slide gate, such that the door cannot be opened unless the slide gate is in the closed position. The equipment shield door between the waste package positioning room and the loadout room is interlocked with the waste package loadout room equipment shield door and waste package loadout personnel shield doors such that the waste package positioning room equipment shield door cannot open if any of the other doors are open. The equipment shield doors are also provided with obstruction sensors that halt travel and open the doors when an obstacle is detected in the pathway of the door. For details of this equipment, refer to Figures 1.2.3-32 and 1.2.4-20. The logic diagram for the IHF waste package positioning room equipment shield door is shown in Figure 1.2.3-33.

1.2.3.2.2.2 Operational Processes

Canister transfer subsystem operations for transferring HLW canisters to a waste package are as described in Section 1.2.4.2.2.2, except that HLW canisters are not staged in the IHF.

Canister transfer for a naval SNF canister is as follows:

- Once a loaded transportation cask has been moved into the cask unloading room and centered under the cask port, the canister transfer machine is moved over the cask port. The canister transfer machine shield skirt is lowered to the floor, and the canister transfer machine slide gate and cask port slide gate are opened.

- The canister guide sleeve is lowered, and the canister transfer machine canister grapple is lowered into the cask unloading room and engages the naval canister lifting adapter. The naval SNF canister and shield ring are lifted out of the cask and into the canister transfer machine shield bell. The canister guide sleeve is raised, the canister transfer machine slide gate and cask port slide gate are closed, and the shield skirt is raised.

- Once the waste package transfer trolley carrying an empty waste package is moved into the waste package loading room, the canister transfer machine is moved over the waste package port slide gate. The canister transfer machine shield skirt is lowered, and the canister transfer machine slide gate and waste package port slide gate are opened. The canister guide sleeve is lowered, the naval SNF canister is lowered into the waste package, the grapple is disengaged and retracted by the canister transfer machine, the canister guide sleeve is raised, the waste package port and canister transfer machine slide gates are closed, and the canister transfer machine skirt is raised.

- The canister transfer machine is moved out of the way and the waste package port slide gate is reopened to allow personnel to unbolt the naval canister lifting adapter from the naval SNF canister. Once the bolts are disengaged from the canister, the waste package port slide gate is closed. The canister transfer machine is moved over the waste package port, the shield skirt is lowered, and the canister transfer machine slide gate and the waste package port slide gate are opened. The canister transfer machine removes the naval canister lifting adapter from the canister, bringing the naval shield ring with it. The slide gates are closed, and the shield skirt is raised.

- The canister transfer machine is moved over the cask port slide gate, the shield skirt is lowered, and the canister transfer machine slide gate and the cask port slide gate are opened. The canister transfer machine places the naval canister lifting adapter, carrying the naval shield ring, into the naval cask in the cask unloading room. The slide gates are closed, and the shield skirt is raised.

- The canister transfer machine picks up the waste package inner lid from its station. The canister transfer machine moves over the waste package port slide gate. The canister transfer machine shield skirt is lowered and the canister transfer machine slide gate and the waste package port slide gate are opened. The waste package inner lid is placed in the waste package and the canister transfer machine retracts the grapple. The waste package port slide gate is then closed, and the waste package is moved by the waste package transfer trolley to the positioning room for closure operations.

1.2.3.2.2.3 Safety Category Classification

The canister transfer machine, canister and lid grapples, naval canister lifting adapter, cask port slide gate, waste package port slide gate, and equipment shield doors in the canister transfer subsystem are categorized as ITS.

1.2.3.2.2.4 Procedural Safety Controls to Prevent Event Sequences or Mitigate Their Effects

The preclosure safety analysis identifies three procedural safety controls related to the operation of components in the canister transfer subsystem of the IHF. Table 1.9-10 identifies the unique numbering of the preclosure procedural safety controls, as well as the associated facility/operations area, SSCs, and bases.

PSC-4—To protect the naval SNF canister from a drop from the canister transfer machine, the naval SNF canister transfer operating procedure will include a warning that the detachment of the naval canister lifting adapter is an important procedural step in the preclosure safety analysis. The naval SNF canister transfer procedure will require that the detachment of the lifting adapter be independently verified prior to removing the lifting adapter and shield ring from the naval SNF canister with the IHF canister transfer machine.

PSC-13—To limit the probability of personnel receiving direct radiation exposure during operations with the canister transfer machine, the canister transfer operating procedure will include a warning that workers entering the IHF canister transfer area (Room 2005) could receive an inadvertent exposure if the canister transfer machine is away from a port with a waste form present and the slide gate open. The procedures will require an independent verification that the port slide gates are closed at the completion of a canister transfer operation.

PSC-14—To limit the probability that a loaded canister is not in a vertical orientation during transfer, the canister transfer operating procedure will include a warning that the lowering of the IHF canister transfer machine guide sleeve prior to lifting or lowering a naval SNF canister is a procedural step important to the preclosure safety analysis. The canister transfer operating procedure will include a prerequisite to confirm guide sleeve lowering prior to lifting or lowering a naval SNF canister. The lowering of the guide sleeve will be independently verified.

1.2.3.2.2.5 Design Bases and Design Criteria

The nuclear safety design bases and design criteria for the canister transfer subsystem in the IHF are addressed in Table 1.2.3-3.

1.2.3.2.2.6 Design Methodologies

The design methodologies used in the design of ITS SSCs in the canister transfer subsystem that are similar to those in other handling facilities, including the canister transfer machine, canister and lid grapples, and naval canister lifting adapter, are addressed in Section 1.2.2.2. The methodologies used in the design of equipment shield doors and the cask port and waste package slide gate are in accordance with Section Q1.2 of ANSI/AISC N690-1994.

1.2.3.2.2.7 Consistency of Materials with Design Methodologies

Materials of construction used in the design of ITS SSCs in the canister transfer subsystem that are similar to those in other handling facilities, including the canister transfer machine, canister and lid grapples, and naval canister lifting adapter, are in accordance with codes and standards provided in Section 1.2.2.2. The materials of construction used in the design of equipment shield doors and the cask port and waste package port slide gates are in accordance with Section Q1.4 of ANSI/AISC N690-1994.

1.2.3.2.2.8 Design Codes and Standards

The principal codes and standards applicable to the canister transfer subsystem are identified in Table 1.2.2-12.

1.2.3.2.2.9 Design Load and Combinations

The load combinations used in the analysis of ITS SSCs for the canister transfer subsystem that are similar to those in other handling facilities, including the canister transfer machine, canister and lid grapples, and naval canister lifting adapter, are in accordance with codes and standards provided in Section 1.2.2.2. The design load combinations analyzed include normal conditions and event sequences, and the effects of natural phenomena. The load combinations and applicable stress limit coefficients used in the design of the equipment shield doors and the cask port and waste package port slide gates are in accordance with Table Q1.5.7.1 of ANSI/AISC N690-1994.

1.2.3.2.3 Waste Package Closure Subsystem

The waste package closure subsystem performs closure operations that include welding, nondestructive examination, inerting, and stress mitigation. The waste package closure subsystem also performs related operations, such as contamination surveys of the exposed portion of the waste package and decontamination if necessary. Figure 1.2.3-3 shows the physical location of the waste package closure subsystem in the IHF (second floor). The waste package closure subsystem for the IHF is the same as the waste package closure subsystem in the CRCF as addressed in Section 1.2.4.2.3, including the process and equipment in the waste package closure room and supporting areas, although the physical arrangement may vary between the IHF and the CRCF. The waste package closure subsystem is categorized as non-ITS except for the bridge of the remote handling system, which is ITS. The bridge of the remote handling system is ITS in order to protect against structural collapse of the bridge due to a spectrum of seismic events. Because the waste package closure subsystems are functionally the same, they are described in detail only once in Section 1.2.4.2.3. The waste package closure subsystem for the IHF closes waste packages containing naval SNF canisters and HLW canisters. There is one waste package closure room in the IHF.

The waste package closure room crane mechanical equipment envelope is shown in Figure 1.2.3-34. Figure 1.2.3-35 shows the IHF waste package closure room remote handling system mechanical equipment envelope.

1.2.3.2.4 Waste Package Loadout Subsystem

1.2.3.2.4.1 Subsystem Description

The waste package loadout subsystem consists of SSCs necessary to transport and orient the sealed waste packages for transfer to the TEV.

1.2.3.2.4.1.1 Subsystem Functions

Waste Package Loadout Subsystem—The waste package loadout subsystem receives sealed waste packages after closure operations and prepares them for transfer to the emplacement and retrieval system.

1.2.3.2.4.1.2 Subsystem Location and Functional Arrangement

The loadout of sealed waste packages takes place in the waste package loadout room. The area where the waste package loadout operations take place is shown in Figures 1.2.3-2 and 1.2.3-3.

1.2.3.2.4.1.3 Subsystem and Components

ITS SSCs in the waste package loadout subsystem that are similar to those used in other handling facilities are listed below and described in Section 1.2.4.2, including figures and logic diagrams.

Waste Package Shield Rings—The waste package shield rings are described in Section 1.2.4.2. The position of the waste package shield ring is shown in Figure 1.2.4-88.

Waste Package Loadout Room Personnel Shield Doors—The personnel shield doors provide personnel access from the adjoining corridor (Room 1014) to the loadout room and from the loadout room to outside the facility. The exterior door is for emergency egress only and is alarmed. This equipment is described in Section 1.2.4.2 and Figures 1.2.4-85 to 1.2.4-86. The logic diagram for the waste package loadout room personnel shield door is shown in Figure 1.2.4-87.

Waste Package Loadout Room Equipment Shield Door (Type 2)—The waste package loadout room equipment shield door provides equipment and personnel access to the waste package loadout room from outside the facility. The Type 2 equipment shield door has dual-slide panels. Each door panel is operated by an electric motor turning a screw, which interacts with a door panel-mounted bracket. The door panels overlap the aperture on the top, bottom, and both sides to prevent streaming. The staggered edge of each door panel provides shielding between the mating panel seam. The weight of the door is supported by rollers under the bottom of the door, which run in a floor-recessed channel.

The waste package loadout room equipment shield door is controlled from the facility operations room. A local emergency open button is provided. An interlock to a dedicated radiation monitor within the loadout area is provided to prevent the equipment shield door from opening during transfer of a waste package from the waste package transfer trolley to the TEV. The equipment shield door is also provided with an obstruction sensor that halts travel and opens the equipment shield door when an obstacle is detected in the path of the equipment shield door. For details of this equipment, refer to Figures 1.2.3-36 and 1.2.4-20. The logic diagram for the IHF waste package loadout room equipment shield door is shown in Figure 1.2.3-37. The logic diagram for the IHF and RF equipment shield door (double) is shown in Figure 1.2.3-38.

Waste Package Transfer Trolley—The waste package transfer trolley in the IHF handles the Naval Short, Naval Long, and 5-DHLW/DOE Short Codisposal waste packages. Due to canister drop height limitations, only 10-ft HLW canisters are handled in the IHF. This equipment is described in Section 1.2.4.2 and Figures 1.2.4-88 and 1.2.4-89. Figure 1.2.4-90 shows the logic diagram associated with the waste package transfer trolley.

Waste Package Handling Crane—The waste package handling crane is described in Section 1.2.4.2.4 and shown in Figure 1.2.3-39. The waste package handling crane does not lift any waste form. It is designed to not collapse. Section 1.2.2.2 and Table 1.2.2-12 provide further details for ITS cranes.

1.2.3.2.4.2 Operational Processes

Waste Package Loadout Subsystem—The movement of the TEV and transfer of the waste package to the TEV, including the inspection of the waste package surface, are described in Section 1.2.4.2.4.2.

1.2.3.2.4.3 Safety Category Classification

The waste package transfer trolley, waste package handling crane, waste package shield rings, and equipment and personnel shield doors in the waste package loadout subsystem are categorized as ITS.

1.2.3.2.4.4 Procedural Safety Controls to Prevent Event Sequences or Mitigate Their Effects

The preclosure safety analysis identifies one procedural safety control related to the operation of components in the waste package loadout subsystem of the IHF. Table 1.9-10 identifies the unique numbering of the preclosure procedural safety controls, as well as the associated facility/operations area, SSCs, and bases.

PSC-3—To limit the probability of personnel receiving direct radiation exposure during the movement of a loaded waste package into the transport and emplacement vehicle, the waste package loading, closure, and loadout operating procedures will include warnings that movement of a loaded waste package could result in inadvertent personnel exposures if operators are present in the IHF waste package positioning room (Room 1006) or the waste package loadout room (Room 1005). The procedures will include prerequisites for movement of the loaded waste package to verify that the IHF waste package positioning room and IHF waste package loadout room are empty of personnel and that access to these potential radiation areas has been appropriately posted and controlled in accordance with the Operational Radiation Protection Program.

1.2.3.2.4.5 Design Bases and Design Criteria

The nuclear safety design bases and design criteria for the waste package loadout subsystem in the IHF are addressed in Table 1.2.3-3.

1.2.3.2.4.6 Design Methodologies

The design methodologies used in the design of ITS components in the IHF waste package loadout subsystem that are similar to those in other handling facilities, including the waste package trolley, waste package shield rings, and waste package handling crane, are in accordance with codes and standards provided in Section 1.2.2.2. The methodologies used in the design of equipment and personnel shield doors are in accordance with Section Q1.2 of ANSI/AISC N690-1994.

1.2.3.2.4.7 Consistency of Materials with Design Methodologies

Materials of construction used in the design of ITS SSCs in the IHF waste package loadout subsystem that are similar to those in other handling facilities, including the waste package trolley, waste package shield rings, and waste package handling crane, are in accordance with codes and standards provided in Section 1.2.2.2.

Materials of construction used in the design of equipment and personnel shield doors are in accordance with Section Q1.4 of ANSI/AISC N690-1994.

1.2.3.2.4.8 Design Codes and Standards

The principal codes and standards applicable to the waste package loadout subsystem are identified in Table 1.2.2-12.

1.2.3.2.4.9 Design Load and Combinations

The load combinations used in the analysis of ITS SSCs for the IHF waste package loadout subsystem that are similar to those in other handling facilities, including waste package transfer trolley, waste package shield rings, and waste package handling crane, are in accordance with codes and standards provided in Section 1.2.2.2. The design load combinations analyzed include normal conditions and event sequences and the effects of natural phenomena. The load combinations and applicable stress limit coefficients used in the design of equipment and personnel shield doors are in accordance with Table Q1.5.7.1 of ANSI/AISC N690-1994.

1.2.3.3 Process Systems

[NUREG-1804, Section 2.1.1.2.3: AC 1(2), (3), (4), AC 2(1), (2), (3), AC 6]

1.2.3.3.1 Cask Cavity Gas Sampling Subsystem

The cask cavity gas sampling system samples the gas inside a loaded transportation cask before it is opened to obtain an indication of the condition of the waste inside. The presence of gaseous fission products or gases other than helium is indicative of off-normal conditions inside the cask.

The cask cavity gas sampling system also vents the cask to the HVAC system to equalize pressure with the room prior to opening the cask.

The design and operation of the cask cavity gas sampling subsystem in the IHF are functionally the same as in the CRCF. Therefore, the system description, operational processes, and codes and standards provided in Section 1.2.4.3.1 also apply to the IHF. The IHF cavity gas sampling subsystem is located in the cask sampling equipment area (Room 1011). The piping and instrumentation diagram for the IHF cask cavity gas sampling subsystem is shown in Figure 1.2.3-40.

The cask cavity gas sampling subsystem is classified as non-ITS.

1.2.3.3.2 Water Collection Subsystem

The water collection subsystem provides floor drains to collect small amounts of water that are discharged or leak from process SSCs and to collect fire suppression water. The potentially contaminated effluents are collected in the tanks and removed by tanker truck from the IHF. The system is classified as non-ITS.

The design and operation of the water collection subsystem in the IHF are functionally similar to that in the CRCF. Therefore, the system description, operational processes, and codes and standards provided in Section 1.2.4.3.2 also apply to the IHF.

Figure 1.2.3-41 shows the IHF liquid low-level waste sampling and sump piping and instrumentation diagram.

1.2.3.4 Initial Handling Facility Heating, Ventilation, and Air-Conditioning Systems

[NUREG-1804, Section 2.1.1.2.3: AC 1(2), (3), (4), AC 2(1), (2), (3), AC 6; Section 2.1.1.6.3: AC 1(2)(a), (2)(d), (2)(j)]

The IHF HVAC system is designed to limit the release of radioactive airborne contaminants for the protection of the workers and public, condition air to support the operation of SSCs, and maintain the indoor environmental conditions required for operations and for the health and safety of the facility workers.

The ventilation confinement zoning in the IHF is based upon normal operations. The IHF is expected to remain clean during normal operations, and airborne contamination is not expected. The confinement zoning for the IHF is tertiary as defined in Table 1.2.2-13. The remaining portions of the IHF where there is no potential for contamination are classified as a nonconfinement zone. Figures 1.2.3-42 through 1.2.3-44 illustrate the confinement zoning for the IHF.

None of the areas within the tertiary confinement zone are required to provide confinement and filtration to mitigate the consequences due to a dropped loaded canister or loaded waste package. There is no requirement to remove heat from any rooms in the IHF during an event sequence. Consequently, the IHF HVAC system is non-ITS.

During normal operations, the HVAC system operates to dissipate the heat gain from various sources to maintain the required room temperature for proper operation of equipment and personnel comfort. Air handling units and fan coil units are utilized to supply conditioned air to various areas and the supply air is then returned and/or exhausted. The air handling units and fan coil units are sized to dissipate the heat generated from lights, solar loads, and operating mechanical and electrical equipment, as well as the decay heat generated from waste forms that are present in the area served by the HVAC system.

A three-dimensional analysis with multiple axial peaks representing the potential loading of naval SNF canisters (both short and long configurations), is being performed. This analysis will be used to determine that the IHF design supports operational limits for the naval SNF canister remaining below 400°F during handling in the IHF. The thermal evaluation of naval SNF canister surface temperatures in the IHF will assess scenarios that represent the naval SNF canister in the naval transportation cask starting with the detensioning of the closure on the naval transportation cask and continuing after the closure lid is removed, in a waste package, and in a waste package in a waste package transfer trolley. The scenarios will be evaluated under loss-of-ventilation conditions for a 30-day duration of naval SNF canister handling in the IHF. The thermal evaluation of the naval SNF described in Section 1.5.1.4 of the Naval Nuclear Propulsion Program Technical Support Document shows that the naval SNF cladding performs acceptably as long as the operational constraints stated in Section 1.2.2.3.6 for the naval SNF canister are met.

The maximum thermal power for a HLW canister is 720 watts. HLW glass temperature, under both normal and off-normal conditions (no heat removal for 30 days), does not exceed 400°C.

1.2.3.4.1 System Description

The IHF HVAC system includes the following subsystems:

- HVAC supply and exhaust subsystems serving the tertiary confinement areas.
- HVAC supply subsystems serving the nonconfinement areas.

Each subsystem is provided with the necessary distribution ductwork and accessories, electrical power, and instrumentation and controls to operate, control, and monitor the system functions.

HVAC Supply and Exhaust Subsystems Serving the Tertiary Confinement Areas—The tertiary confinement areas are served by recirculating air handling units and exhaust HEPA filter assemblies. The recirculating air handling units serve the north and upper level confinement areas and several fan coil units (with standby capability) are utilized to supplement the air handling units. The fan coil units are located in the electrical equipment areas, the waste package loadout area, and the cask preparation areas.

There is no supply of outside air to the confinement area. The IHF relies on infiltration for makeup air for the confinement areas. Sufficient air is exhausted from the confinement areas by the exhaust subsystem to maintain appropriate confinement. The exhaust air is passed through a single stage of HEPA filters prior to discharging to the atmosphere. The exhaust is monitored for radioactivity downstream of the exhaust fans. Upon detection of high exhaust air radiation, a high radiation alarm is annunciated locally, at the Central Control Center, and in the facility operations room. The remaining air is recirculated to the air handling units or the fan coil units.

The normal power battery room is also provided with a separate exhaust that operates continuously with sufficient volume changes per hour to preclude accumulation of hydrogen generated by the batteries during charging such that it is below the lower level explosive limit. Air that is cascaded or supplied into the battery room is exhausted by means of a redundant, one-stage exhaust HEPA filter unit and exhaust fan with spark-resistant construction and explosion proof motors. This exhaust is also provided with a radioactivity monitor.

Figures 1.2.3-45 and 1.2.3-46 show the composite ventilation flow diagrams, and Figures 1.2.3-47 through 1.2.3-53 show the ventilation and instrumentation diagrams for the HVAC supply and exhaust subsystems serving the tertiary confinement areas.

HVAC Subsystems Serving Nonconfinement Areas—The nonconfinement HVAC subsystem provides conditioned air for cooling, heating, and ventilation for the safety, health, and comfort of the personnel and maintains the environmental conditions suitable for the proper performance of SSCs in the noncontaminated areas of the IHF.

The nonconfinement HVAC system is provided for areas such as offices, vestibules, and facility operations rooms that have no potential for contamination. The system supplies more air than is exhausted so that slightly positive pressures are maintained in the clean areas of the facility relative to the confinement areas. The air handling units are provided with economizers. The supply air is either recirculated or exhausted depending on the temperature of the outdoor air relative to the inside room temperature. The make-up air and recirculated air is filtered.

Figure 1.2.3-54 shows the composite ventilation flow diagram, and Figures 1.2.3-55 through 1.2.3-58 show the ventilation and instrumentation diagrams for the HVAC subsystems serving nonconfinement areas.

1.2.3.4.1.1 System Functions

The functions of the IHF HVAC system are to:

- Maintain airflow from areas of lesser contamination potential to areas of greater contamination potential
- Maintain space temperatures within acceptable limits
- Remove potentially contaminated airborne particulate from the exhaust
- Provide a release point to the atmosphere via monitored discharge.

1.2.3.4.1.2 System Location and Functional Arrangement

The location and arrangement of the HVAC supply and exhaust equipment are shown on the IHF floor plan general arrangement (Figures 1.2.3-2 and 1.2.3-3).

Table 1.2.2-14 provides the typical HVAC system monitoring, status, and alarm functions for HVAC systems.

Table 1.2.3-4 provides the IHF indoor design temperatures.

Table 1.2.3-5 provides the IHF HVAC supply components and system design data.

Table 1.2.3-6 provides the IHF exhaust components and system design data.

The confinement area exhaust system components are located on the first level of the facility. The fan coil units serving the electrical areas are located within the electrical area they serve. The redundant battery room exhausts are located on the roof of the battery room. The recirculating air handling units serving the confinement areas are located in the HVAC equipment area (Room 2003) on the second level. The fan coil units serving the cask preparation and the waste package loadout areas are located within the areas they serve. The fan coil units serving the facility operations room and waste package closure equipment room are located within the facility operations room. The nonconfinement air handling units are located on the ground level adjacent to the nonconfinement areas.

1.2.3.4.1.3 Systems and Components

The major components in the IHF HVAC system are also used in the non-ITS portions of the CRCF HVAC system, which are described in Section 1.2.4.4.1.3.

1.2.3.4.2 Operational Processes

The operational processes for the IHF HVAC system are similar to the processes in the CRCF with respect to the non-ITS functions. These operational processes are described in Section 1.2.4.4.2.

1.2.3.4.3 Design Codes and Standards

The SSCs in the IHF HVAC subsystems are designed using the methods and practices in codes and standards identified in Section 1.2.4.4.8.

1.2.3.5 General References

AISC (American Institute of Steel Construction) 1997. *Manual of Steel Construction, Allowable Stress Design*. 9th Edition, 2nd Revision, 2nd Impression. Chicago, Illinois: American Institute of Steel Construction. TIC: 240772.

ANSI/AISC N690-1994. *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*. Chicago, Illinois: American Institute of Steel Construction. TIC: 252734.

ANSI N14.6-1993. *American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More.* New York, New York: American National Standards Institute. TIC: 236261.

ASME NOG-1-2004. 2005. *Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder).* New York, New York: American Society of Mechanical Engineers. TIC: 257672.

NRC (U.S. Nuclear Regulatory Commission) 1980. *Control of Heavy Loads at Nuclear Power Plants.* NUREG-0612. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 209017.

Table 1.2.3-1. IHF Non-ITS Mechanical Handling Structures, Systems, and Components also Used in the CRCF

IHF Non-ITS Mechanical Handling SSCs that are also Used in the CRCF	Location of Information
Nuclear Facilities Grapple Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Cask Handling Yoke Stand	This equipment is used in the IHF and described in Table 1.2.4-1. For details of this equipment, refer to Figure 1.2.3-59.
Canister Transfer Machine Maintenance Crane	This equipment is used in the IHF and described in Table 1.2.4-1. For details of this equipment, refer to Figures 1.2.3-60 and 1.2.4-132.
Loadout Platform	This equipment is used in the IHF and described in Table 1.2.4-1. For details of this equipment, refer to Figure 1.2.3-61.
Impact Limiter Lifting Device	This equipment is used in the IHF and described in Table 1.2.4-1.
Impact Limiter Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Mobile Access Platform	This equipment is used in the IHF and described in Table 1.2.4-1. For details of this equipment, refer to Figures 1.2.3-62 and 1.2.3-63.
Process Opening Cover	This equipment is used in the IHF and described in Table 1.2.4-1.
Process Opening Cover Stand	This equipment is used in the IHF and described in Tables 1.2.4-1 and 1.2.4-5.
Truck Cask Lid Adapter	This equipment is used in the IHF and described in Table 1.2.4-1.
Truck Cask Lid Adapter Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Closure Room Crane	This equipment is used in the IHF and described in Table 1.2.4-1 and Figure 1.2.3-34.
Waste Package Lift Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Pallet Yoke	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Pallet Yoke Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Shield Ring Lift Beam	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Shield Ring Lift Beam Stand	This equipment is used in the IHF and described in Table 1.2.4-1.

Table 1.2.3-1. IHF Non-ITS Mechanical Handling Structures, Systems, and Components also Used in the CRCF (Continued)

IHF Non-ITS Mechanical Handling SSCs that are also Used in the CRCF	Location of Information
Waste Package Shield Ring Stand	This equipment is used in the IHF and described in Table 1.2.4-1.
Remote Handling System Except for Bridge	This equipment is used in the IHF and described in Table 1.2.4-1. For details of this equipment, refer to Figure 1.2.3-35. The bridge of the remote handling system is ITS and is described in Section 1.2.4.2.3.
Waste Package Transfer Carriage Docking Station	This equipment is used in the IHF and described in Table 1.2.4-1.
Waste Package Transfer Carriage	This equipment is used in the IHF and described in Table 1.2.4-1.

Table 1.2.3-2. IHF-Specific Non-ITS Structures, Systems, and Components in the Mechanical Handling System

