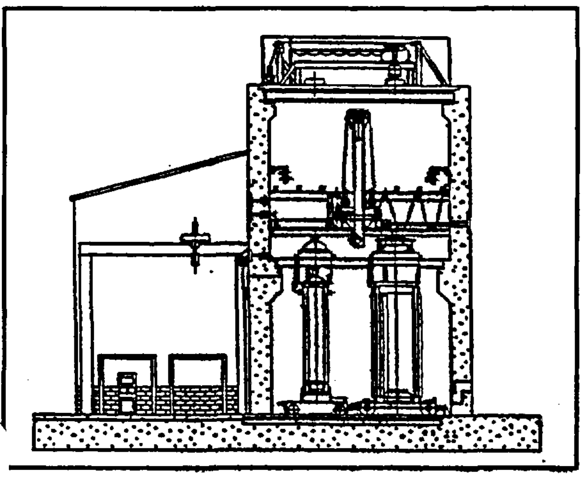
Dry Transfer System

Topical Safety Analysis Report

Volume I



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CHAPTER 1

INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

In the management of spent nuclear fuel both at utility sites and possibly other locations, there is a need to perform certain fuel transfer and packaging operations apart from the conventional pool. Facilities with weight or dimensional access limitations find the pool loading of large multi-element canisters for storage and/or transportation not feasible. A method has been developed whereby a large canister can be loaded in a dry facility external to the reactor or fuel building through the repeated use of a small transfer facility external to the reactor or fuel building through the repeated use of a small transfer cask carrying a small number of spent fuel assemblies. This topical report addresses the safety evaluation of the Dry Transfer System (DTS). The format follows the guidance provided in NRC Regulatory Guide 3.48[1]. (Throughout this report, superscripted numbers in parentheses refer to reference numbers for the Section.) The report is intended for review by the NRC under 10CFR72[2]. Although technically not an Independent Spent Fuel Storage Installation (ISFSI), the Dry Transfer System (DTS) is designed to meet the requirements of 10CFR72 as described herein.

The Dry Transfer System was developed by Transnuclear, Inc. under the direction of the Electric Power Research Institute (EPRI) and the Department of Energy (DOE). The DTS provides particulate confinement, shielding, and heat removal during fuel transfer in conjunction with a 30 ton transfer cask and a 125 ton transport or storage cask. Only single fuel assemblies are transferred, so the criticality control is maintained by the two casks.

The DTS is designed for the on-site transfer of a single bare spent fuel assembly from a top-loading source cask with a maximum capacity of 4 PWR assemblies to a top-loading receiving cask with a maximum capacity of 21 PWR assemblies. The design of the DTS has been selected to enable handling of other fuel and interface with other casks with minor design modifications.

This topical report analyzes the safety related aspects of dry transfer within the DTS. It does not address loading of the source cask in the spent fuel pool, removal of contamination due to immersion of the cask(s) in the spent fuel pool, or preparation or loading of the source cask. It also does not address handling of the source or receiving cask other than the handling required to directly interface with the DTS. These requirements would be covered in specific cask licensing applications.

Some sections of this report identify information that can only be supplied by the applicant for a site-specific license. However, where possible, typical or bounding values for the installation or site-specific information are supplied in this report so that review of the DTS and facility interfaces is facilitated.

1.1 Introduction

The DTS is designed to allow dry transfer of fuel from one cask (taken to be a small transfer or transport cask) to a larger storage or high capacity transport cask. The DTS allows utilities which have handling restrictions to take advantage of the economic benefits of high capacity storage and transport casks. It also provides a means for utilities to unload storage casks without returning the fuel to the spent fuel pool.

The DTS consists of three areas - the Preparation Area, the Lower Access Area, and the Transfer Confinement Area (TCA). A general description of the three areas is provided below and a conceptual sketch of the DTS is provided in Figure 1.1-1. The DTS design is shown in Figure 1.2-1.

1.1.1 Preparation Area

The Preparation Area is where the receiving cask (which is to be loaded with fuel within the DTS) and source cask (which will be unloaded within the DTS) enters, is prepared for fuel transfer and later cask removal, and exits from the DTS. The Preparation Area is a weather resistant Butler-type building at the ground elevation of the transfer facility. Two entrances/exits exist to the Preparation Area. One is a roll up door for the casks and the other is a personnel access door.

The receiving and source cask arrive outside of the Preparation Area where they are mounted and locked onto a trolley mounted on rails (the Receiving and Source Cask Transfer Subsystem). The receiving and source casks are brought into the Preparation Area.

Upon proper positioning in the Preparation Area, the following activities are performed on the Receiving cask:

- Locking of the trolley in place;
- removal and storage of receiving cask lid and canister lids (A shield plug remains on the canister);
- emplacement of lid lifting pintle onto the canister shield plug;
- decontamination and radiation survey of receiving cask, if required.

These operations are performed on an empty cask.

After the receiving cask is loaded within the DTS, the following operations are performed in the Preparation Area:

- The trolley is locked in place to prevent tipover or sliding;
- Removal of lid lifting pintle from the shield plug;
- placement and welding of canister lids and receiving cask lid;

- inerting of receiving cask cavity;
- inspection and leak testing of canister lid closure welds, and
- replacement, bolting, and re-torquing of receiving cask lid.

There is only one railway into the DTS. Therefore, the source cask must enter the DTS after the receiving cask, and be removed before the receiving cask. The receiving cask will be moved into the Lower Access Area prior to moving the source cask into the Preparation Area.

Upon proper positioning in the Preparation Area, the following activities are performed on the source cask:

- unbolting of source cask lid;
- emplacement of lid lifting pintle;
- venting of the source cask gas; and
- decontamination and survey of source cask.

After the source cask is emptied within the DTS, the following operations are performed in the Preparation Area:

- Decontamination and survey of external surfaces of cask;
- Removal of lid lifting pintle; and
- Bolting of the source cask lid.

Lighting and video cameras are located in the Preparation Area so that operations can be viewed from the Control Center. The Heating Ventilating and Air Conditioning System keeps the Preparation Area at a pressure less than the ambient external pressure so that air will flow into the Preparation Area from the outside. In the event of airborne contamination, air flow will be from the outside to the inside. Radiation monitors are located in the Preparation Area to ensure that all operations are performed under safe working conditions.

1.1.2 Lower Access Area

The Lower Access Area is next to the Preparation Area and directly below the Transfer Confinement Area (TCA). This area is located within the concrete and steel structure of the DTS. The Lower Access Area provides shielding, confinement and positioning for the open source and receiving casks during fuel transfer. One entrance/exit exists for this area, a 7 to 9 inch thick steel sliding door.

The Lower Access Area is where the casks are positioned for fuel transfer operations. The source and receiving casks enter the Lower Access Area from the Preparation Area on the Cask Transfer Subsystem rails. Each cask is locked to the floor in the Lower Access Area and is mated to an opening in the steel mezzanine floor of the TCA through the Cask

Mating Subsystem which provides a confinement connection between the cask and the TCA mezzanine floor.

The Lower Access Area also houses the bulk of the HVAC equipment. Radiation Monitors are located in the Lower Access Area. Lighting and one camera are located in the Lower Access Area so that the mating of the cask can be verified from the Control Center.

Personnel are allowed access into the Lower Access Area only when the casks are closed. The source cask lid and the receiving cask shield plug are removed from the casks remotely through openings in the TCA mezzanine floor.

1.1.3 Transfer Confinement Area (TCA)

The TCA is the upper level of the transfer facility directly above the Lower Access Area. This area provides the physical confinement boundary and radiation shielding between the fuel assemblies and the environment. The TCA can only be entered through two covered openings in the roof or through two covered openings in the TCA mezzanine floor from the Lower Access Area.

The TCA is where the fuel assembly transfer from the source cask to the receiving cask occurs in the shielded structure. Removal and replacement of the receiving cask shield plug and the source cask lid are also performed (remotely) in this area.

On the roof of the TCA is the Roof Enclosure Area. This area is enclosed by a steel structure (the protective cover) which contains one personnel access door. The protective cover houses the upper crane which is used to lift and lower the receiving cask canister shield plug and source cask lid. Two openings in the roof plate directly above the source cask and receiving cask allow the upper crane access to the main region of the TCA and the casks. When the upper crane hoist is not in operation, the two openings are covered by shielded port covers. An air conditioner and heating unit are used to maintain temperature within acceptable limits in the Roof Enclosure Area.

The mezzanine floor and the cask mating system provide a confinement barrier between the Lower Access Area and the TCA. Only minimal shielding is provided between these areas, since no personnel are allowed access to the Lower Access Area during fuel transfer.

The TCA is the region where the potential for radioactive contamination is highest. It is maintained at a pressure slightly lower than atmospheric and also lower than the Preparation Area and Lower Access Area. Thus air will flow from regions of lowest potential contamination to regions of highest potential contamination.

1.1.4 Principle Features of DTS

The DTS is designed to enable loading of one receiving cask in ten 24-hour days. It is also designed to turnaround one source cask in one 24-hour day.

The DTS is designed to be constructed at any reactor site or new site where dry transfer is required. The system is designed such that the mechanical equipment can be transported to another site after completion of the fuel transfer campaign.

The principle design features that characterize the DTS are:

- Bare spent fuel assemblies are handled vertically. The fuel assemblies are lifted into a transfer tube which prevents the fuel assembly from swinging during lateral transfer. Each fuel assembly is handled individually.

- Each component is designed to perform only one function, thereby enabling the use of standard equipment and minimizing complexity.

  Several design features are incorporated to ensure that spread of contamination is minimized. Examples of these features are the crud catcher which covers the bottom of the fuel assembly during transfer; pressure differentials to ensure that air flow is from areas of lowest contamination potential to highest contamination potential; and the cask mating subsystem.

- The DTS provides confinement of radioactive contamination by the use of at least one physical barrier.

- All equipment which is operated remotely is backed up by a redundant system which can perform the same function. This can either take the form of a completely separate independent system or by providing access for manual operation from a shielded area.

- The DTS is designed to allow maintenance and repair after routine decontamination.

- The fuel handling crane and the upper crane are designed as single-failure proof cranes.

- The DTS is designed with a heating, ventilating and air conditioning system which prevents the equipment from overheating and also ensures that the decay heat load from the design basis fuel is removed to ensure that maximum fuel cladding temperature limits are not exceeded.

- The building structure, together with the sliding door, roof plate and protective cover provide sufficient shielding to ensure that the requirements of 10CFR20 and 10CFR72

are met.

- The building structure and filtration system ensure confinement of radioactive particulate.

- Ventilation is provided to ensure that occupational radiation exposures will be ALARA.

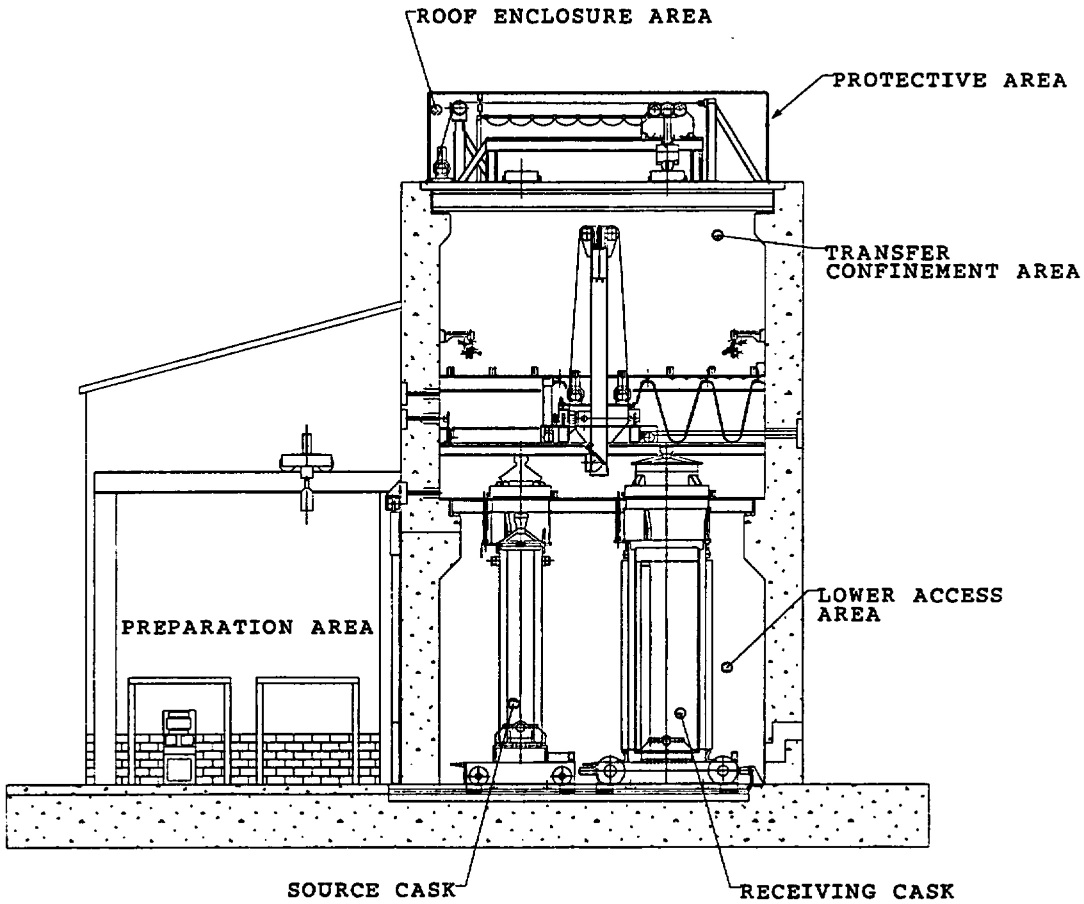
- The design of the DTS, and its construction from steel and concrete, means there is no scope for the initiation and propagation of major fires. Minor local electrical fire or hydrocarbon fires are dealt with by local extinguishers in the Preparation Area and a CO_2 fire suppression system in the TCA.

- The design of the DTS is arranged to contain any potential contamination during operation and to facilitate its removal at the decommissioning stage. The mechanical and electrical equipment are designed to be decontaminated and dismantled.

- Radioactive wastes both of solid or liquid form are minimal with the DTS design.

Figure 1.1-1

Conceptual Sketch of DTS



1.2 General Description of Installation

1.2.1 Principal Design Criteria

This Topical Report addresses the generic DTS. This DTS is designed for transferring fuel from a 30 ton 4 assembly source cask to a 125 ton receiving cask. The receiving cask selected for the base design is a multipurpose canister, with two welded lids placed inside of a transport cask. The two casks were selected to determine the feasibility of the DTS design. The DTS can be adapted to be suitable for any two casks. The site specific applications which reference this Topical Report will address any differences from the base design casks and the selected source and receiving cask.

The DTS design is based on transferring B&W 15 x 15 PWR assemblies, with an initial enrichment of 3.75 weight percent U-235 and 40,000 MWd/MTU burnup. The shielding analysis is based on 5 year cooled fuel. However, the maximum design heat load of the fuel in the receiving cask is 15.5 kW (21 assemblies).

The waste products generated from the DTS are expected to be minimal, and is primarily from the crud levels on the fuel assemblies. Waste products will consist primarily of local decontamination materials, Pre-filters and HEPA filters.

The principal design criteria for the DTS are presented in Table 1.2-1. The DTS is designed to meet the design criteria of 10CFR72.

The DTS has been subdivided into several subsystems which are functionally defined below. The subsystems are classified into three categories: Major Structural Subsystems, Major Operations Subsystems and Major Support Subsystems.

Table 1.2-1

Principal Design Criteria of the DTS

Criteria or Parameter	
Tornado Requirements (Reg Guide 1.76 and NUREG-0800)	
Max. Wind Speed	360 mph
Rotational Speed	290 mph
Translational Speed	70 mph
Pressure Drop	3.0 psi at 2 psi/sec
Tornado Missiles (NUREG-0800)	Spectrum II, Region I
Snow and Ice Pressure(ANSI/ASCE 7-88)	100 psf
Seismic(Reg Guides 1.60 & 1.61 and 10CFR72.102)	0.25 g Horizontal 0.17 g Vertical
Flood	Site Specific Provision
Ambient Temperature	-20 to 115°F
Wind Velocity (ANSI/ASCE 7-88)	110 mph
Temperature Limits	
Fuel Cladding Limits	240°C in air for 2 week period 175°C in air for 2 year period
Concrete Limits	≤ 70° F across structure wall

1.2.2 Major Structural Subsystems

The major structural components provide: a physical confinement barrier during fuel transfer; radiation shielding of fuel assemblies during transfer and while in the source and receiving casks; the structural support of the Major Operations Subsystems within the DTS; and access to the source and receiving cask while in the Lower Access Area. The major structural components are described in more detail in Section 4.2.

The structural components of the DTS are listed below:

- A concrete base pad designed to withstand seismic loading;
- A concrete building structure which forms the Lower Access Area and TCA;
- A roof plate which provides shielding above the TCA;
- A mezzanine floor plate which separates the Lower Access Area and TCA;
- A Butler-type building which provides a weather protective structure around the Preparation Area;
- A Roof Enclosure Area which protects the upper crane from the weather and tornado missiles;
- A sliding door between the Lower Access Area and the Preparation Area which allows cask entry into the Lower Access Area, and
- A roll up door which provides cask entry into the Preparation Area.

Structural details are provided in Figures 1.2-15 and 1.2-16.

1.2.3 Major Operations Subsystems

The Major Operations Subsystems are those subsystems which permit handling of the spent fuel, the receiving cask and the source cask. The locations of the subsystems are shown in Figure 1.2-1. The Major Operations Subsystems are described in detail in Section 5.2.

1.2.3.1 Receiving and Source Cask Transfer Subsystem

The Receiving and Source Cask Transfer Subsystem consists of two trolleys which are mounted on one set of rails. The rails run from the cask receipt and admittance area through the Preparation Area, and into the Lower Access Area. The casks are loaded onto the trolleys in the cask receipt and admittance area using a site specific cask transport and lifting subsystem. To minimize the size of the DTS, there is only one set of rails for the Receiving Cask Transfer Trolley and the Source Cask Transfer Trolley. Therefore, the receiving cask (the larger cask) must enter the DTS before the source cask. The Receiving Cask Transfer Subsystem is shown on Figure 1.2-2. The Source Cask Transfer Subsystem is shown on Figure 1.2-6. Each trolley is motor driven and operated using the local control panels outside and inside the Preparation Area and the Lower Access Area.

The Cask Transfer Subsystem supports the casks during all operations within the DTS,

and prevents the casks from tipping over in a seismic event.

1.2.3.2 Receiving and Source Cask Mating Subsystem

The Receiving and Source Cask Mating Subsystem mates the casks with the floor of the TCA, providing a confinement barrier between the cask and the mezzanine floor. It works in conjunction with the HVAC Subsystem to prevent spread of contamination from the TCA to the Lower Access Area. There are two Cask Mating Subsystems, one for each cask, which are based on the same operating principles. These mating devices are shown on Figures 1.2-3 and 1.2-7. Each Cask Mating Subsystem consists of an overlid with a gripping device, confinement bellows, and a motorized annular platform which supports the overlid. The overlid protects the upper surface of the cask lid from contamination. The gripping device is activated by a drive shaft which is driven by the motorized grapple of the upper crane. The confinement bellows, the annular platform and a static seal between the annular platform and the cask top surface provide the confinement barrier between the TCA and the Lower Access Area. Three electrical screw jacks enable platform lowering and lifting.

1.2.3.3 Receiving and Source Cask Transfer Confinement Port Cover Handling Subsystem

The TC port covers are used for storing the shield plug and source cask lid during fuel transfer. This was considered as a means to reduce the size of the DTS.

The TC (Transfer Confinement) port covers consist of rail mounted trolleys activated by electrical screw jacks. One port cover is positioned above each cask opening in the mezzanine floor plate. The openings allow access into the casks from the TCA for the lid and shield plug grapple and the fuel assembly grapple. The TC port covers are shown on Figure 1.2-8. The TC port covers are very similar to the upper shield port covers, but provide less shielding. A guidance device is mounted on each TC port cover, which allows the source cask lid (or MPC canister shield plug) to be accurately positioned on the port covers during fuel transfer operations.

1.2.3.4 Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem is located in the Roof Enclosure Area of the DTS. This subsystem consists of two distinct portions. One portion is the Upper Crane which is used to remove the receiving cask shield plug and the source cask lid. The second portion is the upper shield port covers which are used to provide the upper crane access to the TCA and Lower Access Area for shield plug and lid removal and replacement.

The upper crane removes the shield plug from the empty receiving cask, places it in its storage position on the TC port cover and replaces it in the receiving cask upon completion of fuel transfer. The upper crane also removes the lid from the source cask, places it in storage, and installs it onto the source cask when unloading is completed.

The upper crane is shown on Figure 1.2-4. It consists of a motorized trolley suspended on rails, a hoist and a motorized grapple. The trolley moves between two fixed positions: directly above the source cask and directly above the receiving cask. The upper crane is housed within the Roof Enclosure Area. When the TC port cover and upper shield port cover are opened, the upper crane hoist lowers the grapple through the opening of the roof plate and the TC mezzanine floor. The grapple engages with a lifting pintle on the cask mating subsystem overlid (See Section 1.2.3.2). The gripping device of the overlid is also activated. The overlid and the lid (or shield plug) are then raised above the top of the TC port cover. While the overlid and lid (or shield plug) are suspended, the TC port cover is moved underneath the lid (or shield plug). The overlid and lid (or shield plug) are then lowered onto the TC port cover for temporary storage. Note that the upper crane is never moved laterally while under load.

During fuel transfer, the grapple is retracted into the Roof Enclosure Area, where it is shielded by the roof plate and upper shield port covers.

The upper shield port covers consist of rail-mounted trolleys activated by electrical screw jacks. They provide shielding over the openings in the roof plate. One port cover is positioned above each opening in the roof plate (above each cask). The openings allow access into the TCA from the Roof Enclosure Area for the lid and shield plug grapple. The upper shield port covers are shown on Figure 1.2-4.

1.2.3.5 Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem is designed to engage a fuel assembly in the source cask by use of a conventional fuel grapple, lift it vertically (in the Z-direction) into the transfer tube, translate it laterally (in both the X and Y directions), and rotate the fuel tube containing the fuel assembly about the centerline to position it directly above the opening in the fuel assembly compartment of the receiving cask. The fuel assembly is then fully lowered into the cask and the fuel grapple is disengaged. Since the Subsystem has a full range of motion in the X, Y, Z and θ directions, it is adaptable to any source and/or receiving cask.

The Fuel Assembly Handling Subsystem consists of:

- A bridge supporting a trolley with two girders and end ties running on rails (X-direction),

- A motor driven trolley supporting a rotating platform and running on bridge girders

(Y-Direction),

- A rotating platform supporting the Z-direction hoists and allowing correct orientation of the transfer tube above the cask basket cell (θ-Direction),

- A transfer tube which encloses and protects the fuel assembly during lateral movement,

- A spent fuel assembly grapple, and

- A crud catcher at the bottom of the fuel transfer tube which provides a confinement function for minimizing the potential spread of contamination from the spallation of crud from the fuel assembly in the TCA.

Two cameras and associated lighting are mounted at the base of the transfer tube. These cameras are used to verify identification of each fuel assembly and ensure that the fuel is properly lifted and lowered into the fuel assembly compartment of the source or receiving cask. The Fuel Assembly Handling Subsystem is shown in Figure 1.2-9.

1.2.3.6 Control Subsystem

The Control Subsystem controls and monitors system operations, including the Radiation Monitoring Subsystem and the HVAC Subsystem. The operations performed in the Preparation Area are locally controlled. The operations performed in the Lower Access Area and in the TCA are monitored and controlled remotely. The Control Subsystem is housed in a trailer, and can be disconnected and moved from one site to another. The Control Subsystem is described in detail in Section 5.5.

1.2.3.7 Closed Circuit Television Subsystem and Lighting Subsystem

The CCTV Subsystem provides viewing to align the casks with the Cask Mating Subsystem, to operate the Fuel Assembly Handling Subsystem, to operate the TC Port Cover, to remove and replace the receiving cask shield plug and the source cask lid, and monitor personnel operations. The CCTV Subsystem is also used for various inspection functions as well as the verification of the fuel assembly identification. There are six cameras in the TCA including two mounted on the fuel transfer tube, one camera in the Lower Access Area and one camera in the Preparation Area. The locations of each of the TV cameras within the DTS are shown on Figure 1.2-14.

This subsystem also provides lighting of the TCA to enable CCTV viewing of system component and operations. Additional general lighting will be provided in the TCA to ensure that operations can proceed and that will allow personnel access for maintenance and repair. This Subsystem provides lighting in the Preparation Area and Lower Access Area to enable the direct and/or CCTV viewing of the operation of the Cask Transfer Subsystem, the

Canister Welding Subsystem, and the Cask Vacuum/Inerting/Leak Test Subsystem, and the Receiving Cask Lid Handling Subsystem.

1.2.4 Major Support Subsystems

The major support subsystems are the other systems which are not part of the structural nor directly a part of the major operation subsystems. These subsystems are described below.

1.2.4.1 HVAC Subsystem

The Heating, Ventilation and Air Conditioning (HVAC) Subsystem maintains negative pressure in the Preparation Area, the Lower Access Area, and the TCA relative to ambient and provides high efficiency filtration for particulate that may be released from assemblies. The HVAC Subsystem maintains air temperature at design levels for the design heat load to allow proper functioning of the operating equipment, monitors, cameras and lighting, as well as to ensure that the fuel clad temperature does not exceed specified levels. The HVAC subsystem is shown in Figures 1.2-12 and 1.2-13. The HVAC Subsystem is described in detail in Section 5.3.1.

1.2.4.2 Radiation Monitoring Subsystem

The Radiation Monitoring Subsystem measures radiation and fixed and removable contamination levels in specified locations and on specified surfaces. It also measures airborne radioactive materials in specified locations. Measurements may be used for record and/or for notification of operating personnel of levels in occupied areas of the DTS or on specified surfaces. The Radiation Monitoring Subsystem also measures the effectiveness of the Decontamination Subsystem. The radiation monitors in the Lower Access Area are interlocked with the sliding door operation to ensure that the door cannot be opened unless the radiation level within the Lower Access Area is low enough to allow personnel entry. The Radiation Monitoring Subsystem is shown in Figure 1.2-10. The Radiation Monitoring Subsystem is described in detail in Section 7.3.1.

1.2.4.3 Receiving Cask Lid Handling Subsystem

The Receiving Cask Lid Handling Subsystem removes the lid from an empty receiving cask, stores it during cask loading, and replaces it when the cask is loaded. This subsystem also removes the two lids from the receiving cask canister, stored them during cask loading, and replaces them when the cask is loaded. This Subsystem is located in the Preparation Area and is shown on Figures 1.2-19 and 1.2-20.

1.2.4.4 Decontamination Subsystem

This Subsystem is designed to collect and contain loose particulate contamination from

the cask surfaces exposed to the interior of the TCA and equipment and surfaces in the DTS. This subsystem is discussed in more detail in Section 4.4.

1.2.5 Other Subsystems, not provided as Part of the DTS

This section describes systems which are not provided as part of the DTS, but may be needed by the utility or other user to properly make use of the DTS.

1.2.5.1 Cask Transport and Lifting Subsystem

A means for loading the receiving cask and source cask onto their respective trolleys outside of the Preparation Area is required. The equipment selected is required to be capable of lifting the loaded receiving cask, 125 tons, 26 inches (640 mm) above ground elevation and capable of lifting the loaded source cask, 30 tons, 46 inches (1170 mm) above ground elevation.

1.2.5.2 Cask Vacuum/Inerting/Leak Test System

This system evacuates, pressurizes with inert gas, and leak tests the receiving cask. The equipment designed for the receiving cask will be adopted for use in the DTS. These operations will be performed in the Preparation Area.

1.2.5.3 Canister Welding Subsystem

It is assumed that the receiving cask will have a welded canister. Therefore, a means to weld the canister lid(s) must be provided. The welding equipment which will be designed for the receiving cask will be adopted for use in the DTS. Welding will be performed in the Preparation Area.

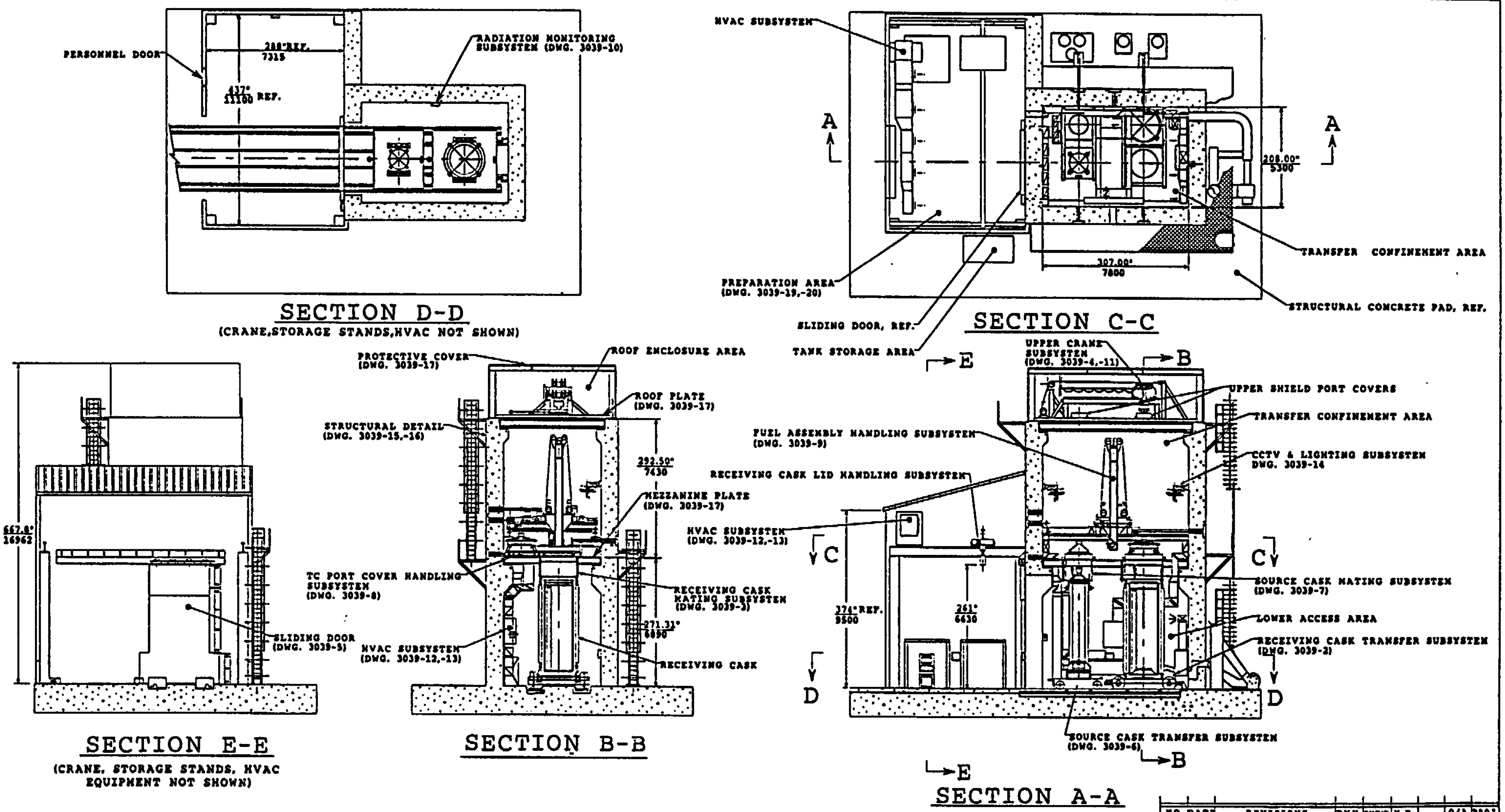
1.2.5.4 DTS Power Subsystem

Primary and secondary electrical power as noted in this Topical Report will be provided by the collocated utility. The DTS Power Subsystem is described in Section 4.3.2.

1.2.6 Master Drawing List

The DTS design drawings are provided as a part of this Section. A list of the design drawings are provided below.

Title	Drawing No.	Rev.	Fig No.	Old Ref.
General Overview	3039-1	0	1.2-1	1051-1
Receiving Cask Transfer Subsystem	3039-2	0	1.2-2	1051-2
Receiving Cask Mating Subsystem	3039-3	0	1.2-3	1051-3
Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem	3039-4	0	1.2-4	1051-4
Sliding Door	3039-5	0	1.2-5	1051-5
Source Cask Transfer Subsystem	3039-6	0	1.2-6	1051-8
Source Cask Mating Subsystem	3039-7	0	1.2-7	1051-9
TC Port Cover Handling Subsystem	3039-8	0	1.2-8	1051-10
Fuel Assembly Handling Subsystem	3039-9	0	1.2-9	1051-13
Radiation Monitoring	3039-10	0	1.2-10	1051-14
Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem	3039-11	0	1.2-11	1051-18
HVAC Subsystem	3039-12	0	1.2-12	1051-11
HVAC Control Subsystem	3039-13	0	1.2-13	1051-15
Closed Circuit Television Subsystem	3039-14	0	1.2-14	1051-41
Structural Detail	3039-15	0	1.2-15	1051-12
Structural Details	3039-16	0	1.2-16	1051-16
Roof Plate, Weather Protective Cover and Mezzanine Details	3039-17	0	1.2-17	1051-27
Penetration Details	3039-18	0	1.2-18	1051-28
Preparation Area Details	3039-19	0	1.2-19	1051-29
Preparation Area Details	3039-20	0	1.2-20	1051-30



NO.	DATE	REVISIONS	DWN.	CHK'D	M.D.	Q/A	PROJ.

TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

DRY TRANSFER SYSTEM
GENERAL OVERVIEW

SCALE: NONE | SIZE: B | DWG. NO.: 3039-1 | REV.: 0

Figure 1.2-1

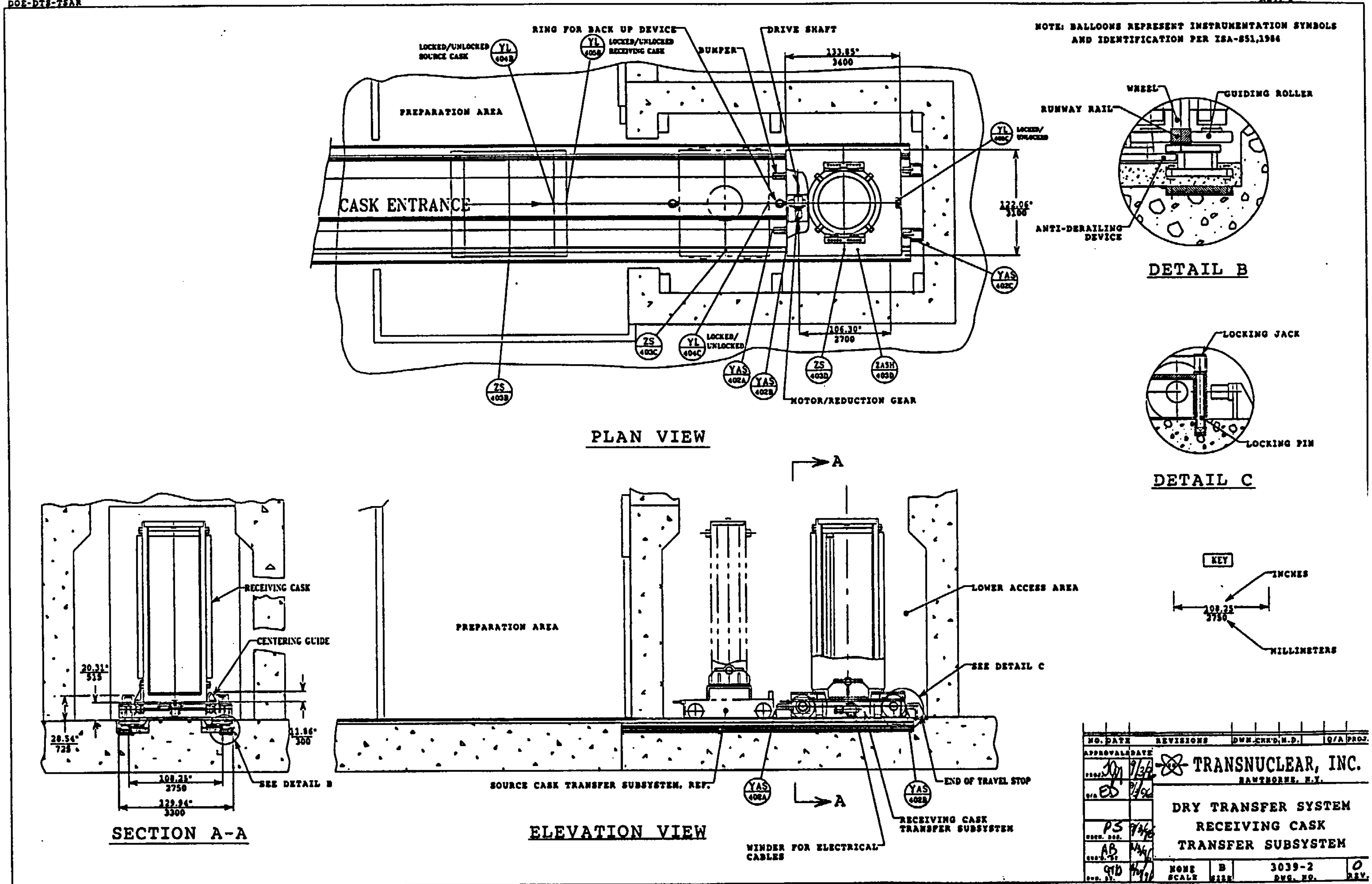

NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51,1984
RING FOR BACK UP DEVICE
DRIVE SHAFT
BUMPER
LOCKED/UNLOCKED SOURCE CASK
LOCKED/UNLOCKED RECEIVING CASK
PREPARATION AREA
CASK ENTRANCE
133.85"
3400
122.06"
3100
106.30"
2700
MOTOR/REDUCTION GEAR
LOCKED/UNLOCKED
PLAN VIEW
WHEEL
GUIDING ROLLER
RUNWAY RAIL
ANTI-DERAILING DEVICE
DETAIL B
LOCKING JACK
LOCKING PIN
DETAIL C
RECEIVING CASK
CENTERING GUIDE
20.31"
515
28.54"
725
11.86"
300
108.25"
2750
129.94"
3300
SEE DETAIL B
SECTION A-A
PREPARATION AREA
LOWER ACCESS AREA
SEE DETAIL C
END OF TRAVEL STOP
SOURCE CASK TRANSFER SUBSYSTEM, REF.
RECEIVING CASK TRANSFER SUBSYSTEM
WINDER FOR ELECTRICAL CABLES
ELEVATION VIEW
KEY
INCHES
108.25"
2750
MILLIMETERS
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
RECEIVING CASK
TRANSFER SUBSYSTEM
NONE
SCALE
B
SIZE
3039-2
DWG. NO.
0
REV.

Figure 1.3-3

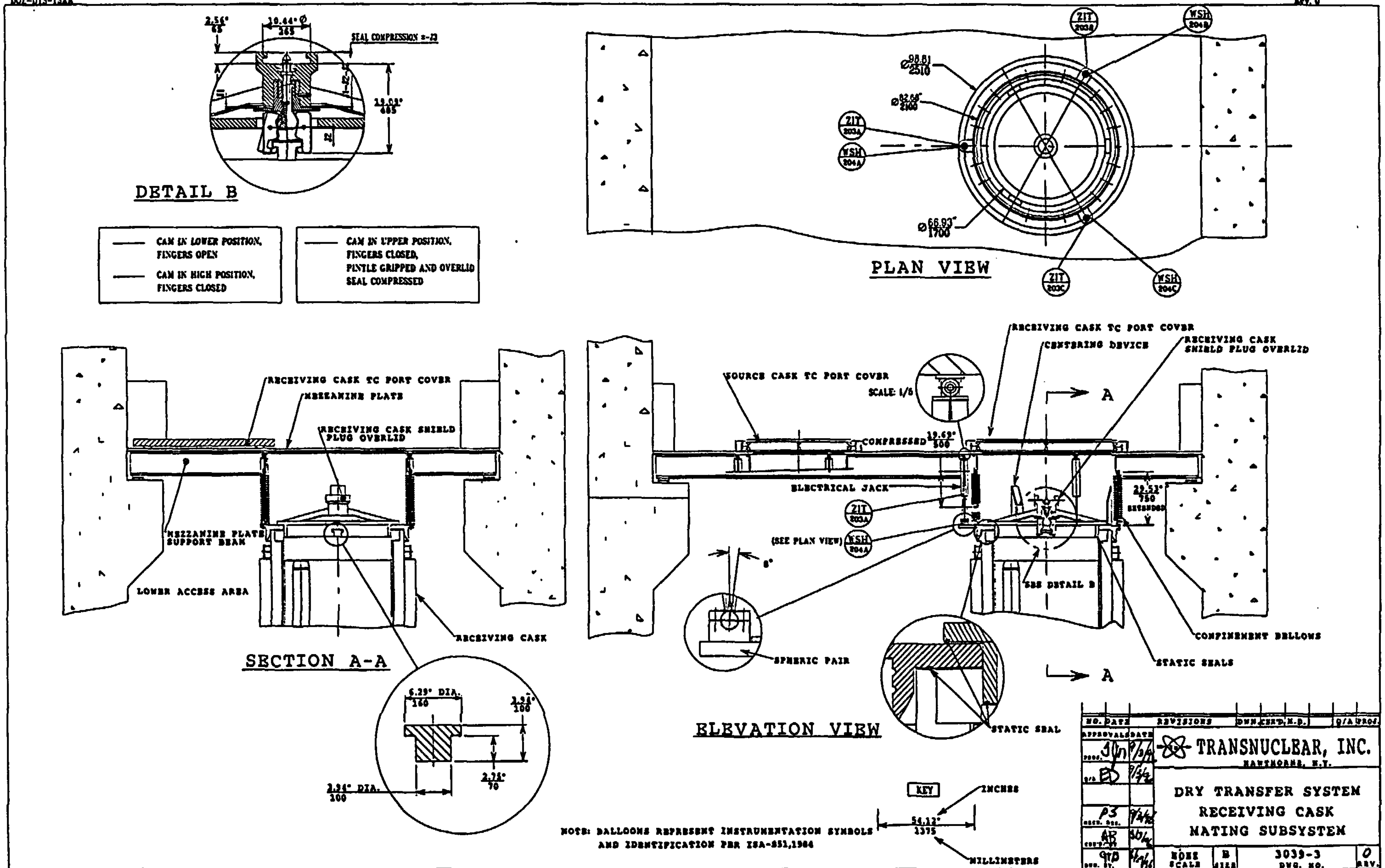

DETAIL B
SEAL COMPRESSION =.23
CAM IN LOWER POSITION, FINGERS OPEN
CAM IN HIGH POSITION, FINGERS CLOSED
CAM IN UPPER POSITION, FINGERS CLOSED, PINTLE GRIPPED AND OVERLID SEAL COMPRESSED
PLAN VIEW
ZIT 203A
WSH 204A
ZIT 203C
WSH 204C
WSH 204B
SECTION A-A
RECEIVING CASK TC PORT COVER
MEZZANINE PLATE
RECEIVING CASK SHIELD PLUG OVERLID
MEZZANINE PLATE SUPPORT BEAM
LOWER ACCESS AREA
RECEIVING CASK
ELEVATION VIEW
SOURCE CASK TC PORT COVER
SCALE: 1/5
COMPRESSED
CENTERING DEVICE
RECEIVING CASK SHIELD PLUG OVERLID
ELECTRICAL JACK
(SEE PLAN VIEW)
EXTENDED
SEE DETAIL B
SPHERIC PAIR
STATIC SEALS
STATIC SEAL
CONFINEMENT BELLOWS
KEY
INCHES
MILLIMETERS
NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51,1984
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
RECEIVING CASK
MATING SUBSYSTEM
NONE SCALE
B SIZE
3039-3 DWG. NO.
0 REV.

Figure 12-3

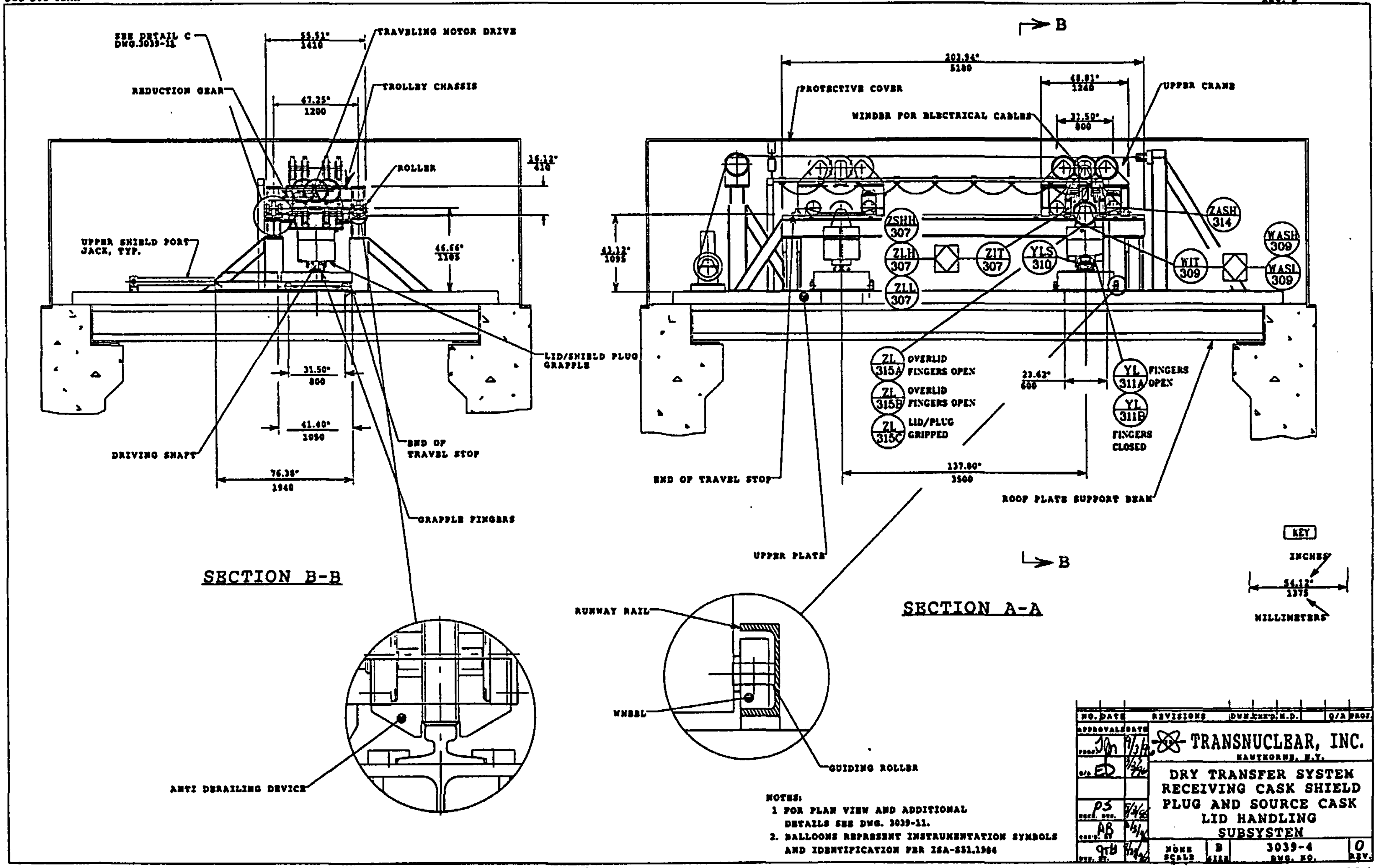

SEE DETAIL C
DWG.3039-11
REDUCTION GEAR
55.51"
1410
TRAVELING MOTOR DRIVE
47.25"
1200
TROLLEY CHASSIS
ROLLER
16.12"
410
UPPER SHIELD PORT JACK, TYP.
46.66"
1185
LID/SHIELD PLUG GRAPPLE
31.50"
800
41.40"
1050
DRIVING SHAFT
END OF TRAVEL STOP
76.38"
1940
GRAPPLE FINGERS
SECTION B-B
ANTI DERAILING DEVICE
B
203.94"
5180
PROTECTIVE COVER
48.81"
1240
UPPER CRANE
WINDER FOR ELECTRICAL CABLES
31.50"
800
43.12"
1095
ZSHH
307
ZLH
307
ZLL
307
ZIT
307
YLS
310
ZASH
314
WASH
309
WIT
309
WASL
309
ZL
315A
OVERLID FINGERS OPEN
ZL
315B
OVERLID FINGERS OPEN
ZL
315C
LID/PLUG GRIPPED
23.62"
600
YL
311A
FINGERS OPEN
YL
311B
FINGERS CLOSED
137.80"
3500
END OF TRAVEL STOP
ROOF PLATE SUPPORT BEAM
UPPER PLATE
B
SECTION A-A
KEY
INCHES
54.12"
1375
MILLIMETERS
RUNWAY RAIL
WHEEL
GUIDING ROLLER
NOTES:
1 FOR PLAN VIEW AND ADDITIONAL DETAILS SEE DWG. 3039-11.
2. BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51.1984
NO. DATE
REVISIONS
DWN. CHK'D. M.D.
Q/A
PROJ.
APPROVALS
DATE
PROJ.
Q/A
MECH. DES.
CHK'D. BY
DWN. BY
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM RECEIVING CASK SHIELD PLUG AND SOURCE CASK LID HANDLING SUBSYSTEM
NONE
SCALE
B
SIZE
3039-4
DWG. NO.
0
REV.

Figure 1.2-4

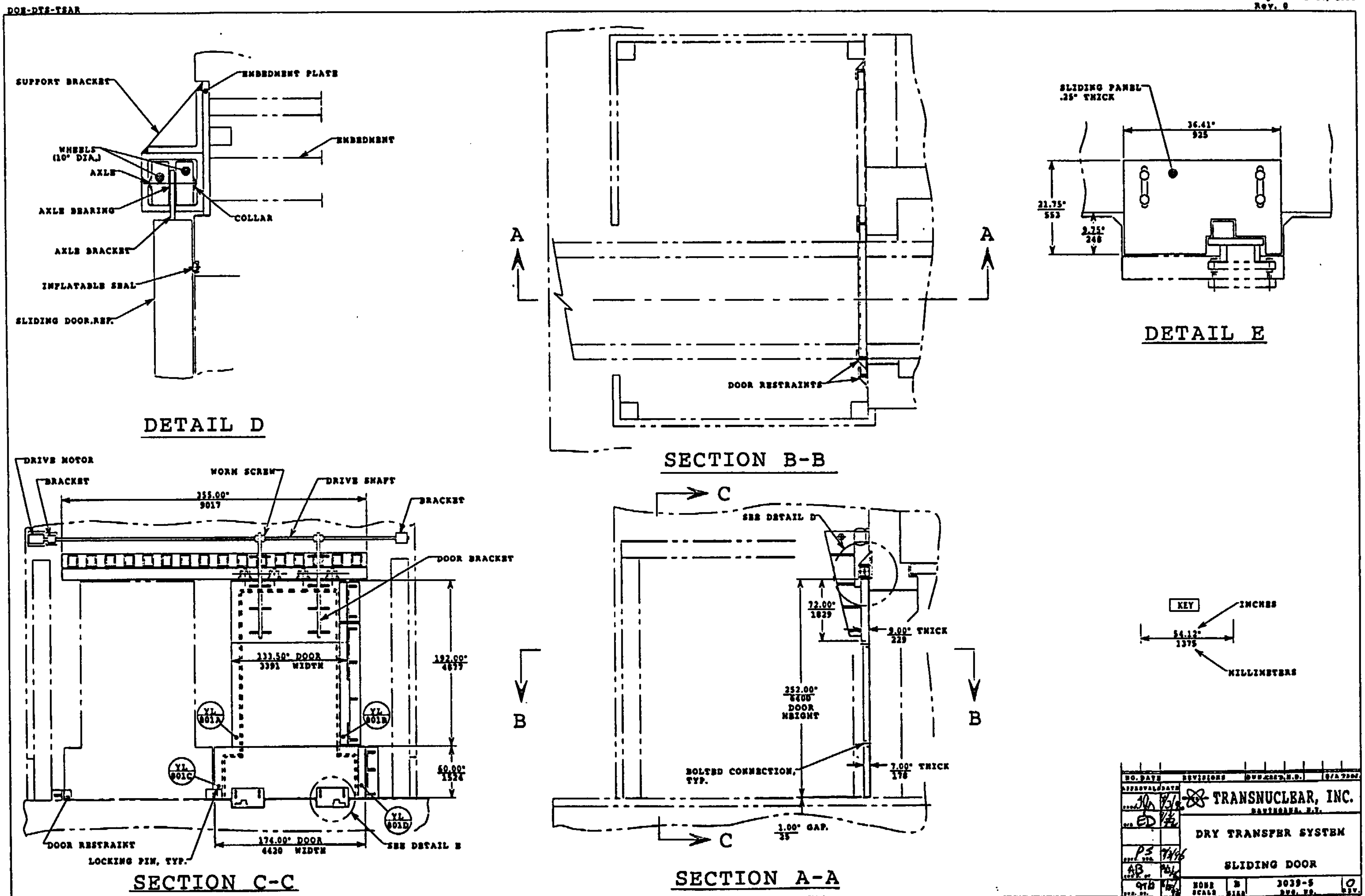

SUPPORT BRACKET
EMBEDMENT PLATE
EMBEDMENT
WHEELS (10" DIA.)
AXLE
AXLE BEARING
COLLAR
AXLE BRACKET
INFLATABLE SEAL
SLIDING DOOR REF.
DETAIL D
A
A
DOOR RESTRAINTS
SECTION B-B
SLIDING PANEL .25" THICK
36.41"
925
21.75"
553
9.75"
248
DETAIL E
DRIVE MOTOR
BRACKET
WORM SCREW
DRIVE SHAFT
BRACKET
355.00"
9017
DOOR BRACKET
133.50" DOOR
3391 WIDTH
192.00"
4877
60.00"
1524
YL 901A
YL 901B
YL 901C
YL 901D
DOOR RESTRAINT
LOCKING PIN, TYP.
174.00" DOOR
4420 WIDTH
SEE DETAIL E
SECTION C-C
C
SEE DETAIL D
72.00"
1829
9.00" THICK
229
252.00"
6400
DOOR HEIGHT
BOLTED CONNECTION, TYP.
7.00" THICK
178
1.00" GAP.
25
C
B
B
SECTION A-A
KEY
INCHES
54.12"
1375
MILLIMETERS
NO. DATE
REVISIONS
APPROVALS DATE
TRANSNUCLEAR, INC.
DRY TRANSFER SYSTEM
SLIDING DOOR
NONE
SCALE
B
SIZE
3039-5
DWG. NO.
0
REV.

Figure 1.3-5

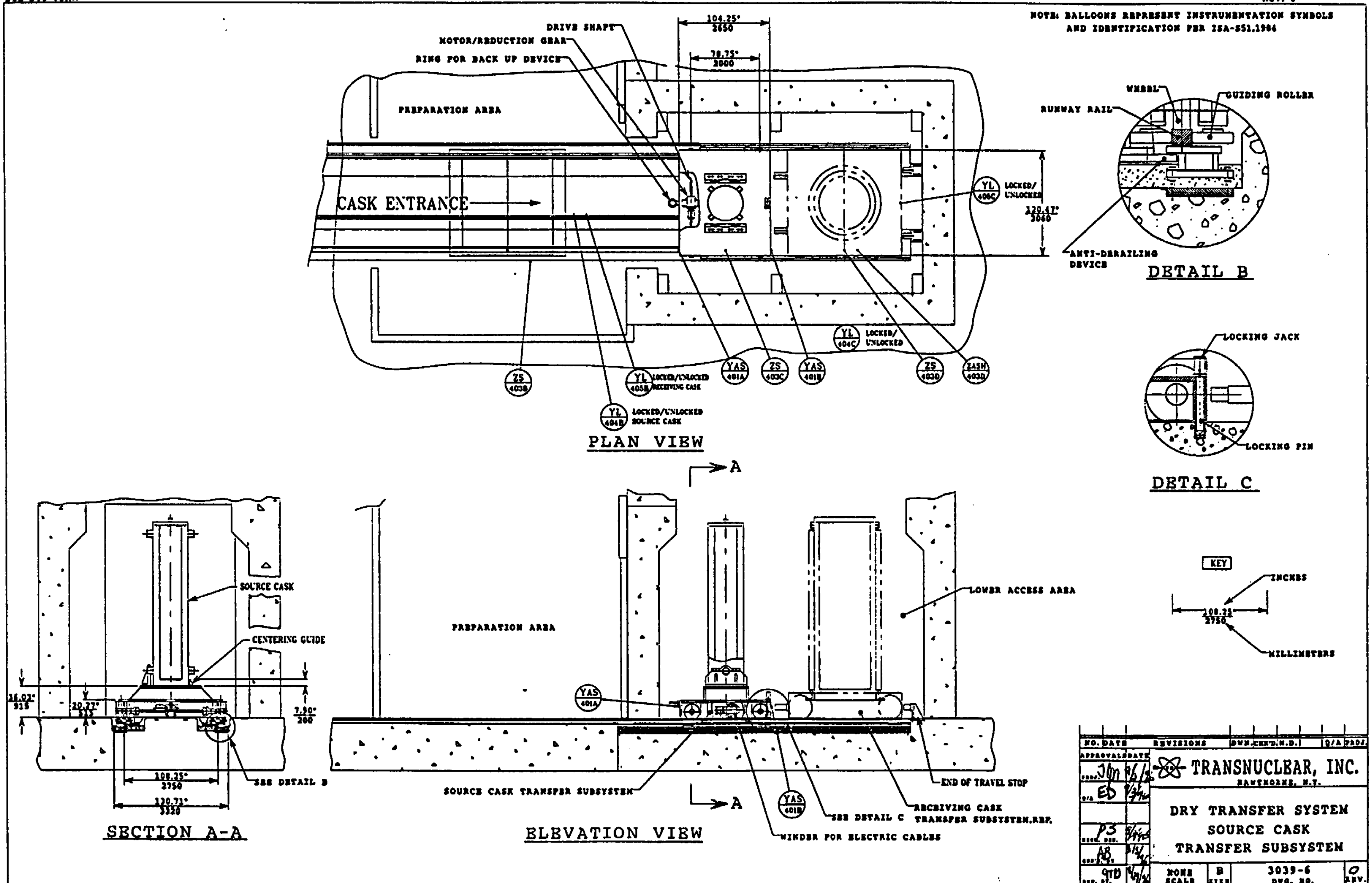

NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51.1984
DRIVE SHAFT
MOTOR/REDUCTION GEAR
RING FOR BACK UP DEVICE
104.25"
2650
78.75"
2000
PREPARATION AREA
CASK ENTRANCE
120.47"
3060
YL 406C LOCKED/UNLOCKED
YL 404C LOCKED/UNLOCKED
ZS 403B
YL 405B LOCKED/UNLOCKED RECEIVING CASK
YL 404B LOCKED/UNLOCKED SOURCE CASK
YAS 401A
ZS 403C
YAS 401B
ZS 403D
ZASH 403D
PLAN VIEW
WHEEL
GUIDING ROLLER
RUNWAY RAIL
ANTI-DERAILING DEVICE
DETAIL B
LOCKING JACK
LOCKING PIN
DETAIL C
SOURCE CASK
CENTERING GUIDE
36.02"
915
20.27"
515
7.90"
200
108.25"
2750
130.71"
3320
SEE DETAIL B
SECTION A-A
A
PREPARATION AREA
LOWER ACCESS AREA
YAS 401A
YAS 401B
SOURCE CASK TRANSFER SUBSYSTEM
END OF TRAVEL STOP
RECEIVING CASK TRANSFER SUBSYSTEM,REF.
SEE DETAIL C
WINDER FOR ELECTRIC CABLES
ELEVATION VIEW
KEY
INCHES
108.25"
2750
MILLIMETERS
NO. DATE REVISIONS DWN. CHK'D. N.D. Q/A PROJ.
APPROVAL DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
SOURCE CASK
TRANSFER SUBSYSTEM
NONE SCALE
B SIZE
3039-6 DWG. NO.
0 REV.

Figure 1.2-6

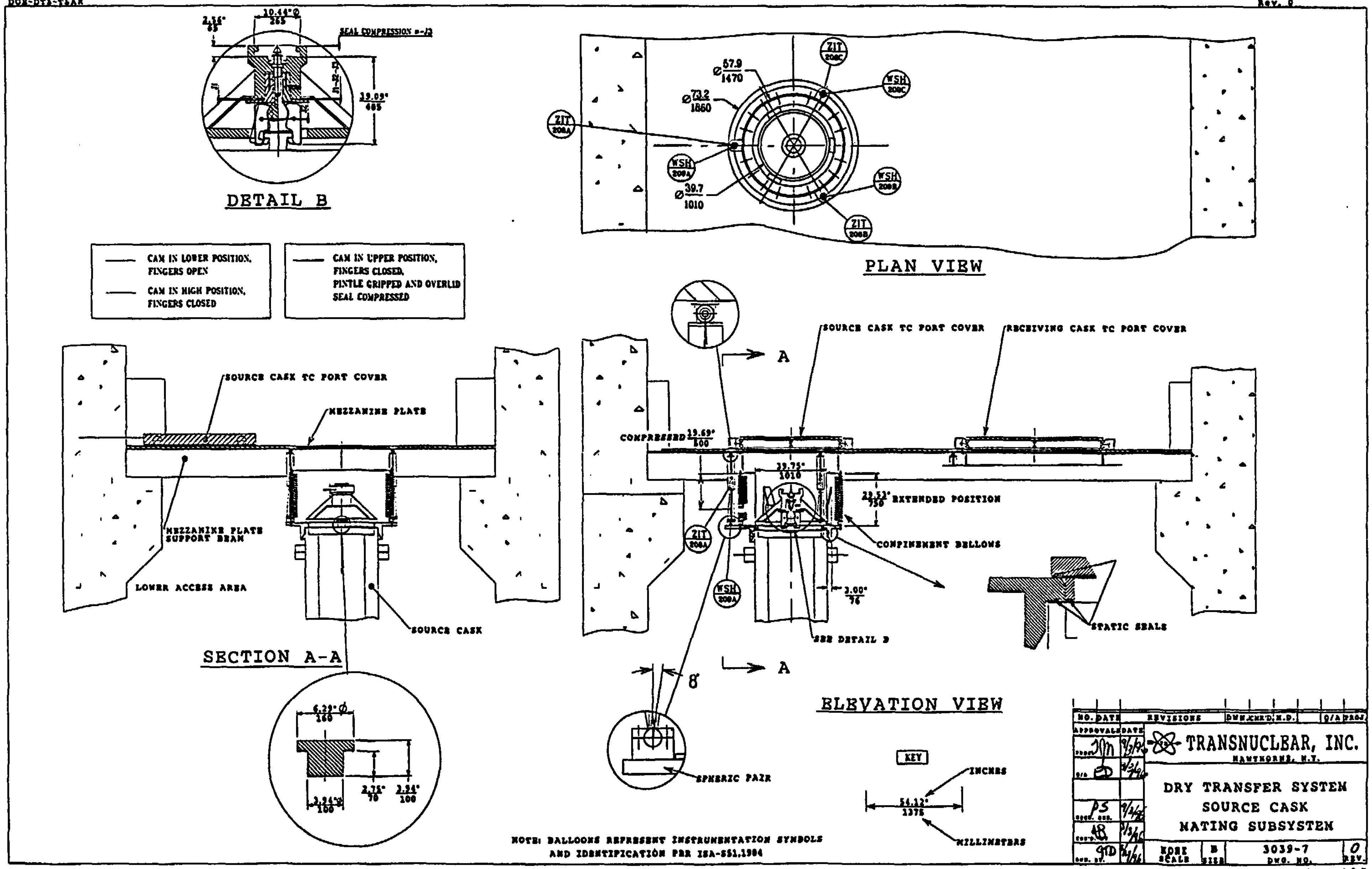

DETAIL B
SEAL COMPRESSION
CAM IN LOWER POSITION, FINGERS OPEN
CAM IN HIGH POSITION, FINGERS CLOSED
CAM IN UPPER POSITION, FINGERS CLOSED, PINTLE GRIPPED AND OVERLID SEAL COMPRESSED
PLAN VIEW
SOURCE CASK TC PORT COVER
MEZZANINE PLATE
MEZZANINE PLATE SUPPORT BEAM
LOWER ACCESS AREA
SOURCE CASK
SECTION A-A
RECEIVING CASK TC PORT COVER
COMPRESSED
EXTENDED POSITION
CONFINEMENT BELLOWS
STATIC SEALS
SEE DETAIL B
SPHERIC PAIR
ELEVATION VIEW
KEY
INCHES
MILLIMETERS
NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51.1984
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
SOURCE CASK
MATING SUBSYSTEM
NONE
B
3039-7
0

Figure 1.3-7

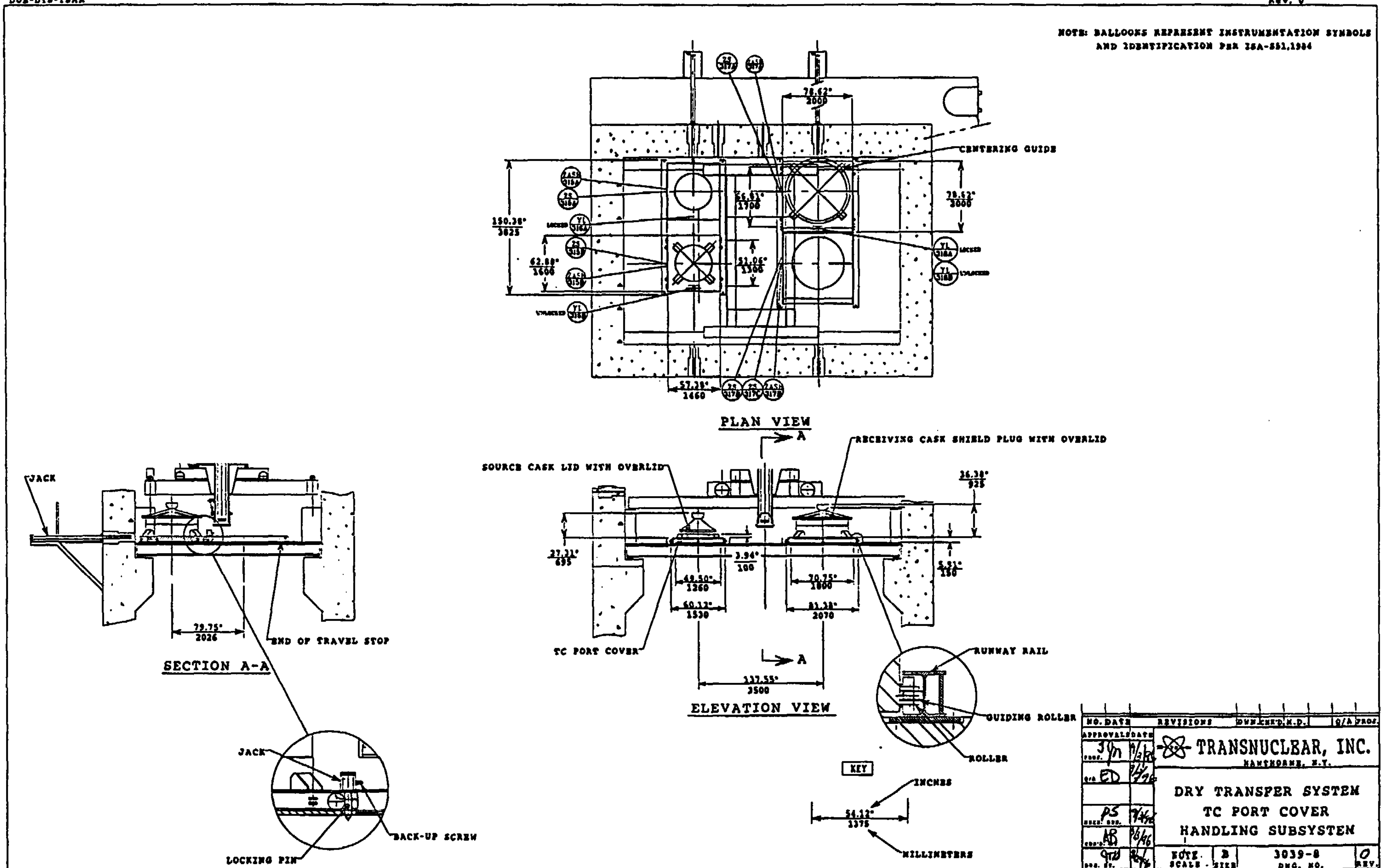
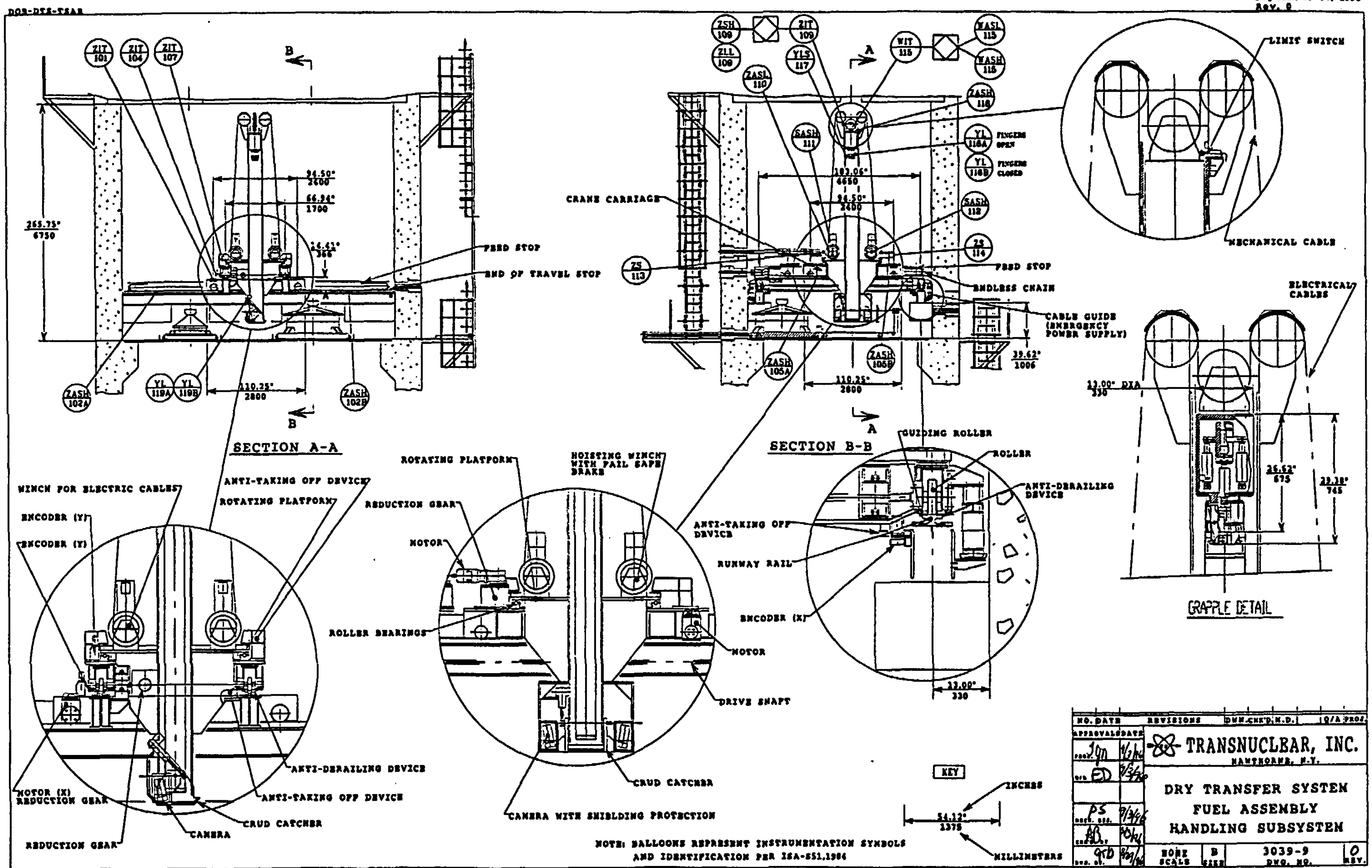

NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51,1984
CENTERING GUIDE
PLAN VIEW
SOURCE CASK LID WITH OVERLID
RECEIVING CASK SHIELD PLUG WITH OVERLID
TC PORT COVER
ELEVATION VIEW
RUNWAY RAIL
GUIDING ROLLER
ROLLER
JACK
END OF TRAVEL STOP
SECTION A-A
BACK-UP SCREW
LOCKING PIN
KEY
INCHES
MILLIMETERS
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
TC PORT COVER
HANDLING SUBSYSTEM
3039-8
DWG. NO.
REV. 0

Figure 1.2-8


SECTION A-A
SECTION B-B
GRAPPLE DETAIL
ZIT 101
ZIT 104
ZIT 107
ZSH 109
ZIT 109
ZLL 109
YLS 117
ZASL 110
WIT 115
WASL 115
WASH 115
ZASH 118
SASH 111
YL 116A FINGERS OPEN
YL 116B FINGERS CLOSED
SASH 112
ZS 114
ZS 113
ZASH 105A
ZASH 105B
ZASH 102A
ZASH 102B
YL 119A
YL 119B
265.75" 6750
94.50" 2400
66.94" 1700
14.41" 366
110.25" 2800
183.06" 4650
94.50" 2400
110.25" 2800
39.62" 1006
13.00" DIA 330
26.62" 675
29.38" 745
13.00" 330
FEED STOP
END OF TRAVEL STOP
CRANE CARRIAGE
ENDLESS CHAIN
CABLE GUIDE (EMERGENCY POWER SUPPLY)
LIMIT SWITCH
MECHANICAL CABLE
ELECTRICAL CABLES
WINCH FOR ELECTRIC CABLES
ANTI-TAKING OFF DEVICE
ROTATING PLATFORM
ENCODER (Y)
ENCODER (Y)
ANTI-DERAILING DEVICE
MOTOR (X) REDUCTION GEAR
ANTI-TAKING OFF DEVICE
CRUD CATCHER
CAMERA
REDUCTION GEAR
ROTATING PLATFORM
HOISTING WINCH WITH FAIL SAFE BRAKE
REDUCTION GEAR
MOTOR
ROLLER BEARINGS
MOTOR
DRIVE SHAFT
CRUD CATCHER
CAMERA WITH SHIELDING PROTECTION
GUIDING ROLLER
ROLLER
ANTI-DERAILING DEVICE
ANTI-TAKING OFF DEVICE
RUNWAY RAIL
ENCODER (X)
KEY
INCHES
54.12" 1375
MILLIMETERS
NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51.1984
NO. DATE REVISIONS DWN. CHK'D. M.D. Q/A PROJ.
APPROVALS DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
FUEL ASSEMBLY
HANDLING SUBSYSTEM
NONE SCALE
B SIZE
3039-9 DWG. NO.
0 REV.

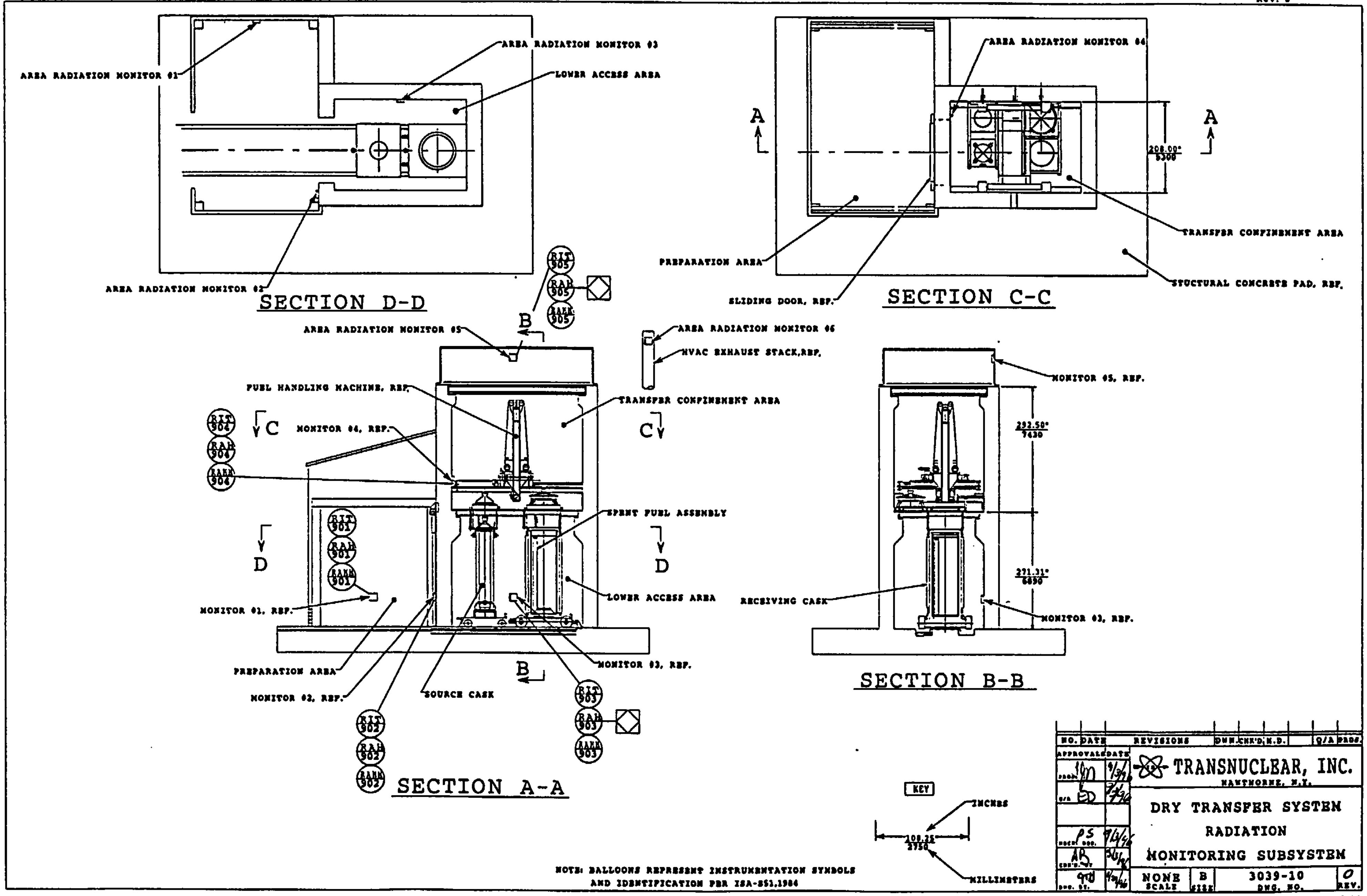

AREA RADIATION MONITOR #1
AREA RADIATION MONITOR #3
LOWER ACCESS AREA
AREA RADIATION MONITOR #2
SECTION D-D
AREA RADIATION MONITOR #4
PREPARATION AREA
TRANSFER CONFINEMENT AREA
STUCTURAL CONCRETE PAD, REF.
SLIDING DOOR, REF.
208.00"
5300
SECTION C-C
RIT 905
RAH 905
RAHH 905
AREA RADIATION MONITOR #5
AREA RADIATION MONITOR #6
HVAC EXHAUST STACK,REF.
FUEL HANDLING MACHINE, REF.
TRANSFER CONFINEMENT AREA
MONITOR #4, REF.
RIT 904
RAH 904
RAHH 904
RIT 901
RAH 901
RAHH 901
SPENT FUEL ASSEMBLY
LOWER ACCESS AREA
MONITOR #1, REF.
PREPARATION AREA
MONITOR #2, REF.
SOURCE CASK
MONITOR #3, REF.
RIT 902
RAH 902
RAHH 902
RIT 903
RAH 903
RAHH 903
SECTION A-A
MONITOR #5, REF.
292.50"
7430
271.31"
6890
RECEIVING CASK
MONITOR #3, REF.
SECTION B-B
KEY
INCHES
108.25
2750
MILLIMETERS
NOTE: BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51,1984
NO. DATE REVISIONS DWN CHK'D M.D. Q/A PROJ.
APPROVALS DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
RADIATION
MONITORING SUBSYSTEM
NONE SCALE
B SIZE
3039-10 DWG. NO.
0 REV.

