CHAPTER 2

SITE CHARACTERISTICS

A site has not been selected for the Dry Transfer System at this time. Generic site design criteria have been developed and used in the non-site-specific design of the DTS. Once a DTS site is selected, the actual site characteristics and parameters will be determined for site-specific design and regulatory review. The generic design of the DTS may be used for the site-specific design, if it is demonstrated that the generic site design criteria bound the site-specific values.

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.

2.1 Geography and Demography of Site Selected

This section is not applicable to a non-site-specific TSAR.

2.2 Nearby Industrial, Transportation and Military Facilities

Nearby industrial, transportation and military facilities have not been identified in this TSAR. If a site is selected near industrial, transportation or military facilities, the impact of these facilities on the evaluation of the DTS will be evaluated in the site specific application. The TSAR assumes that the hazards posed by nearby facilities and transportation routes are enveloped by other site hazards such as tornado winds and tornado-generated missiles. Hazards posed by nearby facilities and transportation routes include explosives, fire, toxic gases, corrosive airborne pollutants and impact hazards. In order to ensure that this approach is conservative, the site-specific submittal will assess the hazards presented by nearby industrial, transportation and military facilities, and verify that the design criteria associated with those hazards are bounded by other design criteria.

2.3 Meteorology

2.3.1 Regional Climatology

In the absence of site-specific information, bounding design criteria related to maximum and minimum temperatures, extreme winds, tornadoes, hurricanes and tropical storms, precipitation, snow storms and ice storms are evaluated. The criteria and their bases are provided below.

2.3.1.1 Maximum and Minimum Temperatures

The DTS is designed for an external temperature range of -20°F (-29°C) to 115°F (46°C). If external temperatures exceed this range, fuel transfer operations will be suspended.

2.3.1.2 Extreme Winds

The design wind speed (three-second gust, non-tornado) is 150 mph. This value bounds all of the 48 contiguous states, based on the American National Standards Institute/American Society of Civil Engineers (ANSI/ASCE) 7-95 Standard (Ref. 2-1).

2.3.1.3 Tornadoes

The design maximum tornado wind speed, rotational plus translational, is 360 mph (579 kph). The tornado wind speed consists of a rotational wind speed of 290 mph (467 kph) and a maximum translational speed of 70 mph (113 kph). The radius of maximum rotational speed is 150 ft (45.7 m). The maximum pressure drop is 3 psi (20,690 Pa) at a rate of 2 psi (13,793 Pa) per second. The design basis tornado bounds the 48 contiguous United States and is based on a Region I tornado described in Regulatory Guide 1.76 (Ref. 2-2).

2.3.1.4 Thunderstorms and Lightning Strikes

In accordance with 10 CFR 72.122(b)(2) (Reference 2-3), the structures, systems, and components (SSCs) important to safety must be designed to withstand the effects of lightning without impairing their capability to perform safety functions. The fundamental principle in protection against lightning is to provide a low impedance path which a lightning discharge current will follow instead of high impedance paths offered by important to safety structures, systems, and components. To satisfy this criterion, the DTS lightning protection system will be designed in accordance with National Fire Protection Association (NFPA) Code 780 (Ref. 2-4).

The provisions in the NFPA code are not based upon geographical location. Therefore, this criterion encompasses all of the 48 contiguous United States. However, final lightning protection system design will be site-specific, as it will depend on the soil and corrosion characteristics of the site and the degree of protection offered by other grounded structures in the proximity of the site.

2.3.1.5 Snow and Ice Storms

The design snow and ice load is 100 psf (4789 Pa). This value bounds most potential sites, based on the ANSI/ASCE 7-95 Standard. However, ANSI/ASCE 7-95 does not provide values in certain parts of the United States, particularly in mountainous areas, due to the degree of variability.

2.3.2 Local Meteorology

This section is not applicable to a generic TSAR.

2.3.3 On-site Meteorological Measurement Program

Existing National Weather Service or best available weather data summaries should be used to validate the bounding values used in this TSAR at each selected site. If sufficient data are not available, the required on-site meteorological measurement program will be described, developed and implemented, commensurate with the degree of risk to the health and safety of the public.