IHF-Specific Non-ITS SSCs in the Mechanical Handling System	**Summary Description**
Naval Adapter Stand	The naval adapter stand is a structural frame used to hold the naval SNF canister lifting adapter when not being used. The stand is located in the cask preparation area. This equipment is designed using the methods and practices provided in *Manual of Steel Construction, Allowable Stress Design* (AISC 1997). For details of this equipment, refer to Table 1.2.4-5 and Figure 1.2.4-126.
Naval Cask Lid Stand	The naval cask lid stand is a structural frame mounted onto the top level of the cask preparation platform in the cask preparation area. The stand is used to hold and store the removed lid from the naval cask and to facilitate the canister removal process. This equipment is designed using the methods and practices provided in *Manual of Steel Construction, Allowable Stress Design* (AISC 1997). For details of this equipment, refer to Table 1.2.4-5 and Figure 1.2.4-126.
Naval Cask Restraint Plate Stand	The naval cask restraint plate stand is a structural frame mounted onto the top level of the cask preparation platform in the cask preparation area. The stand is used to hold and store the removed naval restraint plate, shear rings, and associated bolts during the canister removal process. This equipment is designed using the methods and practices provided in *Manual of Steel Construction, Allowable Stress Design* (AISC 1997). For details of this equipment, refer to Table 1.2.4-5 and Figure 1.2.4-126.
Transfer Staging Stand	The transfer staging stand is a structural frame located in the canister transfer machine maintenance area. The stand is used to hold the DOE cask lid during canister transfer operations. This equipment is designed using the methods and practices provided in *Manual of Steel Construction, Allowable Stress Design* (AISC 1997). For details of this equipment, refer to Table 1.2.4-5 and Figure 1.2.4-126.
Naval Cask Lift Bail Stand	The naval cask lift bail stand is a structural frame used to hold the naval cask lift bale stand when not being used. The stand is located in the cask preparation area. This equipment is designed using the methods and practices provided in *Manual of Steel Construction, Allowable Stress Design* (AISC 1997). For detail of this equipment see Figure 1.2.3-64.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	**Controlling Parameters and Values**	
Initial Handling Facility (IH)	Initial Handling Facility	Structure	Maintain building structural integrity to protect ITS SSCs inside the building from external events	IH.01. The mean frequency of building collapse due to winds less than or equal to 120 mph shall not exceed 1×10^{-6} per year.	Structure is required to be designed to meet the wind and ash loads described in Table 1.2.2-1.
				IH.02. The mean frequency of building collapse due to volcanic ash fall less than or equal to a roof load of 21 lb/ft^2 shall not exceed 1×10^{-6} per year.	Structure is required to be designed to meet the wind and ash loads described in Table 1.2.2-1.
				IH.03. The IHF shall be located such that there is a distance of at least one-half mile between the IHF and the repository heliport.	The heliport is located at least one-half mile from any ITS structure.
			Protect against building collapse onto waste containers	IH.04. The mean frequency of collapse of the IHF structure due to the spectrum of seismic events shall be less than or equal to 2×10^{-6} per year.	Fragility assessment of building collapse is performed to develop the fragility curve for the structure. Convolution of the structure fragility curve and seismic hazard curve (as described in Section 1.7) is performed to demonstrate compliance.
		Rails for the TEV (Inside the Waste Package Loadout Room)	Protect against derailment of the TEV during loading of a waste package	IH.05. The mean frequency of TEV derailment due to failure of the TEV rail system (at the loadout station) due to the spectrum of seismic events shall be less than or equal to 1×10^{-4} per year.	The TEV is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes. The TEV and rails at the loadout station are required to be designed to prevent the TEV from derailing during a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Initial Handling Facility (IH) (Continued)	Initial Handling Facility (Continued)	Shield Doors (Including Anchorages)	Protect against direct exposure of personnel	IH.06. Equipment and personnel shield doors shall have a mean probability of inadvertent opening of less than or equal to 1×10^{-6} per transfer.	Equipment shield doors are required to be interlocked to prevent them from opening when associated equipment and personnel shield doors or transfer port slide gates that have a complementary shielding function are not closed. Equipment shield doors and personnel access doors associated with personnel shield doors at exits from the waste package loadout room are required to be interlocked with a radiation monitor to prevent inadvertent opening during waste package loadout operations.
			Preclude collapse onto waste containers	IH.07. An equipment shield door falling onto a waste container as a result of an impact from a conveyance shall be precluded.	Equipment shield doors are required to be designed in accordance with the applicable provisions of ANSI/AISC N690-1994. Equipment shield doors are required to be designed to not collapse following an impact from a conveyance at its design speed.
			Protect against equipment shield door collapse onto a waste container	IH.08. The mean frequency of collapse of equipment shield doors (including attachment of door to wall and frame anchorages) due to the spectrum of seismic events shall be less than or equal to 6×10^{-6} per year.	Equipment shield doors are required to be designed in accordance with the applicable provisions of ANSI/AISC N690-1994 for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.
		Cask Port Slide Gate (51A-HTC0-HTCH-00001)	Protect against dropping a canister due to spurious closure of the slide gate	IH.HTC.01. The mean probability of a canister drop resulting from a spurious closure of the slide gate shall be less than or equal to 2×10^{-6} per transfer.	The slide gate is required to be power-limited such that the maximum slide gate closing force is insufficient to sever the hoisting ropes.
			Protect against direct exposure to personnel	IH.HTC.02. The mean probability of inadvertent opening of a slide gate shall be less than or equal to 1×10^{-9} per transfer	Slide gate is required to be interlocked to prevent it from opening when an associated equipment shield door that has a complementary shielding function is not closed. The slide gate is required to be interlocked to prevent it from opening unless a canister transfer machine is present above it with its shield skirt lowered.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Initial Handling Facility (IH) (Continued)	Initial Handling Facility (Continued)	Cask Port Slide Gate (51A-HTC0-HTCH-00001) (Continued)	Preclude canister breach	IH.HTC.03. Closure of the slide gate shall be incapable of breaching a canister.	The slide gate is required to be power-limited such that the maximum slide gate closing force is insufficient to breach a canister.
		Waste Package Port Slide Gate (51A-HTC0-HTCH-00002)	Protect against dropping a canister due to a spurious closure of the slide gate	IH.HTC.04. The mean probability of a canister drop resulting from a spurious closure of the slide gate shall be less than or equal to 4×10^{-9} per transfer.	The slide gate is required to be power-limited such that the maximum slide gate closing force is insufficient to sever the hoisting ropes.
			Protect against direct exposure to personnel	IH.HTC.05. The mean probability of inadvertent opening of a slide gate shall be less than or equal to 2×10^{-6} per transfer.	Slide gate is required to be interlocked to prevent it from opening when an associated equipment shield door that has a complementary shielding function is not closed. The slide gate is required to be interlocked to prevent it from opening unless a canister transfer machine is present above it with its shield skirt lowered. The interlock may be bypassed for naval SNF canister handling operations.
			Preclude canister breach	IH.HTC.06. Closure of the slide gate shall be incapable of breaching a canister.	The slide gate is required to be power-limited such that the maximum slide gate closing force is insufficient to breach a canister.
			Preclude canister drop onto floor	IH.HTC.07. The waste package port slide gate shall be incapable of opening without a waste package transfer trolley with waste package in position to receive a canister.	The waste package port slide gate is required to be designed with an interlock to prevent opening of the waste package port slide gate when the waste package transfer trolley with waste package is not correctly positioned below the port.
		Cask Preparation Platform (51A-HMH0-PLAT-00001)	Protect against platform collapse	IH.HMH.01. The mean frequency of collapse of the cask preparation platform due to the spectrum of seismic events shall be less than or equal to 9×10^{-4} per year.	The platform is required to be designed in accordance with the applicable provisions of ANSI/AISC N690-1994 for loads and accelerations associated with a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Mechanical Handling System (H)	Cask Handling	Cask Handling Yoke (51A-HM00-BEAM-00001)	Protect against drop	H.IH.HM.01. The cask handling yoke is an integral part of the load-bearing path. See cask handling crane requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Special lifting devices are required to have an interlock to prevent special lifting device actuation if the special lifting device is not properly connected to the hoisting system and an interlock to prevent hoist motion if the special lifting device is not either fully engaged or fully disengaged. Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
		Cask Handling Crane; 300-ton (51A-HM00-CRN-00001)	Protect against drop	H.IH.HM.02. The mean probability of dropping a loaded cask from less than the two-block height resulting from the failure of a piece of equipment in the load-bearing path shall be less than or equal to 3×10^{-5} per transfer.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes.
				H.IH.HM.03. The mean probability of dropping of a loaded cask from the two-block height resulting from the failure of a piece of equipment in the load-bearing path shall be less than or equal to 4×10^{-7} per transfer.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes.
			Limit drop height	H.IH.HM.04. The two-block drop height shall not exceed 40 ft from the bottom of the shortest cask to the floor.	The crane, in conjunction with the special lifting device, is required to be designed such that the bottom of any cask cannot be more than 40 ft above the floor with the crane hoisting system in a two-block condition.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Mechanical Handling System (H) (Continued)	Cask Handling (Continued)	Cask Handling Crane; 300-ton (51A-HM00-CRN-00001) (Continued)	Protect against drop of a load onto a cask	H.IH.HM.05. The mean probability of dropping a load onto a loaded cask or its contents shall be less than or equal to 3×10^{-5} per cask handled.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes.
			Limit speed	H.IH.HM.06. The speed of the trolley and bridge shall be limited to 20 ft/min.	The trolley and bridge are required to be designed to preclude speeds greater than 20 ft/min.
			Protect against crane collapse onto a waste container	H.IH.HM.07. The mean frequency of collapse of the cask handling crane due to the spectrum of seismic events shall be less than or equal to 8×10^{-6} per year.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.
			Protect against a cask or heavy object drop from the crane	H.IH.HM.08. The mean frequency of a hoist system failure of the cask handling crane due to the spectrum of seismic events shall be less than or equal to 2×10^{-5} per year.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event.
		Cask Transfer Trolley and Pedestals (Trolley: 51A-HM00-TRLY-00001) (Cask Pedestals: 51A-HM00-PED-00001/ 00002) (Naval Cask Pedestal: 51A-HM00-PED-00003)	Limit speed	H.IH.HM.09. The speed of the cask transfer trolley shall be limited to 2.5 mph.	The cask transfer trolley is required to be designed to preclude speeds greater than 2.5 mph.
			Protect against spurious movement	H.IH.HM.10. The mean probability of spurious movement of the cask transfer trolley while a canister is being lifted by the canister transfer machine shall be less than or equal to 1×10^{-9} per transfer.	The cask transfer trolley is required to be designed such that its pneumatic power supply must be disconnected for the cask unloading room equipment shield door to be closed.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	**Controlling Parameters and Values**	
Mechanical Handling System (H) (Continued)	Cask handling (Continued)	Cask Transfer Trolley and Pedestals (Trolley: 51A-HM00-TRLY-00001) (Cask Pedestals: 51A-HM00-PED-00001/ 00002) (Naval Cask Pedestal: 51A-HM00-PED-00003) (Continued)	Protect against impact and inducing stresses on the waste container	H.IH.HM.11. The mean frequency of sliding impact of the cask transfer trolley into a wall or structural column and inducing stresses that can breach the waste container due to the spectrum of seismic events shall be less than or equal to 1×10^{-6} per year.	Operating clearance and energy-absorbing features are required to be provided to minimize the likelihood of seismic-induced sliding impact and control impact loads as needed.
				H.IH.HM.12. The mean frequency of rocking impact of the cask transfer trolley into a wall or structural column and inducing stresses that can breach the waste container due to the spectrum of seismic events shall be less than or equal to 1×10^{-6} per year.	Operating clearance and energy-absorbing features are required to be provided to minimize the likelihood of seismic-induced rocking impact and control impact loads as needed.
		Cask Preparation Crane; 30-ton (51A-HM00-CRN-00002)	Protect against drop	H.IH.HM.13. The mean probability of a drop of a load onto a loaded cask shall be less than or equal to 3×10^{-5} per transfer.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes.
			Protect against collapse of the cask preparation crane	H.IH.HM.14. The mean frequency of collapse of the cask preparation crane due to the spectrum of seismic events shall be less than or equal to 8×10^{-6} per year.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Cask Handling/Cask Receipt	Naval Cask Lift Bail (IHF: 51A-HMC0-BEAM-00001)	Protect against drop	H.IH.HMC.01. The naval cask lift bail is an integral part of the load-bearing path. See cask handling crane requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
		Naval Cask Lift Plate (IHF: 51A-HMC0-HEQ-00005)	Protect against drop	H.IH.HMC.02. The naval cask lift plate is an integral part of the load-bearing path. See cask handling crane requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
	Cask Handling/Cask Preparation	Rail Cask Lid Adapters (51A-HMH0-HEQ -00002)	Protect against drop	H.IH.HMH.01. The rail cask lid adapter is integral to the load-bearing path for the HLW rail cask lid. See cask handling crane requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
	Cask Handling/ Waste Package Preparation	Waste Package Handling Crane (51A-HMP0-CRN-00001)	Protect against collapse of the waste package handling crane	H.IH.HMP.01. The mean frequency of collapse of the waste package handling crane due to the spectrum of seismic events shall be less than or equal to 8×10^{-6} per year.	The crane is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type II cranes, for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer	Canister Transfer Machine (51A-HTC0-FHM-00001)	Protect against drop	H.IH.HTC.01. The mean probability of drop of a canister from below the two-block height due to the failure of a piece of equipment in the load-bearing path shall be less than or equal to 2×10^{-4} per transfer.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes. The canister transfer machine is required to be designed with the following features: • Two hoist upper limit switches • Hoist adjustable speed drive that stops the hoist at setpoints that are independent from the hoist upper limit switches • Load cell overload limit that stops hoist • Sensor to stop hoist when load clears canister transfer machine slide gate.
				H.IH.HTC.02.The mean probability of drop of a canister from the two-block height due to the failure of a piece of equipment in the load-bearing path shall be less than or equal to 3×10^{-8} per transfer.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes. The canister transfer machine is required to be designed with the following features: • Two hoist upper limit switches • Hoist adjustable speed drive that stops the hoist at setpoints that are independent from the hoist upper limit switches • Load cell overload limit that stops hoist • Sensor to stop hoist when load clears canister transfer machine slide gate.
			Limit drop height	H.IH.HTC.03. The two-block drop height shall not exceed 40 ft from the bottom of a canister to the cavity floor of the cask or waste package.	The canister transfer machine, in conjunction with the special lifting device(s), is required to be designed such that the bottom of any canister cannot be more than 40 ft above the cavity floor of the transportation cask or waste package with the canister transfer machine hoisting system in a two-block condition.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	Canister Transfer Machine (51A-HTC0-FHM-00001) (Continued)	Protect against drop of a load onto a canister	H.IH.HTC.04. The mean probability of dropping a load onto a canister shall be less than or equal to 1 × 10^{-5} per transfer.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes. The canister transfer machine is required to be designed with the following features: • Two hoist upper limit switches • Hoist adjustable speed drive that stops the hoist at setpoints that are independent from the hoist upper limit switches • Load cell overload limit that stops hoist • Sensor to stop hoist when load clears canister transfer machine slide gate.
			Protect against spurious movement	H.IH.HTC.05. The mean probability of spurious movement of the canister transfer machine while a canister is being lifted or lowered shall be less than or equal to 7 × 10^{-9} per transfer.	Interlocks are required to be provided to prevent operation of the canister transfer machine bridge and trolley drives unless the canister transfer machine shield skirt is raised indicating that the canister is clear of the canister transfer machine slide gate. The circuit breakers that provide power to the adjustable speed drives for the bridge and trolley motors are required to have instantaneous over-current protection.
			Preclude canister breach	H.IH.HTC.06. Closure of the canister transfer machine slide gate shall be incapable of breaching a canister.	The canister transfer machine slide gate is required to be power-limited such that the maximum slide gate closing force is insufficient to breach a canister.
			Preclude non-flat-bottom drop of a naval SNF canister	H.IH.HTC.07. The canister transfer machine shall preclude non-flat-bottom drops of naval canisters.	The canister transfer machine shall be designed with guide features for naval SNF canisters to preclude non-flat-bottom drops.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	Canister Transfer Machine (51A-HTC0-FHM-00001) (Continued)	Protect against direct exposure of personnel	H.IH.HTC.08. The mean probability of inadvertent radiation streaming due to the inadvertent opening of the canister transfer machine slide gate, the inadvertent raising of the canister transfer machine shield skirt, or an inadvertent motion of the canister transfer machine away from an open port shall be less than or equal to 1×10^{-4} per transfer.	The canister transfer machine is required to be designed with the following features: • Shield skirt–hoist interlock (skirt must be down to permit hoist operation) • Shield skirt–canister transfer machine slide gate interlock (either skirt must be down or gate must be closed) • Shield skirt–port gate interlock (skirt must be down before port gate can be opened). • PSC-13 (Section 1.2.3.2.2.4) addresses closure of the port slide gates at the completion of a canister transfer operation.
			Limit speed	H.IH.HTC.09. The speed of the canister transfer machine trolley and bridge shall be limited to 20 ft/min.	The canister transfer machine trolley and bridge are required to be designed to preclude speeds greater than 20 ft/min.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases: Safety Function	Nuclear Safety Design Bases: Controlling Parameters and Values	Design Criteria
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	Canister Transfer Machine (51A-HTC0-FHM-00001) (Continued)	Protect against drop	H.IH.HTC.10. The mean frequency of drop by the canister transfer machine of the naval SNF canister resulting in breach of the canister shall be less than or equal to 2 × 10^{-5} over the preclosure period.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes. The canister transfer machine is required to be designed with the following features: • Two hoist upper limit switches • A hoist adjustable speed drive that stops the hoist at setpoints that are independent from the hoist upper limit switches • A load cell overload limit that stops hoist • A sensor to stop the hoist when the load clears the canister transfer machine slide gate. The naval SNF canister is required to be designed such that the maximum effective plastic strain from a drop meets the required reliability when evaluated against the naval SNF canister capacity curve. (Note: The preclosure safety analysis depends on the combination of the reliabilities of each component.)
			Protect against collapse of the canister transfer machine	H.IH.HTC.11. The mean frequency of collapse of the canister transfer machine due to the spectrum of seismic events shall be less than or equal to 1 × 10^{-5} per year.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.
			Protect against a canister or heavy object drop from the canister transfer machine	H.IH.HTC.12. The mean frequency of a hoist system failure of the canister transfer machine due to the spectrum of seismic events shall be less than or equal to 2 × 10^{-5} per year.	The canister transfer machine is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	Canister Transfer Machine Grapple (51A-HTC0-HEQ-00001) Canister Grapples (51A-HTC0-HEQ-00003/00004)	Protect against drop	H.IH.HTC.13. Grapples are an integral part of the load-bearing path. See canister transfer machine requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). The special lifting device is required to have mechanical features that prevent special lifting device disengagement when a load is suspended from the special lifting device. Electrically operated special lifting devices are required to have an interlock to prevent special lifting device actuation if the special lifting devices are not properly connected to the hoisting system and an interlock to prevent hoist motion if the special lifting devices are not either fully engaged or fully disengaged. Mechanically operated special lifting devices (HLW canisters only) are required to have an interlock to prevent hoist motion if the special lifting device is not properly connected to the hoisting system or if the special lifting device is not either fully engaged or fully disengaged. Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	Canister Transfer Machine Grapple (51A-HTC0-HEQ-00001) Canister Grapples (51A-HTC0-HEQ-00003/00004) (Continued)	Protect against drop of a load onto a canister	H.IH.HTC.14. The grapples are an integral part of the load-bearing path. See canister transfer machine requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). The special lifting device is required to have mechanical features that prevent special lifting device disengagement when a load is suspended from the special lifting device. Electrically operated special lifting devices are required to have an interlock to prevent special lifting device actuation if the special lifting devices are not properly connected to the hoisting system and an interlock to prevent hoist motion if the special lifting devices are not either fully engaged or fully disengaged. For mechanically operated special lifting devices (HLW canisters only) an interlock is required to prevent hoist motion if the special lifting device is not properly connected to the hoisting system or if the special lifting device is not either fully engaged or fully disengaged. Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
		Naval Canister Lifting Adapter (51A-HTC0-HEQ-00005)	Protect against drop of a canister	H.IH.HTC.15. The naval canister lifting adapter is an integral part of the load-bearing path of the canister transfer machine. See canister transfer machine requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Transfer/ Canister Transfer (Continued)	DOE Waste Package Inner Lid Grapple (51A-HTC0-HEQ-00007)	Protect against the drop of a load onto a canister	H.IH.HTC.16. The lid grapple is an integral part of the load-bearing path of the canister transfer machine. See canister transfer machine requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). The special lifting device is required to have mechanical features that prevent special lifting device disengagement when a load is suspended from the special lifting device. The special lifting device is required to have an interlock to prevent special lifting device actuation if the special lifting device is not properly connected to the hoisting system and an interlock to prevent hoist motion if the special lifting device is not either fully engaged or fully disengaged. Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.
		Naval Waste Package Inner Lid Grapple (51A-HTC0-HEQ-00008)	Protect against the drop of a load onto a canister	H.IH.HTC.17. The lid grapple is an integral part of the load-bearing path of the canister transfer machine. See canister transfer machine requirements.	The special lifting device/adapter is required to be designed in accordance with the requirements of ANSI N14.6-1993, as modified by NUREG-0612 (NRC 1980), Section 5.1.1(4). The special lifting device is required to have mechanical features that prevent special lifting device disengagement when a load is suspended from the special lifting device. The special lifting device is required to have an interlock to prevent special lifting device actuation if the special lifting device is not properly connected to the hoisting system and an interlock to prevent hoist motion if the special lifting device is not either fully engaged or fully disengaged. Special lifting devices/adapters are required to be designed for loads and accelerations associated with a DBGM-2 seismic event.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Package Closure	Remote Handling System Bridge (51A-HWH0-HEQ-00003)	Protect against collapse of the remote handling system bridge	H.IH.HWH.01. The mean frequency of collapse of the remote handling system bridge due to the spectrum of seismic events shall be less than or equal to 8×10^{-6} per year.	The remote handling system bridge is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type II cranes, for loads and accelerations associated with a DBGM-2 seismic event. Additional structural capacity is provided as required to demonstrate compliance.
	Waste Package Loadout	Waste Package Shield Rings (51A-HL00-HEQ-00001/00002)	Provide lateral and vertical stability to the waste package in the waste package transfer trolley	H.IH.HL.01. The mean frequency of the shield ring becoming displaced from the waste package transfer trolley due to the spectrum of seismic events shall be less than or equal to 2×10^{-5} per year.	The waste package transfer trolley, including the associated waste package shield rings, is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event.
		Waste Package Transfer Trolley (including Pedestals, Seismic Rail Restraints, and Rails) (Trolley: 51A-HL00-TRLY-00001) (Pedestals: 51A-HL00-PED-00001/00002/ 00003/00004)	Preclude rapid tilt-down	H.IH.HL.02. The waste package transfer trolley shall be incapable of rapid tilt-down.	The waste package transfer trolley is required to have two drive trains to rotate the shielded enclosure, either of which can support the enclosure. Power is required to be applied to rotate the shielded enclosure in either direction.
			Limit speed	H.IH.HL.03. The speed of the waste package transfer trolley shall be limited to 2.5 mph.	The waste package transfer trolley is required to be designed to preclude speeds greater than 2.5 mph.
			Protect against spurious movement	H.IH.HL.04. The mean probability of spurious movement of the waste package transfer trolley while a canister is being lowered by the canister transfer machine shall be less than or equal to 1×10^{-9} per transfer.	An interlock is required to be provided to interrupt power to the waste package transfer trolley when the waste package port slide gate is opened.

Table 1.2.3-3. Preclosure Nuclear Safety Design Bases and their Relationship to Design Criteria for the IHF (Continued)

System or Facility (System Code)	Subsystem or Function (as Applicable)	Component	Nuclear Safety Design Bases		Design Criteria
			Safety Function	Controlling Parameters and Values	
Mechanical Handling System (H) (Continued)	Waste Package Loadout (Continued)	Waste Package Transfer Trolley (including Pedestals, Seismic Rail Restraints, and Rail System) (Trolley: 51A-HL00-TRLY-00001) (Pedestals: 51A-HL00-PED-00001/00002/ 00003/00004) (Continued)	Protect against a tipover of the waste package transfer trolley holding a loaded waste package	H.IH.HL.05. The mean frequency of tipover of the waste package transfer trolley due to the spectrum of seismic events shall be less than or equal to 2×10^{-6} per year.	The waste package transfer trolley is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event. The waste package transfer trolley is required to operate on seismically designed rails and have seismic restraints such that it will not tip over during a seismic event.
			Protect against rocking (which induces an impact into a wall) of a waste package transfer trolley holding a loaded waste package	H.IH.HL.06. The mean frequency of the rocking impact of the waste package transfer trolley into a wall or column due to the spectrum of seismic events shall be less than or equal to 2×10^{-5} per year.	The waste package transfer trolley is required to be designed in accordance with the requirements of ASME NOG-1-2004 for Type I cranes, for loads and accelerations associated with a DBGM-2 seismic event. The waste package transfer trolley is required to operate on seismically designed rails and have seismic restraints such that it will not have a rocking impact during a seismic event.
Balance of Plant (SB)	Flood Protection	Flood Control Features	Protect ITS SSCs from external flooding events	SB.01. The site flood control features will be designed to the probable maximum flood.	The flood protection features are required to be located and sized to prevent the inundation of the ITS structures due to a flood associated with the probable maximum precipitation event.

NOTE: "Protect against" in this table means either "reduce the probability of" or "reduce the frequency of."
For casks, canisters, and associated handling equipment that were previously designed, the component design will be evaluated to confirm that the controlling parameters and values are met.
Seismic control values shown represent the integration of the probability distribution of SSC failure (i.e., the loss of safety function) with the seismic hazard curve.
The numbers appearing in parentheses in the third column are component numbers.
Facility Codes: IH: Initial Handling Facility; SB: Balance of Plant.
System Codes: H: Mechanical Handling.
Subsystem Codes: HL: Waste Package Loadout; HM: Cask Handling: HMC: Cask Receipt; HMH: Cask Preparation; HMP: Waste Package Preparation; HTC: Canister Transfer; HWH: Material Handling.

Table 1.2.3-4. IHF Indoor Design Temperatures

Area or Room	Maximum Summer Temperature (°F Dry Bulb)	Minimum Winter Temperature (°F Dry Bulb)
Cask Preparation Area	85[a]	65
Cask Unloading Room	100[b]	65
Waste Package Loading Room	100[b]	65
Waste Package Loadout Room	90[b]	65
Canister Transfer Machine Maintenance Area	85[a]	65
Low-Level Radioactive Waste Sump Room	90[b]	65
Dry Low-Level Radioactive Waste Storage Room	85[a]	65
Support Areas	75	70
Cask Sampling Equipment Area	85[b]	65
Electrical Equipment Area	85[a]	65
Battery Room	77	72
Waste Package Positioning Room	90[b]	65
HVAC Room	90[b]	65
HVAC Equipment Area	90[b]	65
Canister Transfer Area	85[a]	65
Waste Package Closure Room	90[b]	65
Waste Package Closure Equipment Room	75	65
Operations Room	75	70
Utility Room	90[b]	65
Corridors and Elevator Lobby	85	65

NOTE: [a]These areas are normally not occupied. However, these areas are designed to be at maximum of 85°F since there is expected extended occupancy during operation.
[b]These areas are normally not occupied and the temperature limits are based on the electrical equipment located in the space.

Table 1.2.3-5. IHF HVAC Supply Components and System Design Data

Subsystem/Components	Number of Units		Nominal Airflow Capacity cfm/unit
	Operating	Standby	
Tertiary Confinement Area Recirculating Supply Air Handling Unit (Equipment Number 51A-VCT0-AHU-00001/00002/00003)	2	1	30,000
Tertiary Confinement Cask Prep Areas Fan Coil Units (Equipment Number 51A-VCT0-FCU-00001/00002/00003/00004)	3	1	12,000
Tertiary Confinement Waste Package Loadout Area Fan Coil Units (Equipment Number 51A-VCT0-FCU-00007/00008)	1	1	8,000
Tertiary Confinement Electrical Areas—Fan Coil Units (Equipment Number 51A-VCT0-FCU-00005/00006/00009)	2	1	10,000
Nonconfinement Waste Package Closure Equipment and Operation Rooms—Fan Coil Units (Equipment Number 51A-VNI0-FCU-00001/00002)	1	1	10,000
Nonconfinement Air Handling Unit—Supply Fan Equipment Number 51A-VNI0-AHU-00001/00002)	1	1	20,000
Nonconfinement Air Handling Unit—Return Fan (Integral to unit 51A-VNI0-AHU-00001/00002)	1	1	7,000

NOTE: Equipment numbers are shown in Figures 1.2.3-45, 1.2.3-46, and 1.2.3-54.

Table 1.2.3-6. IHF Exhaust Components and System Design Data

Subsystem/Components	Number of Units		Nominal Airflow Capacity cfm/unit	HEPA Filter Plenum Components (Number of Banks)		
	Operating	Standby		Demister	Prefilter	HEPA Filter
Non-ITS Confinement Areas Exhaust HEPA Filter Plenum (Equipment Number: 51A-VCT0-FLT-00001/00002/00003)	2	1	18,000	NA	1	1
Non-ITS Confinement Areas Exhaust Fan (Equipment Number: 51A-VCT0-EXH-00001/00002/00003)	2	1	18,000	NA	NA	NA
Non-ITS Battery Room Exhaust HEPA Filter Plenum (Equipment Number: 51A-VCT0-FLT-00004/00005)	1	1	1,000	NA	1	1
Non-ITS Battery Room Exhaust Fan (Equipment Number: 51A-VCT0-EXH-00004/00005)	1	1	1,000	NA	NA	NA
Nonconfinement Men's and Women's Toilet and Locker Room—Exhaust Fan (Equipment Number 51A-VNI0-EXH-00001)	1	NA	800	NA	NA	NA
Nonconfinement Janitor Closet—Exhaust Fan (Equipment Number 51A-VNI0-EXH-00002)	1	NA	100	NA	NA	NA
Nonconfinement Elevator Machinery Room—Exhaust Fan (Equipment Number 51A-VNI0-EXH-00003)	1	NA	500	NA	NA	NA

NOTE: Equipment numbers are shown in Figures 1.2.3-45, 1.2.3-46, and 1.2.3-54.
NA = not applicable.

ROOM LEGEND

INITIAL HANDLING FACILITY

GROUND FLOOR

1001	HVAC (HEPA FILTER EXHAUST)
1002	ELECTRICAL EQUIPMENT AREA (NORMAL POWER)
1003	BATTERY ROOM (NORMAL POWER)
1004	CORRIDOR
1005	WASTE PACKAGE LOADOUT ROOM
1006	WASTE PACKAGE POSITIONING ROOM
1007	WASTE PACKAGE LOADING ROOM
1008	CASK UNLOADING ROOM
1009	CANISTER TRANSFER MACHINE MAINTENANCE AREA
1010	GAS STORAGE AREA
1011	CASK SAMPLING EQUIPMENT AREA
1012	CASK PREPARATION AREA
1013	CORRIDOR
1014	CORRIDOR
1015	STAIR #1
1016	STAIR #2
1017	STAIR #3
1018	STAIR #4
1019	FIRE WATER RISER VALVE ROOM #1
1020	FIRE WATER RISER VALVE ROOM #2
1021	FIRE WATER RISER VALVE ROOM #3
1022	PERSONNEL ELEVATOR
1023	UTILITY ROOM
1024	ELEVATOR LOBBY
1025	CORRIDOR
1026	DRY LOW-LEVEL RADIOACTIVE WASTE STORAGE ROOM
1027	LOW-LEVEL RADIOACTIVE WASTE SUMP ROOM
1028	LOW-LEVEL RADIOACTIVE WASTE COLLECTION TANK AREA
1029	LOW-LEVEL RADIOACTIVE WASTE TRUCK STAGING AREA
1030	PERSONNEL ELEVATOR
1031	ELEVATOR LOBBY

SECOND FLOOR

2001	OPERATIONS ROOM
2002	WASTE PACKAGE CLOSURE EQUIPMENT ROOM
2003	HVAC EQUIPMENT AREA
2004	WASTE PACKAGE CLOSURE ROOM
2005	CANISTER TRANSFER AREA
2006	WASTE PACKAGE CLOSURE SUPPORT ROOM
2007	CORRIDOR
2008	CORRIDOR
2009	CORRIDOR
2010	OPERATIONS SUPERVISOR ROOM
2011 THRU 2014	NOT USED
2015	STAIR #1
2016	STAIR #2
2017	STAIR #3
2018	STAIR #4
2019 THRU 2023	NOT USED
2024	ELEVATOR LOBBY

DRAWING LEGEND

- GRID LINE
- CHECKERED PLATE
- FLOOR GRATING
- PARTITION WALL
- CONCRETE SECTION
- OVERHEAD CRANE HOOK APPROACH
- (XXXX) ROOM/AREA NUMBER
- GRADE SECTION
- MEMBRANE ROOFING
- EYE WASH/SHOWER STATION
- RAISED COMPUTER FLOOR
- METAL EXTERIOR PANEL SYSTEM

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GROUND FLOOR SUPPORT AREA

1200	VESTIBULE
1201	WOMENS LOCKER/SHOWER RESTROOM
1202	MENS LOCKER/SHOWER RESTROOM
1203	SECURITY POST
1204	ENTRANCE LOBBY
1205	CORRIDOR
1206	RADIOLOGICAL PROTECTION EQUIPMENT ROOM
1207	RESPIRATOR ROOM
1208	RADIOLOGICAL PROTECTION GEAR SUPPLY ROOM
1209	RADIOLOGICAL ACCESS CONTROL POINT
1210	VESTIBULE
1211	CONTROLLED EXIT
1212	BRIEFING ROOM
1213	RADIOLOGICAL PROTECTION STAFF WORK ROOM
1214	BREAK/VENDING ROOM
1215	JANITOR CLOSET
1216	VESTIBULE
1217	CHANGE ROOM 1
1218	CHANGE ROOM 2
1219	JANITOR CLOSET
1220	PERSONNEL DECON ROOM
1221	EXIT
1222	RADIOLOGICAL PROTECTION LAB/SAMPLE PREPARATION ROOM
1223	RADIOLOGICAL PROTECTION LAB/COUNT ROOM
1224	RADIOLOGICAL PROTECTION INSTRUMENT ROOM
1225	SMALL EQUIPMENT DECON ROOM

ROOF

R001	PERSONNEL ELEVATOR MACHINE ROOM
R002	PERSONNEL ELEVATOR MACHINE ROOM
R003	CORRIDOR
R015	STAIR #1

PIT

P001	LIQUID LOW-LEVEL RADIOACTIVE WASTE SUMP

Figure 1.2.3-1. IHF General Arrangement Legend

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A and has been updated: Information Designated as Official Use Only, as Figure A-1.

NOTE: LC = load center; MCC = motor control center; WP = waste package.

Figure 1.2.3-2. IHF General Arrangement Ground Floor Plan

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-2.

NOTE: HR = handrail; RHS = remote handling system; WP = waste package.

Figure 1.2.3-3. IHF General Arrangement Second Floor Plan

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-3.

NOTE: CTM = canister transfer machine.

Figure 1.2.3-4. IHF General Arrangement Plan at Elevation +73′

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-4.

Figure 1.2.3-5. IHF General Arrangement Roof Plan

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-5.

NOTE: MCC = motor control center.

Figure 1.2.3-6. IHF General Arrangement Section A

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-6.

NOTE: CTM = canister transfer machine; WP = waste package.

Figure 1.2.3-7. IHF General Arrangement Section B

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-7.

NOTE: HR = handrail; RHS = remote handling system; WP = waste package.

Figure 1.2.3-8. IHF General Arrangement Section C

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-8.

NOTE: HR = handrail.

Figure 1.2.3-9. IHF General Arrangement Section D

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-9.

NOTE: WP = waste package.

Figure 1.2.3-10. IHF General Arrangement Section E

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-10.

NOTE: HR = handrail; RHS = remote handling system; WP = waste package.

Figure 1.2.3-11. IHF General Arrangement Section F

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-11.

NOTE: LC = load center; MCC = motor control center; WP = waste package.

Figure 1.2.3-12. IHF General Arrangement Section G

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-12.

NOTE: CTM = canister transfer machine; HR = handrail; LLW = low-level radioactive waste.

Figure 1.2.3-13. IHF General Arrangement Section H

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A and has been updated: Information Designated as Official Use Only, as Figure A-13.

NOTE: LC = load center; MCC = motor control center.

Figure 1.2.3-14. IHF General Arrangement Section J

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-14.

NOTE: WP = waste package.

Figure 1.2.3-15. IHF Operational Sequences and Material Flow Paths

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-15.