Figure 1.3-10

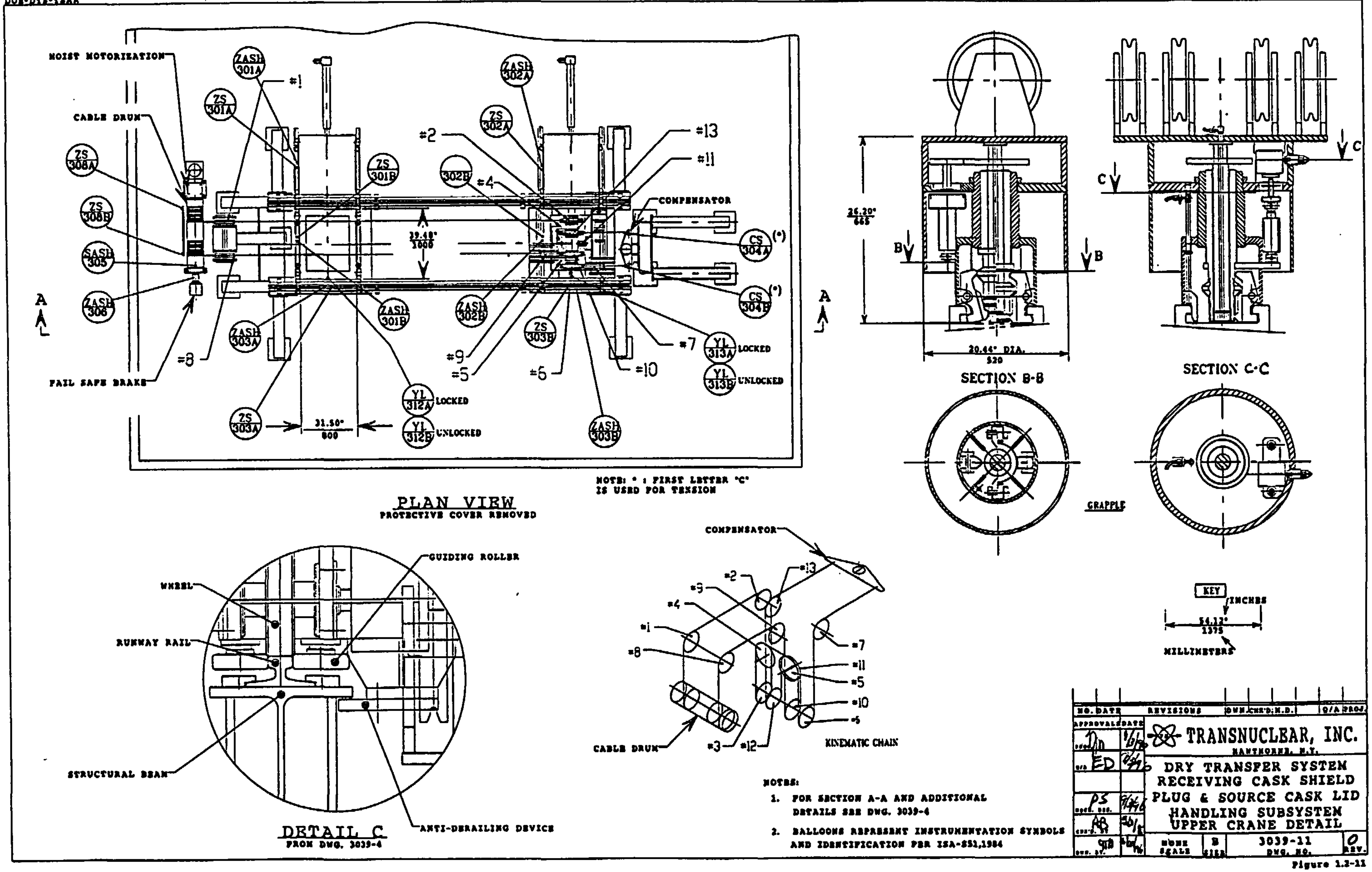
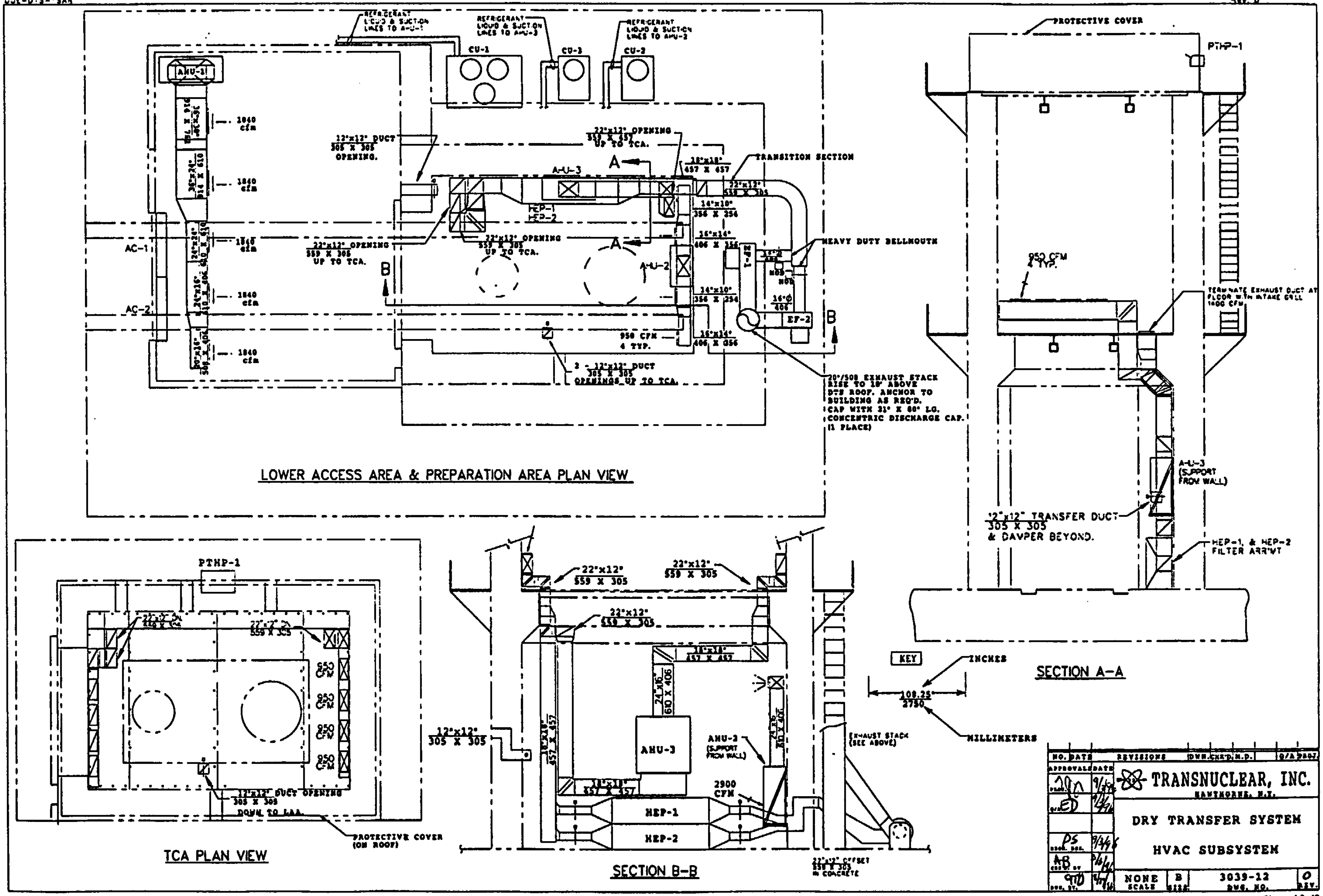
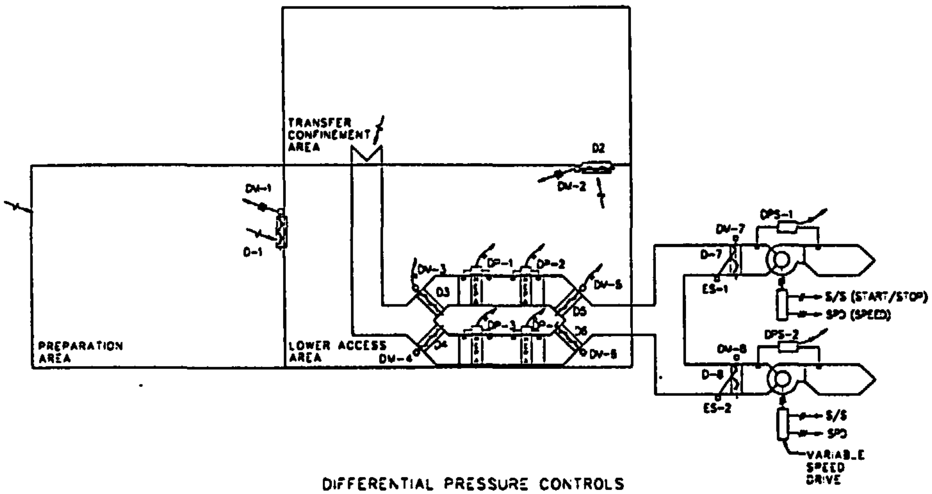

HOIST MOTORIZATION
CABLE DRUM
FAIL SAFE BRAKE
COMPENSATOR
ZASH 301A
ZS 301A
ZS 301B
ZASH 301B
ZASH 302A
ZS 302A
302B
ZASH 302B
ZASH 303A
ZS 303A
ZS 303B
ZASH 303B
ZS 308A
ZS 308B
SASH 305
ZASH 306
CS 304A
CS 304B
YL 312A LOCKED
YL 312B UNLOCKED
YL 313A LOCKED
YL 313B UNLOCKED
39.48"
1000
31.50"
800
NOTE: * : FIRST LETTER "C" IS USED FOR TENSION
PLAN VIEW
PROTECTIVE COVER REMOVED
26.20"
665
20.44" DIA.
520
SECTION B-B
SECTION C-C
GRAPPLE
KEY
INCHES
54.13"
1375
MILLIMETERS
GUIDING ROLLER
WHEEL
RUNWAY RAIL
STRUCTURAL BEAM
ANTI-DERAILING DEVICE
DETAIL C
FROM DWG. 3039-4
KINEMATIC CHAIN
NOTES:
1. FOR SECTION A-A AND ADDITIONAL DETAILS SEE DWG. 3039-4
2. BALLOONS REPRESENT INSTRUMENTATION SYMBOLS AND IDENTIFICATION PER ISA-S51,1984
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
RECEIVING CASK SHIELD
PLUG & SOURCE CASK LID
HANDLING SUBSYSTEM
UPPER CRANE DETAIL
NONE SCALE
B SIZE
3039-11 DWG. NO.
0 REV.

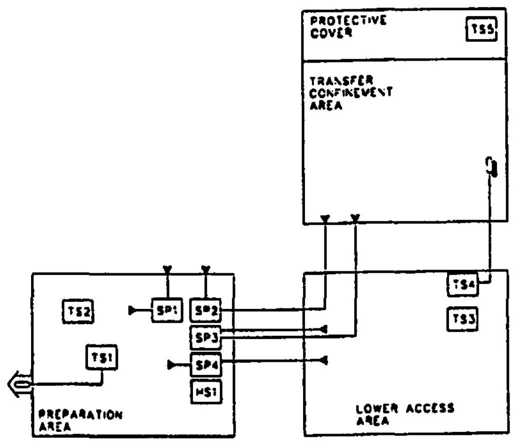
Figure 1.2-11


LOWER ACCESS AREA & PREPARATION AREA PLAN VIEW
TCA PLAN VIEW
SECTION B-B
SECTION A-A
AHU-1
AHU-2
AHU-3
CU-1
CU-2
CU-3
AC-1
AC-2
EF-2
HEP-1
HEP-2
PTHP-1
PROTECTIVE COVER
TRANSITION SECTION
HEAVY DUTY BELLMOUTH
KEY
INCHES
MILLIMETERS
108.25"
2750
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
HVAC SUBSYSTEM
NONE
B
3039-12
0

D-1 & D-2 – DAMPER MOTORS – DIFFERENTIAL PRESSURE CONTROL DAMPERS.
DV-1 – DAMPER MOTORS – SPRING RET., FAIL CLOSED, MODULATING.
DV-2 – DAMPER MOTORS – SPRING RET., FAIL OPEN, MODULATING.
D-3 – D-6 – HEPA UNIT ISOLATION DAMPERS.
DM-3 – DV-6 – DAMPER MOTORS, SPRING RET., FAIL OPEN, MODULATING.
D-7 – D-8 – EXHAUST FAN ISOLATION DAMPERS.
DV-7 – DV-8 – DAMPER MOTORS, SPRING RET., FAIL CLOSED, MODULATING.
ES-1 & ES-2 – DAMPER END SWITCH (DAMPER STATUS).
DP-1 – DP-4 – DIFFERENTIAL PRESSURE SENSORS
DPS-1 & DPS-2 – DIFFERENTIAL PRESSURE SWITCHES

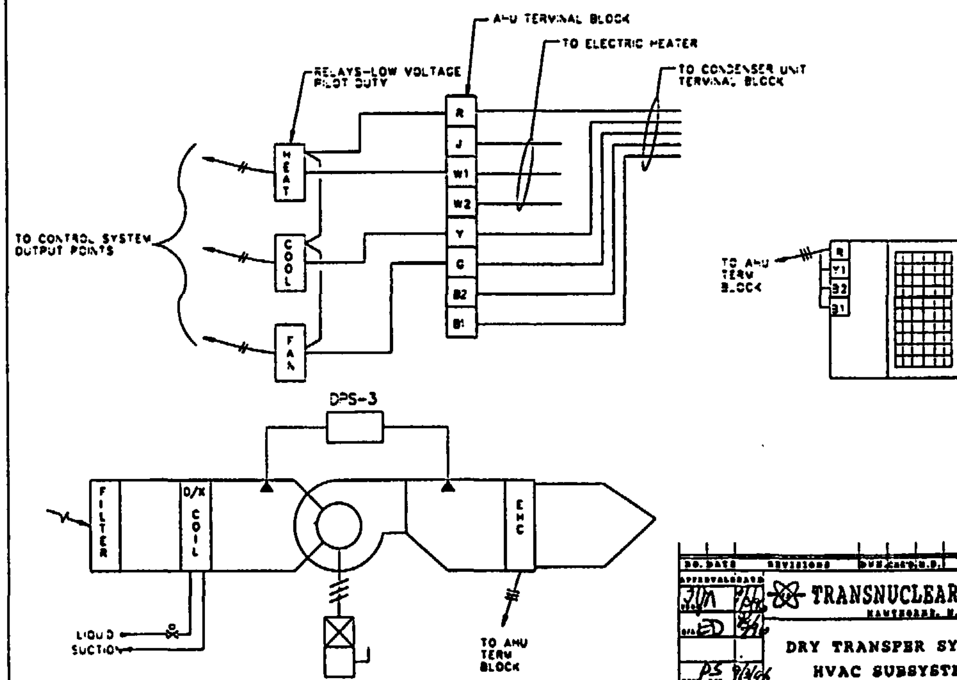


DIFFERENTIAL PRESSURE CONTROLS



HS1 – HUMIDITY SENSOR
TS1 – AMBIENT TEMPERATURE
TS2-TS5 – SPACE TEMPERATURE
SP1 – DIFFERENTIAL PRESSURE, PA TO AMBIENT
SP2 – DIFFERENTIAL PRESSURE, TCA TO AMBIENT
SP3 – DIFFERENTIAL PRESSURE, TCA TO LAA
SP4 – DIFFERENTIAL PRESSURE, LAA TO PA

SENSORS



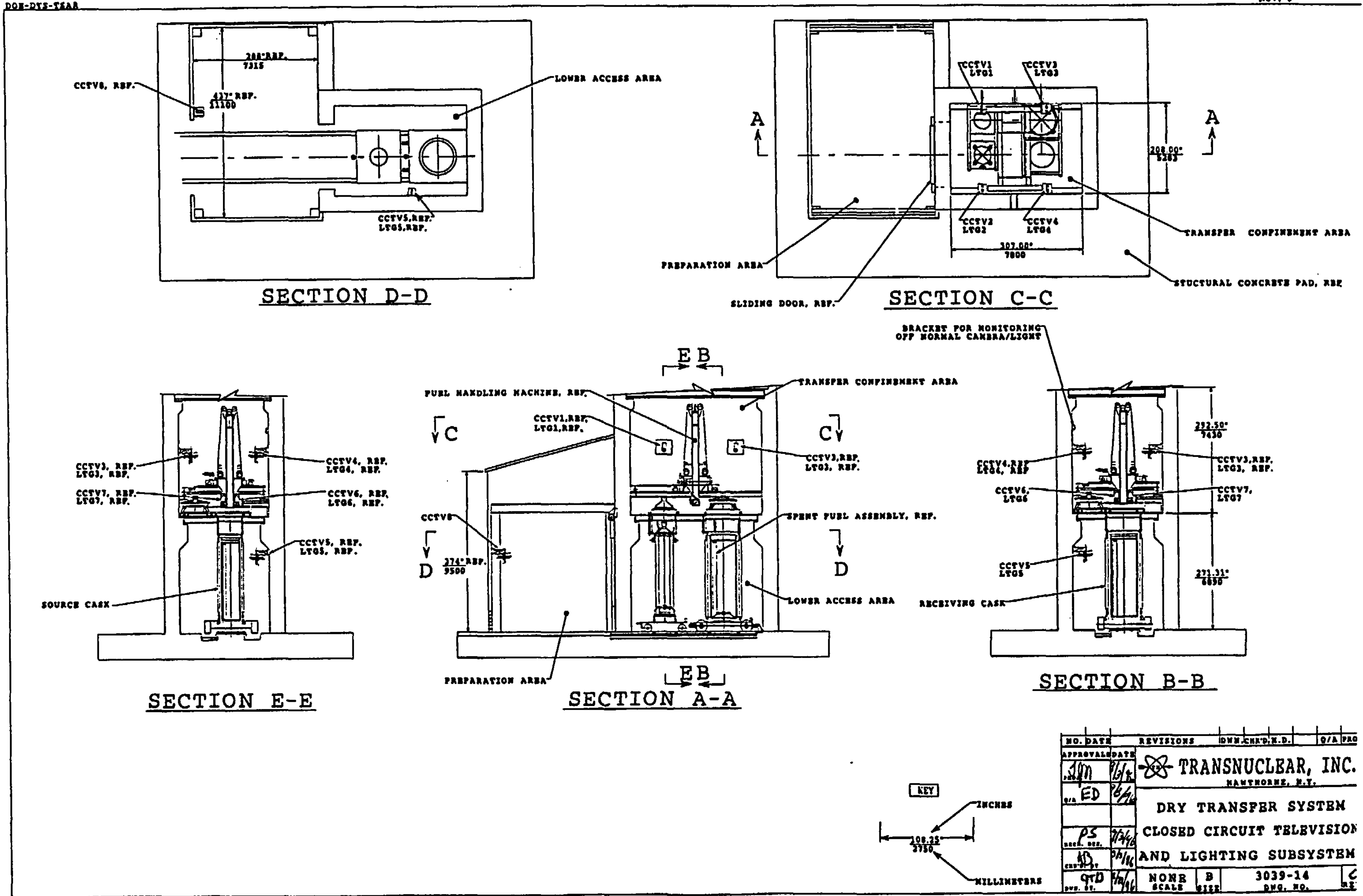
AIR HANDLING UNIT CONTROLS
(TYPICAL OF 3)

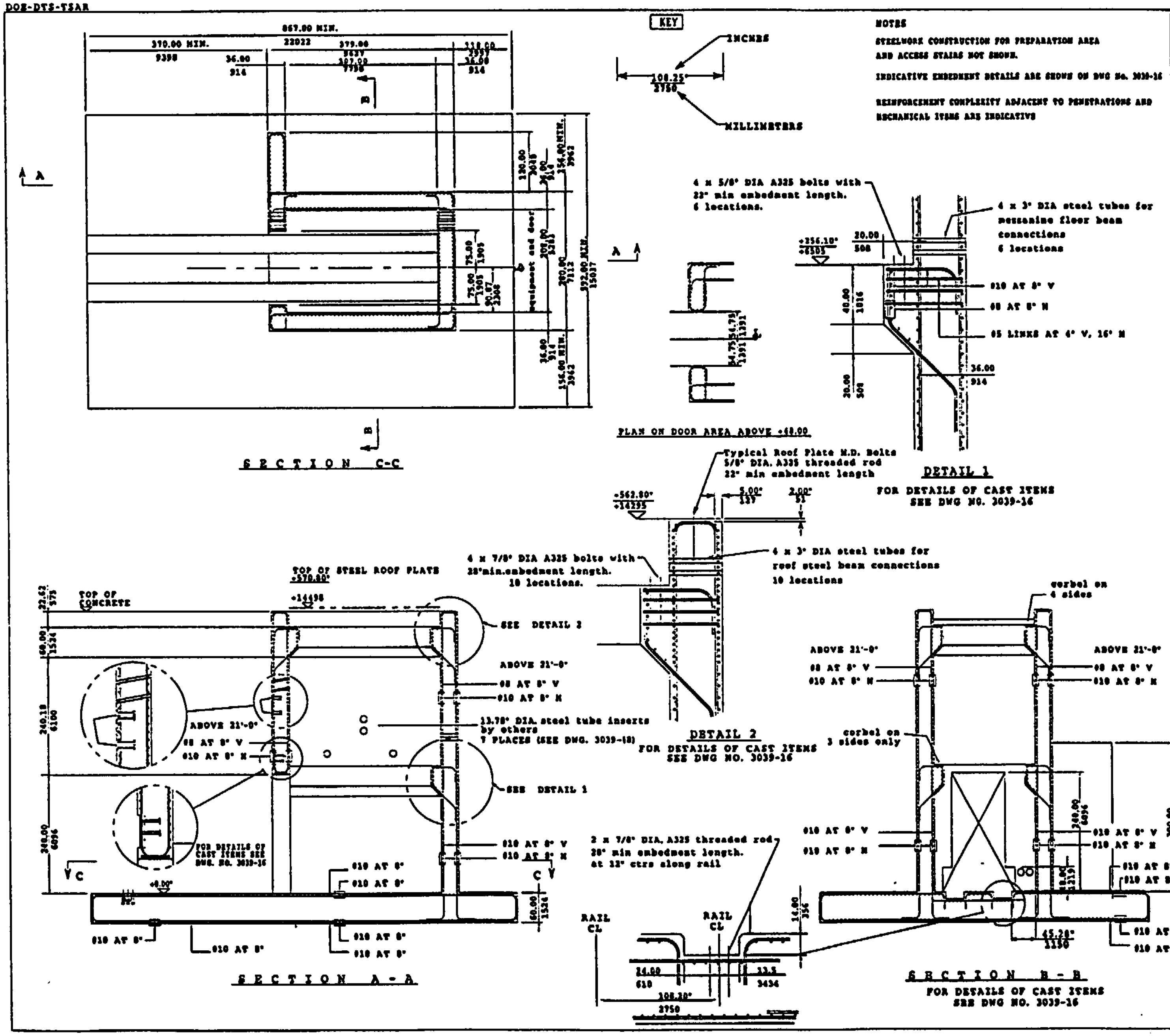
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

DRY TRANSFER SYSTEM
HVAC SUBSYSTEM
CONTROL SCHEMATICS

SCALE	SIZE	DWG. NO.	REV.
NONE	B	3039-33	0

Figure 1.2-13


SECTION D-D
288" REF.
7315
CCTV8, REF.
437" REF.
11100
LOWER ACCESS AREA
CCTV5,REF.
LTG5,REF.
SECTION C-C
CCTV1
LTG1
CCTV3
LTG3
A
A
208.00"
5283
CCTV2
LTG2
CCTV4
LTG4
307.00"
7800
PREPARATION AREA
TRANSFER CONFINEMENT AREA
STUCTURAL CONCRETE PAD, REF.
SLIDING DOOR, REF.
SECTION E-E
CCTV3, REF.
LTG3, REF.
CCTV4, REF.
LTG4, REF.
CCTV7, REF.
LTG7, REF.
CCTV6, REF.
LTG6, REF.
CCTV5, REF.
LTG5, REF.
SOURCE CASK
SECTION A-A
E B
FUEL HANDLING MACHINE, REF.
TRANSFER CONFINEMENT AREA
CCTV1,REF.
LTG1,REF.
CCTV3,REF.
LTG3, REF.
C
C
CCTV8
374" REF.
9500
D
D
SPENT FUEL ASSEMBLY, REF.
LOWER ACCESS AREA
PREPARATION AREA
E B
SECTION B-B
BRACKET FOR MONITORING
OFF NORMAL CAMERA/LIGHT
292.50"
7430
CCTV4,REF
LTG4, REF
CCTV3,REF.
LTG3, REF.
CCTV6,
LTG6
CCTV7,
LTG7
CCTV5
LTG5
271.31"
6890
RECEIVING CASK
KEY
INCHES
108.25"
2750
MILLIMETERS
NO. DATE
REVISIONS
DWN. CHK'D. N.D.
Q/A PRO
APPROVALS DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
CLOSED CIRCUIT TELEVISION
AND LIGHTING SUBSYSTEM
NONE
SCALE
B
SIZE
3039-14
DWG. NO.
C
REV.



NOTES

STEELWORK CONSTRUCTION FOR PREPARATION AREA AND ACCESS STAIRS NOT SHOWN.

INDICATIVE EMBEDMENT DETAILS ARE SHOWN ON DWG No. 3039-16

REINFORCEMENT COMPLEXITY ADJACENT TO PENETRATIONS AND MECHANICAL ITEMS ARE INDICATIVE

Materials and Workmanship Specification

1) All reinforcing bars shall conform to A.S.T.M. A615 Grade 60

2) Concrete mix design to be by contractor to meet strength and durability requirements.
Mix specification by contractor to advise means of ensuring frost resistance, use of admixtures etc.

3) All concrete shall have a specified compressive strength at 28 days of f'c = 3000 P.S.I. (T.N. specification)

4) Concrete protection of reinforcement shall be as follows, unless otherwise indicated on the plans or ordered by the engineer.

Slabs (internal)	1"
Beams	
Stirrups & Ties	2"
Principal Reinforcement	2"
Walls	2"
Footings	
At formed sides and ends and bottoms bearing on workmat.	2"
At unformed sides, tops and ends and bottom bearing on earth.	3"

5) Reinforcement placing drawings must comply fully with the A.C.I. Detailing Manual - 1988. Publication SP-66(88)

6) All civil construction to comply fully with :- A.C.I. 349-90, A.C.I. 318-89

7) Splices

Tension Splice Table
Bars spaced less than 6"(152mm) apart

Size	'Other' bars.	Top bars.
#6	25"(635mm)	35"(889mm)
#7	34"(864mm)	48"(1219mm)
#8	45"(1143mm)	63"(1600mm)
#9	57"(1448mm)	80"(2032mm)
#10	73"(1854mm)	101"(2565mm)

Tension Splice Table
Bars spaced 6"(152mm) or more apart

Size	'Other' bars.	Top bars.
#6	20"(508mm)	28"(711mm)
#7	27"(686mm)	38"(965mm)
#8	36"(914mm)	50"(1270mm)
#9	46"(1168mm)	64"(1626mm)
#10	58"(1473mm)	81"(2057mm)

These tables assume Class 'B' splices
Wall bars are 'Other' bars
All splices shall be considered tension splices
Top bars are all horizontal bars with more than 12"(305mm) concrete cast under them.

Approximate Rebar Weights

Walls	1 ton per 8.7 cubic yards
Slab	1 ton per 14 cubic yards

NO.	DATE	REVISIONS	DWN.	CHK'D	M.D.		Q/A	PROJ.

TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

DRY TRANSFER SYSTEM
STRUCTURAL DETAILS

SCALE	SIZE	DWG. NO.	REV.
NONE	B	3039-15	0

Figure 1.2-15

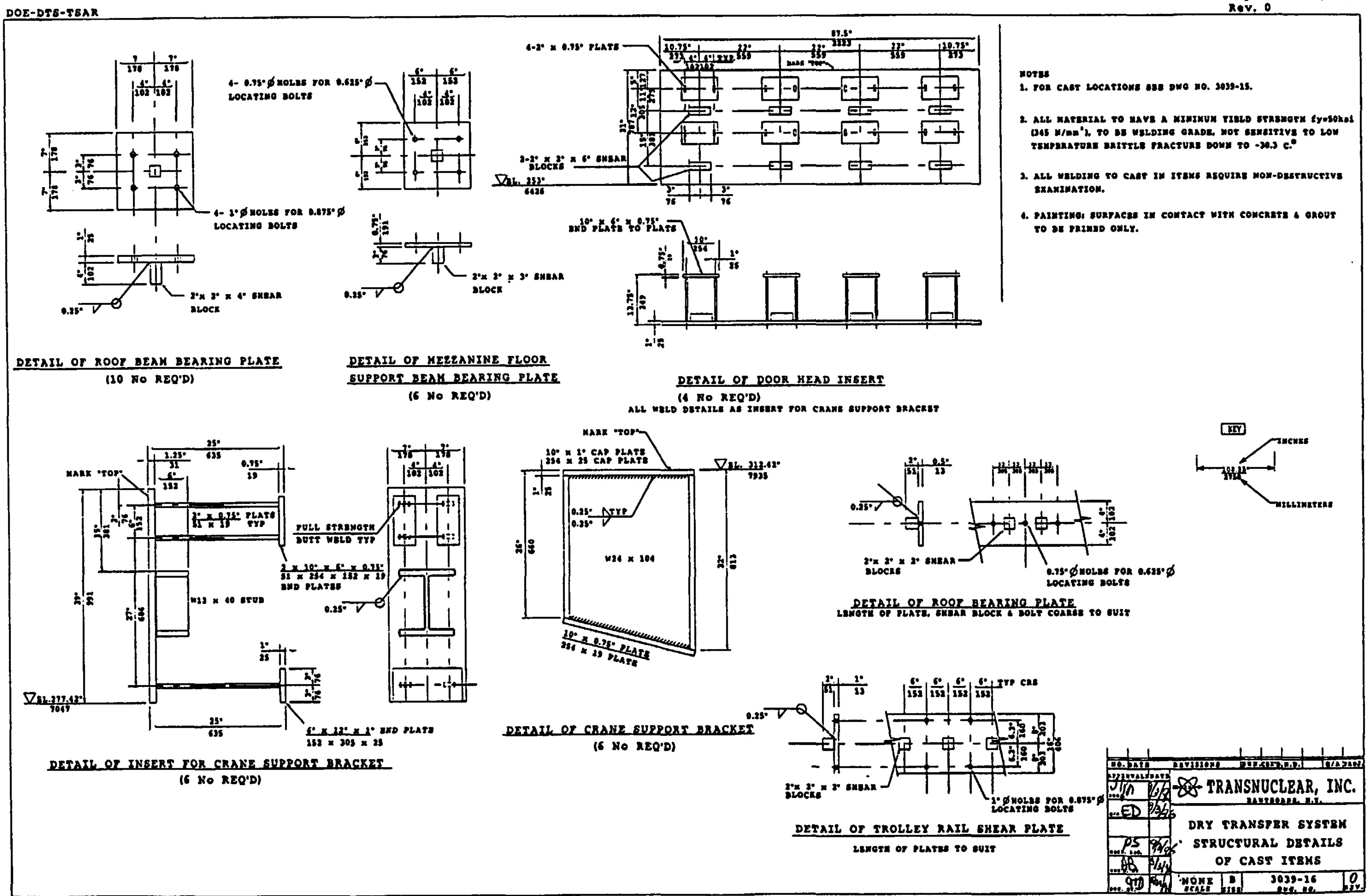

NOTES
1. FOR CAST LOCATIONS SEE DWG NO. 3039-15.
2. ALL MATERIAL TO HAVE A MINIMUM YIELD STRENGTH fy=50ksi (345 N/mm²), TO BE WELDING GRADE, NOT SENSITIVE TO LOW TEMPERATURE BRITTLE FRACTURE DOWN TO -30.3 C.°
3. ALL WELDING TO CAST IN ITEMS REQUIRE NON-DESTRUCTIVE EXAMINATION.
4. PAINTING: SURFACES IN CONTACT WITH CONCRETE & GROUT TO BE PRIMED ONLY.
DETAIL OF ROOF BEAM BEARING PLATE
(10 No REQ'D)
DETAIL OF MEZZANINE FLOOR SUPPORT BEAM BEARING PLATE
(6 No REQ'D)
DETAIL OF DOOR HEAD INSERT
(4 No REQ'D)
ALL WELD DETAILS AS INSERT FOR CRANE SUPPORT BRACKET
DETAIL OF INSERT FOR CRANE SUPPORT BRACKET
(6 No REQ'D)
DETAIL OF CRANE SUPPORT BRACKET
(6 No REQ'D)
DETAIL OF ROOF BEARING PLATE
LENGTH OF PLATE, SHEAR BLOCK & BOLT COARSE TO SUIT
DETAIL OF TROLLEY RAIL SHEAR PLATE
LENGTH OF PLATES TO SUIT
KEY
INCHES
MILLIMETERS
TRANSNUCLEAR, INC.
DRY TRANSFER SYSTEM
STRUCTURAL DETAILS
OF CAST ITEMS
NONE
B
3039-16
0

Figure 1.2-16

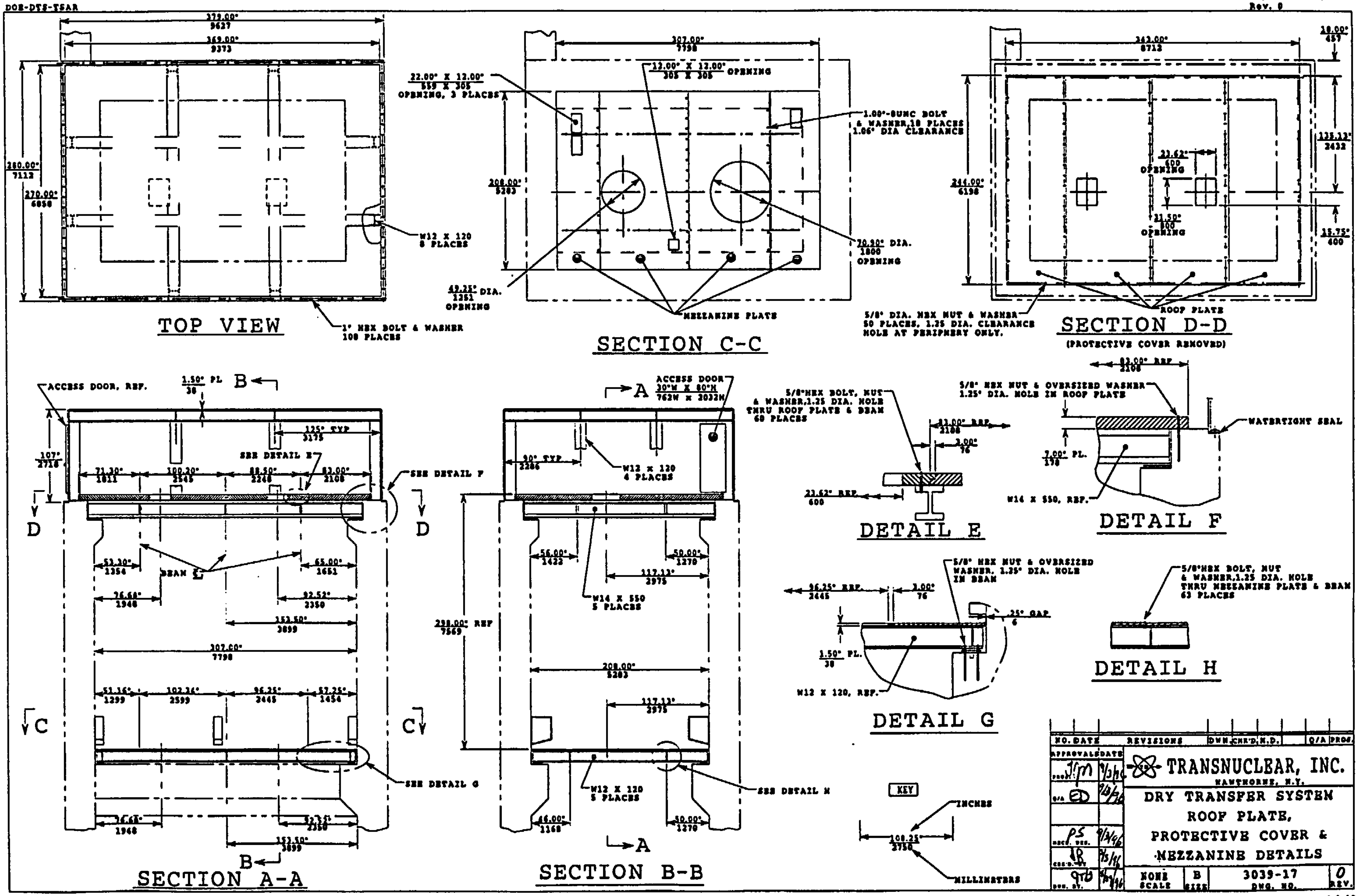
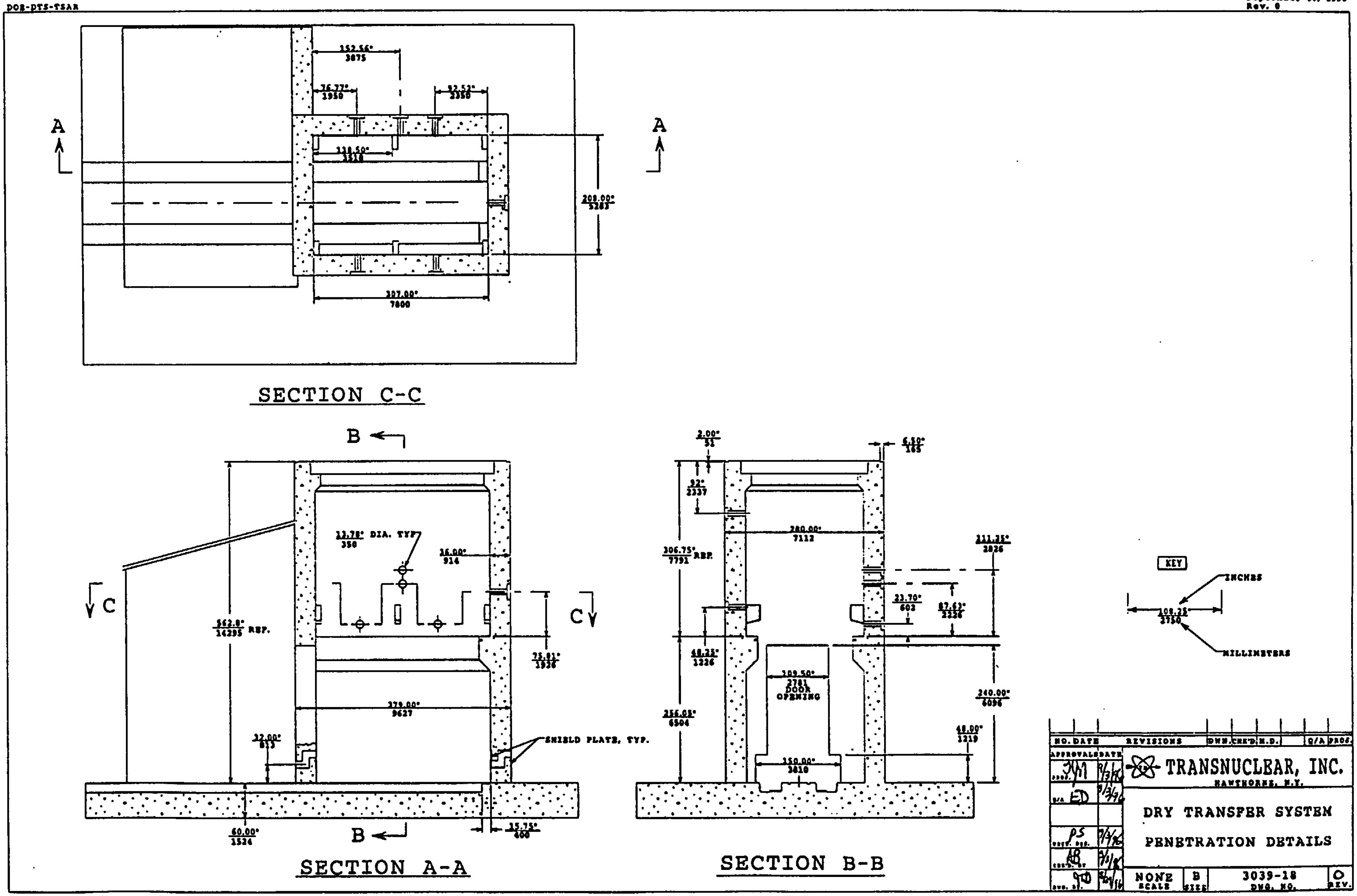
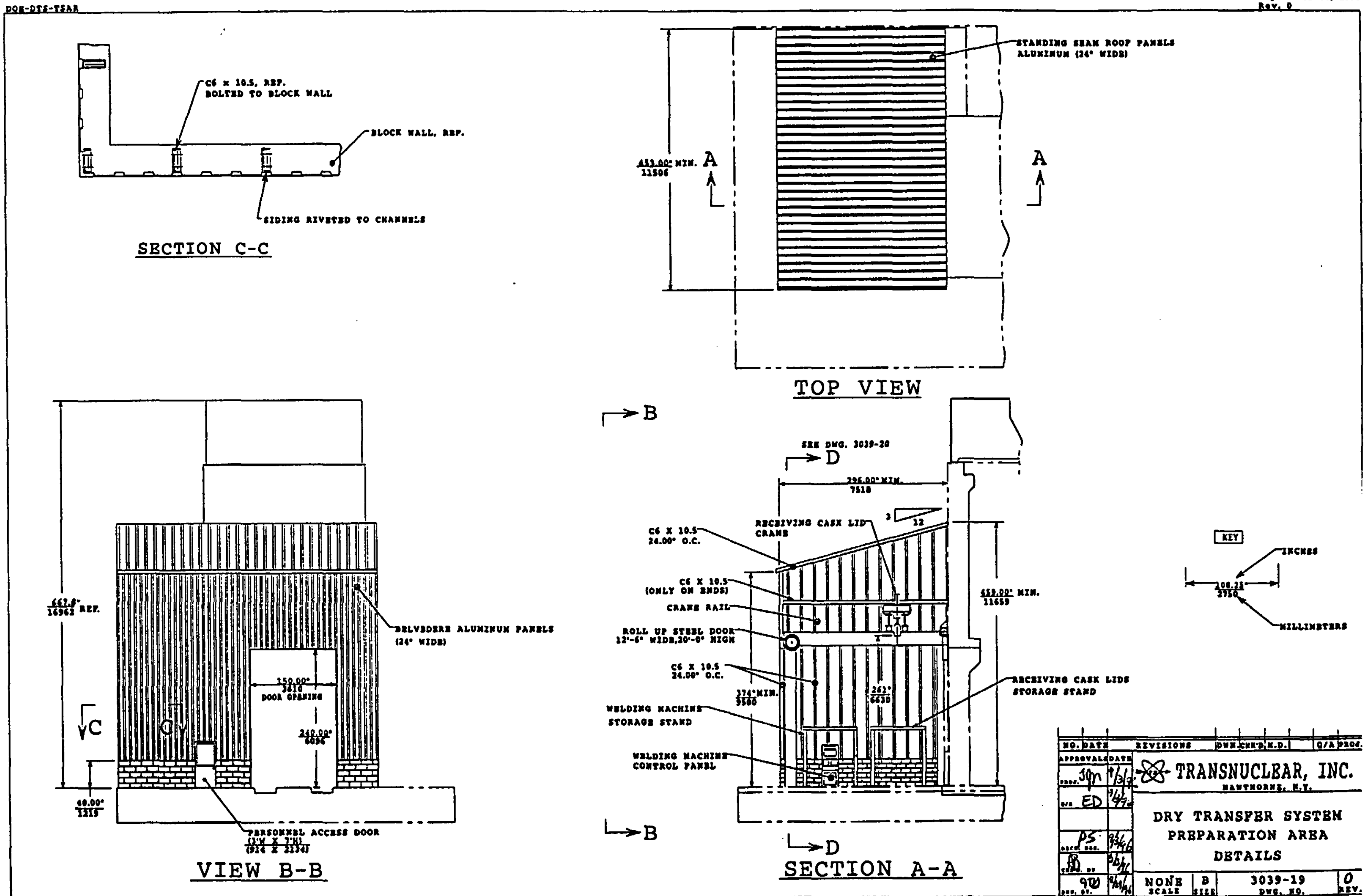

TOP VIEW
W12 X 120
8 PLACES
1" HEX BOLT & WASHER
108 PLACES
SECTION C-C
22.00" X 12.00"
559 X 305
OPENING, 3 PLACES
12.00" X 12.00"
305 X 305 OPENING
1.00"-8UNC BOLT
& WASHER,18 PLACES
1.06" DIA CLEARANCE
70.90" DIA.
1800
OPENING
49.25" DIA.
1251
OPENING
MEZZANINE PLATE
SECTION D-D
(PROTECTIVE COVER REMOVED)
5/8" DIA. HEX NUT & WASHER
50 PLACES, 1.25 DIA. CLEARANCE
HOLE AT PERIPHERY ONLY.
ROOF PLATE
ACCESS DOOR, REF.
SEE DETAIL E
SEE DETAIL F
BEAM ℄
SEE DETAIL G
SECTION A-A
ACCESS DOOR
30"W X 80"H
762W x 2032H
W12 x 120
4 PLACES
W14 x 550
5 PLACES
W12 X 120
5 PLACES
SEE DETAIL H
SECTION B-B
5/8"HEX BOLT, NUT
& WASHER,1.25 DIA. HOLE
THRU ROOF PLATE & BEAM
60 PLACES
DETAIL E
5/8" HEX NUT & OVERSIZED WASHER
1.25" DIA. HOLE IN ROOF PLATE
WATERTIGHT SEAL
W14 X 550, REF.
DETAIL F
5/8" HEX NUT & OVERSIZED
WASHER, 1.25" DIA. HOLE
IN BEAM
.25" GAP
W12 X 120, REF.
DETAIL G
5/8"HEX BOLT, NUT
& WASHER,1.25 DIA. HOLE
THRU MEZZANINE PLATE & BEAM
63 PLACES
DETAIL H
KEY
INCHES
MILLIMETERS
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
ROOF PLATE,
PROTECTIVE COVER &
MEZZANINE DETAILS
NONE
SCALE
B
SIZE
3039-17
DWG. NO.
0
REV.

Figure 1.2-17


SECTION C-C
SECTION A-A
SECTION B-B
A
B
C
152.56"
3875
76.77"
1950
92.52"
2350
138.50"
3518
208.00"
5283
307.00"
7800
13.78" DIA. TYP
350
36.00"
914
562.8"
14295 REF.
75.81"
1926
379.00"
9627
32.00"
813
SHIELD PLATE, TYP.
60.00"
1524
15.75"
400
2.00"
51
6.50"
165
92"
2337
280.00"
7112
306.75" REF.
7791
111.35"
2826
23.70"
602
87.63"
2226
48.25"
1226
109.50"
2781
DOOR OPENING
240.00"
6096
256.05"
6504
48.00"
1219
150.00"
3810
KEY
INCHES
108.25"
2750
MILLIMETERS
NO. DATE
REVISIONS
DWN. CHK'D
Q/A
APPROVALS
DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
PENETRATION DETAILS
NONE
SCALE
B
SIZE
3039-18
DWG. NO.
0
REV.


C6 x 10.5, REF.
BOLTED TO BLOCK WALL
BLOCK WALL, REF.
SIDING RIVETED TO CHANNELS
SECTION C-C
STANDING SEAM ROOF PANELS
ALUMINUM (24" WIDE)
453.00" MIN.
11506
A
A
TOP VIEW
B
SEE DWG. 3039-20
D
296.00" MIN.
7518
3
12
RECEIVING CASK LID
CRANE
C6 X 10.5
24.00" O.C.
C6 X 10.5
(ONLY ON ENDS)
CRANE RAIL
ROLL UP STEEL DOOR
12'-6" WIDE,20'-0" HIGH
C6 X 10.5
24.00" O.C.
374"MIN.
9500
262"
6630
459.00" MIN.
11659
WELDING MACHINE
STORAGE STAND
WELDING MACHINE
CONTROL PANEL
RECEIVING CASK LIDS
STORAGE STAND
B
D
SECTION A-A
667.8"
16962 REF.
BELVEDERE ALUMINUM PANELS
(24" WIDE)
150.00"
3810
DOOR OPENING
240.00"
6096
C
48.00"
1219
PERSONNEL ACCESS DOOR
(3'W X 7'H)
(914 X 2134)
VIEW B-B
KEY
INCHES
108.25"
2750
MILLIMETERS
NO. DATE
REVISIONS
DWN. CHK'D. H.D.
Q/A PROJ.
APPROVALS DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM
PREPARATION AREA
DETAILS
NONE
SCALE
B
SIZE
3039-19
DWG. NO.
0
REV.

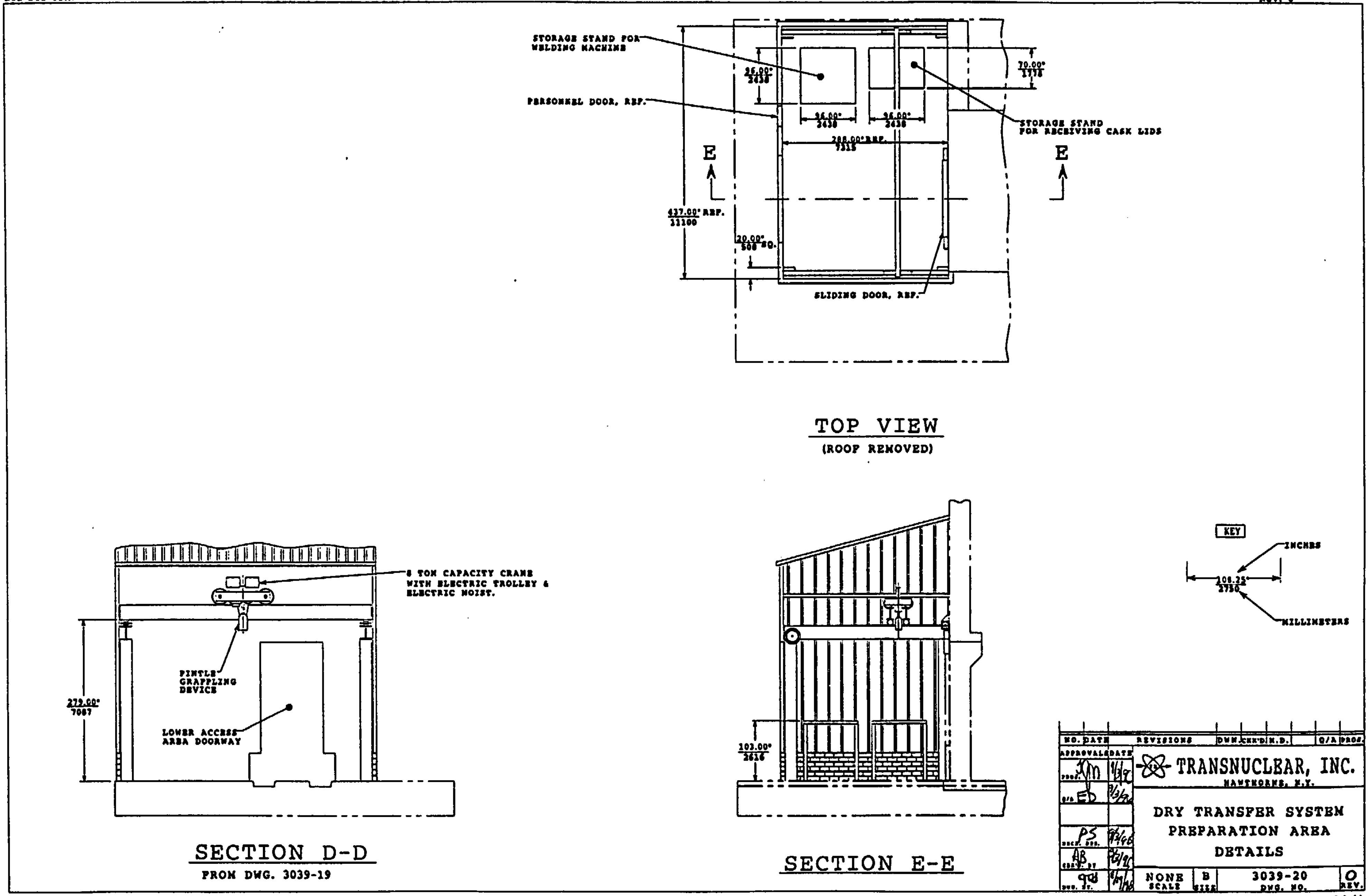

STORAGE STAND FOR WELDING MACHINE
PERSONNEL DOOR, REF.
96.00" 2438
96.00" 2438
96.00" 2438
70.00" 1778
STORAGE STAND FOR RECEIVING CASK LIDS
288.00" REF. 7315
E
E
437.00" REF. 11100
20.00" 508 SQ.
SLIDING DOOR, REF.
TOP VIEW
(ROOF REMOVED)
KEY
INCHES
108.25" 2750
MILLIMETERS
8 TON CAPACITY CRANE WITH ELECTRIC TROLLEY & ELECTRIC HOIST.
PINTLE GRAPPLING DEVICE
279.00" 7087
LOWER ACCESS AREA DOORWAY
SECTION D-D
FROM DWG. 3039-19
103.00" 2616
SECTION E-E
NO. DATE | REVISIONS | DWN. | CHK'D | M.D. | Q/A | PROJ.
APPROVALS | DATE
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.
DRY TRANSFER SYSTEM PREPARATION AREA DETAILS
NONE SCALE
B SIZE
3039-20 DWG. NO.
0 REV.

Figure 1.2-20

1.3 General Systems Description

The sequence of operations performed within the DTS can be divided into the following categories:

Receiving Cask Receipt, Preparation, Inspection, and Positioning
Source Cask Receipt, Preparation, Inspection, and Positioning
Source Cask Mating and Opening
Receiving Cask Mating and Opening
Fuel Transfer
Source Cask Closing and Detachment
Receiving Cask Closing and Detachment
Source Cask Removal
Receiving Cask Removal

These operations are shown schematically in Figures 1.3-1 through 1.3-8.

Figure 1.3-1

Receiving Cask
Receipt, Preparation, Inspection and Positioning

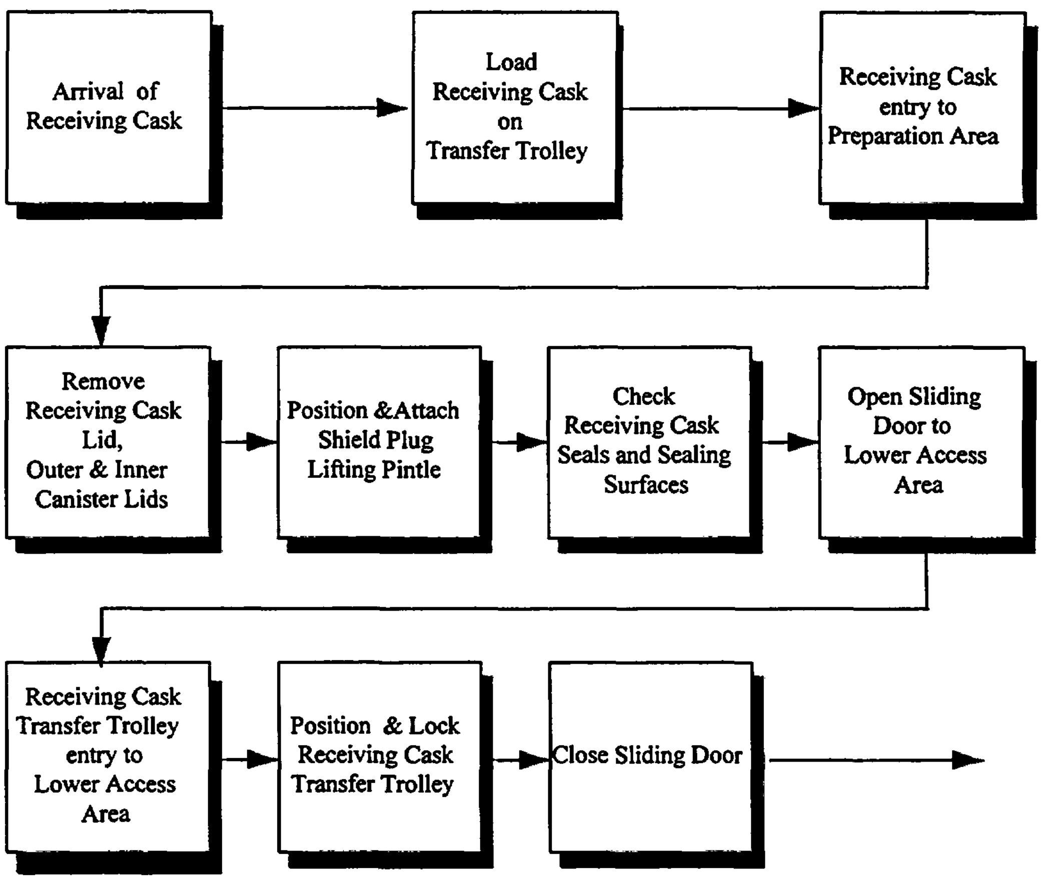


Figure 1.3-2

Source Cask
Receipt, Preparation, Inspection and Positioning

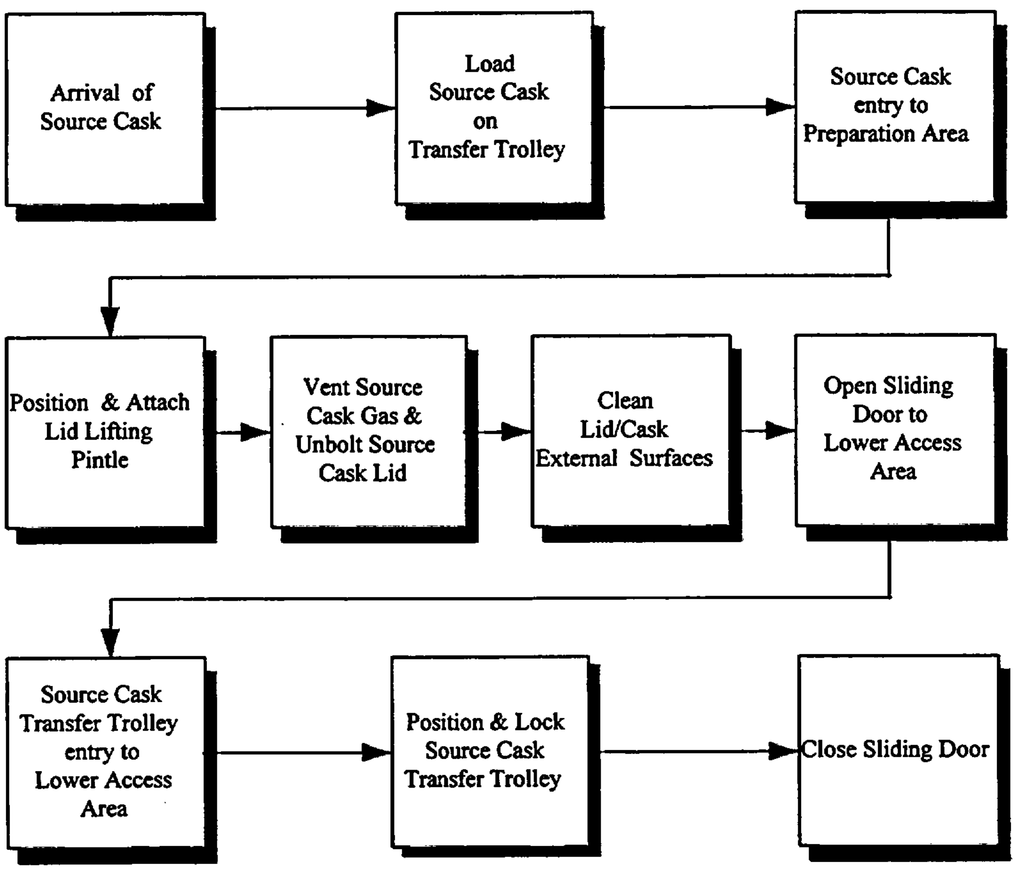


Figure 1.3-3

Source Cask Removal

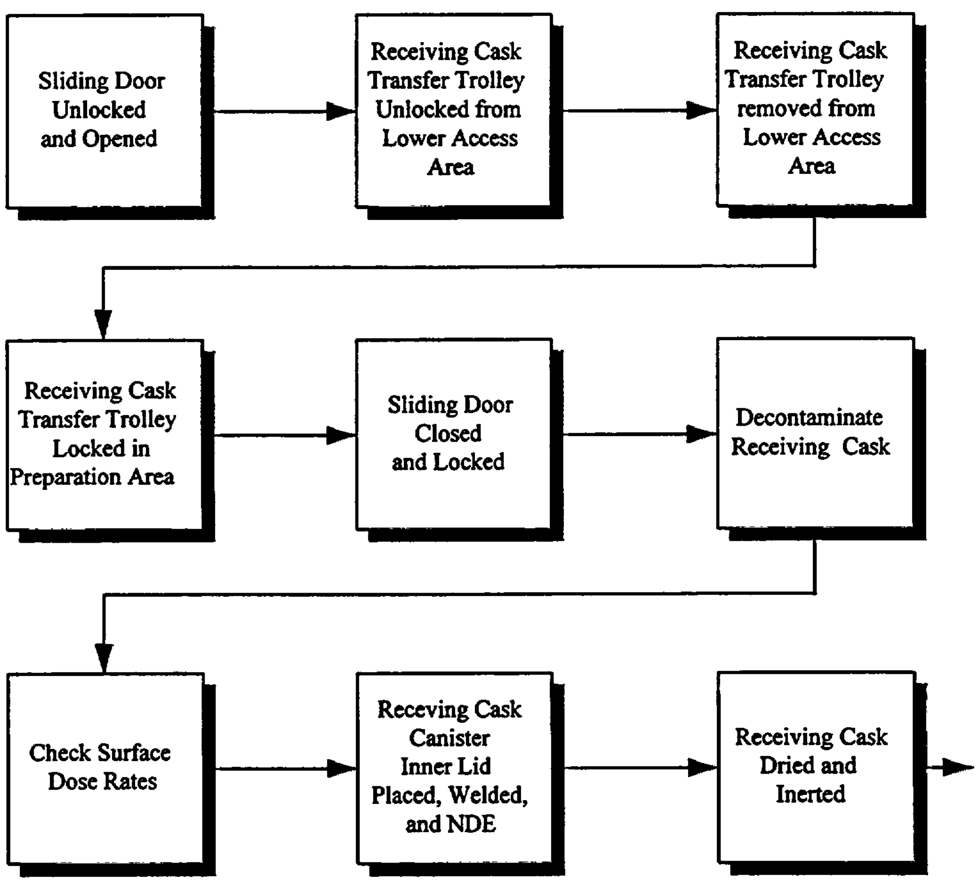


Figure 1.3-4

Receiving Cask Removal

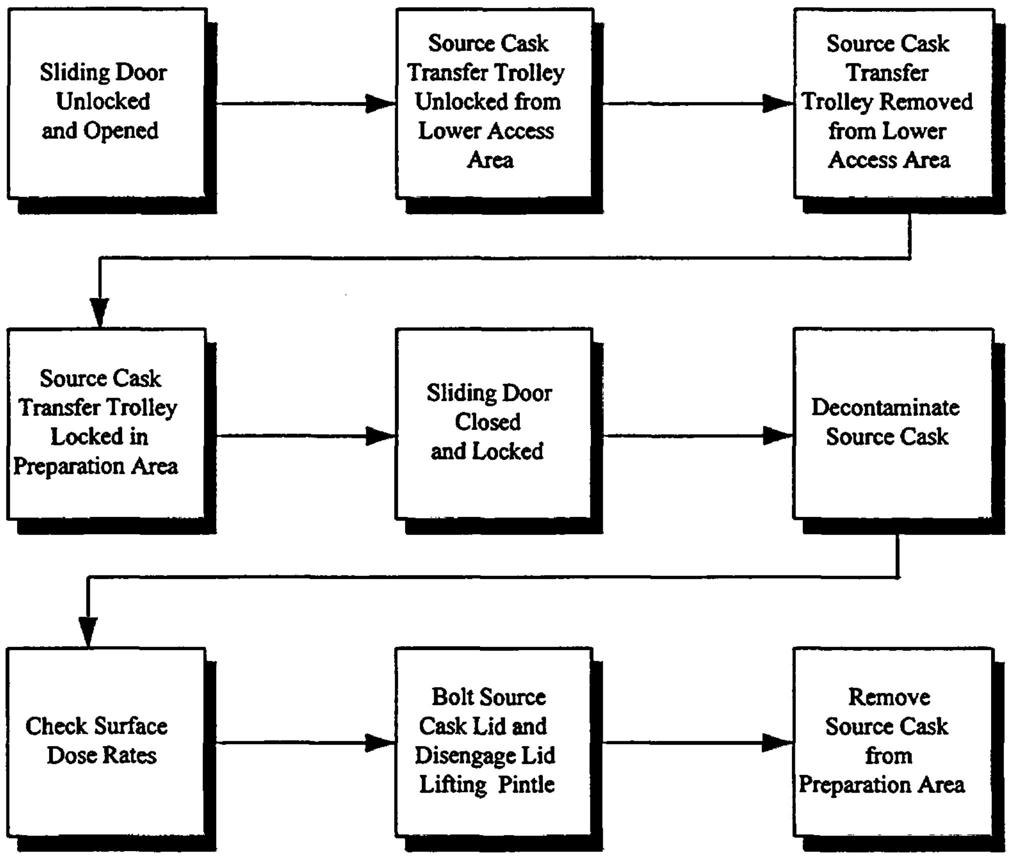


Figure 1.3-4 (Continued)

Receiving Cask Removal

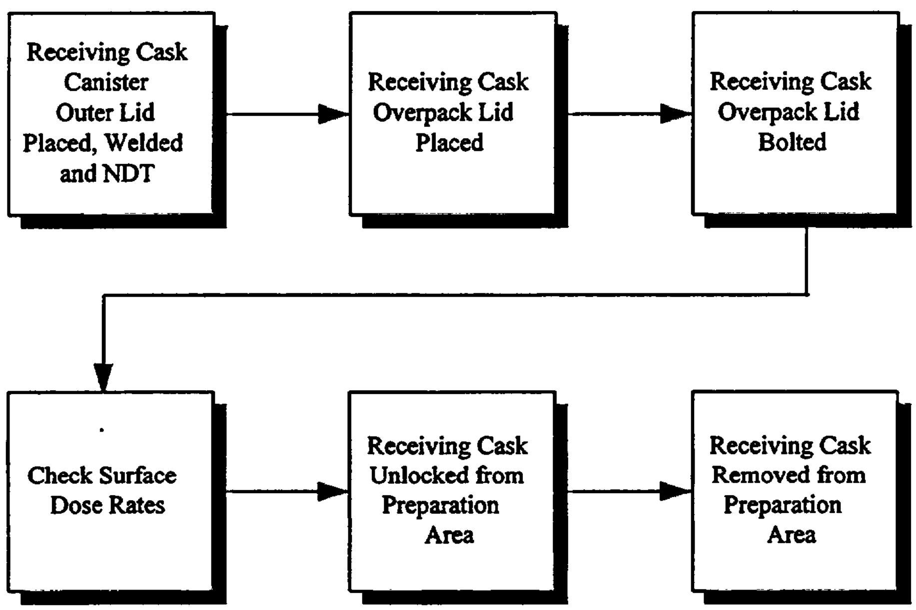
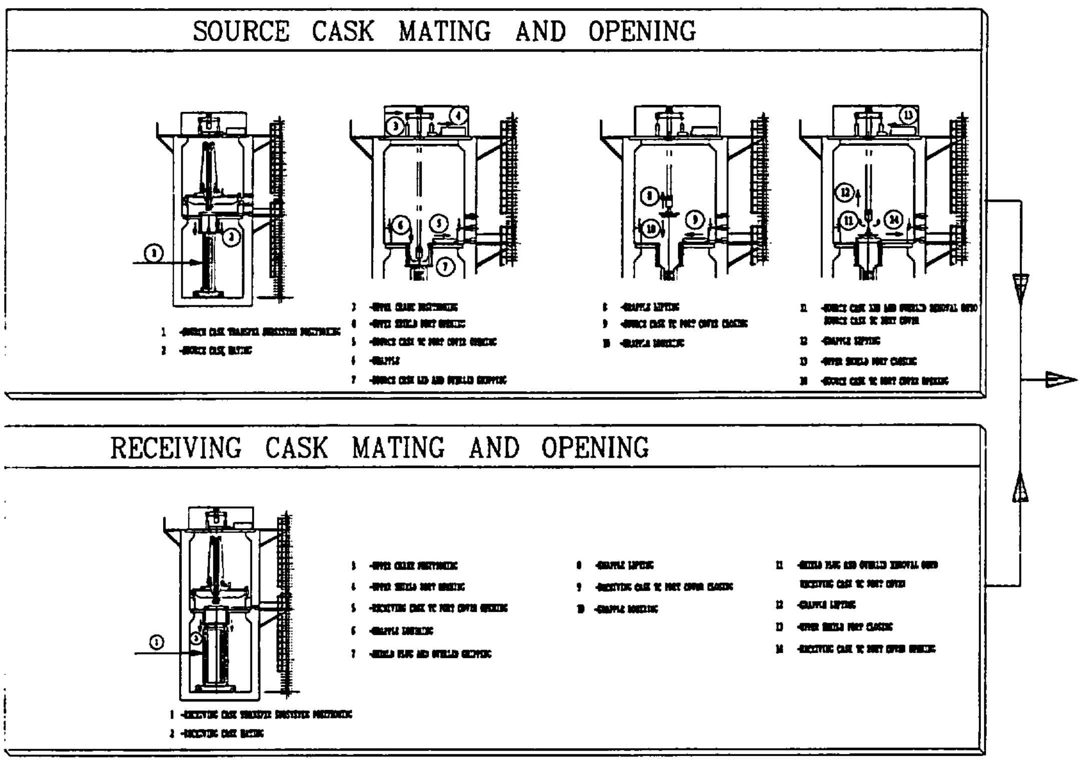


Figure 1.3-5

Receiving and Source Cask Mating and Opening



NOTES: 1 - WHEN CASKS ARE MOVED BETWEEN THE PREPARATION AREA AND THE LOWER ACCESS AREA, THE SHIELD PLUG AND THE SOURCE CASK LID SHOULD BE ON THE RECEIVING CASK AND THE SOURCE CASK, RESPECTIVELY. THE RECEIVING CASK LIDS ARE PLACED ON THE RECEIVING CASK IN THE PREPARATION AREA.

Figure 1-4
Receiving and Source Cask Mating and Opening

Rev. 0 6/96

Figure 1.3-6

Transfer Operations

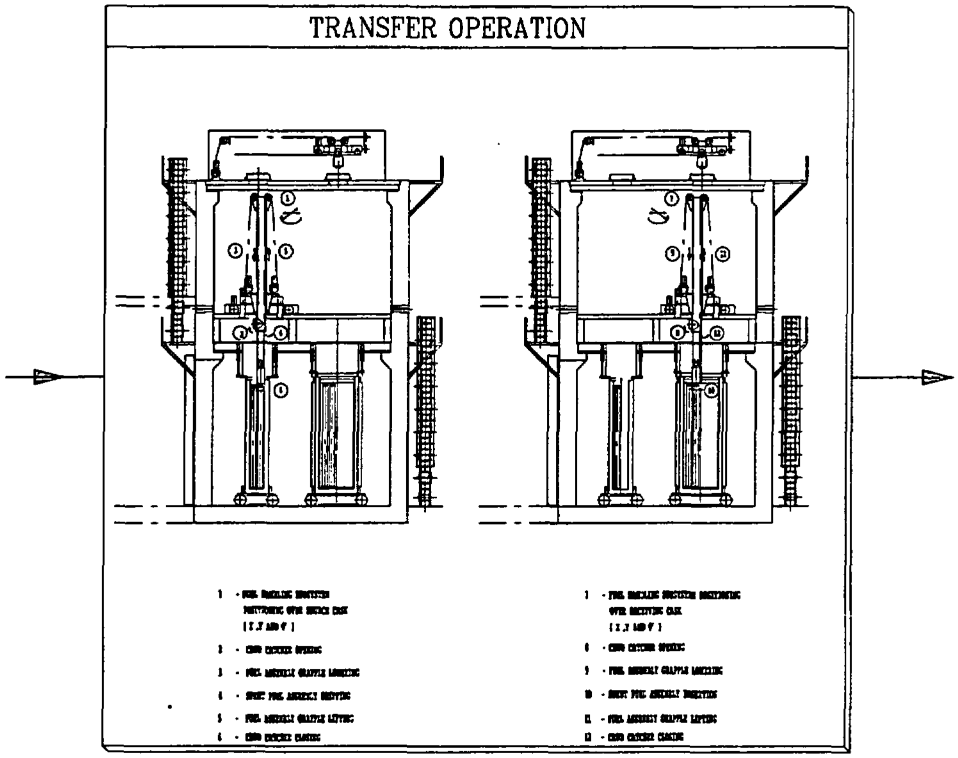


Figure 1-5
Transfer Operations
Rev. 0 6/96

Figure 1.3-7

Receiving and Source Cask Closing and Detachment

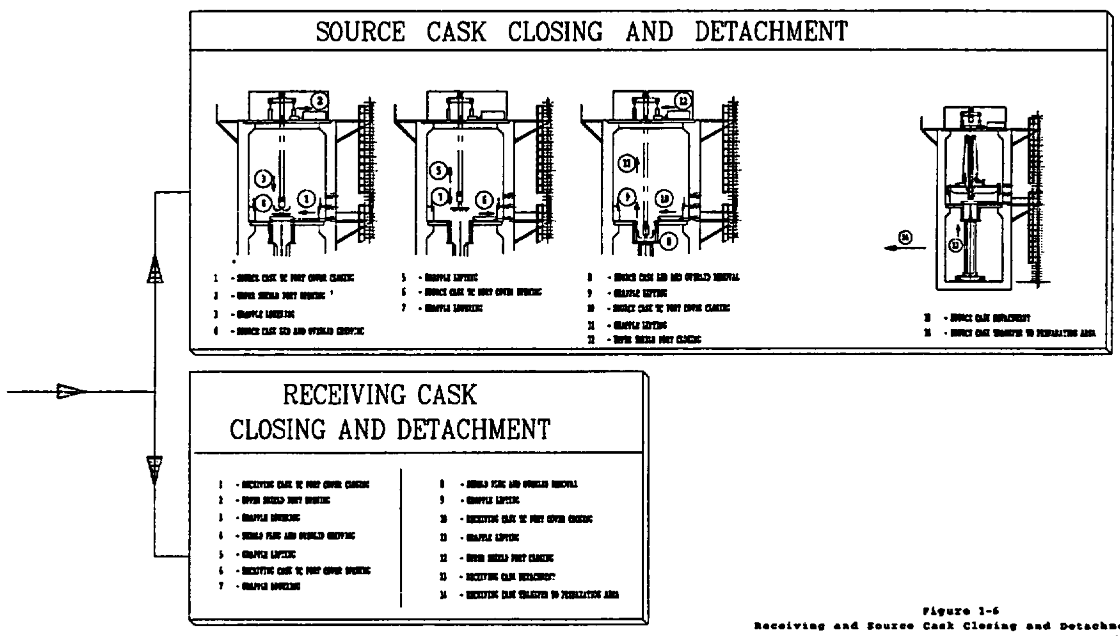


Figure 1-6
Receiving and Source Cask Closing and Detachment
Rev. 0 6/96

1.4 Identification of Agents and Subcontractors

Transnuclear (TN), Inc. of Hawthorne, New York, was contracted by the Electric Power Research Institute (EPRI), Palo Alto, California to design the Dry Transfer System. The project was jointly funded by EPRI and the Department of Energy (DOE).

TN selected SGN Reseau Eurisys of France to perform the design and analysis of the mechanical equipment used for cask and fuel assembly handling. SGN has performed equipment and process design for the La Hague spent fuel reprocessing facility in France and brought that experience to this project.

TN selected Foster Wheeler Energy Company (FWEC) of Clinton, New Jersey to perform design and analysis of the building structure. FWEC subcontracted to GEC Alsthom for much of this work. FWEC and GEC are the designers of the Modular Vault Dry Store spent fuel storage system. This system has a reinforced concrete structure that is similar to the DTS structure.

TN selected National Technical Service (NTS) of Acton, Massachusetts to provide the design and analysis of the heating, ventilating, and air conditioning system. NTS subcontracted to the specialty HVAC design firm of Luchini, Milfort, Goodell and Associates, Inc. of Chelmsford, Massachusetts to conduct the technical work.

The contractors for the construction and operation of the installation will be addressed in the site specific applications.

CHAPTER 2

SITE CHARACTERISTICS

A site has not been selected for the Dry Transfer System at this time. The bounding site characteristics are discussed in Chapter 3, Principal Design Criteria. The DTS will be collocated at a nuclear facility. The DTS relies on certain existing services which are readily available at all nuclear facilities including:

Electrical Power
Access to Transportation
Security System
Waste Disposal System
Health Physics Organization
Trained Operations Personnel

The DTS is designed for temporary use at a collocated nuclear facility. At the end of its useful life, it may be demolished by conventional means. Since the walls of the DTS are three feet thick, it may require the use of high explosives in relatively large quantities. If it is desired to demolish the structure, care should be used in the initial siting of the facility so as not to disrupt nearby facilities and operations during demolition.

CHAPTER 3

PRINCIPAL DESIGN CRITERIA

3.1 Purposes of Installation

The DTS is used to transfer bare fuel assemblies. It is not intended for use as a storage installation. However, the DTS has been designed in accordance with 10CFR72 and the rules governing a dry storage facility, since no regulatory guidance is provided for a Dry Transfer System.

All operations within the DTS are performed in air. The function of the DTS is to transfer fuel from one cask to another, one assembly at a time. This fuel transfer operation is performed in a shielded structure, where all operations are performed remotely.

It is anticipated that the DTS could be adapted for a variety of purposes, such as:

- Transfer of fuel from a small transfer cask to large MPC in transportation overpack (baseline). The DTS design meets the needs of those plants with limited access or limited crane capacity.

- Transfer of fuel from a small transfer cask to a large transport cask: the DTS design permits transfer in cases where the spent fuel pool cannot accommodate a transport cask due to size or weight limitations.

- Transfer of fuel from a dry storage cask to a transport cask: the DTS design allows storage casks to be unloaded into transport casks without pool access.

- Transfer of fuel from a small or large transport cask to an MPC at a DOE Interim Storage Facility; the DTS design meets the need to place fuel into a storage configuration at a centralized storage facility.