2.3.4 Diffusion Estimates

Concentrations of gaseous radionuclides at the site boundary following routine releases and accident releases are based on NRC Regulatory Guide 1.145 (Ref. 2-5). Assumptions related to atmospheric diffusion are:

- Pasquill Stability Class F (moderately stable)
- Average windspeed: 1 m/s
- Wind direction toward closest point of controlled area boundary.

2.4 Surface Hydrology

2.4.1 Hydrologic Description

This section is not applicable to a non-site-specific TSAR.

2.4.2 Floods

The DTS design assumes that all SSCs important to safety are located above the probable maximum flood level. For any selected location, the site drainage facilities will be designed to accommodate the probable maximum precipitation runoff and drainage without flooding any SSCs important to safety.

2.5 Subsurface Hydrology

This section is not applicable to a generic TSAR. This information will be providedin site specific applications.

2.6 Geology and Seismology

2.6.1 Basic Geologic and Seismic Information

This section is not applicable to a generic TSAR. This information will be provided in site specific applications.

2.6.2 Vibratory Ground Motion

The DTS is designed for a maximum ground acceleration of 0.25g horizontal and 0.17g 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. NRC Regulatory Guide 1.60 (Ref. 2-6) response spectra curves were used. In accordance with NRC Regulatory Guide 1.61 (Ref. 2-7), a 7% damping factor was used for the DTS reinforced concrete structure.

Soil Structure Interaction was not included in the analysis. A hard rock site is assumed, which is expected to result in the maximum accelerations of the structure. For each selected site, 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 in this TSAR, or the analysis will be reperformed to consider the site specific soil structure.

2.6.3 Surface Faulting

The DTS design assumes that all SSCs important to safety are located away from capable faults. When a site is selected, site investigation with respect to capable faults will be performed in accordance with applicable NRC regulations. Fault avoidance is the preferred approach for DTS siting.

2.6.4 Stability of Subsurface Materials

Soil characteristics will be evaluated on a site specific basis.

2.6.5 Slope Stability

A flat site is assumed.

2.6.6 Volcanism

The DTS design assumes that there are no nearby volcanic centers that could impact the DTS through explosive forces, lava flow or ash fall. Therefore this section is not applicable to a generic TSAR.

2.7 Summary of Site Conditions Affecting Construction and Operating Requirements

In the absence of site-specific information, the DTS design is based on site characteristics chosen to envelop as much of the contiguous 48 United States as practical. The site-related design criteria are described and tabulated in Chapter 3. Once a site for the DTS is selected, site investigations will be performed to quantify the actual site characteristics. If any DTS design criteria do not conservatively bound the actual site characteristics, then the respective design criteria will be amended in the site specific application, changes to the design incorporated as necessary, the design reverified, and the supporting analysis and changes documented in the site specific license application.

2.8 References

2-1. ANSI/ASCE 7-95, *Minimum Design Loads for Buildings and Other Structures.* American National Standards Institute and American Society of Civil Engineers, 1995.

2-2. Regulatory Guide 1.76. *Design Basis Tornado for Nuclear Power Plants,* Rev. 0, USNRC, April, 1974.

2-3. 10 CFR Part 72. *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.*

2-4. NFPA No. 780. *Lightning Protection Code.* National Fire Protection Association, 1992.

2-5. Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,* Rev. 1, 1983.

2-6. Regulatory Guide 1.60. *Design Response Spectra for Seismic Design of Nuclear Power Plants.* Rev. 1. USNRC. December 1973.

2-7. Regulatory Guide 1.61. *Damping Values for Seismic Design of Nuclear Power Plants,* 1973.

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 (Ref. 3-1) 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 design basis fuel was selected by Transnuclear and EPRI, based on preliminary data established by the Department of Energy for the Multipurpose Canister (MPC) program. It is fully expected that the design basis fuel will change dependent on the needs of the site-specific applicant. The initial enrichment, burn-up and cooling time are typical of fuel that can be stored in currently licensed casks. The design basis fuel has been used to provide an estimate of the operational dose rates and accident dose rates associated with use of a DTS at a utility, and can be used to assist in determining whether construction of a DTS is a feasible option at a given site.