Figure 1.2.3-16. IHF Material Flow Paths—Plan View

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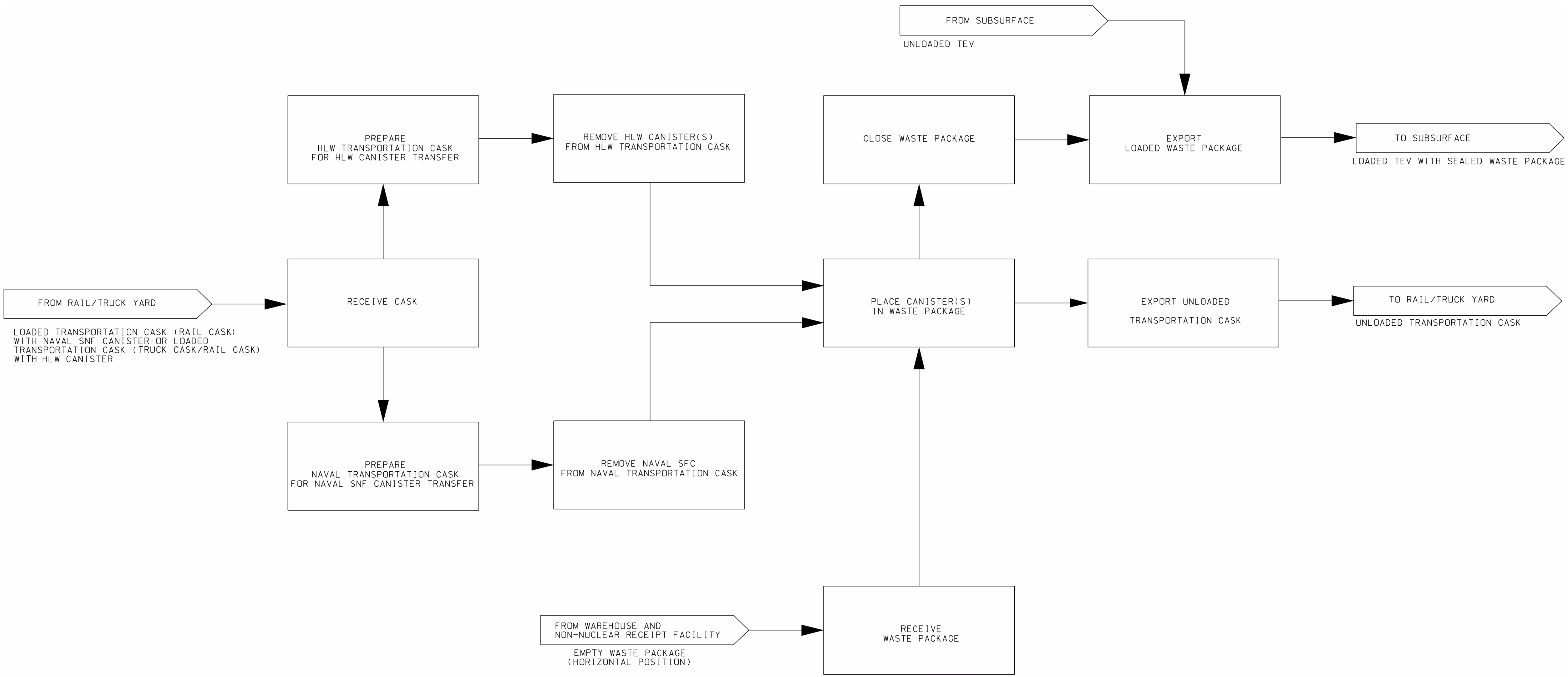

NOTE: SFC = spent fuel canister.

Figure 1.2.3-17. IHF Major Waste Processing Functions

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-16.

NOTE: This figure is an example representing the number of waste forms that could be present in the facility at any one time. It does not define limits on number of waste forms that may be present in specific areas of the facility.

Figure 1.2.3-18. Waste Form Inventory Present Within IHF at Any One Time

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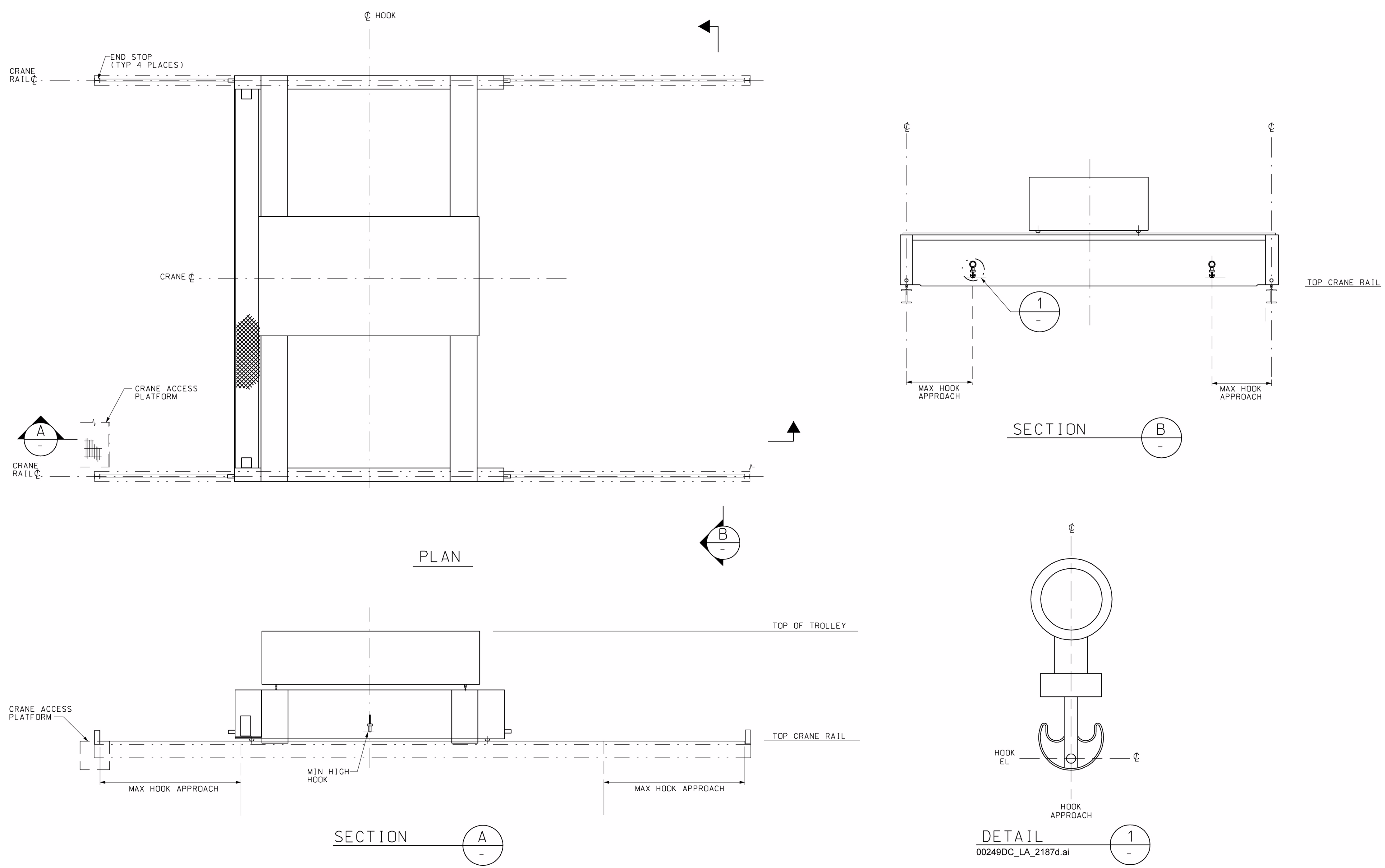

Equipment Number: 51A-HM00-CRN-00001, cask handling crane.

Figure 1.2.3-19. IHF Cask Handling Crane Mechanical Equipment Envelope

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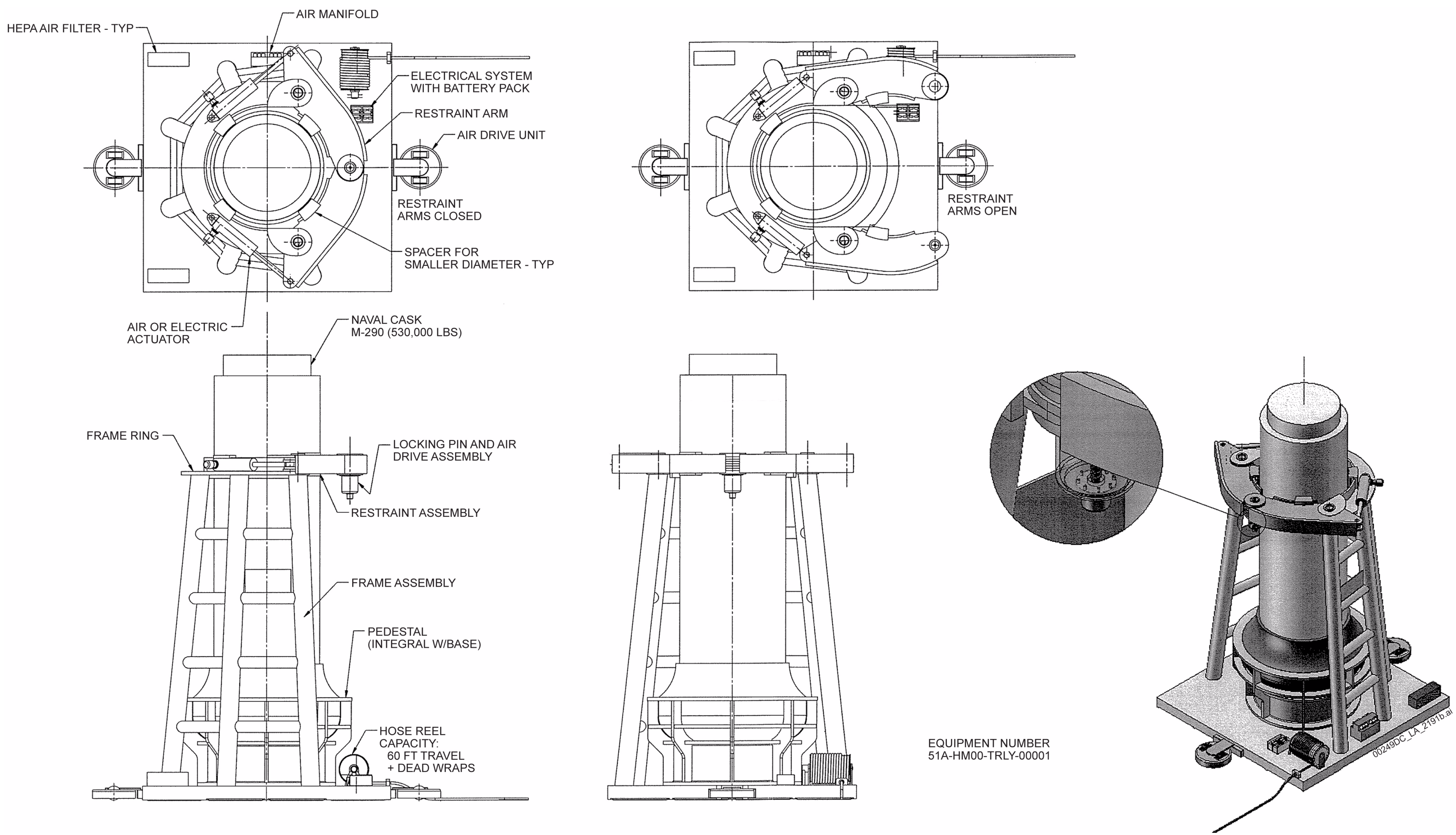

Figure 1.2.3-20. Cask Transfer Trolley Mechanical Equipment Envelope

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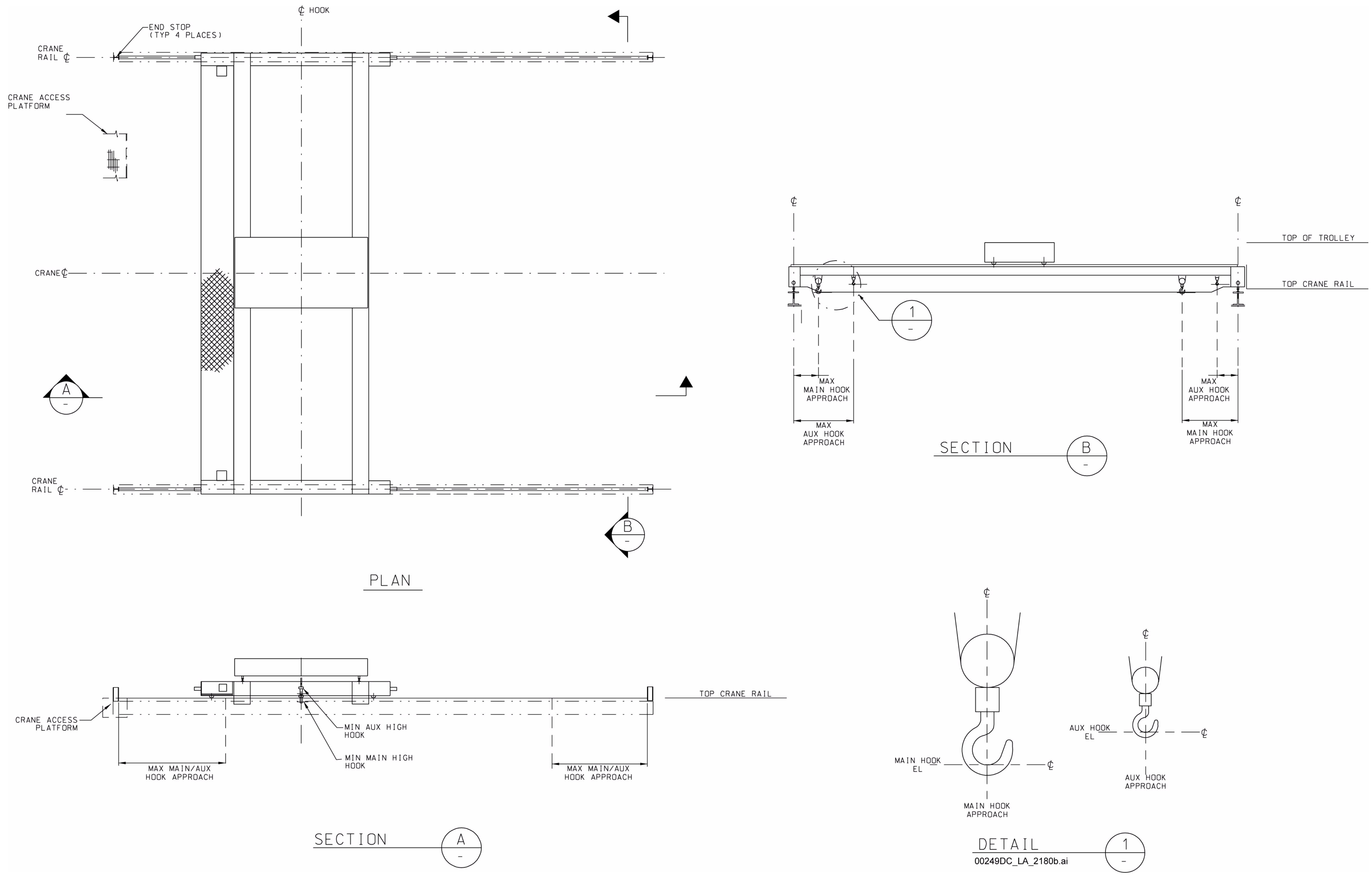

Equipment Number: 51A-HM00-CRN-00002, cask preparation crane.

Figure 1.2.3-21. Cask Preparation Crane Mechanical Equipment Envelope

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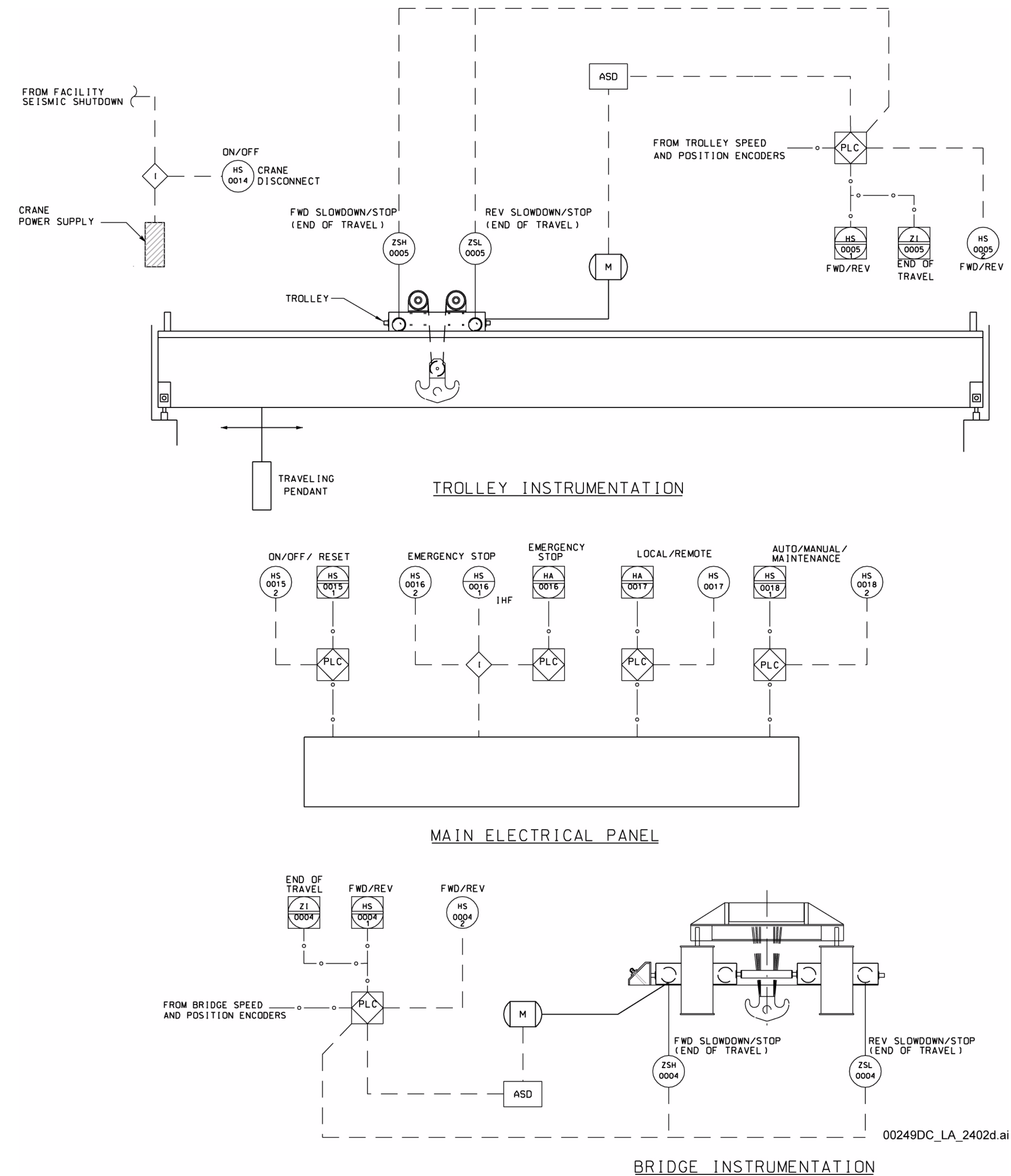

Equipment Number: 51A-HM00-CRN-00002, cask preparation crane.

Figure 1.2.3-22. Cask Preparation Crane Process and Instrumentation Diagram (Sheet 1 of 3)

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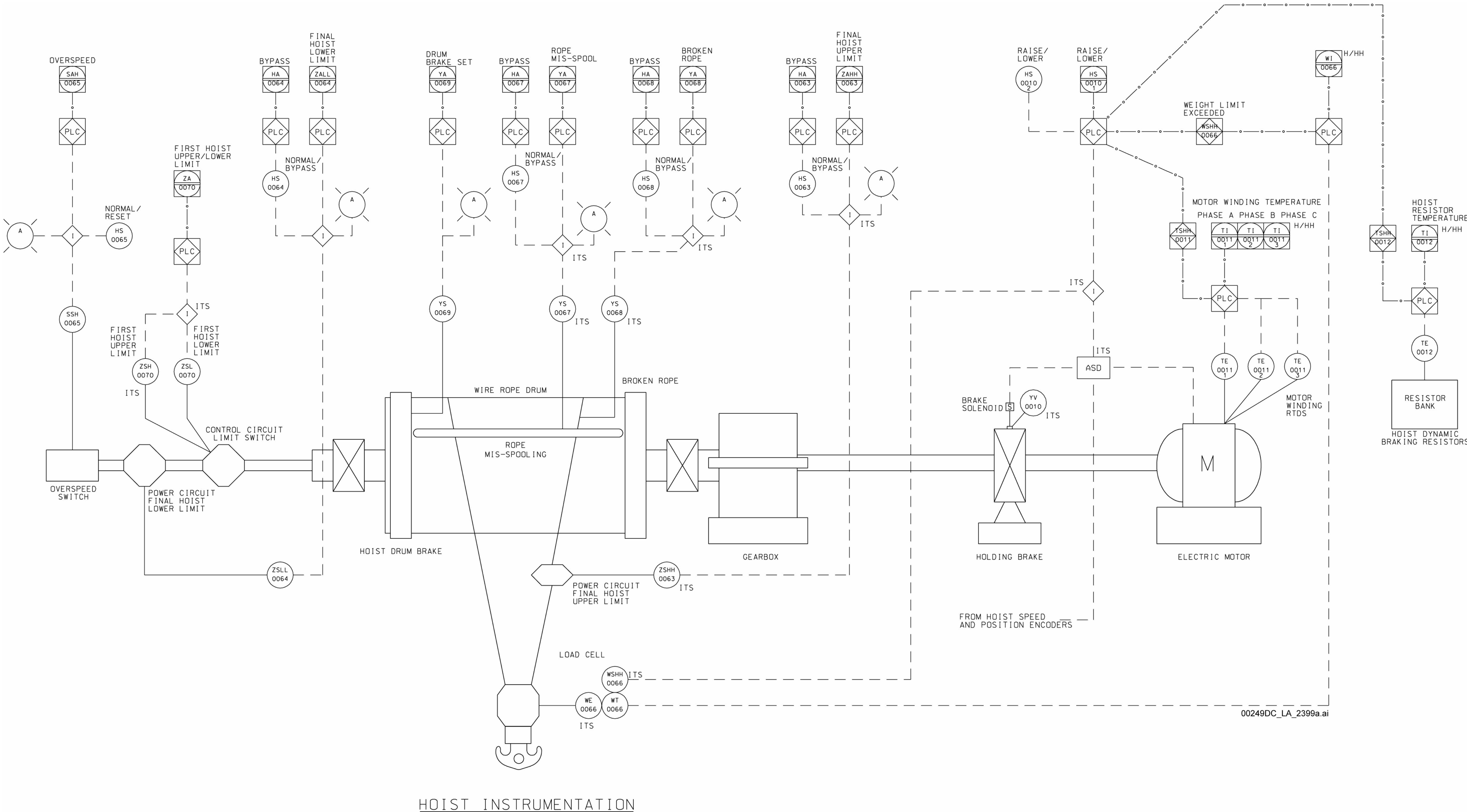

Figure 1.2.3-22. Cask Preparation Crane Process and Instrumentation Diagram (Sheet 2 of 3)

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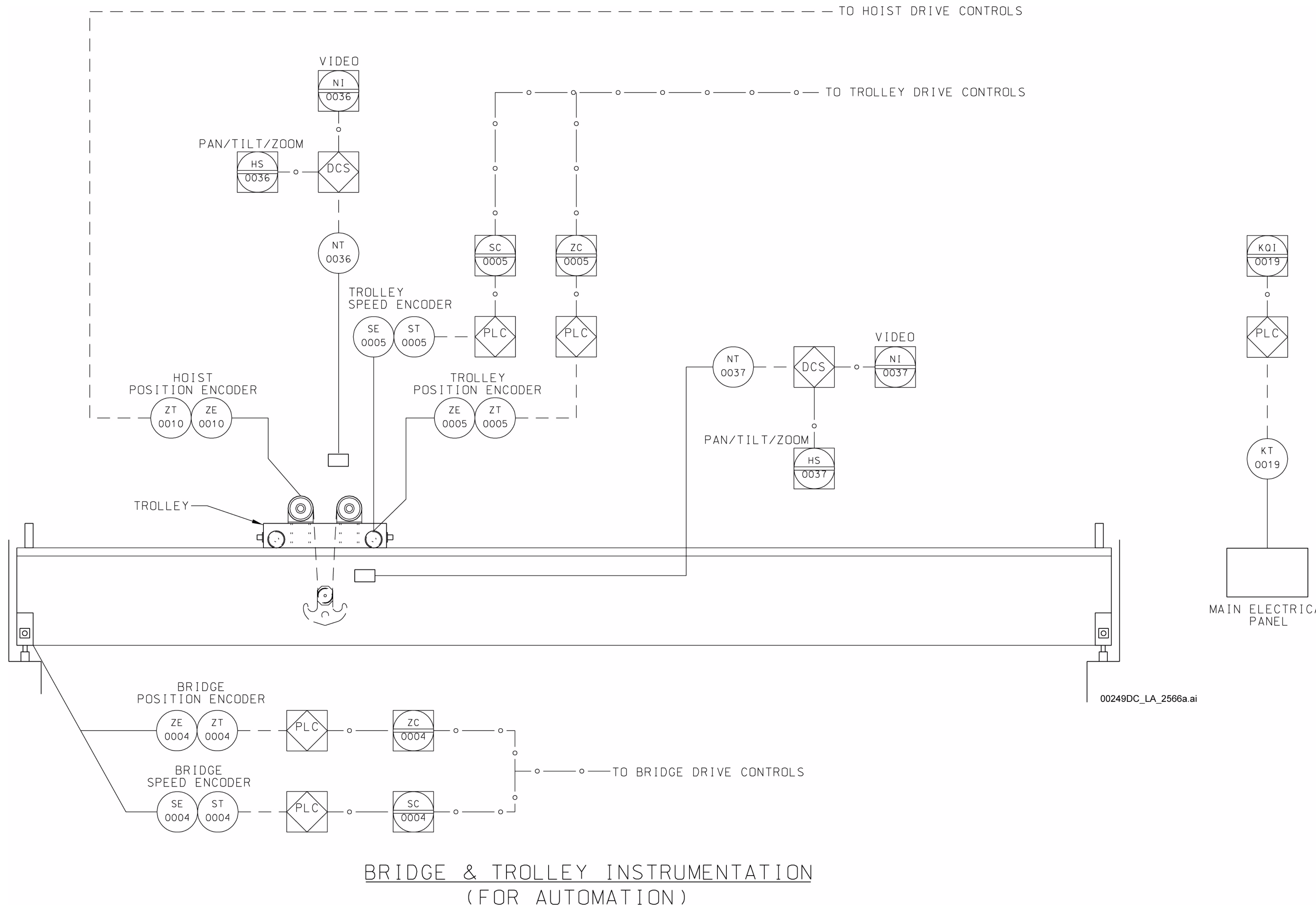

Figure 1.2.3-22. Cask Preparation Crane Process and Instrumentation Diagram (Sheet 3 of 3)

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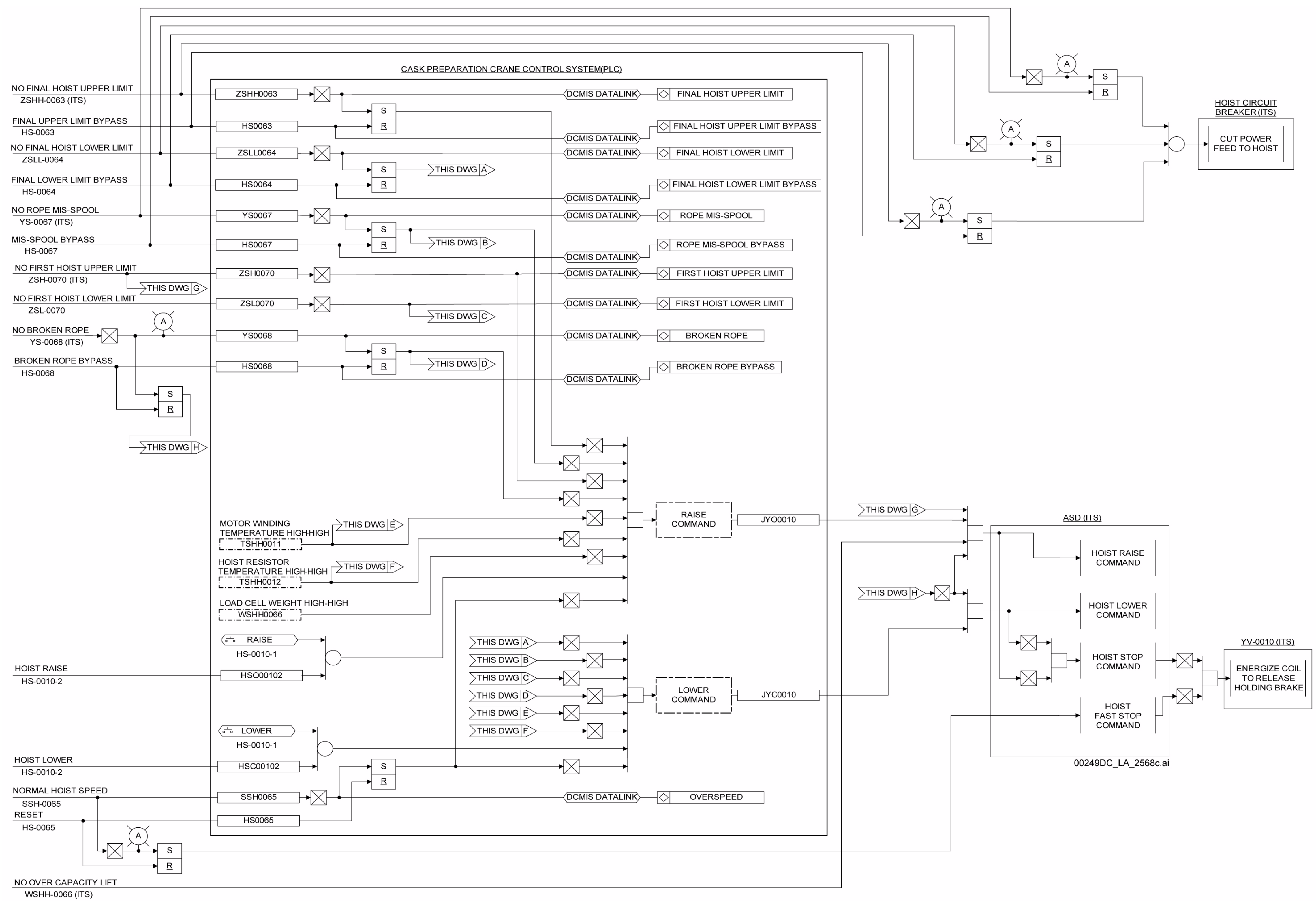

NOTE: Important to safety controls are identified by the letters "ITS" after the instrumentation tag number or control device identifier. The cask preparation crane control system, which controls the hoist, is non-ITS and non-ITWI. Simultaneous remote and local control is prevented by means of a "local/remote" selector switch associated with the cask preparation crane controls. Instrumentation tag numbers are prefixed by "51A-HM00." Software tag numbers are prefixed by "51AHM00." ASD = adjustable speed drive.