- Transfer of fuel from a small or large transport cask to Repository Disposal Overpack: the DTS design could be of potential use by the DOE at the final repository.

- Dry transfer of a variety of fuel types or other wastes in a variety of configurations at DOE sites.

3.1.1 Materials to Be Transferred

The DTS design is based on transferring B&W 15 x 15 PWR assemblies, with an initial enrichment of 3.75 weight percent U-235 and 40,000 MWd/MTU burnup. The shielding analysis is based on 5 year cooled fuel. The maximum design heat load of the fuel in the receiving cask is based on 10 year cooled fuel, 15.5 kW (21 assemblies). This approach allows mixing of less than 10 year cooled fuel with longer cooled fuel in order to stay within the thermal limit.

Damaged fuel is assumed to be detected at the reactor facility and will not be accepted at the DTS facility. Damaged fuel is primarily considered as fuel that is not dimensionally or structurally sound and fuel that cannot be handled by normal means. Fuel assemblies that are damaged in transit will not be transferred.

By replacing the fuel grapple and the fuel transfer tube, the DTS can be modified to handle any standard PWR or BWR fuel. Only the fuel grapple and the fuel transfer tube for the B&W 15x15 fuel is presented in this Topical Report.

The design basis spent fuel assembly characteristics are presented in Table 3.1-1. The normalized gamma source spectra and normalized neutron source spectra used in the shielding analyses are presented in Tables 3.1-2 and 3.1-3.

For criticality calcualtions, the source and receiving casks will be evaluated based on the highest enrichment for a given assembly, whereas for radiation shielding the controlling neutron source term is based on the lowest enrichment since the neutron source term increases considerably with decreasing enrichment and constant burnup.

Table 3.1-1

Spent Fuel Assembly Characteristics

Fuel Assembly Characteristics	PWR
Weight (including Hardware) (lbs)	1720 (780 kg)
Uranium (MTU)	0.49
Overall Length (including hardware) (inches)	180 (4,570 mm)
Section Type	Square
Initial Enrichment (wt percent of U-235)	3.75
Design Burnup (Mwd/MTU)	40,000
Criticality Array Configuration	B&W 15x15
Cooling Time (years since reactor discharge)	minimum 5
Fuel Region Gamma Source (γ/sec) - Avg/ Peak	7.8E+15/9.9E+15
Fuel Region Neutron Source (n/sec) - Avg/peak	2.4E+08/5.4E+08
End Fitting Co-60 Source (Ci) Top/Bottom	114/127

Table 3.1-2

Normalized Gamma Source Spectra Characteristics for Fuel Region Fission Products, Actinides & Activated Light Elements

Mean Energy MeV	Fraction PWR 5 Years Decay
1.25E-01	2.93E-02
2.25E-01	2.43E-02
3.75E-01	1.44E-02
5.75E-01	3.85E-01
8.50E-01	9.26E-02
1.25E+00	4.45E-02
1.75E+00	5.70E-04
2.25E+00	2.94E-04
2.75E+00	9.48E-06
3.50E+00	1.21E-06
5.00E+00	1.27E-09

Table 3.1-3

Normalized Neutron Source Spectra for Fuel Region Spontaneous Fission and Alpha-N Reaction Sources

Group No.	Energy Group MeV	Fraction PWR 5 Years Decay
1	6.43E+00 - 2.00E+01	1.85E-02
2	3.00E+00 - 6.43E+00	2.10E-01
3	1.85E+00 - 3.00E+00	2.32E-01
4	1.40E+00 - 1.85E+00	1.31E-01
5	9.00E-01 - 1.40E+00	1.77E-01
6	4.00E-01 - 9.00E-01	1.93E-01
7	1.00E-01 - 4.00E-01	3.78E-02

The only radioactive waste expected will be from spalled material during the fuel transfer. The spalled material is expected to fall into the receiving cask during fuel assembly placement. Any radioactive material which does not fall into the cask will either be picked up by the HVAC system and deposited into the Pre-filters or HEPA filters or fall onto the top of the cask or other equipment within the DTS, which will need to be decontaminated.

3.1.2 General Operating Functions

This section describes the overall functioning of the DTS as a fuel transfer system and highlights the functional activities of the major items of equipment which constitute the DTS. A detailed sequence of operations and their controls is presented in Chapter 5.

The receiving cask is transported to the DTS by a heavy-haul vehicle or vertical cask transporter. The cask is rotated to vertical if required, and loaded onto the receiving cask transfer trolley outside of the Preparation Area. The cask is tied down to the trolley. For the purpose of this Topical Report, the receiving cask is assumed to be a large Multipurpose Canister (MPC) in a transportation overpack. The information provided in the Multi-Purpose Canister Implementation Program Conceptual Design Phase Report was used to define the design basis receiving cask. The principal characteristics of the Multipurpose Canister and the Transportation Overpack are provided in Tables 3.1-4 and 3.1-5 respectively and shown in Figures 3.1-1 and 3.1-2.

The safety evaluation of the receiving cask will be covered by a separate submittal and is not within the scope of this Topical Report. Limits on the lifting and handling equipment

to ensure that the cask handling parameters are not exceeded outside of the DTS is likewise not within the scope of this Topical Report.

The roll up door to the Preparation Area is opened, and the trolley and cask enter the Preparation Area on rails. In the Preparation Area, the receiving cask lid is removed, as well as the two canister lids. A special lifting pintle which interfaces with the DTS is installed onto the shield plug which remains within the MPC. The cask seals and surfaces are inspected.

Once prepared, the receiving cask is ready to be moved into the Lower Access Area. The sliding door is opened, and the receiving cask trolley is moved to its mating position in the Lower Access Area. The receiving cask trolley is locked into place. All personnel leave the Lower Access Area.

To prevent the spread of contamination, the receiving cask has to be mated to the Transfer Confinement Area (TCA) prior to fuel transfer. This is accomplished by the Receiving Cask Mating Subsystem. The mating operation is performed without personnel in the Lower Access Area, since there is a small risk of contamination during this operation. The Receiving Cask Mating Subsystem seals with the top of the receiving cask. Bellows connect the top of the cask to the mezzanine floor of the TCA to form the confinement barrier between the TCA and Lower Access Area.

Table 3.1-4

Multipurpose Canister Characteristics

Characteristic	Description
Large MPC Capacity	21 spent fuel assemblies
Inner MPC diameter	58.3 inches (1480 mm)
Outer MPC diameter	60.30 inches (1530 mm)
Maximum weight to be lifted:	125 tons (113 metric tons, including transportation overpack)
MPC Inner Lid Weight	1,500 pounds (680 kg)
MPC Outer Lid Weight	2,100 pounds (950 kg)
MPC Shield Plug Weight:	5,700 pounds (2,580 kg)
Compartment size:	8.8 x 8.8 x 180 inches (224 x 224 x 4572 mm)

Table 3.1-5

Transportation Overpack Characteristics

Characteristic	Dimension
Weight (with canister and fuel assemblies)	125 tons (113 metric ton)
Weight of Overpack Lid	6,300 pounds (2,850 kg)
Overall Diameter	85.5 inches (2,170 mm)
Outer Diameter (without neutron shield & lift trunnions)	73 inches (1,850 mm)
Inner Diameter	61 inches (1,550 mm)
Overall Length	208.25 inches (5,090 mm)

The source cask is transported to the DTS by a trailer or vertical cask transporter. The cask is rotated to vertical if required, and loaded onto the source cask transfer trolley outside of the Preparation Area. The cask is tied down to the trolley. For the purpose of this Topical Report, the source cask is assumed to be a 30-ton transfer cask with the characteristics listed in Table 3.1-6 and shown in Figure 3.1-3. The selection of the source cask was arbitrary.

The source cask lid is required to have threaded holes in the lid for attachment of a lifting pintle. The pintle will be installed in the Preparation Area prior to entry into the Lower Access Area. Figure 3.1-4 illustrates the pintle concept.

In general, any source cask can be used, provided that the cask has the following characteristics:

- A means for attaching the lifting pintle,
- Lower trunnions for attachment to the Cask Transfer Subsystem,
- Maximum weight 30 tons (27 metric tons), and
- Sufficient clearance on the top surface of the cask outside of the lid for sealing with the Cask Mating Subsystem.

If a different source cask design is used, the guidance devices and the attachment mechanism on the Source Cask Trolley would be modified. The mating device would be resized, if necessary, to accommodate the cask. The trolley may also need to be resized depending on the size and weight of the cask. The guidance device for the source cask lid on the TC port cover would also be adjusted.

The safety evaluation of the source cask will be covered by a separate submittal and is not within the scope of this Topical Report. Limits on the lifting and handling equipment to ensure that the cask handling parameters are not exceeded outside of the DTS are likewise not within the scope of this Topical Report.

The roll up door to the Preparation Area is opened, and the trolley and source cask enter the Preparation Area on the same rails that were used for the receiving cask trolley. In the Preparation Area, the trolley is locked in place to prevent tipover, and the lifting pintle is installed onto the source cask lid. The cask is vented to a portable HEPA filter. The lid is unbolted, but left on the cask.

The source cask is now ready to be moved into the Lower Access Area. The sliding door is opened, and the source cask trolley is moved to its mating position in the Lower Access Area, and locked in place. All personnel leave the Lower Access Area.

To prevent the spread of contamination, the source cask has to be mated to the TCA prior to fuel transfer. This is accomplished by the Source Cask Mating Subsystem. The mating operation is performed without personnel in

Table 3.1-6

Design Basis Source Cask Characteristics

Characteristic	Dimension
Weight	30 tons (27 metric tons) loaded with 4 PWR assemblies
Outer Diameter	40.5 inches (1,030 mm)
Inner Diameter	25.5 inches (650 mm)
Length	190 inches (4,830 mm)
Weight of Lid	2,500 pounds (1,130 kg)

the Lower Access Area, since there is a small risk of contamination during this operation. The Source Cask Mating Subsystem seals with the top of the receiving cask. Bellows connect the top of the cask to the mezzanine floor of the TCA to form the confinement barrier between the TCA and Lower Access Area.

Once the casks are properly mated, and the sliding door is closed, fuel transfer operations are ready to be performed. These operations are controlled remotely from the Control Center. No personnel are permitted in the DTS during normal fuel transfer operations.

The source cask is opened following the sequence presented in Section 5.1.1.3. All operations are performed remotely from the Control Center. Upon completion of source cask opening, the lid and overlid rest on the TC port cover, and the TC port cover is positioned directly above the opening in the source cask.

The receiving cask is opened following the sequence presented in Section 5.1.1.4. All operations are performed remotely from the Control Center. Upon completion of receiving cask opening, the canister shield plug and overlid are resting on the TC port cover. The two upper shield ports are closed and locked. The receiving cask is covered by the TC port cover.

Fuel transfer can now be performed. Fuel transfer is remotely monitored and controlled from the Control Center. The operator uses two CCTV displays and an operator interface to perform operations. The cameras and lights are controlled by the operator. The fuel transfer operations are presented in Section 5.1.1.5. During lateral motion of the fuel assembly, the crud catcher is closed to prevent spread of contamination in the TCA.

The receiving cask is closed per the operating sequence presented in Section 5.1.1.6. The source cask is closed per the operating sequence presented in Section 5.1.1.7.

The fuel is now safely shielded in the receiving cask. The source cask mating subsystem is disengaged and the sliding door is opened. The source cask trolley is unlocked and moved into the Preparation Area. The sliding door is closed. The source cask outer surfaces are decontaminated, and the surface dose rates are checked. The source cask bolts are installed and torqued, and the lid lifting pintle is disengaged. The source cask is now ready for removal from the DTS for a new fuel loading.

The roll up door is opened, the source cask transfer trolley is unlocked and moved to the loading/unloading area outside of the DTS, and the roll up door is closed. The source cask is detached from the trolley and removed.

The sequence above is continued until the receiving cask is full. With the source cask trolley removed from the DTS, the receiving cask mating subsystem is disengaged and the sliding door is opened. The receiving cask trolley is unlocked and moved into the Preparation Area, where it is again locked in place. The sliding door is closed. The receiving cask is decontaminated and the surface is surveyed. The shield plug lifting pintle is disengaged, and the inner lid is placed on the receiving cask canister. The inner lid is then welded and

inspected. It is anticipated that the welding will be performed automatically, after equipment setup to minimize radiation exposure to workers. The welding equipment is then removed, and the cask is dried and inerted. A leak test is performed on the weld. The valve cover plates are then welded in place. Next the outer canister lid is placed on the receiving cask canister and welded and inspected. Finally, the receiving cask lid is installed, bolted and torqued. An HP survey is performed prior to release for transport or storage.

The roll up door is opened, the receiving cask transfer trolley is unlocked and moved to the loading/unloading area outside of the DTS, and the roll up door is closed. The receiving cask is detached from the trolley and removed.

If the receiving cask is to be transported, it is anticipated that the impact limiters or other special equipment will be installed in the loading/unloading area.

The anticipated solid radioactive waste materials associated with the operation of the DTS are small and restricted to such items as HEPA filters and decontamination materials such as rags and swabs. Provision is made within the Preparation Area for temporary storage of this material in appropriate containers, although ultimately the waste will be transferred to the adjoining on-site Reactor waste processing plant for final disposal. A discussion of the radioactive waste materials generated and how they will be handled is presented in Chapter 6.

Equipment which is no longer in use is expected to be shipped off site as Low Specific Activity (LSA) Material.

Liquid waste arising from decontamination operations will be wiped up with absorbent materials and processed as solid waste.

The gases evacuated from the receiving cask during drying operations is filtered and released.

A detailed description of waste processing and disposal provisions will be given in a site specific license application.

Transportation to and from the DTS is not part of this application. This will be handled on a site specific basis.

Primary and secondary electrical power is provided by the collocated utility.

Figure 3.1-1

Design Basis Receiving Cask Canister

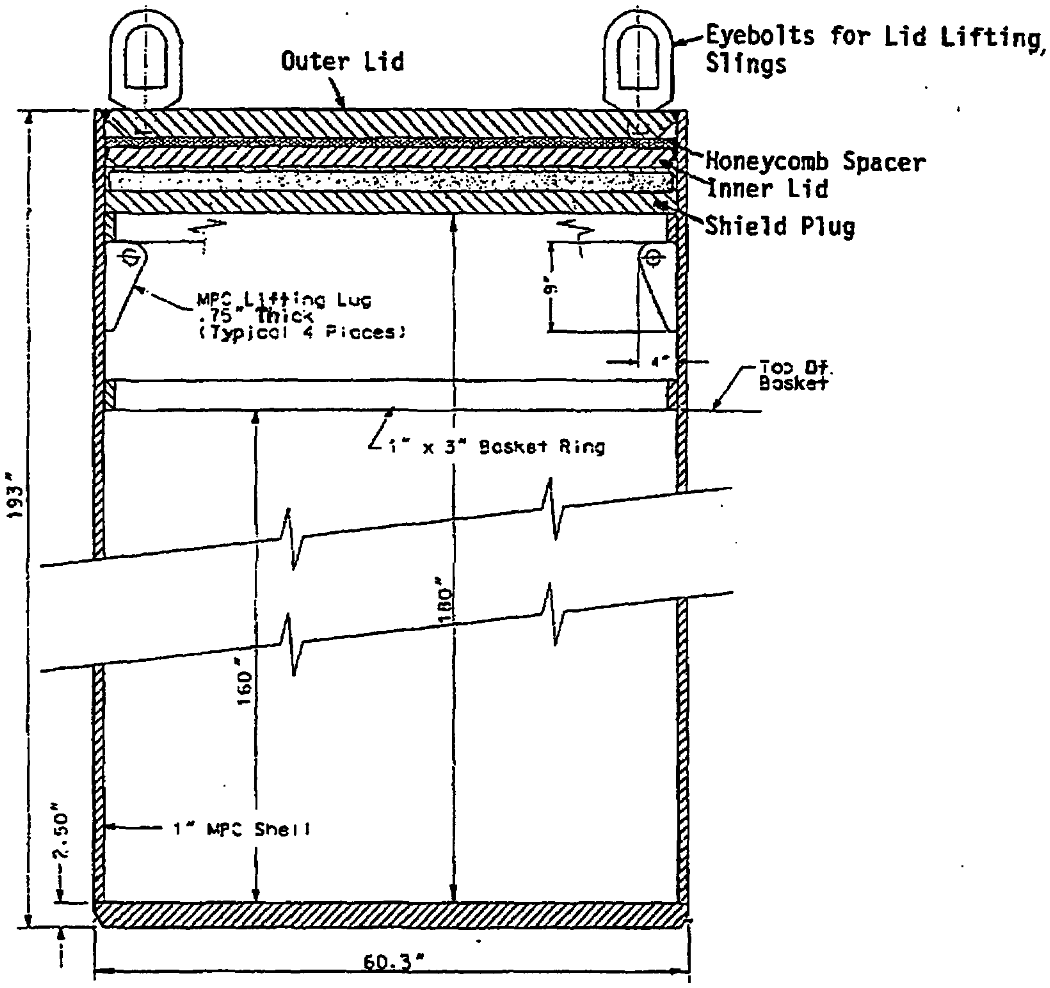
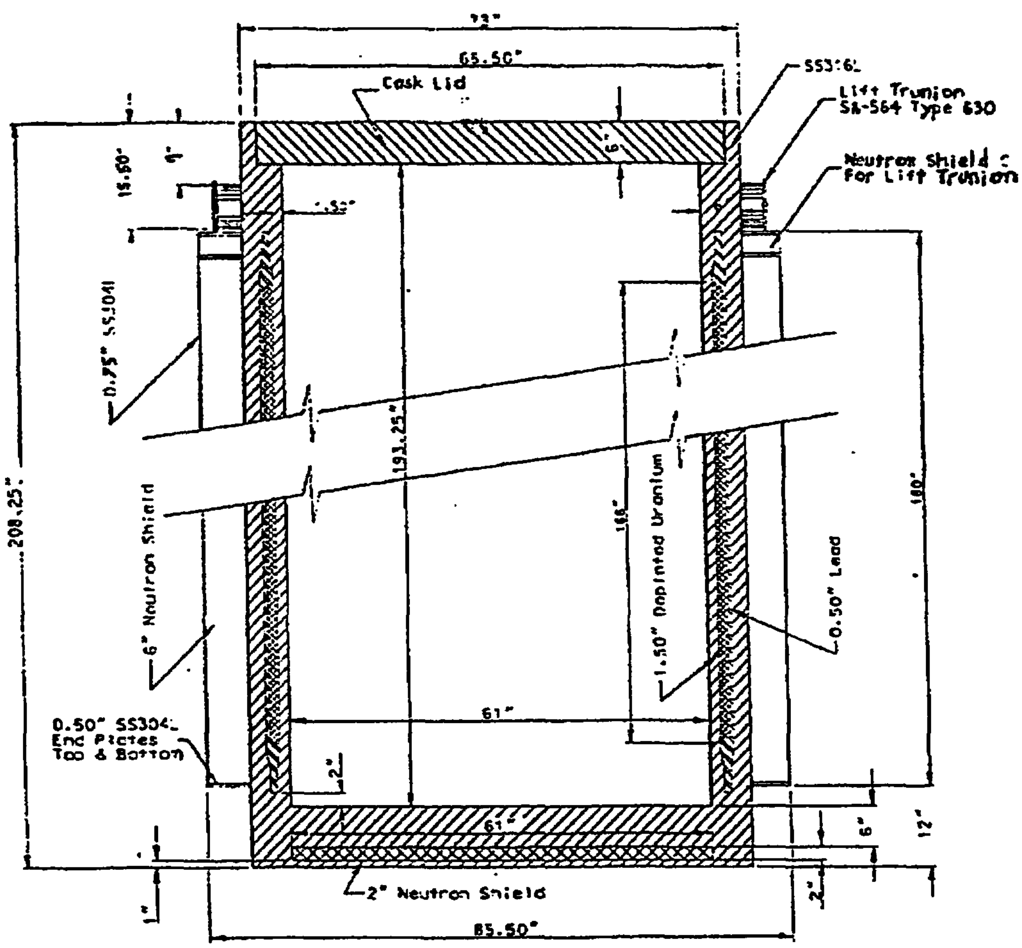
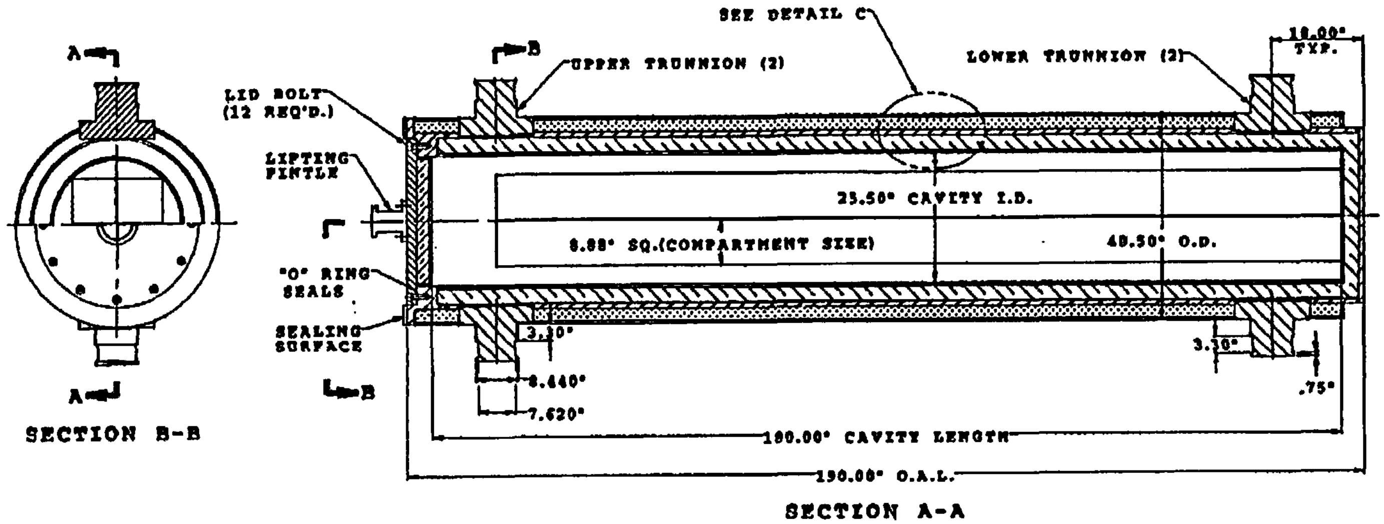


Figure 3.1-2

Design Basis Receiving Cask Transportation Overpack





NOTE:
SEALING SURFACE O.D.= 40.25"
SEALING SURFACE I.D.= 32.25"
CASK WEIGHT(LOADED)= 30 TONS

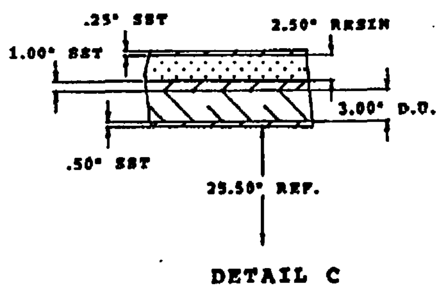
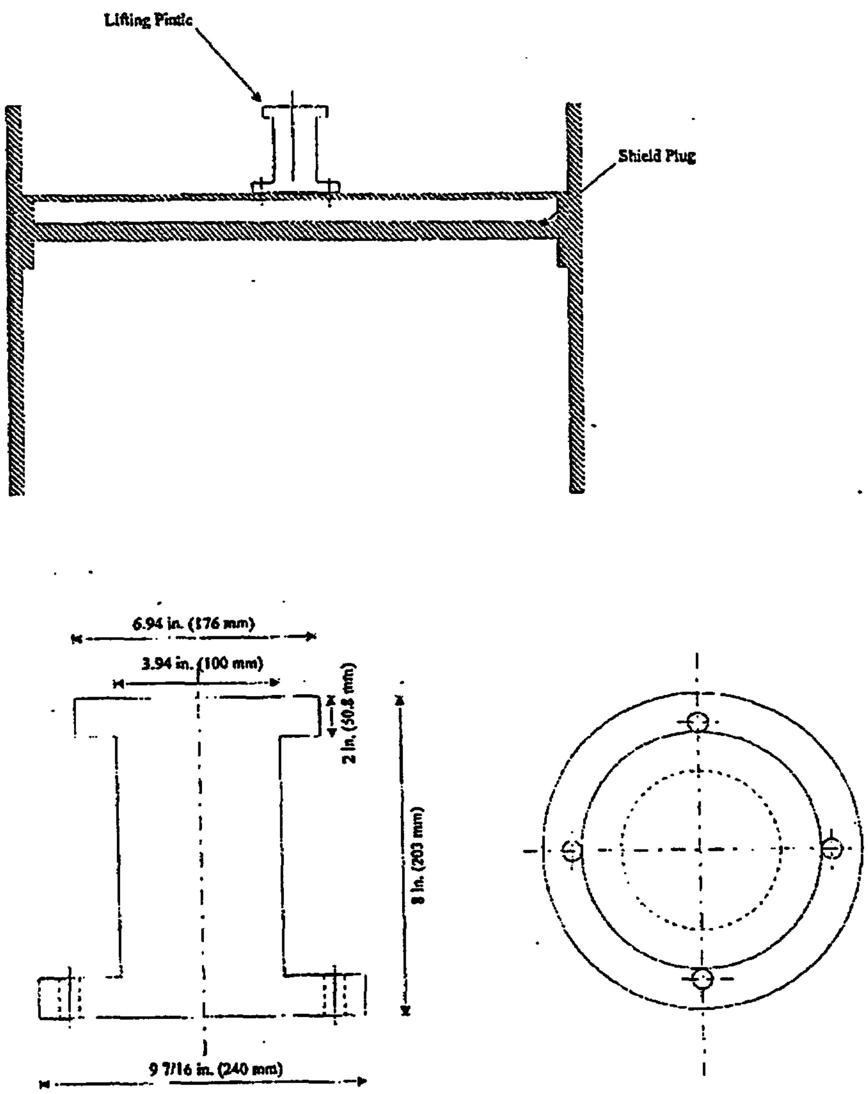


Figure 3.1-3
Design Basis Source Cask

Figure 3.1-4

Pintle Concept



3.2 Structural and Mechanical Safety Criteria

The structures, systems and components of the DTS that are important to safety are listed in 3.4. These systems are designed and analyzed to perform their intended functions under the extreme environmental and natural phenomena specified in 10CFR72.72 and ANSI-57.9[2]. This section describes the relevant environmental and geological features adopted as design criteria for these structures, systems, and components.

3.2.1 Tornado and Wind Loadings

In the event of a tornado warning or watch, the DTS will be shut down. It takes approximately 2 hours to bring the DTS into a full shut down condition. Any unsealed casks in the Preparation Area will be moved into the Lower Access Area. The sliding door will be closed. Any fuel in the transfer process will be lowered into the closest (either source or receiving) cask. The TC port covers and upper shield port covers will be closed. The fuel handling grapple will be moved to its highest position. The control center trailer, if deemed appropriate by the utility, may be moved to a sheltered area.

Operations will not be restarted until the tornado watch has passed.

The DTS structure is designed to withstand loadings due to tornado missiles, hurricanes or high winds. Any component which is outside of the DTS (such as exhaust fans or the condensing coil units for the Heating, Ventilating and Air Conditioning (HVAC) Subsystem are analyzed to ensure that the DTS is still safe in the event of a failure of the component.

The DTS structure protects the equipment housed within the DTS from tornado, tornado missiles and wind loads. The loads transferred to the equipment within the DTS from the design basis tornado missiles are small, and are bounded by the seismic loading. See TSAR section 8.2.4.3.

3.2.1.1 Applicable Design Parameters

The DTS is designed to withstand normal wind loads calculated in accordance with ANSI/ASCE 7-88[3] for the fastest speed of 110 mph (177 kph), at 33 ft (10 m) above ground for Exposure C associated with an annual probability of 0.02.

The most severe tornado and wind loadings specified by NRC Regulatory Guide 1.76[4] and NUREG-0800[5], Section 3.5.1.4 have been selected as the design basis for sites located within the contiguous United States. These loads are applied to the exterior of the DTS structure. The Preparation Area is not protected from tornado and wind loadings.

The most severe parameters corresponding to Region 1 in Regulatory Guide 1.76 are assumed for the design basis tornado:

- A maximum wind speed of 360 mph (579 kph),
- A rotational speed of 290 mph (467 kph),
- A minimum translational speed of 5 mph (8 kph),
- A maximum translational speed of 70 mph (113 kph),
- A radius of maximum rotational velocity of 150 ft (46.5 m),
- A maximum pressure drop of 3.0 psi associated with a rate of pressure drop of 2.0 psi (20,690 Pa) per second.

The spectrum of tornado generated missiles analyzed is based on the National Bureau of Standards as representative of construction site debris in report NBSIR 76-1050[(6)]. These missiles are also identified in NUREG-0800 as Spectrum II missiles. The missile velocities are taken from the Region I data, which is the most severe region. The missiles are described below in Table 3.2-1.

Table 3.2-1

Tornado Missile Spectrum

Missile	Mass (Kg)	Dimensions (m)	Velocity (m/sec)
A. Wood Plank	52 (115 lbs)	0.092 x 0.289 x 3.66	83
B. 6" Sch 40 Pipe	130 (287 lbs)	0.168 D x 4.58	52
C. 1" Steel Rod	4 (9 lbs)	0.0254 D x 0.915	51
D. Utility Pole	510 (1127 lbs)	0.343D x 10.68	55
E. 12" Sch 40 Pipe	340 (751 lbs)	0.32D x 4.58	47
F. Automobile	1810 (4000 lbs)	5 x 2 x 1.3	59

Vertical velocities of 70% of the postulated horizontal velocities are used except for missile C, which is used to test barrier openings, and is assumed to have the same velocity in all directions. Missiles A, B, C, and E are considered at all elevations and missile D and F are considered at elevations up to 30 feet (9.1 m) above all grade levels within 1/2 mile of the facility structures, as specified in NUREG-0800.

3.2.1.2 Determination of Forces on Structures

Gust response factors corresponding to exposure Category C are taken from Table 8 of

ANSI/ASCE 7-88 and are presented in Table 3.2-2.

Velocity pressure exposure coefficients are also given in Table 3.2-2 and are used in conjunction with an importance factor 1.11 for a Category III structure, from Table 5 of ANSI/ASCE 7-88, to determine velocity pressure from

$$q_z = 0.00256K_z\,(IV)^2$$

where:

q_z is the velocity pressure at height z
K_z is the velocity pressure exposure coefficient at height z
I is the importance factor for a Category III structure, and
V is the Basic Wind Speed of 110 mph (177 kph).

Table 3.2-2

Gust Response Factors and Velocity Pressure Exposure Coefficients for the DTS Structure Analysis

Height Above Grade, z(feet)	Gust Response Factors, gz	Velocity Pressure Coefficients, kz
0-15 (0-4.6 m)	1.32	0.80
20 (6.1 m)	1.29	0.87
25 (7.6 m)	1.27	0.93
30 (9.1 m)	1.26	0.98
40 (12.2 m)	1.23	1.06
50 (15.2 m)	1.21	1.13
60 (18.3 m)	1.20	1.19
70 (21.3 m)	1.19	1.24
80 (24.4 m)	1.18	1.29
90 (27.4 m)	1.17	1.34
100 (30.4 m)	1.16	1.38

Design wind pressure will be calculated for the main wind resisting systems and components, from the equations in Table 4 of ANSI/ASCE 7-88, based on the appropriate pressure coefficients taken from Figures 2 and 3 and Table 9 of ANSI/ASCE 7-88.

Design wind pressures for the building main frame and components are evaluated at 25'(7.6 m), 50'(15.2 m) and 55'(16.8 m) above grade. The design wind pressures at the evaluated heights are presented in Table 3.2-3.

The design pressures for the design basis tornado wind speed of 360 mph (579 kph) are presented in Table 3.2-4.

Table 3.2-3
Design Basis Wind Pressure

Component	Wind Speed MPH (kph)	Velocity Pressure q Lbs/ft^2 (Pa)	Gust Response Factor G_h	Pressure Coefficient C_p	Internal Pressure Coefficient GC_{pi}	Design Wind Pressure lbs/ft^2 (Pa)
Wall (25 ft/7.6 m) Windward	110 (177)	36 (1724)	1.27	0.8	±0.25	37 (1772) Pressure
Leeward	110 (177)	44 (2107)	1.27	-0.5	±0.25	39 (1868) Suction
Wall (50 ft/15.2 m)) Windward	110 (177)	43 (2059)	1.21	0.8	±0.25	42 (2011) Pressure
Leeward	110 (177)	44 (2107)	1.21	-0.5	±0.25	38 (1820) Suction
Roof (55 ft/16.8 m)	110 (177)	44 (2107)	1.20	-0.9	±0.25	59 (2826) Suction

Table 3.2-4

Design Basis Tornado Wind Pressure

Component	Wind Speed mph (kph)	Velocity Pressure q Lbs/ft² (Pa)	Gust Response Factor G_h	Pressure Coefficient C_p	Internal Pressure Coefficient GC_{pi}	Design Wind Pressure lbs/ft² (Pa)
Wall (25 ft/7.6 m) Windward	360 (579)	380 (18,199)	1.27	0.8	±0.25	386 (18,487) Pressure
Leeward	360 (579)	474 (22,701)	1.27	-0.5	±0.25	419 (20,067) Suction
Wall (50 ft/15.2 m) Windward	360 (579)	462 (22,126)	1.21	0.8	±0.25	447 (21,408) Pressure
Leeward	360 (579)	474 (22,701)	1.21	-0.5	±0.25	405 (19,397) Suction
Roof (55 ft/16.8 m)	360 (579)	474 (22,701)	1.20	-0.9	±0.25	630 (30,172) Suction

3.2.1.3 Ability of Structures to Perform Despite Failure of Structures Not Designed for Tornado Loads

The DTS structure is resistant to tornado loads. The major operating systems, contained within the DTS are designed to ensure that the loads transmitted by the impacting tornado missile do not result in the equipment becoming projectile. All major operating equipment have backup systems in the event of a malfunction of the primary operating system.

The Preparation Area is not resistant to tornado missiles. However, if the Preparation Area or any equipment within the Preparation Area is struck by a tornado missile, they can be replaced before resuming DTS fuel transfer operations.

Other than the DTS structure, the following equipment is exposed to tornado missiles and high winds:

The control center
Lid welding equipment (located in the Preparation Area)
Preparation Area overhead crane (located in the Preparation Area)
HVAC equipment and duct work
Scaffolding (located in the Preparation Area)
Motors and jacks used to manually operate TC port covers
Closed Circuit Television Subsystem Interface Equipment

In the event of a tornado watch, the fuel is replaced in the casks, the casks are closed and moved into the Lower Access Area (which is tornado resistant). There is no need to control or monitor the operations during these events since all operations are shutdown. There is no recovery requirement for the Control Subsystem, since manual backup can be used to pull the casks outside the Lower Access Area and opening of the sliding door is locally controlled. The Control Center (trailer) could be disconnected and moved to a tornado resistant area, if desired by the utility. The Programmable Logic Controllers, which are housed in the Preparation Area, can be lost during a tornado, but damage will not result in an unsafe condition since all operations have been stopped. Disconnection of the Control Center places the equipment in a safe condition (emergency brakes activated, dampers open, grapples closed, etc.)

The lid welding equipment, scaffolding and the Receiving Cask Lid Handling Subsystem could be damaged during a tornado. The Preparation Area is a very low radiation area while the casks are not in the Preparation Area. Hence, repair or replacement of damaged equipment can be safely performed in this area.

The equipment within the Preparation Area could become projectiles. However, the DTS structure is evaluated for impacts by tornado missiles more severe than the equipment within the Preparation Area. Therefore, the projectiles would not result in release of radioactive material.

It is possible that a missile from the tornado event could damage a HVAC component that is located outside of the DTS. This includes the exhaust fans and their duct work, and the three condensing coil units for the air conditioning systems in the DTS.

If the exhaust fans are damaged, the ventilation system could become inoperable. However, the DTS structure and filters would prevent radioactive particulate release. The cooling system, if still operable, will maintain the operating temperatures in the DTS.

Loss of the cooling system has an insignificant impact if the ventilation system remains operable. The air flow through the DTS will continue to dissipate the spent fuel decay heat.

If both the cooling and ventilating systems are rendered inoperable, the temperature within the DTS will gradually rise. To prevent fuel pin damage, the casks will be moved to the Preparation Area after the tornado has passed, and inerted.

The damage of the HVAC Subsystem due to the tornado event has no radiological consequences since, during tornado conditions, the receiving and source casks will be closed and the DTS will not operate if the HVAC Subsystem is destroyed by a tornado.

If the motors and jacks which are used to manually operate the TC port covers are impacted by a tornado missile, they can be removed and replaced.

The CCTV Subsystem is used upon a tornado watch to place the system in its safety condition. The Preparation Area houses the interface between the cameras, lights, pan and tilt devices and the Control Center. This interface equipment can be lost. Operations which are required to replace the CCTV equipment can be performed on contact.

3.2.1.4 Tornado Missiles

The design of the structure has taken into account the missiles produced by the design basis tornados. The reinforced concrete structure, the protective cover and the sliding door are all evaluated for tornado impact.

The automobile does not create local damage since it is a "soft" missile and crushes on impact. It is considered with respect to overall barrier stability and energy absorption. Similarly, the wood utility pole is subject to considerable deformation and will not locally deform thick steel components. Each of the missiles are addressed separately in this section.

Effect of Missiles on Concrete Structure

The DTS wall thickness is primarily dictated by shielding requirements. The massive walls adequately protect the DTS against tornado missiles and other adverse natural phenomena. The tornado generated missile impacts are considered to bound all other reasonable impact-type accidents.

The side walls of the reinforced concrete are 36 inches thick (914 mm). The walls are designed to provide adequate radiation shielding and easily meet the minimum acceptable barrier thickness requirements for local damage against tornado generated missiles. Nevertheless, in order to demonstrate the adequacy of the DTS design for tornado missiles, a bounding analysis of the concrete wall has been performed. The items evaluated include the resistance to penetration, spalling, scabbing and perforation for a postulated missile impact.

Missile A

The wood plank may partially penetrate the concrete wall, depending on the strength of the wood. From reference 3-15, the highest crush strength of wood is 63.5 MPa (9,210 psi) for hickory. This is higher than the crush strength of the reinforced concrete. Therefore the plank may partially penetrate the concrete wall. The depth of penetration, z, is taken from Reference 3.7, Equation 4.1. The diameter, d, is taken as the equivalent diameter of a rod with the same cross sectional area as the plank, 0.184 m.

$$G = 3.8 \times 10^{-5}\ N\ m\ V_t^{1.8} / f_{cy}^{0.5} d^{2.8}$$

where
N is the nose shape factor, taken as 0.72 for a flat-ended missile
m is 52 kg
V_t is the impact velocity, 83 m/sec
f_{cy} = concrete strength = 21 MPa = 3000 psi
d = diameter = 0.184 m

G = 0.101

The normalized depth of penetration, z, is determined from Equation 4.2b of Reference 3.7:

$$G = (z/2)^2 + 0.0605$$

Therefore, z = 0.4 m

Missile A will penetrate into the concrete wall approximately 0.4 m.

The minimum concrete thickness, t_s required to prevent scabbing from the rear surface is estimated from Equation 4.3 of Reference 3.7:

$$t_s/d = 5.3\ G^{1/3}$$

Solving for t_s:

$t_s = 5.3\ (.101)^{1/3}\ (0.184) = 0.454$ m. Since the concrete is 0.9 meters thick, scabbing will not occur.

In almost all cases where a missile impacts a concrete wall, some of the concrete will be ejected from the front face as a spall. This ejected concrete is generally formed from the cover to the front face reinforcement and is unlikely to cause more than cosmetic damage to the barrier.

To determine whether the missile will perforate the concrete wall, Formula 3.1 of Reference 3.7 is used:

$$V_c = 1.3\ \rho^{1/6}\ f_{cy}^{1/2}\ (P\ e^2/\pi\ m)^{2/3}\ (r + 0.3)^{1/2}$$

where
ρ = Concrete density = 2240 kg/m^3 = 0.081 lbs/in^3
P = Missile perimeter = 2 x (0.092 + 0.289) = 0.762 m = 2.5 ft.
e = Concrete thickness = 0.9 m = 3 ft
r = Reinforcement density, 18%
f_{cy} = Concrete cylinder strength = 21 MPa = 3000 psi
m = mass, 52 kg
and V_c is the velocity at which perforation will occur.

Therefore, V_c = 362 m/sec. Therefore, the missile will not perforate the concrete wall.

<u>Missile B</u>

The 6" schedule 40 pipe will partially penetrate the concrete wall. The depth of penetration, z, of a pipe missile into a reinforced concrete barrier which is of sufficient thickness to suffer no scabbing is estimated from the following formula, taken from Reference 3.7, equation 4.1.

$$G = 3.8 \times 10^{-5}\ N\ m\ V_t^{1.8} / f_{cy}^{0.5} d^{2.8}$$

where
N is the nose shape factor, taken as 0.72 for a flat-ended missile
m is 130 kg
V_t is the impact velocity, 52 m/sec
f_{cy} = concrete strength = 21 MPa = 3000 psi
d = diameter = 0.168 m (6.625 in.)

G = 0.141

The normalized depth of penetration, z, is determined from Equation 5.1 of reference 3.7:

$$G = (z/2)^2$$

Therefore, z = 0.75 m. The missile can penetrate 0.75 meters.

The minimum concrete thickness, t_s required to prevent scabbing from the rear surface is estimated from Equation 4.3 of Reference 3.7:

$$t_s/d = 5.3\ G^{1/3}$$

Solving for t_s:

$t_s = 5.3\ (.141)^{1/3}\ (0.168) = 0.46$ m. Since the concrete is 0.9 meters thick, scabbing will not occur.

In almost all cases where a missile impacts a concrete wall, some of the concrete will be ejected from the front face as a spall. This ejected concrete is generally formed from the cover to the front face reinforcement and is unlikely to cause more than cosmetic damage to the barrier.

To determine whether the missile will perforate the concrete wall, Formula 3.1 of Reference 3.7 is used:

$$V_c = 1.3\ \rho^{1/6}\ f_{cy}^{1/2}\ (P\ e^2/\pi\ m)^{2/3}\ (r + 0.3)^{1/2}$$

where
ρ = Concrete density = 2240 kg/m^3 = 0.081 lbs/in^3
P = Missile perimeter = 0.168 π = 0.528 m = 1.73 ft.
e = Concrete thickness = 0.9 m = 3 ft
r = Reinforcement density, 18%
f_{cy} = Concrete cylinder strength = 21 MPa = 3000 psi
m = mass, 130 kg
and V_c is the velocity at which perforation will occur.

Then V_c = 154 m/sec (505 ft/sec). Since the missile velocity is well below V_c, the missile will not perforate the concrete wall.

Missile C

The 1" steel rod is less severe than the other missiles and will not penetrate the

concrete wall. Penetrations through the wall are sized to prevent the 1" rod from entering the structure.

Missile D

The utility pole may crush upon impact with the concrete structure, depending on the strength of the material. The highest crush strength for wood in Reference 3-15 is 9210 psi (63.5 MPa) for hickory which is stronger than the concrete. Therefore the pole will partially penetrate the concrete wall. The depth of penetration, z, of a nondeforming missile into a reinforced concrete barrier which is of sufficient thickness to suffer no scabbing is estimated from the following formula, taken from Reference 3.7, equation 4.1.

$$G = 3.8 \times 10^{-5} \, N \, m \, V_t^{1.8} / f_{cy}^{0.5} d^{2.8}$$

where N is the nose shape factor, taken as 0.72 for a flat-ended missile
m is 510 kg
V_t is the impact velocity, 55 m/sec
f_{cy} = concrete strength = 21 MPa = 3000 psi
d = diameter = 0.343 m

G = 0.0827

From Reference 3.7, Equation 4.2b, the depth of penetration can be determined.

$$G = (z/2)^2 + 0.0605$$

Solving for z:

$$z = 2(\, 0.0827 - .0605)^{.5} = 0.30 \text{ m}$$

The minimum concrete thickness, t_s required to prevent scabbing from the rear surface is estimated from Equation 4.3 of Reference 3.7:

$$t_s/d = 5.3 \, G^{1/3}$$

Solving for t_s:

$t_s = 5.3\ (.0827)^{1/3}\ (0.343) = 0.792$ m. Since the concrete is 0.9 meters thick, scabbing will not occur.

In almost all cases where a missile impacts a concrete wall, some of the concrete will be ejected from the front face as a spall. This ejected concrete is generally formed from the cover to the front face reinforcement and is unlikely to cause more than cosmetic damage to the barrier.

To determine whether the missile will perforate the concrete wall, Formula 3.1 of Reference 3.7 is used:

$$V_c = 1.3\ \rho^{1/6}\ f_{cy}^{1/2}\ (P\ e^2/\pi\ m)^{2/3}\ (r + 0.3)^{1/2}$$

where
ρ = Concrete density = 2240 kg/m^3 = 0.081 lbs/in^3
P = Missile perimeter = 0.343 π = 1.08m = 3.54 ft.
e = Concrete thickness = 0.9 m = 3 ft
r = Reinforcement density, 18%
f_{cy} = Concrete cylinder strength = 21 MPa = 3000 psi
m = mass, 510 kg
and V_c is the velocity at which perforation will occur.

Then V_c = 100 m/sec (328 ft/sec). Since the missile velocity is well below V_c, the missile will not perforate the concrete wall.

Missile E

The 12" schedule 40 pipe will partially penetrate the concrete wall. The depth of penetration, z, of a pipe missile into a reinforced concrete barrier which is of sufficient thickness to suffer no scabbing is estimated from the following formula, taken from Reference 3.7, equation 4.1.

$$G = 3.8 \times 10^{-5}\ N\ m\ V_t^{1.8} / f_{cy}^{0.5} d^{2.8}$$

where
N is the nose shape factor, taken as 0.72 for a flat-ended missile
m is 340 kg
V_t is the impact velocity, 47 m/sec
f_{cy} = concrete strength = 21 MPa = 3000 psi
d = diameter = 0.32 m

G = 0.0504

The normalized depth of penetration, z, is determined from Equation 5.1 of reference 3.7:

$$G = (z/2)^2$$

Therefore, z = 0.45 m

The minimum concrete thickness, t_s required to prevent scabbing from the rear surface is estimated from Equation 4.3 of Reference 3.7:

$$t_s/d = 5.3\ G^{1/3}$$

Solving for t_s:

$t_s = 5.3\ (.0504)^{1/3}\ (0.32) = 0.63$ m. Since the concrete is 0.9 meters thick, scabbing will not occur.

In almost all cases where a missile impacts a concrete wall, some of the concrete will be ejected from the front face as a spall. This ejected concrete is generally formed from the cover to the front face reinforcement and is unlikely to cause more than cosmetic damage to the barrier.

To determine whether the missile will perforate the concrete wall, Formula 3.1 of Reference 3.7 is used:

$$V_c = 1.3\ \rho^{1/6}\ f_{cy}^{\ 1/2}\ (P\ e^2/\pi\ m)^{2/3}\ (r + 0.3)^{1/2}$$

where
ρ = Concrete density = 2240 kg/m^3 = 0.081 lbs/in^3
P = Missile perimeter =0.32 π = 1.005 m = 3.3 ft.
e = Concrete thickness = 0.9 m = 3 ft
r = Reinforcement density, 18%
f_{cy} = Concrete cylinder strength = 21 MPa = 3000 psi
m = mass, 340 kg
and V_c is the velocity at which perforation will occur.

Then V_c = 124 m/sec (407 ft/sec). Since the missile velocity is well below V_c, the missile will not perforate the concrete wall.

Missile F

The automobile will crush upon impact. The average dynamic force derived from equation 6.4 of reference 3-7 is:

$$F = 15.5\ M^{2/3}\ V^{1.62} = 15.5\ (1800)^{2/3}\ (56)^{1.62} = 1560\ \text{KN}$$

The Dynamic increased factor as per ACI 349 App. C for grade 60 reinforcing steel is: DIF = 1.1

⇒Equivalent average dynamic force F = 1560/1.1 = 1420 KN

Conservatively using dynamic force as static force for bending moment calculation

⇒Equivalent static force F = 1420 KN

Effect of Missiles on Protective Cover

The protective cover is analyzed to verify its adequacy for local barrier impingement of a DBT missile. The cover has been analyzed to verify that it will not be perforated due to a tornado missile. The utility pole and the automobile are limited to elevations up to 30 feet, so they will not impact the protective cover. The wood plank will crush rather than penetrate the steel protective cover. Therefore only the 6 inch and 12 inch pipe are evaluated. The damage due to impact of the 1" steel rod is bounded by the impacts of the pipe missiles.

The minimum thickness of a steel plate capable of being perforated by the postulated DBT missile is given in McDonald [8] and is:

$$T = \frac{(0.5\, M_m\, V_s^2)^{2/3}}{672 d_m}$$

Where for the 12" schedule 40 pipe:

T = minimum plate thickness (in)
M_m= mass of missile, W/g = 751/32.2 = 23.29 slugs (340 kg)
W= weight = 340 kg = 751 lb
g= = 9.8 m/s^2 = 32.2 ft/s^2
V_s= Missile Strike Velocity = 47 m/s = 154.2 ft/s
d_m= Diameter of missile = 0.32m = 12.6 in

Substituting and solving for T produces a minimum plate thickness of 0.502" (13 mm). The specified minimum wall thickness for the protective cover plate is 1.5" (38 mm). Therefore, the pipe will not penetrate the protective cover plate.

For the 6" schedule 40 pipe,

M_m = mass of missile, W/g = 287/32.2 = 8.9 slugs (130 kg)

W = weight = 130 kg = 287 lbs
g = 32.2 ft/s^2 = 9.8 m/s^2
V_s = Missile Strike Velocity = 52 m/s = 170.6 ft/s
d_m = Diameter of missile = 0.168m = 6.6 in

Substituting and solving for T produces a minimum plate thickness of 0.577" (15 mm). Therefore, the pipe will not penetrate the cover plate.

Consequently there is adequate protection against local design basis tornado missile impact damage. Local bending and distortion to the protective cover is acceptable, since the DTS will not be operated during a tornado watch or warning.

Effect of Missiles on the Sliding Door

The thickness of the sliding door is 7" on the bottom and 9" on the top where additional shielding is required (178 mm and 229 mm, respectively). The walls are designed to provide adequate radiation shielding and easily meet the minimum acceptable barrier thickness requirements for local damage against tornado generated missiles, specified in Section 4.0. Each tornado missile is addressed below.

Missile A

The wood plank will crush upon impact with the sliding door. From reference 3-15, the highest crush strength of wood is 63.5 MPa (9,210 psi) for hickory. The maximum impact force is therefore 63.5 MPa x 0.092 m x 0.289 m = 1.69×10^6 N (380 kips).

Missile B

The 6" schedule 40 pipe penetrates the sliding door 0.577 inches as shown above for the protective cover plate. The cross sectional area of the pipe is 5.581 in^2 or 3.6×10^{-3} m^2. The missile kinetic energy is:

$$KE = 0.5\ mv_o^2 = 0.5\ (130)(52)^2 = 1.78 \times 10^5 \text{ N m}$$

The impact force is conservatively based on the yield strength of the pipe. For the purpose of this analysis, the yield strength of the pipe is assumed to be 210 MPa (30,000 psi). Then, the contact force is 7.56×10^5 N (170 kips).

Missile C

The 1" steel rod is bounded by the analysis of the other missiles.

Missile D

The utility pole will crush upon impact with the sliding door. From Reference 3-15, the highest crush strength of wood is 63.5 MPa (9,210 psi) for hickory. The maximum impact force is therefore 63.5 MPa x π $(0.343)^2/4 = 5.87 \times 10^7$ N (1,320 kips).

Missile E

The 12" schedule 40 pipe penetrates the sliding door 0.502 inches, as shown above for the protective cover plate analysis. The cross sectional area of the pipe is 15.74 in^2 or 1.02×10^{-2} m^2.

The missile kinetic energy is:

$$KE = 0.5\ mv_o^2 = 0.5\ (340)(47)^2 = 3.76 \times 10^5\ N\ m$$

The impact force is conservatively based on the yield strength of the pipe. For the purpose of this analysis, the yield strength of the pipe is assumed to be 210 MPa (30,000 psi). Then, the contact force is 2.13×10^6 N (479 kips).

Automobile:

The automobile will crush upon impact. The kinetic energy of the automobile at impact is:

$$KE = (1/2)mv^2 = (1/2)(1810)(59)^2 = 3.15 \times 10^6\ N\text{-}m$$

The cross sectional area of the automobile is 2.6 m^2. The car is assumed to crush 0.9 m (3 ft.) under a constant force during the impact. The loss of kinetic energy is assumed to be dissipated by crushing of the missile:

$$F \times 0.9 = KE$$

Then the constant force is $F = 3.15 \times 10^6 / (0.9) = 3.5 \times 10^6$ N (787 kips). The pressure on the concrete is $F/A = 3.5 \times 10^6 / 2.6 = 1.35\ MN/m^2$ (196 psi).

Based on the above calculation, the missile (automobile) deforms and is crushed during the impact. The local pressure on the sliding door is less than 1% of the sliding door yield strength. Therefore, no local penetration occurs.

3.2.2 Water Level (Flood) Design

The DTS will be sited at an elevation above flood level.

3.2.3 Seismic Design

The DTS is designed for a maximum ground acceleration of 0.25 g horizontal and 0.17 g vertical. This design load encompasses nuclear facilities east of the Rocky Mountains. Proposed sites west of the Rockies will be evaluated for higher g loads, if necessary, on a site specific basis.

A response spectrum analysis was performed on the DTS structure. The response spectrum analysis models the concrete structure, the mezzanine plate and the roof plate.

The DTS is assumed to be located east of the Rocky Mountain Front, in an area of known seismic activity. It is also assumed that the results from onsite foundation and geological investigation, literature review, and regional geological reconnaissance show no unstable geological characteristics, soil stability problems, or potential for vibratory ground motion at the site in excess of an appropriate response spectrum anchored at 0.2 g. The standard design earthquake (DE) anchored at 0.25 g is used.

For sites which are located west of the Rocky Mountain Front, a site specific DE will be determined using the criteria and level of investigations required by 10CFR100[10] Appendix A.

The following input criteria were used:

1. Design Response Spectra Derivations

The NRC Regulatory Guide 1.60[11] response spectra curves with peak ground accelerations of 0.25 g horizontal and 0.17 g vertical were used.

2. Damping

For the DTS reinforced concrete structure, a 7% damping factor was used as specified in NRC Regulatory Guide 1.61[12].

3. Soil

Soil Structure Interaction has not been included in the analysis. A hard rock site is assumed which is expected to result in the maximum accelerations on the structure.

Amplification due to soil structure interaction is a function of the soil properties and the size of the building. Very firm soil (shear velocities less than 800 fps) helps, with an amplification less than 1.0. Shear velocities between 800 and 2000 fps may create some amplification. Soft soil (shear velocities greater than 2000 fps) may be decoupled from the building. Also, smaller buildings of the size of the DTS tend to have lower amplifications.

Therefore, amplifications due to soil structure interaction, if any, is expected to be small. However, for a site specific case, site response spectra will be generated with a soil structure interaction model. Either the site specific response spectra will be shown to be enveloped by the response spectrum considered herein, or else the analysis will be modified to consider the site specific soil structure.

The seismic analysis of the DTS structure and the major operating systems is presented in the appendices of Chapter 8.

3.2.4 Snow and Ice Loadings

The roof of the DTS is designed for a load of 100 psf (4789 Pa) due to snow or ice. This load is taken from ANSI/ASCE 7-88[3] and is the maximum 100 year roof snow load specified for most areas of the continental United States for an unheated structure.

3.2.5 Load Combination Criteria

The load criteria associated with the DTS may be divided into groups as follows:

- Loading on the DTS Reinforced Concrete Structure;
- Loading on the Structural Steel Work including the Protective Cover, Sliding Door, Mezzanine Plate and Roof);
- and Loading on the Major Operating Equipment including Upper Crane, the Fuel Handling Crane and the cask transfer trolleys.

3.2.5.1 DTS Reinforced Concrete Structure

Table 3.2-5 summarizes the design loading on the structure. The DTS is designed to meet the requirements of ACI 349-85[13]. All eleven load combinations specified are considered and the governing combinations are selected for detailed design and analysis. The resulting DTS load combinations and the appropriate load factors are presented in Table 3.2-6. The strength reduction factors are listed in Table 3.2-7.

Table 3.2-5

Summary of Structure Design Loadings

Components	Design Load	Applicable Codes	Design Parameters
Superstructures Shielding Walls Concrete Foundation	Wind	ANSI/ASCE 7-88	Max. Wind Speed: 110 mph (177 kph)Exposure Category "C"
	Tornado (Wind)	Reg. Guide 1.76	Max. Wind Speed: 360 mph (579 kph) Rotational Speed: 290 mph Translational Speed: Max. 70 mph (113 kph) Min. 5 mph (8 kph) Radius of Max. Rotation. Speed: 150 ft (45.7 m) Max. Pressure Drop: 3 psi (20,690 Pa) at a rate of 2 psi (13,793 Pa) per second
	Tornado (Missile)	NUREG 0800 Section 3.5.1.4 Spectrum II, Region I	
	Seismic	Reg Guides 1.60 & 1.61 10CFR72.102	Hor. Ground Acceleration : 0.25 g Vert. Ground Acceleration: 0.17 g
	Snow and Ice	ANSI/ASCE 7-88	Max. Ground Snow Load 100 psf (4789 Pa)
	Live Loads	ANSI/ANS 57.9 ANSI/ASCE 7-88	Uniformly distributed Loads: 250 psf (11,973 Pa) Concentrated Loads: ANSI/ASCE 7-88

Table 3.2-5 (Continued)

Summary of Structure Design Loadings

Components	Design Load	Applicable Codes	Design Parameters
	Dead Loads	ANSI/ANS 57.9	Dead Load of the Structure and Attachments including Permanent equipment and piping
Superstructures Shielding Walls Concrete Foundation	Normal and Off-Normal Operating Temperatures	ANSI/ANS 57.9	
	Normal Handling Loads	ANSI/ANS 57.9	See equipment description in Section 5.0.
	Loads Due To Drop of a Heavy Load	ANSI/ANS 57.9	Drop on mezzanine floor of: Fuel Assembly 28 inches (710 mm) Source Cask Lid 10 inches (250 mm) Receiving Cask Shield Plug 16 inches (410 mm)
	Internal Pressure	10CFR72	
	Fire and Explosion	10CFR72.122	Enveloped by Other Design Basis Events

Table 3.2-6

Load Combinations of Reinforced Concrete Structure

Load Case No.	Load Combination
1	$U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7R_o$
2	$U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7E_o + 1.7R_o$
3	$U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7W + 1.7R_o$
4	$U = D + F + L + H + T_o + R_o + E_{ss}$
5	$U = D + F + L + H + T_o + R_o + W_t$
6	$U = D + F + L + H + T_a + R_a + 1.25\ P_a$
7	$U = D + F + L + H + T_a + R_a + 1.15\ P_a + 1.0\ (Y_r + Y_j + Y_m) + 1.15E_o$
8	$U = D + F + L + H + T_a + R_a + 1.0\ P_a + 1.0\ (Y_r + Y_j + Y_m) + 1.0\ E_{ss}$
9	$U = 1.05D + 1.05F + 1.3L + 1.3H + 1.05\ T_a + 1.3R_o$
10	$U = 1.05D + 1.05F + 1.3L + 1.3H + 1.3E_o + 1.05T_a + 1.3R_o$
11	$U = 1.05D + 1.05F + 1.3L + 1.3H + 1.3W + 1.05T_a + 1.3R_o$

where:

$U =$	required strength to resist factored loads or related internal moments and forces,
$D =$	Dead loads, or related internal moments and forces, including piping and equipment dead loads,
$F =$	Lateral and vertical pressure of liquids or related internal moments and forces, (Not applicable to DTS)
$L =$	Live loads, or related internal moments and forces,
$H =$	lateral earth pressure, or related internal moments and forces,
$R_o =$	Piping and equipment reactions, or related internal moments and forces, which occur under normal operating and shutdown conditions, excluding dead load and earthquake reactions,
$E_o =$	Load effects of operating basis earthquake (OBE) or related internal moments and forces, including OBE-induced piping and equipment reactions,

Table 3.2-6 (Continued)

Load Combinations of Reinforced Concrete Structure

W = Operating basis wind load (OBW) or related internal moments and forces,

T_o = Internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of normal operating and shutdown procedures, (Not applicable to DTS)

E_{ss} = load effects of safe shutdown earthquake (SSE), or related internal moments and forces, including OBE-induced piping and equipment reactions,

W_t = loads generated by the design basis tornado (DBT), or related internal moments and forces. These include loads due to tornado wind pressure, tornado created differential pressures, and tornado generated missiles,

T_a = internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of accident conditions generated by a postulated pipe break and including T_o,

R_a = piping and equipment reactions, or related internal moments and forces, under thermal conditions generated by a postulated pipe break and including R_o, (Not applicable to DTS)

P_a = differential pressure load, or related internal moments and forces, generated by a postulated pipe break, (Not applicable to DTS)

Y_r = loads, or related internal moments and forces, on the structure generated by the reaction of the broken pipe during a postulated break, (Not applicable to DTS)

Y_j = jet impingement load, or related internal moments and forces, on the structure generated by a postulated pipe break, (Not applicable to DTS)

Y_m = missile impact load, or related internal moments and forces, on structure generated by a postulated pipe break, such as pipe whip, (not applicable to DTS)

E_o = Load effects of operating basis earthquake (OBE), or related internal moments and forces, including OBE-induced piping and equipment reactions.

The Dead loads, D, consist of the weight of permanent construction, including walls, floors, roofs, ceilings, and fixed service equipment, plus the net effect of prestress. This load is varied by ± 5% as required by ANSI ANS 57.9.

The Live load, L, includes snow, rain, operational and superimposed loads. These loads are varied from 0 to 100% as required by ANSI ANS 57.9.

Table 3.2-7

DTS Reinforced Concrete Structure Ultimate Strength Reduction Factors

Type of Stress	Reduction Factor
Flexure	0.9
Axial Tension	0.9
Axial Compression	0.7
Shear	0.85
Torsion	0.85
Bearing	0.7

3.2.5.2 Structural Steelwork

The structural steelwork is designed in accordance with the AISC specification for the design, fabrication and erection of structural steel for building and is based on the load combinations and stress limits of ANSI/AISC N690[14]. The resulting DTS load combinations and appropriate load factors for structural steelwork are presented in Table 3.2-8.

The structural steelwork is made from a combination of mild steel (ASTM A36) and high tensile steel (ASTM A441 or equivalent).

Table 3.2-8

Load Combinations and Stress Limits of Structural Steelwork

Load Case No.	Load Combination
1	$S > D + L$
2	$1.5\ S > D + L + R_o + T_o$
3	$S > D + L + W$
4	$S > D + L + E_o$
5	$1.5\ S > D + L + W + R_o + T_o$
6	$1.5\ S > D + L + R_o + T_o + E_o$
7	$1.6\ S > D + L + R_o + T_o + W_t$
8	$1.6\ S > D + L + R_o + T_o + E_{ss}$
9	$1.6\ S > D + L + R_a + T_a + P_a$
10	$1.6\ S > D + L + R_a + T_a + Y_r + Y_j + Y_m + E_o + P_a$
11	$1.7\ S > D + L + R_a + T_a + Y_r + Y_j + Y_m + E_s + P_a$

Where S is the stress limit outlined in Table 3.2-9 and the loads are as defined after Table 3.2-6.

Table 3.2-9
Stress Limits for Structural Steelwork

Stress Type	Allowable Stress[1]
Tensile	0.6 S_y
Compressive	[2]
Bending	0.6 S_y
Shear	0.4 S_y[3]
Interaction	[4]

NOTES:
1. Values are per AISC "Specification For Structural Steel Buildings".
2. Equations E2-1 or E2-2 of the AISC specification are to be used as appropriate.
3. Maximum allowable shear stress for load cases 7 to 11 of Table 3.2-8 is limited to 1.4S (0.56 Sy)
4. Interaction equations per the AISC specification are to be used as appropriate.

Table 3.2-10
Stress Limits for Bolts

Stress Category	Allowable Stress	
	Normal Conditions	Accident Conditions
Average Tensile Stress	2/3 S_y	Lesser of: 0.7 S_u or S_y
Average Shear Stress	0.4 S_y	Lesser of: 0.42 S_u or 0.6 S_y
Maximum Combined Stress	0.9 S_y	S_y

3.2.5.3 Major Operating Equipment

The upper crane, fuel handling crane, and cask trolleys are designed in accordance with ASME NOG-1. The design criteria and load combinations are presented in Appendix 8A2. The following loads are taken into account: dead loads, rated loads, credible critical load during the Safe Shutdown Earthquake, and the seismic loads.

3.3 Safety Protection Systems

3.3.1 General

The DTS is not intended to store fuel for long periods. The design turnaround time for a receiving cask is 10 days and the design turnaround time for a source cask is 24 hours. However, since there is no written regulatory guidance for a Dry Transfer facility, the DTS has been designed to meet the requirements of 10CFR72.

The DTS is designed for safe and secure containment of spent fuel assemblies during the transfer period. The DTS structure is designed for a life of 20 years. However, the DTS is designed to minimize the spread of contamination, so that periodic maintenance in all areas can be performed on contact. The components, structures, and equipment which are designed to assure that this safety objective is met are shown in Table 3.3-1. In addition, the source cask and receiving cask, which are not part of this application, are important to safety.

The DTS has been designed to maintain:

a) Sub-criticality
b) The integrity of the spent fuel assemblies against gross rupture during handling and normal and off-normal events.
c) The capacity to shield operators and the general public from direct radiation and contamination.
d) Prevent gross collapse during all design events and preclude the dropping of heavy objects as a result of building structural failure onto the fuel or onto structures, systems or components Important to Safety.

The key elements of the DTS and its operations which require special design consideration are:

A. Minimizing contamination of the DTS structure and equipment during fuel handling operations.
B. Design of the HVAC system for effective decay heat removal to ensure the integrity of the fuel cladding and proper operation of the cameras, lighting and operational equipment.
C. The provision to backfill the receiving cask with helium for future transport or storage.
D. The provision to weld and examine the welds of the receiving cask canister lids for future transport or storage.
E. Minimizing personnel radiation exposure during all DTS operations.

F. Design of the control system and CCTV System. The control system in conjunction with the cameras located within the DTS allow operations to be performed properly and safely.

G. Design of the transfer cask trolleys to prevent tipover when the receiving cask lids and the source cask bolts are not installed.

H. The integrity of the fuel transfer system to ensure safe handling and placement of the spent fuel assemblies.

3.3.2 Multiple Confinement Barriers and Systems

3.3.2.1 Confinement Barriers and Systems

The primary confinement barrier for the escape of radioactivity from the DTS is the fuel cladding. The integrity of the fuel cladding is ensured by maintaining fuel cladding temperatures below acceptable limits for short term storage in air.

The secondary confinement barrier during cask preparation consists of the casks with the canister shield plug installed in the receiving cask and the source cask lid resting on the source cask. The casks are prevented from tipping over by being structurally secured to the cask transfer trolleys during this operation.

The secondary confinement barrier during fuel transfer operations consists of the sliding door equipped with inflatable seals, the concrete structure, the protective cover with the gasket seals between the cover and the concrete structure, and the HVAC filters. This physical confinement boundary is particulate tight.

In addition, the DTS is equipped with an HVAC system which maintains pressure differentials between the three regions of the DTS and the external environment such that air flows toward areas of increasing levels of potential contamination during Category I, II, and III design events as identified in ANSI/ANS 57.2 (Reference 3-2). An evaluation and discussion of each of the design events is presented in Chapter 8. Redundant components are provided to minimize the potential for failure. The internal pressure for the regions within the DTS are as follows:

Transfer Confinement Area (Including Roof Enclosure Area):	1 in H_2O less than ambient
Lower Access Area:	0.5 in. H_2O less than ambient
Preparation Area:	0.25 in. H_2O less than ambient

The Lower Access Area and the TCA are confinement areas. The Preparation Area is not considered a confinement area.

Gaseous radiation is not a significant source of radioactivity from the DTS. Failed fuel is not accepted, and the fuel loaded into the source cask is examined for gross failures prior to shipment..

The exhaust stack is equipped with a continuous air monitor. The stack monitor collects and monitors airborne particulate, iodine and noble gases. The information is sent through a microprocessor to the Control Center and the Preparation Area, so that in the event of an abnormal release, proper corrective action can be taken.

In addition to the confinement barriers discussed above, the following equipment minimize spread of particulate within the DTS. These include:

The bellows of the cask mating system
Overlids for each cask
Fuel transfer tube and crud catcher

The cask mating system minimizes the spread of contamination from the TCA to the Lower Access Area. Bellows systems mate the mezzanine floor to the tops of the casks. This keeps particulate from contaminating the external surface of the cask or the floor of the Lower Access Area.

Overlids are placed over the opening below the bellows when the casks are detached. This prevents particulate from moving from the TCA to the Lower Access Area, and also makes it easier to maintain the pressure differentials between the two regions. The overlids also cover the top surfaces of the shield plug and source cask lid during storage in the TCA.

The fuel transfer tube and crud catcher enclose the fuel assemblies during lateral transfer. The crud catcher is attached to the bottom of the fuel transfer tube and opens after the transfer tube is positioned above the cask opening. The two components minimize the spread of crud or other particulate from spreading in the TCA, so that the area can be decontaminated more easily.

The achievement of ALARA is provided by the ventilation system, multiple confinement barriers to confine potential contamination that might arise during operations and maintenance, and acceptance of only intact fuel assemblies.

Since the TCA is a very high radiation area, all operating equipment which is required to move the fuel assemblies into a cask or to shield the fuel within the casks are supplied with backup equipment or remote access.

The filters of the HVAC System are protected within the structure from all postulated

man-made and environmental phenomena.

Radiation monitors are interlocked with the control of the sliding door to prevent inadvertent opening of the door while fuel is being transferred, or if the top of a cask has not been shielded. Similarly, the upper shield port cover locks are interlocked with the radiation monitoring equipment to prevent opening during fuel transfer.

The confinement barrier is evaluated for environmental phenomena against the criteria of ACI-349-85 and ANSI/AISC N690 as described in Section 3.2.

3.3.2.2 Ventilation -- Offgas

The HVAC System is designed to:

a) Maintain areas at the desired negative pressures
b) Maintain an air flow pattern within the DTS that is always from a less contaminated to a more contaminated region
c) Provide ventilation for the areas intermittently occupied by operators, when an uncontrolled contamination release hazard may exist.
d) Provide ventilation during welding of the cask lids.
e) Maintain minimum temperatures consistent with operation of the DTS.
f) Ensure that the temperature differential across the DTS walls does not exceed 70° F.

The DTS is designed to maintain a normal operating temperature of 60 ° F to 100 ° F in the Preparation Area and 40° F to 130° F in all other regions.

All air flow exhausted from the DTS will pass through a HEPA filtration system to ensure that most of the potential particulate from the air flow is removed. The cooling system of the HVAC Subsystem is designed to collect any water condensate from the dehumidification process (if any) in a reservoir for analysis and disposal.

The following criteria are established for the design of the ventilation system of the HVAC Subsystem:

1. The air flow within the DTS will be directed from less to more potentially contaminated areas by pressure differentials created by the HVAC Subsystem. The air flow rates will be a low as possible to minimize the potential generation of air-borne contamination while maintaining temperatures consistent with the operation of the DTS.

2. Negative pressures within the DTS will be maintained as follows:

a. TCS	1 in. water less than ambient
b. Lower Access Area	0.5 in. water less than ambient
c. Preparation Area	0.25 in. water less than ambient

This ensures that all air leakage occurs into the DTS. The pressure distribution also directs the air flow from the Preparation Area (a clean or low potential for contamination area) to the TCS (a higher potential for contamination area).

3. All exhaust air flow will be filtered through coarse and HEPA filters prior to being discharged to the environment. The HEPA filters will meet the definition of ASME N509 (a high efficiency particulate air filter having a fibrous medium with a particle removal efficiency of at least 99.97% for 0.3 μm particles). Testing will be performed to establish the maximum pressure drop to indicate a dirty or loaded filter and the minimum pressure drop to detect a blown or damaged filter.

4. Dampers and instrumented controls will be designed to operate within the operating temperature range of the DTS and maintain the negative pressure distribution in the DTS.

3.3.3 Protection by Equipment and Instrumentation Selection

3.3.3.1 Equipment

The equipment important to safety includes the cask transfer subsystem, the shield plug and source cask lid handling subsystem and the upper shield port covers. The details of these systems are covered in Chapters 4, 5 and 8.

Cask Transfer Subsystem

The cask transfer subsystem is designed in accordance with NOG-1 and meets the design criteria of ASME NOG-1, Section NOG-4300. The cask transfer subsystem (both trolleys) are analysed for the following loads:

The live load of the cask and trolley under gravity (Normal Operating Load)
The transverse horizontal load (5% of the live load of the cask and the trolley dead load in the transverse direction per NOG-4133(b)(Normal Operating Load)
Seismic loading (vertical and horizontal accelerations of the cask and trolley due to seismic event)(Accident Load)

The design criteria are taken from ASME NOG-4300 and are repeated below. The nomenclature of NOG-4120 is used. The trolleys will not tipover due to seismic loads

For beams subjected to axial tension and bending:

$$\sigma / \sigma_a + \sigma_{bx} / \sigma_{abx} + \sigma_{by} / \sigma_{aby} \leq 1.0$$

where $\sigma_a = \sigma_{abx} = \sigma_{aby} = 0.9$ Sy (for the seismic case)

σ_a is the axial stress
σ_{abx} and σ_{aby} are the stresses due to the bending moment.

The maximum allowable shear stress under seismic load is 0.5 σ_y.

An additional safety factor of 1.2 is used to take into account imprecision of the data.

For the beams, the tensile stress allowable is:

$$F/A + M_{bx}x/ I_x + M_{by}y/ I_y < 0.9\ \sigma_y/1.2 = 0.75\ \sigma_y$$

The shear stress allowable is $0.5\sigma_y /1.2$

where A is the cross sectional area.
F is the axial force
M_{bx} and M_{by} are bending moments about the x and y axes
I_x and I_y are the moduli of inertia

The allowable stresses in the bolts are taken from NOG-4513. For seismic loading, the maximum allowable tensile load is 0.5 σ_u , and the maximum allowable shear stress is 0.26 σ_u. An additional safety factor of 1.2 is used to take into account imprecision of the data.

The trolley is analyzed for a horizontal g loading of 0.25 g x 1.5 = 0.375 g and a vertical g loading of 0.17 g x 1.5 = 0.255 g.

The trolley's response to each of the three components of seismic input are combined by taking the square root of the sum of the squares (SRSS) per NOG-4153.10:

$$SRSS = \sqrt{(Sx^2 + Sy^2 + Sz^2)}$$

The seismic analysis is performed for two load combinations: seismic loading + static loading and seismic loading - static loading. The static load is the live load of the cask and

the trolley due to gravity.

The trolley wheels and guidance rollers are sized based on static loads. The allowable wheel loads are derived from NOG 5452.3:

$$P_a = KbD \text{ (lbs)}$$
where $K = 1300\ (BHN/260)^{0.333}$

Receiving Cask and Source Cask Mating Subsystem

The lifting components of the Receiving Cask and Source Cask Mating Subsystem are designed for seismic loads and static loading. For static loading, the lifting components are designed with a factor of 6 to yield and 10 to ultimate strength. For seismic loading, the allowable stress is 0.9 $\sigma_y/1.2$. Note that an additional safety factor of 1.2 has been added to allow for uncertainties in the dimensions. The shear stress allowable is 0.5 $\sigma_y/1.2$.

The materials of the Receiving Cask and Source Cask Mating Subsystem are selected for radiation resistance. The bellows and seals will be replaced during each maintenance cycle, which occurs after loading 10 receiving casks.

Shield Plug and Source Cask Lid Handling Subsystem Analysis

The shield plug and source cask lid handling subsystem is designed to meet the criteria of NOG-1. The detailed design criteria are provided in Section 8A.4.4.

Fuel Handling Crane

The fuel handling crane is designed to meet the criteria of NOG-1. The Safety Factor of the non-redundant cable on the fuel hoisting mechanism is equal to 10 based on manufacturer's minimum breaking strength under Normal Conditions, and equal to 2.5 based on minimum breaking strength under seismic loading conditions. The detailed design criteria are provided in Section 8A5.4.

3.3.3.2 Instrumentation

The Control System is described in detail in Section 5.4.1 and Appendix 5A. Instrumentation provided on specific equipment is described in Chapter 5 with the description of the equipment. Due to the remote nature of most of the operations, sensors are installed on the equipment to ensure proper positioning and to notify the operator of an abnormal situation (load sensors, temperature monitors, etc.). All equipment will be tested prior to first implementation. Testing is described in Section 5.4.1.1. In addition, the operating system

checks for consistency between information obtained from different sensors as a check on the proper functioning of the instrumentation.

3.3.4 Nuclear Criticality Safety

Both the source cask and the receiving cask contain fuel baskets which have been designed to provide for criticality safety. The fuel baskets may contain both neutron poison material and flux traps to control reactivity of the fuel/basket configuration. It is assumed that criticality evaluations have been performed for both the source cask and the receiving casks through a separate licensing process(es). In these evaluations, it is further assumed that the casks are evaluated in a wet, flooded condition with optimum moderation (fresh water), and the casks are evaluated based on the highest enrichment for a given assembly.

This system is a dry transfer system which has only a single fuel assembly out of a cask at any one time. There are no specific methods utilized or necessary for criticality control in the Transfer System Installation because there are no conditions that could exist within the installation that are not bounded by the criticality licensing evaluations performed for the casks.

3.3.5 Radiological Protection

3.3.5.1 Access Control

Access to the DTS will be controlled by the provision of a peripheral fence, in accordance with 10CFR72. Access to the fenced in area is limited to personnel needed during DTS operations. These activities include: source and receiving cask receipt and preparation activities; source and receiving cask removal activities; maintenance activities; and security checks.

Normal access to the facility is through a single operator access point. Access to the potentially contaminated areas is controlled through the Control System. Only personnel with special access will be allowed entrance, and entrance will be monitored by Health Physics Personnel. The sliding door, which is interlocked with the Radiation Monitoring System, prevents access to the Lower Access Area during fuel transfer or when a loaded cask is open. If an operator were to attempt to open the sliding door, the Programmable Logic Controller would check to see if a safe condition exists. This would include checking the radiation levels within the Lower Access Area. If the radiation level is acceptable, and access is authorized, the sliding door will open. If the radiation level is above the set acceptable limit, authorization is denied, and the door will not open.

Specific methods of access control will be defined and controlled by site specific security measures.

3.3.5.2 Shielding

A detailed discussion of radiation shielding calculations may be found in Chapter 7. The results of the analyses and the estimated exposure times for the major operations are also provided in Chapter 7.

3.3.5.3 Radiological Alarm Systems

Radiological alarm systems will be provided in accessible work areas as appropriate to warn operating personnel of radiation and airborne radioactive material concentrations above a given set point and of concentrations of radioactive material in effluent above control limits. Radiation alarm systems will be designed with provisions for calibration and testing their operability.

Areas containing radioactive materials will be provided with systems for measuring the direct radiation levels in and around these areas.

3.3.6 Fire and Explosion Protection

An internal explosion is not considered because there are no explosive gases present in the DTS. The fission gases in the spent fuel are not explosive.

The Preparation Area will have personnel present during operations. The Fire Protection Subsystem in the Preparation Area consists of smoke detectors with alarms and hand held fire extinguishers.