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. The design basis spent fuel assembly characteristics provided in Tables 3.1-1, 3.1-2 and 3.1-3 were taken from the document: Multi-purpose Canister (MPC) Subsystem Design Procurement Specification, DBG6000000-01717-6300-00001, Rev. 04, Prepared for the USDOE, by TRW Environmental Safety Systems, Inc., August 26, 1994.

For criticality calculations, 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. As shown in the shielding evaluations, the majority of the operational and public doses are not due to fuel transfer operations, which are performed in a well-shielded area, but to radiation from the source and receiving casks. The selection of a source cask and a receiving cask is left to the site-specific applicant. Shielding calculations will need to be performed, using the actual casks to be used. Therefore it is not worthwhile at this time to bound all fuel that may eventually be selected for final disposal at Yucca Mountain, nor for all fuel scheduled for discharge prior to the year 2003.

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
1.00E-02	2.25E-01
2.50E-02	5.33E-02
3.75E-02	5.71E-02
5.75E-02	4.47E-02
8.50E-02	2.91E-02
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
7.00E+00	1.47E-10
9.50E+00	1.69E-11

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 [Reference: DOE DOC ID-20000000-00811-5705-00001 through 00005] 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 equipment, is installed onto the shield plug which remains within the MPC. After the installation of the lifting pintle, the cask seals and surfaces are inspected.

The lifting pintle concept is currently used on storage casks. The lifting pintle is attached to the lid of the cask by means of four (4) bolts threaded into the lid of the cask. The design of the pintle for the DTS cask, including the attachment bolts, would be dependent on the weight of the cask lid (source cask) or shield plug (receiving cask). The advantage of this system is that a well located attachment point can be easily attached to a grapple either remotely or using long handled tools. Each currently licensed transport/storage cask has a means for lifting the cask lid remotely. This may be by means of slings or an attachment device. It is the responsibility of the site-specific applicant to adapt the source cask and the receiving cask such that a pintle system can be used. The site specific license application will include a description of the design provisions and procedure for installation of the pintle to the shield plug.

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 the Lower Access Area.

The site specific license application will describe any difference between the site specific receiving cask and the receiving cask parameters utilized for the design of the DTS in this Topical Report. In addition, the application will provide an evaluation of the DTS design, the design analyses, and the design changes, made necessary by any differences in the cask design parameter, considering the design criteria for the Multipurpose Canister and the Transportation Overpack presented in Chapter 3, and the bounding conditions analyzed in Chapter 8.

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. The site/cask-specific design provisions and procedure for installation of the pintle to the source cask lid will be described in the site specific license application once the specific cask has been selected.

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 site specific license application will describe any difference between the site specific source cask and the source cask parameters utilized for the design of the DTS in this Topical Report. In addition, the application will provide an evaluation of the DTS design. It will also provide the resulting required design analyses and design changes made necessary by any differences in the cask design parameters, considering the design criteria for the source cask presented in Chapter 3 and the bounding conditions analyzed in Chapter 8.

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 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 source 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 3.1-6
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)