Figure 1.2.3-23. Logic Diagram for the Cask Preparation Crane Hoist

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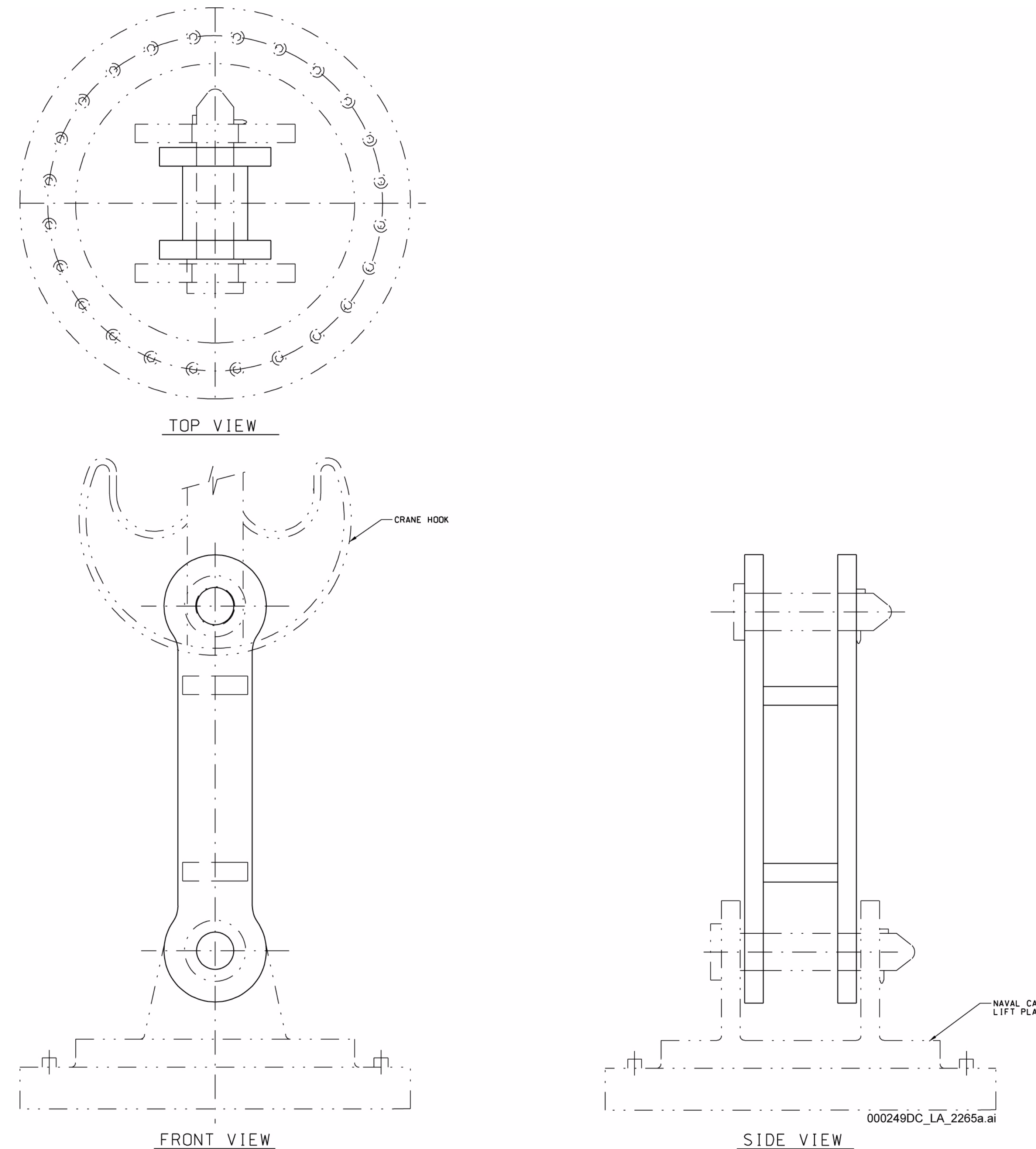

Figure 1.2.3-24. Naval Cask Lift Bail Mechanical Equipment Envelope

Equipment Number: 51A-HMC0-BEAM-00001, naval cask lift bail.

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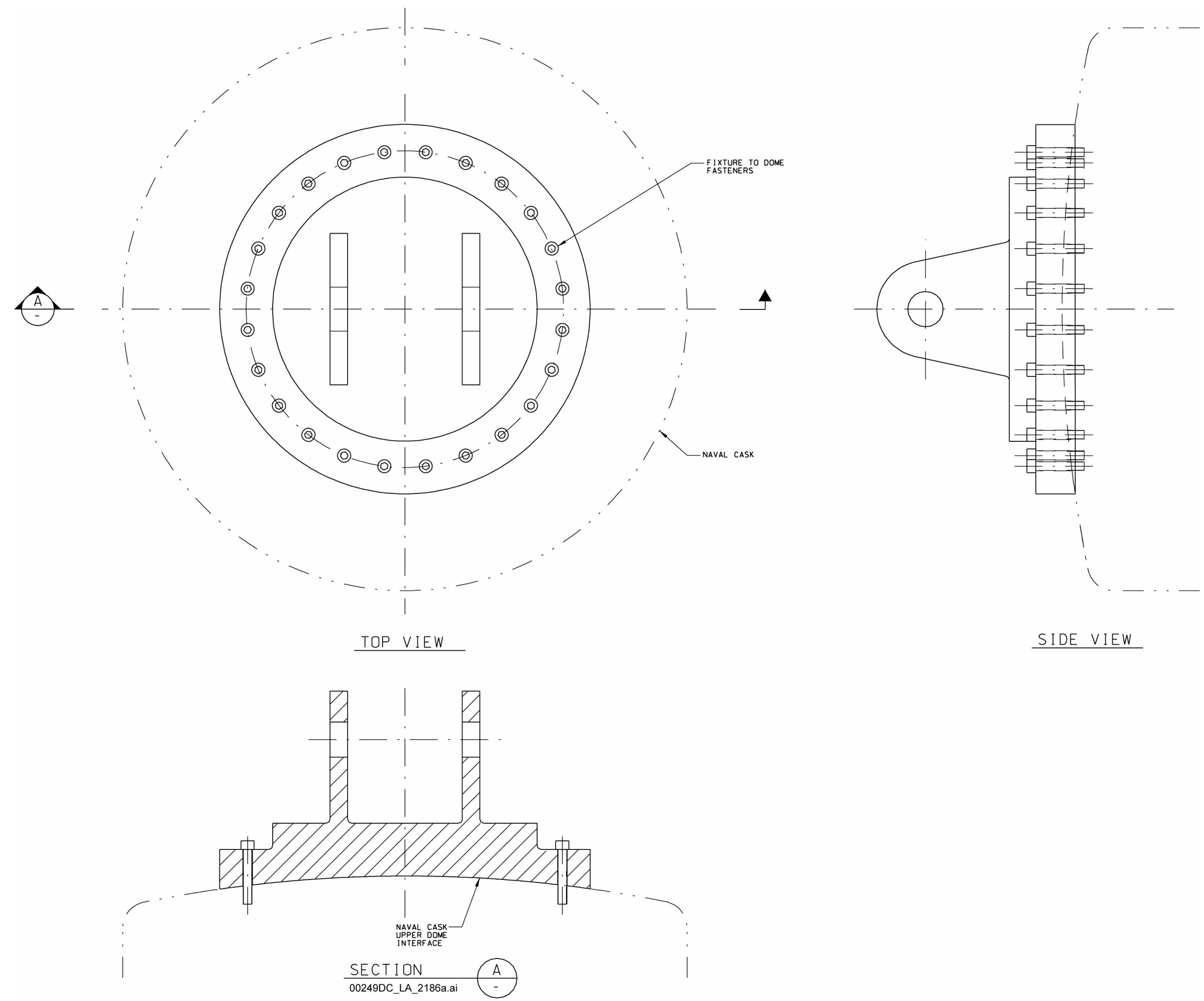

Equipment Number: 51A-HMC0-HEQ-00005, naval cask lift plate.

Figure 1.2.3-25. Naval Cask Lift Plate Mechanical Equipment Envelope

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-17.

Equipment Number: 51A-HMH0-PLAT-00001, cask preparation platform.

Figure 1.2.3-26. Cask Preparation Platform Mechanical Equipment Envelope (Sheet 1 of 2)

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-17.

Figure 1.2.3-26. Cask Preparation Platform Mechanical Equipment Envelope (Sheet 2 of 2)

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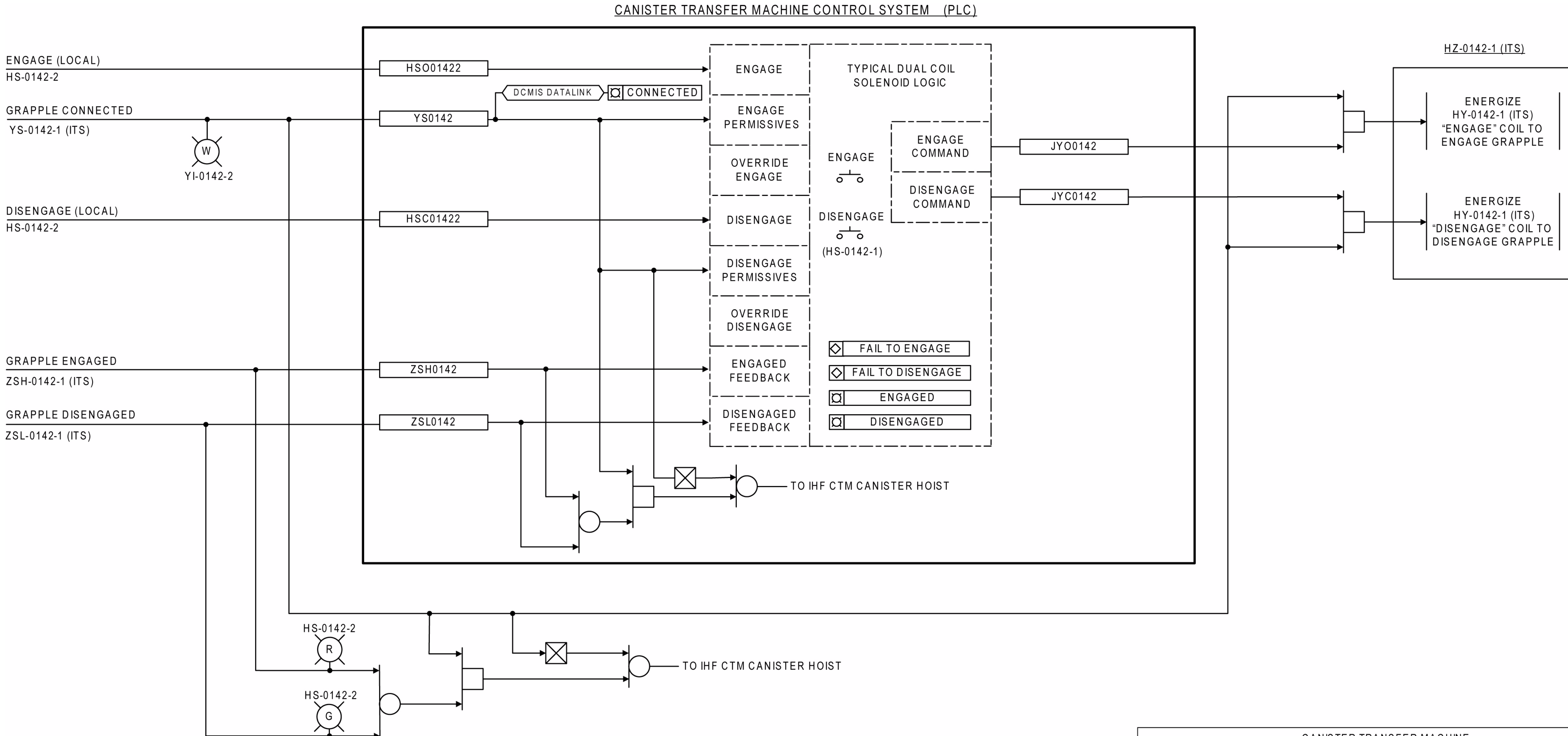

EQUIPMENT	EQUIPMENT NUMBER	CONNECTED LIMIT SW	DISENGAGED LIMIT SW	ENGAGED LIMIT SW	GRAPPLE ACTUATOR	ACTUATOR SOLENOID	CANISTER TRANSFER MACHINE					
							DCMIS HANDSWITCH	LOCAL HANDSWITCH	LOGIC INPUT ENGAGE	LOGIC INPUT DISENGAGE	LOGIC OUTPUT ENGAGE	LOGIC OUTPUT DISENGAGE
DOE WP INNER LID GRAPPLE	51A-HTC0-HEQ-00007	YS-0142-1 (ITS)	ZSL-0142-1 (ITS)	ZSH-0142-1 (ITS)	HZ-0142-1 (ITS)	HY-0142-1 (ITS)	HS-0142-1	HS-0142-2	HSO01422	HSC01422	JYO0142	JYC0142
NAVAL WP INNER LID GRAPPLE	51A-HTC0-HEQ-00008	YS-0142-2 (ITS)	ZSL-0142-2 (ITS)	ZSH-0142-2 (ITS)	HZ-0142-2 (ITS)	HY-0142-2 (ITS)						

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NOTE: Important to safety controls are identified by the letters "ITS" after the instrumentation tag number or control device identifier. The canister transfer machine controls system, which controls the waste package inner lid grapple, is non-ITS and non-ITWI. Simultaneous DCMIS and local control is prevented by means of a "local/remote" selection switch associated with the waste package inner lid grapple controls. Instrumentation tag numbers are prefixed by "51A-HTC0-" and software tag numbers are prefixed by "51AHTC0."
CTM = canister transfer machine; PLC = programmable logic controller; WP = waste package.

Figure 1.2.3-27. Logic Diagram for the Canister Transfer Machine Waste Package Inner Lid Grapples

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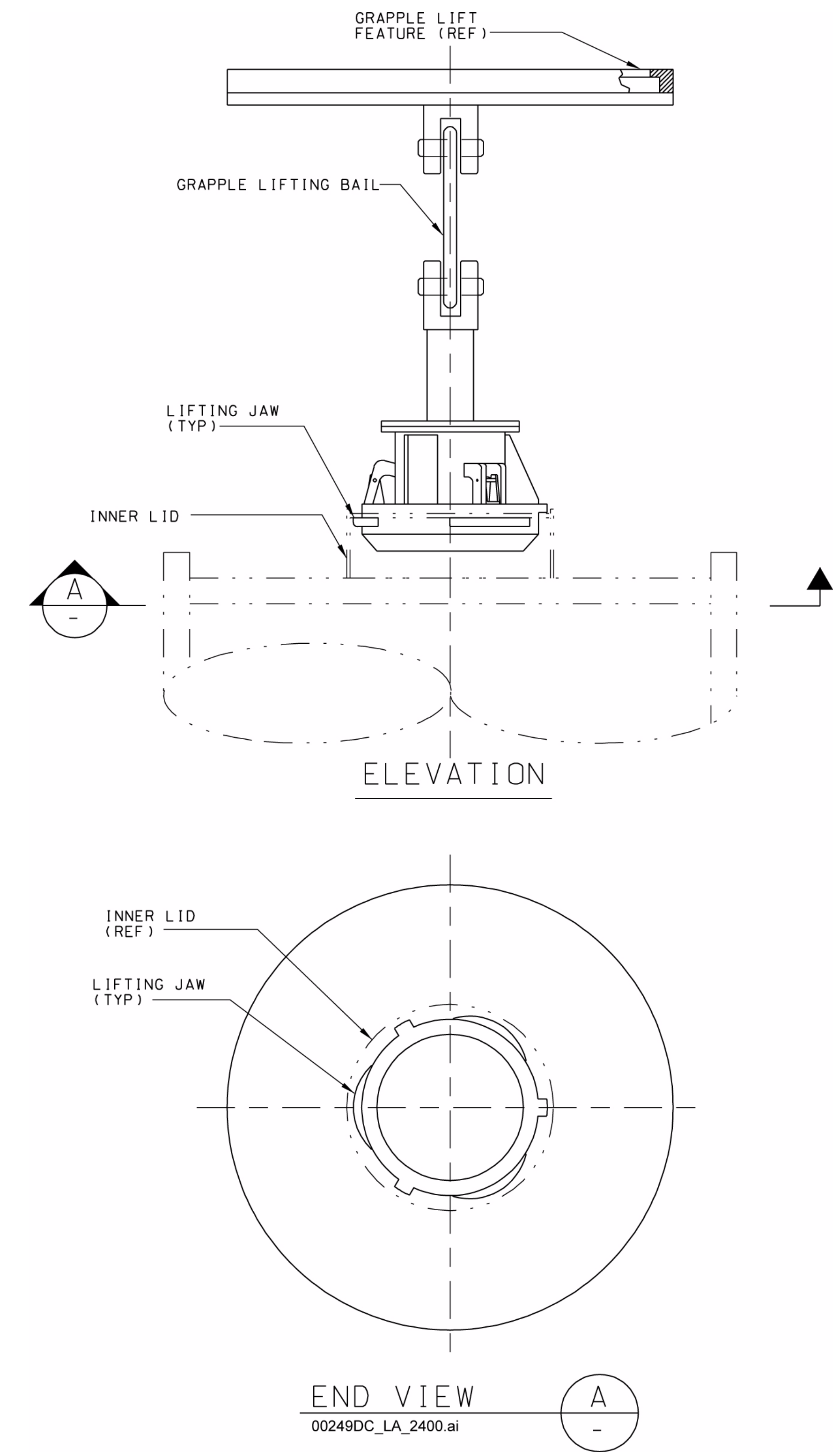

Figure 1.2.3-28. IHF DOE Waste Package Inner Lid Grapple Mechanical Equipment Envelope

Equipment Number: 51A-HTC0-HEQ-00007, IHF DOE waste package inner lid grapple.

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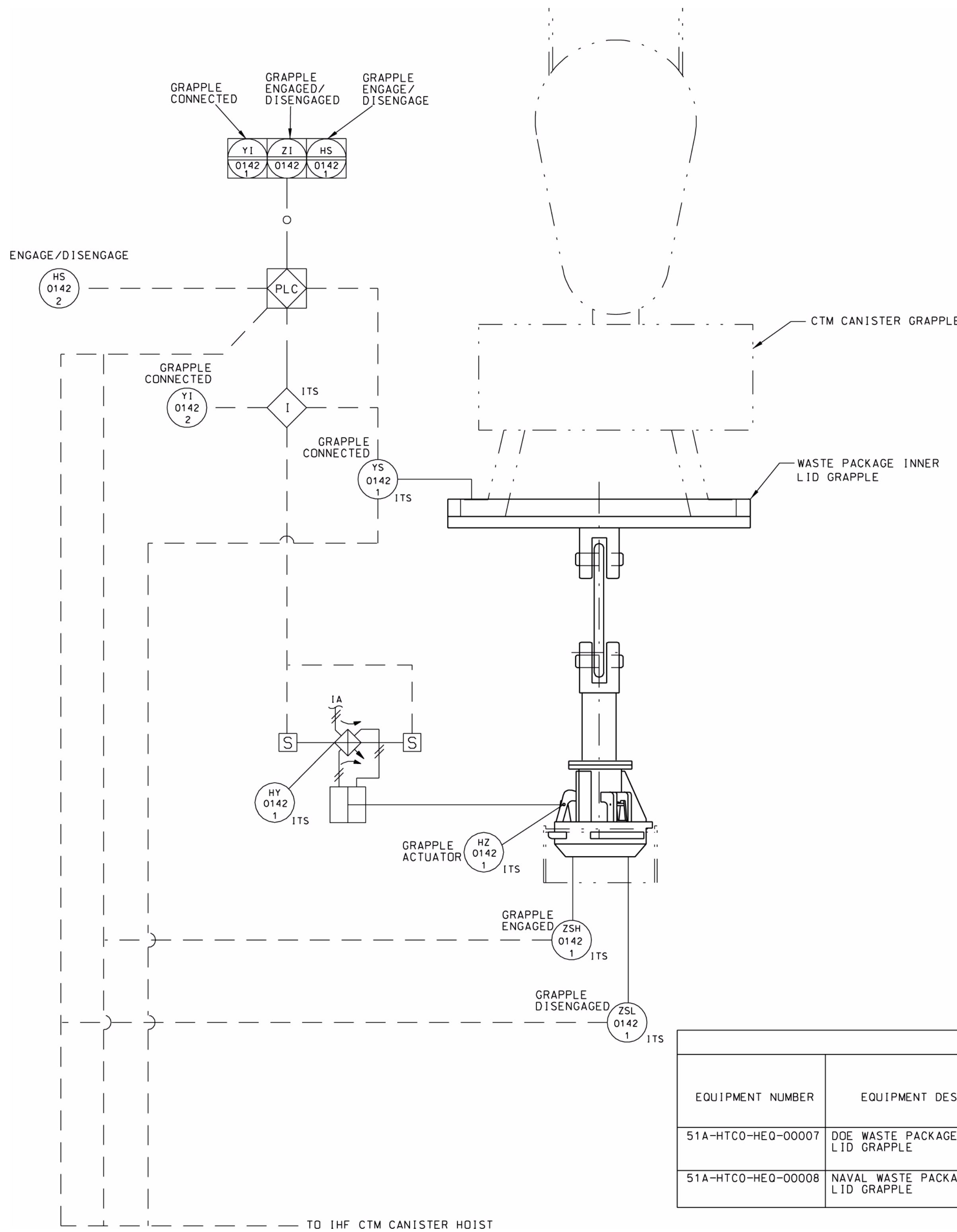

EQUIPMENT AND INSTRUMENTATION TABLE												
				STATUS SWITCHES			CANISTER TRANSFER MACHINE					
							DCMIS HAND SWITCH	DCMIS INDICATORS		LOCAL HAND SWITCH	LOCAL CONNECTED INDICATOR
EQUIPMENT NUMBER	EQUIPMENT DESCRIPTION	GRAPPLE ACTUATOR	ACTUATOR SOLENOID	CONNECTED	ENGAGED	DISENGAGED		GRAPPLE CONNECTED	ENGAGED/ DISENGAGED		
51A-HTC0-HEQ-00007	DOE WASTE PACKAGE INNER LID GRAPPLE	HZ-0142-1 (ITS)	HY-0142-1 (ITS)	YS-0142-1 (ITS)	ZSH-0142-1 (ITS)	ZSL-0142-1 (ITS)	HS-0142-1	YI-0142-1	ZI-0142	HS-0142-2	YI-0142-2
51A-HTC0-HEQ-00008	NAVAL WASTE PACKAGE INNER LID GRAPPLE	HZ-0142-2 (ITS)	HY-0142-2 (ITS)	YS-0142-2 (ITS)	ZSH-0142-2 (ITS)	ZSL-0142-2 (ITS)					

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Figure 1.2.3-29. IHF DOE and Naval Waste Package Inner Lid Grapple Process and Instrumentation Diagram

NOTE: CTM = canister transfer machine.

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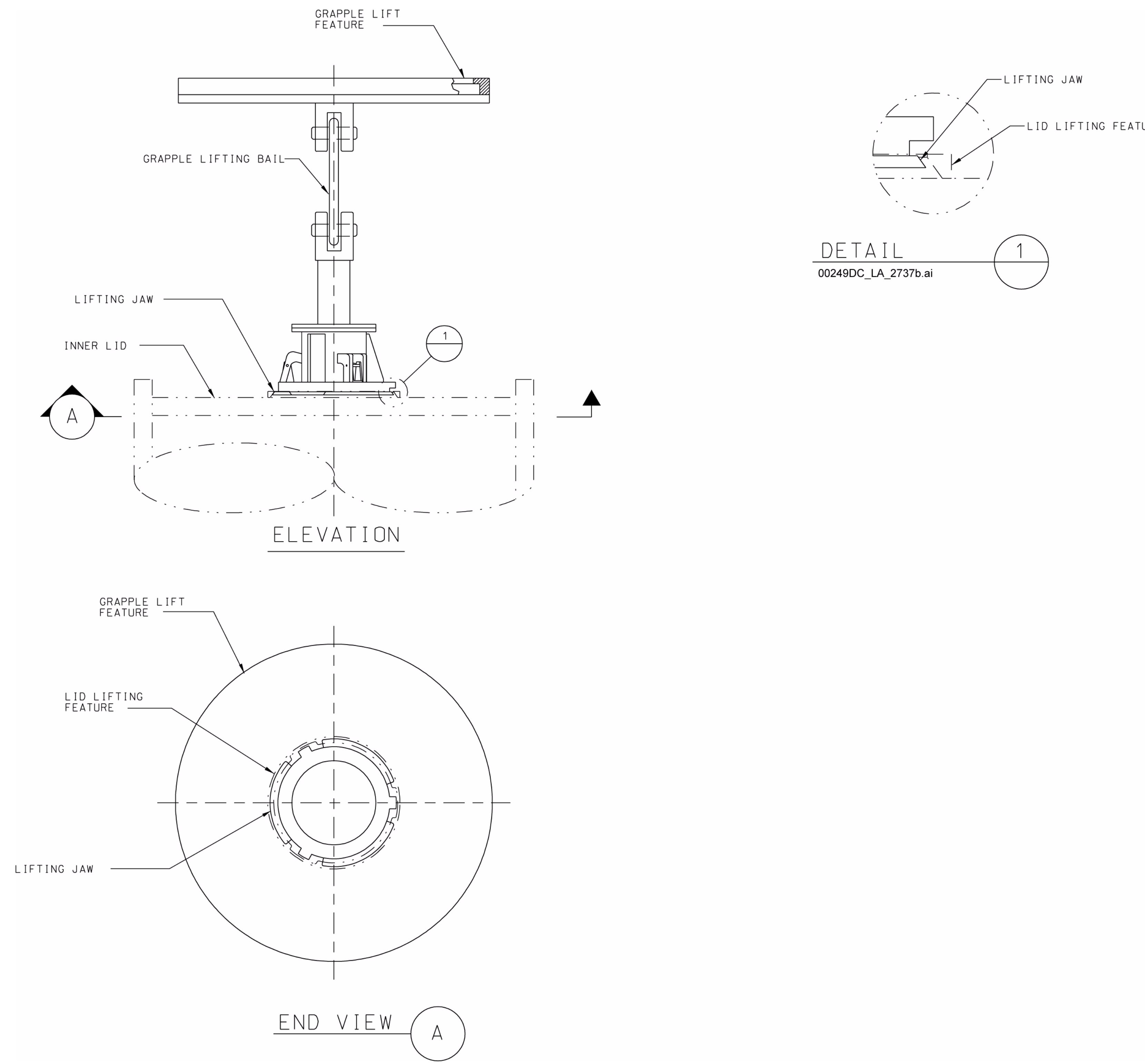

Figure 1.2.3-30. IHF Naval Waste Package Inner Lid Grapple Mechanical Equipment Envelope

Equipment Number: 51A-HTC0-HEQ-00008, IHF naval waste package inner lid grapple.

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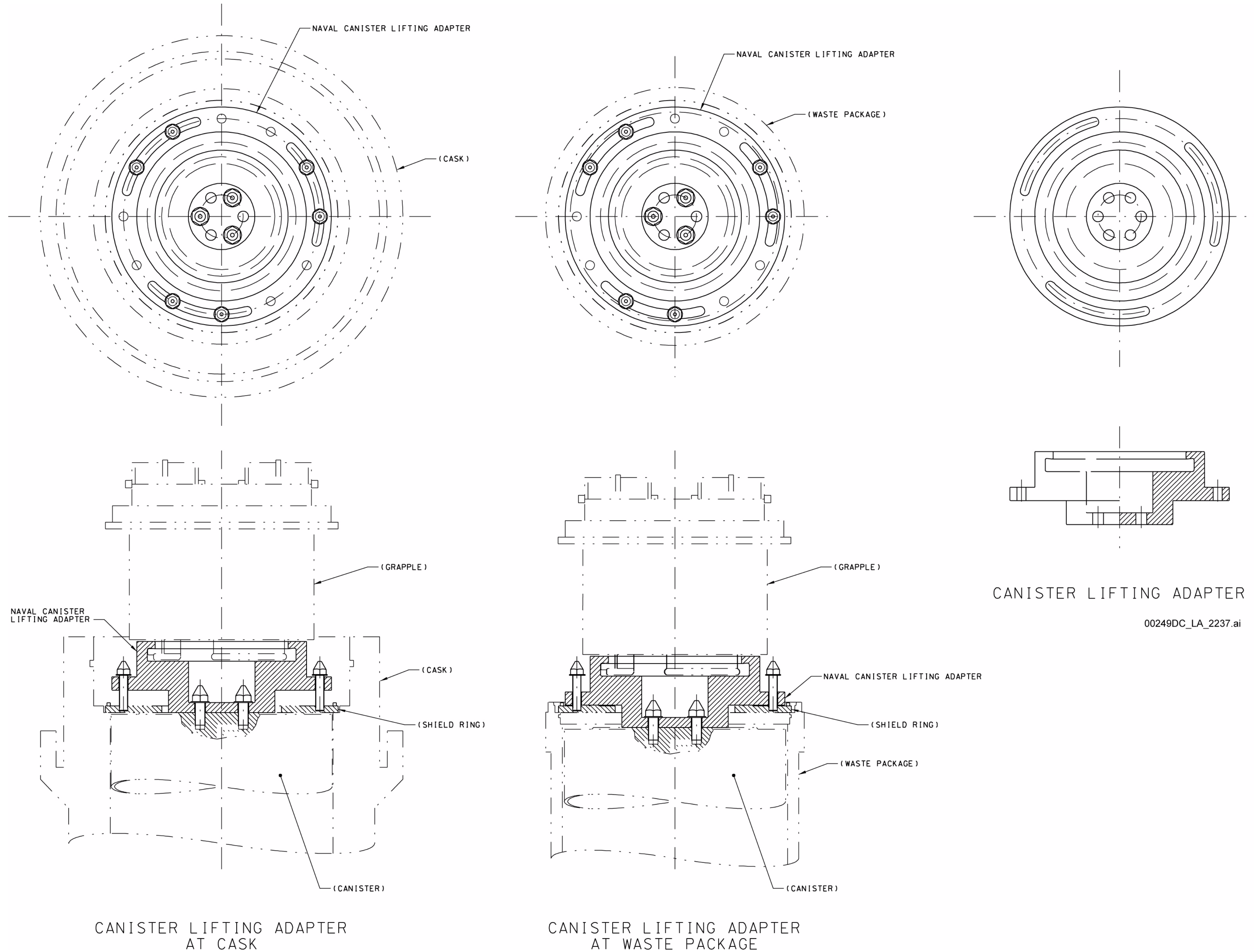

Equipment Number: 51A-HTC0-HEQ-00005, naval canister lifting adapter.