The Lower Access Area and the TCA will be equipped with a Carbon Dioxide Fire Suppression System including fire detection sensors. Typically the gas will be stored in steel cylinders as a liquid under pressure. When applied to a fire, it provides a blanket of heavy gas that reduces the oxygen content within the area to a point where combustion becomes impossible. In addition, carbon dioxide gas provides a cooling effect and leaves no residue. It dissipates into the atmosphere, allowing for rapid cleanup and minimizing downtime.

Carbon dioxide will be supplied for the DTS from a series of tanks held at the tank storage area located outside of the Preparation Area. Piping from the tank storage area will penetrate the walls of the DTS and into the Lower Access Area, the TCA, and the Roof Enclosure Area. The discharge of the carbon dioxide is controlled through a servo-controlled valve. The valve is operated from the Control Center. The smoke detector will alarm in the

Control Center and the operations of the discharge system are administratively controlled to prevent the possibility of discharge while maintenance personnel are within the DTS.

3.3.7 Materials Handling and Storage

3.3.7.1 Spent Fuel or High-Level Radioactive Waste Handling and Storage

The spent fuel assemblies will be handled inside the DTS. During handling, the fuel assemblies are fully contained and shielded, either within the source or receiving cask, or within the TCA. After the source cask lid and receiving cask shield plug are removed, the fuel handling crane is used to move the fuel from one cask to the other.

Since fuel is transferred in air, the temperature of the fuel assemblies must be maintained at a reasonably low temperature during the temporary storage and transfer time within the DTS. With the selected criterion for the fuel assemblies (See Section 3.1.1), the maximum temperature of the fuel will not endanger the integrity of the fuel. The time/temperature conditions that ensure that the uranium dioxide oxidation parameter is not exceeded in air is presented in Appendix 4A.

The DTS is designed to handle only one fuel assembly at a time. Therefore, criticality is not a concern. The source cask and receiving cask are anticipated to contain poison materials to ensure that the fuel within each cask is maintained subcritical.

The DTS is designed so that when not in operation, personnel can perform routine maintenance and parts replacement on contact. Therefore several features have been incorporated into the design of the DTS to ensure that contamination is controlled and minimized. When the fuel is transferred horizontally between casks, a crud catcher is rotated underneath the fuel assembly to prevent particulate from falling onto the mezzanine floor. Similarly, covers are placed onto the source cask lid and shield plug during fuel transfer operations to minimize any crud or radioactive particulate from falling onto the top surfaces of the cask.

It is also desirable to minimize the spread of contamination into areas routinely operated by personnel, including the Lower Access Area and the Preparation Area. Contamination spread into the Lower Access Area from the TCA is minimized through the use of the HVAC generated pressure differential and the cask mating system. This keeps the cask exteriors clean, and allows personnel entry into the Lower Access Area when the casks are covered and fuel transfer is not being performed.

The DTS is not currently designed for handling canistered waste or fuel. However, provided that the canisters meet the dimensional requirements for mating with the fuel

handling crane and can fit inside the fuel transfer tube, there are no physical barriers which would prevent handling these wastes. This would be evaluated on a site specific basis.

Damaged fuel elements will be detected at the reactor facility and will not be accepted at the DTS facility. Damaged fuel is defined as fuel that is not dimensionally or structurally sound or fuel that cannot be handled by normal means. Fuel assemblies that are damaged in transit or storage will not be transferred. The fuel will be inspected as it is lifted into the fuel tube. If it appears to be damaged, it will be replaced into the source cask without transfer.

Since both the receiving cask and the source cask can be used to safely store damaged fuel, no special containers are provided to store damaged fuel elements.

3.3.7.2 Radioactive Waste Treatment

No special provisions for waste treatment are incorporated into the DTS design. Since the DTS is expected to be collocated with a nuclear power plant, it is anticipated that the wastes generated by the DTS will be stored temporarily in 55 gallon drums and then transferred to the plant waste facility. The waste is expected to be minimal, as discussed in Chapter 6 and is limited to filters, and items such as clothing, wipes and vacuum bags.

Liquid wastes are also limited, consisting of small amounts of liquids used for decontamination. Handling of liquid wastes is presented in Chapter 6.

3.3.7.3 Waste Storage Facilities

Waste will be stored in 55 gallon drums until it can be transferred to the plant waste facility. Liquid wastes will be absorbed onto cloth and treated as solid waste.

3.3.8 Industrial and Chemical Safety

No hazardous chemical reactions are involved in the dry transfer system.

3.4 Classification of Structures, Components and Systems

All structures, components and systems which are classified as Important to Safety are identified in this section.

All structures, components and systems which provide a primary confinement function are considered Important to Safety. These include the HEPA filters, the concrete structure including the base mat, the protective cover and the sliding door. Items which provide additional confinement, such as the ventilation system and the cask mating subsystem bellows are not considered Important to Safety.

All structures, components and systems which are required to protect the fuel from damage during all design basis events are also considered Important to Safety. These include the roof plate, the load path items of the Fuel Assembly Handling Subsystem and the components of the Cask Transfer Subsystem which prevents the cask from tipover or prevents the trolley from derailing during any postulated design event.

Additionally, the load path items of the shield plug and source cask lid handling subsystem has been designated as Important to Safety because, if the lid or shield plug were to fall, it would be exceedingly difficult to recover from this event.

The locking device on the upper shield port covers is considered Important to Safety, because, if the covers were to unintentionally open during operations or any design event, the top of the DTS would be undershielded.

The cooling, heating and ventilating components of the HVAC Subsystem are not considered Important to Safety, because it has been shown in this Topical Report, that due to the high thermal inertia of the DTS, there is sufficient time before temperatures fall below or rise above the allowable operating temperatures to recover (by repair or replacement) from a loss of one or all of these components.

The control subsystem is not considered Important to Safety, because all equipment is designed to "fail safe". That is, if the control subsystem were to fail, the equipment would stop operating, but it would not result in a loss of load or an unsafe situation.

The following structures, components or systems have been classified as Important to Safety.

System or Component	Safety Function	Features Important to Safety
Concrete Base mat	Structural, Seismic Protection	Overall Dimensions, Thickness, reinforcement, concrete density
DTS Concrete Structure	Structural, Seismic Protection, Tornado Protection, Weather Protection, Confinement, Shielding	Overall Dimensions, Thickness, Reinforcement, concrete density
Structural Steel including the Roof Plate, Mezzanine Floor Plate, and the Protective Cover	Structural, Tornado Protection, Confinement, Shielding	Thickness, structural integrity
Sliding Door	Structural, Tornado Protection, Confinement, Shielding	Thickness, structural integrity
HVAC Subsystem	Confinement, Cooling	HEPA filtration
Cask Transfer Subsystem	Structural, Seismic Protection	Trunnion tiedowns, seismic restraints
Fuel Assembly Handling Subsystem	Structural, Handling	Load Path Items
Shield Plug and Source Cask Lid Handling Subsystem	Structural, Handling	Load Path Items
Upper Shield Port Covers	Shielding	Locking Device

1. Concrete Base Mat

The concrete basemat supports the DTS (including the Preparation Area) during all design events. The features important to safety include: the thickness, reinforcement and concrete density.

2. DTS Concrete Structure

The concrete structure provides structural support to the DTS equipment. It provides seismic, weather, and tornado protection to all equipment housed within the Lower Access Area and the TCA. It provides shielding and the physical confinement barrier. Features Important to Safety include the overall dimensions, thickness, reinforcement, and concrete density.

3. Structural Steel including the Roof Plate, Mezzanine Floor Plate, and the Protective Cover

The protective cover provides a physical confinement barrier between the Roof Enclosure Area and the external environment. It also protects the upper crane from weather, high winds, tornados, and tornado missiles. Features Important to Safety include the material, overall dimensions, and thickness.

The roof plate and mezzanine floor plate provide support to the operating equipment (TC Port Covers, Upper Port Covers and Upper Crane) and prevent collapse during a seismic event. The Fuel Handling Crane is supported separately on rails. The roof plate is also used for shielding. Features Important to Safety include the material, overall dimensions, and thickness.

4. Sliding Door

The sliding door forms a part of the physical confinement barrier between the DTS and the external environment. It also provides shielding and protection from high winds, tornados, and tornado missiles.

5. HVAC Subsystem

The HVAC Subsystem filters, with the physical confinement barrier provides the primary confinement for the DTS. The HEPA filters are Important to Safety. The pressure differentials maintained by the ventilation system provide an additional level of confinement. The ventilation system and the cooling system prevent equipment from overheating and prevents the fuel cladding from rupture due to excessive temperature. However, since the DTS has a very high thermal inertia, the HVAC system can be rendered inoperable for short

periods of time without harming the fuel or the DTS equipment.

6. Cask Transfer Subsystem

The Cask Transfer Subsystem protects the casks from tipover during a seismic event and during all normal operating conditions. The features important to safety are the trunnion tiedowns, and seismic restraints.

7. Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem protects the fuel from being dropped during all design events. The features Important to Safety include all load path items.

8. Shield Plug and Source Cask Lid Handling Subsystem

The Shield Plug and Source Cask Lid Handling Subsystem has been designated as important to safety, since, if the source cask lid or shield plug were dropped during a seismic or other design event, it would be difficult to recover from this event. The source cask lid and shield plug must be replaced onto the cask prior to removal of the cask from the DTS. The Features Important to Safety include all load path items.

9. Upper Shield Port Covers

The upper shield port covers provide shielding when either receiving or source cask is open. To prevent inadvertent opening of the upper shield port covers during all design events (including the seismic event) the locking device for the upper shield port covers has been designated as Important to Safety.

3.5 Decommissioning Considerations

The design of the DTS lends itself to decommissioning at the end of its mission at a given site. Mechanical equipment is designed to be decontaminated, removed from the structure, and packaged for shipment to another site for installation into the structure.

Decontamination of the components will be performed as required by the site. Because the DTS is designed for hands-on maintenance, it is expected that the contamination levels will be controlled to reasonably low levels during operation of the DTS and that acceptable levels of contamination on equipment and components can be obtained to permit unrestricted handling and, at the worst, strong tight packaging.

Equipment that is not practical to decontaminate will be packaged for disposal in accordance with the site requirements.

The only portions of the DTS that will be left at the site of the original DTS will be the concrete structure and the Cask Transfer Subsystem rails.

Major equipment items will be removed by portable crane, starting with the Weather Protective Cover, the Upper Crane, the Shield Port Covers, and the Roof Plate and support beams and proceeding to the Fuel Assembly Handling Subsystem crane trolley, rails, the TC Port Covers, and the Mezzanine Plate and support beams.

Heavy equipment will be fitted with lifting eyes or brackets as required during the disassembly. This work will be done by professional riggers under supervision of management or staff familiar with the equipment's function.

Packaging of equipment will be designed for the first movement of the equipment after use in order to allow determination of packaging requirements with respect to contamination levels.

The concrete structure will have a surface finish (e.g. paint, strippable coatings, etc.) that lends itself to cleaning by damp wipes during use and by practices used in decommissioning. The concrete structure and the concrete pad can be demolished by conventional means, or left standing. If demolition is planned, this should be considered in the initial siting of the facility so as not to disrupt nearby facilities and operations.

3.6 Summary of Design Criteria

Below is a summary of the design criteria for all structures, systems and components that are Important to Safety.

1. The maximum load capacity of the cranes and other handling equipment:

Fuel Handling Crane	3,400 lbs.
Upper Crane	5 tons
Receiving Cask Transfer Trolley	125 tons
Source Cask Transfer Trolley	30 tons
TC Port Cover	5 tons

2. Maximum dimensions of loads that can be handled.

The TC port covers are sized to accommodate the lid and shield plug sizes specified in Section 3.1.1.

The DTS has been specifically designed for a small source cask and a large receiving cask. If casks that are significantly larger than the design basis casks are used, larger trolleys may be required. If two large casks are used, the building size may need to increase. Variations from the design basis casks will be evaluated on a site specific basis.

The fuel handling crane and transfer tube are sized to accommodate any PWR assembly.

3. Criticality Factor

Criticality control is maintained by the design of the source and receiving casks.

4. Maximum Dose Rates

Exposure to operations personnel will be limited in accordance with 10 CFR 20.1201. These limits apply to design events and are the more limiting of:

i) the total effective dose equivalent of
ii) the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rem).

Appropriate shielding will be used (e.g. shielded eyeglasses) to minimize nonpenetrating

external radiation exposures to the skin and lens of the eye of the workers. The annual limits of 10 CFR 20.1201 to the lens of the eye, to the skin and to the extremities will not be exceeded. The annual does limits are:

An eye dose equivalent of 0.15 Sv (15 rem)
A shallow dose equivalent of 0.50 Sv (50 rems) to the skin or to any extremity.

A controlled area will be established for the DTS. During normal operations and anticipated occurrences, the annual dose equivalent to any individual who is located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid and 25 mrem to any other organ as a result of exposure to:

- Planned discharges of radioactive materials, radon and its decay products excepted, to the general environment,
- Direct radiation from DTS Operations, and
- Any other radiation from uranium fuel cycle operations within the controlled area or adjacent plant site.

Any individual located on or beyond the nearest boundary of the controlled area will not receive a dose greater than 5 rem to the whole body or any organ due to any Design Event III or IV per 10 CFR 72.106(b). The minimum distance from the DTS to the nearest boundary of the controlled area shall be at least 100 meters (328 feet).

Exposure to the general public will be limited in accordance with 10 CFR 20.1301:

The total effective dose equivalent to individual members of the public will not exceed 1 mSv (0.1 rem) in a year.

The dose in any unrestricted area from external sources will not exceed 0.02 mSv (0.002 rem) in any one hour.

5. Ambient Conditions

The DTS will be designed for exposure to environmental conditions of temperature, relative humidity, precipitation and environmental pollutants, including the following:

External Temperature Range, -20°F (-29°C) to 115°F (46°C)

Relative Humidity, 0% to 100%

If external temperatures exceed this range, fuel transfer operations will be suspended.

If there are sites which are unbounded by the external temperature range, separate licensing evaluations will be performed.

6. Tornado Wind Velocities (Rotational and Translational)

See Table 3.2-5.

7. Tornado Pressure Drop

See Table 3.2-5.

8. Maximum Winds.

See Table 3.2-5.

9. Design earthquake peak acceleration

The DTS is designed for a maximum ground acceleration of 0.25 g horizontal and 0.17 g vertical.

10. Explosion peak overpressure.

There is no credible explosion in the area of the DTS.

11. Flood elevations.

It is assumed that the DTS will be sited on a flood dry site.

3.7 References

3-1. Code of Federal Regulations Chapter 10 Part 72 - Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.

3-2. ANSI/ANS-57.9-1992 Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type).

3-3 ANSI/ASCE 7-88 Minimum Design Loads for Buildings and Other Structures

3-4 Nuclear Regulatory Commission Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," April, 1974.

3-5. NUREG-0800, U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," July, 1981.

3-6. NBSIR 76-1050.

3-7. Guidelines for the Design and Assessment of Concrete Structures Subjected to Impact, UKAEA, SRDR439, Issue 3, May 1990.

3-8. J.R. McDonald, K.C. Hehta, and J.E. Minor, "Design Guidelines for Wind Resistant Structures," Institute for Disaster Research and Department of Civil Engineering, Texas Tech University, Lubbock, Texas, June, 1975.

3-9. "Design of Structures for Missile Impact," Bechtel Topical Report, BC-TOP-9A (8.51).

3-10. 10 CFR 100.

3-11. U.S. Nuclear Regulatory Guide 1.61, Damping Values for Seismic Design of Nuclear Power Plants, 1973.

3-12. U.S. Nuclear Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants, 1973.

3-13. American Concrete Institute ACI 349-1R: Code Requirements for Nuclear Safety Related Concrete Structures - Thermal Effects.

3-14. ANSI/AICI N690.

3-15 Baumeister and Marks, Standard Handbook for Mechanical Engineers, 6th Edition

CHAPTER 4

INSTALLATION DESIGN

This chapter describes the DTS structure and equipment. Each component is described and evaluated with emphasis on the features that serve functions that are important to safety. All items which are designated as important to safety will be covered by the quality assurance program of the host facility. The features which are Important to Safety for each component are described.

4.1 Summary Description

This chapter provides a detailed description of the DTS system including the following:

a. Confinement Structure

- Reinforced concrete basemat and superstructure (Important to Safety)
- Protective cover (Important to Safety)
- Structural steel roof plate (Important to Safety)
- Mezzanine plate (Important to Safety)
- Sliding door (Important to Safety)
- Preparation Area Enclosure (Not Important to Safety).

b. Auxiliary Systems

- HVAC System (Important to Safety)
- Electrical System (Not Important to Safety)
- Air Supply System (Not Important to Safety)
- CCTV and Lighting System (Not Important to Safety)
- Radiation Monitoring System (Not Important to Safety)
- Receiving Cask Lid Handling System (Not Important to Safety)

c. Spent Fuel and High-Level Radioactive Waste Handling Operation Systems

- Receiving and Source Cask Transfer Subsystem (Important to Safety)
- Receiving and Source Cask Transfer Confinement Port Cover Handling Subsystem (Not Important to Safety)
- Receiving and Source Cask Mating Subsystem (Not Important to Safety)
- Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem (Important to Safety)

- Fuel Assembly Handling Subsystem (Important to Safety)
- Control Subsystem (Not Important to Safety)

Decontamination methods and repair and maintenance operations are also discussed.

An overall outline description of the complete DTS is given in Chapter 1.

4.1.1 Location and Layout of Installation

This section is site-specific and will be addressed in site specific license applications.

4.1.2 Principal Features

The generic features of the DTS are outlined in Chapter 1, but those specific to a given site will be addressed in the site license applications.

4.1.2.1 Site Boundary

This section is site-specific and will be addressed in site specific license applications.

4.1.2.2 Controlled Area

This section is site-specific and will be addressed in site specific license applications. For shielding analyses, the controlled area boundary is assumed to be 100 meters from the exterior surface of the DTS in all directions.

4.1.2.3 Site Utility Supplies & Systems

This section is site-specific and will be addressed in site specific license applications.

4.1.2.4 Storage Facilities

Storage vessels located near the DTS but not associated with the DTS will be addressed in site specific applications. A compressed air tank used to inflate the seals on the sliding door is located in the Tank Storage Area outside of the Preparation Area. Carbon dioxide gas used to supply this fire protection system is also stored in the Tank Storage Area. Compressed gases used for welding the lids on the canisters will be brought into the Preparation Area as needed.

The three foot thick reinforced concrete walls protect the DTS from all postulated impacts resulting from an explosion of one or more of the storage tanks. The tornado missile analysis presented in Appendix 8A.1 bounds this postulated accident.

4.1.2.5 Stacks

The exhaust stack from the HVAC System extends 10 feet (3 m) above the DTS structure. The stack is 20 in. (508 m) in diameter and is shown on Figure 1.2-16. The stack is not designed for seismic or tornado loadings. If it is lost due to natural phenomena, the exhaust air would be released at lower elevations, resulting in potentially higher than normal operational doses. The loss of the exhaust stack is evaluated in Chapter 8. The location of the stack in relation to other facilities will be addressed in site specific license applications.

4.2 Confinement Structures

This section describes in detail the specifications and functions of the civil structure including the following:

- Reinforced concrete basemat and superstructure;
- Protective cover;
- Structural steel roof plate;
- Mezzanine plate;
- Sliding door; and
- the Preparation Area Enclosure.

4.2.1 Structural Specification

The design bases for the DTS are described in Section 3.0. The main structure (including the basemat and the building structure enclosing the Lower Access Area and the TCA) will be constructed from reinforced concrete and structural steel work, the design of which complies with the following principle specifications:

- American Concrete Institute ACI 349-85: Code Requirements for Nuclear Safety Related Concrete Structures (Reference 4.1)

- American Concrete Institute ACI 318-89: Building Code Requirements for Reinforced Concrete with Commentary (Reference 4.2).

- American Institute of Steel Construction: AISC Specification for the Design, Fabrication and Erection of Structured Steel for Buildings. June, 1989 (Reference 4.3)

The location of the DTS is site specific and will be addressed in the site specific applications. The concrete structure described in these sections is offered for non-site specific approval for the spent fuel specified in Section 3.1.1.

The analysis of the DTS is based on the seismic response of the system resting on a hard-rock site. In the site specific applications, the actual foundation characteristics will be evaluated. The following parameters may need to be adjusted for some DTS sites:

a). The level of the mezzanine plate may need to be adjusted to accommodate the actual casks and fuel assemblies to be transferred in the DTS.

b). The design of the concrete base mat may be adapted for the site specific foundation requirements.

c). The final rebar arrangement within the geometry of the structure can be adjusted to enable the structure to withstand the effects of environment and natural phenomena.

If modifications are required to the existing design, the differences between the design described herein and the modified design will be fully described and evaluated in the site specific application.

The opening in the mezzanine plate is specific to the selected source and receiving casks and is submitted for approval in the Topical Report.

If the DTS is to be used for transfer of fuel between two high capacity casks (e.g. storage only cask to rail transport cask), the building may need to be enlarged. Any increase in the size of the building structure would be evaluated and submitted for approval in the site specific application.

The design loadings and input parameters for the civil structure are presented in Section 3.2. The evaluation of the civil structure to normal and off-normal events is presented in Appendix 8A.1. The design presented is based on a bounding location. Therefore, conservative assumptions have been made for the selection of input parameters including wind loadings, seismic loading, soil conditions, tornado missile loadings, etc.

The reinforced concrete structure, with thicknesses largely governed by shielding requirements, forms a heavy rigid box structure. A finite element model of the DTS structure using ANSYS 4.4A was prepared to evaluate the structure.

The superstructure of the DTS facility comprises a relatively stiff shear wall structure in reinforced concrete supporting plant items and equipment on two flexible internal structural steel floors.

A three dimensional plate model of the concrete superstructure above the top of the base, including the plant equipment masses was prepared. All reinforced concrete walls were represented by four-node shell elements with elastic material properties based on gross uncracked concrete sections. A complete description of the model is presented in Appendix 8A.1.

The design of the structure takes into account the missiles produced by the design basis tornado. This analysis is presented in Appendix 8A.1.

The protective cover is located above 30 feet and is evaluated for damage due to the following tornado missiles:

A. Wood Plank
B. 6 inch schedule 40 pipe
C. 1 inch steel rod
E. 12 inch schedule 40 pipe.

The roof plate is also evaluated for tornado missiles impacting vertically onto the roof. The forces on the structure due to missile impact are presented in Section 3.2.1. The evaluation of the missile loadings is presented in Appendix 8A.1.

Penetrations in the concrete structure (for example the exhaust ducts for the HVAC system) are designed such that tornado missiles cannot pass through the opening.

The design for earthquake loading has been performed using a quasi-static analysis and a response spectrum analysis to verify the structural design. The earthquake input data has been taken from 10 CFR 72.66.

Normal weight reinforced concrete will be used throughout, with the foundations constructed in 4000 psi grade and the super-structure in 5000 psi grade, using Type II Portland cement to ASTM C150 (Reference 4.4) and aggregates meeting the requirements of ASTM C33 (Reference 4.5). In general, reinforcing steel will be to ASTM A615 Grade 60 with a yield strength of 60,000 psi.

Detailed specifications will be prepared for specific projects to establish the quality of the materials and workmanship for both the reinforced concrete and the structural steelwork. In general, these specifications will be based on the following national codes:

- American Concrete Institute: ACI 301: Specifications for Structural concrete for Buildings (Reference 4.6)

- American Institute of Steel Construction: AISC Specification for the design, fabrication and erection of structural steel for buildings (Reference 4.3)

The structural design, procurement, testing, construction, fabrication and erection activities are Important to Safety and will be controlled as part of an overall Quality Plan for the project and will be in accordance with the site-specific license requirements.

4.2.2 Installation Layout

The specific layout of the ISFSI will be developed by the licensee in accordance with

10CFR72. The layout for a typical DTS installation is shown in Figure 4.2-1. The functional features of the DTS storage structure are discussed in Section 4.2.3.

4.2.2.1 Building Plans

The General Overview of the DTS is shown on Figure 1.2-1. Structural details of the Concrete Superstructure are presented in Figures 1.2-5 and 1.2-16. Details of the roof plate, weather protective cover and mezzanine plate are shown on Figure 1.2-17. Penetration details are shown on Figure 1.2-18. Details of the preparation area are shown on Figures 1.2-19 and 1.2-20.

4.2.2.2 Building Sections

See section 4.2.2.1. Detailed drawings of the equipment within the DTS are supplied in Chapter 1.

4.2.2.3 Confinement Features

One of the primary design functions of the DTS structure is to provide a physical barrier for the purpose of preventing the release of radioactive particulate matter (to the environment) above the radiological protection limits described in Section 3.3.5. The achievement of ALARA in this regard is provided by the HVAC Subsystem to further control and confine potential contamination that may be released during transfer operations.

The source of the radioactive particulate under normal and most off-normal conditions is the crud on the external surfaces of the fuel rods and hardware. The primary confinement barrier for the escape of particulate from the fuel is the fuel cladding whether it is integral or contains pinholes or hairline cracks. Degradation of the cladding due to stress rupture and fuel oxidation (a time-at temperature phenomenon) will be minimized by maintaining low fuel temperatures during the short duration of the fuel transfer process. The dedicated active cooling of the HVAC Subsystem will dissipate the decay heat from the fuel. Based on the study performed by Einzinger (Reference 4.7), the following fuel temperature limits have been adopted for the DTS:

- 464°F (240°C) for a two week period (before the receiving cask is inerted)
- 441°F (227°C) for a one month period
- 347°F (175°C) for a two year period

The design basis turnaround time for the source cask is 1 day and the receiving cask is 10 days. Considering that the receiving cask will be only partially filled during most of the actual transfer period, will be open during the transfer operations, has a large thermal mass, and is continuously maintained in a 70°F (21°C) ambient condition, it would be unlikely that

fuel temperatures would exceed the two week temperature limit of 464°F (240°C) during the 10 day design basis turnaround period.

During fuel transfer, the confinement boundary for crud on the fuel assemblies is the physical enclosure formed by the DTS concrete walls including its sealed penetrations; the sliding door between the Preparation Area and the Lower Access Area; the weather protective cover, and the HEPA filters of the HVAC Subsystem. An additional level of confinement is provided by the HVAC Subsystem maintaining the TCA at negative atmospheric pressure so that air infiltration is into this area, and air flow from this potentially contaminated area is exhausted through a HEPA filtration system to the environment.

4.2.3 Individual Unit Description

4.2.3.1 Reinforced Concrete Basemat and Superstructure.

The DTS structure is a reinforced concrete rectangular (on plan) open box shear wall structure (internal clear dimensions 25'7" x 17'4" (7.8 m x 5.3 m) extending from the top of the reinforced concrete basemat (0'0") to a height of 46'11"(14.3 m). The wall thickness is a minimum of 3'0" (914 mm) to provide the necessary radiation shielding and tornado missile impact protection. The box cell structure is supported by an integral foundation raft bearing either directly on the sub-soil or on an array of bearing piles, depending on the ground conditions encountered. A site specific foundation design will depend upon the geophysical data available for the site. However, the design shown on Figure 4.2-1 is representative of a design for a hard rock site. Figures 1.2-15, 1.2-16 and 1.2-18 show details of the reinforced concrete structure. The reinforced concrete basemat and superstructure are not transportable from site to site. The features of the superstructure which are Important to Safety are: missile protection, seismic protection, and shielding.

4.2.3.2 Protective Cover.

The upper crane is enclosed within a prefabricated 1.5" (38 mm) thick carbon steel cover, 22'6" wide x 30'9" long x 8'11" high (6.9 m x 9.4 m x 2.7 m) for protection. The region beneath the protective cover is designated as the Roof Enclosure Area. The protective cover protects the upper crane from rain, wind and tornado missiles and provides a confinement barrier. It is designed to stay intact during the design basis seismic event. The protective cover is shown in Figure 1.2-17. A sealed access door is provided into the Roof Enclosure Area. The protective cover is not transportable. The protective cover also provides some shielding.

4.2.3.3 Structural Steel Roof Plate.

The structural steel roof plate is 7" thick x 20'4" wide x 28'7" long (178 mm x 6.2 m x 8.7 m) and is fabricated in four pieces for handling and transporting. These plates are bolted to

the concrete corbel and roof beams, but their entire weight is supported by the roof beams. The roof plate is described in detail in Figure 1.2-17. The roof plate performs two major functions:

- Support of the Upper Crane and Upper Shield Port Covers; and
- Radiation shielding.

4.2.3.4 Mezzanine Plate.

The mezzanine plate is 1.5" thick x 17'4" wide x 25'7" long (38 mm x 5.3 m x 7.8 m) and is fabricated in four pieces for handling and transporting. These four plates are bolted to and supported by the beams. Figure 1.2-17 shows the details of the mezzanine plate. The major function of the mezzanine plate is to support the Cask Mating System, and the TC port covers. It also provides a confinement barrier between the Lower Access Area and the TCA during normal operating conditions. The mezzanine plate is not designated as Important to Safety. The primary. confinement barrier between the DTS and the environment is the sliding door, the concrete structure and the structural steel protective cover.

4.2.3.5 Sliding Door.

The sliding door consists of three sections; 9" thick x 133.5" wide x 72" long (229 mm x 3.4 m x 1.8 m), 7" thick x 133.5" wide x 120" long (178 mm x 3.4 m x 3 m), and 7" thick x 174" wide x 60" long (178 mm x 4.4 m x 1.5 m). These three sections are bolted together to form a reverse T shaped door. The total weight of the door is 85,000 lbs (38,560 kg). The door is supported from the top by eight (8)-10" (254 mm) drop forged steel wheels. An inflatable seal is provided between the door periphery and concrete wall, which, when actuated, forms the confinement boundary between the Lower Access Area and the Preparation Area. The sliding door is designed to withstand tornado winds and missiles and the design basis seismic load. The sliding door is activated by the use of a drive motor attached to a worm screw adapted to open and close the door. The sliding door has four locking pins and two sliding panels. The four locking pins are locked manually. The two sliding panels are used to minimize air leakage at the rail/door location. The sliding panels are manually positioned. The sliding door is illustrated in Figure 1.2-5. The safety functions of the sliding door are to:

- Provide a primary confinement barrier for the DTS;
- Provide tornado missile protection; and
- Provide radiation shielding.

The sliding door locking system is interlocked with the radiation monitoring system. This prevents unlocking of the sliding door in the event of high radiation in the Lower Access Area. The sliding door locking system is also interlocked with the TC port covers to prevent

opening of the TC port covers (and potentially opening of a cask) if the sliding door is not locked. Interlocks are discussed in Section 5.4.

The door is designed to stay attached during a seismic event.

The sliding door can be removed and transported to a secondary site location after decommissioning.

4.2.3.6 Preparation Area.

The Preparation Area is a prefabricated aluminum Butler-type building intended for weather protection. Its dimensions are 38'3" high x 37'9" wide x 24'8" deep (11.7 m x 11.5 m x 7.5 m). The building has a roll-up door to permit the Cask Transfer Subsystem trolley access. Figures 1.2-19 and 1.2-20 show details of the Preparation Area.

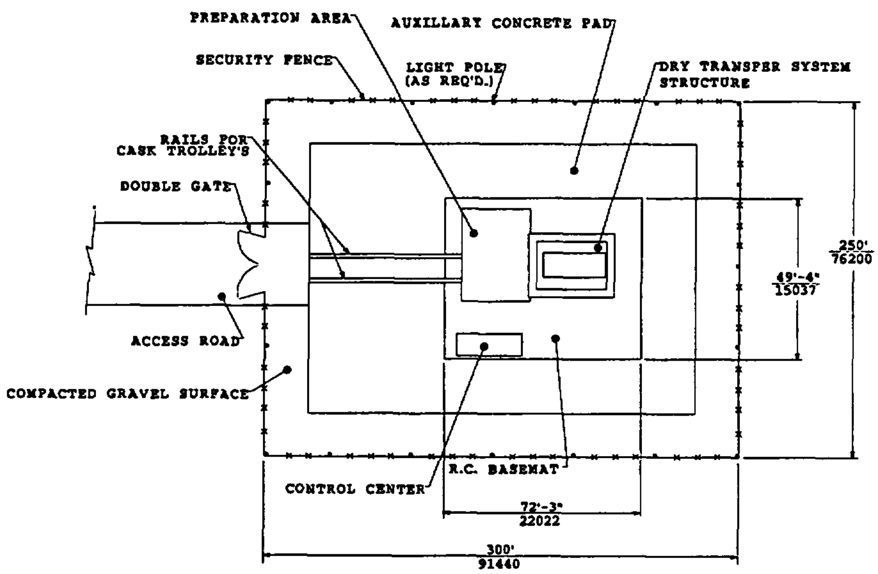
The major functions of the Preparation Area are to:

- Enclose an 8 ton capacity overhead crane mounted in the building to handle the receiving cask lids;
- Enclose the welding machine and receiving cask lids;
- Enclose the HVAC equipment and ducts;
- Provide space for the Cask Transfer Subsystem trolleys to deliver the source and receiving casks to the Lower Access Area; and
- Provide space for cask access scaffolding.

The building is a weather resistant structure which does not provide a safety function. The Preparation Area building can be disassembled and transported to a secondary site location after decommissioning.

Figure 4.2-1

Typical DTS Site Layout



4.3 Auxiliary Subsystems

The auxiliary equipment described in this Section, with the exception of the HEPA fileters, is designated as "Not Important to Safety", since the equipment does not provide primary confinement, shielding, or protection fron design events. However, this equipment is necessary for continuous, efficient normal operations. Therefore, the equipment is included in this section.

4.3.1 Ventilation and Offgas Systems

Conventional and commercially procured components are used for the HVAC equipment. Note that the Heating and Cooling System is separate from the Ventilation System. A listing and a detailed description of the equipment selected is provided in this section. Figures 1.2-12 and 1.2-13 show details of the components of the HVAC Subsystem.

The HVAC subsystem is designed to provide an additional level of confinement of radioactive material associated with the transfer of spent fuel assemblies, to direct air flow from areas of low levels of potential contamination to areas of higher levels of potential contamination, and to control the temperatures of the spent fuel, fuel transfer equipment, the DTS structure and associated components. The three areas of the DTS, i.e., the Preparation Area, the Lower Access Area and the TCA are served by the HVAC Subsystem.

4.3.1.1 Functional Description

The HVAC subsystem performs its confinement function by maintaining negative pressures in various areas relative to atmospheric pressure. By establishing pressure differentials, air flow is directed from the ambient into the Preparation Area through the Lower Access Area to the TCA. This ensures that leakage is into the DTS, and in the unlikely event of a release of radioactive particulate anywhere in the system, contaminants would be retained within the DTS or in the HVAC ducting/filtration system. The air is exhausted through HEPA filter banks up a 20 in diameter (508 mm) stack that extends approximately 10 ft (3 m) above the DTS structure. Figure 4.3-1 is a schematic diagram of the HVAC Subsystem and shows the direction of flow through the areas in the DTS as a result of the pressure differentials.

Redundant components such as exhaust fans and HEPA filters have been incorporated into the design to minimize the potential for failure of the confinement function during normal operating conditions. Typically, 50% of the air flow will be through each of the HEPA filter banks during normal operating conditions. Motorized dampers can isolate a HEPA filter bank for replacement of the filter. Before the filtered exhausted air is released to the atmosphere from the ventilation stack, it is monitored by the Radiation Monitoring Subsystem.

The temperature in each area of the DTS is maintained with a combination of air conditioning and heating units. The units have the capacity to dissipate the design basis heat released in each area. The cooling and heating system is also shown on Figure 4.2-1. The air in the Roof Enclosure Area is also maintained by a separate air conditioning/heat pump unit.

4.3.1.2 Applicable Documents

The HVAC system is designed and the components will be fabricated using the following applicable documents for guidance:

- American Society of Mechanical Engineers. Nuclear Power Plant Air Cleaning Units and Components, ASME N509. (Reference 4.8)
- American Society of Mechanical Engineers. Code on Nuclear Air and Gas Treatment, ASME AG-1 (Reference 4.9)

4.3.1.3 Design Requirements

The requirements for the design of the HVAC Subsystem are listed below.

Ambient Conditions

· Temperature	-20 to 115°F (-29 to 46°C)
· Solar heat load	Typical for a U.S. site
· Humidity	100%

Normal Operating Temperature and Pressure Setpoints

· Humidity	50%
· Temperature	70°F (21°C)

The temperature setpoint is reduced to 50°F (10°C) when the ambient temperature is below 0°F (-18°C) to maintain a maximum temperature difference of 70°F (21°C) across the DTS concrete walls.

Air Supply

The outside air will be filtered after it enters the Preparation Area to minimize dust content. The humidity of incoming air will be regulated to maintain a non-condensing atmosphere in the DTS.

Internal Sub-Atmospheric Pressures in DTS areas

the DTS.

- Transfer Confinement Area0.036 psi (1 in. water)
- Lower Access Area0.018 psi (0.5 in. water)
- Preparation Area0.009 psi (0.25 in. water)

Exhausted Air

Exhaust air flow will be filtered through coarse and HEPA filters prior to being discharged to the environment. The design permits the replacement of filters during operation and has a redundant exhaust system. Equipment for measuring pressure changes across the filter will be required.

Air Flow Rates

Air flow rates will be as low as achievable in the TCA to minimize the generation of air-borne contamination while maintaining the pressure differential between the Preparation Area and the Lower Access Area, and the Lower Access Area and the TCA.

4.3.1.4Operational Description

The operation of the HVAC system is controlled by the HVAC Control System. Although the system is integrated with the DTS Control System, it operates independently of that system.

Ventilation System

The operational sequence for the HVAC system is described below.

Upon start-up, with DTS doors closed, the lead exhaust fan isolation control damper open. The fan starts and ramps up via its variable frequency drive to a speed which will maintain the static pressure setpoint for the TCA. Motorized dampers in the transfer ducts between the three areas of the DTS modulate as required to maintain static differentials between the Preparation Area and Lower Access Area, and between the Lower Access Area and TCA. The negative static pressures are maintained with respect to atmosphere increasing from the Preparation Area to the TCA. The system reacts to changes in the infiltration of air into the DTS by speeding up or slowing down the fan and opening or closing dampers as necessary to maintain pressure differential setpoints. This is the typical operating mode during which the transfer of fuel will occur.

When the source or receiving casks are moved in or out of the DTS, the ventilation system air flow is controlled to prevent high air flow rates within the TCA which could increase the risk of the generating airborne contamination. Information that the Cask Mating Subsystem has been disengaged or the DTS sliding door has been opened, is transmitted to the HVAC control system to override the fan/damper components from trying to re-establishing the pressure setpoints. A high velocity air curtain at the Preparation Area entrance helps to minimize the influx of dust and insects and to minimize the potential for outdrafts when the Preparation Area door is open.

In the event that the control system senses a failure of the lead exhaust fan on startup, the lead fan isolation damper will close, the standby fan isolation damper will open, and the startup sequence will continue as described above. In the event that a failure is sensed during normal operation (for example, a fan belt breaks) the lead fan isolation damper and the two transfer dampers will close, the standby fan isolation damper will open, and the startup sequence will continue as described above. The control dampers in the Lower Access Area and the TCA are designed to fail in the open position to allow the airflow through these areas to continue in the proper direction in the event of a loss of control of any damper. Supplemental gravity operated backdraft dampers adjacent to the exhaust fan isolation control dampers will prevent excessive backflow through the standby fan in this instance. The control damper in the duct between the Preparation Area and the Lower Access Area is designed to fail in the closed position. Air flow, although reduced, will occur between the Preparation Area and the Lower Access Area through leakage paths around the DTS sliding door.

Heating and Cooling System

The air handling units (AHU), shown in Figure 4.3-2 operate in response to temperature sensors in each of the three areas of the DTS. On a call for cooling, the PA unit (AHU-1) starts and its associated condensing unit (CU-1) energizes, feeding refrigerant to the direct expansion (D/X) cooling coil located in the AHU. On a call for heating, the AHU starts and an electric resistance heating coil located in the unit is energized. In addition, a humidity sensor can initiate a call for dehumidification, in which case the fan and refrigerant equipment is energized. In the event of overcooling by the dehumidification cycle, the heater will be energized and reheat supply air to the setpoint discharge temperature. The Lower Access Area and TCA units (AHU-2 & 3) function similarly in the cooling and heating modes. (Heating requirements for these areas are expected to be minimal; however, electric heating coils have been included to maintain temperatures in those instances when supplemental heating is required.) Base heating setpoint for the Lower Access Area and TCA will be 70°F (21°C). Setpoints will be reset as required to maintain a maximum temperature difference across the concrete structure of 70°F (21°C).

4.3.1.5 Major Equipment and Components

The layout of the major equipment and components of the HVAC Subsystem is shown in Figures 4.3-2, 4.3-3 and 4.3-4. The HVAC Subsystem schedules and details are presented in Figure 4.3-5. The major components within each area with dimensions and weights are listed in Table 4.3-1. All equipment in the DTS will be restrained so that the HVAC components do not become projectiles during a seismic event. The HEPA filters and its associated housing and ductwork (which provide a physical barrier to prevent the release of radioactive particulate matter) will be designed to maintain physical integrity during a seismic event.

Table 4.3-1

Dimensions and Weight of Major HVAC Components

Equipment	Location	Dimensions	Weight
AHU-1	Preparation Area	92½ in x 30½ in x 84 in (2350 mm x 775 mm x 2130 mm)	1118lb (506 kg)
AHU-2	Lower Access Area	64½ in x 26 in x 54 in (1640 mm x 660 mm x 1370 mm)	473 lb (214 kg)
AHU-3	Lower Access Area	64½ in x 26 in x 54 in (1640 mm x 660 mm x 1370 mm)	473 lb (214 kg)
PTHP-1	Protective Cover	43¼ in x 22¼ in x 16¼ in (1100 mm x 565 mm x 413 mm)	150 lb (67.9 kg)
CU-1	Outdoors on Pad	93½ in x 44 in x 44¾ in (237 mm x 1120 mm x 1140 mm)	866 lb (392 kg)
CU-2	Outdoors on Pad	38 in x 51 in x 39 in (965 mm x 1300 mm x 991 mm)	493 lb (223 kg)
CU-3	Outdoors on Pad	38 in x 51 in x 39 in (965 mm x 1300 mm x 991 mm)	493 lb (223 kg)
EF-1	Outdoors on Pad	36 in x 40 in x 44 in (914 mm x 1020 mm x 1120 mm)	200 lb (90.5 kg)
EF-2	Outdoors on Pad	36 in x 40 in x 44 in (914 mm x 1020 mm x 1120 mm)	200 lb (90.5 kg)
HEP-1	Lower Access Area	124 in x 30 in x 30 in (3150 mm x 762 mm x 762 mm)	350 lb (158 kg)
HEP-2	Lower Access Area	124 in x 30 in x 30 in (3150 mm x 762 mm x 762 mm)	350 lb (158 kg)
AC-1	Preparation Area	12 in x 84 in x 14 in (305 mm x 2130 mm x 356 mm)	236 lb (107 kg)
AC-2	Preparation Area	12 in x 84 in x 14 in (305 mm x 2130 mm x 356 mm)	236 lb (107 kg)

4.3.1.6 HVAC Control Subsystem - Control Logic (Sequence of Operations)

Static Pressure (Confinement) Controls

At system start-up, dampers between areas are closed. The lead exhaust fan will ramp up to achieve TCA negative static pressure setpoint as sensed by the TCA static pressure sensor. After an adjustable delay period, the damper between the Lower Access Area and the TCA will come under control of the Lower Access Area static pressure sensor and will modulate to maintain Lower Access Area static setpoint. After a second similar delay, the damper between the Preparation Area and the Lower Access Area will come under control of the Preparation Area static pressure sensor and will modulate to maintain the Preparation Area static setpoint. As each of these dampers comes on line, the exhaust fan speed will increase as required to maintain the TCA static setpoint. In the event that the lead exhaust fan fails, dampers will close, the standby fan will start, and the start-up sequence will be repeated. An alarm will annunciate at the operator station indicating the failure. The static pressure control will only operate when the source and receiving casks are mated to the TCA, and the DTS sliding door and Preparation Area doors are closed.

When the Preparation Area door is opened, the air curtain units will be energized via a door mounted end switch to help prevent the influx of dust and insects. When the Preparation Area door is closed, these units will automatically be turned off.

Temperature Controls

On a call for cooling in any of the three areas of the DTS, the respective air handling unit fan will start and its associated condensing unit will energize the refrigeration cycle to maintain space setpoint as sensed by the space temperature sensor. On a call for heating, the fan will start and the electric heating coil will cycle to maintain setpoint. The heating setpoint for the Lower Access Area and the TCA will track outside air temperature to ensure that the temperature difference across the concrete structure does not exceed 70°F (21°C).

In the Preparation Area, the humidity sensor can override the temperature sensor and start the fan and refrigeration cycle for the purposes of dehumidification. In this event the temperature sensor will control the electric heater to prevent overcooling of the space.

Software for the temperature and humidity sensors will set off an alarm when the signal from any sensor strays from within a given range. This will alert the operator that there is either a problem with the sensor, or with the heating/cooling equipment. Sensor failure will be detected by system diagnostics when the sensor signal strays from the design range of the sensor itself.

Monitoring of HEPA Filters

The pressure differential across the individual HEPA filter modules will be established at the site prior to each campaign by testing. Using several new or clean HEPA filter modules the pressure differentials across the filters will be recorded and averaged to set the minimum pressure differential for the steady state air flow through the DTS. This established minimum setting will be used as the basis to detect the presence of a damaged filter module.

Differential pressure sensors across the individual HEPA filter modules will monitor the condition of the filters and alert the operator when the resistance reaches the equivalent of the manufacturer's suggested maximum resistance of 0.072 psi (2 in water) at 4000 cfm. A decision would be made at this time whether to replace the filters at the end of the current loading cycle.

4.3.1.7 Design Calculations

The DTS heating/cooling load are calculated using a computerized load and analysis program called CHVAC, Full Commercial HVAC loads by Elite Software Development Inc. This program was designed to accurately calculate the maximum heating and cooling loads for buildings with multiple zones and systems. CHVAC uses the exact procedures and methods as described in the 1989 ASHRAE Handbook of Fundamentals (Reference 4.10). The HVAC design calculations are provided in Appendix 4A.

4.3.1.8 Interface Requirements With Other Systems

The HVAC Subsystem interfaces with the DTS Control Subsystem and the Radiation Monitoring Subsystem. The HVAC control subsystem is integrated with that for the DTS. The operating status of all the HVAC equipment, including DTS temperatures and pressures, is transmitted to the Control Center and displayed. Information on the open/closed status of the DTS doors and the position of the cask mating system is transmitted to the HVAC control subsystem, and is used to control the speed of the exhaust fans when spent fuel is not being transferred in the TCA. The HVAC Subsystem maintains negative pressures relative to ambient atmospheric pressure, and filters the exhausted air via a HEPA filter unit. The filtration is considered important to safety. Redundant equipment and systems are incorporated into the design to ensure that the system is dependable.

The HVAC Subsystem also maintains indoor environmental conditions within the DTS. This function is accomplished with a combination of split system air conditioning and electric resistance heaters. This function is not Important to Safety.

The exhaust systems operate as follows: Upon start-up, with all facility doors closed, the lead exhaust fan isolation control damper will open, and its end switch will report its status. When the "open" status has been verified, the fan will start and ramp up via its

variable frequency drive to a speed which will maintain the static pressure set point for the TCA. Motorized dampers in the transfer ducts between the Preparation Area and the Lower Access Area and between the Lower Access Area and the TCA, modulate as required to maintain the static differentials between the Preparation Area and the Lower Access Area, and between the Lower Access Area and the TCA. The negative static pressures maintained with respect to atmosphere increase from the area of lowest potential contamination (the Preparation Area) to the area of the highest potential contamination (the TCA). The system reacts to the opening and closing of doors by speeding up or slowing down the fan and opening or closing of transfer dampers as necessary to maintain pressure set points. A high velocity air door is included in the design at the Preparation Area entrance to help minimize the influx of dust and insects and any potential outdrafts when the door is open.

The Air Handling Units (AHU's) operate in response to temperature sensors in each of the three areas of the DTS. If cooling is necessary, the Preparation Area unit (AHU-1) will start and its associated condensing unit (CU-1) will energize, feeding compressed refrigerant to the direct expansion (D/x) cooling coil located in the AHU. On a call for heating, the AHU will start and an electric resistance heating coil located in the unit will be energized. In addition, a humidity sensor can initiate a call for dehumidification, in which case the fan and refrigerant equipment will be energized. In the event of overcooling by the dehumidification cycle, the heater will be energized and reheat supply air to the set point discharge temperature. The Lower Access Area and the TCA units (AHU-2 and AHU-3) will function similarly in the cooling and heating modes. Heating in the Lower Access Area and the TCA is expected to be minimal; however, electric heating coils have been included to maintain temperatures in those instances when supplemental heating is required.

Base heating set point for the Lower Access Area and the TCA is expected to be 70°F. The set point will be reset as required to maintain a maximum temperature gradient across the reinforced concrete walls of 70°F. For example, if the outside temperature falls to -10° F, the maximum allowable inside temperature is 60°F.

In the event that the control system senses a failure of the lead exhaust fan on startup, in that a start signal has been sent and no corresponding fan "on" status signal is returned, the lead fan isolation damper shall close, the standby fan isolation damper shall open, and the startup sequence will continue as described above. In the event that a failure is sensed during normal operation, the lead fan isolation damper and the two transfer dampers will close, the standby fan isolation will open, and the startup sequence will continue as described above. Should a fan isolation damper fail, as indicated by an "open" control signal and a "closed" status signal or vice versa, the standby fan and damper will be energized according to the startup sequence. All control dampers will fail in the open position to allow the airflow through the facility to continue in the proper direction in the event of a loss of control of any damper. Supplemental gravity operated backdraft dampers adjacent to the exhaust fan isolation control dampers will prevent excessive backflow through the standby fan.

The DTS heating and cooling loads were calculated using a computerized load program and analysis program called CHVAC, Full Commercial HVAC loads by Elite Software Development, Inc. This program was designed to accurately calculate the maximum heating and cooling loads for buildings with multiple zones and systems. CHVAC uses the methods and procedures described in the 1989 ASHRAE Handbook of Fundamentals.

4.3.1.9 Safety Considerations and Controls

Only the filtration system is considered as "Important to Safety". Redundant exhaust fans and HEPA filters have been incorporated into the design to minimize the potential for failure of the confinement function during normal operating conditions. The exhaust fans and motorized dampers are supplied by both the main power supply and the secondary power supply, to ensure that the confinement is maintained in the event of a loss of power.

The HEPA filters and its associated housing and duct work (which provide a physical barrier to prevent the release of radioactive particulate matter) are designed to maintain physical integrity during a seismic event.

The HEPA filters are located inside the DTS, protected from the effects of wind, tornadoes, and tornado missiles.

Low pressure and high pressure monitors are installed across the HEPA filters to monitor filter effectiveness. If the pressure differential across one set of HEPA filters is too low or too high, the flow can be diverted to the other set of HEPA filters.

The worst case fire or explosion, and the loss of filter integrity are bounded by the complete loss of HEPA filters. This scenario has been analyses in Chapter 8, and shows that the accident doses at the site boundary are well below the accident allowable doses.

Contaminated spills is not credible within the DTS. Decontamination operations will be performed with water spray and damp rags only.

4.3.2 Electrical Systems

Electrical power will be supplied to the DTS by the collocated Power Plant. This site supply is distributed within the DTS from a distribution panel (containing isolators and circuit breakers) located in the Preparation Area. All equipment, including the HVAC Subsystem, will be supplied by this primary power system. The characteristics of the power supply are site specific and will be addressed in a site license application. The electrical system is not considered "Important to Safety".

Electrical systems in the DTS are designed to be consistent with the following principles and meet the requirements of ANSI/ANS 57.9 (Reference 4.11):

- Electrical equipment is arranged for safe and convenient operation. Functionally different pipework, cabling, wiring (digital and analog signals at high and low levels) are physically segregated.

- On static control systems, equipment and wiring is segregated from power equipment wiring to prevent 'pick up' of unwanted electrical 'noise'.

The DTS equipment requires a 440V and 220V 3 phase supply. The operating equipment in the DTS requires a peak power of 25 kW. The HVAC Subsystem components require 194 kW of electrical power. A transformer rated at 440/220 V, 225 kVA is required.

A secondary electrical power supply system is specified to support the operation of the following equipment:

- HVAC system exhaust fans and motorized dampers (15 kW)
- All DTS operation equipment (10 kW max.) (The receiving cask trolley requires about 15 kW of power and could be operated after the HVAC system is shutdown temporarily)
- Control Subsystem (1 kW)
- Camera and Lighting Subsystem (2 kW)

The secondary power source will have its own dedicated power lines and will be independent of the primary power supply. Failure of the primary power supply will result in the operator switching over to the secondary power source. The emergency power source could be a generator or separate power lines from the plant.

Radiation monitors, control system CPU and emergency lights will be powered by self-contained batteries in the event of loss of the primary power supply. This will prevent a loss of information until secondary power is provided.

The worst possible configuration for a power failure is with a fuel assembly stuck in its up position closest to the wall of the DTS. In this condition, the DTS provides sufficient shielding such that the site boundary dose is 43 mrem if the fuel assembly is left in position for a period of two weeks.

Since the DTS is expected to be located at a utility, power can be restored within the two week period. The majority of the operating equipment is supplied with manual backup devices. The exception is the lifting and lowering mechanism on the fuel handling system. This system is supplied with two independent electrical drive systems. The cables for each drive unit are segregated to ensure that in the event of an electrical fire, both sets of cables

will not be damaged.

4.3.3 Air Supply Systems

The DTS Air Supply Subsystem is designed to supply air to inflate the seals on the sliding door between the Preparation Area and the Lower Access Area. The subsystem consists of an air tank that will be stored in the Tank Storage Area outside of the Preparation Area. This system is not Important to Safety.

4.3.4 Steam Supply and Distribution System

Not Applicable.

4.3.5 Water Supply Subsystem

Water is required for general purpose cleaning only. Water will be brought into the DTS in bottles. There are no water supply lines required.

4.3.6 Sewage Treatment System

No waste water collection and piping system is present in the DTS.

4.3.7 Communication and Alarm Systems

The communication system provides reliable communications between all areas of the DTS and to the Control Center.

4.3.7.1 Communication System

The communication system consists of:

- A Page/Party public address and evacuation alarm system.
- A sound powered telephone system.
- A hand-held portable radio system
- A commercial telephone.

The communication system is in addition to the Control System and the Alarms.

The Page/Party system provides communications from the Control Center to areas within the DTS and for one area to any other area. Loudspeakers and paging phones are located throughout the DTS. The system is normally used in daily operation activities to communicate messages between individuals. The evacuation alarm is manually initiated from the Control Center and overrides the paging system to ensure audibility throughout the DTS.

A sound powered telephone system is installed in the DTS. It is a multichannel system with a network of plug-in jacks. Headsets consisting of earphones and a microphone permit direct communications between persons in different areas. This system is normally used for maintenance and calibration.

Hand-held portable radios will be available for use during maintenance and emergency conditions. The radios operate on two VHF band frequencies. The system is normally used for maintenance and operating communications.

A commercial telephone system is installed in the Control Center.

During an emergency, the sound powered telephone system and the hand-held portable radios can be used as an alternative means to relay messages between different areas of the DTS.

The Page/Party System could be linked to the Utility communication system if desired by the host utility.

The design of the communications system permits routine testing and inspection without disrupting normal communications. All systems are in regular use to ensure proper operation.

4.3.7.2 Alarms

The alarms in the DTS are separated into four categories: mechanical equipment alarms; radiation monitoring alarms; HVAC alarms; and Emergency stop alarms. Each set of alarms is distinguishable from one another (e.g. different locations in the control center, different color indications and different sounds) to prevent the operator from misinterpreting the alarm source. The four category of alarms are described below.

Mechanical Equipment Alarms

The alarms generated by the mechanical equipment are further separated into two categories: defaults and incidents.

Alarms generated from defaults are those alarms which result from the sensors of the mechanical equipment. These alarms are indicators of mechanical or electrical functioning defaults which can show the loss of redundancy (over travel) or indicate an unsafe condition (over speed).

The PLC detects the inconsistencies between information supplied by different sources. For example, a TC port cover may be sensed in both the open and close position. This type of inconsistency indicates an instrumentation failure and is considered a default. In some

cases, the operator can release the alarm and resume operations. However, if the information which resulted in the alarm is used for an interlock, the use of a bypass is also necessary.

If the alarm indicates an unsafe condition, the operation being performed is stopped. No operation can be resumed before alarm deactivation which requires password entry. The defaults are generated by the sensors (e.g. over travel, overload, and collision detectors).

Alarms generated from incidents correspond to a time discrepancy in the operating sequence. The Control Subsystem is programmed with the anticipated times of each operating sequence. The Control Subsystem will monitor the time of the operating sequence and compare it to the anticipated time. If the performance time is too short or too long, this could be an indication of equipment malfunction. These alarms are detected and managed by the PLC on the mechanical equipment. Release of this alarm requires operator identification. The resumption of operations will not require particular administrative procedures, since these types of alarms do not indicate unsafe conditions. The monitoring system will display a way to recover normal conditions, based on the status of the equipment.

Alarm generated by defaults and incidents are displayed in the Control Center. For locally controlled operations, the alarms are also visible and audible in the Preparation Area and in the Lower Access Area.

Radiation Alarms and Warnings

Radiation monitors are located in the Preparation Area, in the Lower Access Area, in the TCA and in the Roof Enclosure Area. All radiation levels can be remotely monitored in the Control Center.

One warning level and two alarm levels are used for the Radiation Monitoring Subsystem: a low radiation level warning, a high radiation level alarm, and a low battery/detector failure alarm. The warning and alarms are displayed both locally in the DTS and remotely in the Control Center. Each level is distinguishable by the use of different indication lights and different sounds.

The warning and alarms are displayed by the Radiation Monitoring Subsystem Panel in the Control Center. The involved monitor and the cause of the warning or alarm is displayed. The warning is used by the operator to understand the operational process. For example, the warning can be used to verify that the sliding door is open or closed, or if the upper shield ports are open or closed.

If an alarm is actuated, the operator will evaluate the cause of the alarm and perform the necessary corrective action. Once the corrective action has occurred, the operator will

deactivate the alarm.

A Radiation Monitoring Subsystem alarm does not result in the automatic shutdown of operations. The operator is free to perform the necessary corrective action to bring the system into a safe condition.

The radiation monitor in the Lower Access Area is used by the PLC (Programmable Logic Controller) controlling the mechanical equipment to interlock the sliding door. The radiation monitor in the Roof Enclosure Area is used to interlock the upper shield ports.

HVAC Alarms and Warnings

Three alarm levels are considered for the HVAC Subsystem: high level alarms, low level alarms and warnings.

High level alarms correspond to the loss of the double confinement provided by this system or abnormal high temperature in any area. The loss of double confinement is detected by the absence of pressure differential at the level of the two outside blowers. The alarms are audible and visible in the Preparation Area and in the Control Center. The monitoring system provides sufficient means to locate the failing equipment (temperature monitoring in each room displayed, blower activity and pressure differential displayed). The deactivation of alarms requires bypasses. Operations are not shutdown by these alarms, allowing a fast recovery to a safe condition.

The loss of redundancy of the blowers detected by the absence of pressure differential, the loss of a Fan Coil Unit (FCU) detected by the absence of pressure differential with a local temperature above the FCU initiation level, or the malfunctioning of a damper (detected by the equipment) generate low level alarms. These alarms are only audible and visible in the Control Center.

If during fuel transfer operations, the HVAC is not able to maintain the pressure differential between the three areas, a low level alarm is generated. Detection begins automatically when the two casks are mated and is automatically deactivated when the first operation after transfer is initiated (lifting of a mating flange). Deactivation of the alarms requires operator identification.

The need for HEPA filters maintenance detected by an abnormal low or high pressure differential across the filters initiates a warning.

Emergency Stop Alarms

Emergency push buttons to stop all DTS operations are present in the DTS in each area (the Preparation Area, the Lower Access Area, the Transfer Confinement Area, the Roof Enclosure Area, and outside the Preparation Area) as well as in the Control Center.

4.3.8 Fire Protection System

No combustible materials are stored within or adjacent to the DTS area. The DTS material of construction, primarily concrete and steel, can withstand any postulated credible fire hazard at the DTS.

The Lower Access Area and the TCA contain no volatile materials or gases, therefore no credible internal explosion is postulated. The design basis for explosions away from the DTS is bounded by the design basis tornado described in Section 8.2.5.

Electrical wiring insulation of the fire retardant type meeting the requirements of IEEE-383 will be specified. This insulation burns slowly accompanied by considerable smoke. Control and instrument wires will have flame retardant jackets and fillers which are flame retardant and nonwicking.

Flammable materials in the DTS, therefore, consist only of wire insulation and hoses used for inert welding gas and helium. The main postulated source of fire arises from electrical insulation in the Transfer Confinement Area (TCA) where there are a number of electric cables and electrical motors. Welding of the lids in the Preparation Area is also a potential source of fire.

The Fire Protection System in the Preparation Area consists of smoke detectors with alarms and hand-held fire extinguishers. Operators are present during the preparation of the welding preparations. During the welding operations, the operators are no longer in the Preparation Area but are standing by in the adjacent area. The Control Center monitors the welding process, so they can alert the operators of any problems.

The Lower Access Area, the TCA and the Roof Enclosure Area (REA) are equipped with a Carbon Dioxide Fire Suppression System. Fire and smoke detectors are connected to an alarm system at the Control Center. When applied to a fire, it provides a blanket of heavy gas that reduces the oxygen content within the area to a point where combustion becomes impossible. In addition, carbon dioxide gas provides a cooling effect and leaves no residue. It dissipates into the atmosphere, allowing for rapid cleanup and minimizing downtime.

Carbon dioxide is supplied for the DTS from a series of tanks held at the tank storage area located outside of the Preparation Area. Piping from the tank storage area penetrates the walls of the DTS and into the Lower Access Area, the TCA, and the REA. The discharge of

the carbon dioxide is controlled through a servo-controlled valve. In case of a fire alarm or smoke alarm in the Lower Access Area, TCA and REA, the CO2 system can be administratively over-ridden to prevent discharge of CO2 while personnel are in the DTS. If after a fire or smoke alarm, there is no action from the Control Center, after a pre-set time, CO2 will automatically discharge and the HVAC System will shut down. In the case of an over-ride by the Control Center, the system can be activated only upon a second action by the Control Center when all personnel have left the area.

Portable suppression equipment, such as fire extinguishers will be located in the Lower Access Area and Preparation Area of the DTS and outside the DTS Building. Operations and security personnel will be trained in the use of hand-held portable fire suppression equipment.

When personnel are present in any DTS area, fire fighting can be by the operating staff trained in fire fighting. If fire is discovered by personnel, hand extinguishers would be used to immediately suppress the fire. Control Center operators would be notified to close down the ventilation system as soon as practical. Note that shutting down the ventilation system allows dampers separating adjacent areas to close and minimizing CO2 and smoke from entering the ventilation system as well as reducing oxygen supply to the fire.

All fire fighting equipment will be provided in accordance with NFPA 12 standards, 1993 Edition.

The DTS fire detection features will be provided per NFPA Standard 72D and Fire Suppression Systems per the guidance of ANSI/NFPA 12 - 1993.

Further fire protection details are deferred to each specific site.

4.3.9 Maintenance Systems

The DTS is designed such that no equipment should require maintenance for a loading cycle of 10 receiving casks. The design period is 100 days. All maintenance of equipment within the Preparation Area is done directly on the failed item. To minimize exposures to operating personnel, any loaded casks will be removed from the area if maintenance is expected to require a significant period of time. Equipment within the Lower Access Area is maintained directly on the failed item after the casks and all fuel are removed from the Area. Maintenance or repair of equipment within the TCA and in the Roof Enclosure Area is also expected to be performed directly on the failed item, after all fuel and casks are removed from the TCA and Lower Access Area.

The equipment is designed for quick change out of parts and reliability. All parts

which may need to be repaired or replaced will be provided with lifting attachments (rings, hooks, threaded holes) which are easily accessible without specific tools.

All equipment within the TCA is checked and inspected after each loading cycle of 10 receiving cask loadings.

All remotely operated equipment are supplied with backups, in order to ensure that the DTS can be shutdown in a safe condition for manual access in the event of equipment failure.

It is envisaged that no maintenance operations will require gamma shielding and the majority can be accomplished with normal clean conditions confinement techniques. Personnel protection will be covered more fully in the site specific submission when any potential contamination can be defined more accurately. The DTS incorporates features to eliminate the uncontrolled spread of contamination and to control the movement of personnel to areas of potential radiation risk.

Filters will be replaced during each maintenance cycle, or when indicated by the control system.

4.3.10 Cold Chemical Systems

There are no chemical processes incorporated into the design of the DTS.

4.3.11 Air Sampling Systems

Air sampling is incorporated as part of the Heating, Ventilating and Air Conditioning System. The air leaving the stacks is constantly monitored, as described in Chapter 7.0.

Figure 4.3-1

HVAC Subsystem Schematic

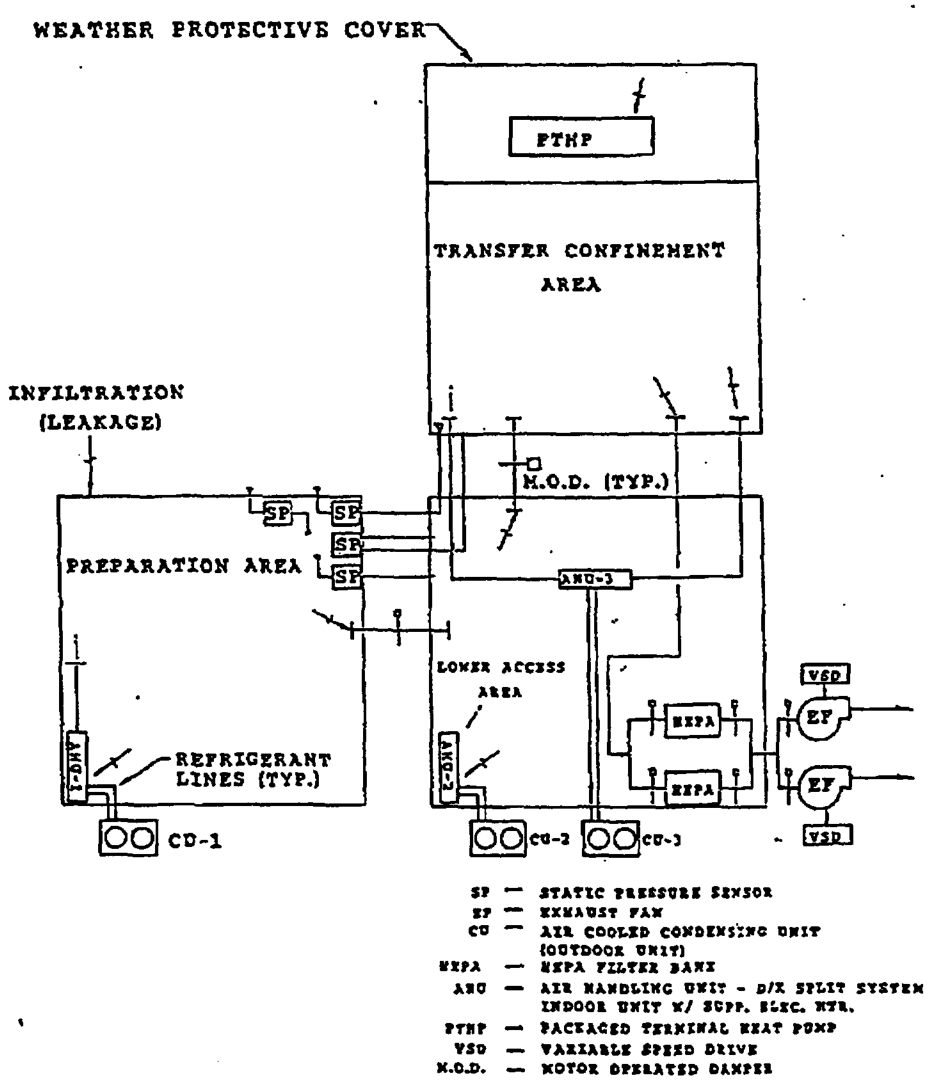


Figure 4.3-2

HVAC Subsystem Lower Access Area and Preparation Area Plan View

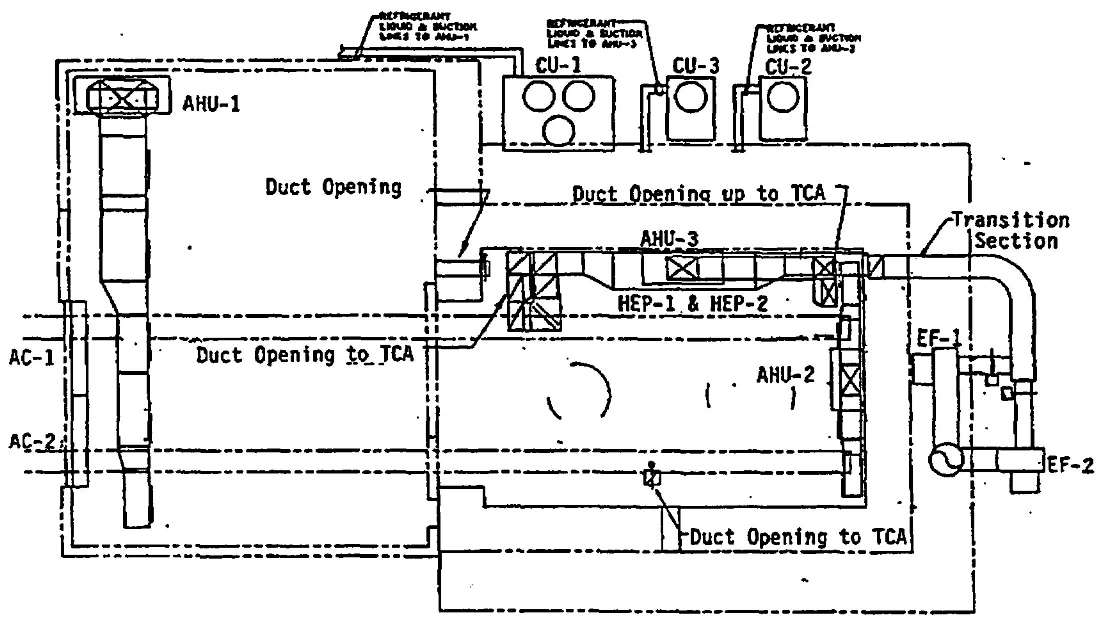


Figure 4.3-3

HVAC Subsystem Elevation Section of Lower Access Area and TCA

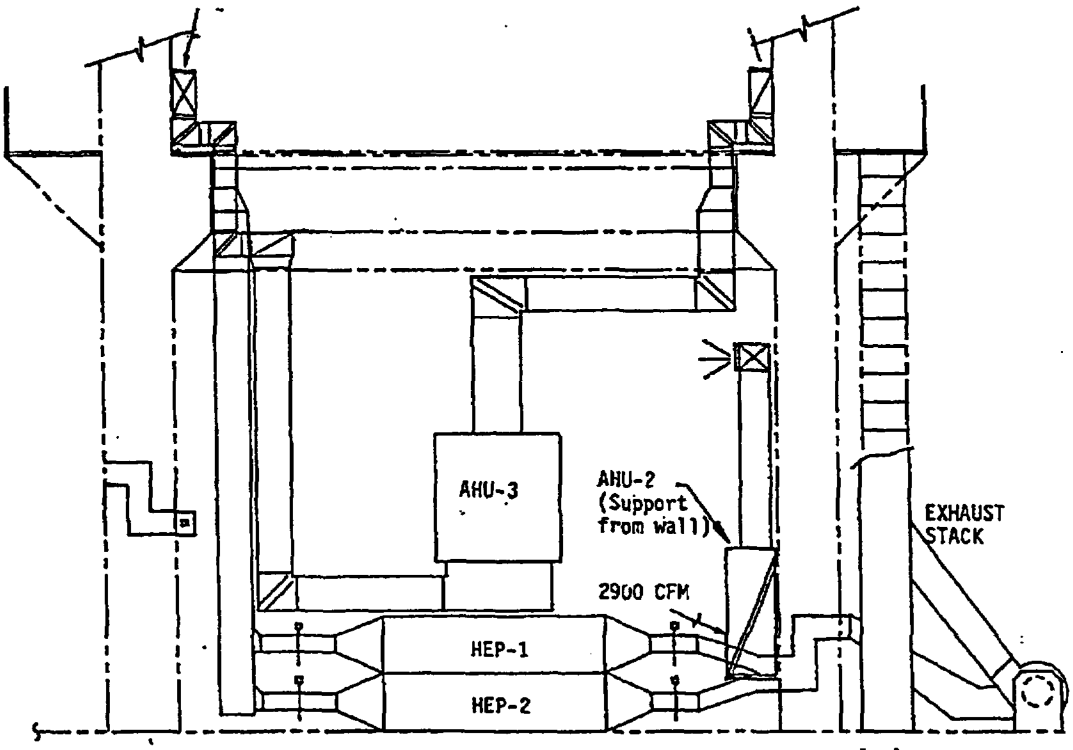


Figure 4.3-4

HVAC Subsystem End Section of Lower Access Area and TCA with Protective Cover

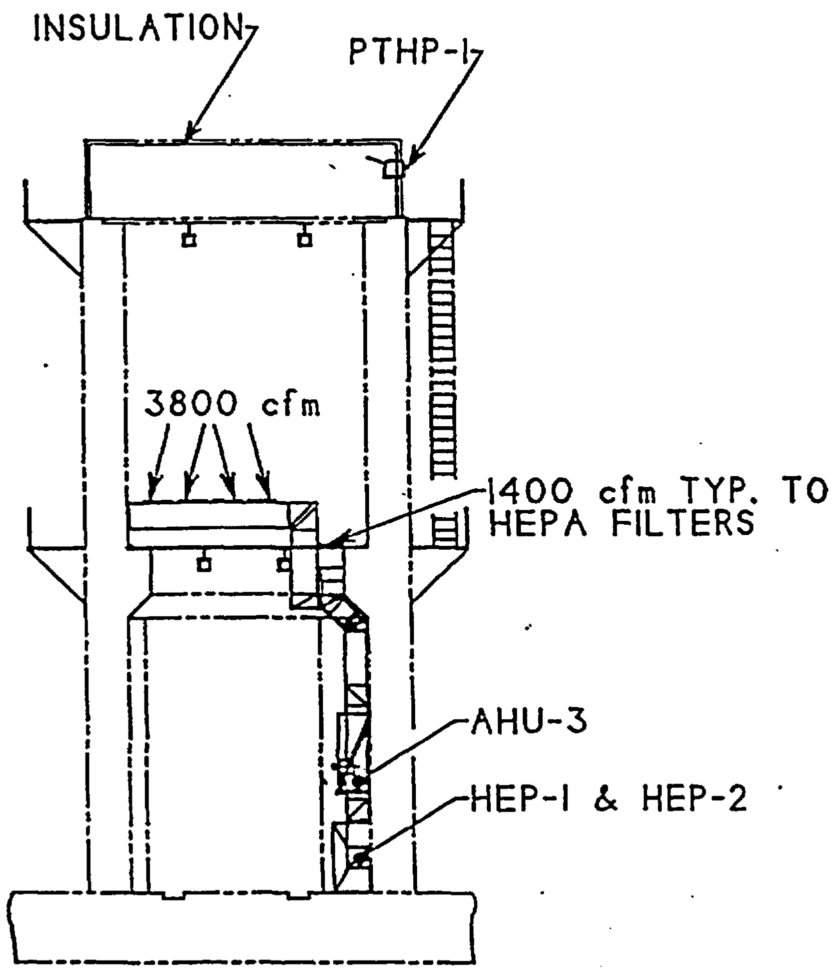


Figure 4.3-5

HVAC Details and Schedules

AIR CURTAIN SCHEDULE						
TAG	MANUFACTURER	MODEL	CFM	HP	ELECTRICAL	REMARKS
AC-1	MARS	EHH-84	9600	2 @ 3	460/60/3	
AC-2	MARS	EHH-84	9600	2 @ 3	460/60/3	

EXHAUST FAN SCHEDULE									
TAG	MANUFACTURER	MODEL	CFM	E.S.P.	BHP	HP	RPM	ELECTRICAL	REMARKS
EF-1	GREENHECK	15 BISW	4000	7.5	5.38	7.5	2204	460/60/3	FURNISH W/VARIABLE SPEED DRIVE
EF-2	GREENHECK	15 BISW	4000	7.5	5.38	7.5	2204	460/60/3	FURNISH W/VARIABLE SPEED DRIVE

CONDENSING UNIT SCHEDULE						
TAG	MANUFACTURER	MODEL NO.	MBH	ELECTRICAL	O.A. DB/WB	REMARKS
CU-1	TRANE	TTA240B	226	460/3	115/85	FURNISH WITH HOT GAS BYPASS
CU-2	TRANE	TTA120A	124	460/3	115/75	FURNISH WITH HOT GAS BYPASS
CU-3	TRANE	TTA120A	124	460/3	115/75	FURNISH WITH HOT GAS BYPASS

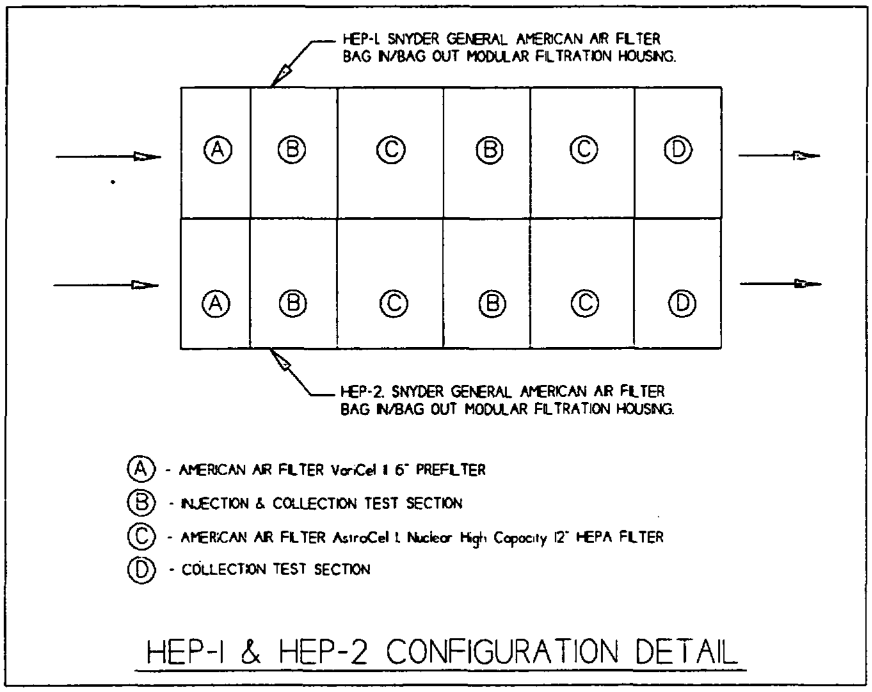
Figure 4.3-5 (Continued)

HVAC Details and Schedules

AIR HANDLING UNIT SCHEDULE																
			FAN DATA						REFRIGERATION COIL					ELECTRIC HEATING COIL		REMARKS
TAG	MANUFACTURER	MODEL	CFM	RPM	E.S.P.	BHP	HP	ELCTRICAL	TMBH	SMBH	EDB	EWB	REFR	MBH	MODEL	
AHU-1	TRANE	TWE240B	9200	932	1.0"	4.4	5	460/3/60	239	125	80	73	R-22	171	BAYHTRM450A	
AHU-2	TRANE	TWE120A	3800	813	1.0"	1.73	3	460/3/60	116	71.5	90	67	R-22	58	BAYHTRL325A	
AHU-3	TRANE	TWE120A	3800	935	1.5"	1.94	3	460/3/60	116	88.6	90	67	R-22	58	BAYHTRL325A	
PTHP-1	TRANE	PTHP120E-C	300	2 SPD.	N/A	1.94	1/4	208/1/60	12	9	90	73	R-22	7100	2.5 KW	

Figure 4.3-5 (Continued)

HVAC Details and Schedules



4.4 Decontamination Systems

4.4.1 Equipment Decontamination

There are no built in decontamination facilities within the DTS. All the equipment decontamination systems will be mobile.