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

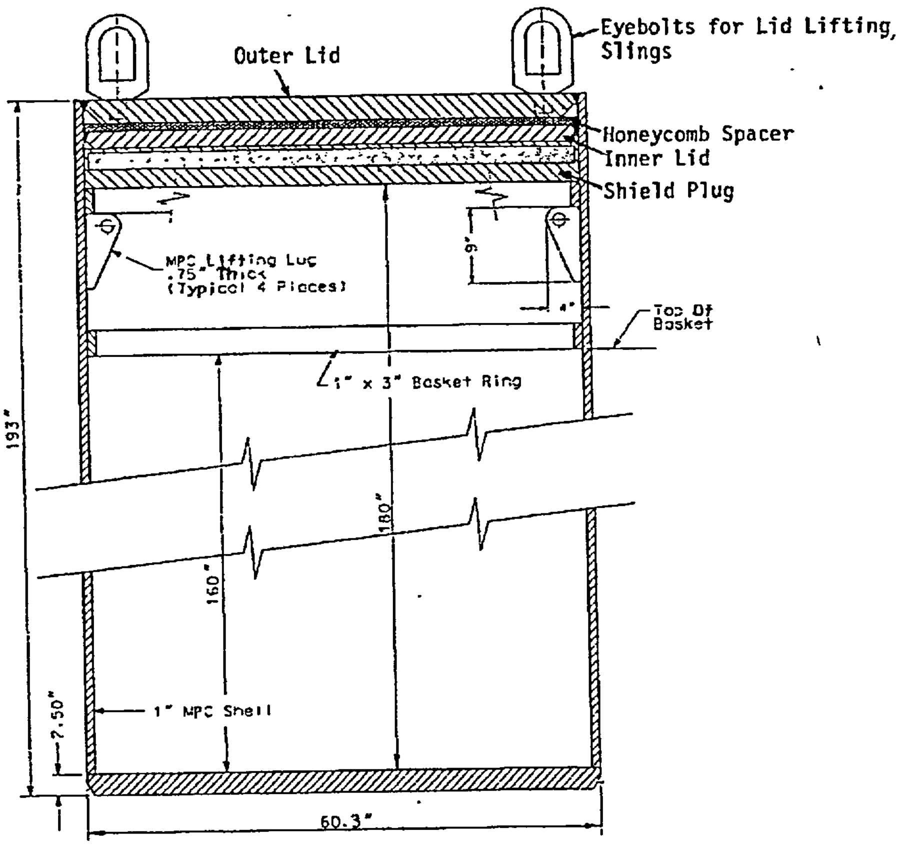


Figure 3.1-2
Design Basis Receiving Cask Transportation Overpack

Security-Related Information Figure Withheld Under 10 CFR 2.390.

Figure 3.1-3
Design Basis Source Cask

Security-Related Information Figure Withheld Under 10 CFR 2.390.

Figure 3.1-4
Pintle Concept

Security-Related Information Figure Withheld Under 10 CFR 2.390.

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 (Ref. 3-2).

The DTS lightning protection system will be designed in accordance with National Fire Protection Association (NFPA) Code 780. The worst credible fire will also be evaluated for each site, in compliance with NFPA. Postulated explosions will be evaluated on a site-specific basis, using Regulatory Guide 1.91, Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants. Regulatory Guide 1.91 provides guidance for 'Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants'. The Regulatory Guide states that an acceptable method of demonstrating that the risk of damage to the nuclear power plant, due to explosions (occurring on transportation routes), is sufficiently low as to show that the exposure rate to peak positive incident overpressures in excess of 1 psi, is less than 10^{-7} per year. A review of several utility ISFSI Safety Analysis Reports indicates that an explosion of a couple of psi or less, is postulated as the worst case explosion. An evaluation of actual potential explosions will be addressed in the site-specific Safety Analysis Report. However, postulated off-site and on-site explosions are expected to result in external pressures of no more than 3 psi, and would therefore be bounded by other design basis loads such as wind and tornado loads.

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 placed in a safe condition. Transfer of a cask into or out of the DTS will be completed, if in process. The sliding door will be closed, if open. Any fuel in transfer will be lowered into the closest (either source or receiving) cask and all fuel transfer operations will be suspended for the duration of the warning or watch. The TC port covers as well as the 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. It is possible that a tornado will hit without warning, leaving the operators of the DTS with no choice but to shut off power. The DTS is designed to be in a safe condition at any point in the fuel transfer process, in the event of a power shut down.

The following initial conditions have been considered.

Receiving or Source Cask in the Preparation Area

This is a safe condition while the cask lids remain bolted to the cask. The lid on a cask will not be unbolted until the cask has been attached to the transfer trolley and until just prior to the scheduled movement of the cask into the Lower Access Area. Furthermore, a cask lid will not be unbolted in the event a tornado watch or warning is in effect.

It is considered extremely unlikely that conditions favorable for the formation of a tornado will develop without warning during the relatively short time required to unbolt a cask lid and move the transfer trolley with the cask into the Lower Access Area. However, should a tornado watch or warning be issued while a cask lid is being unbolted, operations to unbolt the cask lid will be immediately suspended and the transfer trolley moved into the Lower Access Area. The estimated time to perform this operation is as follows:

Sliding Door Opening	5.0 Min
Transfer Trolley Entry	3.0 Min
Transfer Trolley Positioning	5.0 Min
Sliding Door Closing	5.0 Min
Total Time	18.0 Min

Time estimates for each operation are from Section 5.1.