Figure 1.2.3-31. Naval Canister Lifting Adapter Mechanical Equipment Envelope

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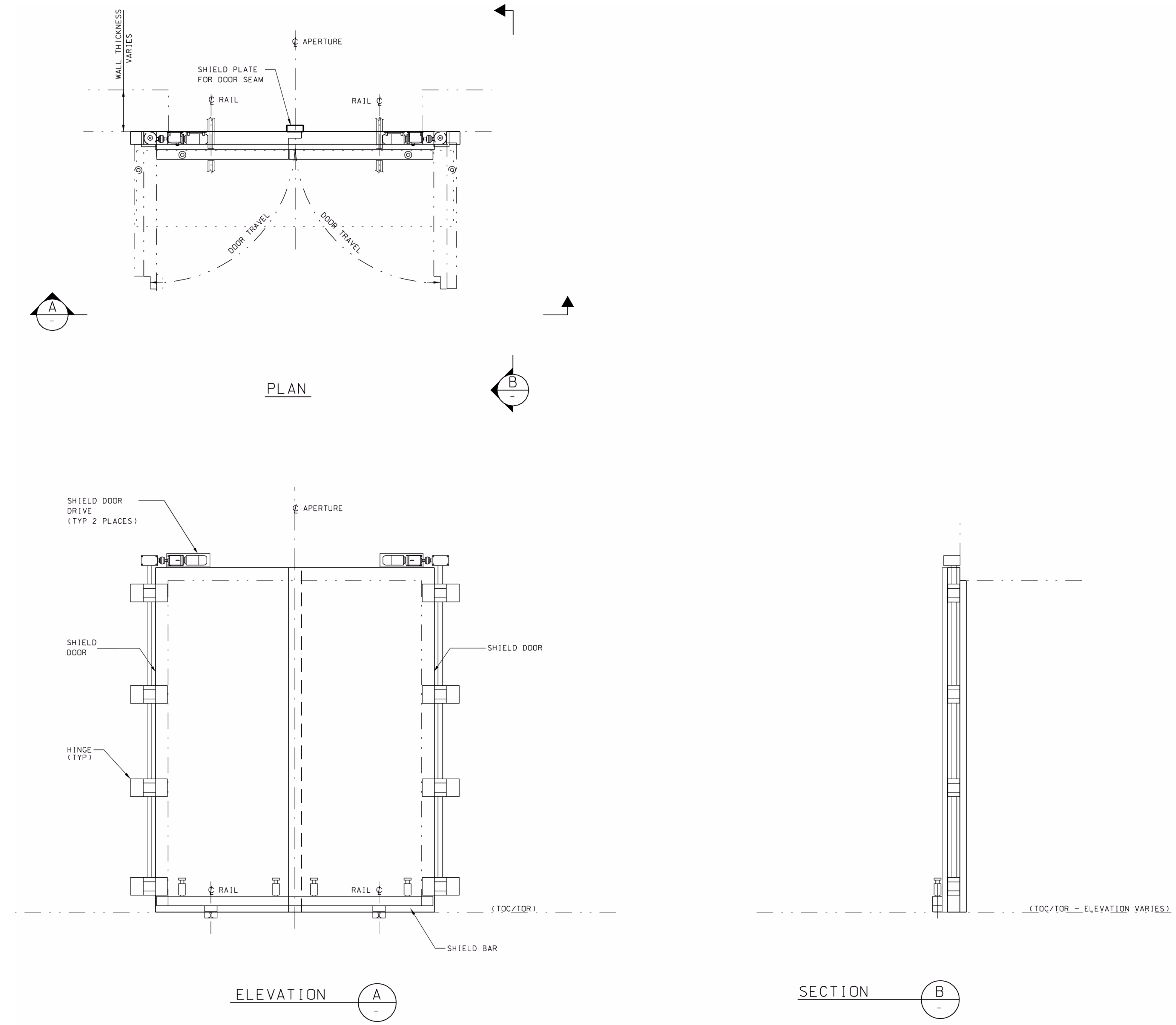

Figure 1.2.3-32. Waste Package Positioning Room Equipment Shield Door (Type 3) Mechanical Equipment Envelope

Equipment Number: 51A-IH00-DR-00003, waste package positioning room equipment shield door.

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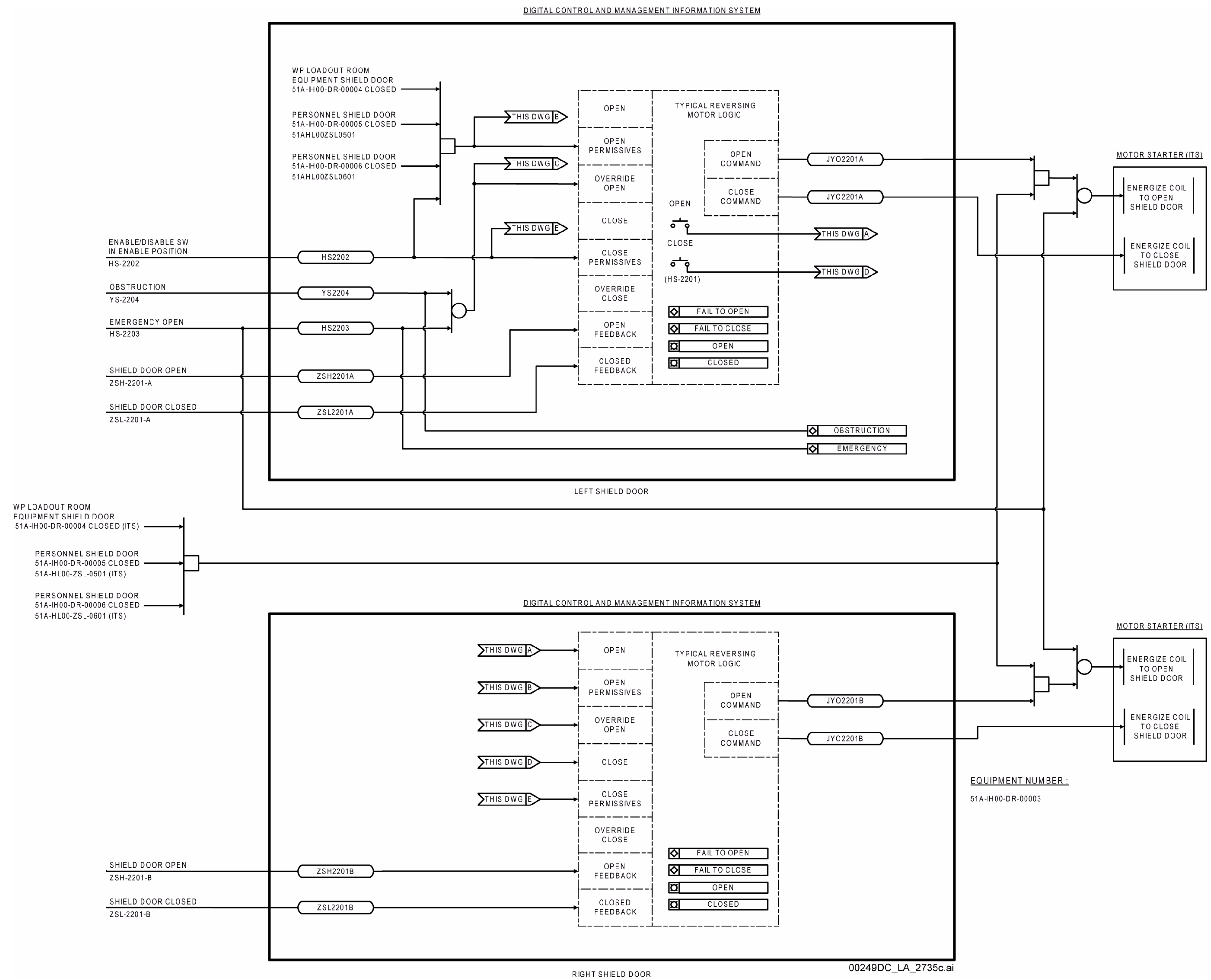

NOTE: Important to safety controls are identified by the letters “ITS” after the instrumentation tag number or control device identifier. The DCMIS is non-ITS and non-ITWI. Instrumentation tag numbers are prefixed by “51A-HW00-” and software tag numbers are prefixed by “51AHW00.”

Figure 1.2.3-33. IHF Waste Package Positioning Room Equipment Shield Door Digital Logic Diagram

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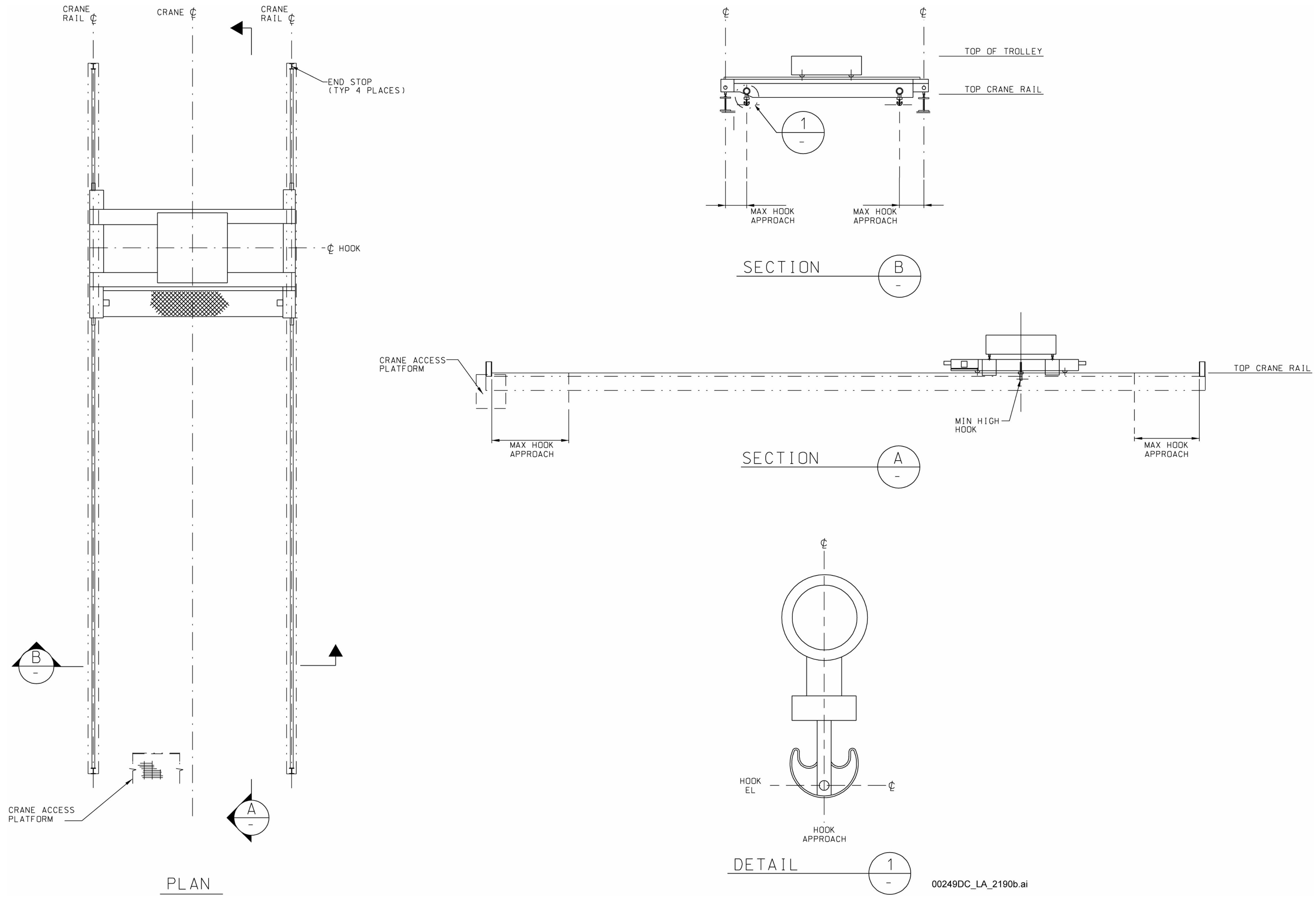

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51 A-HW00-CRN-00001, waste package closure room crane.

Figure 1.2.3-34. Waste Package Closure Room Crane Mechanical Equipment Envelope

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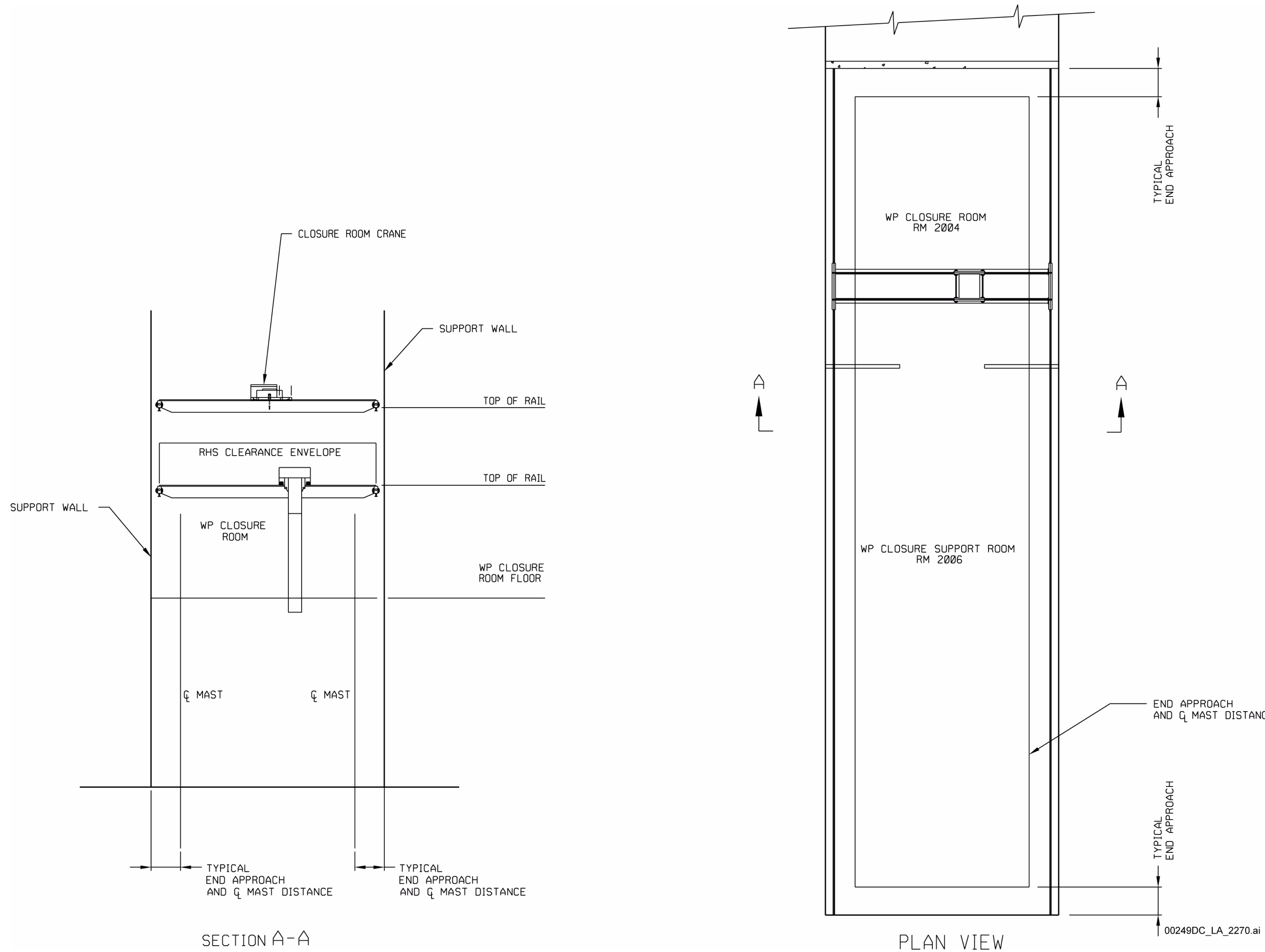

NOTE: WP = waste package.

Equipment Number: 51A-HWH0-HEQ-00003, remote handling system.

Figure 1.2.3-35. IHF Waste Package Closure Room Remote Handling System Mechanical Equipment Envelope

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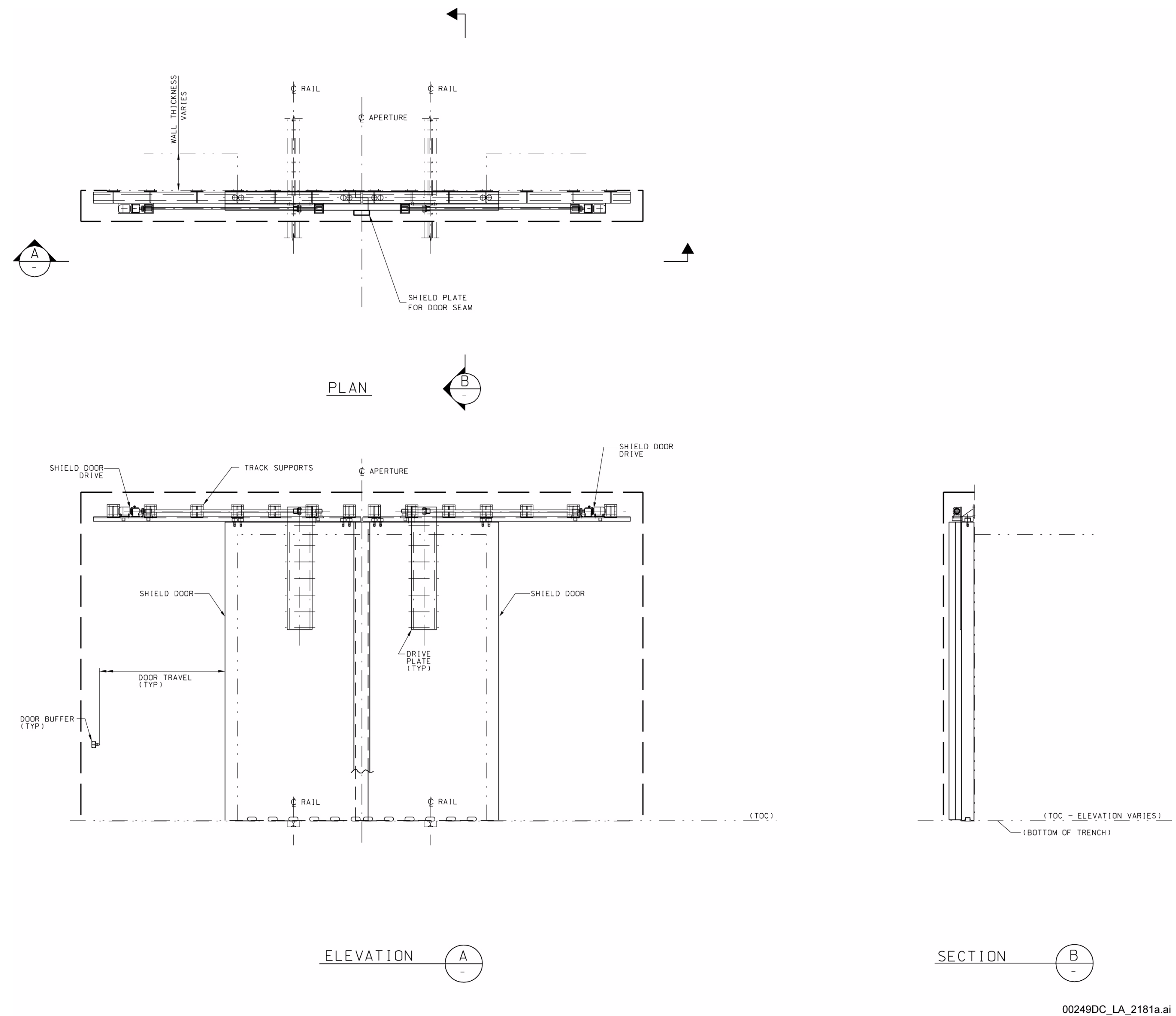

Equipment Number: 51A-IH00-DR-00004, IHF waste package loadout room equipment shield door (type 2); 200-RF00-DR-00002, RF loading room equipment shield door.

Figure 1.2.3-36. IHF and RF Waste Package Loadout Room Equipment Shield Door (Type 2)

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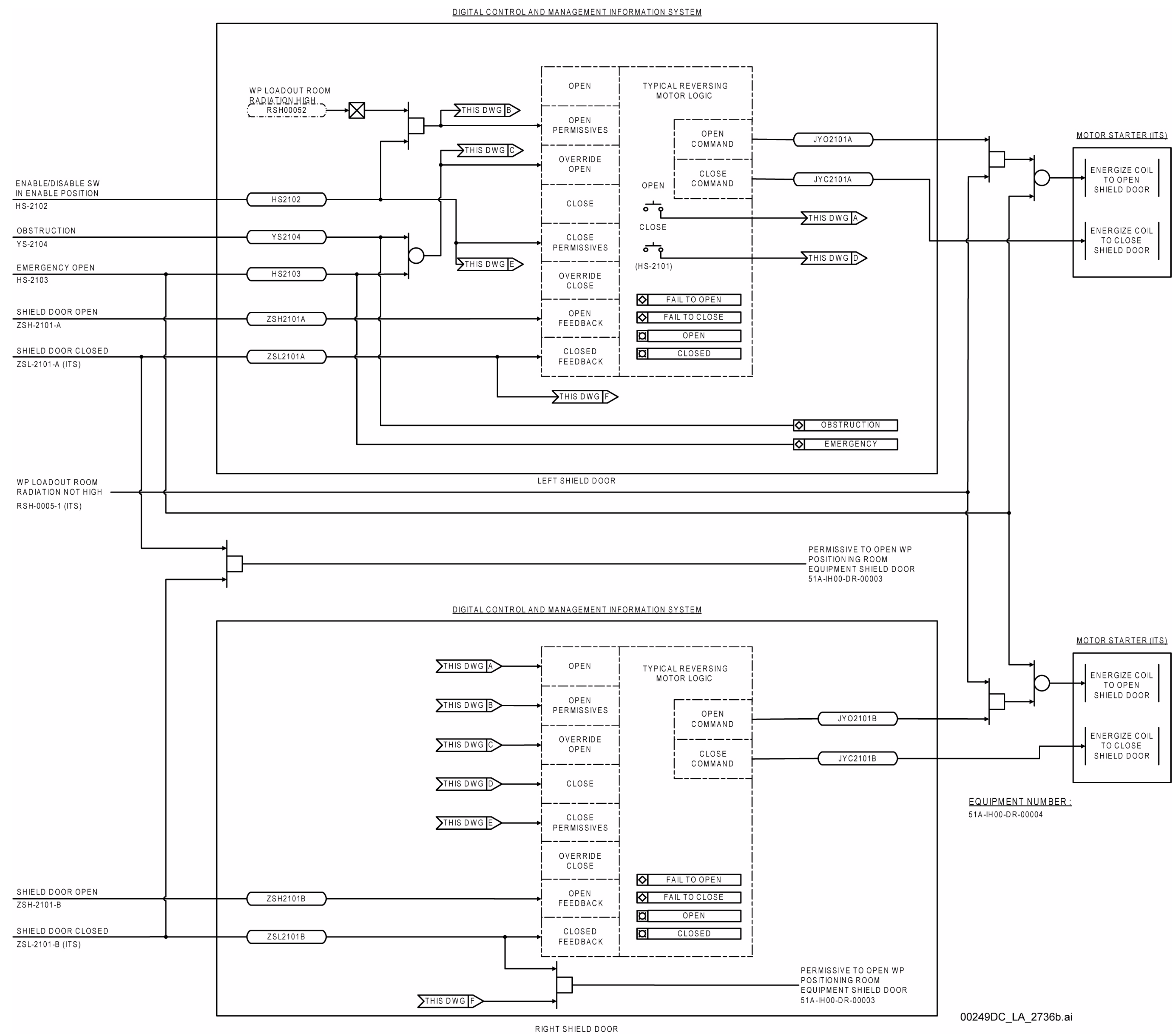

NOTE: Important to safety controls are identified by the letters “ITS” after the instrumentation tag number or control device identifier. The DCMIS is non-ITS and non-ITWI. Instrumentation tag numbers are prefixed by “51A-HL00-” and software tag numbers are prefixed by “51AHL00.” WP = waste package.

Figure 1.2.3-37. IHF Waste Package Loadout Room Equipment Shield Door Logic Diagram

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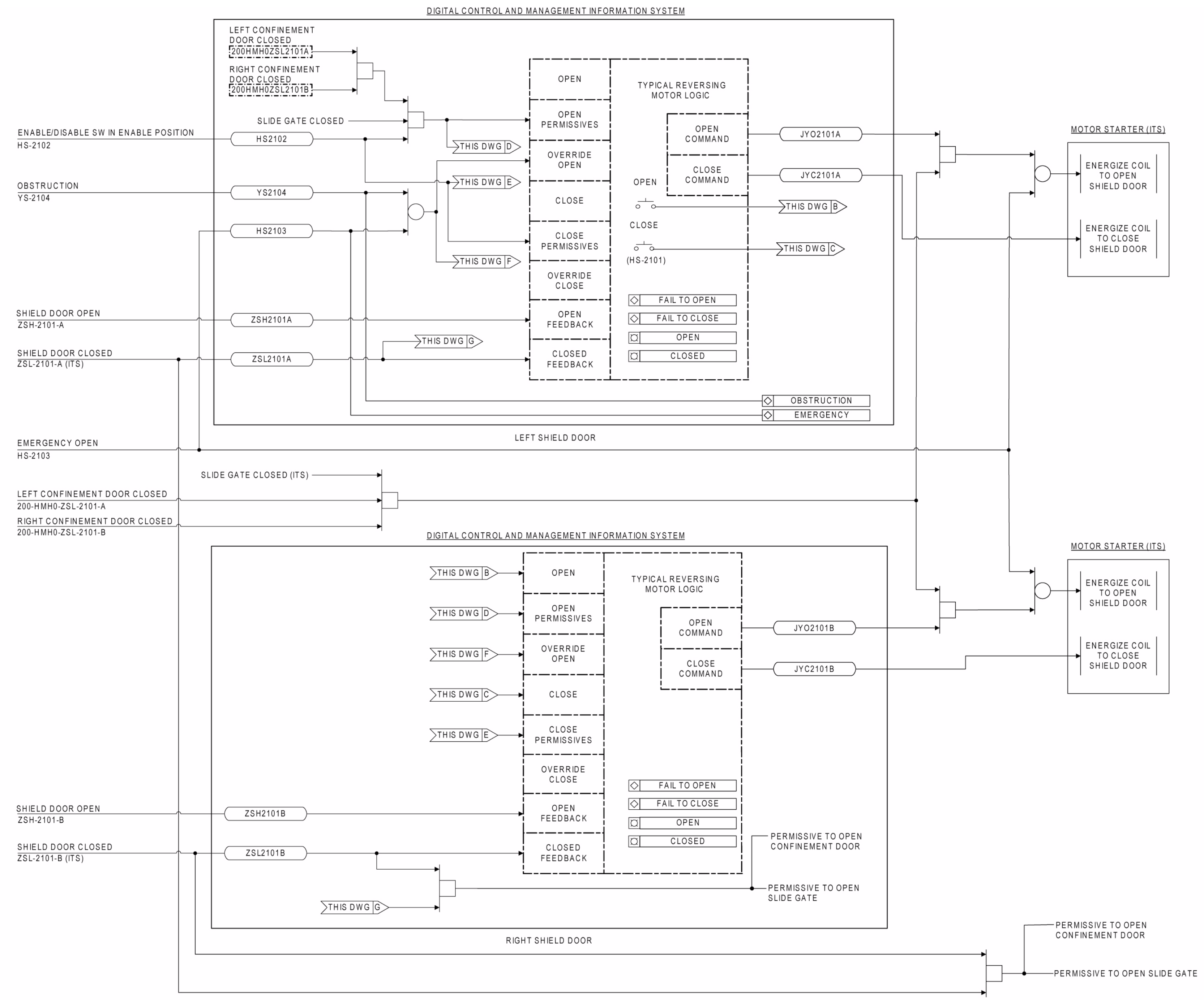

FACILITY NAME	AREA CODE	SYSTEM CODE	SHIELD DOOR EQUIPMENT NUMBER	OPEN/CLOSE HANDSWITCH	ENABLE/ DISABLE SW	EMERGENCY OPEN SW	OBSTRUCTION SW	OPEN LIMIT SW		CLOSED LIMIT SW		LOGIC OUTPUT OPEN		LOGIC OUTPUT CLOSE		INTERFACING SLIDE GATE EQUIPMENT NUMBER	INTERFACING CONFINEMENT DOOR		
								LEFT DOOR	RIGHT DOOR	LEFT DOOR	RIGHT DOOR	LEFT DOOR	RIGHT DOOR	LEFT DOOR	RIGHT DOOR		EQUIPMENT NUMBER	LEFT DOOR CLOSED LIMIT SW	RIGHT DOOR CLOSED LIMIT SW
RECEIPT FACILITY	200	HTC0	200-RF00-DR-00001	HS-2101	HS-2102	HS-2103	YS-2104	ZSH-2101-A	ZSH-2101-B	ZSL-2101-A (ITS)	ZSL-2101-B (ITS)	JYO2101A	JYO2101B	JYC2101A	JYC2101B	200-HTC0-HTCH-00001	200-RF00-DR-00003	200-HMH0-ZSL-2101-A	200-HMH0-ZSL-2101-B
			200-RF00-DR-00002	HS-2201	HS-2202	HS-2203	YS-2204	ZSH-2201-A	ZSH-2201-B	ZSL-2201-A (ITS)	ZSL-2201-B (ITS)	JYO2201A	JYO2201B	JYC2201A	JYC2201B	200-HTC0-HTCH-00002	N/A	N/A	N/A
INITIAL HANDLING FACILITY	51A	HW00	51A-IH00-DR-00002	HS-2101	HS-2102	HS-2103	YS-2104	ZSH-2101-A	ZSH-2101-B	ZSL-2101-A (ITS)	ZSL-2101-B (ITS)	JYO2101A	JYO2101B	JYC2101A	JYC2101B	51A-HTC0-HTCH-00002	N/A	N/A	N/A

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NOTE: This equipment is used in the IHF and RF. Important to safety controls are identified by the letters “ITS” after the instrumentation tag number or control device identifier. The DCMIS is non-ITS and non-ITWI. Instrumentation tag numbers are prefixed by “XXXYYYY-” and software tag numbers are prefixed by “XXXYYYY,” where XXX is the area code and YYYY is the system code.

Figure 1.2.3-38. IHF and RF Equipment Shield Door (Double) Logic Diagram

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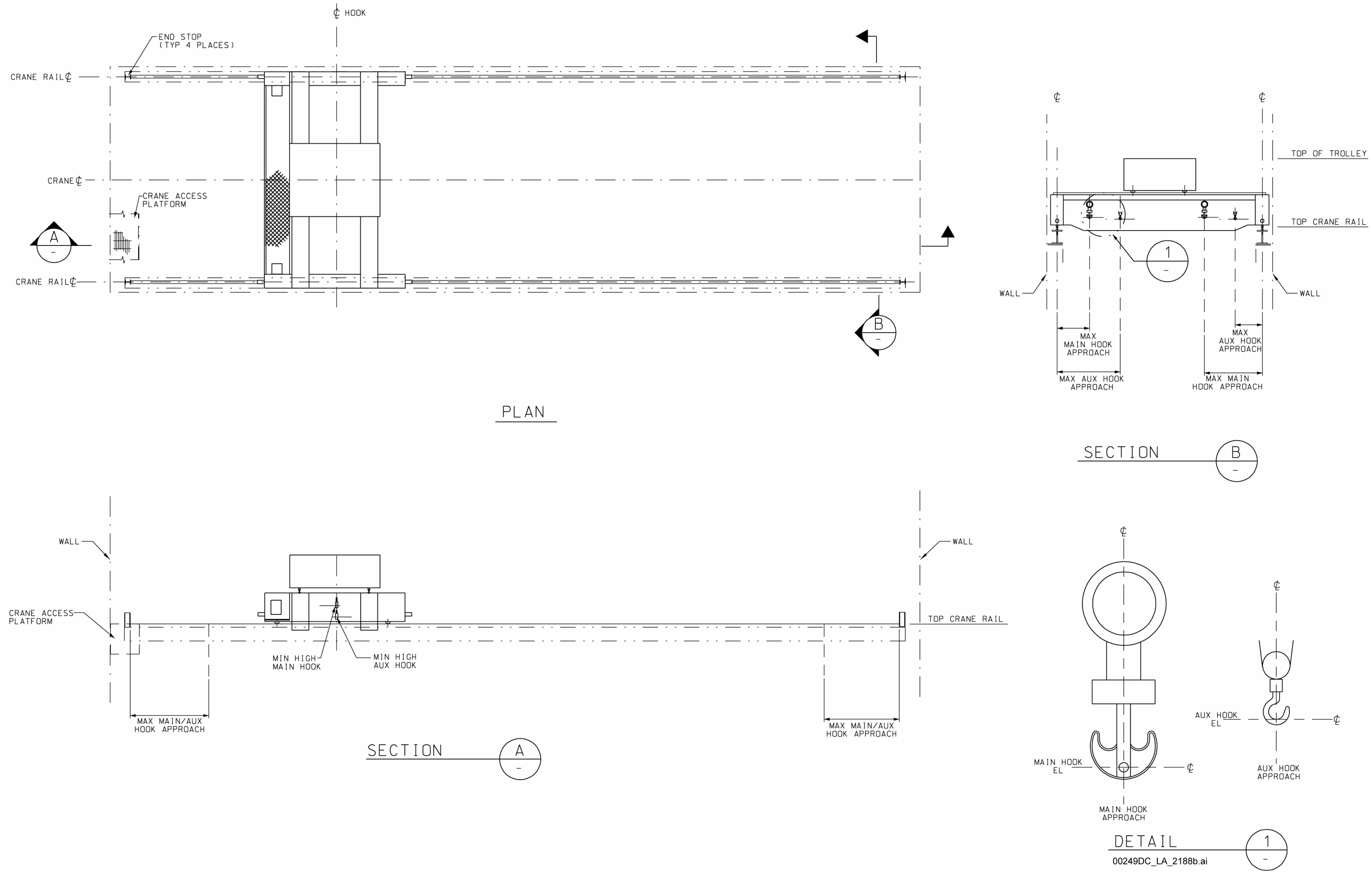

Equipment Number: 51A-HMP0-CRN-00001, waste package handling crane.