After each complete transfer, most of parts of the DTS will be decontaminated to a level of activity sufficiently low to permit maintenance activities. These decontamination efforts are expected to be small, since the DTS is designed to minimize the spread of contamination.

The exterior surfaces of the casks will be wiped down with damp wipes to remove contamination resulting from mating with the DTS or from crud falling from fuel assemblies. In case of high contamination, the decontamination procedures specific to the cask will be applied.

The Cask Transfer Subsystem components will be also wiped with damp clothes to remove any potential contamination.

The Preparation Area and equipment will be vacuumed and wiped as needed to remove any loose contamination due to the welding of the lid.

The Lower Access Area and equipment will be vacuumed and wiped to remove contamination due to the mating subsystem.

The Transfer Confinement Area will be decontaminated prior to performance of maintenance activities. It is expected that prior to entering the TCA for maintenance activities, the area and accessible equipment will be vacuumed to remove loose contamination. Other areas which indicate contamination will be wiped down with damp wipes. In case of maintenance activity on the fuel assembly handling subsystem, and due to the potential high level of contamination of the crud catcher or the fuel assembly transfer tube, polyvinyl covering and metallic covering can be used to permit directly handling on this system. It may be necessary to vacuum out the crud catcher and the fuel transfer tube. This can be accomplished from the Lower Access Area.

Most loose contamination will be picked up by the HVAC System and deposited into the HEPA filters. When it is the time to change these filters, they will be removed from the filter enclosure and sealed in polyvinyl and placed in a container with sufficient shielding to reduce exposure levels to permissible value. Contaminated materials protected in this manner will be removed to appropriate site facilities.

4.4.1.1 Major Component and Operating Characteristics

It is anticipated that only dry techniques will be necessary using damp wipes and portable vacuum cleaning equipment.

The vacuum cleaning by a portable system is a simple and effective technique for removing loose contamination. The portable vacuum unit consists of a vacuum hose with a nozzle of a form suitable for the type of work desired, a settling box with baffle plates and a filter of large surface area, and an absolute (HEPA) filter assembly. The particules and vapor go directly to the settling box where larger particules are removed, and the air free of all but the finest powder goes to the HEPA unit. All parts of the vacuum system are mounted on wheels to facilitate movement.

This system will be choosen in accordance with the site specification on such equipment.

4.4.1.2 Safety Considerations and Controls

All operations will be controlled to comply with site health physics and conventional safety requirements of specific host utility.

4.4.2 Personnel Decontamination

The personnel decontamination facilities of the host utility will be used if required.

4.5 Shipping Cask Repair and Maintenance

No cask maintenance will be carried out in the DTS.

4.6 Cathodic Protection

The DTS ISFSI is dry and above ground so that cathodic protection in the form of impressed current is not required. The normal operating environment for most metallic components (excluding cooling coils) is above the HVAC maintained air temperatures in the DTS. The HVAC Subsystem will maintain a non-condensing atmosphere within the DTS structure. Moisture will be removed from the air flowing into the DTS structure in the Preparation Area.

4.7 Spent Fuel and Waste Handling Operation Systems

The fuel handling operating systems are dealt with in depth in Chapter 5. Waste handling is discussed in Chapter 6.

Appendix 4A HVAC Computer Code Printout

Program Input/Output

What follows is a description of inputs and outputs of the program using the Preparation Area (PA) as a working example. Loads associated with the PA were calculated to allow sizing and selection of AHU-1. The program output for the PA begins on page 4A-5. The LAA and TCA were also input producing similar results and were calculated to allow sizing of AHU-2 and AHU-3 respectively with the program output beginning on page 10. Program output for the PA beginning on page 4A-5 begins with building master data and design parameters for a city called Anytown, USA and consists of worst case dry bulb/wet bulb ambient temperatures as well as indoor summer/winter conditions as specified in E-13245, "Design Criteria for the Heating, Ventilation and Air Conditioning of the Dry Transfer System.". What follows this section is building U-factors for walls, windows, roofs and doors as well as general project information including barometric pressure etc. and an arbitrarily assigned latitude and longitude for the city. Page 4A-6 continues with more general project information which is readily self explanatory in the program output.

The detailed project zone load calculations on page 4A-7 illustrate the heating/cooling load for each wall, window, door and roof as well as the load for people, lights equipment and infiltration. The totals on this page indicate the total building heat loss, sensible gain and latent gain.

The air system analysis on page 4A-8 and 4A-9 is used in sizing and selecting the HVAC equipment based on peak design conditions as selected by the program using building construction information and weather data algorithms as well as basic heat transfer formulas. According to the loads AHU-1 was to be selected to handle a total cooling load of 252,917 BTUH or 21.08 tons at 9300 CFM and a total heating load of 92,410 BTUH. These loads include a 10% saftey factor. Based on the total loads above a standard unit was selected with a total cooling and heating capacity of 239,000 BTUH or 20 tons at 9200 CFM and 171,000 BTUH respectively. This selection is within the saftey factor which allows us to standardize unit selection and avoid specifying a significantly more costly larger unit for AHU-1.

LUCHINI MILFORT & GOODELL
78 BEAVER ROAD
WETHERSFIELD, CT 06109

PROJECT: EPRI DRY XFER FACILITY
CLIENT: N.T.S.
DATE: 06/22/95

FULL COMMERCIAL HVAC LOADS PROGRAM
(PREPARATION AREA)

DESIGNER: DROV

BUILDING MASTER DATA AND DESIGN PARAMETERS:

DESIGN MONTH	OUTDOOR DRY BULB	OUTDOOR WET BULB	INDOOR REL.HUM	INDOOR DRY BULB	GRAINS DIFF.	IN/OUTDOOR CORRECTION
APRIL	115	85	50%	80	59.08	16
MAY	115	85	50%	80	59.08	16
JUNE	115	85	50%	80	59.08	16
JULY	115	85	50%	80	59.08	16
AUGUST	115	85	50%	80	59.08	16
SEPTEMBER	115	85	50%	80	59.08	16
WINTER	-20	0	50%	50	0.00	

ROOF TYPE	ASHRAE ROOF #	ROOF U-FAC	ROOF COLOR	SUSP CLG.
1.	12	0.224	LIGHT	NO
2.	1	0.090	LIGHT	NO

PART TYPE	PART U-FAC	COOL T-D	HEAT T-D
1.	0.400	20	10

WALL TYPE	ASHRAE GROUP	WALL U-FAC	WALL COLOR
1.	A	0.224	LIGHT
2.	G	0.090	LIGHT

GLASS NO.	SUMMER U-FAC.	WINTER U-FAC.	GLASS SHD.COEF	INTERIOR SHADING	INTERIOR SHD.COEF	ROOM CONST	GLASS WIDTH	GLASS HEIGHT
1.	0.400	0.400	0.050	NO	0.000	LIGHT	12.50	20.00

GENERAL PROJECT INFORMATION:

PROJECT FILE NAME:	C:TN-PA
PROJECT LOCATION:	ANYTOWN, USA
BAROMETRIC PRESSURE:	29.625 IN.HG
ALTITUDE:	275 FEET
NORTH LATITUDE:	43 DEGREES
MEAN DAILY TEMPERATURE RANGE:	25 DEG.F
ATMOSPHERIC CLEARNESS FACTOR:	1.00
GROUND REFLECTANCE:	20 PERCENT
STARTING TIME FOR HVAC LOAD CALCULATIONS:	1 AM
ENDING TIME FOR HVAC LOAD CALCULATIONS:	12 AM
FLOOR HEAT LOSS COEFFICIENT:	0.50 BTUH/FT-F
NUMBER OF UNIQUE ZONES IN THIS PROJECT:	1

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
******************** GENERAL PROJECT DATA (CONTINUED) ********************

BUILDING DEFAULT VALUES:

CALCULATIONS PERFORMED:	BOTH HEATING AND COOLING LOADS
LIGHTING REQUIREMENTS:	2.00 WATTS PER SQUARE FOOT
EQUIPMENT REQUIREMENTS:	1.00 WATTS PER SQUARE FOOT
PEOPLE SENSIBLE LOAD MULTIPLIER:	325 BTUHS PER PERSON
PEOPLE LATENT LOAD MULTIPLIER:	435 BTUHS PER PERSON
ZONE SENSIBLE SAFETY FACTOR:	10%
ZONE LATENT SAFETY FACTOR:	10%
ZONE HEATING SAFETY FACTOR:	10%
PEOPLE DIVERSITY FACTOR:	100%
LIGHTING PROFILE NUMBER:	0
EQUIPMENT PROFILE NUMBER:	0
PEOPLE PROFILE NUMBER:	1
BUILDING DEFAULT CLG. HEIGHT:	22.00 FEET
BUILDING DEFAULT WALL HEIGHT:	22.00 FEET

INTERNAL OPERATING LOAD PROFILES (C=100):

REF NO.	HR 1	HR 2	HR 3	HR 4	HR 5	HR 6	HR 7	HR 8	HR 9	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23	HR 24
1.	C	C	C	C	C	C	C	C	C	C	70	70	70	C	C	C	C	C	C	C	C	C	C	C
2.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
3.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
4.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
5.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
6.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
7.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
8.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
9.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
10.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

ALL DESIGN DATA TAKEN FROM THE 1989 ASHRAE HANDBOOK OF FUNDAMENTALS

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*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                              WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                               06/22/95
******************* DETAILED PROJECT ZONE LOAD CALCULATIONS ****************
```

LOAD DESCRIPTION	UNIT QUAN	-SC- CFAC	CLTD SHGF	U.FAC -CLF-	SEN. GAIN	LAT. GAIN	HTG. MULT.	HTG. LOSS
1. PREPARATION AREA SYS# 1 PEAK TIME 3 PM JUN.						(24 X 32) = 768 SF		
ROOF-2-1-NO.CLG-L	768	0.500	95	0.090	3836		6.300	4838
S. WALL-2-G-L	688	0.650	60	0.090	2762		6.300	4334
W. WALL-2-G-L	667	0.650	73	0.090	3185		6.300	4202
N. WALL-2-G-L	688	0.650	41	0.090	1997		6.300	4334
PARTITION-1	250		20/10	0.400	2000		4.000	1000
W. GLS- 1- 90-TRANS	250	1.000	30	0.400	3000		28.000	7000
0%S- 0- L- NS-SOLAR	250	0.050	215	0.450	1209			
LIGHTS-0	1536.00	1.000	100%	3.410	5238			
EQUIPMENT-0	35500.00	1.000		3.410	121055	0		
PEOPLE-1	10.00	1.000		325/435	3250	4350		
SUMMER INFL	734			38.119	27979	29197		
WINTER INFL	734						74.852	54941
TOTAL					175,511	33,547		80,649
					X 1.10	X 1.10		X 1.10
					193,062	36,902		88,714

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
******************** AIR SYSTEM # 1 (AHU-1) ZONE SUMMARY ******************

ZN. NO.	ZONE - DESCRIPTION PEAK TIME & MONTH	FLOOR AREA	HTG.LOSS O.A. CFM	SEN.GAIN O.A. CFM	LAT.GAIN EXH. CFM	HTG.CFM CFM/SF.	CLG.CFM CFM/SF.
1	PREPARATION AREA	768	88,714	193,062	36,902	1,728	9,330
	3 PM JUNE		0	0	0	2.25	12.15
	ZONE PEAK TOTALS	768	88,714	193,062	36,902	1,728	9,330
	TOTAL ZONES: 1		0	0	0	2.25	12.15

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                              WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                               06/22/95
**************** AIR SYSTEM # 1 (AHU-1) TOTAL LOAD SUMMARY *****************

AIR HANDLER DESC: AHU-1 WITH VAV TERMINALS
SUPPLY AIR FAN: BLOW-THRU WITH PROGRAM ESTIMATED HORSEPOWER OF  4.97 HP.
FAN INPUT: 65% COMBINED FAN AND MOTOR EFF. WITH 2.20 IN WATER ACROSS THE FAN
SENSIBLE HEAT RATIO: 0.84 ----- THIS SYSTEM OCCURS 1 TIME(S) IN THE BUILDING

AIR SYSTEM PEAK TIME:  4 PM IN JUNE
OUTDOOR CONDITIONS:  114 DB, 85 WB, 137.96 GRAINS      INSIDE: 80 DB, 50% RH

BECAUSE OF THE DIVERSITY IN ZONE, PLENUM, AND VENT. LOADS, THE ZONE SENSIBLE
PEAK TIME IN JUNE        AT  3 PM IS DIFFERENT FROM THE TOTAL SYS. PEAK TIME
HENCE, THE AIR SYSTEM CFM WAS COMPUTED USING A ZONE SEN. LOAD OF     193,062

SUMMER: NONE CONTROLS OUTSIDE AIR  -----  WINTER:  NONE CONTROLS OUTSIDE AIR

ZONE   SPACE  SEN.LOSS:            28,279 BTUH
INFILTRATION  SEN.LOSS:            60,435 BTUH (        734 CFM)
OUTSIDE  AIR  SEN.LOSS:                 0 BTUH (          0 CFM)
SUPPLY DUCT   SEN.LOSS:             3,696 BTUH
RETURN DUCT   SEN.LOSS:                 0 BTUH
TOTAL SYSTEM  SEN.LOSS:                                              92,410 BTUH

SUPPLY AIR: 92,410 / (0.990 X 1.08 X 50) =  (      1,728 CFM)
WINTER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

ZONE   SPACE  SEN.GAIN:           162,580 BTUH
INFILTRATION  SEN.GAIN:            29,898 BTUH (        734 CFM)
DRAW-THRU FAN SEN.GAIN:                 0 BTUH
SUPPLY  DUCT  SEN.GAIN:            10,161 BTUH
TOTAL SEN.GAIN ON SUPPLY SIDE OF COIL:                              202,639 BTUH

SUPPLY AIR:203,223 / (0.990 X 1.10 X 20) =  (      9,330 CFM)
SUMMER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

RETURN DUCT   SEN.GAIN:                 0 BTUH
RETURN PLENUM SEN.GAIN:                 0 BTUH
OUTSIDE AIR   SEN.GAIN:                 0 BTUH (          0 CFM)
BLOW-THRU FAN SEN.GAIN:            12,484 BTUH
TOTAL SEN.GAIN ON RETURN SIDE OF COIL:                               12,484 BTUH

TOTAL SEN.GAIN ON AIR HANDLING SYSTEM:                              215,123 BTUH

ZONE   SPACE  LAT.GAIN:             4,786 BTUH
INFILTRATION  LAT.GAIN:            33,008 BTUH (        734 CFM)
OUTSIDE  AIR  LAT.GAIN:                 0 BTUH (          0 CFM)
TOTAL LAT.GAIN ON AIR HANDLING SYSTEM:                               37,794 BTUH

TOTAL SYSTEM SENSIBLE AND LATENT GAIN:                              252,917 BTUH

TOTAL TONNAGE REQUIRED WITH OUTSIDE AIR:                              21.08 TONS
```

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*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                               WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                                06/22/95
************** AIR SYSTEM # 1 (AHU-1) PSYCHROMETRIC ANALYSIS ***************
```

SYSTEM LOAD ANALYSIS	LATENT	GRAINS	SENSIBLE	TEMP	CFM
LEAVING COIL CONDITION		71.220		60.000	
DRAW-THRU FAN			0	0.000	0
MISC LOAD ON SUPPLY SIDE			0	0.000	0
SUPPLY AIR DUCT			10,161	1.000	467
ZONE LOADS	37,794	6.017	193,062	19.000	8,863
ZONE CONDITION	37,794	77.237	203,223	80.000	9,330
RETURN AIR DUCT			0	0.000	
RETURN AIR PLENUM			0	0.000	
MISC LOAD ON RETURN SIDE			0	0.000	
VENT AIR 0 CFM	0	0.000	0	0.000	
BLOW-THRU FAN			12,484	1.229	
ENTERING COIL CONDITION	37,794	77.237	215,707	81.229	9,330

```
GENERAL PSYCHROMETRIC EQUATIONS USED IN ANALYSIS:

PR  = (BAROMETRIC PRESSURE OF SITE / STANDARD ASHRAE PRESSURE OF 29.921)
TSH = PR X 1.10 X CFM X (DB.ENTERING - DB.LEAVING)
TLH = PR X 0.68 X CFM X (GRAINS.ENTERING - GRAINS.LEAVING)
GTH = PR X 4.50 X CFM X (ENTHALPY.ENTERING - ENTHALPY.LEAVING)

TSH = 0.990 X 1.10 X      9,330 X (  81.229 -  60.000 ) =      215,708 BTUH
TLH = 0.990 X 0.68 X      9,330 X (  77.237 -  71.220 ) =       37,794 BTUH
                                                             -----------
SUM =                                                          253,502 BTUH
GTH = 0.990 X 4.50 X      9,330 X (  31.602 -  25.468 ) =      254,978 BTUH
TOTAL SYSTEM LOAD                                       =      252,917 BTUH

CHILLED-HOT WATER FLOW RATES:

COOLING GPM =       254,978 / ( 10.0 X 500 )           =         51.0 GPM
HEATING GPM =        92,410 / ( 20.0 X 500 )           =          9.2 GPM

ENTERING COOLING COIL CONDITIONS:          ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        81.23         DRY BULB TEMPERATURE:        50.00
WET BULB TEMPERATURE:        67.00
RELATIVE HUMIDITY(%):        48.03
ENTHALPY:               31.60 BTU/LBM

LEAVING  COOLING COIL CONDITIONS:          LEAVING  HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        60.00         DRY BULB TEMPERATURE:       100.00
WET BULB TEMPERATURE:        58.43
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RELATIVE HUMIDITY(%):        91.36
ENTHALPY:                25.47 BTU/LBM
```

LUCHINI MILFORT & GOODELL
78 BEAVER ROAD
WETHERSFIELD, CT 06109

PROJECT: EPRI DRY XFER FACILITY
CLIENT: N.T.S
DATE: 06/22/95

FULL COMMERCIAL HVAC LOADS PROGRAM
(LOWER ACCESS AREA & TRANSFER CONFINEMENT AREA)

DESIGNER: D. ROVATTI

BUILDING MASTER DATA AND DESIGN PARAMETERS:

DESIGN MONTH	OUTDOOR DRY BULB	OUTDOOR WET BULB	INDOOR REL.HUM	INDOOR DRY BULB	GRAINS DIFF.	IN/OUTDOOR CORRECTION
APRIL	115	85	50%	85	45.23	11
MAY	115	85	50%	85	45.23	11
JUNE	115	85	50%	85	45.23	11
JULY	115	85	50%	85	45.23	11
AUGUST	115	85	50%	85	45.23	11
SEPTEMBER	115	85	50%	85	45.23	11
WINTER	-20	0	50%	50	0.00	

ROOF TYPE	ASHRAE ROOF #	ROOF U-FAC	ROOF COLOR	SUSP CLG.
1.	12	0.224	LIGHT	NO
2.	1	0.090	LIGHT	NO

PART TYPE	PART U-FAC	COOL T-D	HEAT T-D
1.	0.400	10	20

WALL TYPE	ASHRAE GROUP	WALL U-FAC	WALL COLOR
1.	A	0.224	LIGHT
2.	G	0.090	LIGHT

GLASS NO.	SUMMER U-FAC.	WINTER U-FAC.	GLASS SHD.COEF	INTERIOR SHADING	INTERIOR SHD.COEF	ROOM CONST	GLASS WIDTH	GLASS HEIGHT
1.	0.400	0.400	0.050	NO	0.000	LIGHT	12.50	20.00

GENERAL PROJECT INFORMATION:

PROJECT FILE NAME:	C:TNLAATCA
PROJECT LOCATION:	ANYTOWN, USA
BAROMETRIC PRESSURE:	29.625 IN.HG
ALTITUDE:	275 FEET
NORTH LATITUDE:	43 DEGREES

MEAN DAILY TEMPERATURE RANGE:	25 DEG.F
ATMOSPHERIC CLEARNESS FACTOR:	1.00
GROUND REFLECTANCE:	20 PERCENT
STARTING TIME FOR HVAC LOAD CALCULATIONS:	1 AM
ENDING TIME FOR HVAC LOAD CALCULATIONS:	12 AM
FLOOR HEAT LOSS COEFFICIENT:	0.50 BTUH/FT-F
NUMBER OF UNIQUE ZONES IN THIS PROJECT:	4

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
******************** GENERAL PROJECT DATA (CONTINUED) ********************

BUILDING DEFAULT VALUES:

CALCULATIONS PERFORMED:	BOTH HEATING AND COOLING LOADS
LIGHTING REQUIREMENTS:	2.00 WATTS PER SQUARE FOOT
EQUIPMENT REQUIREMENTS:	1.00 WATTS PER SQUARE FOOT
PEOPLE SENSIBLE LOAD MULTIPLIER:	325 BTUHS PER PERSON
PEOPLE LATENT LOAD MULTIPLIER:	435 BTUHS PER PERSON
ZONE SENSIBLE SAFETY FACTOR:	10%
ZONE LATENT SAFETY FACTOR:	10%
ZONE HEATING SAFETY FACTOR:	10%
PEOPLE DIVERSITY FACTOR:	100%
LIGHTING PROFILE NUMBER:	0
EQUIPMENT PROFILE NUMBER:	0
PEOPLE PROFILE NUMBER:	1
BUILDING DEFAULT CLG. HEIGHT:	22.00 FEET
BUILDING DEFAULT WALL HEIGHT:	22.00 FEET

INTERNAL OPERATING LOAD PROFILES (C=100):

REF NO.	HR 1	HR 2	HR 3	HR 4	HR 5	HR 6	HR 7	HR 8	HR 9	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23	HR 24
1.	C	C	C	C	C	C	C	C	C	C	70	70	70	C	C	C	C	C	C	C	C	C	C	C
2.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
3.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
4.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
5.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
6.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
7.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
8.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
9.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
10.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

ALL DESIGN DATA TAKEN FROM THE 1989 ASHRAE HANDBOOK OF FUNDAMENTALS

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*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                             WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                              06/22/95
****************** DETAILED PROJECT ZONE LOAD CALCULATIONS ***************

LOAD                     UNIT  -SC- CLTD  U.FAC   SEN.    LAT.  HTG.    HTG.
DESCRIPTION              QUAN  CFAC SHGF  -CLF-   GAIN    GAIN  MULT.   LOSS
-------------------      ----  ---- ----  -----   ----    ----  -----   ----

1. L.A.A SKIN (AHU-1)  SYS# 1  PEAK 12 AM SEPTEMBER.       (26 X 17)=461 SF

S.  WALL-1-A-L            585 0.650   41  0.224   3997          15.680   9173
E.  WALL-1-A-L            381 0.650   33  0.224   2159          15.680   5974
N.  WALL-1-A-L            585 0.650   21  0.224   2293          15.680   9173
PARTITION-1               250     10/20  0.400   1000           8.000   2000
EQUIPMENT-0            461.00 1.000        3.410   1572       0

TOTAL                                             11,021      0        26,320
                                                 X 1.10  X 1.10       X 1.10
                                                 ------  ------       ------
                                                 12,123       0       28,952

2. T.C.A. SKIN (AHU-1)  SYS# 1  PEAK 10 PM JUNE.   (26.58 X 17.33) = 461 SF

ROOF-1-12-NO.CLG-L        461 0.500   53  0.224   3304          15.680   7228
S.  WALL-1-A-L            585 0.650   32  0.224   3230          15.680   9173
E.  WALL-1-A-L            381 0.650   37  0.224   2381          15.680   5974
N.  WALL-1-A-L            585 0.650   25  0.224   2634          15.680   9173
W.  WALL-1-A-L            278 0.650   37  0.224   1737          15.680   4359
EQUIPMENT-0            461.00 1.000        3.410   1572       0

TOTAL                                             14,858      0        35,907
                                                 X 1.10  X 1.10       X 1.10
                                                 ------  ------       ------
                                                 16,344       0       39,498

3. L.A.A. LOAD (AHU-2)  SYS# 2  PEAK 12 AM SEPTEMBER.      (26 X 17)=461 SF

EQUIPMENT-0          16000.00 1.000        3.410  54560       0

TOTAL                                             54,560      0             0
                                                 X 1.10  X 1.10       X 1.10
                                                 ------  ------       ------
                                                 60,016       0             0

4. T.C.A LOAD (AHU-3)  SYS# 3  PEAK TIME 7 PM JUN.  (26.58 X 17.33) = 461 SF

ROOF-1-12-NO.CLG-L        461 0.500   58  0.224   3563          15.680   7228
EQUIPMENT-0          20000.00 1.000        3.410  68200       0

TOTAL                                             71,763      0         7,228
                                                 X 1.10  X 1.10       X 1.10
                                                 ------  ------       ------
                                                 78,939       0         7,951
```

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
************** AIR SYSTEM # 1 (LAA/TCA SKIN LOAD) ZONE SUMMARY *************

ZN. NO.	ZONE - DESCRIPTION PEAK TIME & MONTH	FLOOR AREA	HTG.LOSS O.A. CFM	SEN.GAIN O.A. CFM	LAT.GAIN EXH. CFM	HTG.CFM CFM/SF.	CLG.CFM CFM/SF.
1	L.A.A SKIN (AHU-1)	461	28,952	12,123	0	549	553
	12 AM SEPTEMBER		0	0	0	1.19	1.20
2	T.C.A. SKIN (AHU-1	461	39,498	16,344	0	750	746
	10 PM JUNE		0	0	0	1.63	1.62
	ZONE PEAK TOTALS	922	68,450	28,467	0	1,299	1,299
	TOTAL ZONES: 2		0	0	0	1.41	1.41

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                              WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                               06/22/95
********** AIR SYSTEM # 1 (LAA/TCA SKIN LOAD) TOTAL LOAD SUMMARY ***********

AIR HANDLER DESC: LAA/TCA SKIN LOAD WITH CV (PROPORTION) TERMINALS
SUPPLY AIR FAN: BLOW-THRU WITH PROGRAM ESTIMATED HORSEPOWER OF  0.12 HP.
FAN INPUT: 50% COMBINED FAN AND MOTOR EFF. WITH 0.30 IN WATER ACROSS THE FAN
SENSIBLE HEAT RATIO: 1.00 ----- THIS SYSTEM OCCURS 1 TIME(S) IN THE BUILDING

AIR SYSTEM PEAK TIME: 11 PM IN JUNE
OUTDOOR CONDITIONS:   96 DB, 80 WB, 130.84 GRAINS     INSIDE: 85 DB, 50% RH

SUMMER: NONE CONTROLS OUTSIDE AIR  -----  WINTER:  NONE CONTROLS OUTSIDE AIR

ZONE   SPACE  SEN.LOSS:          68,450 BTUH
INFILTRATION  SEN.LOSS:               0 BTUH (          0 CFM)
OUTSIDE  AIR  SEN.LOSS:               0 BTUH (          0 CFM)
SUPPLY DUCT   SEN.LOSS:               0 BTUH
RETURN DUCT   SEN.LOSS:               0 BTUH
TOTAL SYSTEM  SEN.LOSS:                                          68,450 BTUH

SUPPLY AIR: 68,450 / (0.990 X 1.08 X 49) =  (      1,299 CFM)
WINTER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

ZONE   SPACE  SEN.GAIN:          28,305 BTUH
INFILTRATION  SEN.GAIN:               0 BTUH (          0 CFM)
DRAW-THRU FAN SEN.GAIN:               0 BTUH
SUPPLY  DUCT  SEN.GAIN:               0 BTUH
TOTAL SEN.GAIN ON SUPPLY SIDE OF COIL:                           28,305 BTUH

SUPPLY AIR: 28,305 / (0.990 X 1.10 X 20) =  (      1,299 CFM)
SUMMER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

RETURN DUCT   SEN.GAIN:               0 BTUH
RETURN PLENUM SEN.GAIN:               0 BTUH
OUTSIDE AIR   SEN.GAIN:               0 BTUH (          0 CFM)
BLOW-THRU FAN SEN.GAIN:             308 BTUH
TOTAL SEN.GAIN ON RETURN SIDE OF COIL:                              308 BTUH

TOTAL SEN.GAIN ON AIR HANDLING SYSTEM:                           28,613 BTUH

ZONE   SPACE  LAT.GAIN:               0 BTUH
INFILTRATION  LAT.GAIN:               0 BTUH (          0 CFM)
OUTSIDE  AIR  LAT.GAIN:               0 BTUH (          0 CFM)
TOTAL LAT.GAIN ON AIR HANDLING SYSTEM:                                0 BTUH

TOTAL SYSTEM SENSIBLE AND LATENT GAIN:                           28,613 BTUH

TOTAL TONNAGE REQUIRED WITH OUTSIDE AIR:                           2.38 TONS
```

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                              WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                               06/22/95
******** AIR SYSTEM # 1 (LAA/TCA SKIN LOAD) PSYCHROMETRIC ANALYSIS *********

-----------------------------------------------------------------------------
SYSTEM LOAD ANALYSIS          LATENT  GRAINS    SENSIBLE   TEMP          CFM
-----------------------------------------------------------------------------
LEAVING COIL CONDITION                91.081               65.000
DRAW-THRU FAN                                          0    0.000          0
MISC LOAD ON SUPPLY SIDE                               0    0.000          0
SUPPLY AIR DUCT                                        0    0.000          0
ZONE LOADS                         0   0.000      28,305   20.007      1,299
-----------------------------------------------------------------------------
ZONE CONDITION                     0  91.081      28,305   85.000      1,299
RETURN AIR DUCT                                        0    0.000
RETURN AIR PLENUM                                      0    0.000
MISC LOAD ON RETURN SIDE                               0    0.000
VENT AIR            0 CFM          0   0.000           0    0.000
BLOW-THRU FAN                                        308    0.218
-----------------------------------------------------------------------------
ENTERING COIL CONDITION            0  91.081      28,613   85.218      1,299
-----------------------------------------------------------------------------

GENERAL PSYCHROMETRIC EQUATIONS USED IN ANALYSIS:

PR  = (BAROMETRIC PRESSURE OF SITE / STANDARD ASHRAE PRESSURE OF 29.921)
TSH = PR X 1.10 X CFM X (DB.ENTERING - DB.LEAVING)
TLH = PR X 0.68 X CFM X (GRAINS.ENTERING - GRAINS.LEAVING)
GTH = PR X 4.50 X CFM X (ENTHALPY.ENTERING - ENTHALPY.LEAVING)

TSH = 0.990 X 1.10 X      1,299 X (  85.218 -  65.000 ) =        28,603 BTUH
TLH = 0.990 X 0.68 X      1,299 X (  91.081 -  91.081 ) =             0 BTUH
                                                              -----------
SUM =                                                            28,603 BTUH
GTH = 0.990 X 4.50 X      1,299 X (  34.753 -  29.783 ) =        28,759 BTUH
TOTAL SYSTEM LOAD                                       =        28,613 BTUH

ENTERING COOLING COIL CONDITIONS:          ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        85.22         DRY BULB TEMPERATURE:       50.00
WET BULB TEMPERATURE:        70.79
RELATIVE HUMIDITY(%):        49.65
ENTHALPY:             34.75 BTU/LBM

LEAVING  COOLING COIL CONDITIONS:          LEAVING  HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        65.00         DRY BULB TEMPERATURE:       99.28
WET BULB TEMPERATURE:        64.52
RELATIVE HUMIDITY(%):        97.54
ENTHALPY:             29.78 BTU/LBM
```

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
**************** AIR SYSTEM # 2 (AHU-2 (L.A.A)) ZONE SUMMARY ***************

ZN. NO.	ZONE - DESCRIPTION PEAK TIME & MONTH	FLOOR AREA	HTG.LOSS O.A. CFM	SEN.GAIN O.A. CFM	LAT.GAIN EXH. CFM	HTG.CFM CFM/SF.	CLG.CFM CFM/SF.
3	L.A.A. LOAD (AHU-2	461	0	60,016	0	0	2,900
	12 AM SEPTEMBER		0	0	0	0.00	6.29
	ZONE PEAK TOTALS	461	0	60,016	0	0	2,900
	TOTAL ZONES: 1		0	0	0	0.00	6.29

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                              WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                               06/22/95
************ AIR SYSTEM # 2 (AHU-2 (L.A.A)) TOTAL LOAD SUMMARY *************

AIR HANDLER DESC: AHU-2 (L.A.A) WITH VAV TERMINALS
SUPPLY AIR FAN: BLOW-THRU WITH PROGRAM ESTIMATED HORSEPOWER OF  1.54 HP.
FAN INPUT: 65% COMBINED FAN AND MOTOR EFF. WITH 2.20 IN WATER ACROSS THE FAN
SENSIBLE HEAT RATIO: 1.00 ----- THIS SYSTEM OCCURS 1 TIME(S) IN THE BUILDING

AIR SYSTEM PEAK TIME: 12 AM IN SEPTEMBER
OUTDOOR CONDITIONS:   95 DB, 80 WB, 132.48 GRAINS      INSIDE: 85 DB, 50% RH

SUMMER: NONE CONTROLS OUTSIDE AIR  -----  WINTER:  NONE CONTROLS OUTSIDE AIR

ZONE   SPACE  SEN.LOSS:                0 BTUH
INFILTRATION  SEN.LOSS:                0 BTUH (          0 CFM)
OUTSIDE  AIR  SEN.LOSS:                0 BTUH (          0 CFM)
SUPPLY DUCT   SEN.LOSS:                0 BTUH
RETURN DUCT   SEN.LOSS:                0 BTUH
TOTAL SYSTEM  SEN.LOSS:                                                0 BTUH

SUPPLY AIR:       0 / (0.990 X 1.08 X  0) =  (          0 CFM)
WINTER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

ZONE   SPACE  SEN.GAIN:           60,016 BTUH
INFILTRATION  SEN.GAIN:                0 BTUH (          0 CFM)
DRAW-THRU FAN SEN.GAIN:                0 BTUH
SUPPLY  DUCT  SEN.GAIN:            3,159 BTUH
TOTAL SEN.GAIN ON SUPPLY SIDE OF COIL:                            63,175 BTUH

SUPPLY AIR: 63,175 / (0.990 X 1.10 X 20) =  (      2,900 CFM)
SUMMER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (          0 CFM)

RETURN DUCT   SEN.GAIN:                0 BTUH
RETURN PLENUM SEN.GAIN:                0 BTUH
OUTSIDE AIR   SEN.GAIN:                0 BTUH (          0 CFM)
BLOW-THRU FAN SEN.GAIN:            3,881 BTUH
TOTAL SEN.GAIN ON RETURN SIDE OF COIL:                             3,881 BTUH

TOTAL SEN.GAIN ON AIR HANDLING SYSTEM:                            67,056 BTUH

ZONE   SPACE  LAT.GAIN:                0 BTUH
INFILTRATION  LAT.GAIN:                0 BTUH (          0 CFM)
OUTSIDE  AIR  LAT.GAIN:                0 BTUH (          0 CFM)
TOTAL LAT.GAIN ON AIR HANDLING SYSTEM:                                 0 BTUH

TOTAL SYSTEM SENSIBLE AND LATENT GAIN:                            67,056 BTUH

TOTAL TONNAGE REQUIRED WITH OUTSIDE AIR:                            5.59 TONS
```

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                               WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                                06/22/95
********** AIR SYSTEM # 2 (AHU-2 (L.A.A)) PSYCHROMETRIC ANALYSIS ***********

----------------------------------------------------------------------------
SYSTEM LOAD ANALYSIS            LATENT  GRAINS    SENSIBLE    TEMP        CFM
----------------------------------------------------------------------------
LEAVING COIL CONDITION                  91.081               65.000
DRAW-THRU FAN                                            0    0.000          0
MISC LOAD ON SUPPLY SIDE                                 0    0.000          0
SUPPLY AIR DUCT                                      3,159    1.000        145
ZONE LOADS                           0   0.000      60,016   19.000      2,755
----------------------------------------------------------------------------
ZONE CONDITION                       0  91.081      63,175   85.000      2,900
RETURN AIR DUCT                                          0    0.000
RETURN AIR PLENUM                                        0    0.000
MISC LOAD ON RETURN SIDE                                 0    0.000
VENT AIR             0 CFM           0   0.000           0    0.000
BLOW-THRU FAN                                        3,881    1.229
----------------------------------------------------------------------------
ENTERING COIL CONDITION              0  91.081      67,056   86.229      2,900
----------------------------------------------------------------------------

GENERAL PSYCHROMETRIC EQUATIONS USED IN ANALYSIS:

PR  = (BAROMETRIC PRESSURE OF SITE / STANDARD ASHRAE PRESSURE OF 29.921)
TSH = PR X 1.10 X CFM X (DB.ENTERING - DB.LEAVING)
TLH = PR X 0.68 X CFM X (GRAINS.ENTERING - GRAINS.LEAVING)
GTH = PR X 4.50 X CFM X (ENTHALPY.ENTERING - ENTHALPY.LEAVING)

TSH = 0.990 X 1.10 X      2,900 X (  86.229 -   65.000 ) =        67,057 BTUH
TLH = 0.990 X 0.68 X      2,900 X (  91.081 -   91.081 ) =             0 BTUH
                                                             -----------
SUM =                                                             67,057 BTUH
GTH = 0.990 X 4.50 X      2,900 X (  35.001 -   29.783 ) =        67,422 BTUH
TOTAL SYSTEM LOAD                                         =       67,056 BTUH

CHILLED-HOT WATER FLOW RATES:

COOLING GPM =         67,422 / ( 10.0 X 500 )             =         13.5 GPM

ENTERING COOLING COIL CONDITIONS:            ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        86.23           DRY BULB TEMPERATURE:        50.00
WET BULB TEMPERATURE:        71.08
RELATIVE HUMIDITY(%):        48.07
ENTHALPY:              35.00 BTU/LBM

LEAVING  COOLING COIL CONDITIONS:            LEAVING  HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:        65.00           DRY BULB TEMPERATURE:        50.00
WET BULB TEMPERATURE:        64.52
RELATIVE HUMIDITY(%):        97.54
```

ENTHALPY: 29.78 BTU/LBM

*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY 06/22/95
**************** AIR SYSTEM # 3 (AHU-3 (T.C.A)) ZONE SUMMARY ***************

ZN. NO.	ZONE - DESCRIPTION PEAK TIME & MONTH	FLOOR AREA	HTG.LOSS O.A. CFM	SEN.GAIN O.A. CFM	LAT.GAIN EXH. CFM	HTG.CFM CFM/SF.	CLG.CFM CFM/SF.
4	T.C.A LOAD (AHU-3)	461	7,951	78,939	0	3,815	3,815
	7 PM JUNE		0	0	0	8.28	8.28
	ZONE PEAK TOTALS	461	7,951	78,939	0	3,815	3,815
	TOTAL ZONES: 1		0	0	0	8.28	8.28

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                               WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                                06/22/95
************ AIR SYSTEM # 3 (AHU-3 (T.C.A)) TOTAL LOAD SUMMARY *************

AIR HANDLER DESC: AHU-3 (T.C.A) WITH VAV TERMINALS
SUPPLY AIR FAN: BLOW-THRU WITH PROGRAM ESTIMATED HORSEPOWER OF  2.03 HP.
FAN INPUT: 65% COMBINED FAN AND MOTOR EFF. WITH 2.20 IN WATER ACROSS THE FAN
SENSIBLE HEAT RATIO: 1.00 ----- THIS SYSTEM OCCURS 1 TIME(S) IN THE BUILDING

AIR SYSTEM PEAK TIME:  7 PM IN JUNE
OUTDOOR CONDITIONS:  107 DB, 83 WB, 134.27 GRAINS      INSIDE: 85 DB, 50% RH

SUMMER: NONE CONTROLS OUTSIDE AIR  -----  WINTER:  NONE CONTROLS OUTSIDE AIR

ZONE   SPACE  SEN.LOSS:          7,951 BTUH
INFILTRATION  SEN.LOSS:              0 BTUH (          0 CFM)
OUTSIDE  AIR  SEN.LOSS:              0 BTUH (          0 CFM)
SUPPLY DUCT   SEN.LOSS:          8,158 BTUH
RETURN DUCT   SEN.LOSS:              0 BTUH
TOTAL SYSTEM  SEN.LOSS:                                               16,109 BTUH

SUPPLY AIR: 16,109 / (0.990 X 1.08 X  4) =  (       3,815 CFM)
WINTER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (           0 CFM)

ZONE   SPACE  SEN.GAIN:         78,939 BTUH
INFILTRATION  SEN.GAIN:              0 BTUH (          0 CFM)
DRAW-THRU FAN SEN.GAIN:              0 BTUH
SUPPLY  DUCT  SEN.GAIN:          4,155 BTUH
TOTAL SEN.GAIN ON SUPPLY SIDE OF COIL:                                83,094 BTUH

SUPPLY AIR: 83,094 / (0.990 X 1.10 X 20) =  (       3,815 CFM)
SUMMER VENT OUTSIDE AIR (0.00% OF SUPPLY):  (           0 CFM)

RETURN DUCT   SEN.GAIN:              0 BTUH
RETURN PLENUM SEN.GAIN:              0 BTUH
OUTSIDE AIR   SEN.GAIN:              0 BTUH (          0 CFM)
BLOW-THRU FAN SEN.GAIN:          5,105 BTUH
TOTAL SEN.GAIN ON RETURN SIDE OF COIL:                                 5,105 BTUH

TOTAL SEN.GAIN ON AIR HANDLING SYSTEM:                                88,199 BTUH

ZONE   SPACE  LAT.GAIN:              0 BTUH
INFILTRATION  LAT.GAIN:              0 BTUH (          0 CFM)
OUTSIDE  AIR  LAT.GAIN:              0 BTUH (          0 CFM)
TOTAL LAT.GAIN ON AIR HANDLING SYSTEM:                                     0 BTUH

TOTAL SYSTEM SENSIBLE AND LATENT GAIN:                                88,199 BTUH

TOTAL TONNAGE REQUIRED WITH OUTSIDE AIR:                                7.35 TONS
```

```
*** FULL COMMERCIAL HVAC LOADS PROGRAM BY ELITE SOFTWARE DEVELOPMENT INC ***
LUCHINI MILFORT & GOODELL                               WETHERSFIELD, CT 06109
EPRI DRY XFER FACILITY                                                06/22/95
********** AIR SYSTEM # 3 (AHU-3 (T.C.A)) PSYCHROMETRIC ANALYSIS ***********
```

SYSTEM LOAD ANALYSIS	LATENT	GRAINS	SENSIBLE	TEMP	CFM
LEAVING COIL CONDITION		91.081		65.000	
DRAW-THRU FAN			0	0.000	0
MISC LOAD ON SUPPLY SIDE			0	0.000	0
SUPPLY AIR DUCT			4,155	1.000	191
ZONE LOADS	0	0.000	78,939	19.000	3,624
ZONE CONDITION	0	91.081	83,094	85.000	3,815
RETURN AIR DUCT			0	0.000	
RETURN AIR PLENUM			0	0.000	
MISC LOAD ON RETURN SIDE			0	0.000	
VENT AIR 0 CFM	0	0.000	0	0.000	
BLOW-THRU FAN			5,105	1.229	
ENTERING COIL CONDITION	0	91.081	88,199	86.229	3,815

GENERAL PSYCHROMETRIC EQUATIONS USED IN ANALYSIS:

```
PR  = (BAROMETRIC PRESSURE OF SITE / STANDARD ASHRAE PRESSURE OF 29.921)
TSH = PR X 1.10 X CFM X (DB.ENTERING - DB.LEAVING)
TLH = PR X 0.68 X CFM X (GRAINS.ENTERING - GRAINS.LEAVING)
GTH = PR X 4.50 X CFM X (ENTHALPY.ENTERING - ENTHALPY.LEAVING)

TSH = 0.990 X 1.10 X     3,815 X (  86.229 -  65.000 ) =       88,199 BTUH
TLH = 0.990 X 0.68 X     3,815 X (  91.081 -  91.081 ) =            0 BTUH
                                                           -----------
SUM =                                                          88,199 BTUH
GTH = 0.990 X 4.50 X     3,815 X (  35.001 -  29.783 ) =       88,680 BTUH
TOTAL SYSTEM LOAD                                       =       88,199 BTUH
```

CHILLED-HOT WATER FLOW RATES:

```
COOLING GPM =        88,680 / ( 10.0 X 500 )         =        17.7 GPM
HEATING GPM =        16,109 / ( 20.0 X 500 )         =         1.6 GPM
```

```
ENTERING COOLING COIL CONDITIONS:         ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:       86.23         DRY BULB TEMPERATURE:        50.00
WET BULB TEMPERATURE:       71.08
RELATIVE HUMIDITY(%):       48.07
ENTHALPY:               35.00 BTU/LBM

LEAVING  COOLING COIL CONDITIONS:         LEAVING  HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE:       65.00         DRY BULB TEMPERATURE:        53.95
WET BULB TEMPERATURE:       64.52
```