Figure 1.2.3-39. Waste Package Handling Crane Mechanical Equipment Envelope

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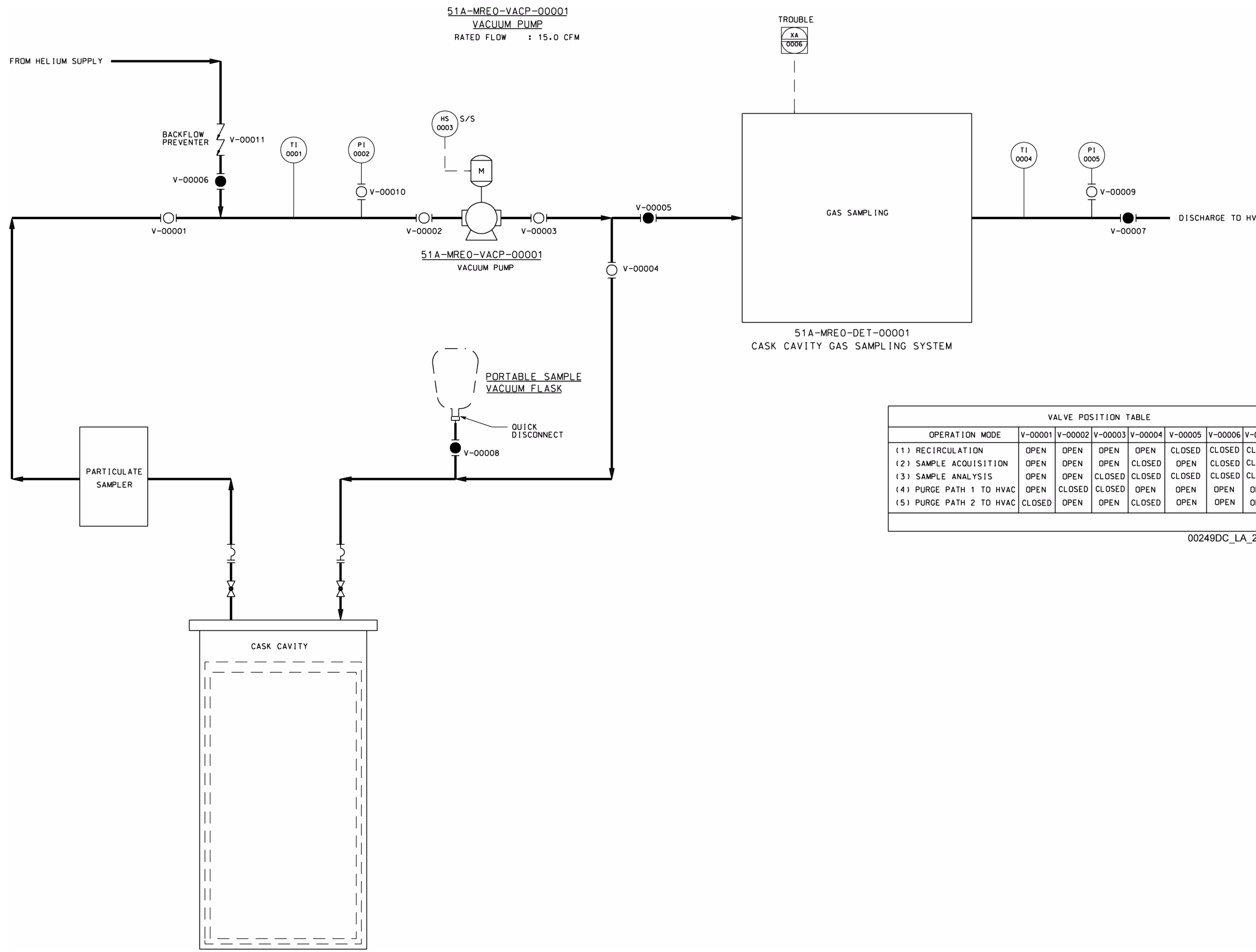

VALVE POSITION TABLE

OPERATION MODE	V-00001	V-00002	V-00003	V-00004	V-00005	V-00006	V-00007
(1) RECIRCULATION	OPEN	OPEN	OPEN	OPEN	CLOSED	CLOSED	CLOSED
(2) SAMPLE ACQUISITION	OPEN	OPEN	OPEN	CLOSED	OPEN	CLOSED	CLOSED
(3) SAMPLE ANALYSIS	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
(4) PURGE PATH 1 TO HVAC	OPEN	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN
(5) PURGE PATH 2 TO HVAC	CLOSED	OPEN	OPEN	CLOSED	OPEN	OPEN	OPEN

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NOTE: This figure includes no SSCs that are either ITS or ITWI. Naval casks come with one connection. Valves that are not included in the valve position table maintain the position as indicated in the figure.

Figure 1.2.3-40. Cask Cavity Gas Sampling Piping and Instrumentation Diagram

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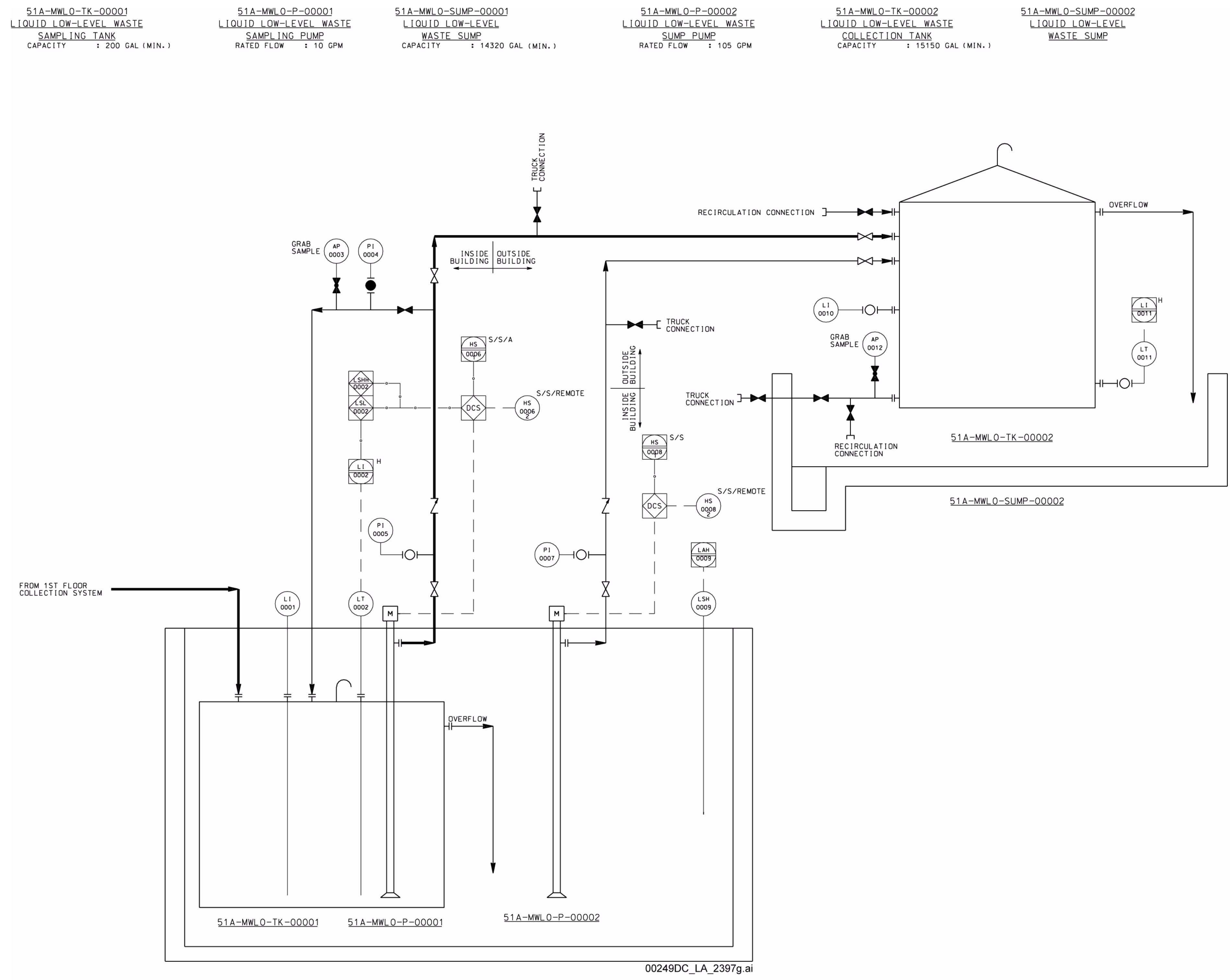

Figure 1.2.3-41. IHF Liquid Low-Level Waste Sampling and Sump Collection Piping and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI.

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-18.

Figure 1.2.3-42. IHF Confinement Zoning, Ground Floor

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-19.

Figure 1.2.3-43. IHF Confinement Zoning, Second Floor

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This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-20.

Figure 1.2.3-44. IHF Confinement Zoning, Third Floor

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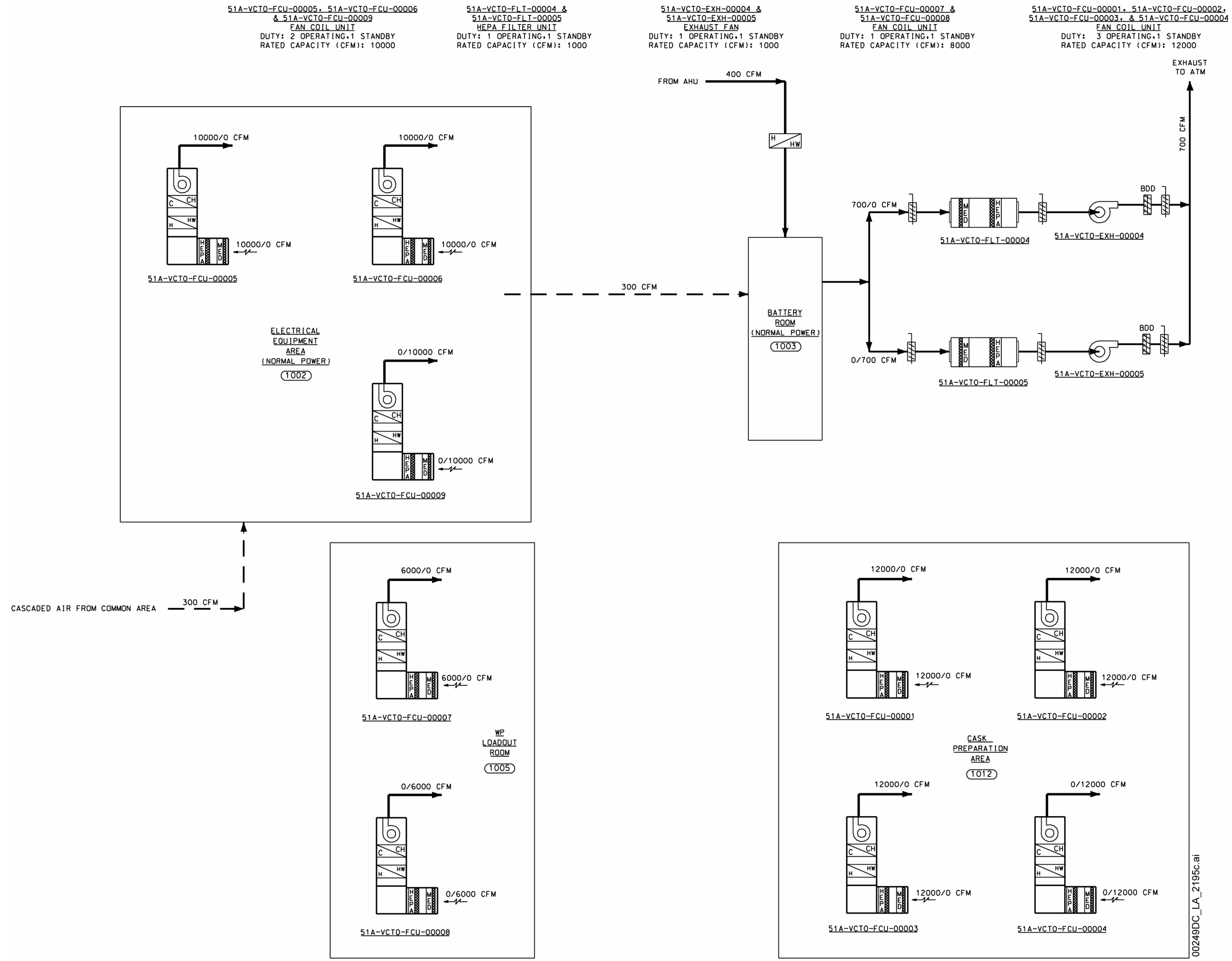

Figure 1.2.3-45. IHF Composite Ventilation Flow Diagram, Tertiary Confinement HVAC Miscellaneous Areas

NOTE: This figure includes no SSCs that are either ITS or ITWI.

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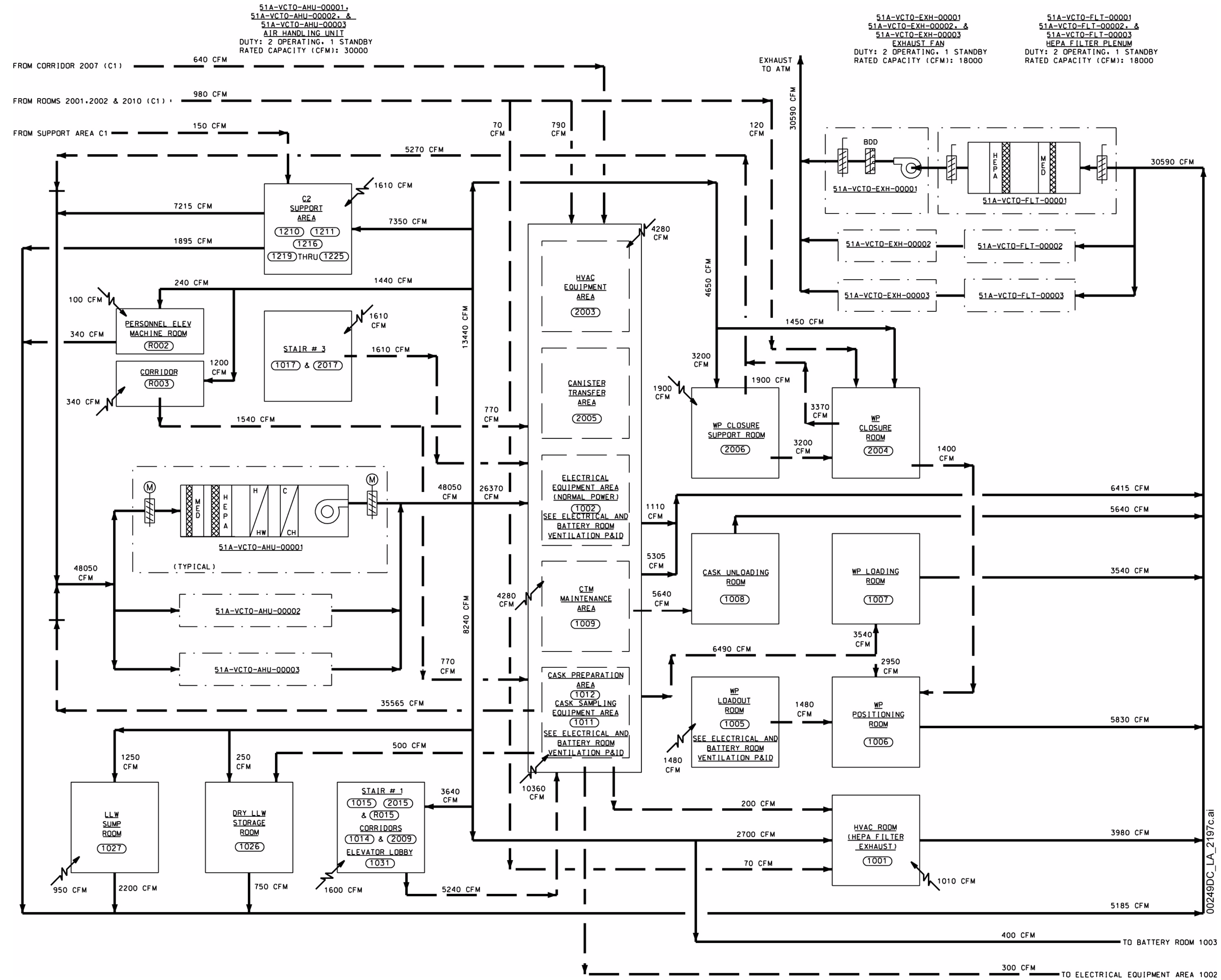

Figure 1.2.3-46. IHF Composite Ventilation Flow Diagram, Tertiary Confinement HVAC Supply and Exhaust Systems

NOTE: This figure includes no SSCs that are either ITS or ITWI. CTM = canister transfer machine; LLW = low-level radioactive waste; WP = waste package.

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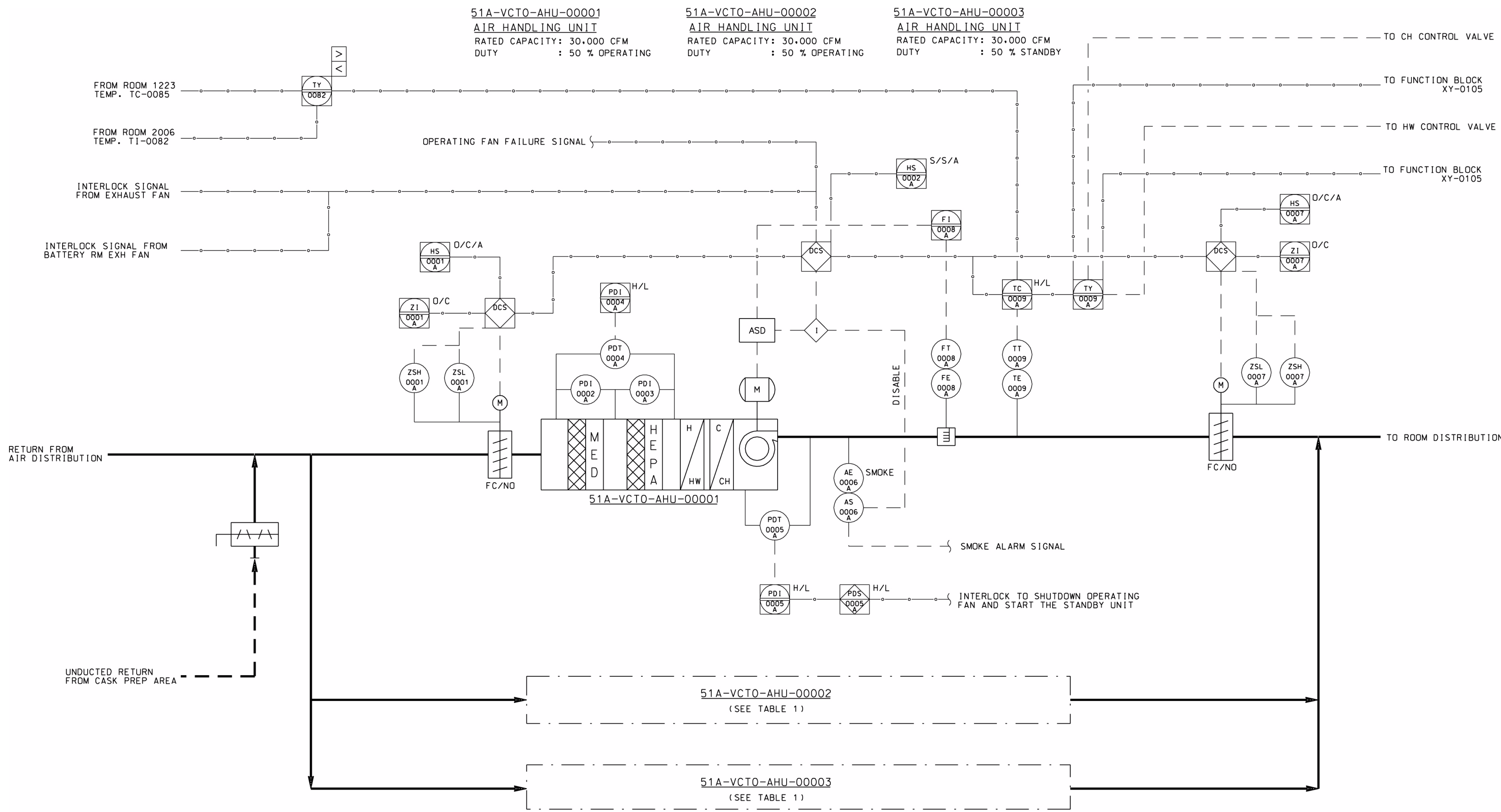

TABLE 1:

MECHANICAL COMPONENT	AIR HANDLING UNIT					INLET DAMPER				OUTLET DAMPER				SMOKE		FLOW			TEMPERATURE				FAN ΔP		
AIR HANDLING UNIT	HS	PDI	PDI	PDT	PDI	HS	ZI	ZSL	ZSH	HS	ZI	ZSL	ZSH	AE	AS	FE	FT	FI	TE	TT	TC	TY	PDT	PDI	PDS
51A-VCTO-AHU-00001	0008A	0002A	0003A	0004A	0004A	0001A	0001A	0001A	0001A	0007A	0007A	0007A	0007A	0006A	0006A	0008A	0008A	0008A	0009A	0009A	0009A	0009A	0005A	0005A	0005A
51A-VCTO-AHU-00002	0008B	0002B	0003B	0004B	0004B	0001B	0001B	0001B	0001B	0007B	0007B	0007B	0007B	0006B	0006B	0008B	0008B	0008B	0009B	0009B	0009B	0009B	0005B	0005B	0005B
51A-VCTO-AHU-00003	0008C	0002C	0003C	0004C	0004C	0001C	0001C	0001C	0001C	0007C	0007C	0007C	0007C	0006C	0006C	0008C	0008C	0008C	0009C	0009C	0009C	0009C	0005C	0005C	0005C

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NOTE: This figure includes no SSCs that are either ITS or ITWI. If a smoke alarm signal is detected, the signal is directed to fire alarm panel. An interlock is provided to shut down the operating fan and start the standby unit upon detection of high or low differential pressure across the operating fan. An operating fan failure signal starts this unit (if it is in auto). CH = chilled water; HW = hot water.

Figure 1.2.3-47. IHF Confinement Areas HVAC Supply System Ventilation and Instrumentation Diagram

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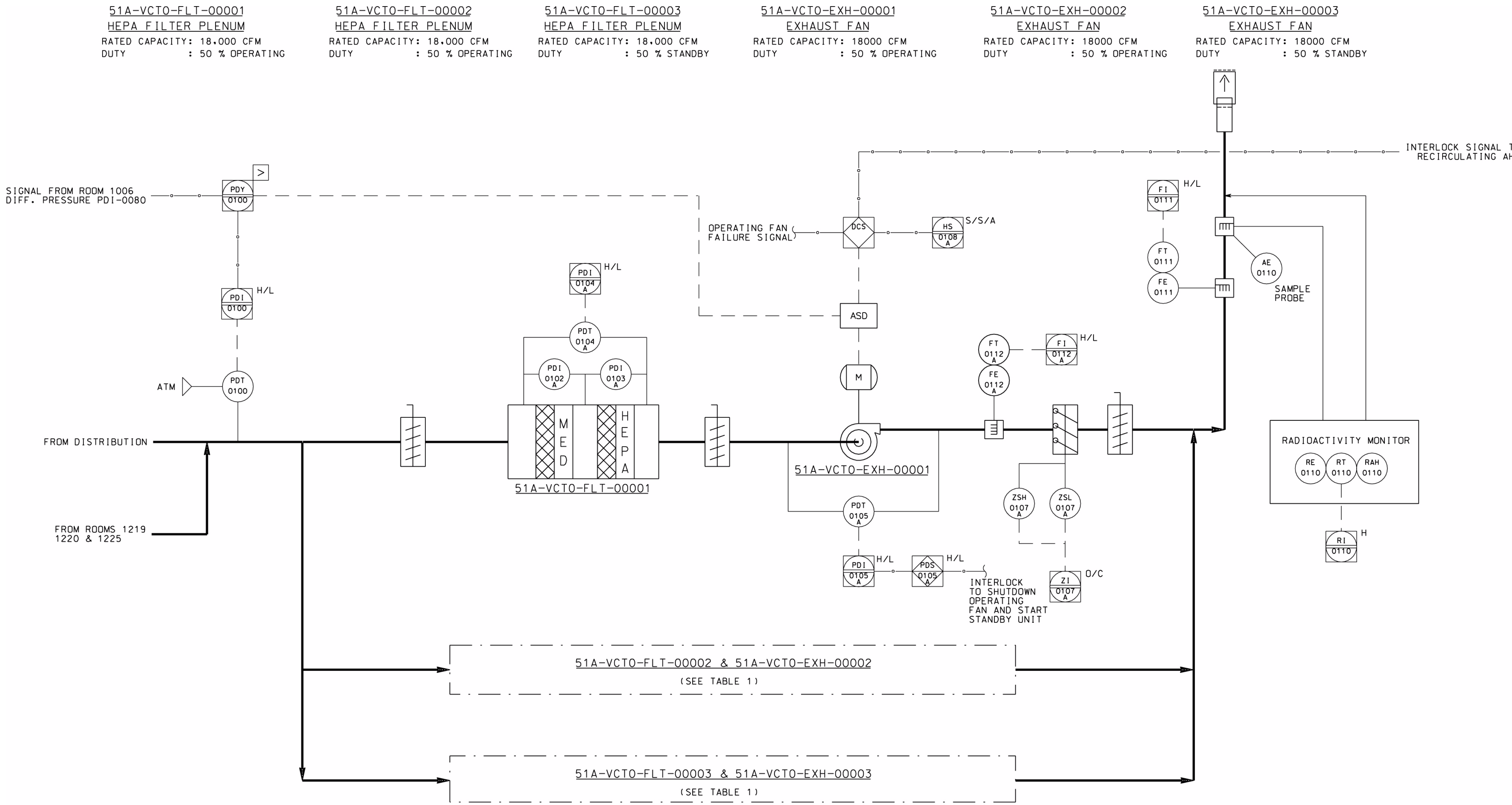

TABLE 1:

MECHANICAL COMPONENT	HEPA PLENUM				MECHANICAL COMPONENT	FAN				BACKDRAFT DAMPER			FLOW ELEMENT		
FILTER	PDI	PDI	PDT	PDI	FAN	HS	PDT	PDI	PDS	ZSL	ZSH	ZI	FE	FT	FI
51A-VCTO-FLT-00001	0102A	0103A	0104A	0104A	51A-VCTO-EXH-00001	0108A	0105A	0105A	0105A	0107A	0107A	0107A	0112A	0112A	0112A
51A-VCTO-FLT-00002	0102B	0103B	0104B	0104B	51A-VCTO-EXH-00002	0108B	0105B	0105B	0105B	0107B	0107B	0107B	0112B	0112B	0112B
51A-VCTO-FLT-00003	0102C	0103C	0104C	0104C	51A-VCTO-EXH-00003	0108C	0105C	0105C	0105C	0107C	0107C	0107C	0112C	0112C	0112C

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NOTE: This figure includes no SSCs that are either ITS or ITWI. An operating fan failure signal starts this unit (if it is in auto). An interlock is provided to shut down the operating fan and start the standby unit upon detection of high or low differential pressure across the operating fan. AHU = air handling unit.

Figure 1.2.3-48. IHF Confinement Areas HEPA Exhaust System Ventilation and Instrumentation Diagram

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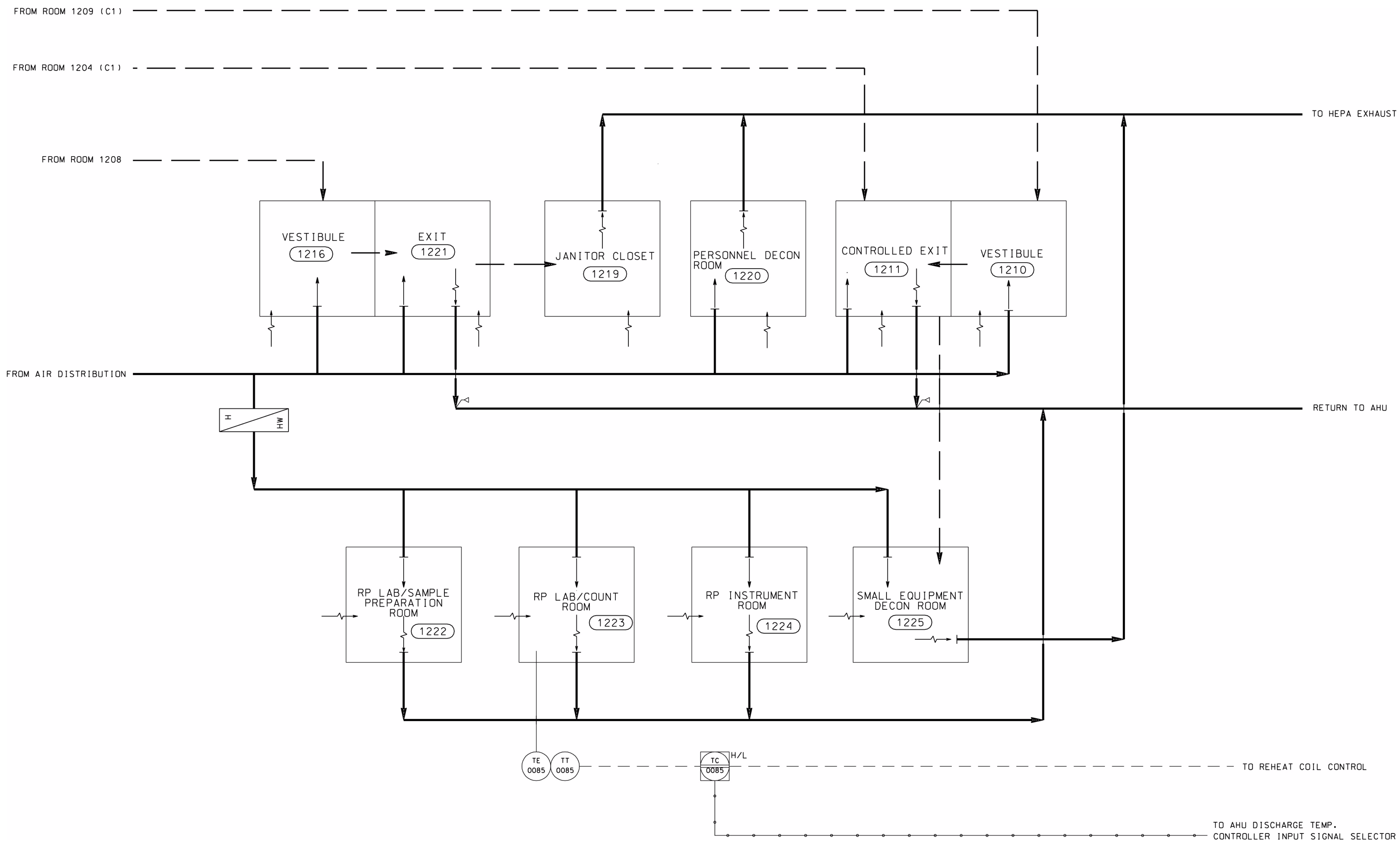

NOTE: This figure includes no SSCs that are either ITS or ITWI. AHU = air handling unit; RP = radiological protection.