```
RELATIVE HUMIDITY(%):       97.54
ENTHALPY:               29.78 BTU/LBM
```

CHAPTER 5

OPERATION SYSTEMS

This chapter provides a description of all operations, including the systems, equipment and instrumentation and their operating characteristics for the safe transfer of fuel from one cask to another cask. Operational safety features which prevent against hazards are also presented.

5.1 Operation Description

The following sections outline the handling procedures and systems for the DTS. The handling systems have been developed to minimize the radiation dose to operators and to enable the operations involved in the transfer of irradiated fuel from the source cask to the receiving cask to be performed safely.

5.1.1 Narrative Description

This section provides a detailed description of the operations required to transfer fuel within the DTS including cask receipt, preparation, cask opening, fuel transfer, cask closure and removal. This section is focused on the major operations equipment and control system, but functions of the ancillary equipment during operations is also discussed. A brief overview of the operational sequence is presented in Section 1.3. The description is broken down into the following subsections:

Receiving Cask Receipt, Preparation, Inspection, Positioning and Mating
Source Cask Receipt, Preparation, Inspection and Positioning and Mating
Source Cask Opening
Receiving Cask Opening
Fuel Transfer
Source Cask Closing
Receiving Cask Closing
Source Cask Detachment and Removal
Receiving Cask Detachment and Removal

The words "operator interface" are used to denote the monitor and control panel in the control center which indicates the status of the equipment within the DTS. The operator interface provides information to the operator from sensors on the equipment such as limit switches, encoders and load cells.

The words "Portable Communication System" are used to denote the means used to communicate between the Preparation Area, Lower Access Area or during maintenance

operations, the TCA and the Control Center. The system, as a minimum, allows audio communication.

5.1.1.1 Receiving Cask Receipt, Preparation, Inspection, Positioning and Mating

Receiving Cask Receipt

The receiving cask is transported to the DTS by a site specific method. This may be a horizontal cask transporter, a rail car, or a heavy haul trailer. Handling of the receiving cask prior to loading onto the receiving cask transfer trolley will be addressed in the site specific application. The receiving cask is positioned and loaded on the receiving cask transfer trolley to allow its entry into the Preparation Area as follows:

1. Position the receiving cask transporter (e.g. truck, rail car) in the cask loading/unloading area outside of the Preparation Area.

2. Open the roll up door to the Preparation Area. The roll up door is controlled using specific control panels inside and outside the Preparation Area.

3. Visually check that there is no obstruction on the rails.

4. Position the source cask transfer trolley at the end of the runway rails.

   The control of the source cask transfer trolley is achieved by use of a joystick on the Preparation Area control panel. The joystick has two different positions in each direction to set the current speed of the trolley motorization. The Source Cask Transfer Subsystem is energized using a push button on the control panel.

   - Activate the Preparation Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until it is roughly 6 feet (2 m) from the end of the runway rails. Operators communicate via portable communication devices to place the trolley in proper position.
   - End the movement using the slow speed.
   - Position the transfer trolley near the end of the runway rails.
   - Switch off Source Cask Transfer Subsystem power.

5. Position the receiving cask transfer trolley in its attachment location.

   The control of the receiving cask transfer trolley is achieved by use of a joystick on the Preparation Area control panel. The joystick has two different positions in each direction to set the current speed of the trolley motorization. The Receiving Cask

Transfer Subsystem is energized using a push button on the control panel.

- Switch on Receiving Cask Transfer Subsystem power.
- Move the trolley using the fast speed until roughly 6 feet (2 m) from the loading area. Operators communicate via portable communication devices to place the trolley in proper position.
- End the movement using the slow speed.
- Visually check the correct positioning of the transfer trolley.
- Switch off Receiving Cask Transfer Subsystem power.
- Deactivate the Preparation Area control panel.

6. Close the roll up door to the Preparation Area.

7. Remove the trunnion tiedowns and bolts and store temporarily.

8. Load the receiving cask onto the trolley. This operation will most likely be performed using a crane, and will be addressed in the site specific applications.

9. Fasten the cask onto the trolley using the trunnion tiedowns and bolts.

The cask is now ready for entry into the Preparation Area.

Receiving Cask Entry in the Preparation Area

The receiving cask trolley is fixed in position and locked in place in the Preparation Area. This is to prevent movement of the trolley along its rails in a seismic event and also to prevent inadvertent activation of the trolley while the cask is inspected and prepared for unloading. The locking device is actuated by use of push buttons on the Preparation Area control panel. The sequence of operations is as follows:

1. Visually check the proper fixation of the receiving cask on the transfer trolley.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the receiving cask transfer trolley in its preparation location.

   - Activate the Preparation Area control panel.
   - Switch on Receiving Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until roughly 6 feet (2 m) from its locking position in the preparation location.

- End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its preparation location.
- Close the roll up door.
- Lock the transfer trolley in position.
- Correct locking of the trolley is indicated by the operator interface in the Control Center. The operator is notified that the operation is satisfactorily completed using the portable communication system.
- Switch off receiving cask transfer trolley power.
- Deactivate the Preparation Area control panel.

Receiving Cask Preparation and Inspection

The design basis receiving cask consisting of the MPC and its overpack (cask) must be prepared prior to being introduced into the Lower Access Area and receiving transferred fuel assemblies. The sequence of operations is as follows:

1. Remove the receiving cask lid.

2. Remove the canister outer lid.

3. Remove the canister inner lid.

4. Position and attach the shield plug lifting pintle.

5. Visually check receiving cask seals and surfaces for scratches or defects.

Receiving Cask Positioning in the Lower Access Area

The receiving cask is now ready for entry into the Lower Access Area. It must be placed and locked in its mating position in the Lower Access Area. A control panel in the Lower Access Area having the same functions as the Preparation Area control panel is used to control the positioning of the receiving cask trolley. The sequence of operations is as follows:

1. Open the sliding door. The sliding door is operating from a control panel on the Preparation Area wall.

2. Visually check the closed position of the two TC port covers.

3. Visually check that the two mating flanges are in upper position.

4. Visually check that there is no obstruction on the rails.

5. Position the receiving cask transfer trolley in its transfer position in the Lower Access Area.

   - Activate the Lower Access Area control panel.
   - Switch on receiving cask transfer trolley power.
   - Unlock the receiving cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the transfer location.
   - End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its transfer location.
   - Visually check the correct positioning of the transfer trolley.

6. Lock the receiving cask transfer trolley in its transfer position. The locking function is activated manually from the trolley. The completion of the operation is indicated by the operator interface in the Control Center. The locking function prevents the trolley from moving along its rails in a seismic event. The operator is notified that the operation is completed using the portable communication system.

7. Switch off receiving cask transfer trolley power.

8. Deactivate the Lower Access Area control panel.

9. Visually check the locked position of the receiving cask transfer trolley.

10. Leave the Lower Access Area.

11. Close the sliding door after verifying that all personnel have left the Lower Access Area.

<u>Receiving Cask Mating</u>

The receiving cask is mated with the Transfer Confinement Area prior to start of the fuel transfer. The main control panel, located in the Control Center, provides the necessary equipment to remotely control the mating operations. Mating of the receiving cask is performed without anyone in the Lower Access Area.

1. Visually check the closed position of the sliding door.

2. Mate the receiving cask with the Transfer Confinement Area.

   - Switch on Receiving Cask Mating Subsystem power.
   - Lower the mating flange. Monitor the operation with a CCTV display. A

unique push button is used to request the control of the three electric jacks. The Programmable Logic Controller (PLC) controls the mating process based on height and pressure information. The operator is notified that the operation is completed by the operator interface (control panel or monitor).

- Check the consistency of the height informationof the three electric jacks displayed by the operator interface.
- Switch off Receiving Cask Mating Subsystem power.

5.1.1.2 Source Cask Receipt, Preparation, Inspection, Positioning and Mating

Source Cask Receipt·

The source cask, which contains four spent fuel assemblies, is transported to the DTS by truck, rail or a vertical cask transporter. It must be positioned on the source cask transfer trolley prior to entry in the Preparation Area. The method used to load the source cask onto the transfer trolley will be addressed in site specific applications. The sequence of operations is as follows:

1. Position the source cask transporter.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the source cask transfer trolley in its loading position.

   - Activate the Preparation Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Move the trolley using the fast speed until roughly 6 feet (2 m) from the attachment location. Operators communicate via portable communication system to place the trolley in proper position.
   - End the movement using the slow speed.
   - Visually check the correct positioning of the transfer trolley.
   - Switch off Source Cask Transfer Subsystem power.
   - Deactivate the Preparation Area control panel.

5. Close the roll up door.

6. Remove the trunnion tiedowns and bolts.

7. Lift the source cask onto the trolley and replace the trunnion tiedowns and bolts.

Source Cask Entry in the Preparation Area

Once the source cask is fixed on its transfer trolley, it has to be positioned and locked in the Preparation Area prior to process preparation operations. The locking device is actuated by use of push buttons on the Preparation Area control panel.

1. Check the proper fixation of the source cask on the transfer trolley.

2. Open the roll up door.

3. Visually check that there is no obstruction on the rails.

4. Position the transfer trolley in its preparation location.

    - Activate the Preparation Area control panel.
    - Switch on Source Cask Transfer Subsystem power.
    - Move the trolley using the fast speed until roughly 6 feet (2 m) from the preparation location.
    - End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its preparation location.
    - Close the roll up door.

5. Lock the transfer trolley in position.

    The completion of the operation is indicated by the operator interface in the Control Center. The operator is notified that the operation is completed using the portable communication system.

6 Switch off Source Cask Transfer Subsystem power.

7. Deactivate the Preparation Area control panel.

Source Cask Preparation and Inspection

The following operations will be performed in the Preparation Area before moving the Source Cask into the Lower Access Area.

1. Vent Source Cask to portable HEPA filter.

2. Unbolt source cask lid.

3. Position and attach lid lifting pintle to the lid..

4. Clean Lid/Source Cask External Surfaces.

Source Cask Positioning in the Lower Access Area

Once prepared, the source cask has to be placed and locked in its mating position in the Lower Access Area.

1. Manually unlock and remove sliding panels from the sliding door. The sliding panels fit around the rails to reduce the amount of open area between the Preparation Area and the Lower Access Area. They are removed for trolley entrance and egress.

2. Open the sliding door.

3. Visually check the closed position of the two TC port covers.

4. Visually check that the receiving cask is mated.

5. Visually check that the source cask mating flange is in upper position.

6. Visually check that there is no obstruction on the rails.

7. Position the source cask transfer trolley in its mating position.

    - Activate the Lower Access Area control panel.
    - Switch on Source Cask Transfer Subsystem power.
    - Unlock the source cask transfer trolley.
    - Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the mating location.
    - End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its mating location.
    - Visually check the correct positioning of the transfer trolley.
    - Lock the source cask transfer trolley in its transfer position.
      The completion of the operation is indicated by the operator interface in the Control Center. The operator is notified that the operation is completed using the portable communication system.
    - Switch off Source Cask Transfer Subsystem power.
    - Deactivate the Lower Access Area control panel.

8. Leave the Lower Access Area.

9. Close the sliding door after verifying that all personnel have left the Lower Access Area.

10. .Lock the sliding door manually, placing the four locking pins in their locations. Place sliding panels in position for sealing the sliding door around the rails.

11. Check with the Control Center that the sliding door is locked.

Source Cask Mating

The source cask is mated with the Transfer Confinement Area prior to start of any transfer operation. The main control panel, located in the Control Center provides the necessary equipment to remotely control the mating operations.

1. Check the locked position of the sliding door.

2. Check the locked position of the source cask transfer trolley.

3. Mate the source cask with the Transfer Confinement Area as follows.

   - Switch on Source Cask Mating Subsystem power.
   - Lower the mating flange. Monitor the operation with a CCTV display in the Control Center. A unique push button is used to control the three electric jacks. The PLC controls the mating process based on height and pressure information. The operator is notified that the operation is completed by the operator interface.
   - Check the consistency of the height information of the three electric jacks displayed by the operator interface.
   - Switch off Source Cask Mating Subsystem power.

5.1.1.3 Source Cask Opening

1. Verify using the operator interface that the two upper shield ports are in the closed and locked positions.

2. Verify using the operator interface that the lid/shield plug grapple is stopped in upper Z position.

3. Position the upper crane above the source cask.

   The positioning operation is automatically stopped when the upper crane reaches the source cask position.

4. Verify using the operator interface that the upper crane is in source cask position.

5. Verify that the radiation level in roof enclosure is acceptable.

6. Unlock the source cask upper shield port.

   The operator interface displays when this operation is completed.

7. Verify using the CCTV monitor that the receiving cask TC port cover is closed.

8. Open the source cask upper shield port.

   The operation is automatically stopped when the shield port reaches the open position.

9. Verify using the operator interface that the source cask upper shield port is open.

10. Switch on source cask TC port cover power.

11. Open the source cask TC port cover.

    The source cask TC port cover is controlled with push buttons (open, closed) on the main control panel. Monitor the motion of the port cover with the CCTV display. The operation is automatically stopped when the TC port cover reaches the open position.

12. Verify using the CCTV monitor and the operator interface that the source cask TC port cover is in open position.

13. Verify using the operator interface that the lid/shield plug grapple is in the disengaged position.

14. Lower the lid/shield plug grapple to the overlid level.

    The operator can use a variable speed. Monitor the operation with the CCTV displays when the grapple is in the TCA. Monitor the speed, the position and the load of the system with the operator interface when visibility is lost. The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

15. Verify the Z position of the grapple with the operator interface.

16. Verify using the operator interface that the cables are unloaded.

17. Grapple the source cask lid.

The operator interface notifies the operator when the source cask lid is fully grappled.

18. Lift the lid above the TC port cover.

    Monitor the position of the lid using the CCTV display. The operation is automatically stopped when the limit position is reached.

19. Verify using the CCTV and the operator interface that the lid is above the source cask TC port cover.

20. Close the source cask TC port cover.

    Monitor visually the motion of the source cask TC port cover. The operation is automatically stopped when it reaches the closed position.

21. Verify using the CCTV and the operator interface that the source cask TC port cover is stopped in closed position.

22. Switch off source cask TC port cover power.

23. Lower the lid onto the source cask TC port cover.

    The operator can only use the slow speed for this operation. Visually monitor the motion of the lid and its positioning on the port cover. The operation stops automatically when the lid seats on the TC port cover.

24. Check the Z position of the grapple with the operator interface.

25. Ensure that the cables are unloaded using the operator interface.

26. Disengage the grapple.

    The operator interface indicates when the grapple is fully disengaged.

27. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Visually monitor the motion of the grapple when it is underneath the upper plate. The operation is automatically stopped when the grapple reaches its upper Z position.

28. Verify using the operator interface the Z position of the lid/shield plug grapple.

29. Close the source cask upper shield port.

    The operation stops automatically when the upper shield port reaches the closed position.

30. Verify using the operator interface the closed position of the upper shield port.

31. Lock the source cask upper shield port.

    The operator interface indicates when the operation is completed.

32. Switch off Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem power.

5.1.1.4 Receiving Cask Opening

1. Verify using the operator interface the closed and locked position of the two upper shield ports.

2. Verify using the operator interface that the lid/shield plug grapple is stopped in upper Z position.

3. Verify using the operator interface that the HVAC Subsystem is effective by checking each room pressure.

4. Switch on the Source Cask Lid and Receiving Cask Shield Plug Subsystem power.

5. Position the upper crane above the receiving cask.

    The upper crane is controlled with a joystick on the main control panel which allows the operator to position the upper crane in the receiving or source cask position. The positioning operation automatically stops when the upper crane reaches the receiving cask position.

6. Verify using the operator interface that the upper crane is in receiving cask position.

7. Verify using the operator interface that the fuel assembly grapple is in disengaged position.

8. Verify using the operator interface that the fuel assembly hoist system is not loaded.

9. Verify that the radiation level in the Roof Enclosure Area is within acceptable limits.

10. Unlock the receiving cask upper shield port.

    The upper shield port locking devices are controlled with push buttons (lock, unlock) on the main control panel. The operator interface notifies the operator when the upper shield port is unlocked.

11. Verify that the source cask TC port cover is closed.

12. Open the receiving cask upper shield port.

    The upper shield ports are controlled with push buttons (open, close) on the main control panel. The operation stops when the shield port is in open position.

13. Verify using the operator interface that the receiving cask upper shield port is open.

14. Switch on the receiving cask TC port cover power.

15. Open the receiving cask TC port cover.

    The receiving cask TC port cover is controlled with push buttons (open, off center, closed) on the main control panel. Monitor the movement of the port cover with the CCTV display. The operation stops automatically when the TC port cover reaches the open position.

16. Verify using the CCTV and the operator interface that the receiving cask TC port cover is in open position.

17. Verify using the operator interface that the lid/shield plug grapple is in disengaged position.

18. Verify using the CCTV monitor that the fuel assembly handling crane is stopped in its parking position.

19. Lower the lid/shield plug grapple to the overlid level.

    The lid/shield plug hoist system is controlled using a joystick on the main control panel, which allows the use of variable speed in both directions. Monitor the operation with the CCTV displays when the grapple is in the TCA. Monitor the speed, the position and the load of the system with the operator interface when visibility is blocked. The operation stops automatically when the cables are unloaded so when the

grapple is in contact with the overlid.

20. Check the Z position of the grapple with the operator interface.

21. Verify using the operator interface that the cables are unloaded.

22. Grapple the shield plug.

    The lid/shield plug grapple is controlled using push buttons on the main control panel (grapple, ungrapple). The PLC pilots the lower level operations and interactions between the shield plug, the overlid and the grapple. The operator interface notifies the operator when the shield plug is completely grappled.

23. Lift the shield plug above the TC port cover.

    Use the same control device as for the lowering operation. Visually monitor the position of the shield plug when it is above the mezzanine level. The operation is automatically stopped when the limit position is reached.

24. Verify using the CCTV monitor and the operator interface that the shield plug is above the receiving cask TC port cover.

25. Position the receiving cask TC port cover in the off centered position.

    Visually monitor the movement of the receiving cask TC port cover. The operation is automatically stopped when it reaches the off centered position.

26. Verify using the CCTV monitor and the operator interface that the receiving cask TC port cover is stopped in the off centered position.

27. Lower the shield plug on the receiving cask TC port cover.

    The operator uses the slow speed for this operation. The operation is automatically stopped when the shield plug is on the TC port cover.

28. Verify the correct Z- position of the grapple is displayed on the operator interface.

29. Verify that the operator interface indicates that the cables are unloaded.

30. Disengage the grapple.

    The operator interface displays the status of the grapple.

31. Lift the lid/shield plug grapple to an intermediate level (above the maximum height of the shield plug when resting on the TC port cover).

    The operator can use the high speed for this operation. Visually monitor the movement of the grapple. The operator stops the motion when he sees that there is sufficient clearance between the top of the port cover and the bottom of the shield plug.

32. Close the receiving cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

33. Verify using the CCTV and the operator interface that the receiving cask TC port cover is closed.

34. Switch off receiving cask TC port cover power.

35. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Visually monitor the movement of the grapple when it is beneath the upper plate. The operation stops when the grapple reaches its upper Z position.

36. Check with the operator interface the Z position of the lid/shield plug grapple.

37. Close the receiving cask upper shield port.

    The operation stops when the upper shield port reaches the closed position.

38. Verify using the operator interface that the upper shield port is closed.

39. Lock the receiving cask upper shield port.

    The operator is notified by the operator interface when the operation is completed.

5.1.1.5 Fuel Transfer

Fuel transfer is remotely monitored and controlled from the Control Center. The operator uses two CCTV displays and an operator interface (the operator interface includes the monitoring display prompted by the monitoring software as well as the indication panels in the Control Center). The cameras and the lights are controlled by the operator.

1. Verify that the operator interface indicates that the two upper shield ports are locked.

2. Switch on receiving cask TC port cover power.

3. Switch on source cask TC port cover power.

4. Open the source cask TC port cover.

   This operation can be performed simultaneously with the receiving cask TC port cover opening. Visually monitor the movement of the port cover. The operation stops when the port cover reaches the open position.

5. Verify using the CCTV and the operator interface display that the source cask TC port cover is open.

6. Lock the source cask TC port cover.

   The operator interface indicates when the operation is completed. This operation can be performed simultaneously with the receiving cask TC port cover locking operation.

7. Open the receiving cask TC port cover.

   Visually monitor the movement of the port cover. The operation stops when the port cover reaches the open position.

8. Verify using the CCTV monitor and the operator interface that the receiving cask TC port cover is open.

9. Lock the receiving cask TC port cover.

   The operator operator interface indicates when the operation is completed.

10. Switch off receiving cask TC port cover power.

11. Switch off source cask TC port cover power.

12. Check with the operator interface that the fuel assembly grapple is in upper Z position.

13. Check with the CCTV that the crud catcher is in closed position.

14. Switch on power for the Fuel Assembly Handling Subsystem.

15. Position the transfer tube above a fuel assembly (in the source cask) centerline.

The positioning is composed of three phases. The first phase is a rough positioning in X and Y directions. It can be automatically controlled using the personal computer (PC). The second phase is a fine positioning (X,Y) controlled by using a joystick for the X and Y direction movement. In manual mode, the speed is limited to the slow one (X,Y). The third phase is the positioning in θ direction. The rotating platform is controlled with a joystick on the main control panel. Two speeds can be used for the platform rotation. The second and third phases can be performed simultaneously.

- Set the coordinates (X,Y) in the PC of the position to be reached by the transfer tube.
- Run the automatic positioning of the transfer tube. Monitor visually the operation. The operator is notified when the operation is completed.
- Verify, using the CCTV monitor and the operator interface, the rough positioning (X,Y) of the transfer tube.
- Accurately position (X,Y) the transfer tube above the fuel assembly centerline. Monitor visually the X,Y motion and position. The operator stops the movement when the proper position is reached.
- End the positioning with the θ rotation. Monitor visually the θ movement and position. The operator stops movement when the proper position is reached.
- Identify the fuel assembly and record.

16. Open the crud catcher.

The crud catcher is controlled using push buttons on the main control panel. The operator is notified when the operation is completed.

17. Verify using the CCTV that the crud catcher is open.

18. Select the operating winch.

Two winches can be used to lift the fuel assembly. One is used as a backup. The operator selects, using a switch on the main control panel, the winch to be used for the transfer process.

19. Lower the fuel assembly grapple.

The operating winch is activated using a joystick on the main control panel which gives the operator the opportunity to use a variable speed in both directions. For a limited distance, the PLC limits the speed to the minimum slow speed. The grapple is not visible while it is in the transfer tube. Cameras on the TCA walls provide viewing of the grapple between the bottom of the transfer tube and the mezzanine plate. When

the grapple is close to the fuel assembly, one camera, at least, at the bottom of the transfer tube provides viewing of the operation. The operator monitors the Z position of the grapple on the operator interface. The communication system transmits the operation sounds so the operator can detect any interference or motor failure. The operation is automatically stopped when the handling cable is unloaded.

20. Check with the operator interface that the cables are not under load.

21. Verify the Z position of the grapple using the operator interface.

22. Grapple the fuel assembly.

    The fuel assembly grapple is controlled using push buttons on the main control panel (grapple, ungrapple). The operator interface indicates that the operation is completed.

23. Lift the fuel assembly to its upper Z position.

    Use the same control and monitoring means as for the lowering operations. The operator can use the variable speed until the upper Z position. The sound of the operation is displayed in the Control Center. The operator monitors the Z position of the grapple and the cable load with the operator interface. The operation stops automatically when the grapple has reached its upper Z position.

24. Verify using the operator interface that the grapple is in its upper Z position.

25. Verify using the CCTV that the fuel assembly is retracted into the transfer tube.

26. Close the crud catcher.

    The operator interface displays that the operation is completed.

27. Verify the closed position of the crud catcher using the CCTV monitor.

28. Position the transfer tube above an empty cell centerline in the receiving cask.

29. Open the crud catcher.

30. Verify using the CCTV monitor the open position of the crud catcher.

31. Lower the fuel assembly to the bottom of the receiving cask.

32. Check with the operator interface that the cables are not under load.

33. Check with the operator interface the Z position of the grapple.

34. Ungrapple the fuel assembly.

    The fuel assembly ungrappling operation is controlled using the specific push button on the main control panel. The operator interface displays that the operation is completed.

35. Lift the fuel assembly grapple to its upper Z position.

36. Verify the Z position of the grapple using the operator interface.

37. Close the crud catcher.

38. Verify the closed position of the crud catcher using the CCTV monitor.

39. Repeat steps 15 through 38 until the source cask is empty.

40. Position the fuel assembly handling crane carriage in its parking position.

    Only gross positioning in the X and Y directions is necessary.

41. Verify the position of the fuel assembly handling crane carriage using the CCTV monitor.

42. Switch off power to the Fuel Assembly Handling Subsystem equipment.

43. Switch on receiving cask TC port cover power.

44. Switch on source cask TC port cover power.

45 Unlock the receiving cask TC port cover.

    The operator is notified by the operator interface when the unlocking operation is completed.

46. Off-center the receiving cask TC port cover.

    The operation is automatically stopped when the TC port cover reaches the off-centered position.

47. Verify that the receiving cask TC port cover is in the off-centered position using the

CCTV monitor.

48. Unlock the source cask TC port cover.

    The operator is notified when the unlocking operation is completed. This operation can be performed simultaneously with the receiving cask TC port cover unlocking.

49. Close the source cask TC port cover.

    The operation is automatically stopped when the source cask TC port cover reaches the closed position. This operation can be performed simultaneously with the receiving cask TC port cover off centering operation.

50. Verify the closed position of the source cask TC port cover using the CCTV monitor.

51. Switch off receiving cask TC port cover power.

52. Switch off source cask TC port cover power.

5.1.1.6 Receiving Cask Closing

1. Verify the closed and locked position of the two upper shield ports.

2. Verify that the lid/shield plug grapple is stopped in upper Z position.

3. Verify that the receiving cask TC port cover is in the off-centered position using the CCTV monitor.

4. Check that the source cask TC port cover is closed with the CCTV.

5. Switch on the Source Cask Lid and Receiving Cask Shield Plug Subsystem power.

6. Position the upper crane above the receiving cask.

   The positioning operation is automatically stopped when the upper crane reaches the receiving cask position.

7. Verify using the operator interface that the upper crane is in receiving cask position.

8. Verify using the operator interface that the fuel assembly grapple is in disengaged position.

9. Verify using the operator interface that the fuel assembly hoist system is not loaded.

10. Verify that the radiation levels in the Roof Enclosure Area are acceptable.

11. Unlock the receiving cask upper shield port.

    The operator interface displays when the operation is completed.

12. Open the receiving cask upper shield port.

    The operation is automatically stopped when the upper shield port is in open position.

13. Verify that the receiving cask upper shield port is open using the operator interface.

14. Verify that the lid/shield plug grapple is in disengaged position using the operator interface.

15. Verify that the fuel assembly handling crane is stopped in the parking position using the CCTV monitor.

16. Lower the lid/shield plug grapple to the level of the overlid on the port cover.

    Monitor the operation with the CCTV displays. Monitor the speed, the position and the load of the system using the operator interface. The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

17. Verify that the operator interface displays the correct Z position of the grapple.

18. Verify that the operator interface displays that the cables are unloaded.

19. Grapple the shield plug.

    The operator interface displays that the shield plug is grappled.

20. Lift the shield plug above the TC port cover.

    Visually monitor the position of the shield plug when it is visible above the mezzanine level. The operation is automatically stopped when the limit position is reached.

21. Verify that the shield plug is above the receiving cask TC port cover using the CCTV and that the correct position is displayed on the operator interface.

22. Switch on the receiving cask TC port cover power.

23. Open the receiving cask TC port cover.

    Monitor the movement of the port cover with the CCTV display. The operation is automatically stopped when the TC port cover reaches the open position.

24. Verify that the receiving cask TC port cover is in open position using the CCTV monitor and the operator interface displays that the cover is in the open position.

25. Lower the shield plug on the receiving cask.

    The operator can use only the slow speed. Visually monitor the movement of the shield plug when it is above the mezzanine plate. Monitor the Z position of the grapple and the cable load with the operator interface when it is underneath the mezzanine level. The operation is automatically stopped when the shield plug is on the TC port cover.

26. Verify that the correct Z position of the grapple is shown on the operator interface.

27. Verify that the operator interface displays that the cables are unloaded.

28. Disengage the grapple.

    The operator interface will display that the grapple is disengaged.

29. Lift the lid/shield plug grapple to an intermediate level.

    The operation does not require accuracy. The operator can use the variable speed. Monitor the grapple position and the cables load using the operator interface. Visually monitor the movement of the grapple when it is above the mezzanine level. The operator stops the movement when there is sufficient clearance beneath the grapple to close the receiving cask TC port cover.

30. Close the receiving cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

31. Verify that the receiving cask TC port cover is closed using the CCTV monitor and the operator interface.

32. Switch off receiving cask TC port cover power.

33. Lift the lid/shield plug grapple to its upper Z position.

The operator can use the variable speed. Visually monitor the movement of the grapple when it is underneath the upper plate. The operation is automatically stopped when the grapple reaches its upper Z position.

34. Verify that the operator interface displays the correct Z position of the lid/shield plug grapple.

35. Close the receiving cask upper shield port.

    The operation is automatically stopped when the upper shield port reaches the closed position.

36. Verify that the operator interface displays that the receiving cask upper shield port is closed.

37. Lock the receiving cask upper shield port.

    Verify that the operator interface displays that the receiving cask upper shield port is locked.

5.1.1.7 Source Cask Closing

1. Verify that the operator interface displays that the two upper shield ports are closed and locked.

2. Verify that the operator interface displays that the lid/shield plug grapple is stopped in the upper Z position.

3. Verify that the receiving cask TC port cover is in the closed position using the CCTV monitor.

4. Verify that the source cask TC port cover is in the closed position using the CCTV monitor.

5. Position the upper crane above the source cask.

   The positioning operation is automatically stopped when the upper crane reaches the source cask position.

6. Verify that the operator interface indicates that the upper crane is positioned above the source cask.

7. Verify that the radiation levels in the Roof Enclosure Area are acceptable.

8. Unlock the source cask upper shield port.

   The operator interface displays the unlocked condition.

9. Open the source cask upper shield port.

   The operation is automatically stopped when the upper shield port is in open position.

10. Verify that the operator interface indicates that the source cask upper shield port is open.

11. Verify that the operator interface displays that the lid/shield plug grapple is disengaged.

12. Lower the lid/shield plug grapple to the level of the lid on the port cover.

    Monitor the operation using the CCTV displays. Monitor the speed, the position and the load of the system with the operator interface. The operation is stopped automatically when the cables are unloaded indicating that the grapple is in contact with the overlid.

13. Verify that the correct Z position of the grapple is displayed on the operator interface.

14. Verify that the operator interface displays that the cables are unloaded.

15. Grapple the source cask lid.

    The operator interface displays that the grapple is closed.

16. Lift the source cask lid above the TC port cover.

    Monitor the position of the source cask lid when it is above the mezzanine level using the CCTV monitor. The operation is automatically stopped when the limit position is reached.

17. Verify that the source cask lid is above the source cask TC port cover using the CCTV monitor and the operator interface.

18. Switch on the receiving cask TC port cover power.

19. Open the source cask TC port cover.

    Monitor the movement of the port cover using the CCTV display. The operation is

automatically stopped when the TC port cover reaches the open position.

20. Verify that the source cask TC port cover is in the open position using the CCTV monitor and the operator interface.

21. Lower the source cask lid onto the source cask.

    The operator can only use the slow speed. Visually monitor the movement of the lid when it is above the mezzanine plate. Monitor the Z position of the grapple and the cable load with the operator interface when it is underneath the mezzanine level. The operation is automatically stopped when the lid is on the TC port cover.

22. Verify that the operator interface displays the correct Z position of the grapple.

23. Verify that the operator interface displays that the cables are unloaded.

24. Disengage the grapple.

    The grapple status is displayed by the operator interface.

25. Lift the lid/shield plug grapple to an intermediate level.

    The operation does not require accuracy. The operator can use the variable speed. Monitor the grapple position and the cable load using the operator interface. Visually monitor the movement of the grapple when it is above the mezzanine level. The operator stops the movement when there is sufficient clearance below the grapple to close the TC port cover.

26. Close the source cask TC port cover.

    Visually monitor the movement of the port cover. The operation is automatically stopped when the port cover reaches the closed position.

27. Verify that the source cask TC port cover is closed using the CCTV monitor and the operator interface.

28. Switch off source cask TC port cover power.

29. Lift the lid/shield plug grapple to its upper Z position.

    The operator can use the variable speed. Monitor visually the movement of the grapple when it is underneath the roof plate. The operation is automatically stopped when the grapple reaches its upper Z position.

30. Verify that the correct Z position of the lid/shield plug grapple is displayed on the operator interface.

31. Close the source cask upper shield port.

    The operation is automatically stopped when the upper shield port reaches the closed position.

32. Verify the closed position of the upper shield port using the operator interface.

33. Lock the source cask upper shield port.

    The locked condition is displayed on the operator interface.

34. Switch off Source Cask Lid / Receiving Cask Shield Plug Handling Subsystem power.

5.1.1.8 Source Cask Detachment and Removal

Source Cask Detachment

1. Verify using the CCTV that the two TC port covers are in the closed position.

2. Verify using the CCTV that the source and receiving casks are closed.

3. Verify using the operator interface that the sliding door is locked.

4. Disengage the source cask from the Transfer Confinement Area as follows:

    - Switch on Source Cask Mating Subsystem power.
    - Lift the source cask mating flange. Monitor the operation with a CCTV display. A unique push button is used to lift the three electric jacks. The operator can monitor the height of the electrical jacks. The operator stops the motion when desired according to monitoring information.
    - Switch off Source Cask Mating Subsystem power.

Source Cask Removal from the Lower Access Area

1. Check the radiation level in the Lower Access Area to ensure that the casks are closed.

2. Unlock manually and raise the sliding panels on the sliding door.

3. Open the sliding door.

4. Position the source cask in the preparation location as follows:

   - Activate the Lower Access Area control panel.
   - Switch on Source Cask Transfer Subsystem power.
   - Unlock the source cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly 6 feet (2 m) from the preparation location.
   - End the movement using the slow speed. The source cask transfer trolley is automatically stopped in its preparation location.
   - Visually check the proper positioning of the source cask transfer trolley.
   - Lock the source cask transfer trolley in the preparation position.
   - Switch off Source Cask Transfer Subsystem power.
   - Deactivate the Lower Access Area control panel.

5. Close the sliding door.

6. Lock the sliding door manually and lower the sliding panels on the sliding door.

<u>Source Cask Preparation for Removal</u>

1. Decontaminate source cask using damp cloths.

2. Check surface dose rates.

3. Disengage lid lifting pintle.

4. Bolt and verify bolt torque on source cask lid.

5. Verify surface dose rates are acceptable.

<u>Source Cask Removal From the Preparation Area</u>

1. Open the rolling door.

2. Position the source cask transfer trolley in the loading/unloading area as follows:

   - Activate the Preparation Area control panel.
   - Unlock the source cask transfer trolley.
   - Move the source cask transfer trolley using the fast speed until roughly 6 feet (2 m) from the loading/unloading area.
   - End the positioning operation using the slow speed.
   - Visually check the proper positioning of the transfer trolley.

- Deactivate the Preparation Area control panel.

3. Close the rolling door.

4. Unfasten source cask from the trolley.

5. Remove the source cask from the trolley.

5.1.1.9 Receiving Cask Detachment and Removal

Receiving Cask Detachment

1. Verify that the source cask is removed from the DTS.

2. Visually check the locked position of the sliding door.

3. Disengage the receiving cask from the Transfer Confinement Area.

   - Switch on Receiving Cask Mating Subsystem power.
   - Lift the receiving cask mating flange. Monitor the operation with a CCTV display. A unique push button is used to lift the three electric jacks. The operator can monitor the electrical jacks height information. The operator stops the motion when desired according to monitoring information.
   - Switch off Receiving Cask Mating Subsystem power.

Receiving Cask Removal from the Lower Access Area

1. Check the radiation level in the Lower Access Area to ensure that the sliding door can be opened safely.

2. Unlock the sliding door manually and raise the sliding panels on the sliding door.

3. Open the sliding door.

4. Position the receiving cask in the preparation location as follows:

   - Activate the Lower Access Area control panel.
   - Switch on Receiving Cask Transfer Subsystem power.
   - Unlock the receiving cask transfer trolley.
   - Transfer the trolley using the fast speed until roughly distant from 6 feet (2 m) to the preparation location.
   - End the movement using the slow speed. The receiving cask transfer trolley is automatically stopped in its preparation location.

- Visually check the proper positioning of the receiving cask transfer trolley.
- Lock the receiving cask transfer trolley in the preparation position.
- Switch off Receiving Cask Transfer Subsystem power.
- Deactivate the Lower Access Area control panel.

5. Close the sliding door.

Receiving Cask Preparation for Removal

1. Decontaminate receiving cask using damp cloths.

2. Survey receiving cask surface dose rates.

3. Disengage shield plug lifting pintle.

4. Place inner lid on receiving cask canister.

5. Install annulus welding protection.

6. Install remote welding equipment.

7. Weld the canister inner lid following approved procedures in compliance with receiving cask topical report.

8. Perform NDE on weld following approved procedures in compliance with receiving cask topical report.

9. Remove welding equipment.

10. Install inerting and drying equipment.

11. Dry and Inert receiving cask following approved procedures in compliance with receiving cask topical report.

12. Remove Drying and inerting equipment.

13. Perform a leak test of the seal weld following approved procedures in compliance with receiving cask topical report.

14. Weld valve cover plates in accordance with approved procedures in compliance with receiving cask topical report.

15. Install canister outer lid.

16. Set up remote welding equipment.

17. Weld receiving cask outer lid following approved procedures in compliance with receiving cask topical report.

18. Perform NDT on welds following approved procedures in compliance with receiving cask topical report.

19. Remove weld equipment.

20. Remove annulus weld protection.

21. Install receiving cask overpack lid.

22. Perform HP survey.

23. Bolt and torque receiving cask lid following approved procedures in compliance with receiving cask topical report.

Receiving Cask Removal from the Preparation Area

1. Verify that the source cask transfer trolley is out of the building at the far end of the rails.

2. Open the rolling door.

3. Position the receiving cask transfer trolley in the attachment location as follows:

    - Activate the Preparation Area control panel.
    - Unlock the receiving cask transfer trolley.
    - Move the receiving cask transfer trolley using the fast speed until roughly 6 feet (2 m) from the attachment location.
    - End the positioning operation using the slow speed.
    - Verify the proper positioning of the transfer trolley with respect to the unloading vehicle (rail car or heavy haul trailer).
    - Deactivate the Preparation Area control panel.

4. Close the rolling door.

5. Unfasten the receiving cask from the trolley.

6. Remove receiving cask from the trolley.

5.1.1.10 Ancillary Activities

Radiation monitoring is performed continually within the DTS. The radiation monitoring functions are fully described in Chapter 7.

The HVAC system is fully described in Section 4.3. The HVAC System monitors interior temperatures to ensure that pressure differentials are maintained and to ensure that the DTS is operated at safe temperatures.

Periodic examinations for structural deterioration, foundation soundness and security of contents will be performed, and addressed in the site specific applications.

Waste handling is described in Chapter 6.

The main interfaces, related to safety, between the different DTS subsystems, are those involving the mechanical equipment, the Radiation Monitoring Subsystem and the HVAC Subsystem.

All these interfaces are managed by the Control Subsystem which prevents any unsafe operation which could result in an abnormal exposure for the workers (Radiation Monitoring and mechanical equipment interface), in a release of contaminated particles (HVAC and mechanical equipment interface) or in any compromise of the recovery requirements (mechanical equipment interface). These interfaces are described in subsequent sections of this Topical Report.

5.1.2 Flowsheets

The following flow charts describe the DTS operating sequence. The flow charts describe the logic of the transfer process. The operating sequence is broken into 13 macro-operations. The flow chart of macro-operations is provided in Figure 5.1-1. The anticipated time to perform each operation is also listed.

Each macro-operation is further broken into operations as shown in Figures 5.1-2 through 5.2-8. The operations are further broken down into a sequence of controls which is detailed in Appendix 5A.

Performance of the DTS operating sequence and the macro-operations are controlled by administrative procedure.

5.1.3 Identification of Subjects for Safety Analysis

5.1.3.1 Criticality Prevention

Both the source cask and the receiving cask contain fuel baskets which have been designed to provide for criticality safety. The fuel baskets may contain both neutron poison material and flux traps to control reactivity of the fuel/basket configuration. It is assumed that criticality evaluations have been performed for both the source cask and the receiving casks through a separate licensing process(es). In these evaluations, it is further assumed that the casks are evaluated in a wet, flooded condition with optimum moderation (fresh water). This system is a dry transfer system which has only a single fuel assembly out of a cask at any one time. There are no specific methods utilized or necessary for criticality control in the Transfer System Installation because there are no conditions that could exist within the installation that are not bounded by the criticality licensing evaluations performed for the casks.

5.1.3.2 Chemical Safety

No chemicals which could give rise to a hazard are required for the function of the DTS.

5.1.3.3 Operational Shutdown Modes

The DTS can be shut down for extended or short-term periods or in the event of an emergency, such as a tornado warning.

The DTS may be shut down for extended periods of time for maintenance or when there is no fuel to transfer. All fuel will be moved into the receiving cask. The normal sequence of operations will be followed until all fuel is transferred into the receiving cask, and both casks are moved out of the DTS. The time required to complete the total operating sequence is approximately ten 24 hour days. The majority of this time is required to weld the receiving cask canister lids in place. Details of the time required to perform DTS operations is provided in Table 7.4-1.

After an extended shut down, the DTS will be fully operationally tested.

The DTS may be shut down for short-term periods for repairs, equipment replacement, etc. If the repair is performed in the Preparation Area, and will take a significant period of time, the loaded casks should be moved into the Lower Access Area to minimize worker radiation exposure. If the repair must be performed in the Lower Access Area or the TCA, the casks must be closed, and moved into the Preparation Area. This requires approximately 1 hour to complete the fuel transfer operation, and one hour to install the source cask lid and receiving cask shield plug. It takes another 2 hours to remove the casks from the Lower

Access Area.

Prior to entry into the Lower Access Area or the TCA for maintenance, the areas would be checked for contamination and decontaminated as necessary. Start up would occur after operational testing of the faulty equipment.

In the event of an emergency or a tornado watch, the DTS would be put into a temporary shut down condition. This would entail completing the fuel transfer of the assembly currently in transfer, installing the source cask lid and the receiving cask shield plug and closing the TC port covers and upper shield port covers. These operations take approximately 2 hours.

To start up, the cask can simply be reopened and operations be restarted.

5.1.3.4 Instrumentation

Process instrumentation and controls throughout the DTS allow the control and monitoring of the following:

- Mechanical equipment including the Cask Transfer Subsystem; the Cask Mating Subsystem; the TC Port Shield Subsystem; the MPC Shield Plug and Source Cask Lid Handling Subsystem; and the Fuel Assembly Handling Subsystem.
- The HVAC Subsystem equipment.
- The Radiation Monitoring Subsystem.

The control and monitoring of DTS mechanical equipment and HVAC Subsystem equipment is described in Section 5.2.

The control and monitoring of the Radiation Monitoring Subsystem is described in this section.

The Radiation Monitoring Subsystem includes permanently mounted area radiation detectors in the Preparation Area, in the Lower Access Area, in the Transfer Confinement Area, in the Roof Enclosure Area, and in the HVAC Subsystem.

The Radiation Monitoring Subsystem has displays at the detector location, the Preparation Area and the Control Center. Audible and visible alarms for high radiation levels, low radiation/low battery, and detector failure are also at the detector location, the Preparation Area and the Control Center.

The Radiation Monitoring Subsystem is interlocked with the sliding door. Once fuel transfer begins, the area radiation monitor within the Lower Access Area will be interlocked with the sliding door preventing the door from being opened until the radiation levels inside the Lower Access Area have fallen below a given set point. This is to prevent inadvertent access to the Lower Access Area during fuel transfer.

The roof enclosure radiation monitor is interlocked with the upper shield ports to prevent their opening in the presence of high radiation levels.

The DTS has installed radiation monitoring equipment which continuously monitors and displays the radiation dose rates. This avoids the need to have personnel routinely entering areas to obtain the data manually. This also allows the monitoring of radiation level changes throughout operations and permits prompt personnel action if alarm situations occur.

The following features are included in the system:

- Display at each detector location and remote display at the Preparation Area and the Control Center;
- Warning for Low Level Detection;
- Alarms for High Level Detection, Detector Failure, and Low Battery;
- Audible and visible alarms at each detector, the Preparation Area, and the Control Center;
- Battery backup of monitoring equipment;
- Remotely operated check source; and
- Associated electronic equipment and cabling.

The selected equipment has readout capability at the highest anticipated radiation levels and positive readout at lowest radiation levels.

Area gamma radiation monitors are mounted at several fixed locations within the DTS. The monitors are located in areas where personnel will be for periods of time during transfer operations and maintenance operations. Neutron measurements will be taken using portable instrumentation as necessary. Two detectors are mounted in the Preparation Area, one detector is mounted in the Lower Access Area, one is mounted in the Transfer Confinement Area, one is in the Roof Enclosure Area and one is on the exhaust stack off the DTS.

To support maintenance of the detector, each is mounted at a height of 5 feet (1.5 m) from the flooring. A list of the installed radiation monitors, their locations, and effective range is presented in Table 5.1-1. The lower end range is such that the radiation levels below this point are not significant. The upper end range is above the anticipated radiation levels in the area.

The exhaust stack is equipped with a continuous air monitor. This monitor is

configured to allow the electronics to be mounted remotely from the sampling/detection system. The stack monitor collects and monitors airborne particulate, iodine and noble gases.

The sample stream will be drawn from the stack using an isokinetic probe. A pump/motor assembly is present to draw the sample and produce a flow through the monitor. A rotary vane pump with a 3/4 hp (0.56 kW) motor provides a flow rate of up to 4 CFM. One inch inlet and outlet sample lines are used. A mass flow transducer with a controller integral to the monitor is used to regulate the flow.

Once the sample is drawn, particulate is collected on filter paper with a collection efficiency of 99% for particles 0.3 micron and larger. After passing through the filter paper, the sample stream is passed through the iodine and noble gas detectors.

After the sample has passed through the detectors, it is returned the exhaust stack down stream of the sample inlet point.

Table 5.1-1

Locations of Area Radiation Monitors within the DTS

Detector Location	Range
Preparation Area, Monitor #1	0.1-10,000 mrem/hr (0.001-100 mSv)
Preparation Area, Monitor #2	0.1-10,000 mrem/hr (0.001-100 mSv)
Lower Access Area	0.1-10,000 mrem/hr (0.001-100 mSv)
Transfer Confinement Area	1-100,000 mrem/hr (0.01-1,000 mSv)
Roof Enclosure Area	0.1-10,000 mrem/hr (0.001-100 mSv)
Exhaust (HEPA Filters) Stack	1-100,000 mrem/hr (0.01-1,000 mSv)

The outputs are sent through a microprocessor to the Control Center and the Preparation Area. Audible and visible alarms will be present at both the Preparation Area and the Control Center.

5.1.3.5 Maintenance Techniques

Maintenance operations are carried out on the equipment when the fuel and casks are removed from the DTS. In the TCA, maintenance operations are generally limited to change out of equipment, and minor repairs. The TCA is accessed through the Lower Access Area by way of the cask openings. Scaffolding will be available for ease of entry.

In the Lower Access Area, filter change out and maintenance on the Cask Mating Systems will be performed. Filter change out and cask mating system change out will be performed using conventional "bagging" techniques.

Upper crane and upper shield port covers will be maintained on contact in the Roof Enclosure Area. A sealed door is provided for maintenance activities in this area. Maintenance activities will not be performed in this area when fuel is being transferred or while either the source or receiving cask is open.

Maintenance on the cask trolleys and lid welding equipment will be performed in the Preparation Area when the casks are removed from the area.

Items requiring substantial maintenance or refurbishment or which are heavily contaminated will be serviced in the on-site reactor facilities.

The spare parts and component list will be provided in the site specific application.

Figure 5.1-1

DTS Operating Sequence
Flow Chart of Macro-Operations

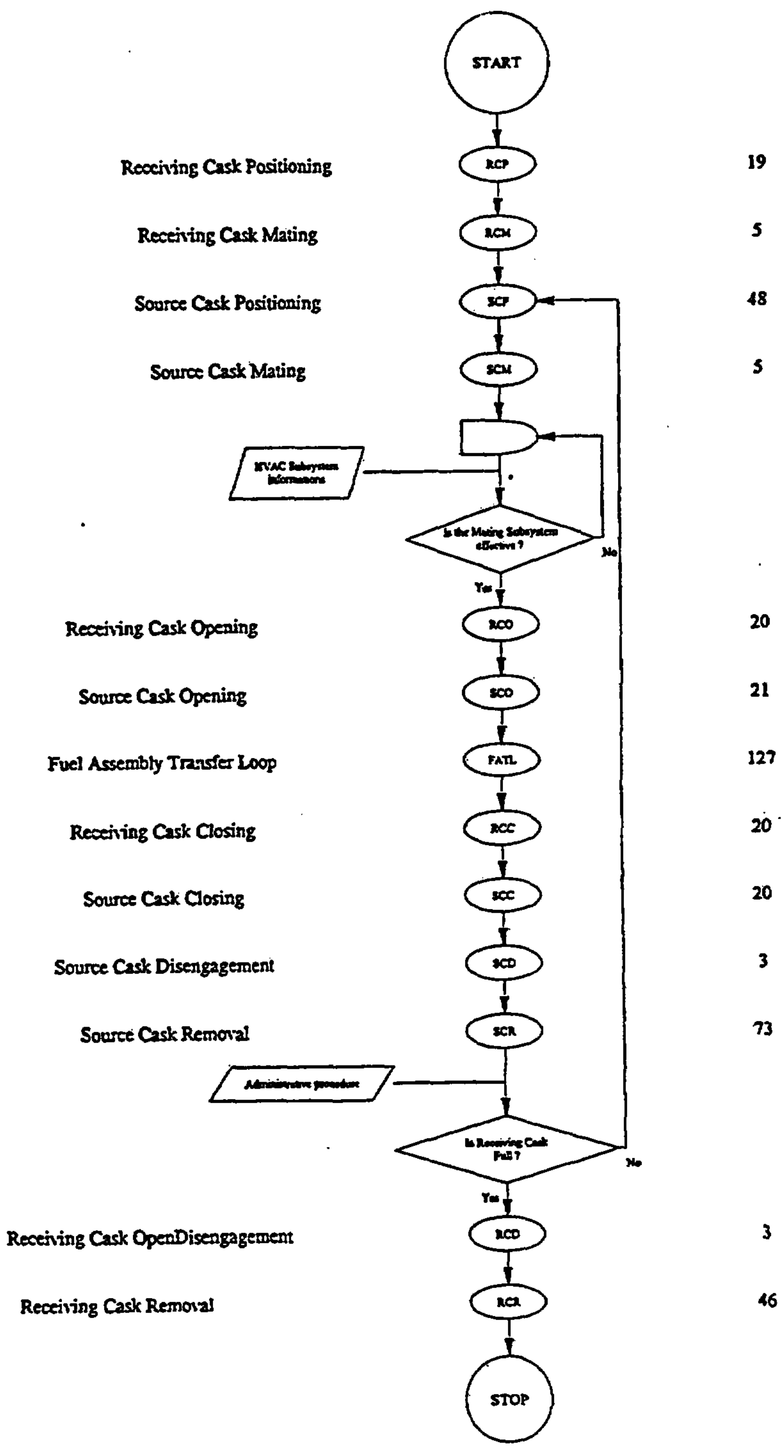


Figure 5.1-2

Positioning of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

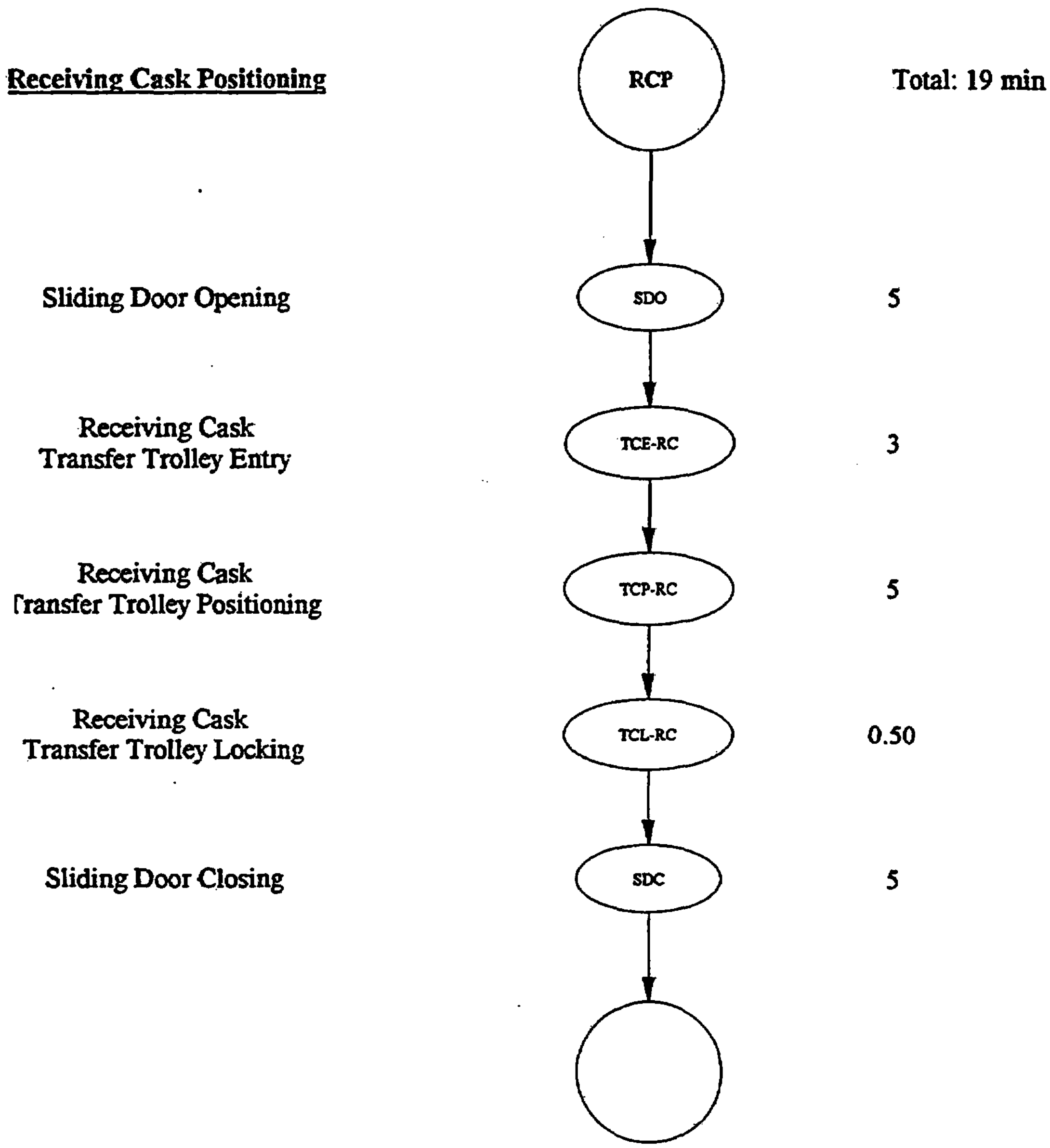


Figure 5.1-2 (Continued)

**Positioning of Source and Receiving Casks Macro-Operation
Flow Chart of Operations**

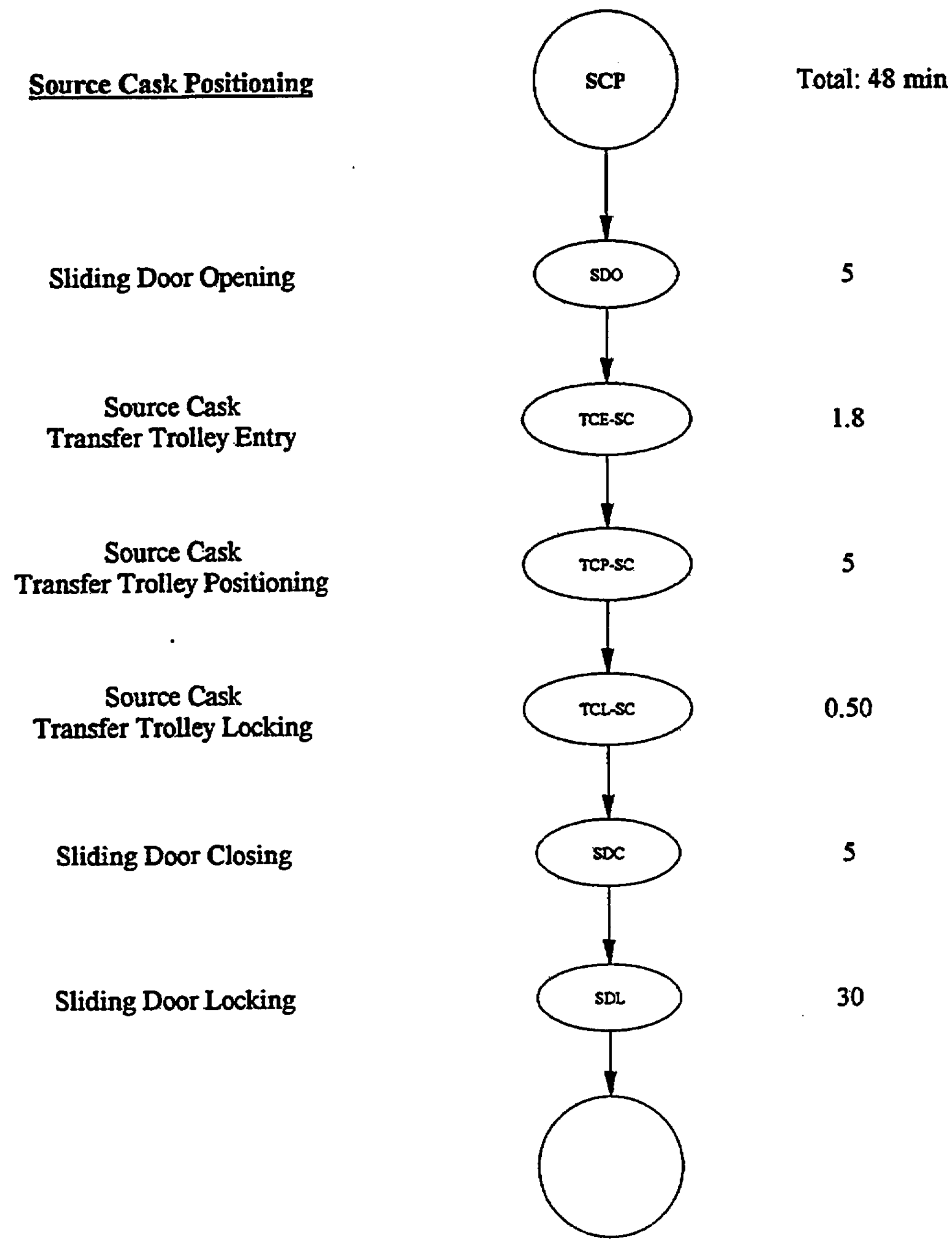


Figure 5.1-3

Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

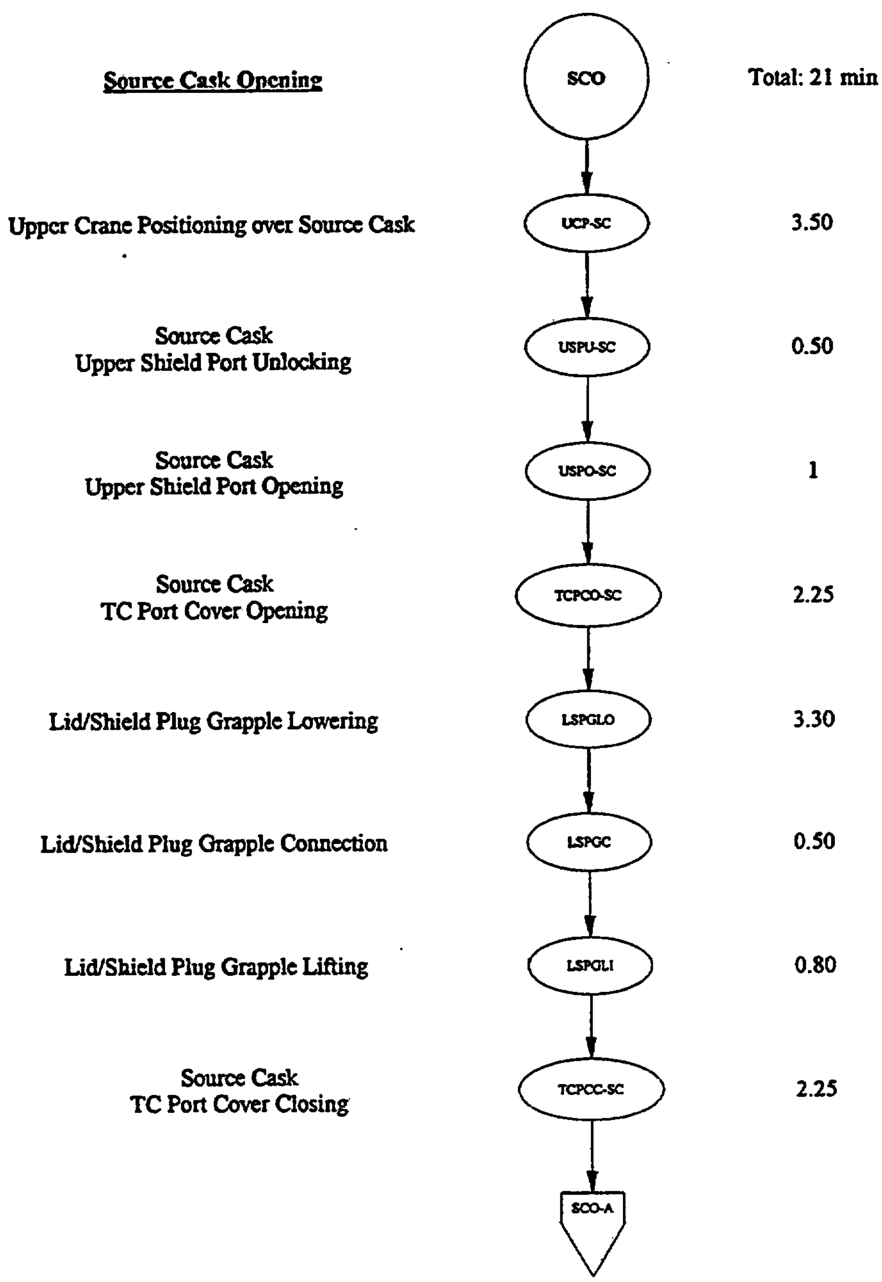


Figure 5.1-3 (Continued)

Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

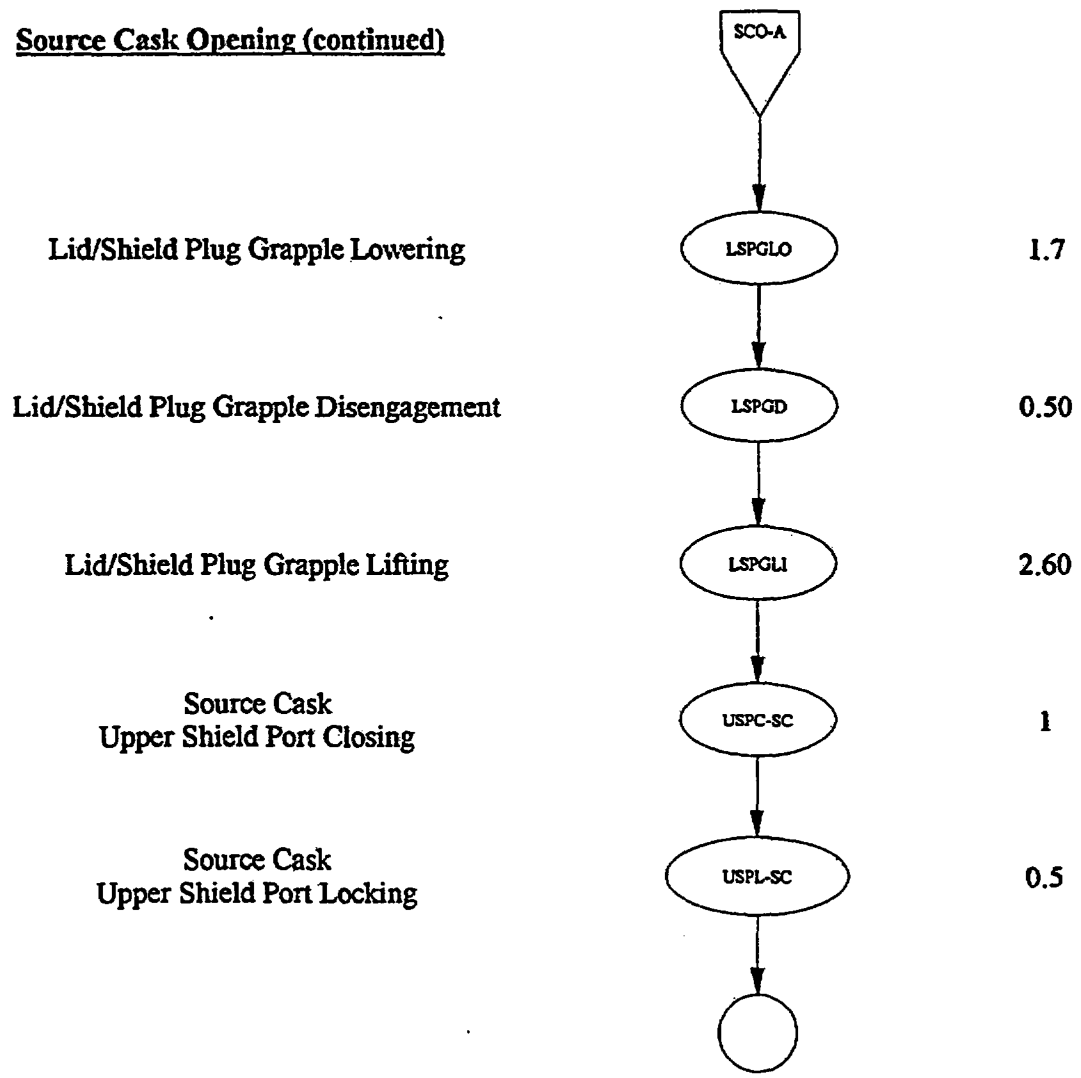


Figure 5.1-3 (Continued)

Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

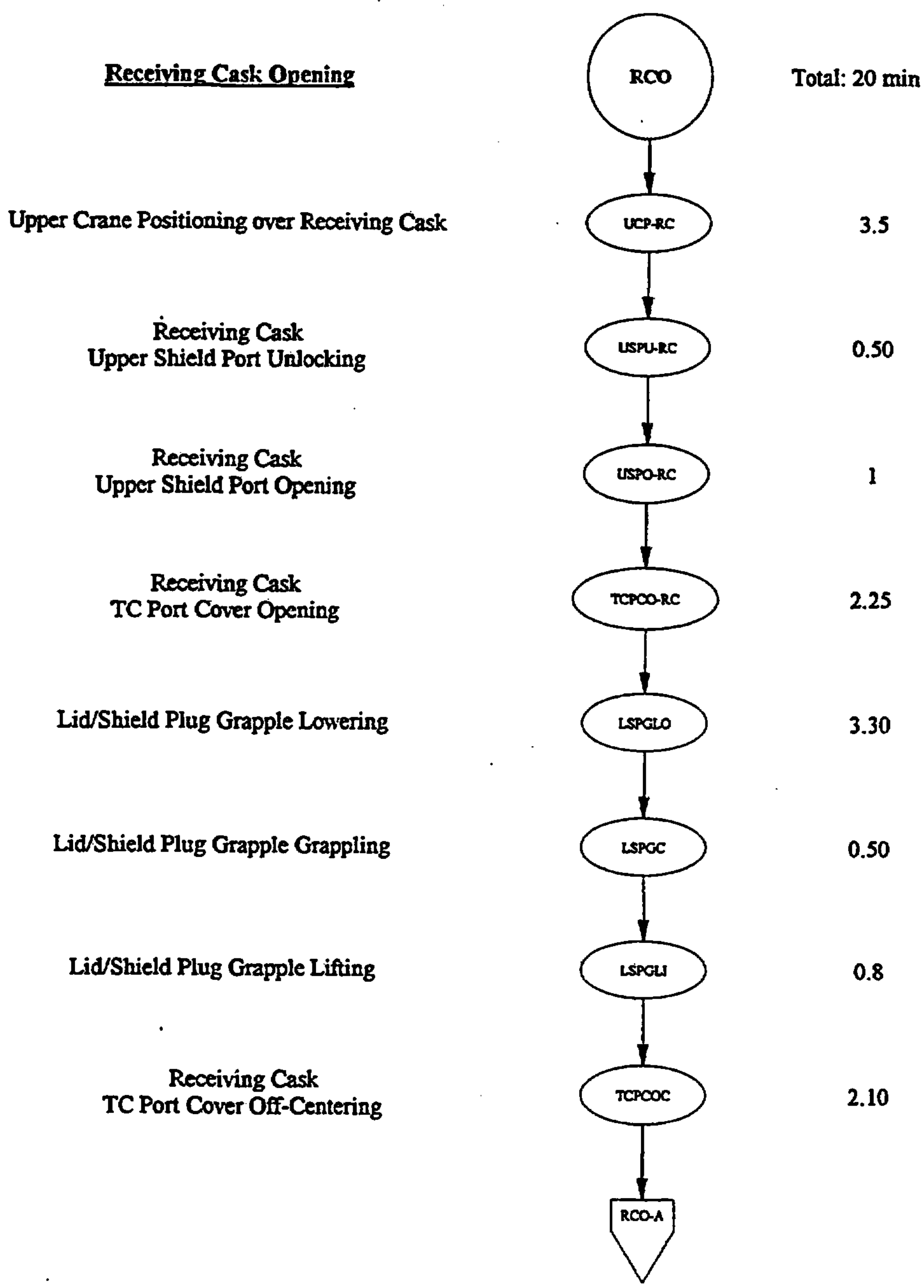


Figure 5.1-3 (Continued)

**Opening of Source and Receiving Casks Macro-Operation
Flow Chart of Operations**

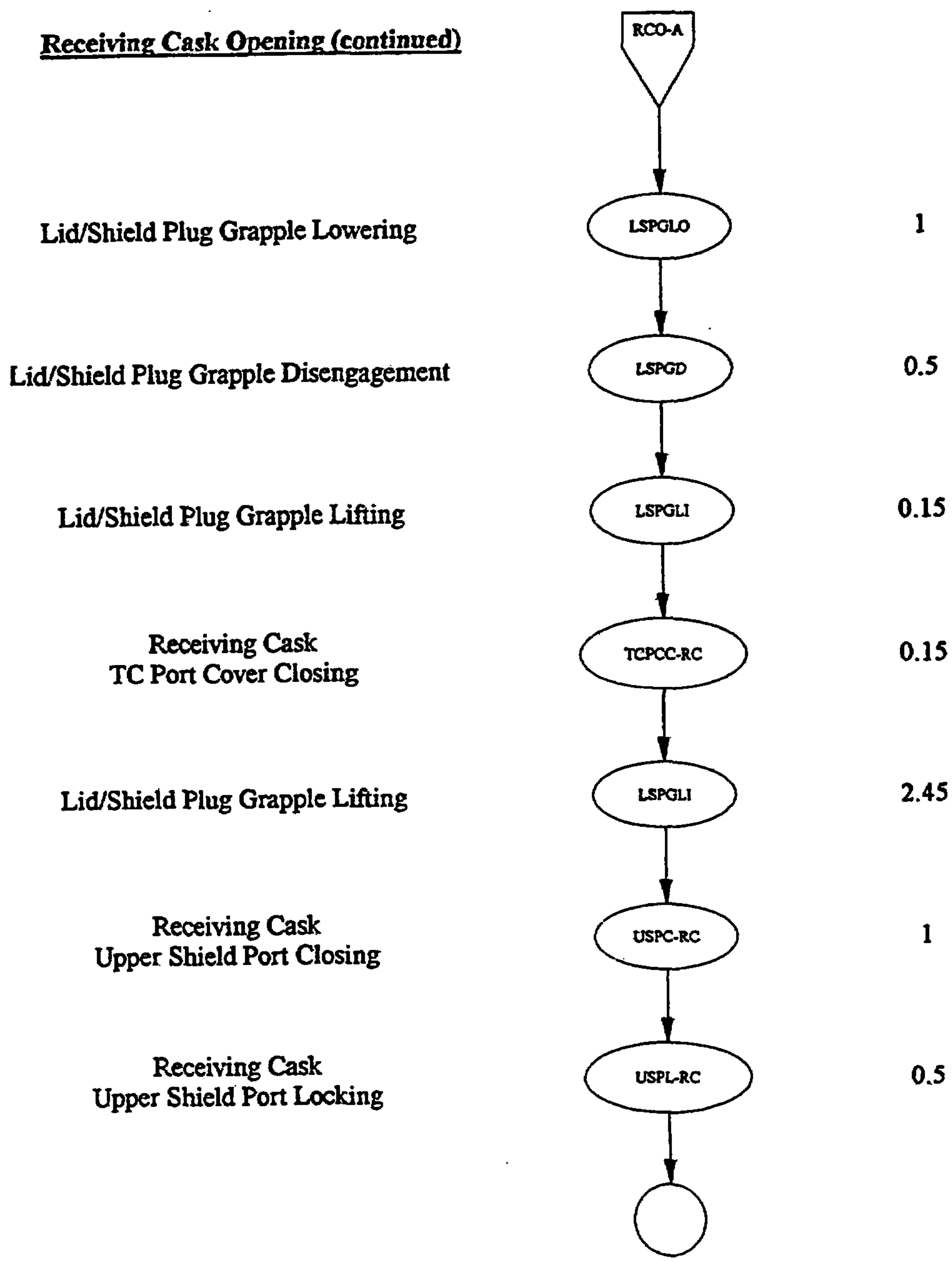


Figure 5.1-4

Fuel Assembly Transfer Loop Macro-Operation Flow Chart of Operations

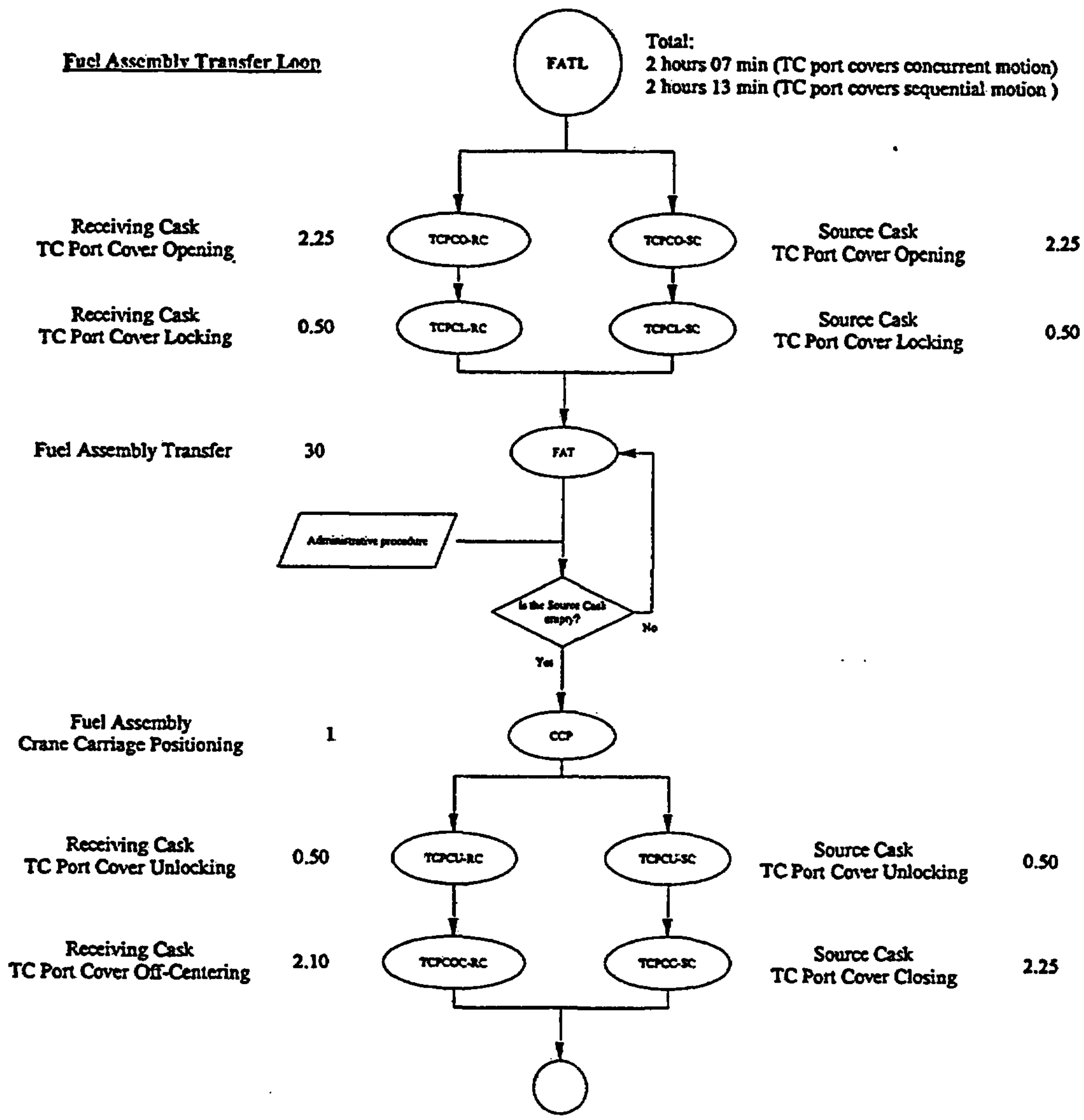


Figure 5.1-5

Fuel Assembly Transfer Macro-Operation Flow Chart of Operations

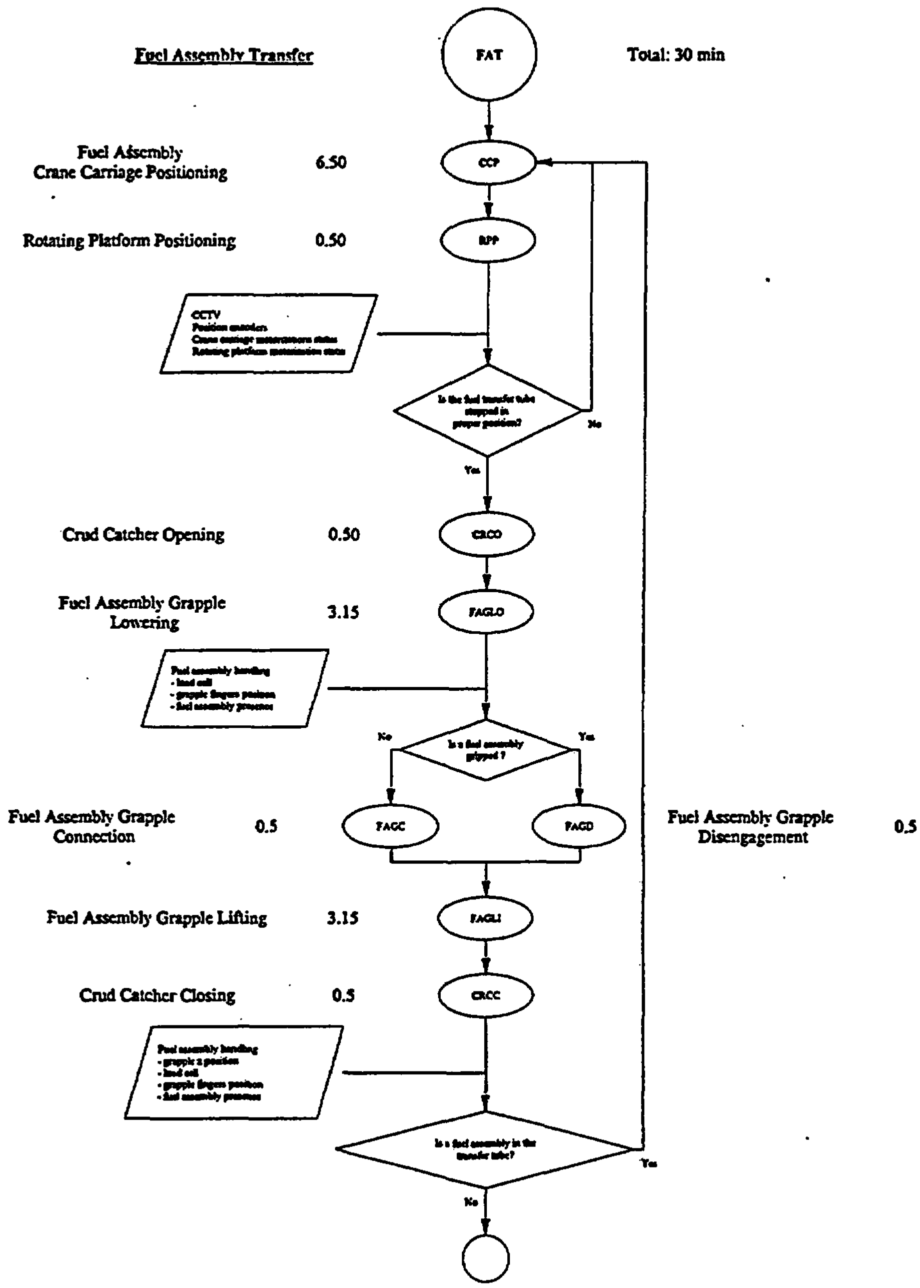


Figure 5.1-6

Closing of Source and Receiving Casks Macro-Operation Flow Chart of Operations

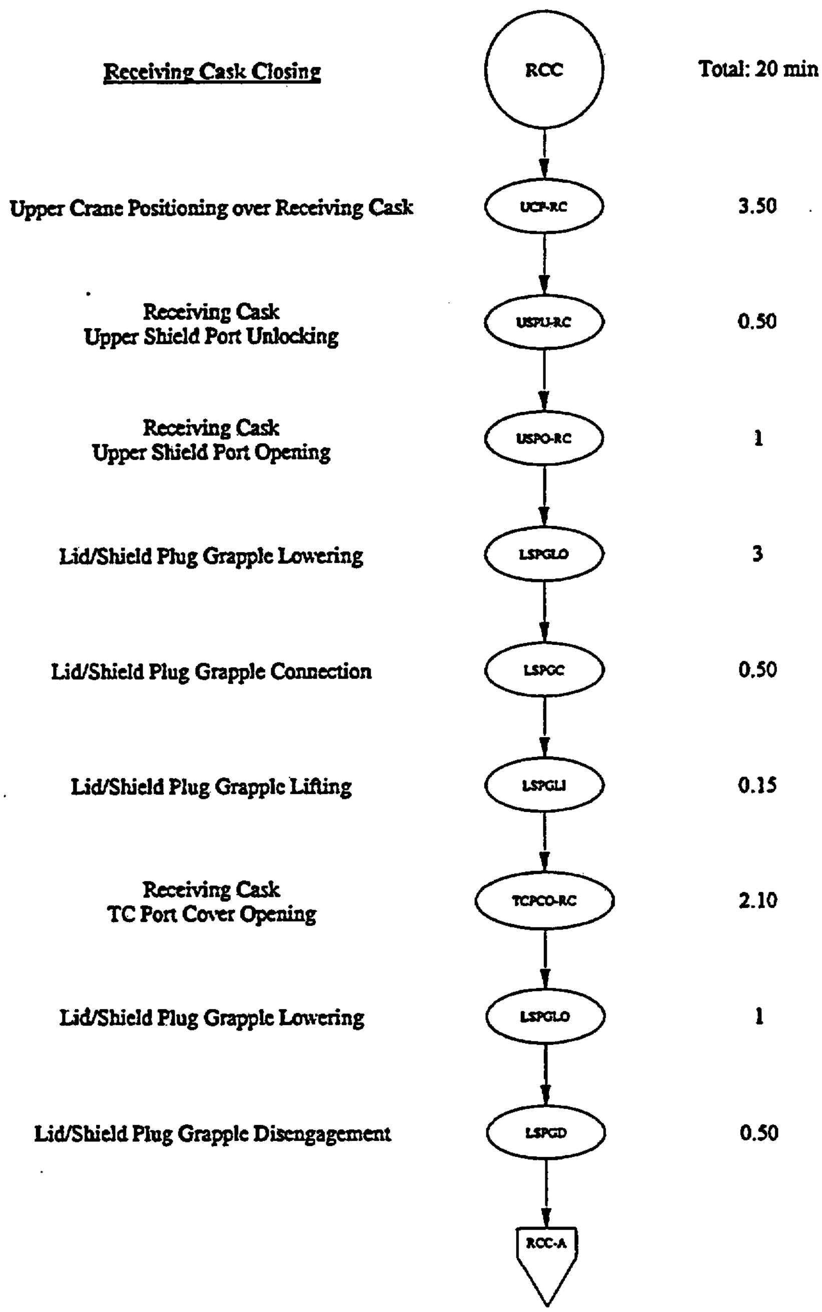


Figure 5.1-6 (Continued)