Figure 1.2.3-49. IHF Confinement Support Areas Air Distribution System Ventilation and Instrumentation Diagram

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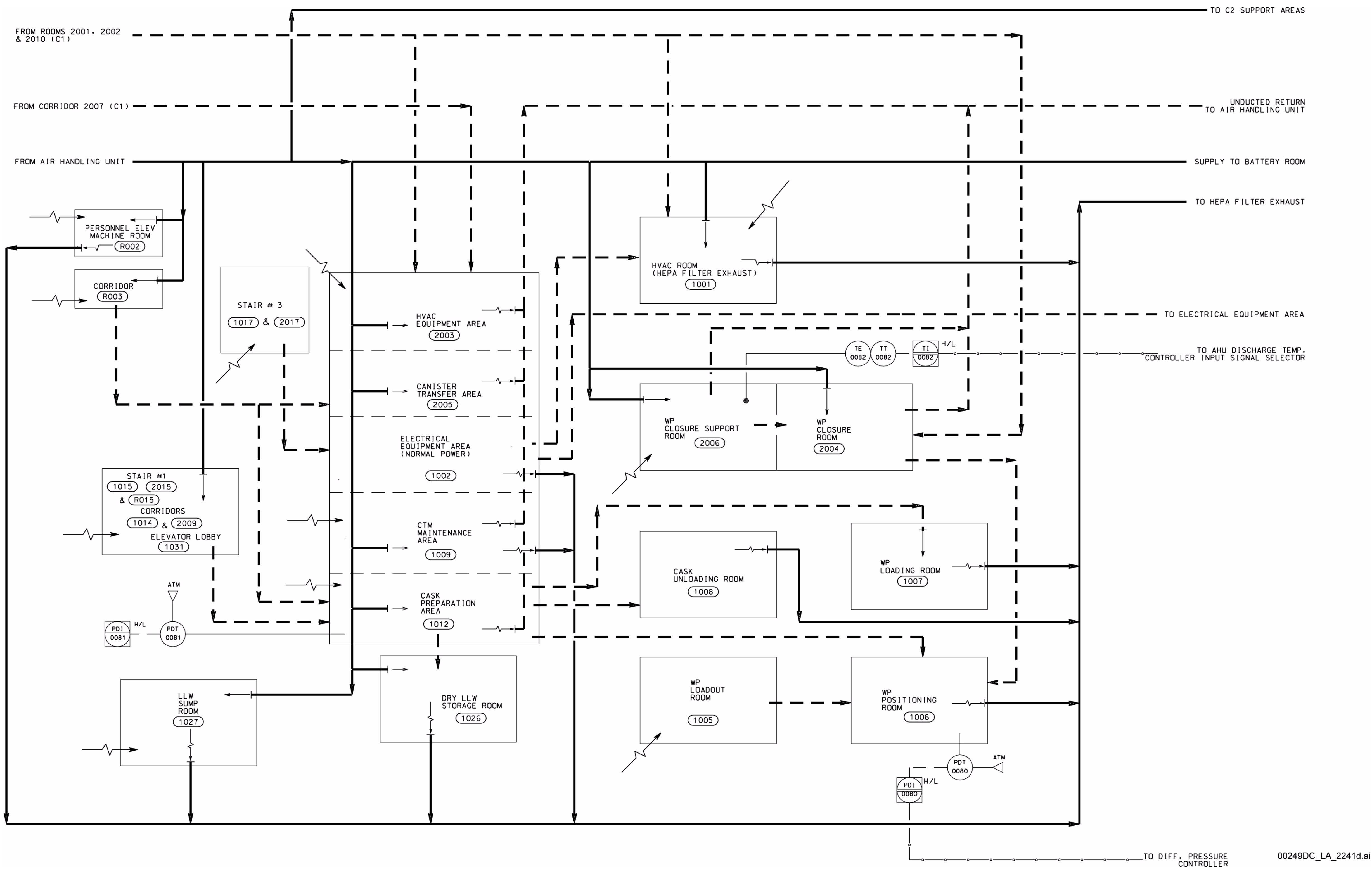

Figure 1.2.3-50. IHF Confinement Miscellaneous Areas Air Distribution System Ventilation and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI. AHU = air handling unit; CTM = canister transfer machine; LLW = low-level radioactive waste; WP = waste package.

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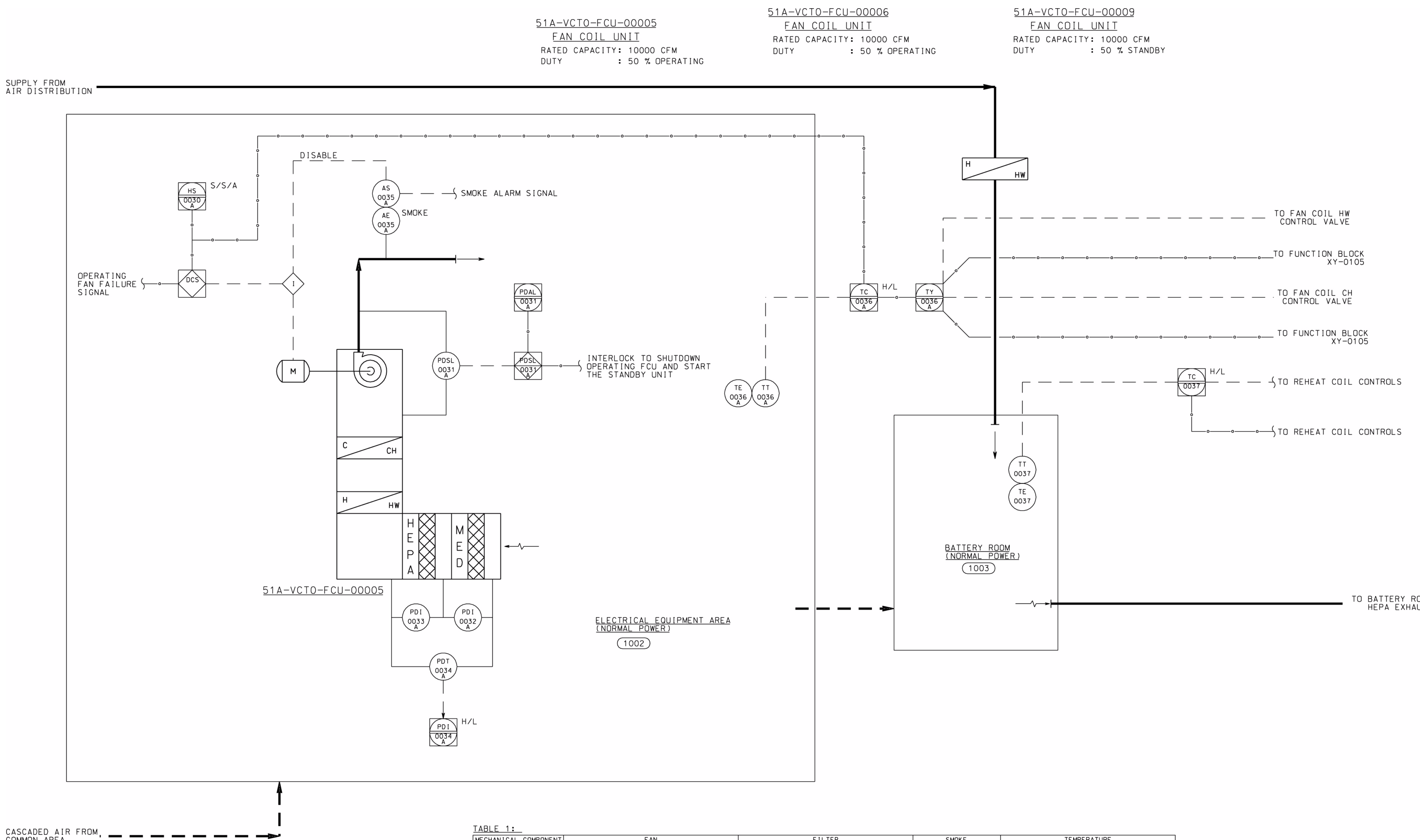

TABLE 1:

MECHANICAL COMPONENT	FAN				FILTER				SMOKE		TEMPERATURE			
FAN COIL UNIT	HS	PDSL	PDAL	PDSL	PDI	PDI	PDT	PDI	AE	AS	TE	TT	TC	TY
51A-VCTO-FCU-00005	0030A	0031A	0031A	0031A	0032A	0033A	0034A	0034A	0035A	0035A	0036A	0036A	0036A	0036A
51A-VCTO-FCU-00006	0030B	0031B	0031B	0031B	0032B	0033B	0034B	0034B	0035B	0035B	0036B	0036B	0036B	0036B
51A-VCTO-FCU-00009	0030C	0031C	0031C	0031C	0032C	0033C	0034C	0034C	0035C	0035C	0036C	0036C	0036C	0036C

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Figure 1.2.3-51. IHF Confinement Electrical and Battery Room HVAC System Ventilation and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI. CH = chilled water; HW = hot water.

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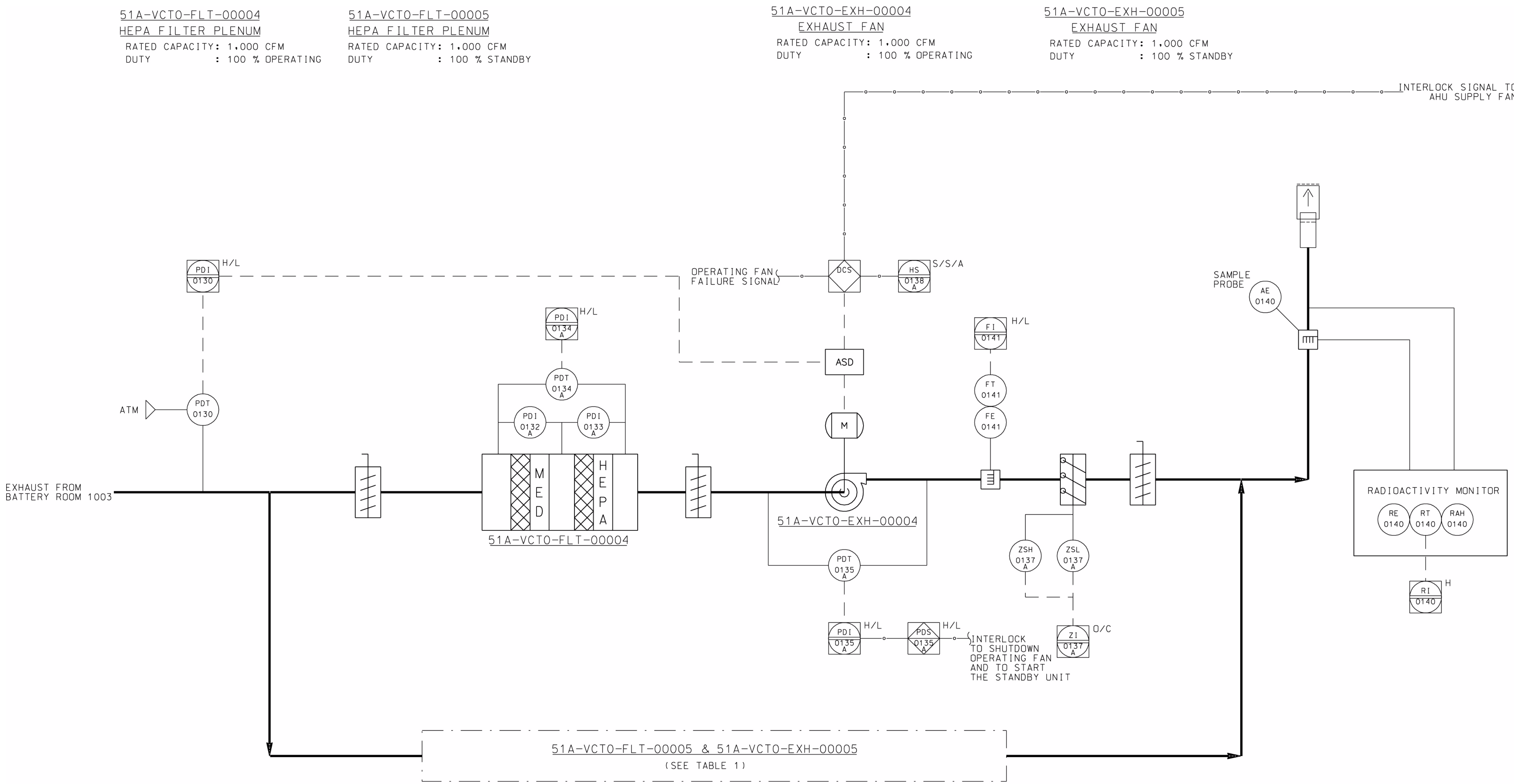

TABLE 1:

MECHANICAL COMPONENT	HEPA PLENUM				MECHANICAL COMPONENT	FAN				BACKDRAFT DAMPER		
FILTER	PDI	PDI	PDT	PDI	FAN	HS	PDT	PDI	PDS	ZSL	ZSH	ZI
51A-VCTO-FLT-00004	0132A	0133A	0134A	0134A	51A-VCTO-EXH-00004	0138A	0135A	0135A	0135A	0137A	0137A	0137A
51A-VCTO-FLT-00005	0132B	0133B	0134B	0134B	51A-VCTO-EXH-00005	0138B	0135B	0135B	0135B	0137B	0137B	0137B

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Figure 1.2.3-52. IHF Confinement Battery Room HEPA Exhaust System Ventilation and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI.

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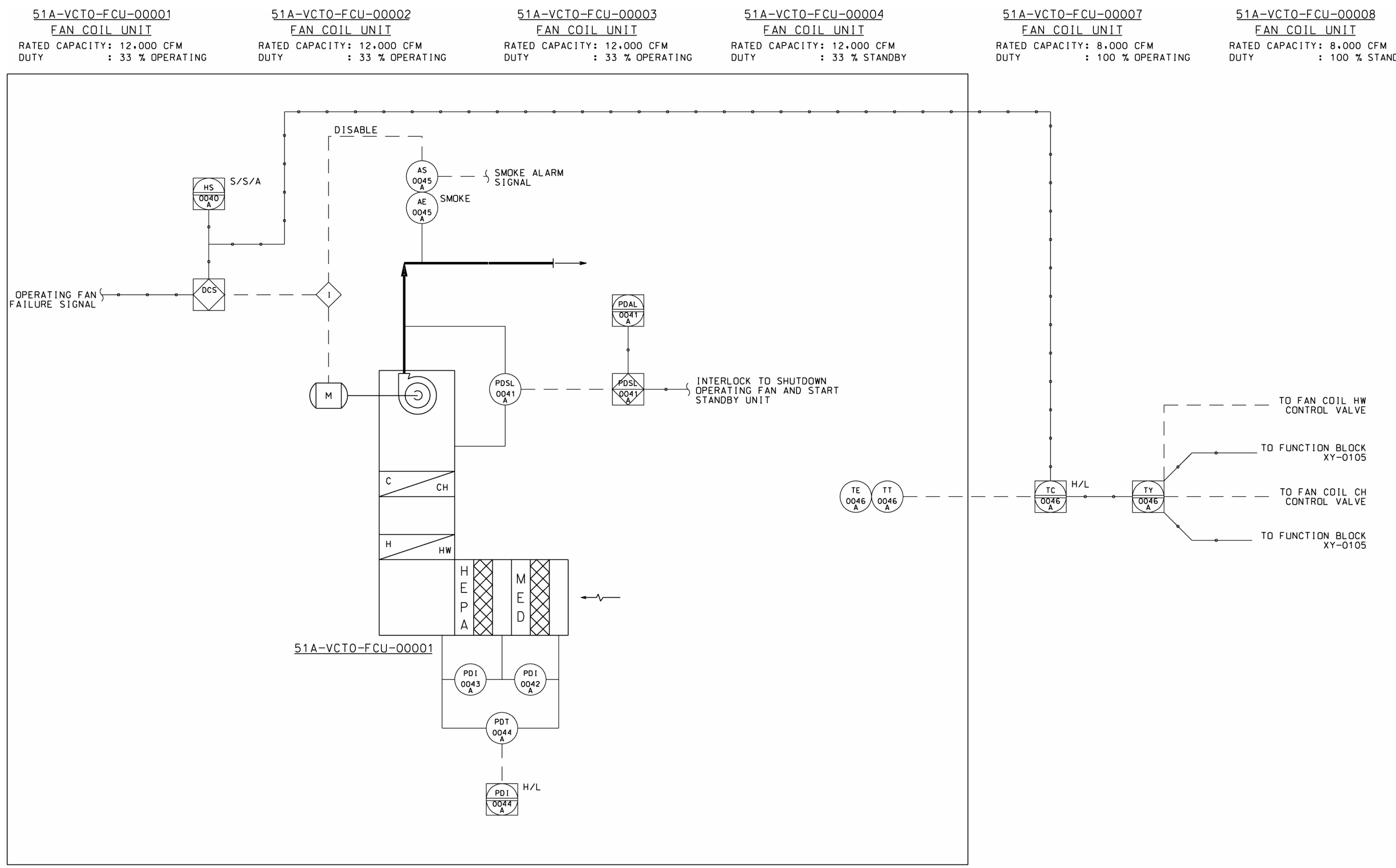

TABLE 1:

		MECHANICAL COMPONENT	FAN				FILTER				SMOKE		TEMPERATURE			
ROOM NO.	ROOM NAME	FAN COIL UNIT	HS	PDSL	PDAL	PDSL	PDI	PDI	PDT	PDI	AE	AS	TE	TT	TC	TY
ROOM 1012	CASK PREP AREA	51A-VCTO-FCU-00001	0040A	0041A	0041A	0041A	0042A	0043A	0044A	0044A	0045A	0045A	0046A	0046A	0046A	0046A
ROOM 1012	CASK PREP AREA	51A-VCTO-FCU-00002	0040B	0041B	0041B	0041B	0042B	0043B	0044B	0044B	0045B	0045B	0046B	0046B	0046B	0046B
ROOM 1012	CASK PREP AREA	51A-VCTO-FCU-00003	0040C	0041C	0041C	0041C	0042C	0043C	0044C	0044C	0045C	0045C	0046C	0046C	0046C	0046C
ROOM 1012	CASK PREP AREA	51A-VCTO-FCU-00004	0040D	0041D	0041D	0041D	0042D	0043D	0044D	0044D	0045D	0045D	0046D	0046D	0046D	0046D
ROOM 1005	WP LOADOUT	51A-VCTO-FCU-00007	0050A	0051A	0051A	0051A	0052A	0053A	0054A	0054A	0055A	0055A	0056A	0056A	0056A	0056A
ROOM 1005	WP LOADOUT	51A-VCTO-FCU-00008	0050B	0051B	0051B	0051B	0052B	0053B	0054B	0054B	0055B	0055B	0056B	0056B	0056B	0056B

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Figure 1.2.3-53. IHF Confinement Cask Preparation Area and Waste Package Loadout Room HVAC System Ventilation and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI. An interlock is provided to shut down the operating fan and start the standby unit upon detection of low differential pressure across the operation fan coil unit. CH = chilled water; HW = hot water; WP = waste package.

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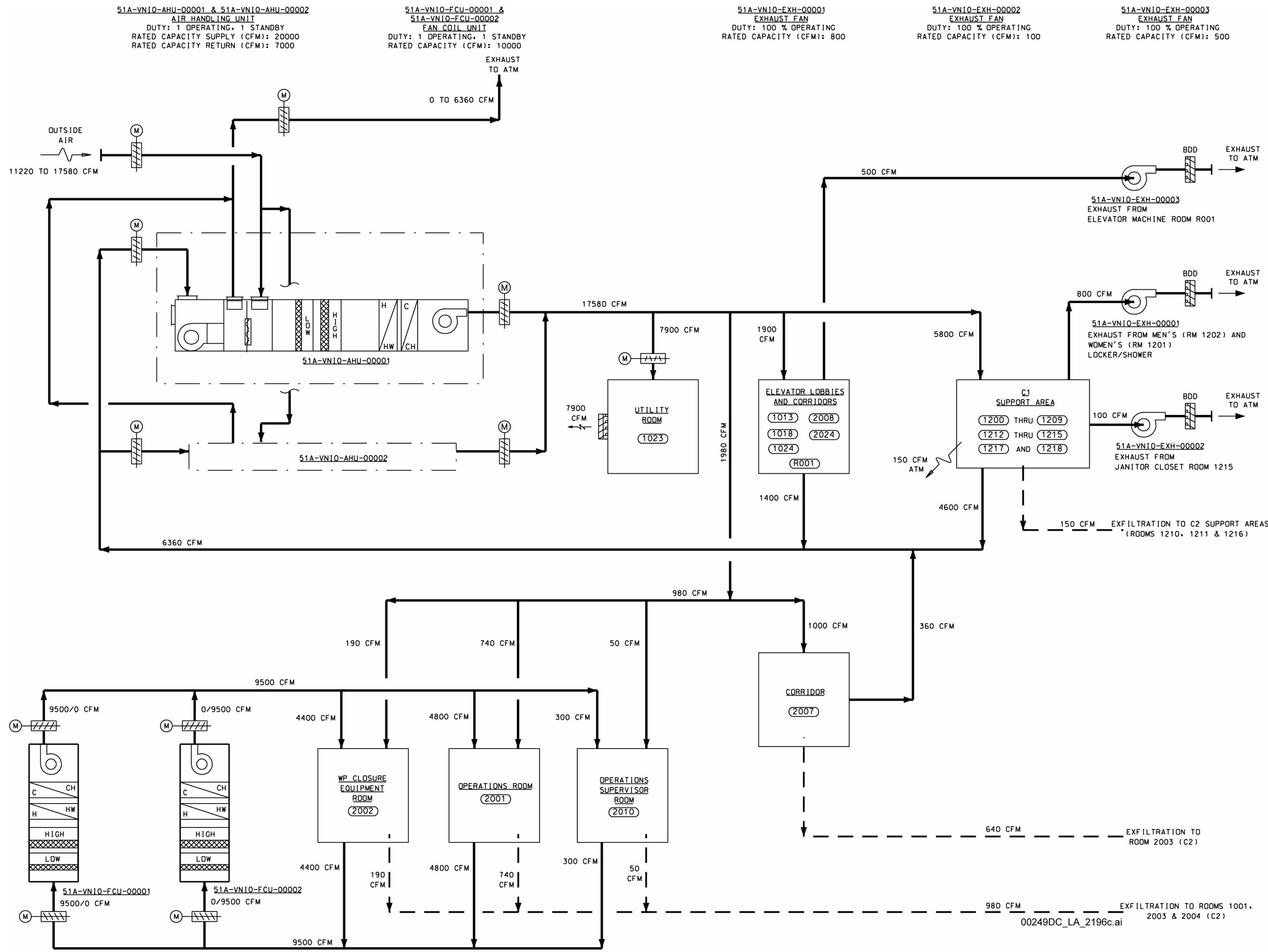

Figure 1.2.3-54. IHF Composite Ventilation Flow Diagram, Nonconfinement HVAC Systems

NOTE: This figure includes no SSCs that are either ITS or ITWI.

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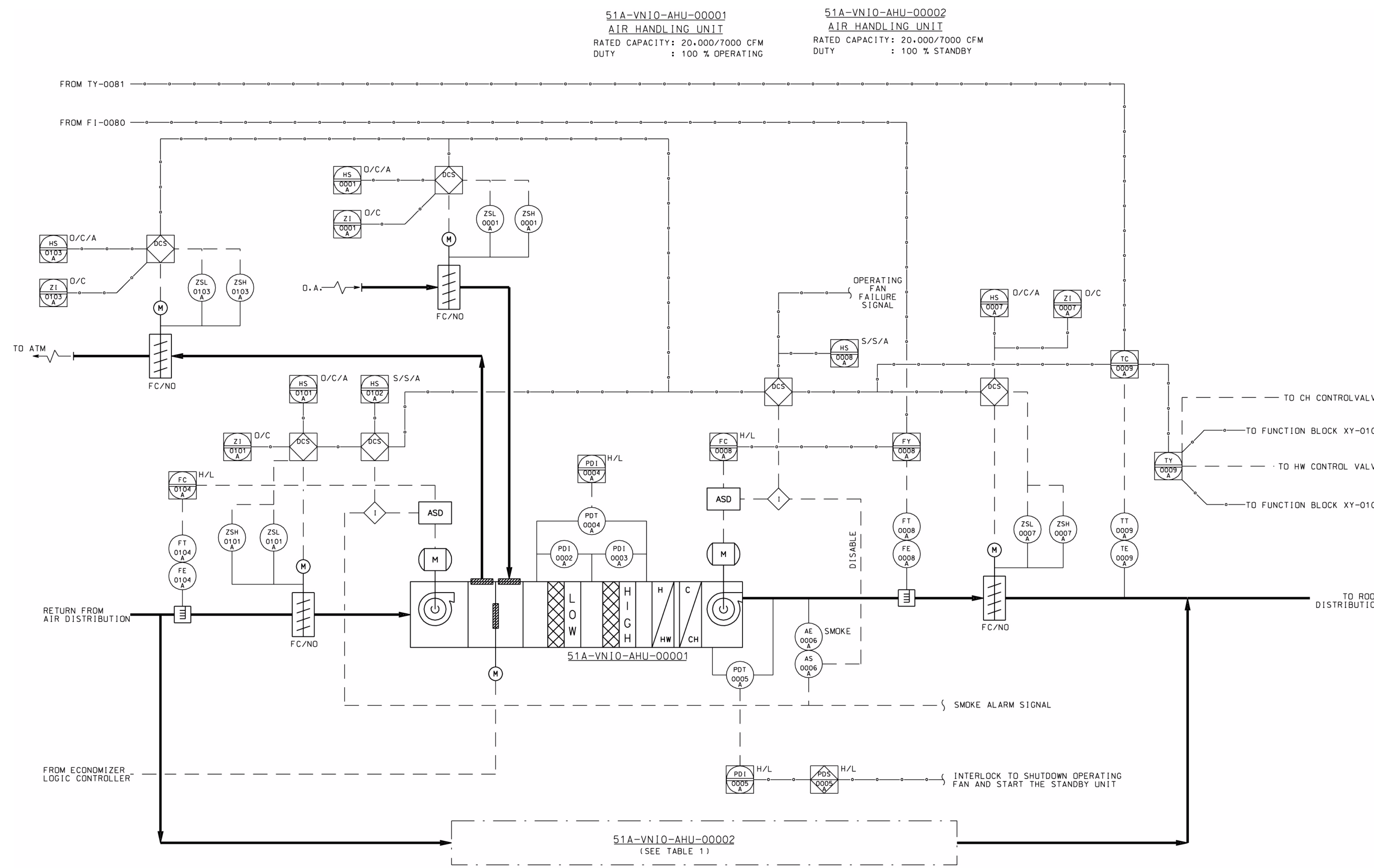

TABLE 1:

MECHANICAL COMPONENT	AHU - SUPPLY/RETURN						FAN DP		
AIR HANDLING UNIT	HS SUPPLY	HS RETURN	PDI	PDI	PDT	PDI	PDT	PDI	PDS
51A-VNI0-AHU-00001	0008A	0102A	0002A	0003A	0004A	0004A	0005A	0005A	0005A
51A-VNI0-AHU-00002	0008B	0102B	0002B	0003B	0004B	0004B	0005B	0005B	0005B

MECHANICAL COMPONENT	INLET DAMPER				OUTLET DAMPER				SMOKE	
AIR HANDLING UNIT	HS	ZSL	ZSH	ZI	HS	ZSL	ZSH	ZI	AE	AS
51A-VNI0-AHU-00001	0101A	0101A	0101A	0101A	0007A	0007A	0007A	0007A	0006A	0006A
51A-VNI0-AHU-00002	0101B	0101B	0101B	0101B	0007B	0007B	0007B	0007B	0006B	0006B

MECHANICAL COMPONENT	SUPPLY FAN FLOW		RETURN FAN FLOW		EXHAUST DAMPER			
AIR HANDLING UNIT	FE	FT	FE	FT	HS	ZSH	ZSL	ZI
51A-VNI0-AHU-00001	0008A	0008A	0104A	0104A	0103A	0103A	0103A	0103A
51A-VNI0-AHU-00002	0008B	0008B	0104B	0104B	0103B	0103B	0103B	0103B

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TABLE 1:

MECHANICAL COMPONENT	O.A. DAMPER				OUTLET TEMPERATURE			
AIR HANDLING UNIT	HS	ZSL	ZSH	ZI	TE	TT	TC	TY
51A-VNI0-AHU-00001	0001A	0001A	0001A	0001A	0009A	0009A	0009A	0009A
51A-VNI0-AHU-00002	0001B	0001B	0001B	0001B	0009B	0009B	0009B	0009B

NOTE: This figure includes no SSCs that are either ITS or ITWI. If a smoke alarm signal detected, it is directed to the fire alarm panel. An interlock is provided to shut down the operating fan and start the standby unit upon detection of high or low differential pressure across the operating fan. CH = chilled water; HW = hot water; OA = outside air.

Figure 1.2.3-55. IHF Nonconfinement Areas HVAC Supply System Ventilation and Instrumentation Diagram

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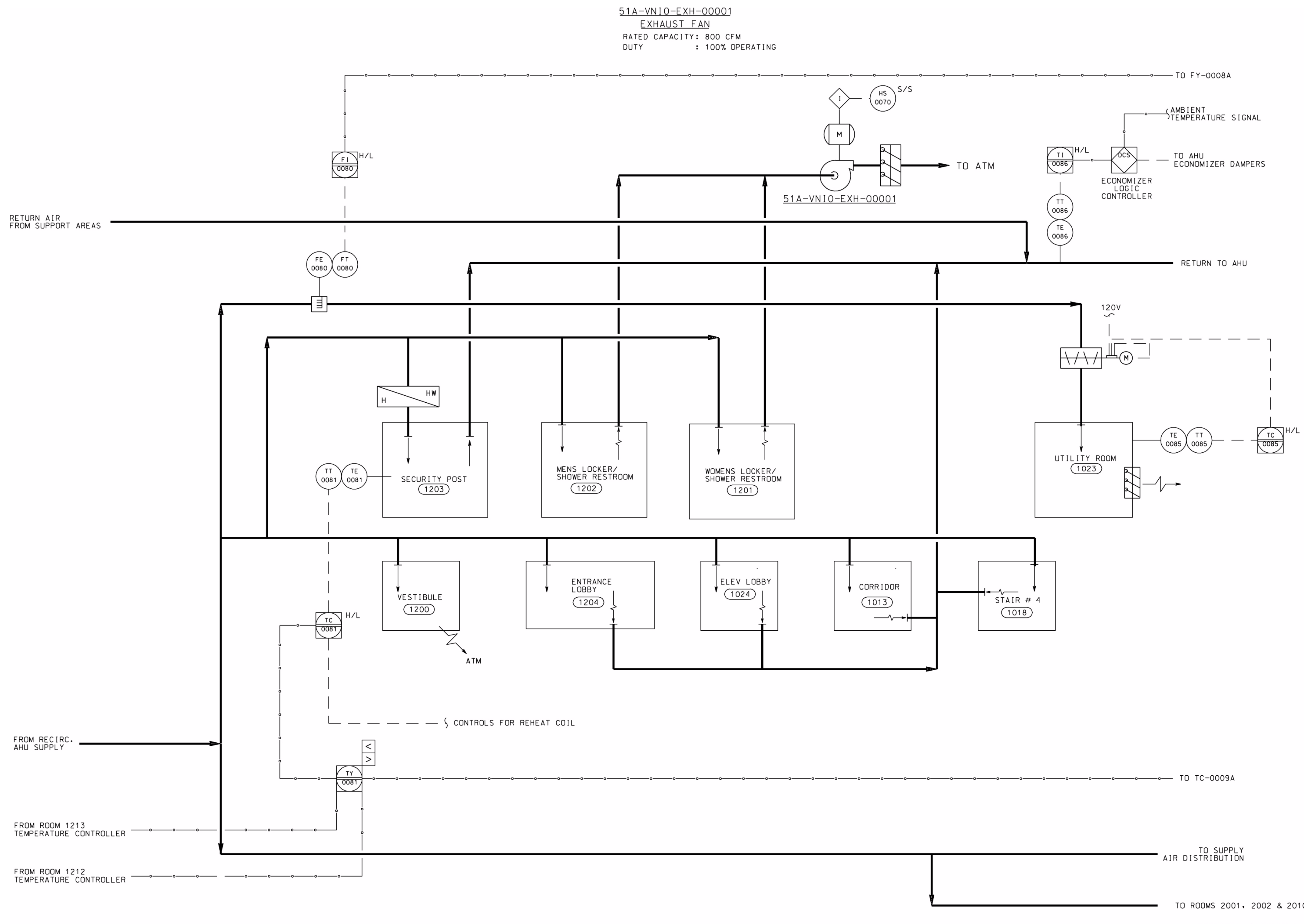

NOTE: This figure includes no SSCs that are either ITS or ITWI. The ambient temperature signal is received from the site meteorological station (Section 1.4.2).
AHU = air handling unit.

Figure 1.2.3-56. IHF Nonconfinement Areas Air Distribution System (North) Ventilation and Instrumentation Diagram

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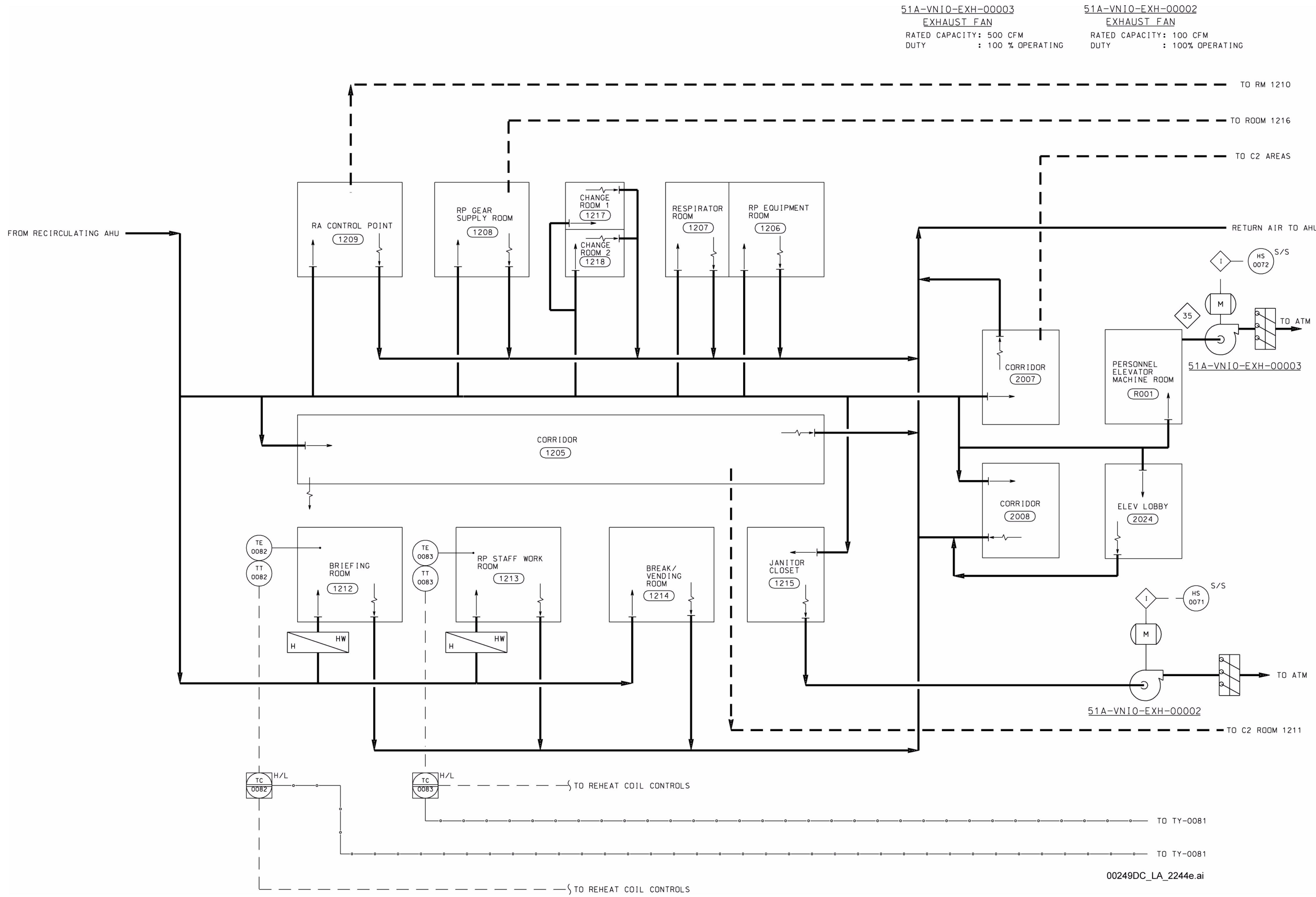

Figure 1.2.3-57. IHF Nonconfinement Areas Air Distribution System (South) Ventilation and Instrumentation Diagram

NOTE: This figure includes no SSCs that are either ITS or ITWI. AHU = air handling unit; RA = radiological access; RP = radiological protection.

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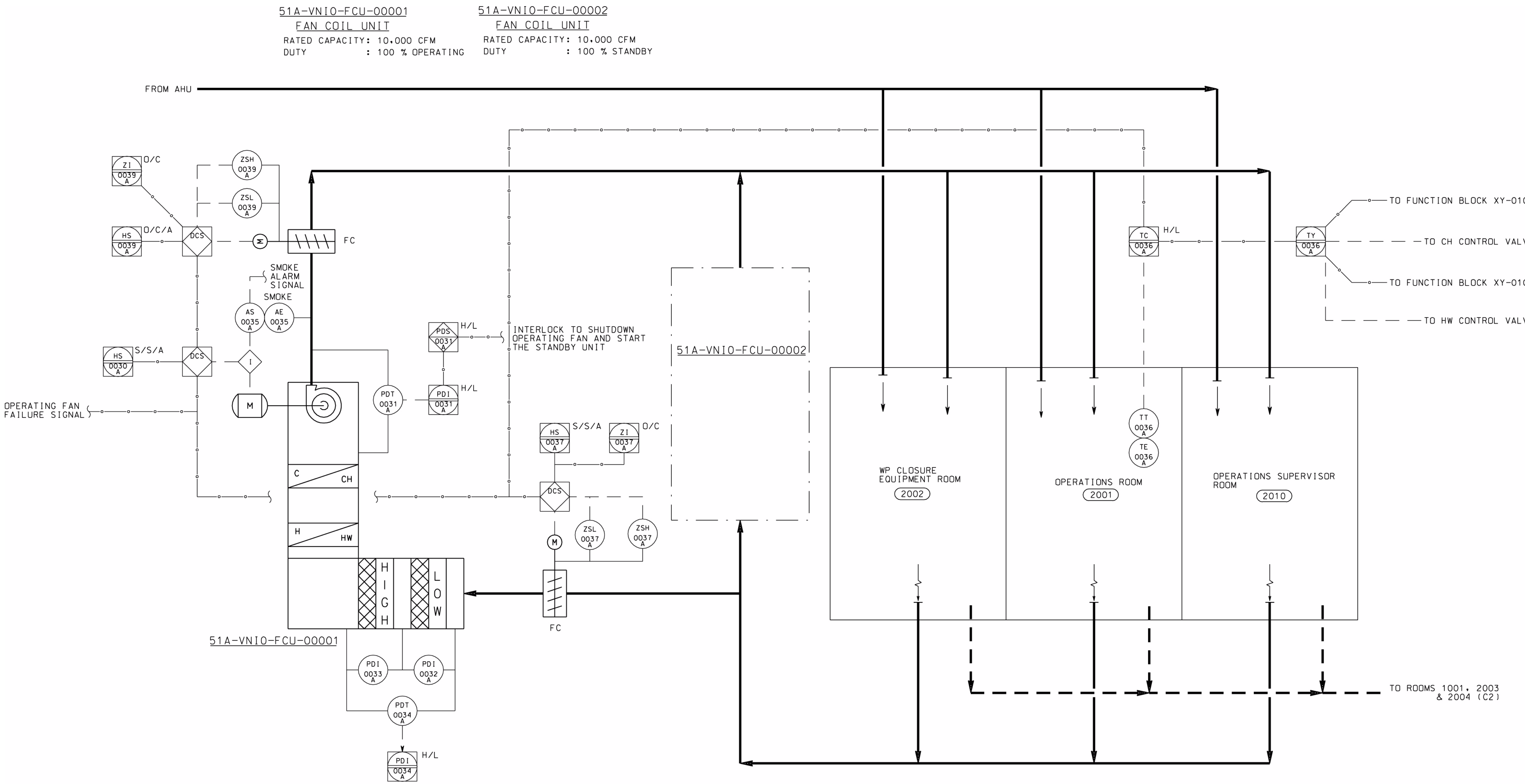

TABLE 1:

MECHANICAL COMPONENT	FAN COIL					INST. TO INTERLOCK			OUTLET DAMPER				SMOKE		INLET DAMPER				TEMPERATURE			
FAN COIL UNIT	HS	PDI	PDI	PDT	PDI	PDSL	PDAL	PDSL	HS	ZSL	ZSH	ZI	AE	AS	HS	ZSL	ZSH	ZI	TE	TT	TC	TY
51A-VNI0-FCU-00001	0030A	0032A	0033A	0034A	0034A	0031A	0031A	0031A	0039A	0039A	0039A	0039A	0035A	0035A	0037A	0037A	0037A	0037A	0036A	0036A	0036A	0036A
51A-VNI0-FCU-00002	0030B	0032B	0033B	0034B	0034B	0031B	0031B	0031B	0039B	0039B	0039B	0039B	0035B	0035B	0037B	0037B	0037B	0037B	0036B	0036B	0036B	0036B

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NOTE: This figure includes no SSCs that are either ITS or ITWI. An interlock is provided to shut down operating fan and start the standby unit upon detection of high or low differential pressure across the operation fan coil unit. CH = chilled water; HW = hot water; WP = waste package.

Figure 1.2.3-58. IHF Nonconfinement Operations Area HVAC System Ventilation and Instrumentation Diagram

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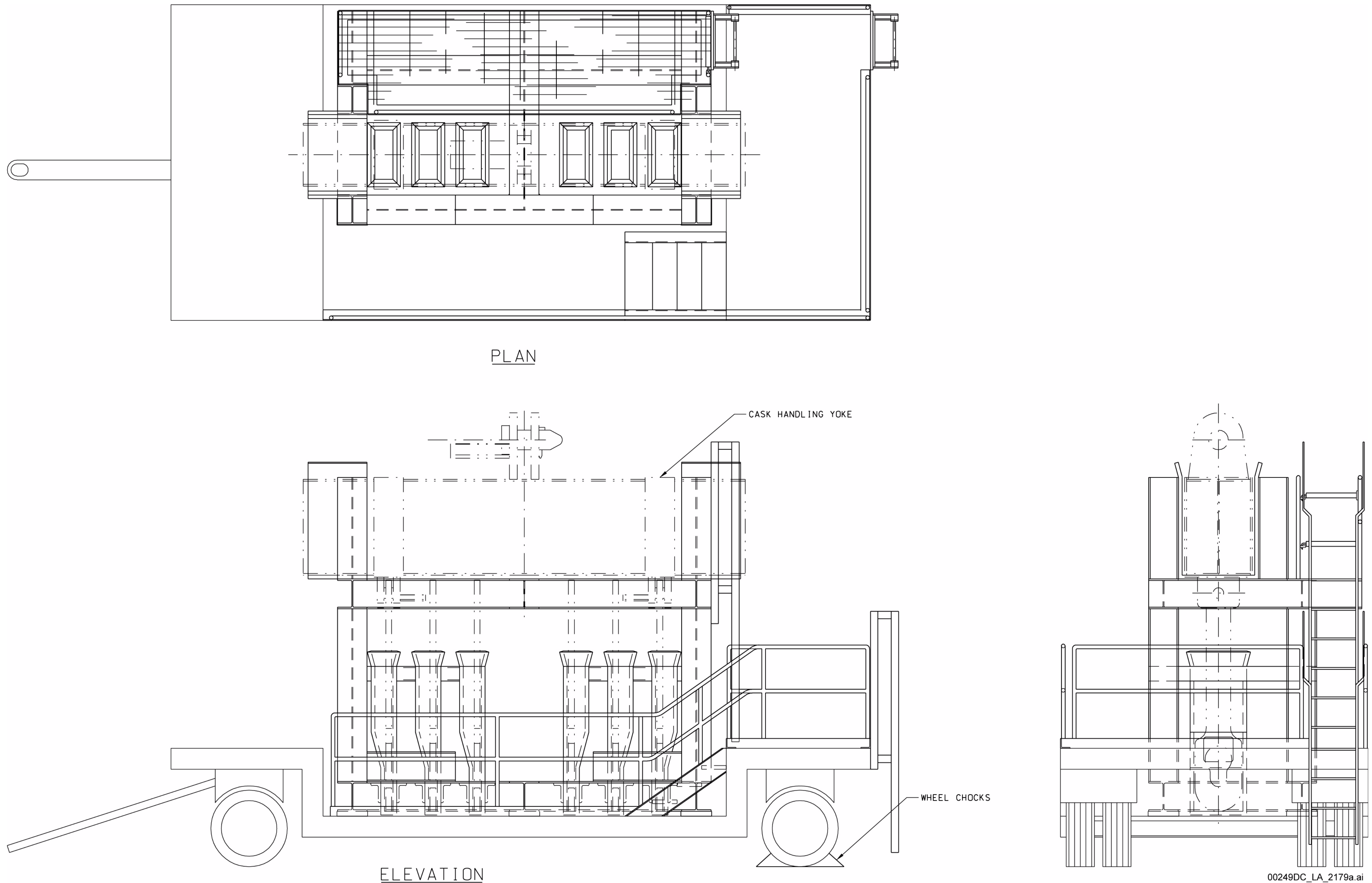

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51A-HM00-RK-00001, cask handling yoke stand.

Figure 1.2.3-59. Cask Handling Yoke Stand Mechanical Equipment Envelope

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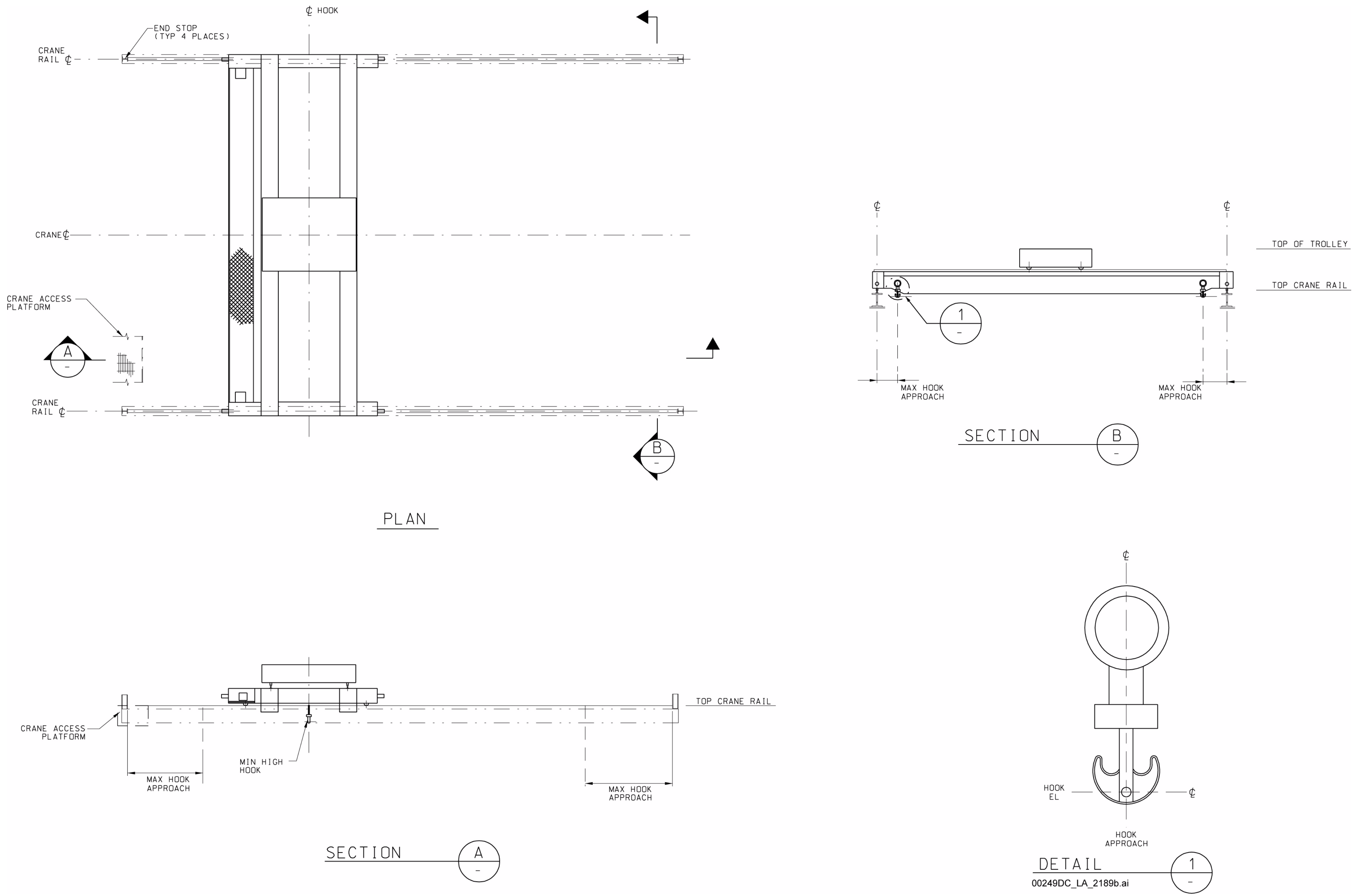

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51A-HTC0-CRN-00001, canister transfer machine maintenance crane.

Figure 1.2.3-60. Canister Transfer Machine Maintenance Crane Mechanical Equipment Envelope

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This figure has been designated Official Use Only under the Freedom of Information Act (5 U.S.C. 552), Exemption 2, Circumvention of Statute.

This figure is included in Appendix A: Information Designated as Official Use Only, as Figure A-21.

NOTE: This figure includes no SSCs that are either ITS or ITWI. WP = waste package.

Equipment Number: 51A-HL00-PLAT-00001, IHF loadout platform 1; 51A-HL00-PLAT-00002, IHF loadout platform 2.

Figure 1.2.3-61. IHF Loadout Platform Mechanical Equipment Envelope

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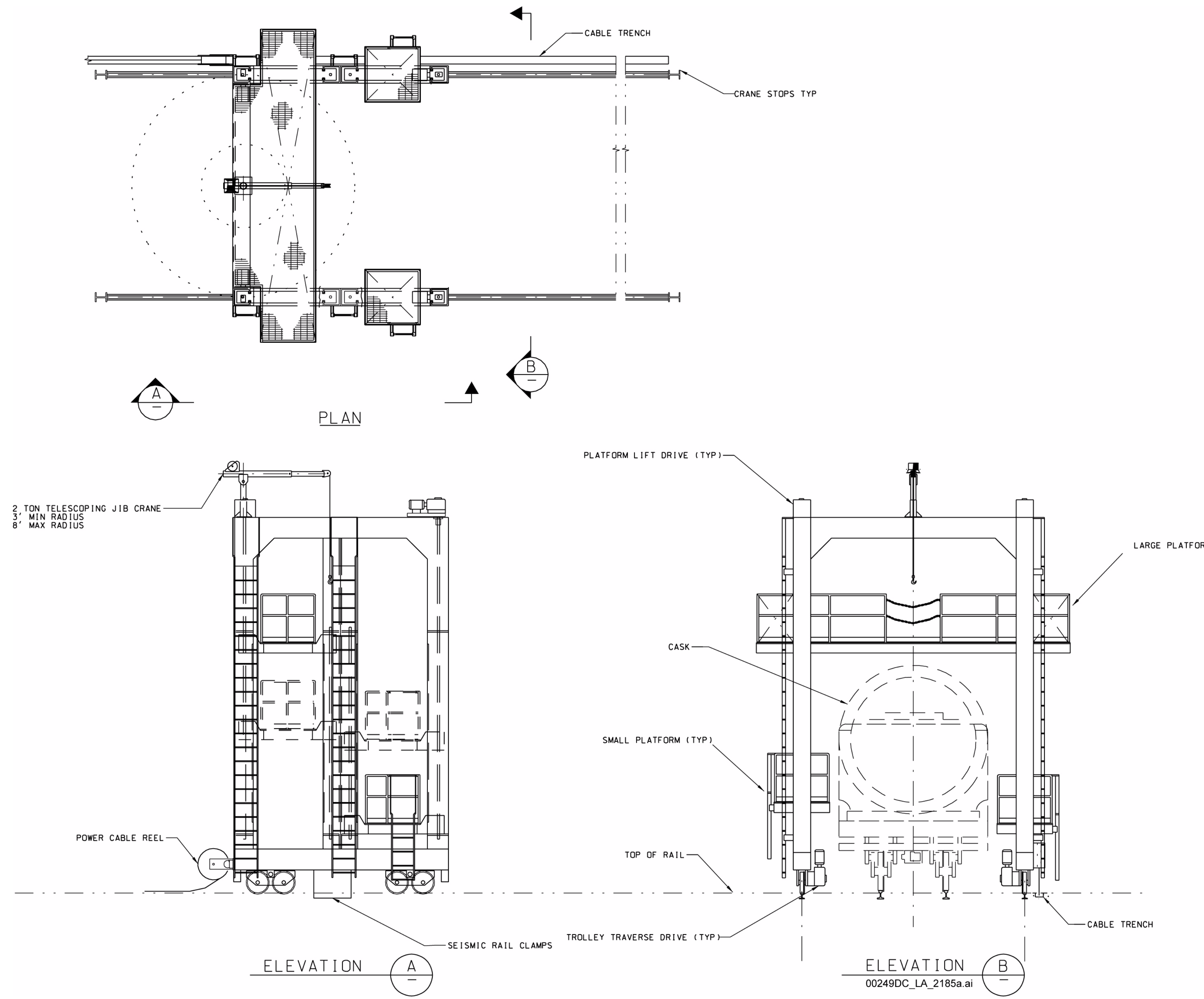

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51A-HMC0-PLAT-00001, IHF mobile access platform.

Figure 1.2.3-62. IHF Mobile Access Platform Mechanical Equipment Envelope

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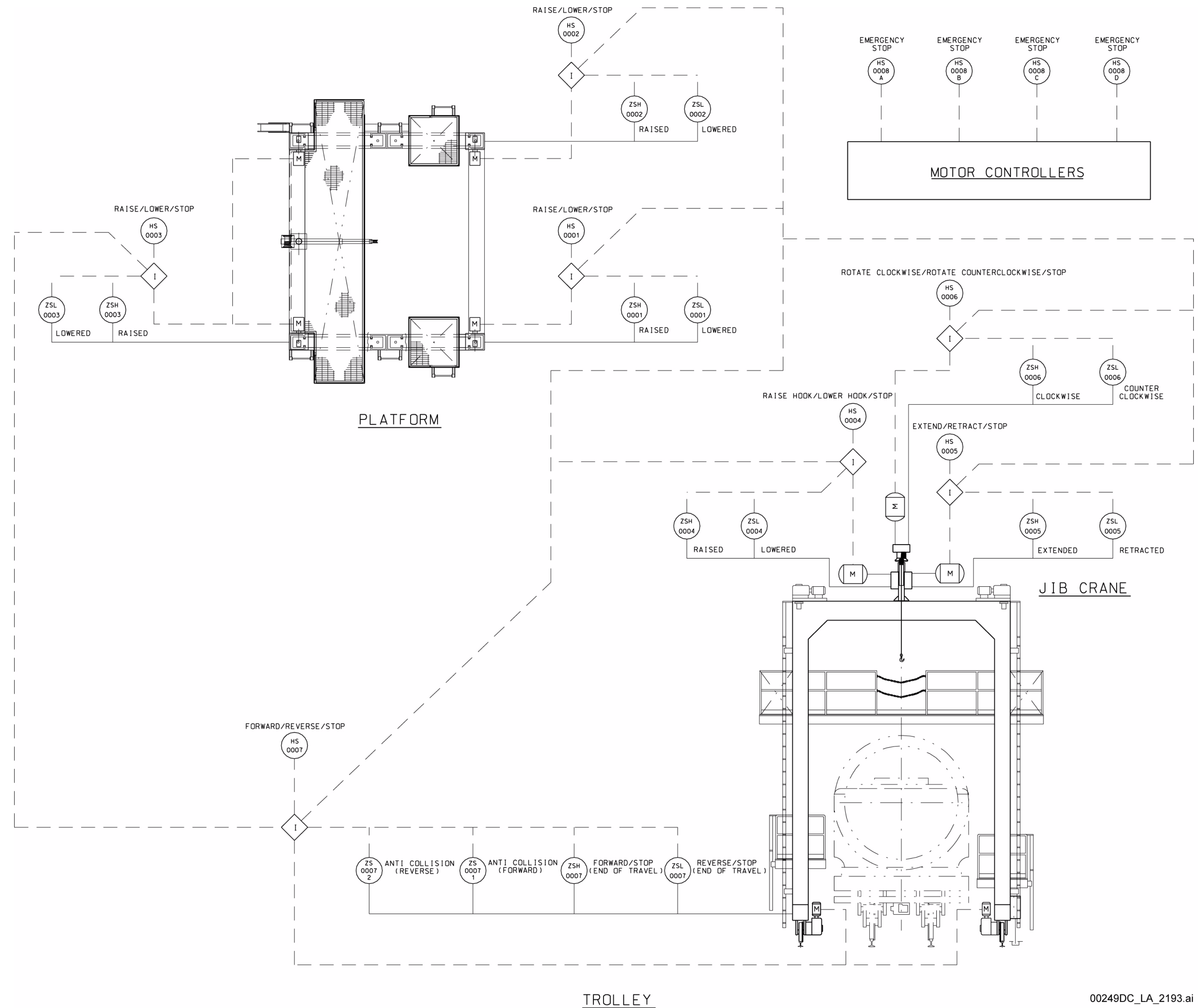

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51A-HMC0-PLAT-00001, IHF mobile access platform.

Figure 1.2.3-63. IHF Mobile Access Platform Process and Instrumentation Diagram

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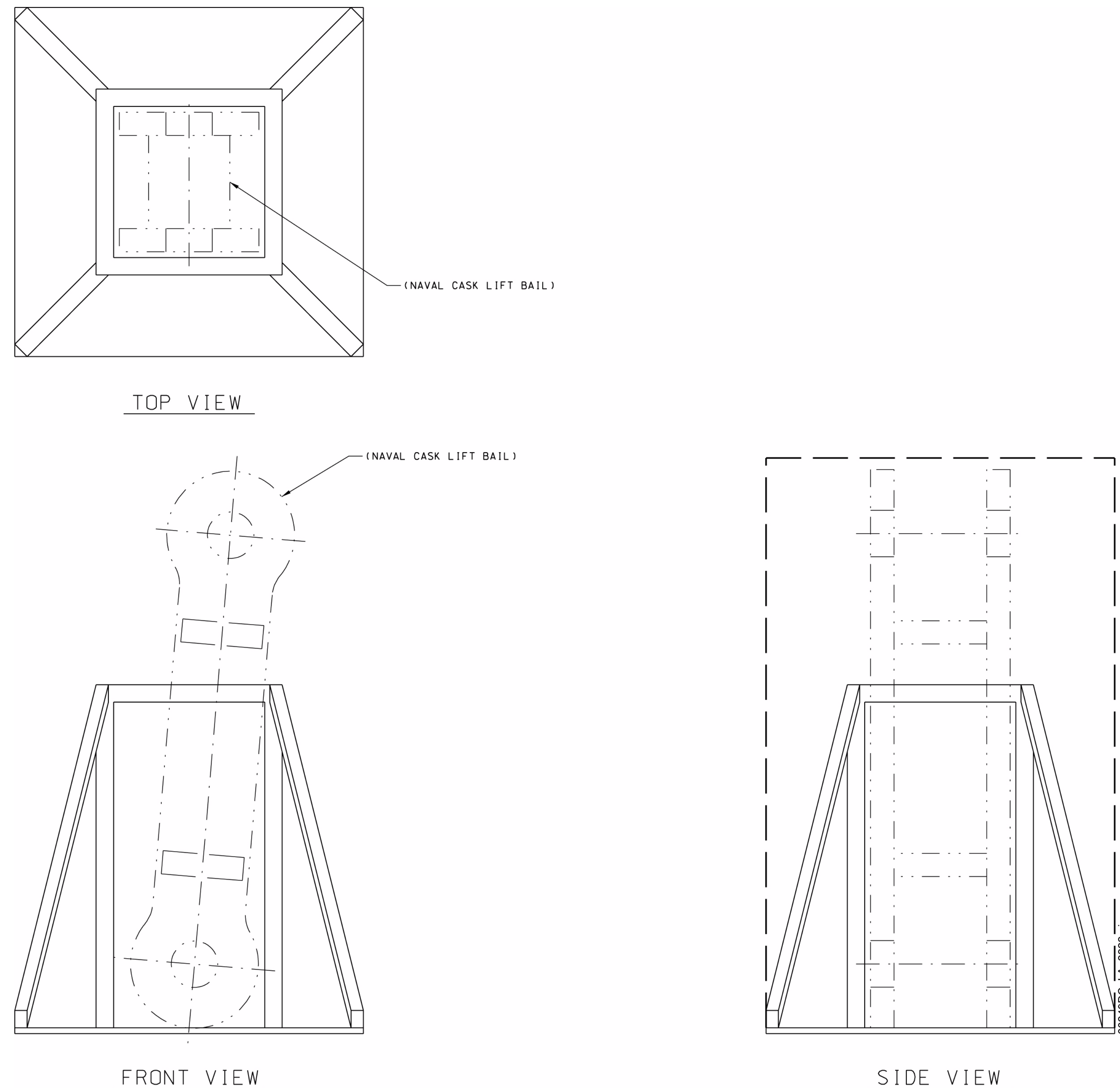

NOTE: This figure includes no SSCs that are either ITS or ITWI.

Equipment Number: 51A-HMC0-RK-00001, IHF naval cask lift bail.

Figure 1.2.3-64. IHF Naval Cask Lift Bail Stand Mechanical Equipment Envelope

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