Closing of Source and Receiving Casks Macro-Operation Flow Chart of Operations

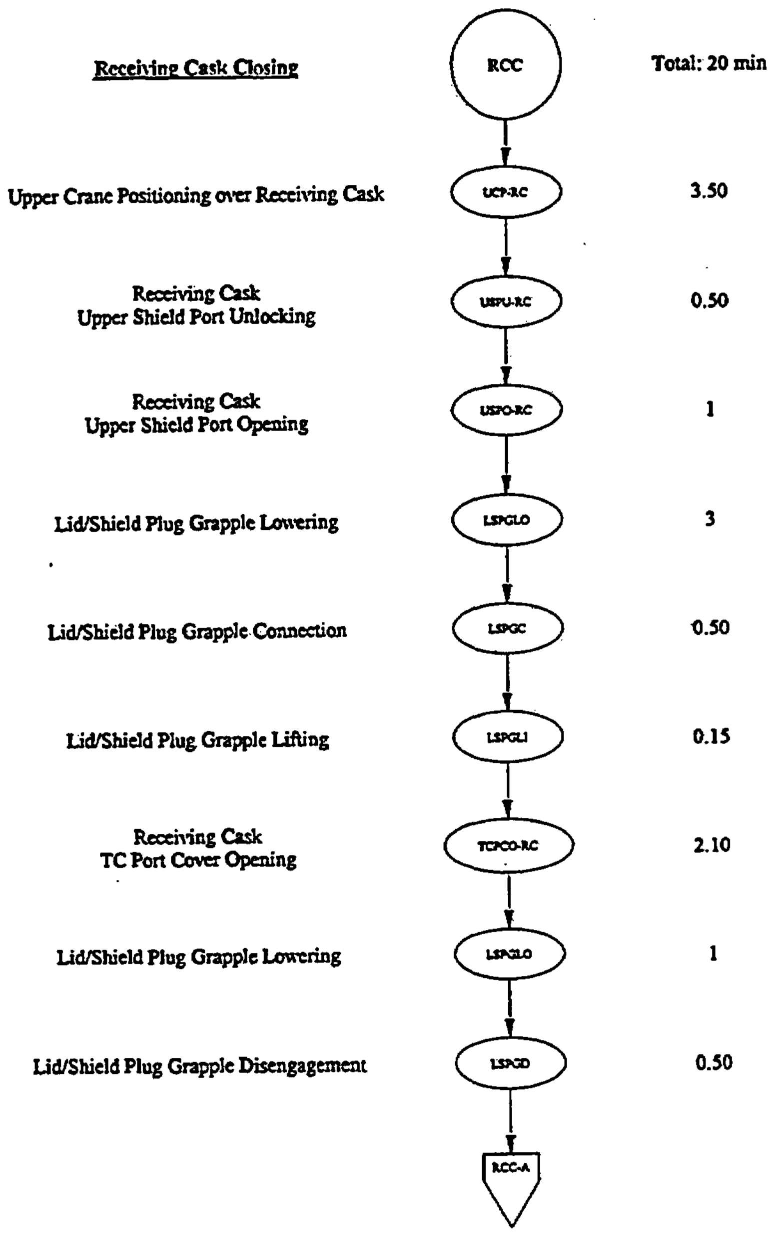


Figure 5.1-6 (Continued)

Closing of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

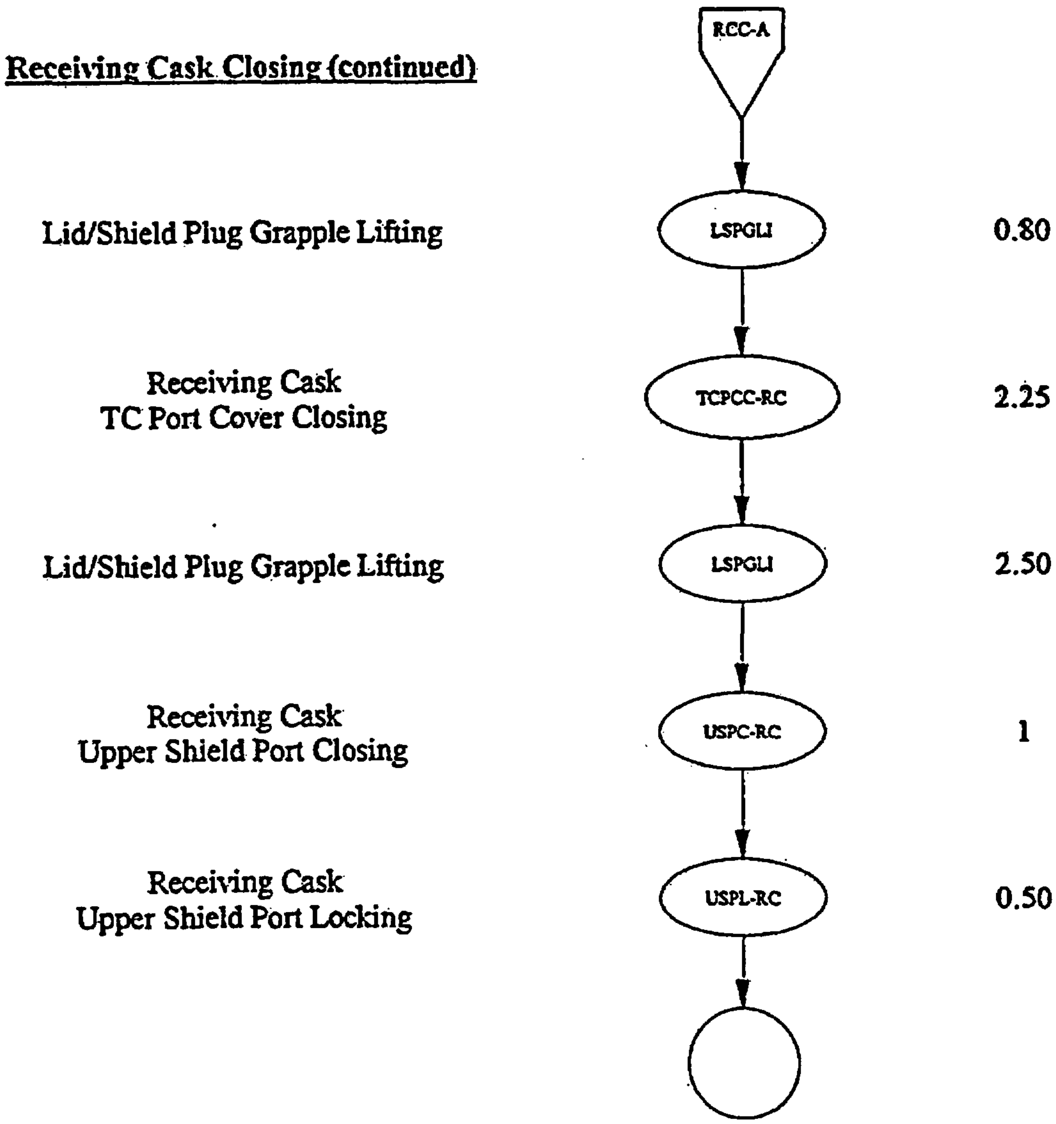


Figure 5.1-6 (Continued)

Closing of Source and Receiving Casks Macro-Operation Flow Chart of Operations

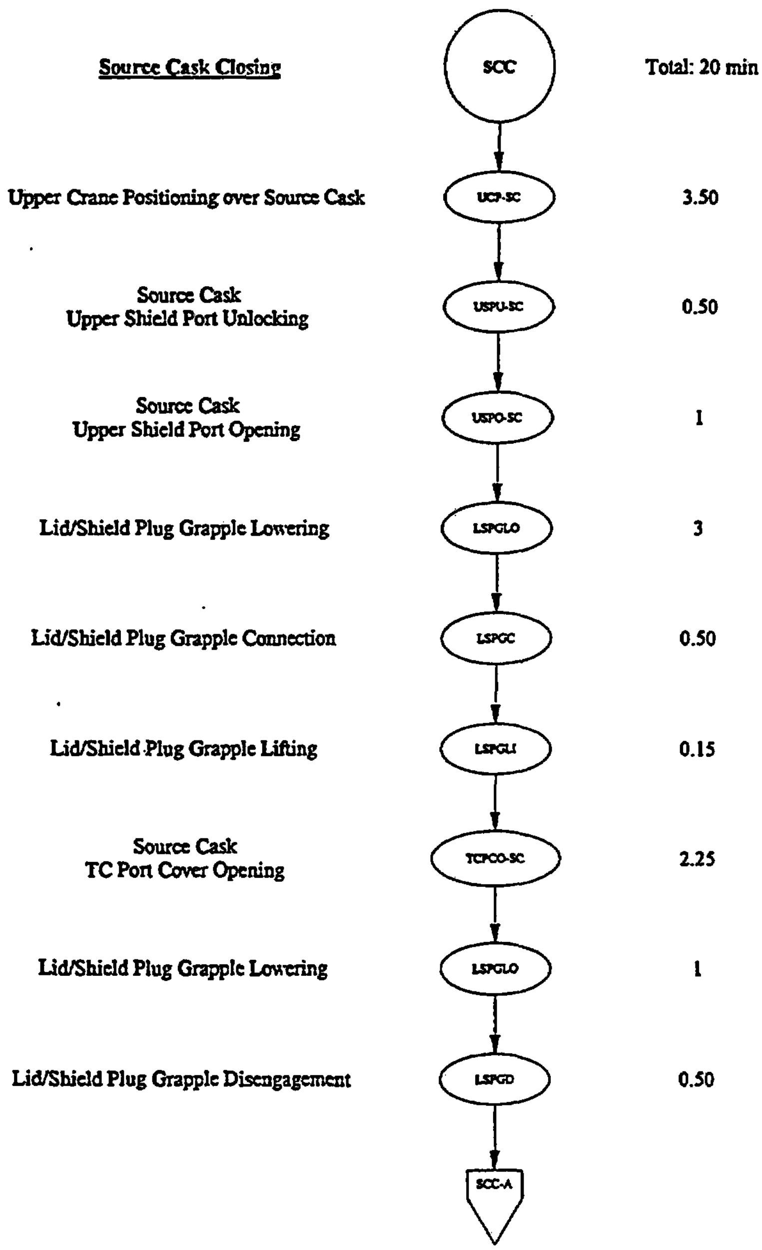


Figure 5.1-7

Removal of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

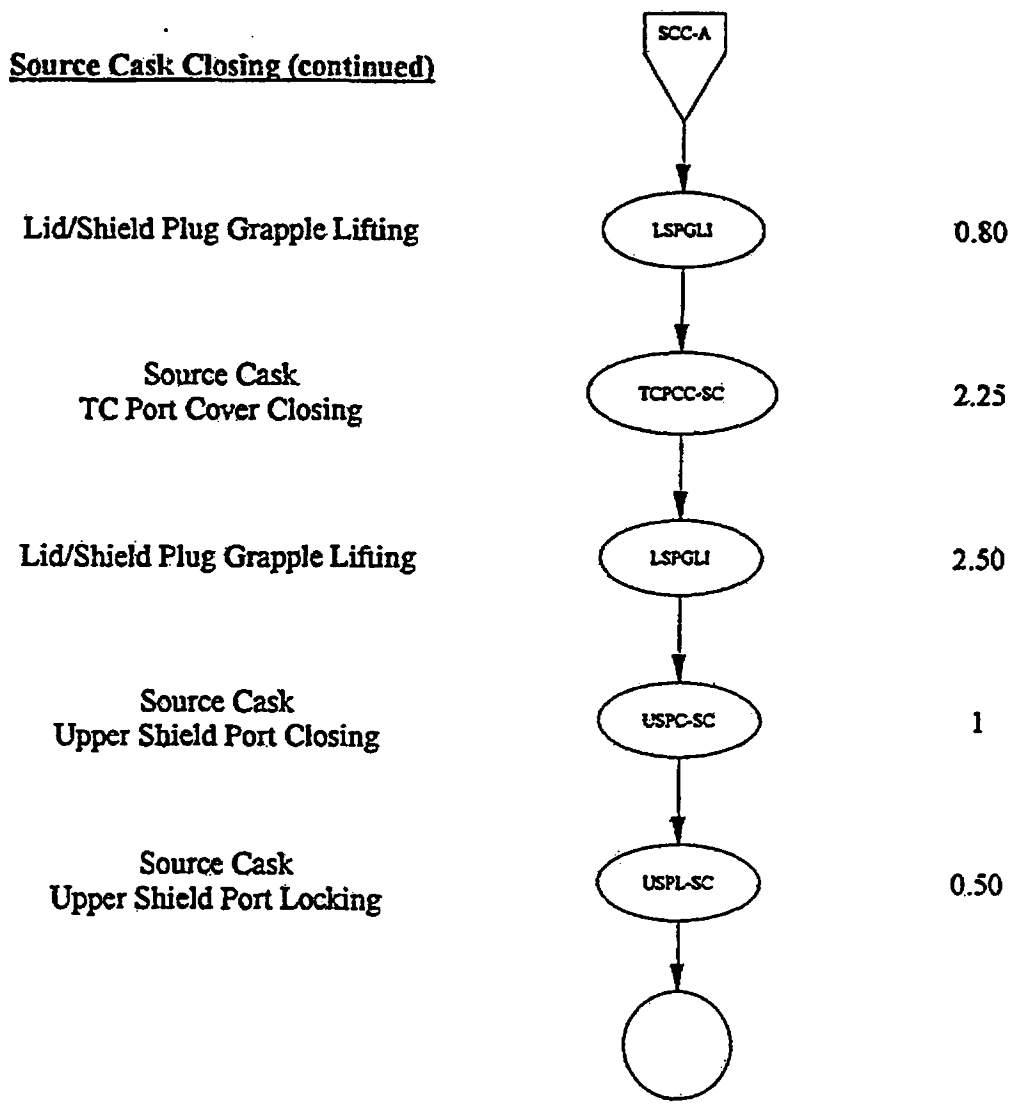


Figure 5.1-7 (Continued)

Removal of Source and Receiving Casks Macro-Operation
Flow Chart of Operations

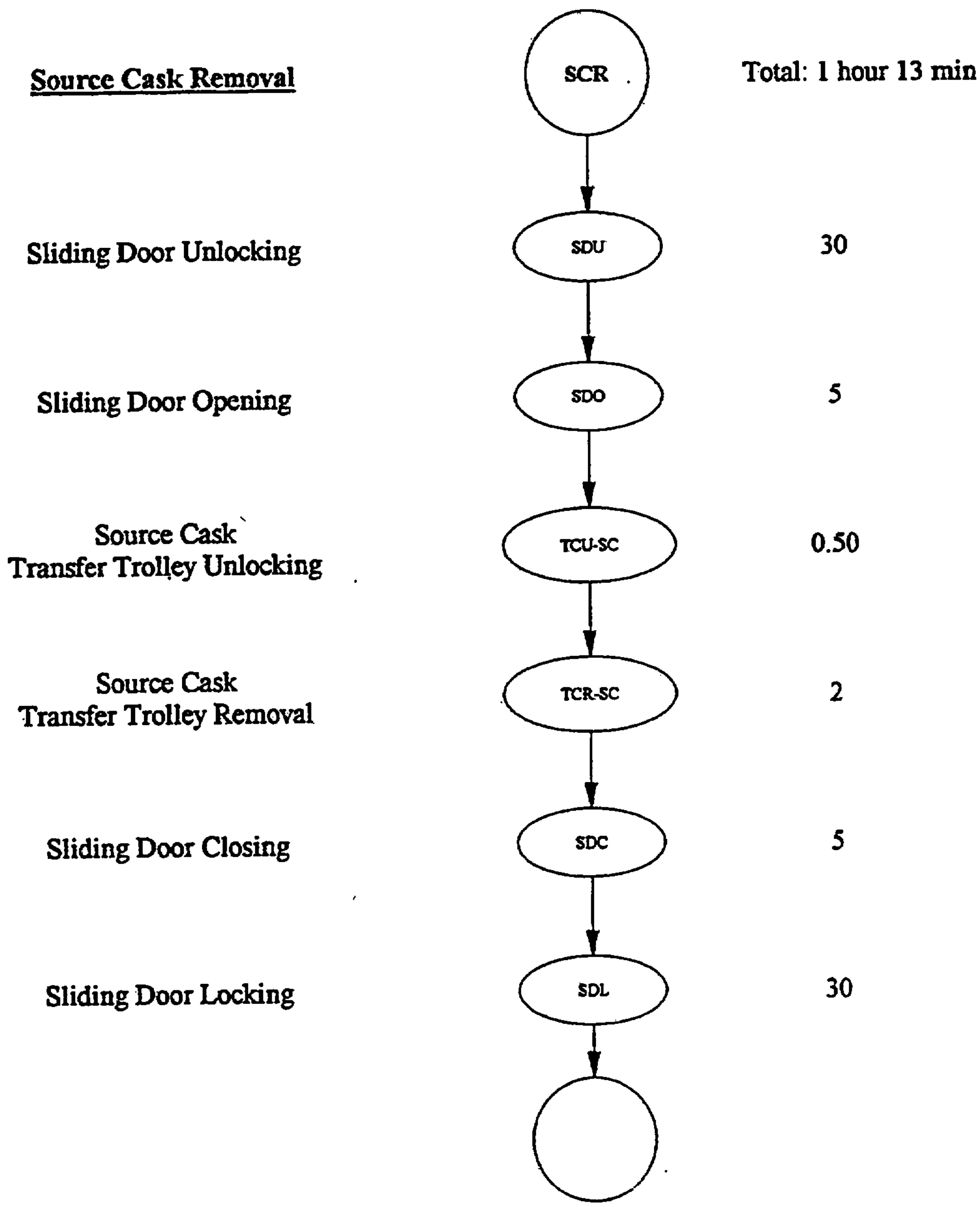
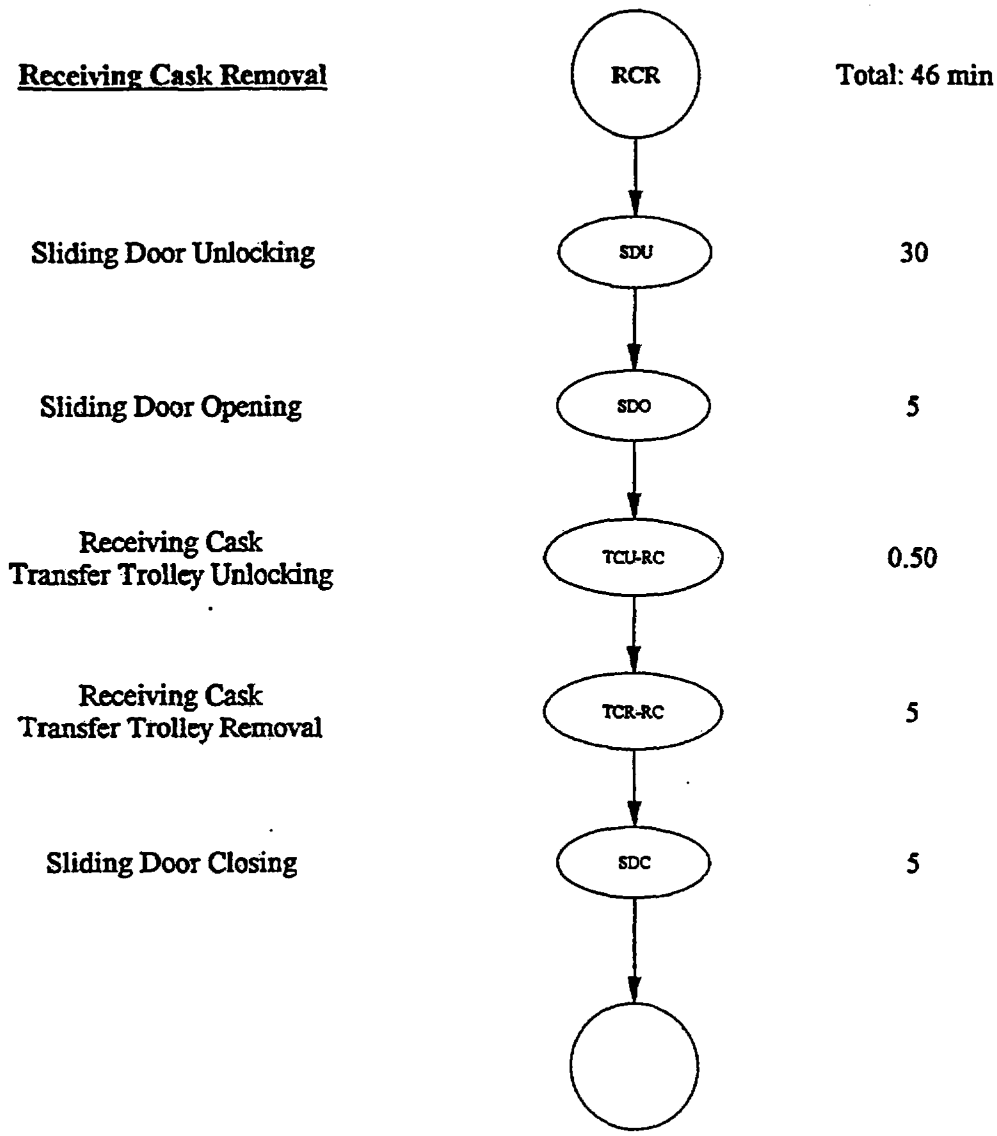


Figure 5.1-7 (Continued)

**Removal of Source and Receiving Casks Macro-Operation
Flow Chart of Operations**



5.2 Spent Fuel Handling Systems

This section describes the functions, design bases, and the pertinent design features of the major operating equipment. Each subsection describes a specific operating subsystem. The flow diagram for the operations is presented in Chapter 1, Figures 1.3-2 through 1.3-8.

5.2.1 Receiving and Source Cask Transfer Subsystem

The Receiving and Source Cask Transfer Subsystem consists of two trolleys which are mounted on one set of rails. The rails run from outside of the DTS structure, through the Preparation Area, and into the Lower Access Area. Since there is only one set of rails, the receiving cask must enter the DTS before the source cask. The Receiving Cask Transfer Subsystem is shown on Figure 1.2-2. The Source Cask Transfer Subsystem is shown on Figure 1.2-6. Each trolley is motor driven and operated using identical control panels located in the Preparation Area and the Lower Access Area. The control panels are key operated such that only one panel can be operated at any time.

The Cask Transfer Subsystem supports the casks during operations within the DTS, and prevents the casks from tipping over in a seismic event.

Receiving Cask Transfer Subsystem

The Receiving Cask Transfer Subsystem is shown in Figure 1.2-2.

The receiving cask trolley is 11.2 ft x 10.2 ft x 3.4 ft (3.4 m x 3.1 m x 1.0 m) and has a capacity of 125 tons (113 metric tons). It runs on rails 9 ft (2.75 meters) apart, and has a wheel base of 8.9 ft (2.7 m). The main components of the trolley are made from painted carbon steel. The trolley wheels are 27.6 in (700 mm) minimum diameter.

Four tapered centering guides, bolted to the top plate of the trolley, guide the cask in place during lowering. The lead angle on the centering guides allows for 4 inches (100 mm) of misalignment. These centering guides also resist the horizontal loading during a seismic event. The centering guides can be removed and repositioned for receiving casks with different dimensions.

The cask is fixed on the trolley by means of two trunnion cradles with bolted tiedown covers. These are shown in Figure 5.2-1. The trunnion cradles are bolted to the top plate of the trolley. Six 1.25 in (30 mm) dia. bolts are used to attach each tiedown cover. The trunnion cradles, together with their covers, prevent the cask from becoming disengaged during a seismic event. This analysis is presented in Appendix 8A.2. The trunnion cradles are bolted to the trolley. The tiedown covers weigh a maximum of 60 lbs (27 kg) and can be removed manually.

The trolley is driven by means of an asynchronous motor and service brake. The service brake can be manually disengaged. Only two out of four trolley wheels (one on each side) are motorized. The motor has two speeds which results in a trolley movement of 0.7 ft/min (≈ 0.2 m/min) or 10 ft/min (≈ 3 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor.

The operator manually starts the trolley motion from the control panel in the Preparation Area. The trolley moves at its selected fast speed for gross positioning and the slower speed for fine positioning. Limit switches mounted on the trolley rail stop the trolley to ensure that the trolley is positioned in the correct location in the Preparation Area and the Lower Access Area.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 20 horsepower (15 kW)

The motor produces approximately 4.5 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power (and can be manually disengaged, if necessary). The emergency brake is engaged as a parking brake when the trolley is not in motion.

The receiving cask trolley is locked in place by means of a locking pin which engages with a hole in the concrete floor in the Preparation Area and in the Lower Access Area. See Figure 5.2-2 . This prevents the trolley from sliding along its rails while work is performed on the cask. This safety feature was incorporated since there are periods during receiving cask loading when the fuel is in the receiving cask with only the shield plug in place. The locks prevent damage to personnel and equipment in the event of inadvertent activation of the trolley. The locking pin is evaluated in Appendix 8A.2.

The trolley locking pin is not used during cask loading or unloading. The cask is either empty or the lids are welded and bolted closed during these operations.

Trolley guidance is made by two sets of lateral rollers on one of the two runway rails. See Figure 5.2-3. The rollers are 7.1 inches (180 mm) in diameter and are sized to withstand a lateral load of 5% of the vertical load. The guidance rollers are not designed to withstand the seismic event. Lateral rollers were used instead of flanged wheels to ensure accurate positioning of the trolley on its rails. The lateral rollers are evaluated for normal and accident loads in Appendix 8A.2.

A plate mounted beneath the trolley which runs below the runway rail at each wheel location prevents the trolley from tipping over in a seismic event. This plate is defined as the "anti-taking off device" and is shown in Figure 5.2-3. The minimum thickness of the plate is 1.6 inches (40 mm), and must run beneath the rail for at least 6.3 inches (160 mm). The plate is attached to the trolley by means of four 1 inch (25 mm) diameter bolts. The anti-tajubg iff devices are evaluated in Appendix 8A.2.

Bumper guards are located at the end of each runway rail to prevent damage to the trolley. A tow ring for attaching a pulling device (e.g., a tractor) in the event of a motor failure is mounted on one end of the trolley.

The electrical cables for the motor and sensors on the trolley are run underground. The slack in the electrical cables is taken by a winder mounted on the base of the trolley.

Due to the heavy weight of the receiving cask and trolley, and the need to prevent cask or trolley tipover during a seismic event, a special composite runway rail was designed. The runway rail is shown in Figure 5.2-3. The composite runway provides a large bearing area for the anti-taking off device. It also provides guidance for the lateral guidance rollers which take the lateral loads due to the seismic event.

The receiving cask transfer trolley is evaluated in Appendix 8A.2. The specified dimensions of the key components of the Receiving Cask Transfer Subsystem are presented in Table 5.2-1.

Table 5.2-1

Receiving Cask Transfer Subsystem Specified Dimensions

Part	Calculated Size
Bolts of Cradle	6 bolts 30 mm (1.2 in)
Plate of Anti-Taking Off Device	Thickness 40 mm (1.6 in)
Bolts of the Anti-Taking Off Device	4 bolts 24 mm (1 in)
Diameter of the Locking Pin	D = 120 mm (4.8 in)
Wheel Diameter	D = 700 mm (27.6 in)
Rail Width Minimum	100 mm (3.9 in)
Guidance Roller	D = 180 mm (7.1 in)
Rail Height Minimum	50 mm = (1.97 in)

Source Cask Transfer Subsystem

The Source Cask Transfer Subsystem is essentially identical to the Receiving Cask Transfer Subsystem, except for its size. It also has a spacer between the trolley base plate and the cask such that the top surface of the receiving cask and the top surface of the source cask are at the same elevation. The source cask is loaded onto its transfer trolley outside of the Preparation Area.

After the trolley is loaded, it is moved into the Preparation Area on rails. During preparation the source cask remains on the trolley and the trolley is locked by means of a jack actuated pin that penetrates into the floor of the Preparation Area.

The source cask trolley is 10.2 ft x 8.5 ft x 4.4 ft (3.1 m x 2.6 m x 1.3 m) and has a capacity of 30 tons (27.3 metric tons). It runs on rails 9 ft (2.75 meters) apart, and has a wheel base of 6.6 ft (~2 m). The main components of the trolley are made from painted carbon steel. The trolley wheels are 17.7 in (450 mm) minimum diameter.

Four tapered centering guides, bolted to the top plate of the trolley, guide the cask in place during lowering. The lead angle on the centering guides provides for 4 inches (100 mm) misalignment. These centering guides also resist the horizontal loading during the seismic event.[7] The centering guides can be removed and repositioned for source casks with different dimensions. The cask is fixed on the trolley by means of two trunnion cradles with bolted tiedown covers, similar to those used for the receiving cask. The cradles and centering guides are evaluated in Appendix 8A.2.

The trolley is driven by means of an asynchronous motor and service brake. The service brake can be manually disengaged. Only two, out of four trolley wheels (one on each side) are motorized. The motor has two speeds which results in a trolley movement of 0.7 ft/min (≈ 0.2 m/min) or 10 ft./min (≈ 3 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor.

The operator manually starts the transfer from the control panel in the Preparation Area. The trolley is moved at its selected fast speed for gross positioning and is moved at its slow speed for fine positioning. Limit switches mounted on the trolley rail stop the trolley and ensure that it is positioned in the correct location in the Preparation Area and the Lower Access Area.

The drive motor characteristics are listed below:

- 440 three phase V;
- 60 Hz; and
- 5.4 horsepower (4 kW).

The motor produces approximately 1.2 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft from the gear reducer. Both brakes engage upon loss of electrical power (and if necessary, can be manually disengaged). The emergency brake is engaged as a parking brake when the trolley is not in motion.

The locking device described for the receiving cask trolley is also used for the source cask trolley. This prevents the trolley from sliding along its rails during a seismic event.

The trolley guidance device and the anti-taking off device are identical to the devices described for the receiving cask trolley, with the exception of the sizes of the components. A summary of the calculated dimensions required on the source cask trolley are presented in Table 5.2-2. The Source Cask Transfer System is evaluated in Appendix 8A.2.

Table 5.2-2

Source Cask Transfer Subsystem

Specified Dimensions

Part	Calculated Size
Bolts of Cradle	6 bolts 30 mm (1.2 in)
Plate of Anti-Taking Off Device	Thickness 30 mm (1.2 in)
Bolts of the Anti-Taking Off Device	4 bolts 16 mm (~0.6 in)
Diameter of the Locking Pin	D = 80 mm (3.2 in)
Wheel Diameter	D = 450 mm (17.7 in)
Rail Width Minimum	40 mm = (1.6 in)
Guidance Roller	D = 150 mm (5.9 in)
Rail Height Minimum	30 mm (1.2 in)

Cask Transfer Subsystem Sensors

Several sensors are used to ensure that the Cask Transfer Subsystem operates properly. These sensors are listed below.

- Two limit switches on each trolley (one on the front and one on the back) stop motion in the event of collision with the bumper guards. These prevent damage to equipment.
- One limit switch on the back of the receiving cask trolley stops motion in the event of a collision with the source cask.
- One limit switch at the end of the runway rails in the Lower Access Area stops motion if the trolley travels beyond a specified position. This is to prevent crashing into the wall of the Lower Access Area.
- Three limit switches mounted on the rails stop motion of the trolleys. One limit switch is at the space in the Preparation Area for locking. One limit switch is located in the Lower Access Area at the space for locking and mating of the receiving cask trolley. One limit switch is located in the Lower Access Area at the space for locking and mating of the source cask trolley.
- There are three electrical contacts which are mounted in the locking pin housing in the concrete basemat. These tell the operators that the locking pins are fully engaged. One electrical contact is located in each of the three locking locations: In the preparation area used for both casks, in the Lower Access Area in the Receiving Cask Mating Position and in the Lower Access Area in the Source Cask Mating Position.

Maintenance and Repair

Maintenance and repair operations are performed by operators working directly on the failed item. To keep dose rates as low as reasonably achievable, repairs and maintenance will be performed on the trolleys only when the casks are removed, when possible. The casks will be closed prior to any maintenance or repair on the trolleys. A tractor can be used to pull the trolleys out of the Lower Access Area and into the Preparation Area or outside the DTS in the case of a motor failure.

5.2.2 Receiving and Source Cask Mating Subsystem

The Receiving and Source Cask Mating Subsystem provides mating of the casks with the floor of the TCA to provide a confinement seal between the cask upper surface and the floor. The mating subsystem provides a physical confinement barrier with the HVAC performing a secondary confinement function to prevent gross spread of contamination from the TCA to the Lower Access Area. Backup confinement to the Receiving and Source Cask Mating Subsystem is provided by the sliding door between the Lower Access Area and the Preparation Area. The evaluation of the cask mating subsystems is presented in Appendix 8A.3.

The Receiving and Source Cask Mating Subsystem is operated remotely from the Control Center. It is designed such that personnel are not required to be present in the Lower Access Area when this operation is performed. This operation is performed remotely since there is potential contamination on the equipment, and to minimize radiatin exposure. The design incorporates several features which reduce the potential for spread of contamination.

A camera in the Lower Access Area provides partial viewing of these operations.

There are two Cask Mating Subsystems, one for each cask, which are based on the same operating principles. These mating devices are shown on Figures 1.2-3 and 1.2-7 Each Cask Mating Subsystem consists of an overlid with a gripping device, confinement bellows, and a motorized annular platform which supports the overlid. The overlid protects the upper surface of the cask lid from contamination. The gripping device is activated by a drive shaft which is driven by the motorized grapple of the upper crane. The confinement bellows, the annular platform and a static seal between the annular platform and the cask top surface provide the confinement barrier between the TCA and the Lower Access Area. Three electrical screw jacks enable platform lowering and lifting.

The Receiving and Source Cask Mating Subsystem is shown schematically in Figure 5.2-4.

<u>Overlid with Gripping Device</u>

The overlid protects the upper surface of the source cask lid (or receiving cask shield plug) from contamination during removal and storage within the TCA. A static seal at the bottom of the overlid which mates with the top edge of the source cask lid (or receiving cask shield plug) provides this function. The overlid and its gripping device is a welded structure which is made primarily of painted carbon steel.

The overlid contains a gripping device which engages the lifting pintle on the source cask lid (or receiving cask shield plug). The gripping device is operated by a drive screw activated by the motorized grapple of the upper crane. The use of the overlid and gripping device essentially keeps the source cask lid and the pintle free of radioactive contaminants. The overlid gripping device is shown in Figure 5.2-5. A brief description of how the gripping device operates follows:

<u>Initial Condition:</u>

The overlid is initially resting on the annular platform. The gripping fingers are open and the cam is in its lowest position. Due to the geometry of the annular platform and the overlid, the lifting pintle is aligned with the overlid. See Figure 5.2-5.

Step I:

The drive screw is activated, and the cam is lifted to its locked upper position. See Figure 5.2-6. The drive screw is engaged by the motorized grapple on the upper crane which is not shown in the Figures. At this point there is still a gap between the gripping fingers and the source cask lifting pintle.

Step II:

The drive screw continues to turn, lifting the spring plate against the internal spring. A shear pin prevents the spring plate from rotating. The internal spring prevents the spring plate from lifting until the cam is first lifted to its locked position. This last small motion compresses the static seal between the overlid and the source cask lid (or shield plug) and lifts the gripping fingers slightly, closing the gap between the pintle and the gripping fingers. A small recess in the lifting pintle ensures positive lifting, and prevents the fingers from disengaging under load. See Figure 5.2-7.

There are four gripping fingers, and in case of a failure of one finger, the others are able to support the load. The gripping device is identical for the Source Cask Mating Subsystem and the Receiving Cask Mating Subsystem. Therefore, the gripping device stresses were calculated based on the weight of lifting the receiving cask shield plug.

Above the gripping device is the lifting attachment for the overlid. This is shown in Figure 5.2-5. The overall dimensions of the overlids and loads on the gripping devices are provided in Table 5.2-3. The critical dimensions of the TC Cask Mating Subsystem are presented in Table 5.2-4 and shown in Figure 5.2-8.

Table 5.2-3

Receiving and Source Cask Mating Subsystem Overlid Dimensions and Loading

Description	US Units	Metric Units
Source Cask		
Overlid Overall Dimensions	3.3 ft dia x 2.0 ft thick	100 cm dia. x 60 cm thick
Maximum Live Load	1.7 tons	≈ 1.5 tons
Estimated Dead Load	0.88 tons	≈ 0.8 tons
Receiving Cask		
Overlid Overall Dimensions	5.6 ft dia. x 2.0 ft thick	170 cm dia. x 60 cm thick
Maximum Live Load	3.3 tons	≈ 3 tons
Estimated Dead Load	1.6 tons	≈ 1.5 tons

Table 5.2-4

TC Cask Mating Subsystem Calculated Dimensions and Stresses

Description	Size
Axis for Finger of the Overlid Diameter	1.0 in (25 mm)
Thickness of the Finger of the Overlid	2.0 in (50 mm)
Overlid Pintle Thickness	1.6 in (40 mm)
Shield Plug Pintle Thickness	2.0 in (50 mm)

Confinement Bellows

The confinement bellows form the confinement boundary between the TCA mezzanine plate and the cask. They are mounted onto the bottom face of the mezzanine plate and to the top of the annular platform (Figure 5.2-9). Table 5.2-5 presents the confinement bellow characteristics.

Table 5.2-5

Confinement Bellows Characteristics

Characteristic	US Units	Metric Units
Inside Diameter Source Cask Mating Subsystem	4.3 ft	≈ 1.3 m
Inside Diameter Receiving Cask Mating Subsystem	6.6 ft	≈ 2 m
Height, h (Compressed)	1.6 ft	≈ 0.5 m
Thickness	0.1 in	≈ 2 mm
Allowable Deflection Δ	0.3 ft	≈ 0.1 m
Allowable Stretch δ	0.8 ft	≈ 0.25 m
Material	Silicon Coated Polyester Fabric	
Minimum Operating Temperature	40°F	≈ 4°C
Maximum Operating Temperature	240°F	≈ 115°C
Minimum Integrated Dose Design Value	10^7 rad	

Motorized Annular Platform

Three electrical jacks mounted on the bottom of the mezzanine plate are used to stretch the confinement bellows and lower and lift the annular platform. The annular platform supports the overlid, and contains a static seal which is used to mate with the top surface of the cask. The static seal and the confinement bellows provide the confinement boundary between the TCA mezzanine plate and the cask.

The electrical jacks are mounted on spherical bearings which enable the platform lowering and lifting. The jacks operate independently and allow angular and axial misalignment between the real and theoretical cask position. Identical jacks are used for both mating subsystems. The jacks have the following estimated characteristics:

Table 5.2-6 Jack Characteristics

Characteristic	US Units	Metric Units
Force	4500 lbs	2000 daN
Power Requirement	1.6 hp	1.2 kW
Speed	2 ft/min	0.6 m/min
Stroke	1 ft	0.30 m

The annular platforms are made from stainless steel. The annular platform for the receiving cask mating subsystem weighs approximately 1.1 tons (1.0 metric tons). The annular platform for the Source Cask Mating Subsystem weighs approximately 0.66 tons (0.6 metric tons).

Guides on the annular platform are used to ensure proper alignment. These guides fit over the outside diameter of the cask.

The sequence of operations of the motorized annular platforms is as follows:

The platform is lowered, roughly horizontally, by the three jacks operating together until contact is made with the cask. Lowering of the platform continues by the three jacks operating together until one jack reaches its set contact load. The contact load automatically stops movement of the individual jack. The remaining jacks continue to lower the platform until they reach their set contact load. The three jacks are again operated together a last time to ensure that all three have reached their contact load. The platform is raised using the three jacks operating together until they reach their upper position.

Sensors

The load on each jack is measured to ensure proper engagement of the subsystem with the cask. The vertical position of each jack is also measured by a potentiometer which provides backup information regarding proper mating.

A rod which runs through the drive shaft of the gripping device actuates sensors in the grapple of the upper crane regarding positive engagement and disengagement of the gripping device.

Maintenance

Cask Mating System maintenance is done by operators working directly on the failed item. Maintenance is only performed when the casks and fuel assemblies have been removed from the TCA and Lower Access Area. The confinement bellows and seals are expected to be replaced after about 100 days of operation. The bellows and the lower annual platform are bagged in plastic. While still covered with the plastic, the bellows are unbolted from the lower annular platform and are allowed to drop into a plastic confinement bag. The contaminated bellows are disposed of appropriately. A clean set of bellows are placed in a clean plastic confinement bag and are brought back to the lower annular platform and bolted, while still covered with the plastic.

5.2.3 Receiving and Source Cask Transfer Confinement Port Cover Handling Subsystem

The receiving and source cask TC port covers are rail mounted trolleys activated by electrical screw jacks. One port cover is positioned above each cask opening in the mezzanine floor. The openings allow access into the casks from the TCA for the lid and shield plug grapple and the fuel assembly grapple. The receiving and source cask TC port covers are shown on Figure 1.2-8. A guidance device is mounted on each TC port cover, which allows the source cask lid (or receiving cask shield plug) to be accurately positioned on the port cover during fuel transfer operations.

The TC port covers are operated remotely from the Control Center.

The source cask TC port cover has two positions: open and closed. The receiving cask TC port cover has three positions: open, closed and off-centered. The off-centered position is the position in which the shield plug is lowered or lifted off the receiving cask TC port cover. Both port covers move only in the Y - direction.

The main components of the TC port covers are:

- Two motorized port covers and
- Two sets of runway rails.

Each port cover has four wheels (two on each side) which run on the rails. The port cover is guided on the rails by four sets of lateral rollers as shown in Figure 5.2-10 The shape of the runway rail prevents the port cover from becoming disengaged from the rails due to a seismic event.

A locking pin which penetrates into a hole in the mezzanine plate prevents the port cover from accidental forward or backward movement when fuel is being transferred. This prevents the port cover from hitting into the fuel assembly transfer tube if it becomes disengaged or accidentally closed while fuel is being transferred. The locking pin is jack operated and can be accessed through a penetration in the wall of the DTS for manual operation in the event of an equipment failure. The source cask TC port cover locking pin is 2 inches (50 mm) in diameter and the receiving cask TC port cover locking pin is 1.6 in (40 mm) in diameter.

The TC port covers are actuated by electrical screw jacks. The motors for the jacks are located outside of the TCA, allowing easy replacement in case of a failure. The jack is able to move the port cover with an average travel length of 6.6 feet (≈ 2 m). The jacks run on 440 3 phase voltage. 1.7 hP (1.3 kW) are required for the source cask TC port cover and 2.7 hP (2 kW) are required for the receiving cask TC port cover. Both jacks run at a speed of 3 ft/min (0.9 m/min).

The jacks will be shielded from the weather.

The main structural components are made from painted carbon steel. The paint will meet the requirements of Category A - Service Level 1 coatings as defined in ASME-NOG-1.

The main characteristics of the source and receiving cask TC port covers are presented in Tables 5.2-7 and 5.2-8.

Table 5.2-7

Source Cask TC Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	5.2 ft x 4.9 ft x 5.9 in	≈ 1.6 m x 1.5 m x 0.15 m
Length of Runway	12.8 ft.	≈ 3.9 m
Span	5 ft	≈ 1.5 m
Wheel Base	5.3 ft	≈ 1.6 m
Maximum Live Load	2.5 tons	≈ 2.3 tons
Dead Load	≈ 1.7 tons	≈ 1.5 tons

Table 5.2-8

Receiving Cask TC Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	6.6 ft x 6.6 ft x 5.9 in	≈ 2 m x 2 m x 0.15 m
Length of Runway	13.6 ft.	≈ 4.2 m
Span	6.9 ft	≈ 2.1 m
Wheel Base	5.6 ft	≈ 1.7 m
Maximum Live Load	5 tons	≈ 4.5 tons
Dead Load	≈ 2.8 tons	≈ 2.5 tons

Sensors

Limit switches mounted on the rails at each of the set locations (open and closed for the source cask TC port cover and open, closed and off-centered for the receiving cask TC port cover) automatically stop movement. Additional limit switches at each end of the runway rails prevent over travel. Electrical contacts in the mezzanine plate and in the jacks indicate whether the lock is engaged or disengaged.

Maintenance and Repair

Maintenance is performed directly on the failed item after removal of the fuel and casks from the DTS. Maintenance on the jacks can be performed at any time since they are housed outside of the confinement area.

5.2.4 Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem

The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem consists of two different parts. The first part is the Upper Shield Port Covers which is the equipment which controls the opening and closing of the upper shield port covers on the roof of the TCA (In the Roof Enclosure Area). The second is the Upper Crane which is housed in the Roof Enclosure Area. The Upper Crane is used to lift and lower the receiving cask shield plug and the source cask lid. The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem is evaluated in Appendix 8A.4.

5.2.4.1 Receiving and Source Cask Upper Shield Port Covers

The upper shield port covers are rail mounted trolleys activated by electrical screw jacks. They provide shielding over the openings in the roof plate. One upper shield port cover is positioned above each opening in the roof plate (above each cask). The two upper shield port covers are identical. The openings allow access into the TCA from the Roof Enclosure Area for the lid and shield plug grapple. The upper shield port covers are shown on Figure 1.2-4. The upper shield port covers are operated from the Control Center.

The upper shield port covers operate on the same principle as the TC port covers and also provide shielding. The covers are seven inch (178 mm) thick painted carbon steel.

Both upper shield port covers move in the Y - direction and have two fixed positions: open and closed.

The main components of the upper shield port covers are:

- Two motorized port covers and
- Two sets of runway rails.

Each upper shield port cover has four wheels (two on each side) which run on the rails. The upper shield port cover is guided by four sets of lateral rollers as shown in Figure 5.2-11. The shape of the runway rail prevents the upper shield port cover from becoming disengaged from the rails due to a seismic event.

A one inch (24 mm) diameter locking pin which penetrates into a hole in the upper plate prevents the upper shield port cover from accidental forward or backward movement when it is in the closed position. This prevents the upper shield port cover from opening due to a seismic event which would result in inadequate shielding at the roof. The locking pin is jack operated and can be manually activated in the event of an equipment failure.

The upper shield port covers are actuated by electrical screw jacks. The jacks are located in the Roof Enclosure Area, allowing easy replacement in case of a failure. Each jack is able to move the port cover with an average travel length of 2.8 feet (≈ 85 cm). The jacks run on 440 3 phase voltage. 0.4 hP (0.3 kW) are required for movement of each upper shield port cover. Both jacks run at a speed of 3 ft/min (0.9 m/min).

The main structural components are made from painted carbon steel. The paint will meet the requirements of Category A - Service Level 1 coatings as defined in ASME-NOG-1.

The main characteristics of the upper shield port cover are presented below.

Upper Shield Port Cover Characteristics

Characteristic	US Units	Metric Units
Overall Dimensions	31.5 in x 38 in x 7 in	≈ 0.8 m x 1 m x 0.18 m
Length of Runway	7.5 ft.	≈ 2.3 m
Span	2.9 ft	≈ 0.9 m
Wheel Base	2.6 ft	≈ 0.8 m
Weight	1.4 tons	≈ 1.3 tons

Upper Shield Port Covers Sensors

Limit switches mounted on the rails at each of the set locations (Open and Closed) automatically stop movement. Additional limit switches at each end of the runway rails prevent over travel. Electrical contacts in the upper plate and in the jacks indicate whether the locks are engaged or disengaged.

Maintenance and Repair

Maintenance is performed directly on the failed item, after the fuel is returned to the casks and the casks are closed. Maintenance can be performed in the roof enclosure area for short periods of time, in the event of an emergency while fuel is in the TCA, following special procedures.

5.2.4.2 Upper Crane

The upper crane removes the shield plug from the empty receiving cask, places it in its storage position on the TC port cover and replaces it in the receiving cask upon completion of fuel transfer. The upper crane also removes the lid from the source cask, places it in storage, and installs it onto the source cask when unloading is completed.

The upper crane is shown on Figure 1.2-4. It consists of a motorized trolley suspended on rails, a hoist and a motorized grapple. It is a Type 1 crane as designated in ASME NOG-1. The trolley moves between two fixed positions: directly above the source cask and directly above the receiving cask. The upper crane is housed within the Roof Enclosure Area. When the TC port cover and upper shield port cover are opened, the hoist lowers the grapple through the opening of the roof plate and the TC mezzanine floor. The grapple engages with a lifting pintle on the source cask lid or receiving cask shield plug. The lid (or shield plug) is then raised above the top of the TC port cover. While the lid (or shield plug) is suspended, the TC port cover is moved underneath the lid (or shield plug). The lid (or shield plug) is then lowered onto the TC port cover for temporary storage. Note that the upper crane is never moved laterally while under load.

During fuel transfer, the upper crane is not operated, and is shielded by the roof plate and upper shield port covers.

The protective cover protects the crane from environmental loads (wind and snow and tornado missiles).

Motor Driven Trolley

The trolley is motorized and moves along the X-axis on rails. The trolley is 4.3 ft x 4.6 ft x 2.8 ft (1.3 m x 1.4 m x 0.85 m) and has a capacity of 6.1 tons (5.5 metric tons). It runs on rails 3.9 ft (1.2 meters) apart, and has a wheel base of 2.6 ft (0.8 m). The main components of the trolley are made from painted carbon steel. The trolley positioning accuracy is at least ± 0.4 inches (± 1 cm).

The trolley is driven by means of an asynchronous motor and service brake. Two trolley wheels are motorized. The trolley has a speed of 3.3 ft/min (≈ 1 m/min).

The operator indicates which position the trolley should be in (above source cask or above receiving cask) and the trolley moves to the desired position. Limit switches mounted on the rail stop motion and ensure that the trolley is positioned in the correct location.

The drive motor characteristics are listed below:

- 440 three phase V,
- 60 Hz, and
- 2.7 horsepower (2 kW).

The motor produces approximately 0.6 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power (and can be manually disengaged, if necessary). The service brake is engaged as a parking brake when the trolley is not in motion.

Trolley guidance is made by two sets of lateral rollers on one of the two runway rails. See Figure 5.2-12. The rollers are 1.4 inches (36 mm) in diameter, and are sized to withstand a lateral load of 5% of the vertical load. The guidance rollers are not designed to withstand the seismic event.

A plate mounted beneath the trolley which runs below the runway rail at each wheel location prevents the trolley from tipping over in a seismic event. This plate is defined as the "Anti-taking off Device", and is shown in Figure 5.2-12. The minimum thickness of the plate is 0.8 inches (20 mm), and must run beneath the rail for at least 5.5 inches (140 mm). The plate is attached to the trolley by means of four 5/8 inch (16 mm) diameter bolts. It is sized to take the vertical static and seismic loads.

The anti-derailing devices are sized to withstand the lateral loads on the trolley due to static and seismic loading. See Figure 5.2-13.

The trolley has a hoist ring for attaching a winch and an auxiliary motor to move the trolley in the event of malfunction. The winch and auxiliary motor would be set on the top of the upper plate prior to maintenance intervention.

A summary of the calculated dimensions required for the upper crane trolley are presented in Table 5.2-9.

Wiring for equipment mounted on the trolley is guided on rails mounted adjacent to the trolley rails.

Table 5.2-9

Upper Crane Trolley Calculated Dimensions

Part	Calculated Size
Plate of Anti-Taking Off Device	Thickness 20 mm (0.8 in)
Bolts of the Anti-Taking Off Device	4 bolts 16 mm (5/8 in)
Wheel Diameter	D = 139 mm (5.5 in)
Rail Width Minimum	37 mm (1.45 in)
Guidance Roller	D = 36 mm (1.4 in)

Upper Crane Hoist

The hoist motorization is shown schematically in Figure 5.2-14. The hoist is designed to lift and lower the overlid (described in the Cask Mating Subsystem Section) with the receiving cask shield plug or the source cask lid. The hoist consists of two cables, 1 cable drum, a compensator and a series of pulleys. The reeving system is divided into two separate load paths so that either path will support the load and maintain vertical alignment in the event of cable breakage or failure in the cable system.

The cable drum is mounted on the upper plate of the DTS. Each cable runs from the cable drum, around a pulley mounted on the crane support structure (pulleys #1 and #8), around a pulley on the trolley (pulleys #2 and #9), down and around a pulley on the grapple device (pulleys #3 and #10), up and around pulleys on the trolley (pulleys #4 and #5 and #11) down again around a pulley on the grapple (pulleys #6 and #12), up to a pulley on the trolley (pulleys #7 and #13) to the compensator. The kinematic chain is shown in Figure 5.2-15. The compensator is used to balance the load, taking up the slack in the cables. It is also used in the event of a cable break to alert the operator.

The hoist has an asynchronous motor, reduction gear, emergency brake and service brake. The service brake is housed within the motor, but can be manually disengaged. The emergency brake is housed on the drum, and is activated in the event of a malfunction of the

service brake as indicated by overtravel or overspeed indications or in the event of a loss of power.

The hoist has a variable speed drive which results in lift speeds from 1 ft/min (0.3 m/min) to 16.4 ft/min (5 m/min). Using a frequency variable speed drive, acceleration and deceleration slopes are utilized to avoid load oscillation.

Each cable is capable of safely lifting the entire load and keeping the load balanced. The cable is made from 0.48 inch (12 mm) 6 x 37 wire rope.

Lid/Shield Plug Grapple

The motorized grapple is used to grip the overlid and to activate the overlid gripping device to engage the receiving cask shield plug or source cask lid. The grapple is shown in Figures 5.2-16 and 5.2-17. The overlid gripping is accomplished by means of four fingers which are activated by an electrical screw jack. The four fingers engage with the pintle on the overlid. The jack moves a shaft with a cam shaped base up and down. In the full up position, the grapple fingers are disengaged. In the full down position, the grapple fingers are fully engaged.

The grapple can be disengaged manually in the event of a jack malfunction, by means of a long handled pole which can be installed through a penetration in the wall of the DTS, or by means of a long handled tool lowered down through the roof plate opening. If the grapple fails to engage properly, it will be moved back up to the roof enclosure area and inspected.

The overlid gripping device is activated by means of an electrical motor and gear train. The motor and gears turn the drive shaft which activates the gripping device.

A winder for the electrical cables used for sensors and equipment on the grapple is mounted on the trolley.

Upper Crane Sensors

There are four limit switches which stop motion of the trolley, all mounted on the trolley rails. Switches stop motion at the correct location above the source cask and the receiving cask. A switch at each end of one of the rails also stops motion. These limit switches would only be activated in the event of a failure of one of the other switches or the service brake.

The hoist has several sensors, as required by NOG-1 for a Type 1 crane. A wire potentiometer mounted on the trolley provides information regarding the absolute positioning of the grapple. This information is used to control the speed of the grapple, and to stop the grapple in the following positions:

First High Limit	The lid and overlid are lifted above the TC port cover
Second High Limit	The grapple is in the upper position above the roof plate
First Low Limit	The lid and overlid are seated on the TC port cover
Second Low Limit	The lid or shield plug is seated in the cask

Note that the low limits are different for the source cask lid and the receiving cask shield plug.

An electrical switch mounted on the trolley is used to stop motion in the event of an overtravel in the high direction (The grapple has gone beyond the second high limit). An electrical switch mounted on the cable drum is used to stop motion in the event of an overtravel in the low direction. An electrical switch on the cable drum is used to stop motion in the event of the hoist speed exceeding its maximum speed.

Two electrical switches (one for each cable) mounted on the drum are used to detect improper threading of the hoist rope in the hoist drum grooves. Actuation of this switch shall result in removal of power from all crane drive motors and setting of the emergency brakes. Actuation of the limit switch prevents further hoisting or lowering. When this occurs, an operator knowledgeable in the hoist control system shall determine and correct the cause of the tripping of the limit switch. That operator shall direct the lowering of the load.

Two electrical switches mounted on the compensator are used to stop motion in the event of an unbalanced load. These switches will be activated in the event of a cable break, or a failure in one of the load paths.

A load cell is mounted on the grapple. If the reading from the load cell is abnormally high or abnormally low during lifting or lowering under load, motion will be stopped.

A rod mounted on the overlid gripping device connects to a positioning device within the grapple. This sensor provides information regarding the status of the overlid gripping device fingers. There are three positions which are used to control the overlid gripping device: fingers open, fingers closed, and fingers gripped.

An electrical contact on the grapple provides information regarding the status of the grapple fingers. There are two positions of the grapple fingers: open and closed.

Upper Crane Maintenance and Repairs

Maintenance on parts of the upper crane is performed by operators directly on the failed item after the grapple has been moved into the Roof Enclosure Area. Maintenance and repairs would normally be done after the fuel and casks have been removed from the DTS. However, if necessary, limited repairs can be performed on the upper crane if the upper shield port covers are closed and locked.

In the event of a malfunction, equipment can be manually activated to ensure that the source cask lid and receiving cask shield plug can be reinstalled in the casks.

Standard industry practice will be followed regarding preventative maintenance. All equipment and sensors will be tested prior to use. Inspection and testing before operation and during storage will be performed following the equipment supplier's recommendations and handling equipment rules and regulations.

5.2.5 Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem is an NOG-1, Type 1 gantry crane. The gantry crane consists of:

- A bridge supporting a trolley with two girders and end ties running on rails (X-direction);
- A motor driven trolley supporting a rotating platform and running on bridge girders (Y-Direction);
- A rotating platform supporting the Z-direction hoists and allowing correct orientation of the transfer tube above the cask basket cell (θ-Direction);
- A transfer tube which encloses and protects the fuel assembly during lateral movement;
- A spent fuel assembly grapple; and
- A crud catcher at the bottom of the transfer tube which minimizes the spread of contamination in the TCA.

Two cameras and associated lighting are mounted at the base of the transfer tube. These cameras are used to verify identification of each fuel assembly and ensure that the fuel is properly lifted and lowered into the fuel assembly compartment.

The Fuel Assembly Handling Subsystem is shown on Figure 1.2-9 and shown schematically in Figure 5.2-18.

The Fuel Assembly Handling Subsystem grapple attaches to a fuel assembly in the source cask, lifts it vertically (in Z direction) into the transfer tube, translates it laterally (both in X and Y directions), and rotates about the fuel assembly centerline to position it directly above the opening in the fuel cell of the receiving cask. The fuel assembly is then lowered and released. Since the subsystem has a full range of motion in the X, Y, Z and θ directions it is adaptable to any two vertical loading/unloading casks.

The fuel handling crane has been analyzed for static (dead and live loads) and seismic loads. The seismic loads are analyzed with and without the rated load. The fuel handling crane is evaluated in Appendix 8A.5.

Fuel Assembly Handling Bridge

The fuel handling bridge consists of a welded structure of two girders and two end ties mounted on rails. Each bridge rail is simply supported on the concrete structure. The rails are W 12 x 96 beams reinforced by two plates on the outside. KS22-A45 runway rails are mounted on the beams, and clamped in place by steel shapes bolted to the main beams.

The bridge allows movement in the X-direction for nearly the full width of the TCA. This allows the fuel transfer tube to be positioned over any fuel assembly location in either the source cask or the receiving cask. The X-direction movement is approximately 18 feet (≈ 5.5 m). The average bridge travel is 16 feet (≈ 5 m).

The bridge has the following characteristics:

Overall Dimension	9 ft x 16 ft x 2 ft (2.8 m x 5 m x 0.6 m)
Wheel Base	7.9 ft (≈ 2.4 m)
Span	15.4 ft (≈ 4.7 m)
Maximum Bridge Live Load	6.6 tons (≈ 6 metric tons)
Bridge Dead Load	5 tons (≈ 4.5 metric tons)
Positioning Accuracy	± 1/8 inch (± 3 mm)

The bridge is guided by two sets of lateral rollers on one of the runway rails as shown in Figure 5.2-19. The rollers are 1.1 inch (28 mm) minimum diameter and are sized to withstand a lateral load of 5% of the dead and live loads on the bridge. The guidance rollers are not designed to withstand the seismic event.

An anti-derailing device and an anti-taking off device are used to prevent the bridge from becoming disengaged during a seismic event. There are four anti-derailing devices bolted to the underside of the bridge. These act as bumpers which take the lateral loadings during a seismic event. See Figure 5.2-20.

The anti-taking off device is a plate mounted beneath the bridge which runs below the top flange of the structural beam. See Figure 5.2-20. The plate is sized to withstand the vertical loading due to a seismic event, and prevent the bridge from becoming disengaged from its rails. The minimum thickness of the plate is 1.2 inches (30 mm) and must run beneath the beam flange for at least 5.5 inches (140 mm). The plate is attached to the bridge by four 5/8 inch (16 mm) diameter bolts.

The bridge is made up of two kinds of beams: W 12 x 8 x 0.5 beams which span the rails and W 14 x 82 beams which run above the rails. The beams are reinforced by two plates on the sides. A schematic of the bridge is shown in Figure 5.2-22.

The bridge is driven by means of an asynchronous motor and brake. The drive is a "A-1" Drive as defined in ASME NOG-1. The brake can be manually disengaged. One axle is motorized. Two bridge speeds are used: a slow speed of 0.33 ft/min (≈ 0.1 m/min) and a higher speed 26 ft/min (≈ 8 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor and to avoid load oscillation.

The bridge is operated semi-automatically. The destination position is input into a PC in the Control Center. The operator then initiates the movement by inputting a command into the PC. When the programmed position is reached, movement stops. Fine positioning is performed using a joystick with the aid of a video camera mounted on the fuel transfer tube. Fine positioning is performed at the slow speed. A stop button on the control panel can be used to stop movement at any time. The operator views the TCA and the fuel cell location on monitors in the Control Center during this operation.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 2 horsepower (1.5 kW)

The motor produces approximately 0.5 kW of heat output while in operation.

The bridge has two braking mechanisms: a service brake and an emergency brake.

The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power. The service brake is engaged as a parking brake when the bridge is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

An endless chain is located on one side of the bridge and is used in case of a motor failure. An operator can push or pull the endless chain using a rod through a wall penetration to move the bridge.

Cable guides run along each side of the bridge. One is used for the primary power supply to the fuel hoist and grapple. The other is used for emergency power supply to the fuel hoist and grapple. Cable separation has been provided for safety purposes to keep the hoist systems independent and redundant.

Fuel Assembly Handling Trolley

The fuel assembly handling trolley is supported on rails bolted to the fuel assembly handling bridge. Four bumper guards, one at the end of each rail, can stop the trolley in the event of a malfunction. The trolley is shown schematically in Figure 5.2-23. The rails are W 12 x 96 beams reinforced by two plates on the outside. KS22-A45 runway rails are mounted on the beams, and clamped in place by steel shapes bolted to the structural beams.

The trolley allows movement in the Y - direction and allows the fuel transfer tube to be positioned over any fuel assembly location in either the source cask or the receiving cask.

The trolley has the following characteristics:

Overall Dimension	6.6 ft x 9.2 ft x 1.2 ft (2 m x 2.8 m x 0.4 m)
Wheel Base	7.9 ft (≈ 2.4 m)
Span	5.6 ft (≈ 1.7 m)
Maximum Trolley Live Load	4.9 tons (≈ 4.5 metric tons)
Trolley Dead Load	1.7 tons (≈ 1.5 metric tons)
Positioning Accuracy	± 1/8 inch (± 3 mm)

The trolley is guided by two sets of lateral rollers on one of the runway rails as shown in Figure 5.2-24. The rollers are 1.1 inch (28 mm) minimum diameter and are sized to withstand a lateral load of 5% of the dead and live loads on the bridge. The guidance rollers

are not designed to withstand the seismic event.

An anti-derailing device and an anti-taking off device are used to prevent the trolley from becoming disengaged during a seismic event. There are four anti-derailing devices bolted to the underside of the trolley. These act as bumpers which take the lateral loadings during a seismic event. The anti-derailing device is shown in Figure 5.2-25.

The anti-taking off device is a plate mounted beneath the bridge which runs below the top flange of the supporting bridge beam. The plate is sized to withstand the vertical loading due to a seismic event, and prevent the trolley from becoming disengaged. The minimum thickness of the plate is 1.2 inches (30 mm) and must run beneath the beam flange for at least 5.5 inches (140 mm). The plate is attached to the bridge by 4 5/8 inch (16 mm) diameter bolts.

The trolley is made from a frame of W12 x 12 x 0.5 beams bolted to a flat plate.

The trolley is driven by means of an asynchronous motor and brake. The drive is an "A-1A" Drive as defined in ASME NOG-1. The brake can be manually disengaged. One axle is motorized. The motor has a variable speed which results in a trolley movement of 0.33 ft/min (≈ 0.1 m/min) at slow speed and 20 ft/min (≈ 6 m/min). Since the motor has a frequency variable speed drive, acceleration and deceleration slopes are used to minimize stress on the motor and to avoid load oscillation.

The trolley is operated semi-automatically. The destination position is input into a PC in the Control Center. The operator then initiates the movement by inputting a command into the PC. When the programmed position is reached, movement stops. Fine positioning is performed using a joystick with the aid of a video camera mounted on the fuel transfer tube. Fine positioning is performed at the slow speed. A stop button on the control panel can be used to stop movement at any time. The operator views the TCA and the fuel cell location on monitors in the Control Center during this operation.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 1.2 horsepower (0.9 kW)

The motor produces approximately 0.3 kW of heat output while in operation.

The trolley has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the

output shaft. Both brakes engage upon loss of electrical power. The service brake is engaged as a parking brake when the bridge is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

An endless chain is located on one side of the trolley and is used in case of a motor failure. An operator can push or pull the endless chain using a rod through a wall penetration to move the bridge. The endless chain can only be accessed with the bridge in a designated position. Therefore, if manual operation is required, the trolley must be positioned prior to positioning the bridge crane.

Rotating Platform

The rotating platform is a welded mechanical structure which supports the transfer tube and the hoist motorization. The rotating platform is shown schematically in Figure 5.2-26 . The rotating platform has overall dimensions of 5.6 ft in diameter by 3.3 ft high (≈ 1.7 m diameter by 1 m high). The maximum live load on the rotating platform is 3.8 tons (3.4 metric tons). The dead load of the rotating platform is 1.6 tons (1.4 metric tons).

The rotating platform is driven by means of an asynchronous geared motor and brake, mounted on the trolley. The brake can be manually disengaged. The rotating platform can be positioned within ± 1°.

The motor has a variable speed set to operate at two speeds: high and low. The slow speed is 10°/min and the high speed is 180°/min. Acceleration and deceleration slopes are utilized to avoid load oscillation. The operator controls the rotation through the use of a joystick in the Control Center, choosing a direction (clockwise or counter-clockwise) and the speed. Motion stops when the joystick is released.

The drive motor characteristics are listed below:

- 440 three phase V
- 60 Hz
- 0.9 horsepower (0.7 kW)

The motor produces approximately 0.2 kW of heat output while in operation.

The rotating platform has two braking mechanisms: a service brake and an emergency brake. Both brakes engage upon loss of electrical power (and manually disengaged if necessary). The service brake is engaged as a parking brake when the rotating platform is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit switch is activated;
- The operator pushes the emergency brake button; or
- Loss of Power.

The rotating platform is supported by ball bearings. A toothed wheel located at the upper edge of the plätform engages with a ring gear on the rotating platform. In the event of a malfunction, a rod through a wall penetration can be used to manually drive the gearing system.

An anti-taking off device is used to ensure that the rotating platform does not become disengaged from the trolley in a seismic event. The anti-taking off device is a brace mounted to the trolley which extends over the top of the rotating platform.

Fuel Assembly Transfer Tube and Hoisting System

The transfer tube is a 0.8 inch thick (20 mm) stainless steel tube which is mounted to the rotating platform. The fuel assembly grapple pulls the fuel through the transfer tube during lifting. The transfer tube fully encloses the fuel assembly during lateral transfer and rotation. The bottom of the transfer tube is the crud catcher which can be opened or closed.

There are two separate hoisting mechanisms as shown in Figure 5.2-27. The hoists are motorized by two separate power lines (one for each motor). There is only one cable, which is designed as fail-safe. The cable runs between two cable drums mounted on the rotating platform. Two pulleys mounted on the top of the transfer tube and one pulley mounted on the grapple allow the fuel assembly grapple to be lifted and lowered. Each cable drum is designed to store the total length of the cable.

Each hoist is operated by means of a variable speed motor with a service brake and an emergency brake. The motors are identical, but are designed to operate one at a time. The motors has two speeds. The speeds are 0.33 ft/min ($\approx$ 0.1 m/min) or 16 ft/min ($\approx$5 m/min). Acceleration and deceleration slopes are used to avoid load oscillation.

The hoist is operated by means of a joystick in the Control Center. Below a certain height, the hoist will only operate at the slow speed.

The power supply system has the following characteristics:

- 440 three phase V
- 60 Hz
- 3 hP (2.2 kW)

The motor produces approximately 0.7 kW of heat output while in operation.

The hoist has two braking mechanisms: a service brake and an emergency brake. The service brake is located on the motor drive shaft. The emergency brake is located on the output shaft. Both brakes engage upon loss of electrical power. The service brake is engaged as a parking brake when the hoist is not in motion. The emergency brake is activated in the following events:

- A sensor such as an overtravel limit or overspeed indication is detected;
- The operator pushes the emergency brake button; or
- Loss of Power.

In case of a failure of one motor, the other motor can complete the fuel transfer.

At the base of the transfer tube, two viewing cameras are mounted which are used to precisely locate the tube above a fuel cell and also positively identify each fuel assembly.

Fuel Assembly Grapple

The fuel assembly grapple shown on the drawings is based on engaging a 15 x 15 B&W PWR fuel assembly. However the basic principles in the design of this grapple can be used for other types of fuel. Since PWR and BWR nozzles are different, two different gripping devices would be used. The BWR fuel would be gripped from the outside, while the PWR fuel is gripped internally.

The PWR grapple consists of a welded mechanical structure supporting the gripping device. When the fuel assembly is gripped, the gripping device is securely engaged in order to avoid the drop load.

The grapple has two independent actuating mechanisms. One electrical jack (connected to the primary power line) is used during normal operating conditions. Two additional electrical jacks (connected to the secondary power line) are used in the event of a failure in the primary electrical jack. The grapple design is shown in Figure 5.2-28.

Crud Catcher

The crud catcher is the bottom portion of the transfer tube. It covers the bottom of the fuel assembly when it is fully retracted into the transfer tube, and minimizes the spread of radioactive particulate during fuel transfer. During lateral movement and rotation of the fuel assembly, the crud catcher is closed.

The crud catcher is powered by an electrical jack mounted on the side of the transfer tube. It can rotate up to 90° so that it can be emptied over an open cask.

In case of a malfunction of the crud catcher, the operator can manually unlock the device using a rod through a wall penetration. The crud catcher is shown in Figure 5.4-29.

Fuel Assembly Handling Subsystem Sensors

There are two limit switches which stop motion at the end of the bridge runway rails. A synchroresolver provides the operator with absolute positioning information on the bridge.

Similarly, there are two limit switches which stop motion at the end of the trolley rails. A synchroresolver provides the operator with absolute positioning information on the trolley.

The rotating platform is also equipped with a synchroresolver which provides the operator with the rotational position of the fuel transfer tube.

The hoist has several sensors, as required by NOG-1 for a Type 1 crane. A wire potentiometer mounted on the top of the transfer tube provides information regarding the absolute positioning of the grapple. This information is used to control the speed of the grapple, and to stop the grapple in the following positions:

First High Limit	Fuel grapple is in the maximum operating position
First Low Limit	The fuel grapple is below a set position where only slow speed can be used.
Second Low Limit	The fuel grapple is in the engagement or disengagement position in the source cask.
Third Low Limit	The fuel grapple is in the engagement or disengagement position in the receiving cask.

An electrical switch mounted on the top of the transfer tube is used to stop motion in the event of an overtravel in the high direction (The grapple has gone beyond the first high limit). An electrical switch mounted on each cable drum is used to stop motion in the event of an overtravel in the low direction. An electrical switch on the cable drum is used to stop motion in the event of the hoist speed exceeding its maximum speed.

Two electrical switches (one for each drum) are used to detect improper threading of the hoist rope in the hoist drum grooves. Actuation of this switch shall result in removal of power from all crane drive motors and setting of the brakes. Actuation of the limit switch prevents further hoisting or lowering. When this occurs, a person knowledgeable in the hoist control system shall determine and correct the cause of the tripping of the limit switch. That person shall direct the lowering of the load.

A load cell is mounted on the hoist system. If the reading from the load cell is abnormally high or abnormally low during lifting or lowering under load, motion will be stopped.

A limit switch on the grapple indicates that the fuel assembly is present under the grapple, and stops motion.

A limit switch on the grapple provides information regarding the status of the grapple fingers. There are two positions used to operate the grapple: open and closed.

Fuel Assembly Handling Subsystem Maintenance and Repairs

Maintenance on parts of the Fuel Handling Subsystem is done by operators directly on the failed item after the fuel and casks have been removed from the DTS.

In the event of a malfunction, all equipment is backed up by completely redundant systems or can be manually activated to ensure that the fuel assembly can be reinstalled in a cask.

Standard industry practice will be followed regarding preventative maintenance. Equipment and sensors will be tested prior to use. Inspection and testing before operation and during storage will be performed following the equipment supplier's recommendations and handling equipment rules and regulations.

Figure 5.2-1

Cask Transfer Subsystem Trunnion Cradles

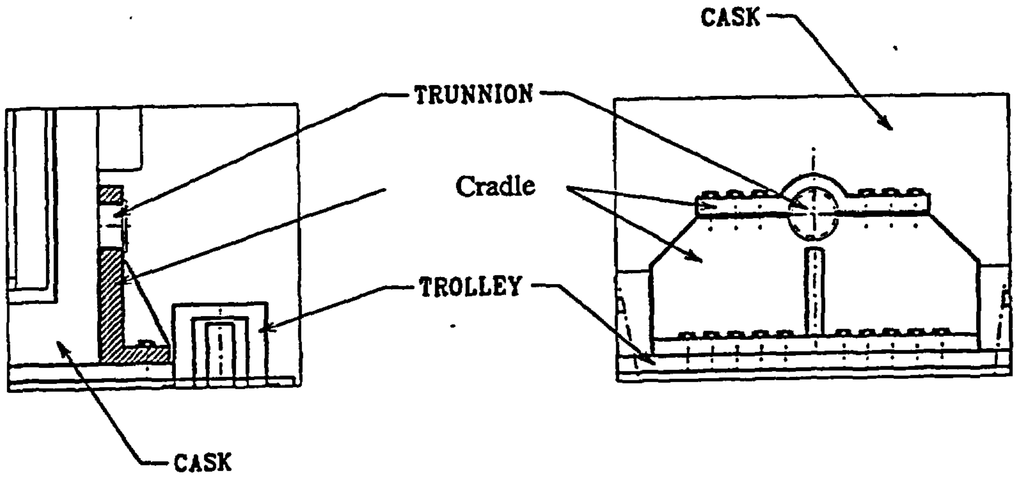


Figure 5.2-2

Cask Transfer Subsystem Locking Pin

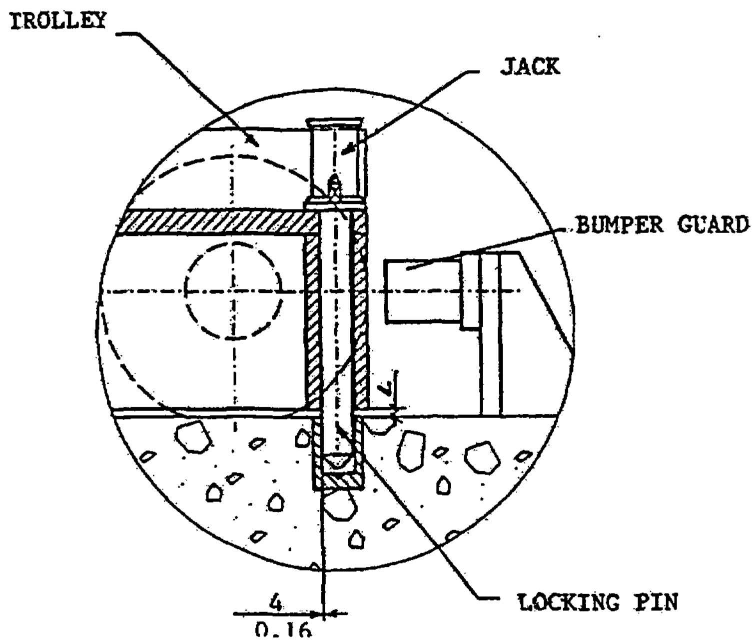


Figure 5.2-3

Cask Transfer Subsystem Trolley Guidance and Anti-Taking Off Device

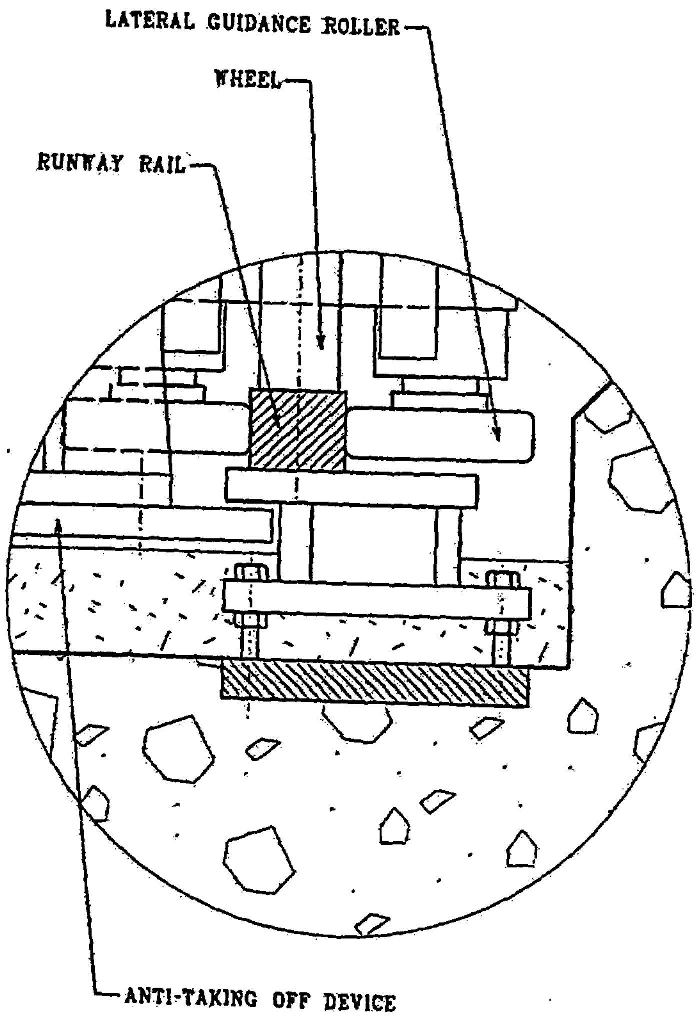


Figure 5.2-4

Receiving and Source Cask Mating Subsystem

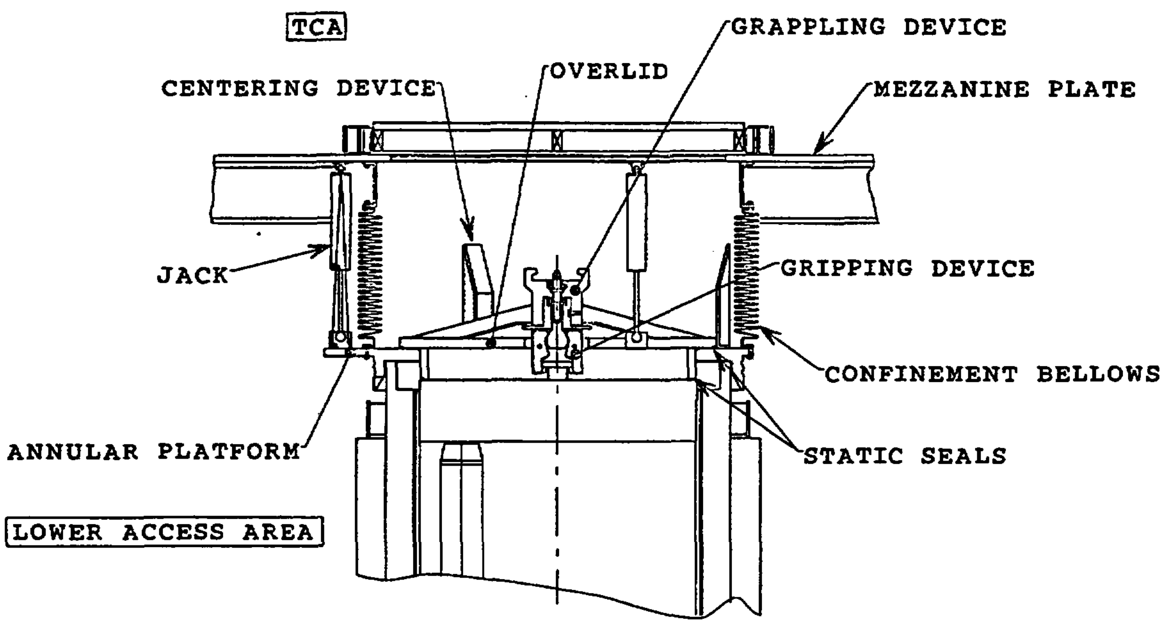


Figure 5.2-5

Gripping Device - Initial Open Position

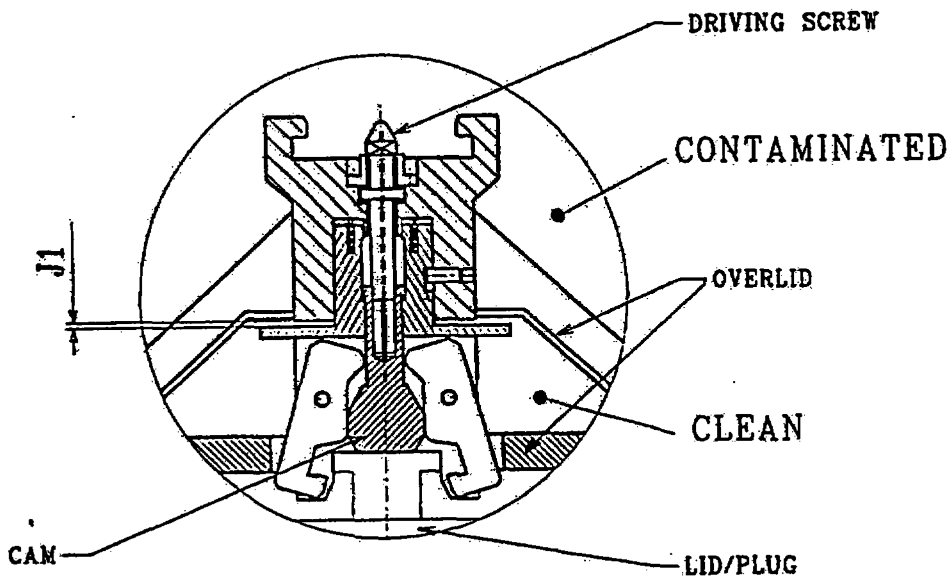


Figure 5.2-6

Gripping Device - Intermediate Position

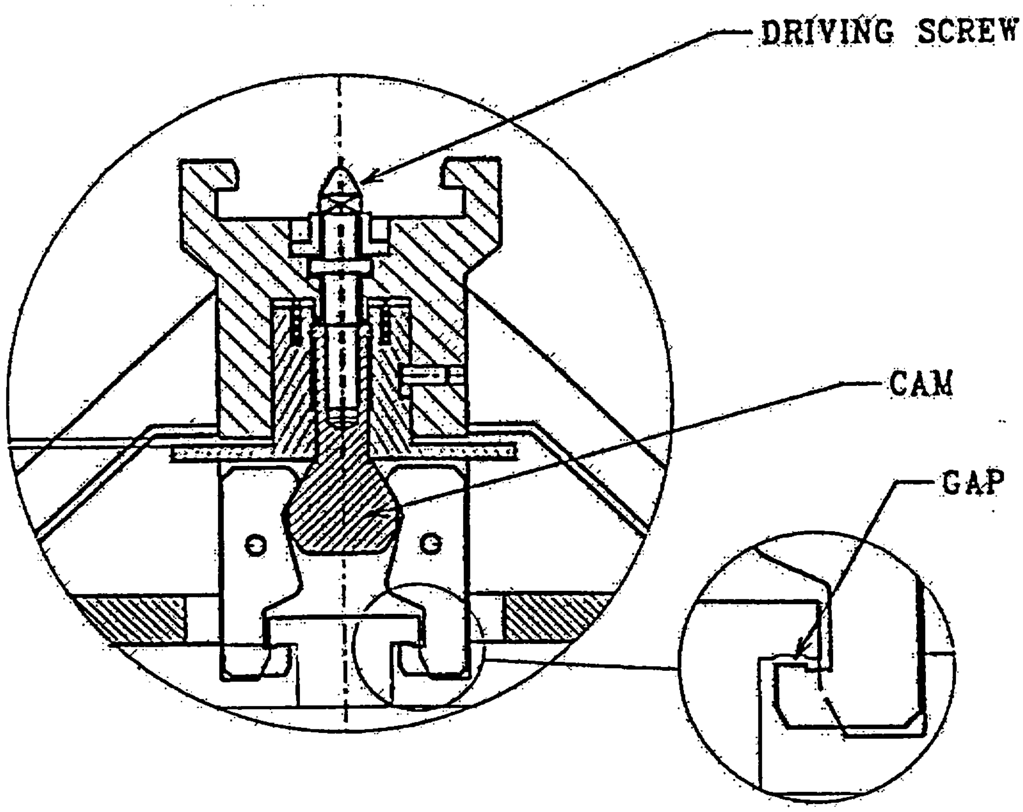


Figure 5.2-7

Gripping Device - Final Engaged Position

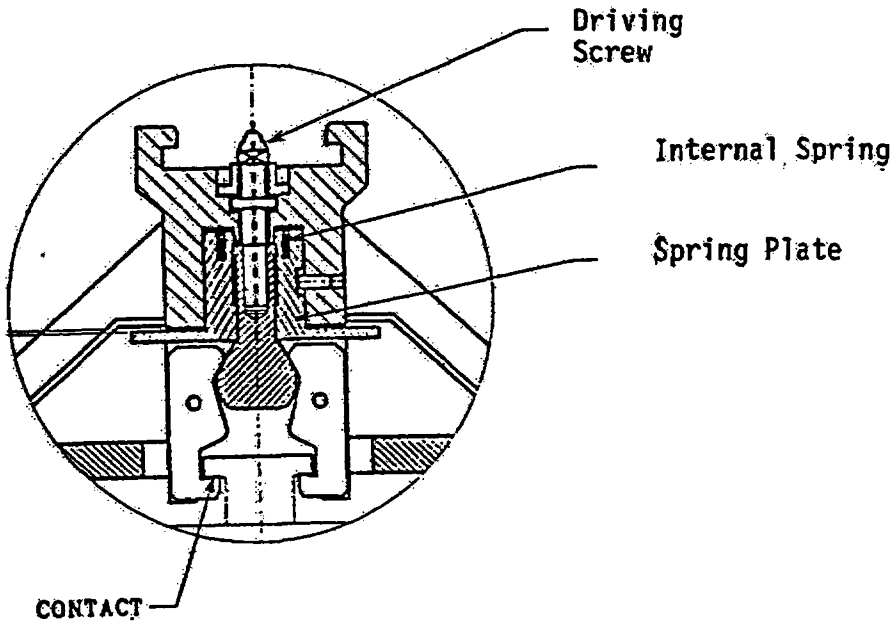


Figure 5.2-8

Dimensions of Gripping Device

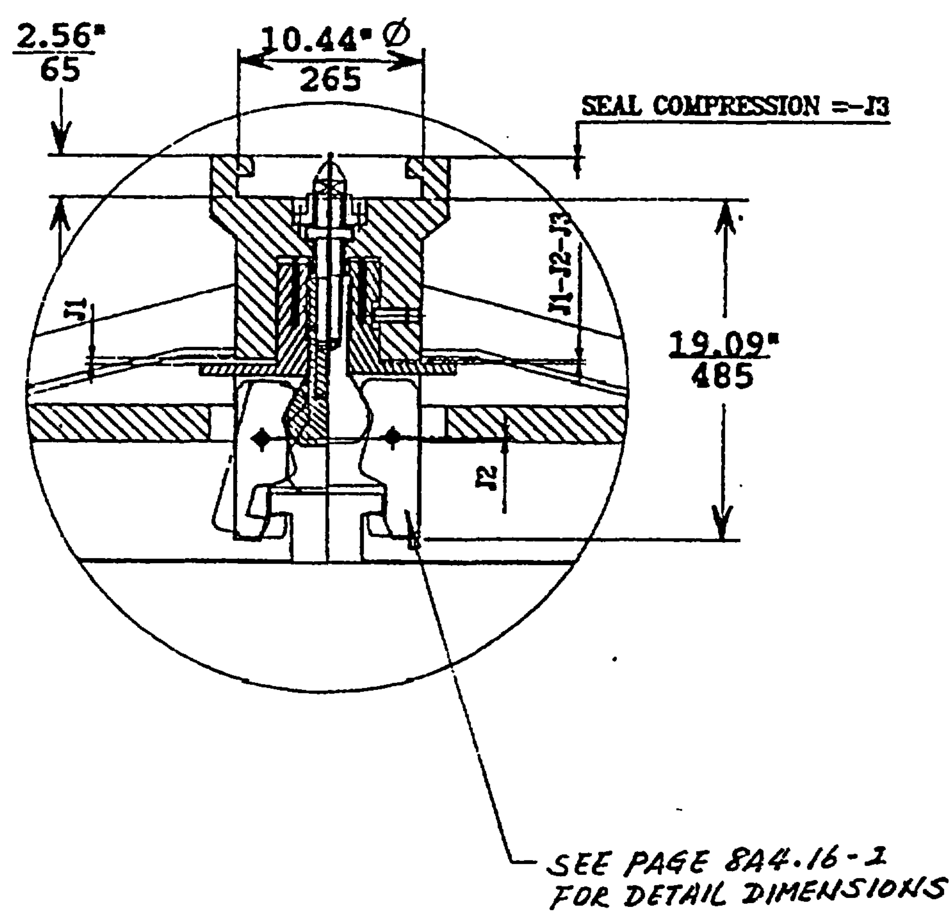


Figure 5.2-9

Confinement Bellows Schematic

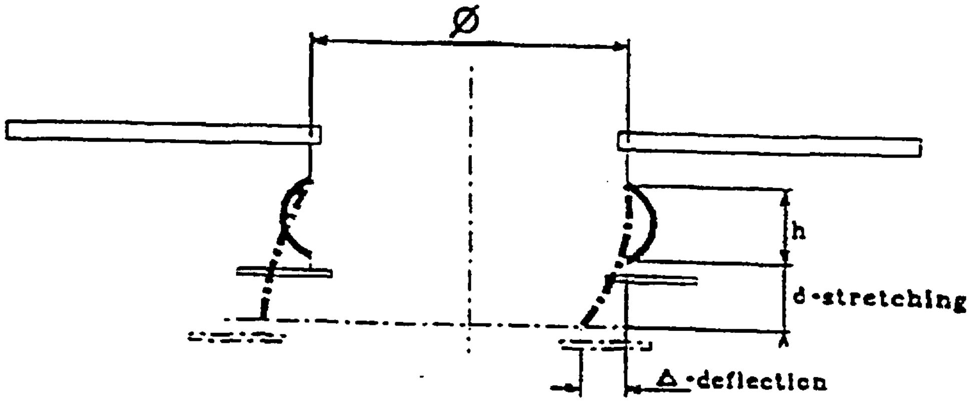


Figure 5.2-10

TC Port Cover Rails

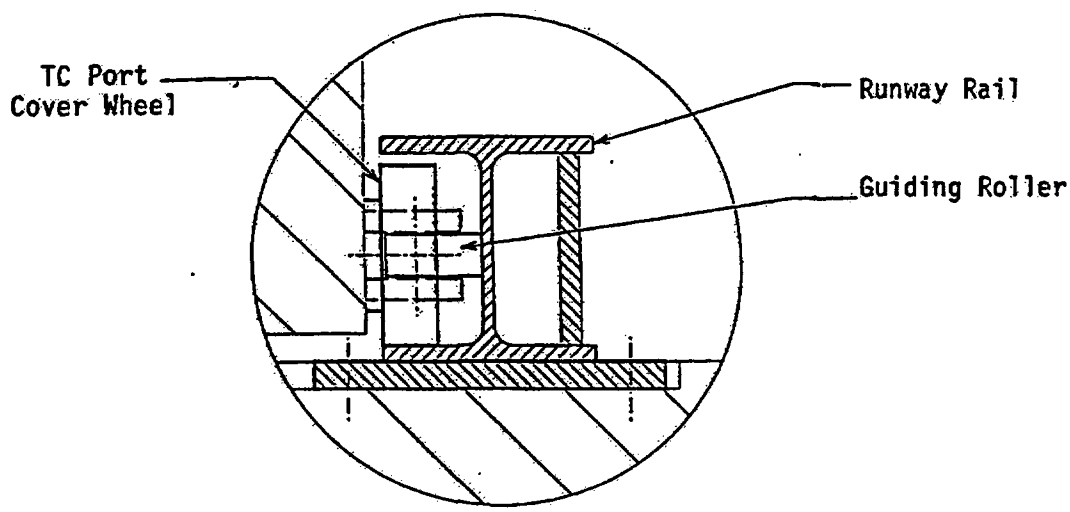


Figure 5.2-11

Upper Shield Port Cover Rails

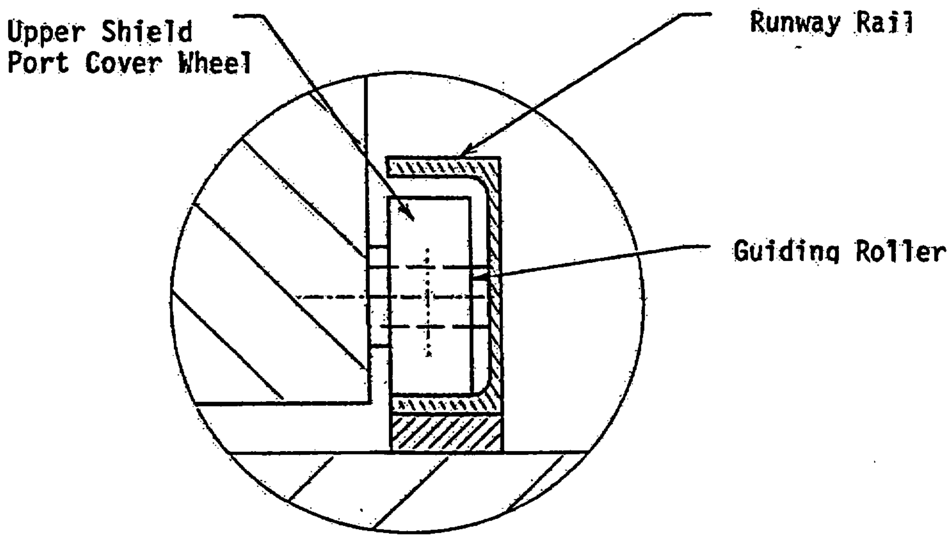


Figure 5.2-12

Upper Crane Trolley Rails

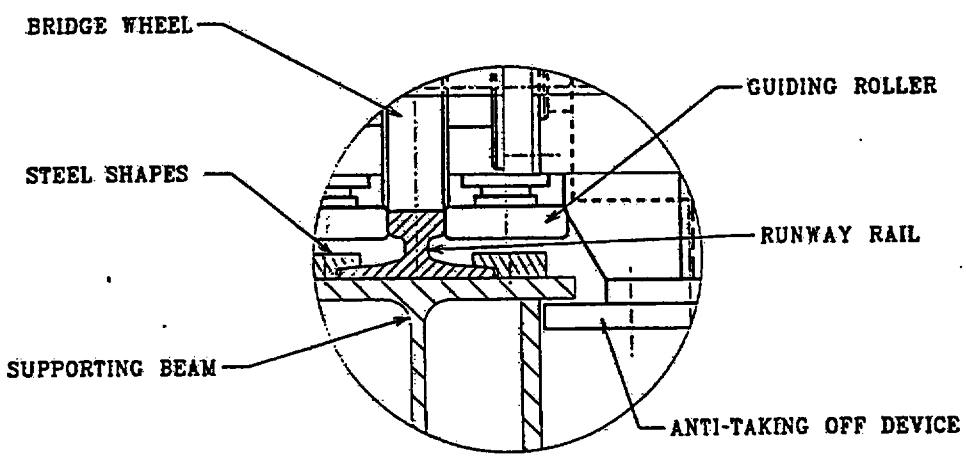


Figure 5.2-13

Upper Crane Trolley Anti-Derailing Device

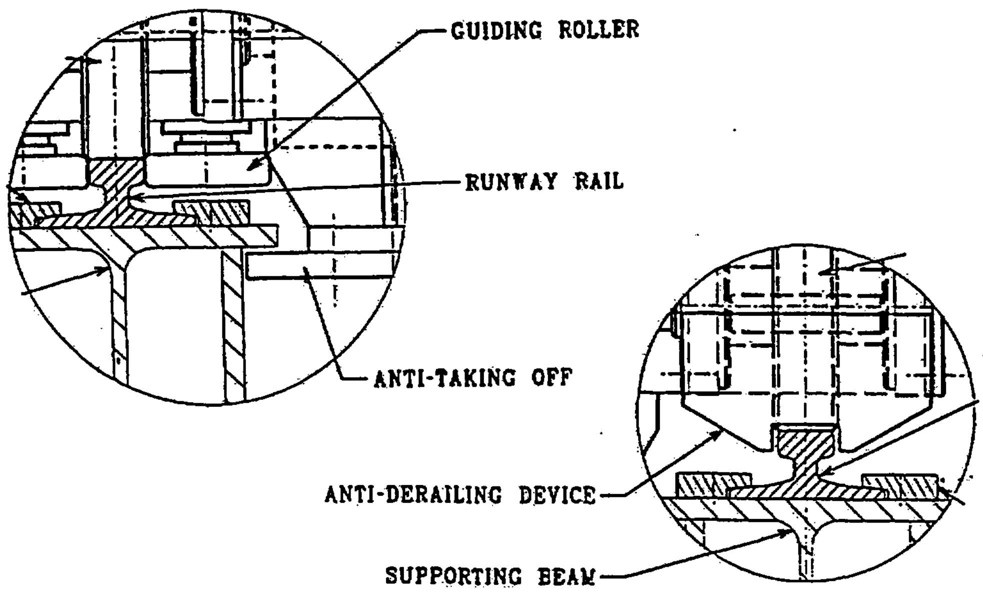


Figure 5.2-14

Upper Crane Hoist Motorization

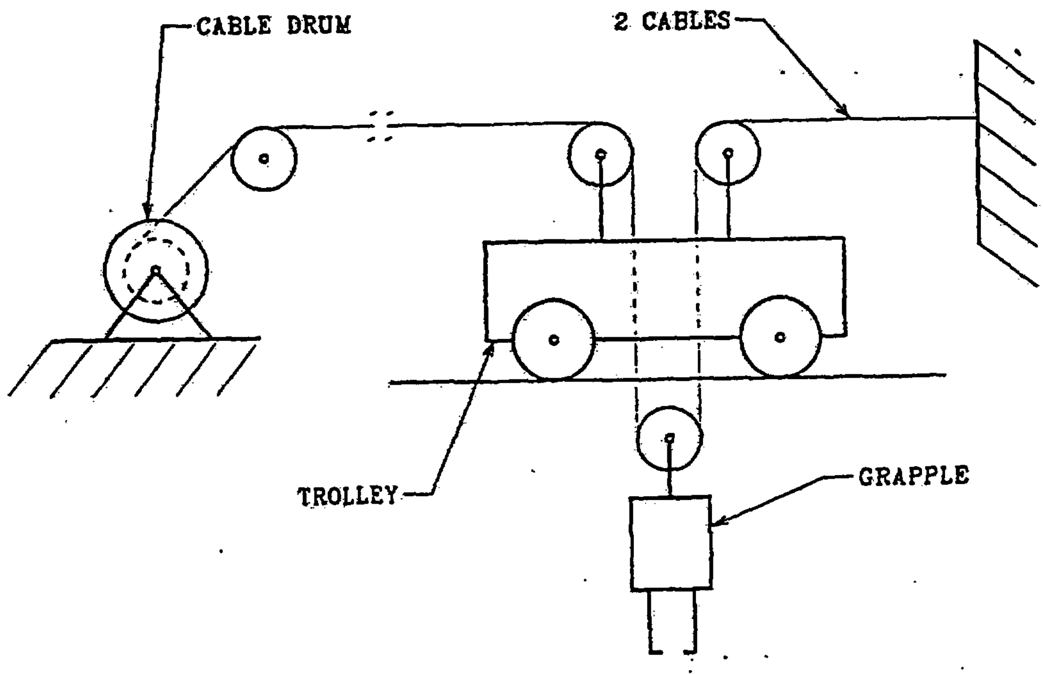


Figure 5.2-15

Upper Crane Kinematic Chain

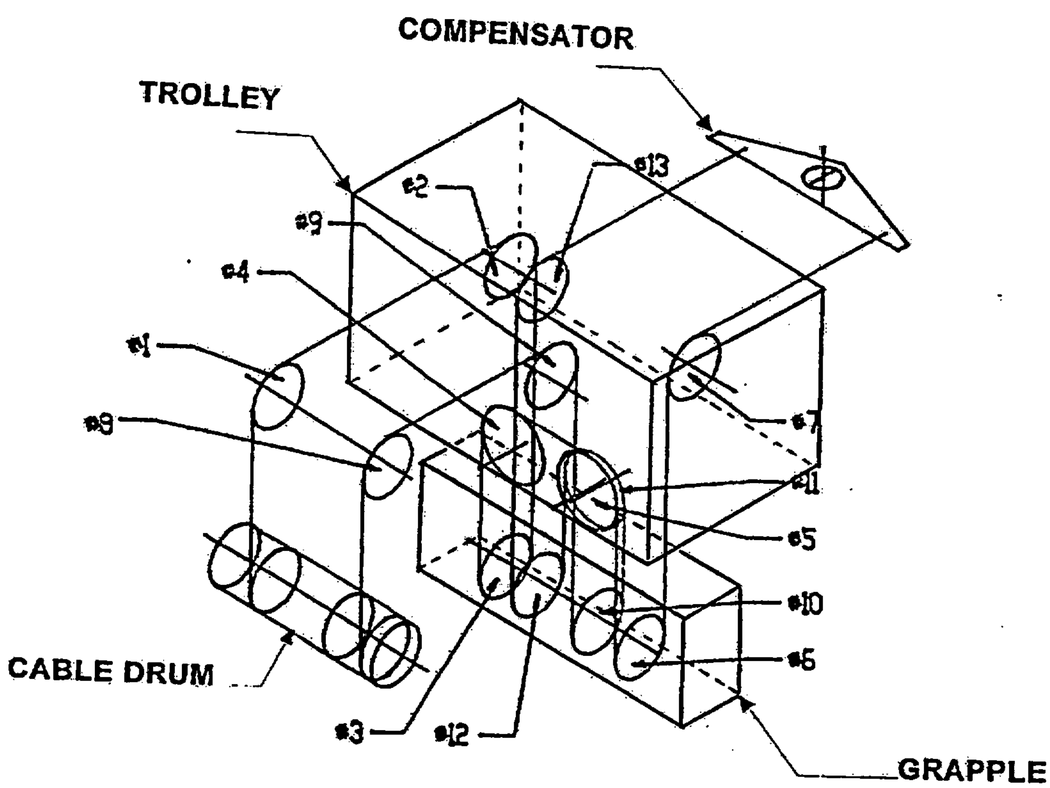


Figure 5.2-16

Upper Crane Motorized Grapple Showing Jacking Mechanism

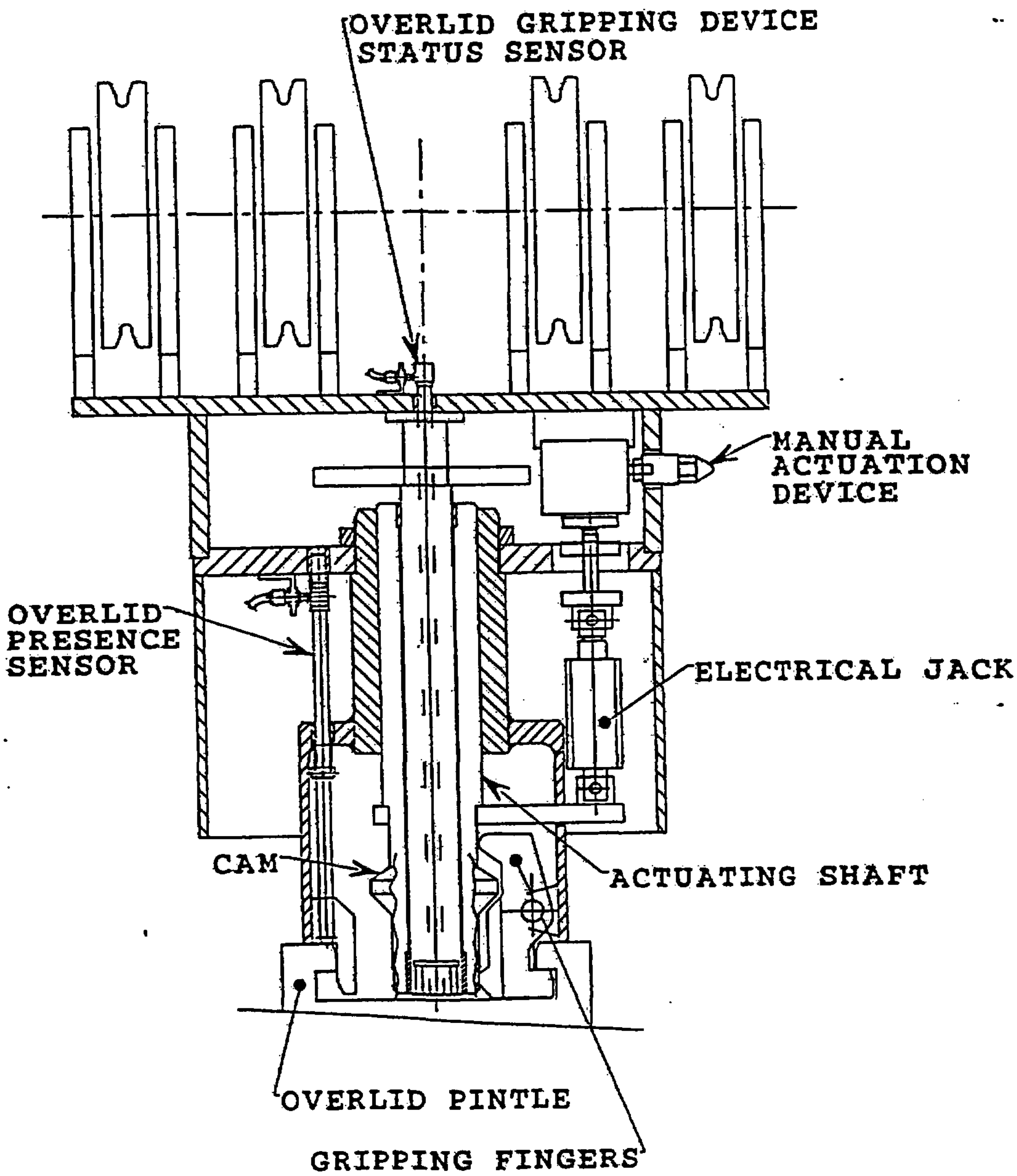


Figure 5.2-17

Upper Crane Motorized Grapple Showing Overlid Gripping Device Activation

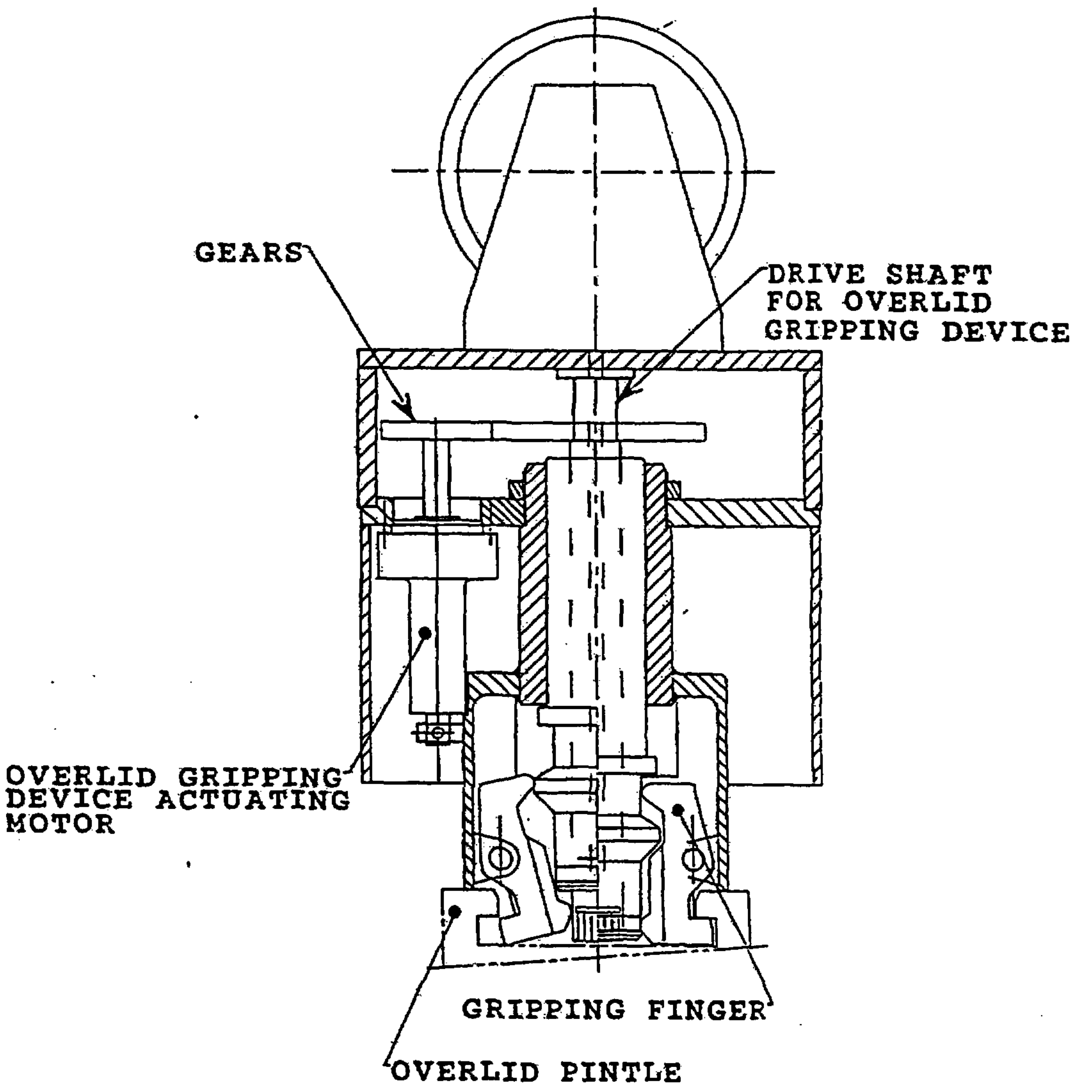
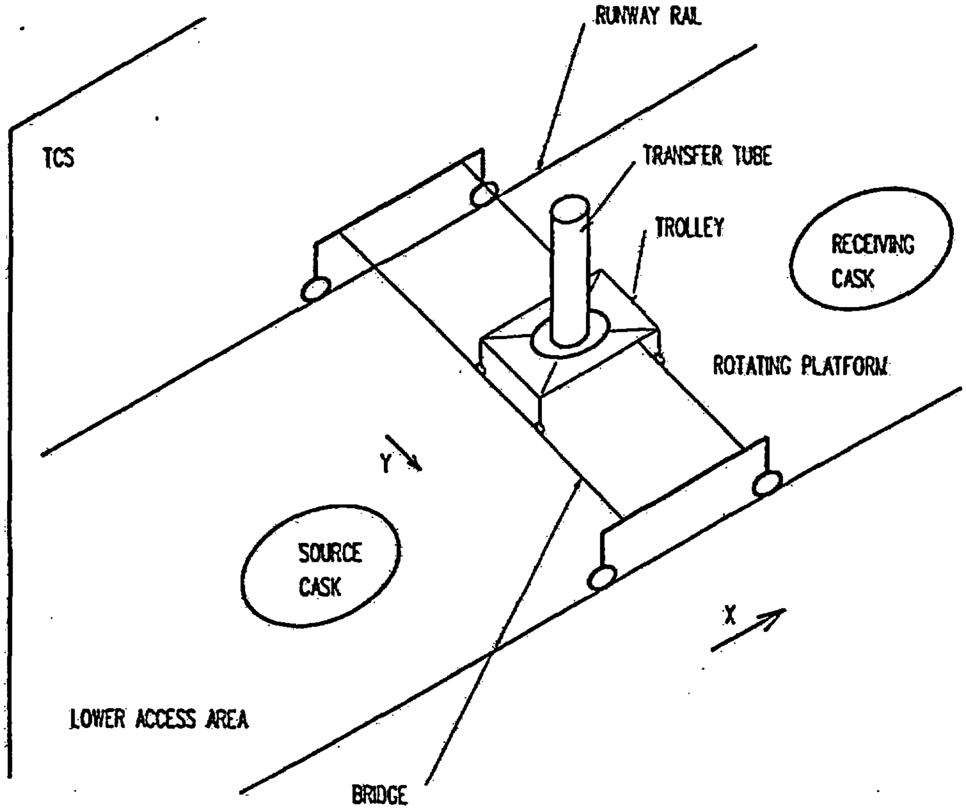


Figure 5.2-18

Fuel Assembly Handling Subsystem



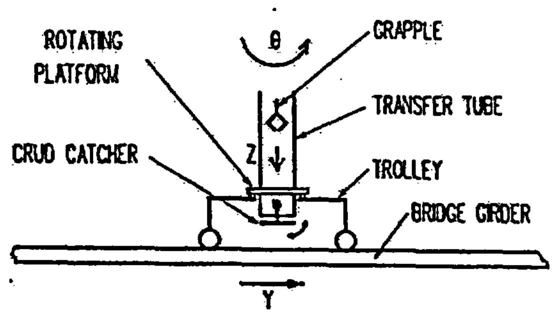


Figure 5.2-19

Fuel Handling Bridge Rail

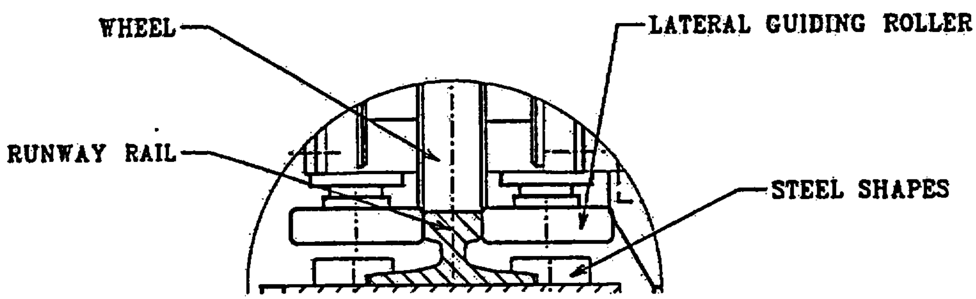


Figure 5.2-20

Fuel Handling Bridge Anti-Derailing Device

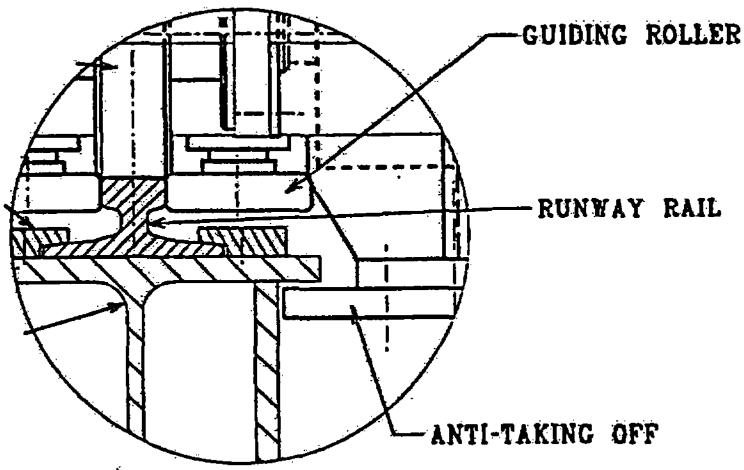


Figure 5.2-21

Fuel Handling Bridge Anti-Taking Off Device

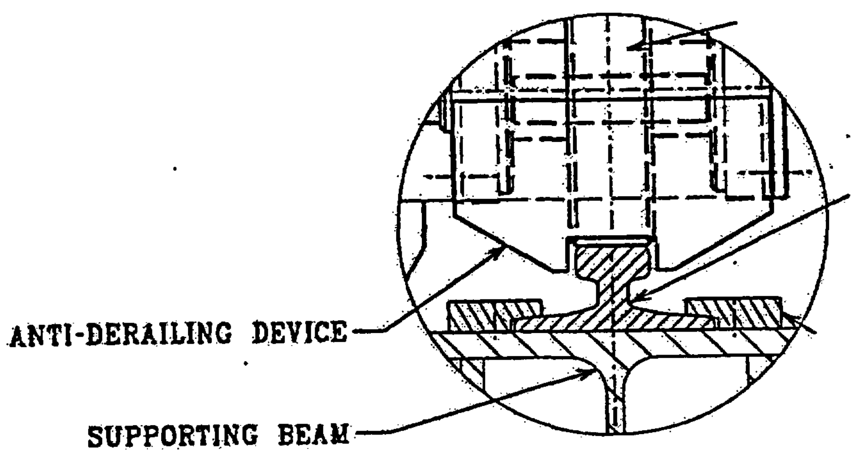


Figure 5.2-22

Schematic of Fuel Handling Bridge

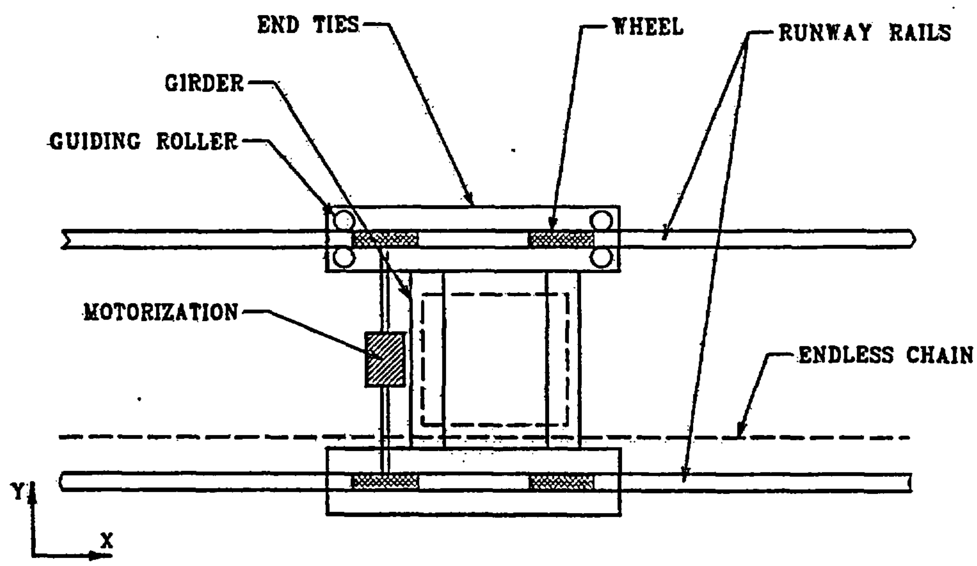


Figure 5.2-23

Fuel Assembly Handling Trolley

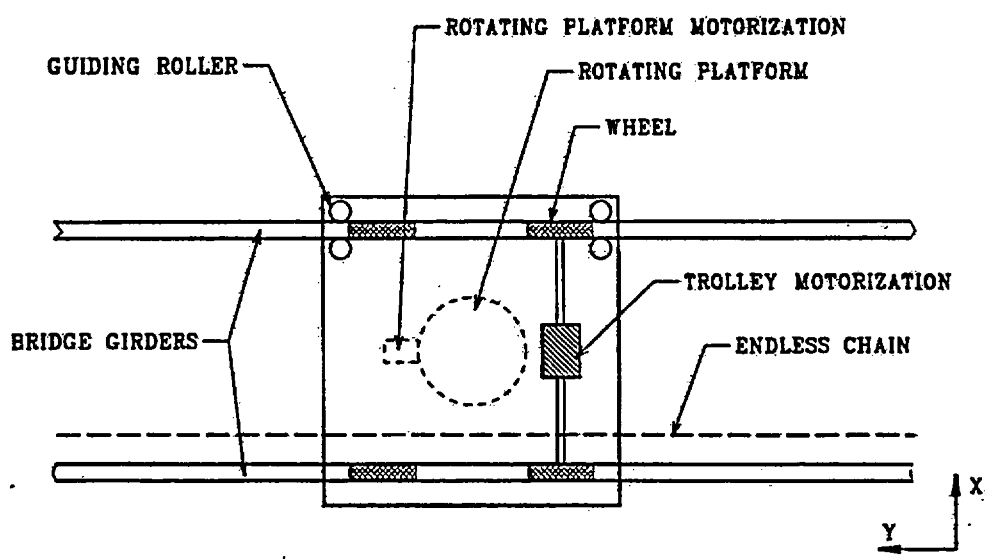


Figure 5.2-24

Fuel Assembly Handling Trolley Rail

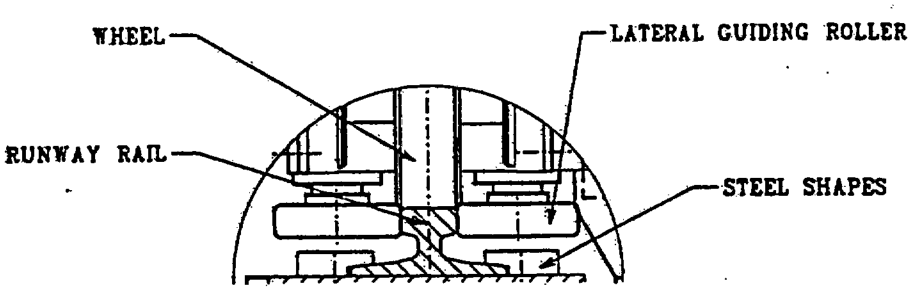


Figure 5.2-25

Fuel Assembly Handling Trolley Anti-Derailing Device

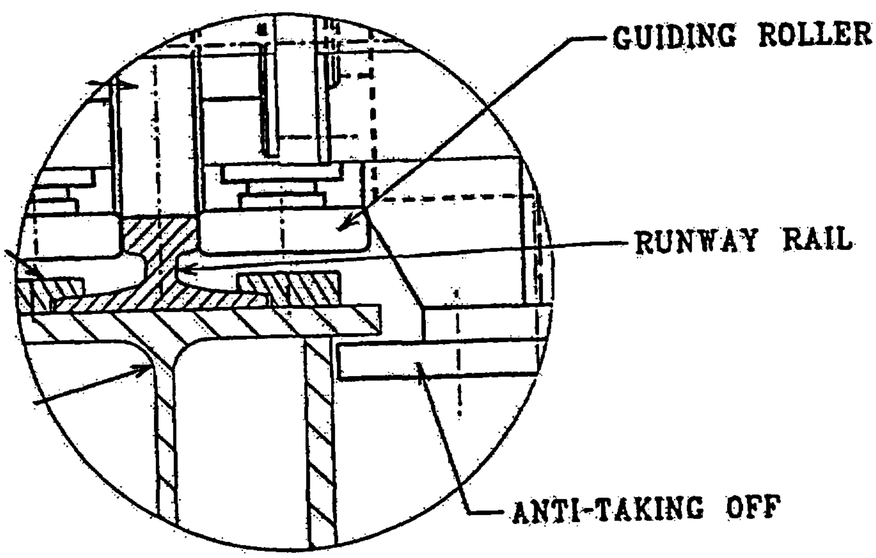


Figure 5.2-26

Rotating Platform Schematic

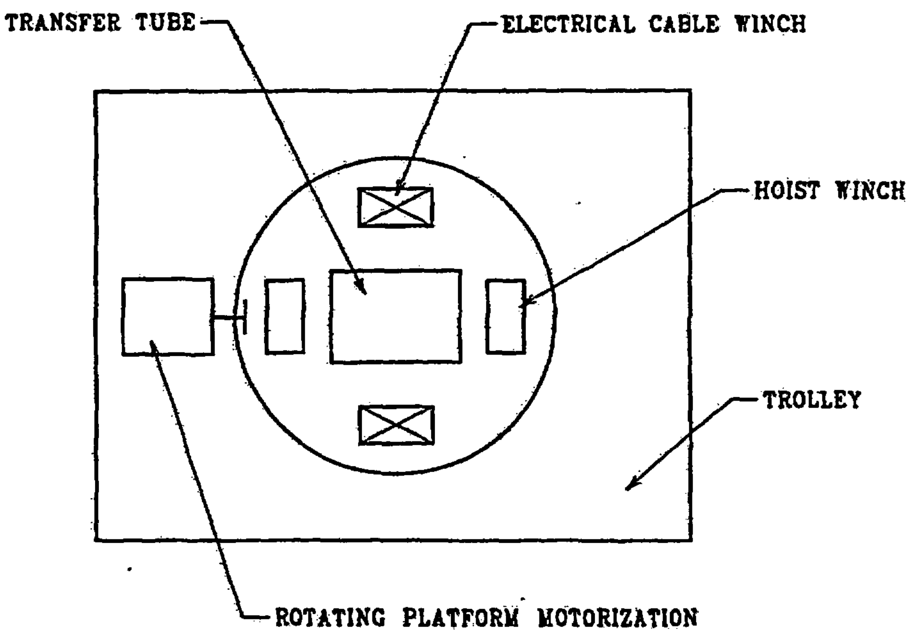


Figure 5.2-27

Fuel Assembly Hoisting System

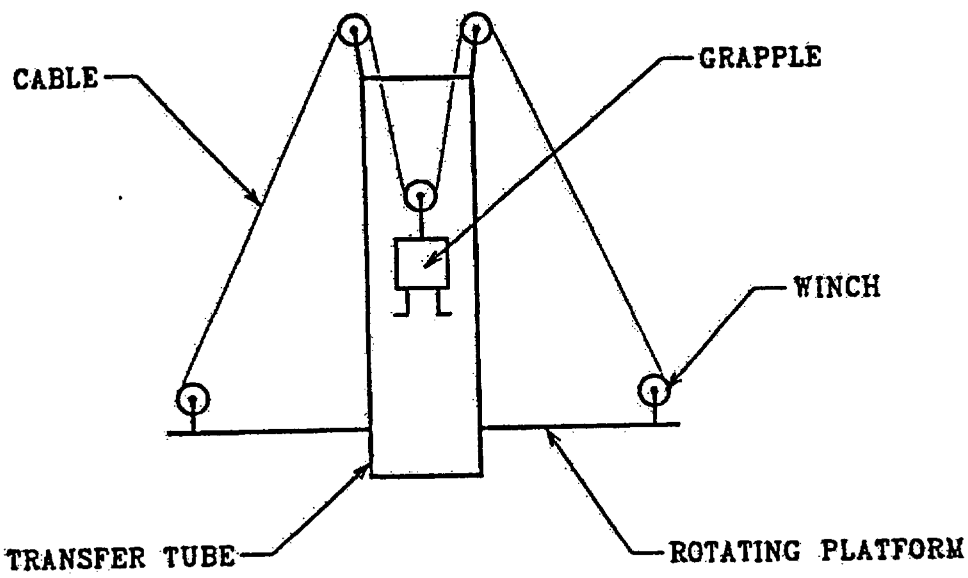


Figure 5.2-28

Fuel Handling Grapple

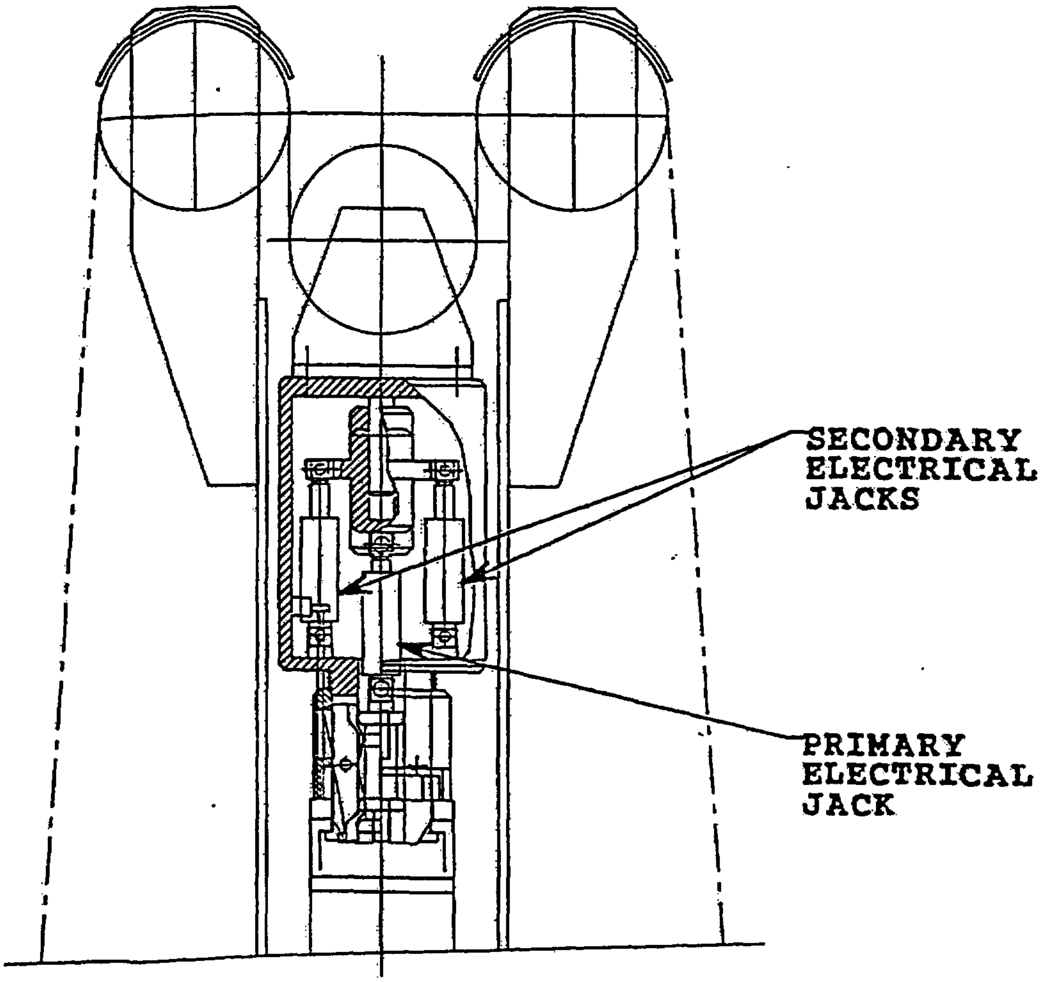
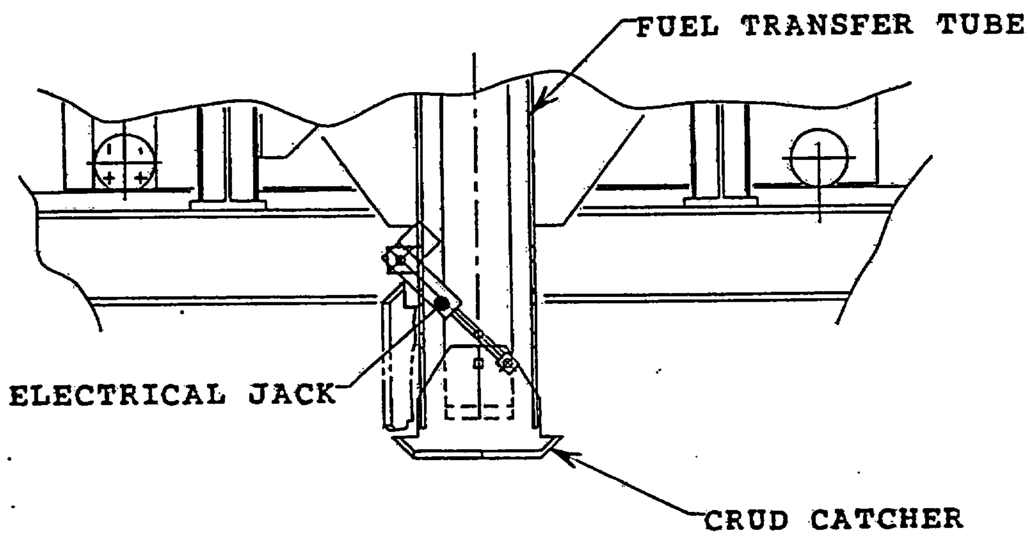


Figure 5.2-29

Crud Catcher



5.3 Other Operating Systems

5.3.1 HVAC Subsystem

The HVAC Subsystem is fully described in Section 4.3.1.

5.3.2 Welding Subsystem

The welding subsystem for welding the lids and shield plug will be adopted from the Department of Energy, based on the work performed on the Multi-Purpose Canister (MPC) program. This equipment will be fully described in the site specific applications.

5.3.3 Inerting Subsystem

The receiving cask will be inerted prior to final closure. The equipment required to perform the inerting will be adopted from the Department of Energy, based on the work performed on the MPC program. This equipment will be fully described in the site specific applications.

5.4 Operation Support Systems

5.4.1 Instrumentation and Control Systems

This section described the instrumentation and control features associated with operation control, monitors and alarms, and the relationship of one to the other. The details of the operational control system is provided in Appendix 5A.

Section 5.4.1.1 describes the structure of the control system. Section 5.4.1.2 describes the control of the Cask Transfer Subsystem. Section 5.4.1.3 describes the control of the Cask Mating Subsystem. Section 5.4.1.4 describes the control of the Lid/Shield Plug Handling Subsystem. Section 5.4.1.5 describes the control of the Fuel Handling Subsystem.

5.4.1.1 Control System Structure

This section presents the structure of the Control System and describes the control and monitoring equipment used by the operator to safely conduct a fuel transfer cycle. The Instrumentation and Control Structural Diagram, Figure 5.4-1, provides a schematic view of the Control Subsystem structure. The operator/machine interfaces for the control and monitoring of equipment are located in three areas:

- the Control Center, located in a trailer outside of the DTS building;
- the Preparation Area; and
- the Lower Access Area.

The operations which are locally controlled and monitored in the Preparation Area are:

- the receiving and source cask transfer (including trolley entry, positioning, removal, locking, and unlocking);
- the rolling door and the sliding door (including rolling door opening and closing, sliding door opening, locking, unlocking and closing operations); and
- the receiving cask lids removal and replacement.

A panel indicating the radiation levels from each of the area radiation monitors in the DTS is present in the Preparation Area.

The operations in the Lower Access Area which are locally controlled and monitored are the receiving and source cask transfer (including transfer trolleys entry, positioning, removal, locking, and unlocking).

The radiation monitor in the Lower Access Area displays the radiation level in this area.

The operations which are remotely controlled and monitored in the Control Center are:

- the receiving and source cask mating;
- the receiving and source cask transfer confinement port cover opening and closing;
- the receiving cask shield plug and source cask lid removal and replacement: including upper shield ports opening and closing, upper crane positioning, grapple lowering and lifting; and
- the fuel assembly transferring.

The HVAC subsystem is controlled and monitored in the Control Center. A panel displaying the radiation levels from each of the radiation monitors in the DTS is provided in the Control Center, as well.

The instrumentation and monitors in the control center are described in Section 5.5. The instrumentation and monitoring equipment outside of the Control Room is described in the following sections.

The main control panel and the personal computer (PC) are linked to two Programmable Logic Controllers (PLC's) and to the Radiation Monitoring equipment. One PLC controls all the mechanical equipment, while the other controls the sliding door and the HVAC equipment.

When a control is requested, the PLC checks that all safety conditions are met for the operation to be performed, and that the interface between the Power Subsystem and the equipment is established. In the other direction, the sensors provide information to the PLC on the status and position of the equipment, and the PLC transmits this information to the PC to prompt the supervisor and to update the knowledge of the process in the instruction guide software and to the other PLC if the information constitutes an interface (as the mating status for example).

The second PLC regulates the HVAC equipment and triggers alarms when necessary.

The support of communication between the PC and the PLC's is a local network.

All alarms are, as much as possible, directly activated by the equipment which detects the problem. Therefore, the equipment, the instrumentation, the PLC and the PC are all linked to the alarm system.

Transition Conditions

The Control System prevents unsafe control of the transfer operations. Adherence to the operating sequence is achieved through administrative procedure.

The safety of the complete transfer cycle depends on the control of each operation. The safety criteria is based on maintaining the integrity of the fuel assemblies, preventing damage to the source cask lid and receiving cask shield plug which would prevent proper closure, keeping radiation exposure to a minimum and ensuring that there is a means to recover from any failure of equipment. The safe control of an operation is achieved by the automatic checking of the initial conditions which are important to safety. During an operation process, safety is guaranteed by the design of the alarms and by the design of the equipment.

The results of operations or equipment status are used as conditions to allow the initiation of subsequent operations.

A transition condition can be necessary to process consecutive operations. The first validation, the administrative control and the interlocks (if applicable) guarantee the validation for the consecutive operations.

Each transition is classified in accordance to its importance to safety :

- If the transition condition is only necessary for the operating process, it is classified as Operating.
- If the transition condition is important to safety, it is classified as Safety.

The means used to validate a transition condition depends on its level of importance to safety. Most mechanical operations are monitored using the CCTV Subsystem. For the operations which are important with respect to the operating sequence, the administrative control, the viewing provided by the CCTV Subsystem and the indications provided by the mechanical equipment (motorization status, device position, ...) are sufficient to validate a transition. Operations which are important to safety, are validated by the means described above and are also validated using interlocks between the equipment. These interlocks are managed by the PLC's.

Interlocks

Table 5.4-1 provides a list of the interlocks used to safely control operations.

Bypasses

In the case of a sensor default, an accidental or equipment failure condition, the interlocks may prevent the initiation of related operations. To continue operating or to recover to a safe condition, the interlocks may need to be deactivated. This deactivation or shunt is regulated (usage of passwords or keys ...) to prevent unauthorized or untrained personnel from performing the operation. Two different levels are implemented:

- Administrator level
- Operator level

Table 5.4-1

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-CRC	Crud catcher	YL 119A YL 119B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the crud catcher is not in closed position
			Rotating platform	Any motion of the rotating platform if the crud catcher is not in closed position
			Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the crud catcher is not opened
I-FAHCC	Fuel assembly handling crane carriage (bridge and trolley)	No transmitter	Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly handling crane carriage is in motion.
			Crud catcher	Opening of the crud catcher if the fuel assembly handling crane carriage is in motion.
			Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the fuel assembly handling crane carriage is in motion.
I-FAHG	Fuel assembly handling grapple	YL 116B YL 116A YLS 117	Fuel assembly handling hoist system	Lifting of the fuel assembly grapple if it is not totally connected or disconnected
			Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly grapple is engaged
			Receiving and Source Cask upper shield ports and locking devices	Unlocking and opening of any upper shield port if the fuel assembly grapple is engaged

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-FAHHAP	Fuel assembly handling hoist system	ZIT 109	Fuel assembly handling grapple	Disconnecting the fuel assembly if the fuel assembly grapple is not in a proper position
I-FAHHLC	Fuel assembly handling hoist system	WIT 115	Fuel assembly handling grapple	Disconnecting the fuel assembly if the hoist is loaded
			Receiving and Source Casks upper shield ports and locking devices	Unlocking and opening of any upper shield port if the fuel assembly handling hoist is loaded
			Receiving and Source Casks TC port covers and locking devices	Unlocking and closing of any TC port cover if the fuel assembly handling hoist is loaded
I-FAHHUP	Fuel assembly handling hoist system	ZSH 109	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the fuel assembly grapple is not in its upper z position
			Rotating platform	Any motion of the rotating platform if the fuel assembly grapple is not in its upper z position
			Crud catcher	Closing of the crud catcher if the fuel assembly grapple is not in its upper z position
I-FAHPP	Fuel assembly handling crane carriage (bridge and trolley)	ZIT 101 ZIT 104	Lid/shield plug handling hoist system	Lowering and lifting of the lid/shield plug grapple if the crane carriage is not stopped in parking position

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-LSPHAP	Lid/shield plug handling hoist system	ZIT 307	Lid/shield plug grapple	Disconnecting of the lid/shield plug if the grapple is not in the proper position
			Receiving and Source Casks TC port covers	Closing of any TC port cover if the lid/shield plug handling hoist system is not above the position of the shield plug overlid on the TC port cover level
I-LSPHGP	Lid/shield plug handling grapple	YL 311A YL 311B YLS 310 ZL 315A ZL 315B	Lid/shield plug handling hoist system	Lifting of the lid/shield plug handling grapple if the grapple is not totally connected or disconnected (including overlid)
I-LSPHLC	Lid/shield plug handling load cell	WIT 309	Lid/shield plug handling grapple	Disconnecting the lid/shield plug if the cables are loaded
I-LSPHUP	Lid/shield plug handling hoist system	ZLL 307	Receiving and Source Casks upper shield ports	Closing of any upper shield port if the lid/shield plug grapple is not stopped in its upper z position
			Upper crane	Any motion of the upper crane if the lid/shield plug grapple is not stopped in its upper z position
I-RM-UL	Radiation monitoring at the upper level	RAH 905	Receiving and Source Casks upper shield ports and locking devices	Unlocking and opening of any upper shield port if the radiation level is too high
I-RM-SD	Radiation monitoring Lower Access Area	RAH 903	Sliding door	Opening of the sliding door in case of high radiation levels in the Lower Access Area

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-RP	Rotating platform	No transmitter	Fuel assembly handling hoist system	Lowering of the fuel assembly grapple if the rotating platform is not stopped
I-RP	Rotating Platform	None	Crud catcher	Opening of the crud catcher if the rotating platform is not stopped
I-SDLD	Sliding door locking device	YL 801A YL 801B YL 801C YL 801D	Receiving and Source Casks TC port covers	Opening of any TC port cover if the sliding door is not locked in closed position
I-TCPC-RC-C	Receiving Cask TC port cover	ZS 317B	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in the closed or off centered position
I-TCPC-RC-C	Receiving Cask TC port cover	ZS 317B	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in the closed or off centered position
I-TCPC-RC-O	Receiving Cask TC port cover	ZS 317A	Receiving Cask TC port cover locking device	Locking of the Receiving Cask TC port cover if the port cover is not in open position
I-TCPCLD-RC	Receiving Cask TC port cover locking device	YL 318A YL 318B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Receiving Cask TC port cover is not locked in opened position

Table 5.4-1(Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-TCPC-RC-OC	Receiving Cask TC port cover	ZS 317C	Source Cask upper shield port	Opening of the Source Cask upper shield port if the Receiving Cask TC port cover is not in closed or off centered position I-TCPC-SC-C
Source Cask TC port cover	ZS 315B	Receiving Cask upper shield port	Opening of the Receiving Cask upper shield port if the source cask TC port cover is not in closed position	I-TCPC-SC-O
I-TCPC-SC-O	Source Cask TC port cover	ZS 315A	Source Cask TC port cover locking device	Locking of the source cask TC port cover if the port cover is not in open position
I-TCPCLD-SC	Source Cask TC port cover locking device	YL 316A YL 316B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Source Cask TC port cover is not locked in open position
I-TTLD-RC	Transfer trolley for the Receiving Cask locking device	YL 405C	Receiving Cask mating flange electric jacks	
I-TTLD-SC	Transfer trolley for the Source Cask Locking Device	YL 404C	Source Cask Mating flange electric jacks	Lowering of the source cask mating flange if the source cask transfer trolley locking device is not in locked position

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-USP-RC-C	Receiving cask upper shield port	ZS 302B	Upper Crane	Any motion of the upper crane if the receiving cask upper shield port is not in closed position
			receiving cask upper shield port locking device	Locking of the receiving cask upper shield port if it is not in closed position
			source cask upper shield port	Opening of the source cask upper shield port if the receiving cask is not in closed position
I-USP-SC-C	Source cask upper shield port	ZS 301B	upper crane	Any motion of the upper crane if the source cask upper shield port is not in closed position
			source cask upper shield port locking	locking of the source cask upper shield port if it is not in closed position
			receiving cask upper shield port	opening of the receiving cask upper shield port if the source cask upper shield port is not closed
I-USPLD-RC	receiving cask upper shield port locking device	YL 313A YL 313B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the receiving cask upper shield port is not locked in closed position
			Source cask TC port cover	Opening of the source cask TC port cover if the receiving cask upper shield port is not locked (in closed position)

Table 5.4-1 (Continued)

Interlocks

Interlock Acronym	Source equipment	Sensor	Interlocked Equipment	Prevention description
I-USPLD-SC	Source Cask upper shield port locking device	YL 312A YL 312B	Fuel assembly handling crane carriage (bridge and trolley)	Any motion of the fuel assembly handling crane carriage if the Source Cask upper shield port is not locked in closed position
			Receiving Cask TC port cover	Opening of the Receiving Cask TC port cover if the Source Cask upper shield port is not locked (in closed position)

One unique administrator is able to associate users, passwords and the bypasses that they can use. The operators are able to use the bypasses defined by the administrator.
Any transition between process operations being interlocked has the possibility to be bypassed, in order to allow recovery to a safe condition and testing of the equipment.

During integration, the following tests are implemented:

- All the software (for PC and PLC) unit level are tested to verify correct execution of software elements,
- interfaces are tested to verify that software units execute together as expected,
- computer software configurations are tested to verify the execution of the software as a unit,
- system-level is tested to verify the softwares' performance within the overall system,
- system is tested to verify that the software will not cause an abnormal condition or event under abnormal circumstances, such as unexpected input values.

Similar tests are performed on the Control Subsystem at the supplier's office using input/output simulators before integration.

Maintenance requirements of the Control System shall be provided as part of the site specific applications.

5.4.1.2 Cask Transfer Subsystem

The Casks Transfer Subsystem permits entry of the source and receiving casks into the Lower Access Area and supports and positions (X direction) them accurately beneath the Mating Subsystem. The equipment that supports the cask is composed of two motor driven trolleys on rails and locking devices. The Source and Receiving Casks subparts of the Subsystem are identical in regard to the control and monitoring of the operations. The system is described in Section 5.2.1.

The two transfer trolleys are locally controlled by the operator using the Preparation Area or the Lower Access Area control panel. The operator controls the entry, positioning and removal operations by setting the direction and the speed of the trolleys' motorization. The trolleys stop when they reach a specific position in these areas. They are locally monitored by the operator. Only indications on locking positions are indicated in the Control Center.

Between the cask positioning and removal macro-operations of a source cask, no operator will be present in the Lower Access Area. The access to the Lower Access Areas is regulated by the Radiation Monitoring Subsystem (interlocked with the sliding door of the

Between the cask positioning and removal macro-operations of a source cask, no operator will be present in the Lower Access Area. The access to the Lower Access Areas is regulated by the Radiation Monitoring Subsystem (interlocked with the sliding door of the Structural Subsystem). The transfer trolleys can only be unlocked locally, which guarantees that a cask will always be closed (lid/shield plug on) when its transfer trolley is unlocked. There is no interlock on this equipment.

Redundant instrumentation is not necessary for the control of the trolleys since they can be accessed for maintenance if required.

Redundant instrumentation is povided to ensure that the casks won't get damaged by a crash into a wall in the Lower Access Area, into the sliding door or due of a collision between the two casks as described below:

- limit switches located on the runway rails stop the trolleys in position,
- limit switches located on the runway rails stop the trolleys in case of an overtravel,
- electrical switches stop the trolleys upon detection of a collision with bumper guards,
- electrical switch stops source cask motion upon detection of a collision with the receiving cask.

In the Preparation Area, the source and receiving casks are stopped by the preparation position limit switch (one position for the two casks) and, by the collision detectors in the event of overtravel. In the Lower Access Area, when the casks are being positioned, the receiving cask can be stopped by its transfer position limit switch, by the overtravel electrical switch or by the collision with bumper guards detector while the source cask can be stopped by its transfer position limit switch, or by the collision with the receiving cask detector.

Redundant instrumentation is not necessary for proper position detection because the accuracy required is only to ensure that the transfer trolley can be locked.

Locking is performed locally and will be verified visually by the operator.

The collision and overtravel detectors generate alarms which are audible and visible in the Preparation Area, in the Lower Access Area and in the Control Center.

Table 5.4-2 lists the necessary instrumentation for the Casks Transfer Subsystem.

TABLE 5.4-2
Casks Transfer Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Source cask trolley	Collision with bumper guard	Electrical switch	Stop motion	YAS 401A YAS 401B
Receiving cask trolley	Collision with bumper guard	Electrical switch	Stop motion	YAS 402A YAS 402C
	Collision with source cask trolley	Electrical switch	Stop motion	YAS 402B
Runway rails	Over travel	Electrical switch	Stop motion	ZASH 403D
	Preparation position	Electrical switch	Stop motion	ZS 403B
	Source cask loading position	Electrical switch	Stop motion	ZS 403C
	Receiving cask loading position	Electrical switch	Stop motion	ZS 403D
Ground	Locking at preparation position / Source cask	Electrical contact	----	YL 404B
	Locking at preparation position / Receiving cask	Electrical contact	----	YL 405B
	Locking at loading position / Source cask	Electrical contact	----	YL 404C
	Locking at loading position / Receiving cask	Electrical contact	----	YL 405C

5.4.1.3 Transfer Confinement Cask Mating Subsystem

The Transfer Confinement Casks Mating Subsystem provides the mating and disengagement of the source and receiving casks with the floor of the TCA. The Subsystem is divided into two functionnally identical parts, each one using three electric jacks attached to the mating flange, guiding its movement to make it fit around the cask. The mating flange provides a seal through the use of confinement bellows and static seals. Each subpart uses an overlid which permits the gripping and removal of the Source Cask lid/ Receiving Cask shield plug when activated by the lid/shield plug handling grapple. This subsystem is fully described in Section 5.2.2.

The two parts of the Subsystem are identical in regard to the control and monitoring of the operations.

The operations are remotely controlled. A camera provides viewing of the movement of the two mating flanges motion and z position. The operator controls the mating and disengagement operations. The electric jacks are operated simultaneously by a PLC.

Mating operations:

Once actuated, the jacks lower the platform until it makes contact with the top of the cask. Each of the three electric jacks individually and automatically stops when the contact load is reached. When the three jacks are stopped, the same procedure is repeated to ensure that the contact with the cask is perfect. The completion of the operation is displayed by the supervisor.

Disengagement operations:

The three jacks are actuated together. The operator has to stop motion when the platform reaches the mezzanine level.

The vertical position of each jack and the correct completion of the mating operation is displayed in the Control Center (in case of any load sensor failure).

The mating flange lowering operation is interlocked with the locking devices of the Cask Transfer Subsystem (interlock on one cask) to prevent any mating flange lowering if the corresponding Casks Transfer Subsystem's trolley is not locked. This ensures that the trolleys are locked in place before the casks are opened.

The proper positioning of the jacks is controlled by a PLC using the electric jack's pressure and vertical position information.

The mating status is transmitted to the PLC managing the HVAC Subsystem. This information is required to enable the system to properly regulate the HVAC process.

Redundant instrumentation is not prpvoded for the control of the mating flanges because the source and receiving casks are closed (lid/shield plug on) during the mating and disengagement operations, permitting removal and repair of defective instrumentation.

Redundancy is provided for each jack's proper positioning detection.

Table 5.4-3 lists the necessary instrumentation for the TC Casks Mating Subsystem.

TABLE 5.4-3
Transfer Confinement Casks Mating Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
TC Source cask mating subsystem	Vertical position	Potentiometer	----	ZIT 208A ZIT 208B ZIT 208C
	Pressure operated by jack	Force (or load) sensor	Stop jack lowering	WSH 209A WSH 209B WSH 209C
TC Receiving cask mating subsystem	Vertical position	Potentiometer	----	ZIT 203A ZIT 203B ZIT 203C
	Pressure operated by jack	Force (or load) sensor	Stop jack lowering	WSH 204A WSH 204B WSH 204C

5.4.1.4 Transfer Confinement Port/Shield Handling Subsystem

The Transfer Confinement Port/Shield Handling Subsystem consists of two port covers that have a locking device. They support the source cask lid and receiving cask shield plug when the casks are opened. The ports and the locking devices are actuated by electric jacks. This subsystem is described in Section 5.2.3.

There are slight differences in the control and monitoring of the two port covers, because the receiving cask shield plug needs to be off centered on the TC port cover (one more specific position).

Cameras in the TCA provide viewing of the movement and position of the TC port covers. Both TC port covers and their locking devices are remotely controlled. The locking devices are only used in the open position, prior to transfer of any fuel assembly. Both TC port covers use a finite number of positions and need accurate positioning. The operator activates a TC port cover setting the position to be reached. The TC port cover is automatically stopped when the position is reached. The operator activates a locking device by setting the desired locking position. When the locking operation is completed, the information is transmitted to the supervisor which displays it.

The position and motorization status of the TC port covers and locking devices are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the TC port covers with the Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem hoist. This prevents any TC port cover from closing if the lid / shield plug grapple is not stopped above the TC port cover (with lid/shield plug on), thus preventing a potential collision of the equipment.

- Interlock the TC port covers with the upper shield ports. This prevents any TC port cover from opening if the diagonal upper shield port is not closed, thus ensuring proper shielding to the roof enclosure area at all times.

- Interlock the TC port covers and their locking devices with the Fuel Assembly Handling Subsystem crane carriage. It shall prevent any TC port cover unlocking and closing or off-centering if the crane carriage of the Fuel Assembly Handling Subsystem is not stopped in the x and y directions or if fuel is being transferred. This prevents a potential collision of equipment.

- Interlock the TC port covers with the Structural Subsystem. It shall prevent opening of any TC port cover if the sliding door of the Structural Subsystem is not locked (in closed position). This ensures that the radiation levels in the Preparation Area will be acceptable during fuel transfer.

- Interlock each TC port cover with its locking device. It shall prevent locking if the TC port cover is not in the opened position.

The PLC shall memorize the TC port covers' movements as well as those of the lid/shield plug grapple in order to know (logically) if the lid/shield plug is present on the port cover. This information shall be used to prevent any TC port cover opening when the relative upper shield port is opened if the lid/shield plug hoist is not handling the lid/shield plug and if the cask is not closed.

The interlocks on the TC port covers and their locking device prevent:

- any damage to the fuel assembly during a transfer due to an inadvertent TC port cover closure (seismic event or human error).

- high radiation levels at the upper plate level during the opening or closing of a

cask due to a wrong synchronisation between the TC and upper shield ports and the lid/shield plug handling hoist system.

- high radiation levels at the sliding door level in case of a seismic event.

- compromise of recovery requirements (port cover stuck)

Redundant instrumentation is not provided for the control of the TC port covers and their locking devices, since manual backup equipment is provided for the locking devices and the port covers drives are outside the TCA. Two different instrumentation are used to detect the locked and unlocked positions of the TC port covers.

Redundant instrumentation is not provided for the TC port covers position detection because the CCTV Subsystem provides viewing of this equipment and the verification of the alignment with references on the mezzanine is included in the operation validation.

Table 5.4-4 lists the necessary instrumentation for the TC Port Shield Subsystem.

Table 5.4-4

TC Port Shield Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Receiving cask TC port cover	Open position	Electrical switch	Stop motion	ZS 317A
	Closed position	Electrical switch	Stop motion	ZS 317B
	Off centered position	Electrical switch	Stop motion	ZS 317C
	Over travel	Electrical switch	Stop motion	ZASH 317A ZASH 317B
	Locked (in open position)	Electrical contact	----	YL 318A
	Unlocked (in open position)	Electrical contact	----	YL 318B
Source cask TC port cover	Open position	Electrical switch	Stop motion	ZS 315A
	Closed position	Electrical switch	Stop motion	ZS 315B
	Over travel	Electrical switch	Stop motion	ZASH 315A ZASH 315B
	Locked (in open position)	Electrical contact	----	YL 316A
	Unlocked	Electrical contact	----	YL 316B

5.4.1.5 <u>Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem</u>

The Receiving Cask Shield Plug and Source Cask Lid Handling Subsystem consists of a motor driven trolley which utilizes a motorized grapple attached to a hoist system and two shield ports actuated by electric jacks. The subsystem is housed on the roof of the Transfer Confinement building and the shield ports provide access to the Transfer Confinement Area for the grapple. The motorized grapple is capable of grappling the overlid in order to grip the receiving cask shield plug or the source cask lid. This subassembly is described in Section 5.2.4.

The function of the Control Subsystem is to allow:

- the upper crane to be properly positioned above the Source or Receiving Cask
- the upper shield ports to be opened, closed and locked in closed position
- the lid/shield plug grapple to be lowered and lifted
- the lid/shield plug grapple to connect and disengage the overlids, and to activate the source cask lid or the receiving cask shield plug connection and disengagement.

Cameras are used to visually monitor the operations which occur in the Transfer Confinement Area, but not in the Roof Enclosure Area. Monitoring and control are in the Control Center.

Control and Monitoring of the Upper Crane

The upper crane is a motor driven trolley which positions the handling equipment over the source cask lid or receiving cask shield plug.

The operation consists of positioning of the upper crane in the source cask or receiving cask position. There is a finite number of positions and accurate positioning over the source cask lid or the receiving cask shield plug is required. The operator activates the upper crane motion setting the position to be reached. The upper crane is automatically stopped when the position is reached. There is no CCTV monitoring of the upper crane motion or position.

The position of the trolley and its motorization status are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the upper crane with the hoist system. It will prevent any motion of the upper crane if the lid / shield plug handling grapple is not stopped in its upper z position.

- Interlock the upper crane with the upper shield ports. It will prevent any motion of the upper crane if both upper shield ports are not stopped in the closed position.

The interlocks prevent any inadvertent motion of the trolley during handling, because that could cause:

- pendulum movement of the lid/shield plug (which can cause high dose rates)
- damage to the lid/shield plug
- damage to the fuel assembly transfer tube

- damage to the confinement bellows

Redundant instrumentation is not required for the control of the upper crane since the Roof Enclosure Area housing the upper crane drive is shielded.

Redundant instrumentation is provided to prevent any damage to the trolley: limit switches corresponding to the source and receiving positions and overtravel detectors on each side of the runway rails stop the trolley motion when activated.

Redundant instrumentation is not required for the upper crane position detection because a mispositioning will prevent other operations to be processed (grapple connection). This does not have an impact on safety.

Table 5.4-5 lists the instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem trolley.

Control and Monitoring of the Upper Shield Ports

The upper shield ports provide shielding between the TCA and the Roof Enclosure Area. They permit lid/shield plug grapple access to the TCA allowing lid/shield plug removal and replacement on the casks. They consist of trolleys with a locking device. The equipment is actuated by electric jacks.

Both upper shield ports and their locking devices are remotely controlled. The locking devices are only used in the closed position. The operator activates an upper shield port or its locking device setting the position to be reached. The upper shield ports are automatically stopped when the position is reached. When the operation is completed, the information is transmitted to the supervisor which displays it.

The position and motorization status of the upper shield ports and locking devices are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the upper shield ports with the lid/shield plug handling hoist system. This will prevent closing of the upper shield ports if the lid / shield plug grapple is not in the upper z position and if the hoist is loaded.

- Interlock the upper shield ports and the TC port covers. This will prevent opening of any upper shield port if the opposite TC port cover is not closed (or off centered).

- Interlock the upper shield ports and their locking device with the fuel assembly handling hoist system. This will prevent unlocking and opening of the upper shield ports if a fuel assembly is being transferred.

- Interlock the upper shield ports and their locking device with the radiation monitoring subsystem. This will prevent unlocking and opening of an upper shield port if the radiation at the level of the roof enclosure is too high.

- Interlock the receiving and source casks upper shield ports. This will prevent the opening of an upper shield port if the other is not closed.

- Interlock each upper shield port with its locking device. This will prevent locking if the upper shield port is not in the closed position.

The interlocks prevent:

- any damage to the lid/shield plug and the fuel assembly transfer tube due to the closure of an upper shield port on the lid/shield plug handling cables.

- abnormal high radiation levels on the top of the building due to incorrect synchronisation of the upper shield ports with the TC port covers

- abnormal high radiation levels on the top of the building due to a seismic event during a fuel assembly transfer.

In the event of malfunction, the instrumentation for the upper shield ports and their locking devices can be replaced, since they are located in the shielded Roof Enclosure Area.

Two different sensors are provided to detect the locked and unlocked position of the upper shield ports prior to initiating the transfer process.

Redundant instrumentation is provided to prevent any damage to the upper shield ports: limit switches corresponding to the open and closed positions and overtravel detectors on each side of the two sets of runway rails stop the trolley motion when activated.

Table 5.4-5 lists the required instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem upper shield ports.

<u>Control and Monitoring of the Hoist System</u>

The motorized hoist system lowers and lifts the grapple by means of two cables. Cable

breaking is detected by a compensator. Its motorization is located inside the Roof Enclosure Area.

The hoist system of the lid/shield plug handling system is remotely activated by the operator, setting the direction of the hoist motorization and using a variable speed. The viewing of the system is provided in the Transfer Confinement Area only.

Lowering:

The motion is automatically stopped when the cables are underloaded.

Lifting:

The motion is automatically stopped when the grapple reaches the upper position and the safety position above the TC port cover when the cables are loaded.

The motion and the direction of the hoist system are indicated in the Control Center, as well as the grapple z position. The speed is variable but is automatically lowered to its minimum when a limit distance from the target is reached.

The following interlocks will be implemented:

- Interlock the hoist with the cable load monitoring device and the grapple position monitoring device. This will prevent the lifting of the grapple over the limit position if the cables are loaded.
- Interlock the hoist with the fuel assembly handling crane carriage. This will prevent lowering and lifting if the crane is not stopped in parking position.
- Interlock the hoist with the lid/shield plug grapple. This will prevent lifting if the grapple is not totally disengaged from the overlid or if both grapple and overlid are not totally engaged.

The interlock with the lid/shield plug grapple ensures that the source cask lid or the receiving cask shield plug won't be dropped during lifting due to an incomplete engagement or disengagement of the grapple.

The interlock with the position of the crane carriage ensures that the lid/shield plug can't collide with the crane bridge which could damage it and compromise recovery requirements.

The control of the winch motor is not redundant since it is located in the Roof Enclosure Area and is accessible for repair in case of a malfunction.

The instrumentation includes all the sensors required by NOG-1.

The overload limit is adapted to the weight to be handled and so, this limit depends on the upper crane position. The overload, underrun, overrun, overspeed, abnormal drum rope level wind and cable breaking are abnormal situations and their detection generates an alarm and automatically stops motion.

Redundancy is provided to detect the proper positioning of the grapple relative to the lid/shield plug. The underload is a normal situation, its detection automatically stops motion. The z position of the grapple is then verified to validate the positioning operation.
In addition, the lid/shield plug grapple design includes a sensor to detect the overlid presence.

Table 5.4-5 lists the necessary instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem hoist.

Control and Monitoring of the Lid/Shield Plug Grapple

The grapple is motorized and can grapple or disengage the source or receiving cask overlid that can grip or disengage the source cask lid or receiving cask shield plug.

The concerned operations are the connection and disconnection of the lid/shield plug grapple with the source cask lid or receiving cask shield plug. The operator activates the grappling operation by setting the desired status (connected/disconnected). The operation is automatically stopped when the desired status is reached, and this information is displayed by the supervisor. The remote viewing of the operation by CCTV is possible when it occurs above the mezzanine level.

The following interlock will be implemented:

Interlock the grapple with the hoist system. This interlock prevents the disengagement of the overlid if the cables are loaded and if the grapple is not in its proper z position. It prevents the dropping of the lid/shield plug and uses redundant information: load and z position.

No redundant sensors are necessary for the control of the grapple since a manual backup is provided to disengage it in case of a malfunction.

Redundant sensors are provided to detect the position of the grapple fingers. The overlid presence detector provides an additional level of redundancy to the proper positionig of the grapple on the overlid. The overlid fingers position detection uses three different sensors activated by a unique mechanical device.

Table 5.4-5 lists the instrumentation for the Source Cask Lid/Receiving Cask Shield Plug Handling Subsystem grapple.

Table 5.4-5

Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Trolley (x)	Position above source cask	Electrical switch	Stop motion	ZS 303A
	Position above receiving cask	Electrical switch	Stop motion	ZS 303B
	Over travel	Electrical switch	Stop motion	ZASH 303A ZASH 303B
Upper shield ports (x2)	Open position	Electrical switch	Stop motion	ZS 301A ZS 302A
	Closed position	Electrical switch	Stop motion	ZS 301B ZS 302B
	Over travel	Electrical switch	Stop motion	ZASH 301A ZASH 301B ZASH 302A ZASH 302B
	Locked (in closed position)	Electrical contact	----	YL 312A YL 313A
	Unlocked	Electrical contact	----	YL 312B YL 313B

Table 5.4-5 (Continued)

Source Cask Lid and Receiving Cask Shield Plug Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Hoist motorization	Absolute lifting positioning	Wire potentiometer	----	ZIT 307
	First high limit	Form ZIT 307	----	ZLH 307
	Second high limit	Form ZIT 307	Stop motion	ZSHH 307
	Overtravel (final high limit)	Position selector	Stop motion	ZASH 314
	First low limit	Form ZIT 307	----	ZLL 307
	Overtravel (final low limit)	Position selector	Stop motion	ZASL 306
	Hoist overspeed limits	Electrical switch	Stop motion	SASH 305
	Hoist drum rope level winds limits	Electrical switch	Stop motion	ZS 308A ZS 308B
	Unbalanced load limits	Electrical switch	Stop motion	CS 304A CS 304B
	Weight of live load	Load cell	----	WIT 309
	Abnormal high weight of live load	From WIT 309	Stop motion	WASL 309 WASH 309
Lid/shield plug grapple	Grapple fingers open	Electrical contact	----	YL 311A
	Grapple fingers closed	Electrical contact	----	YL 311B
	Overlid presence	Electrical switch	Stop motion	YLS 310
	Overlid fingers open	Position detector	----	ZL 315A
	Overlid fingers closed	Position detector	----	ZL 315B
	Overlid fingers gripped	Position detector	----	ZL 315C

5.4.1.6 Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem consists of a crane carriage which supports a rotating platform and a transfer tube fitted with a hoist system (including two motorized winches), a motorized grapple and a crud catcher. This subsystem is described in Section 5.2.5.

The functions of the Control Subsystem for this subsystem are to allow:

- positioning of the fuel transfer tube in the x, y and θ directions.
- the hoist system to lower / lift the grapple.
- the grapple to connect / disengage the fuel assembly.
- the crud catcher to be opened / closed.

Monitoring and control are performed in the Control Center. Cameras are available to visually monitor the position and motion of the crane carriage, the rotating platform, and the crud catcher. Other cameras are available to visually monitor the positioning of the fuel transfer tube above a cell, the state of the grapple connection and the introduction of a fuel assembly in a cell.

Control and Monitoring of the Crane Carriage

The crane carriage consists of a motorized bridge (X direction) which supports a motorized trolley (Y direction) which supports a motorized rotating platform (θ). It can reach three types of positions :

- Over the source cask : over a fuel assembly centerline (or an empty cell in case of design event IV to replace a fuel in the source cask if necessary).
- Over the receiving cask : over an empty cell.
- In a "parking position" before opening or closing the source and receiving casks.

The motion is "strongly" computer assisted. To position the crane carriage of the Fuel Assembly Handling Subsystem, the operator sets the coordinates of the position (X,Y) to be reached. After motion request, the bridge and the trolley are automatically positioned by the PLC using concurrent X and Y movement. The PLC limits the use of the speeds to the slow one during fine positioning.

The position is rough and the operator has to finish the positioning of the transfer tube controlling directly the X, Y and θ motions. Fine tuning permits the operator to make the crane carriage reach the exact position over a fuel assembly (or empty cell) centerline.

The operator is helped by the CCTV Subsystem which provides two cameras (one only may be used depending on the position) fitted at the bottom of the transfer tube, the view of a complete cell.

The current (X,Y) position and the motorizations states are displayed in the Control Center.

The following interlocks will be implemented:

- Interlock the crane carriage (bridge and trolley) with the hoist system.This will prevent motion of the crane carriage if the fuel assembly grapple is not in its upper z position.

- Interlock the crane carriage (bridge and trolley) with the crud catcher. This will prevent motion of the crane carriage if the crud catcher is not closed.

- Interlock the crane carriage (bridge and trolley) with the upper shield ports. This will prevent motion of the crane carriage if the two upper shield ports are not locked (in closed position).

- Interlock the crane carriage (bridge and trolley) with the TC port covers. This will prevent motion of the crane carriage if the two TC port covers are not locked (in open position).

The interlocks prevent the crane carriage from moving during fuel assembly lifting/lowering operations. They guarantee that:

- if fuel is in the transfer tube, the crud catcher can minimize the spread of contamination and the fuel is fully retracted into the transfer tube during motion.

- if fuel is being lowered or lifted, the crane carriage won't move which could damage the fuel assembly and compromise recovery requirements.

- shielding to the roof of the DTS building during normal operating conditions or in case of a seismic event.

- the fuel transfer can't occur if the TC port covers are unlocked. If a seismic event occurs during a fuel transfer, the TC port covers will not collide with the fuel

assembly.

- the safety of the source cask lid or receiving cask shield plug lifting won't be compromised by a collision with the fuel assembly handling crane

Redundant instrumentation is not required to control the crane carriage, since manual backup is provided.

The positioning of the crane carriage uses position encoders. Limit switches on each end of the runway rails detect overtravels and stop the X and Y motions when activated.

Redundant instrumentation is not required for the proper positioning of the crane carriage as the CCTV Subsystem provides the viewing of a cell.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem crane carriage.

Control and Monitoring of the Rotating Platform

The rotating platform is motor driven, it supports the hoist motorization and can rotate around its centerline to allow the proper positioning of the fuel transfer tube above a fuel assembly centerline or an empty cell.

The operator remotely controls the θ motion of the rotating platform, chooses the direction (clockwise, counter clockwise) and the speed. The CCTV provides the viewing of the empty cell or of the fuel assembly.

The position (θ) of the rotating platform and the motorization status is displayed in the Control Center.

The following interlockswill be implemented:

- Interlock the rotating platform with the hoist system. This will prevent any rotation of the platform if the assembly grapple is not in upper z position.

- Interlock the rotating platform with the crud catcher. This will prevent any rotation of the platform if the crud catcher is not closed.

The interlocks prevent the rotating platform from moving during a fuel assembly lifting or lowering operation which could damage the fuel assembly and compromise recovery

requirements.

A manual backup can rotate the platform in case of a malfunction, so redundant instrumentation is not required. The position encoder and the CCTV Subsystem provide sufficient information to properly position the rotating platform.

Table 5.4-6 lists the instrumentation for the Fuel Handling Subsystem rotating platform.

Control and Monitoring of the Crud Catcher

The crud catcher is a trapdoor actuated by an electric jack, which covers the bottom of the fuel assembly when it is fully retracted into the transfer tube. It minimizes the spread of radioactive particulate during the fuel transfer.

The crud catcher is remotely controlled. The operator sets the position he wants to reach (open/closed). When the electric jack is in the desired position, the completion of the operation and the position are displayed by the supervisor. The CCTV Subsystem provides viewing of this equipment.

Monitoring and control of the crud catcher are performed in the Control Center.

The following interlocks will be implemented:

- Interlock the crud catcher with the crane carriage (bridge and trolley) motorizations. This will prevent the crud catcher opening if the crane carriage is not stopped in x and y directions.
- Interlock the crud catcher with the rotating platform. This will prevent the crud catcher opening if the rotating platform is in motion.
- Interlock the crud catcher with the fuel assembly handling hoist system. This will prevent the crud catcher closure if the grapple is not in the upper z position.

The interlocks prevent crud catcher opening during fuel transfer tube positioning. They also ensure that if a fuel assembly is present in the transfer tube during positioning, it is fully retracted into it.

The interlock with the hoist system ensures that the crud catcher can't damage the fuel assembly during closure.

Redundant instrumentation is not required for the control of the crud catcher since a manual backup is provided.

Two different sensors are used to detect the open and closed positions of the crud catcher. This allows easy detection of the failure of a sensor which could have an impact on the interlocks. The CCTV provides an additional means for validation.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem crud catcher.

Control and Monitoring of the Hoist System

The hoist system consists of a cable with two motorized winches.

Only one winch is controlled at a time. The operator selects the current winch, and activates it for lowering and lifting operations.

Lowering:

The speed of each winch is variable. The lowering operation is automatically stopped when the cables are underloaded.

Lifting:

The operator uses the variable speed and the operation is automatically stopped when the grapple is in the upper position.

During operations, the operator can monitor the z position of the grapple. The CCTV Subsystem provides the viewing of the top of the fuel assembly in the cask or of the top of an empty cell. The operator can monitor the entry of the fuel assembly in an empty cell.

The two motorized winches can not operate simultaneously and use the two different power supply channels. The speed is variable and is controlled by the operator. However the slow speed is automatically selected below a limit z position of the grapple.

The following interlocks will be implemented:

- Interlock the hoist system with the crud catcher. This will prevent lowering of the grapple if the crud catcher is closed.

- Interlock the hoist system with the fuel assembly grapple. This will prevent lifting if the grapple is not totally engaged or disengaged.
- Interlock the hoist system with the crane carriage and the rotating platform. This will prevent lowering if the crane carriage and the rotating platform are not stopped.

These interlocks prevent:

- the fuel assembly from getting stuck in the transfer tube; and
- dropping of a fuel assembly due to an improper gripping.

Redundant motorization, on two different power channels are provided.

The instrumentation includes all the sensors required by NOG-1.

Redundancy is provided to detect the proper positioning of the grapple relative to the fuel assembly. The underload is a normal situation, its detection automatically stops motion. The z position of the grapple is then verified to validate the positioning operation
In addition to that, the fuel assembly grapple design includes a fuel assembly presence detector. The overrun/underrun, overload, overspeed and abnormal drum rope level winds situations are abnormal, their detection generates an alarm and automatically stops motion.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling Subsystem hoist.

Control and monitoring of the grapple

The motorized grapple is used to connect and disengage the spent fuel assembly. There are three motors, one for normal operating conditions and the two others for backup.

The operator selects the normal or backup equipment using a switch on the main control panel, and activates it by setting the desired status (connected/disconnected). The operation is automatically stopped when the desired status is reached and this information is displayed by the supervisor. The CCTV Subsystem provides viewing of the status of the connection (mechanical flags).

The backup equipment will only be used to disengage the grapple.

All the indications on connection and motorization status are displayed in the Control Center.

The following interlock will be implemented:

Interlock the grapple with the hoist system. This will prevent the disengagement of the fuel assembly if the cable is loaded and if the grapple is not stopped in a proper position.

The interlock with the hoist system ensures that the spent fuel can't be dropped due to an operator error.

The grapple motorization is redundant. The two backup motors shall be on the secondary power channel.

Two different sensors are used to detect the position of the grapple fingers.

Table 5.4-6 lists the instrumentation for the Fuel Assembly Handling grapple.

Table 5.4-6

Fuel Assembly Handling Subsystem Instrumentation

Equipment	Data	Sensor type	Action	Reference
Bridge (x)	Absolute traveling positioning	Synchroresolver	----	ZIT 101
	Over travel	Electrical switch	Stop motion	ZASH 102A ZASH 102B
Trolley (y)	Absolute traversing positioning	Synchroresolver	----	ZIT 104
	Over travel	Electrical switch	Stop motion	ZASH 105A ZASH 105B
Rotating platform	Absoulte rotating positioning	Synchroresolver	----	ZIT 107
Crud catcher	Open position	Electrical contact	----	YL 119A
	Closed position	Electrical contact	----	YL 119B
Hoist motorization	Absolute lifting positioning	Wire potentiometer	----	ZIT 109
	First high limit	from ZIT 109	Stop motion	ZSH 109
	Final overtravel high limit	Electrical switch	Stop motion	ZASH 118
	First low limit	from ZIT 109	----	ZSLL 109
	Final overtravel low limit	Electrical switch	Stop motion	ZASL 110
	Hoist overspeed limits	Electrical switch	Stop motion	SASH 111 SASH 112
	Hoist drum rope level winds	Electrical switch	Stop motion	ZS 113 ZS 114
	Weight of live load	Load cell	----	WIT 115
	Limit weights	from WIT 115	Stop motion	WASH 115 WASL 115

Table 5.4-6 (Continued)

Fuel Assembly Handling Subsystem Instrumentation

Equipment	Data	Sensor Type	Action	Reference Grapple
Grapple	Grapple fingers closed	Electrical switch	----	YL 116B
	Grapple fingers open	Electrical switch	----	YL 116A
	fuel assembly presence	Electrical switch	Stop motion	YLS 117

Figure 5.4-1

Instrumentation and Control Structural Diagram

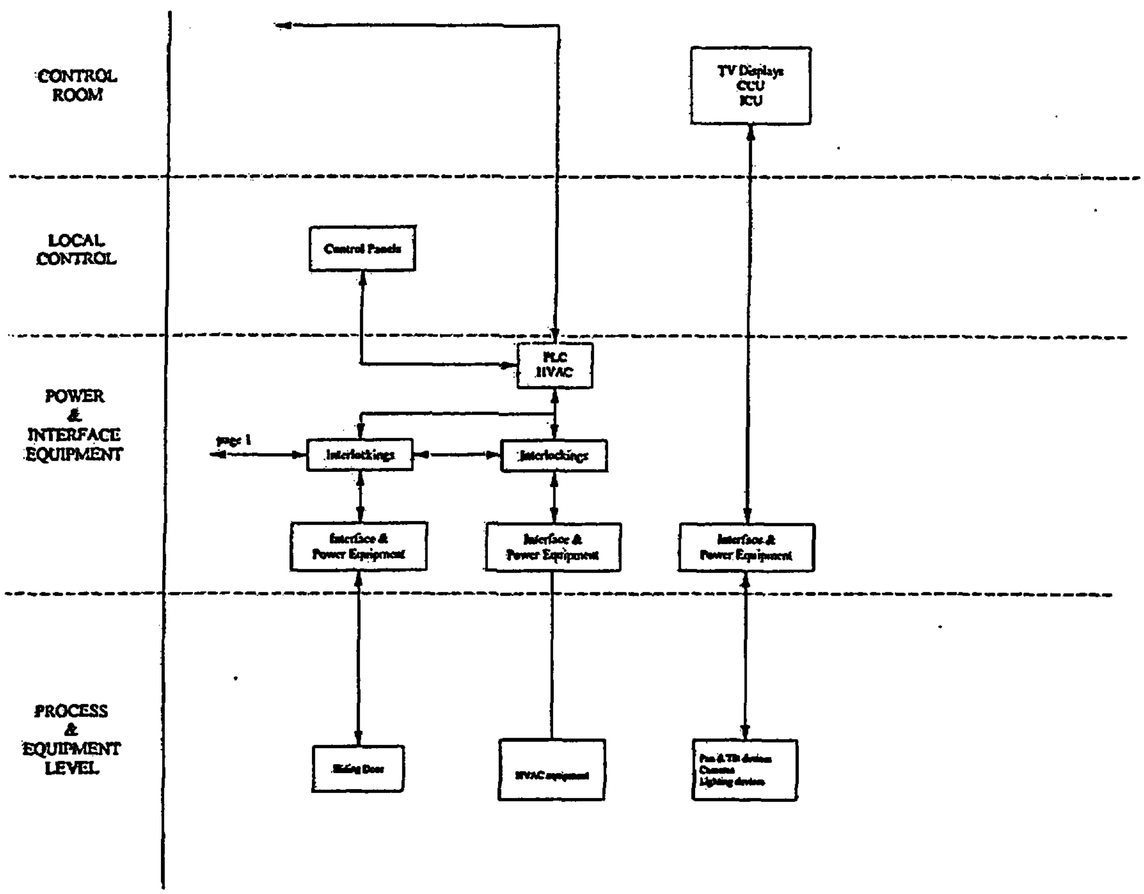
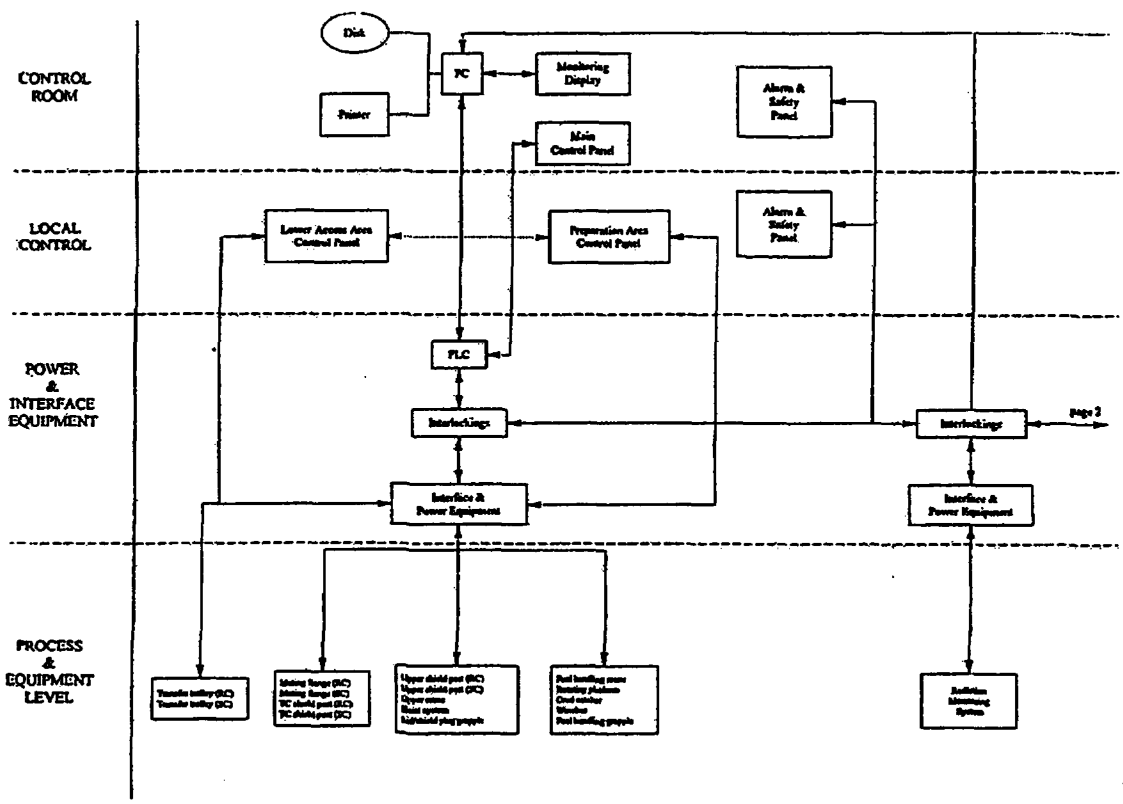


Figure 5.4-1 (Continued)

Instrumentation and Control Structural Diagram



5.5 Control Room and Control Areas

5.5.1 Control Location and Operations

As shown in the Instrumentation and Control Structure Diagram (Figure 5.4-1), the human/machine interfaces for the control and monitoring of the equipment are located in three areas:

- the Control Center which is located on a trailer outside the DTS building,
- the Preparation Area, and
- the Lower Access Area.

The locally controlled and monitored operations are those involving:

- the Casks Transfer Subsystem (transfer trolleys entry/positioning/removal and locking/unlocking operations), and
- the Structural Subsystem (roll-up and sliding doors opening/closing operations).

All the other operating subsystems are remotely controlled and monitored from the Control Center.

5.5.2 Local Control and Monitoring Under Normal Conditions

Two identical control panels are located in the Lower Access Area and in the Preparation Area to control the Cask Transfer Subsystem during normal operating conditions. A unique key activates the control panel, in order to give control to an authorized operator.

The control of the sliding door is performed using specific control panels in the Lower Access Area and in the Preparation Area. The control of the roll-up door is performed using specific control panels outside of the building and in the Preparation Area.

5.5.3 Remote Control and Monitoring Under Normal Conditions

The following instrumentation is provided to remotely control and monitor operations during normal conditions:

- a video system (2 CCTV displays, Intensity Control Units and Camera Control Units),
- one main control panel,
- a personal computer,
- a monitoring display, and
- an audio system.

Two CCTV displays provide viewing of the Lower Access Area, of the Transfer Confinement Area and of the upper part of the casks' baskets. They permit the operator to validate operations and transition conditions and to position the fuel assembly transfer tube above a fuel cell, to check the entry of a fuel assembly in a cask and to detect physical equipment problems, abnormal process conditions or the initiation of a fire. They also provide viewing of the Preparation Area (for security reasons) and of the welding process.

The main control panel permits the operator to control every remote operation by use of push buttons and joysticks, and to control the power of each equipment group (locking device and motorization for example). It includes a general emergency push button which deenergizes all the mechanical equipment when activated and generates alarms.

The personal computer enables the operator to set the coordinates of the target position of the fuel assembly transfer tube prior to activate its positioning. It also houses the monitoring software (supervisor) which displays all the necessary monitoring information to safely control the operations as:

- Mechanical equipment: equipment status and positions, etc,
- HVAC: temperature and pressure in each area, equipment status,
- Radiation Monitoring: radiation level in the different areas.

The audio system provides an additional monitoring means for the operations which occur in the Transfer Confinement Area.

5.5.4 Local Control Under Off-Normal conditions

During off-normal conditions, the local operations can only be processed if:

- there is no fuel being transferred,
- if the two casks are closed,
- if the radiation level is under the admissible limit.

The local operations affected by off-normal conditions are the unlocking and removal of the transfer trolleys. The unlocking operation can be processed manually. The transfer trolleys can be removed using a prime mover. In case of a complete loss of the Control System, the disengagement of the casks (remote operation under normal conditions) with the mezzanine floor can be operated locally, taking all the necessary precautions.

5.5.5 Remote Control Under Off-Normal Conditions

Most equipment has a manual backup or is accessible for repair and so can be controlled under any condition. The equipment which do not have manual backup and are not accessible for

repairs include:

- the fuel assembly grapple
- the fuel assembly hoists

Selectors on the main control panel allows the operator to switch the current hoist and to use the backup motorizations of the grapple in case of a motorization or power supply failure. For both systems, the main motorization and its backup are on the two different power supply channels and don't share any control or power wire.

Failure of monitoring and control system (design event II)

In the case of a loss of the remote control of this equipment (fuel assembly hoist and grapple), the system is designed to fail safe (brakes engage upon loss of electrical power, grapple fingers opening mechanically impossible). Two different PLC's manage the HVAC and the mechanical equipment. So, a failure of the control of the fuel assembly hoist or grapple doesn't necessarily implicate a failure of the control of the HVAC System. In the case where the failure of the Control Subsystem is due to a failure upstream of the PLC, the HVAC can be switched to a "manual mode" where the speed of the exhaust fan is set by the operator as well as the activity of the cooling system. In these conditions, the Control System can be repaired without time restrictions.

Tornado missiles, hurricanes and high winds (design event IV)

In the case of a tornado warning or watch, the installation is placed in a safe condition (fuel replaced in the casks and casks closed). The Control Center may be disconnected from the DTS and moved to a sheltered area. The HVAC system can be controlled manually. No remote control is required during this temporary shutdown period. If a tornado hits, and depending on the damage caused to the Preparation Area and to the HVAC exhaust fans, two solutions can be chosen:

- either the Control System and the HVAC can be repaired and the casks can be reopened or the transfer can be completed,
- or the casks need to be inerted and removed from the DTS.

In the worst case, the Preparation Area is lost and the receiving cask overpack lid is damaged or lost which prevents the cask from being inerted. The utility may wish to keep a backup overpack lid for this reason. The damages caused to the Preparation Area (housing the PLC's) and to the HVAC can be fixed without time restrictions.

5.6 Analytical Sampling

Section 7.3.4 describes the sampling which will be performed to ensure that operations are within prescribed radiological limits.