Receiving or Source Cask being transferred into the LAA

This is the same condition as the case above, except that the sliding door is open-end the cask lid has been unbolted. Transfer of the cask will be completed and the sliding door closed. The time required to perform each of these operations are presented in Section 5.1 of the TSAR. The maximum time required, assuming movement of the Transfer Trolley has not been started, will be as follows:

Transfer Trolley Entry	3.0 Min
Transfer Trolley Positioning	5.0 Min
Sliding Door Closing	5.0 Min
Total Time	13.0 Min

The tornado missile analysis does not take credit for the Sliding Door being locked, therefore,the locking time of 30 minutes does not need to be included in the above time estimate.

Receiving Cask, or Receiving Cask and Source Cask in the LAA while receiving cask shield plug and source cask lid are on

The Receiving cask containing the spent fuel would normally only be in the LAA with the shield plug on, just prior to moving a new source cask in, or just after moving a source cask out of the LAA, or just prior to moving the Receiving cask out of the LAA. If the lid (source cask) or the shield plug (receiving cask) is on, the fuel cladding temperatures will gradually increase. Depending on the specific cask design, the number of assemblies in the cask, and the specific fuel assembly exposures and decay times, the final steady-state temperature of the fuel in the casks may exceed the safe limits for the fuel exposed to air.

The site specific DTS operating procedures will address the length of time a cask lid is allowed to remain on a cask which has not been inerted. The DTS LAA will be provided with tanks of an inert gas, such as argon, that can be used to back-fill the cask in the event of an extended interruption of fuel transfer operations. When the cask is filled with an inert gas, the fuel can be maintained in the cask for an indefinite period of time.

Receiving Cask and Source Cask in the LAA with Receiving Cask Shield Plug and Source Cask Lid off and Fuel being transferred.

This is a safe condition. However, to preclude the possibility of fuel being suspended on the grapple for an extended period of time, any fuel being transferred will be lowered into the nearest cask (source or receiving) prior to suspending the operations. The time required to accomplish this operation, using the time estimates from Section 5.1 is:

Fuel Assembly Crane Carriage Positioning	6.5 Min
Rotating Platform Positioning	0.5 Min
Crud Catcher Opening	0.5 Min
Fuel Assembly Grapple Lowering	3.2 Min
Fuel Assembly Grapple Disengagement	0.5 Min
Total Time	11.2 Min

The above time estimates are not affected by variations in ambient temperature.

The DTS structure is designed to withstand the operating basis wind loads, and the loads generated by design basis tornado. Any component which is outside of the DTS (such as exhaust fans, the duct work, and the condensing coil units for the Heating, Ventilating and Air Conditioning (HVAC) Subsystem are housed in a missile resistant room adjacent to the DTS. This protects the 'Important to Safety' components of the HVAC and ensures that all Systems in the DTS are still safe under the tornado, tornado missile, and wind loadings. Operations will not be restarted until the tornado watch has passed

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 7-95 (Ref. 3-3) for the fastest speed of 150 mph (241 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 (Ref. 3-4) and NUREG-0800 (Ref. 3-5), 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 NUREG-0800 (Ref. 3-5) 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 Wind and Tornado Wind Forces on Structures

Velocity pressure coefficients corresponding to Exposure Category C are taken from Table 6-3 of ANSI/ASCE 7-95 (Ref. 3-3), and are presented below in Table 3.2-2.

Table 3.2-2
Velocity Pressure Exposure Coefficients and Velocity Pressure, For the DTS Structure Analysis

Height Above Grade, z(feet)	Velocity Pressure Coefficients, K_z/K_h	Velocity Pressure q_z
0-15 (0-4.6m)	0.85	56.3
20 (6.1 m)	0.90	59.62
25 (7.6 m)	0.94	62.27
30 (9.1 m)	0.98	64.92
40 (12.2 m)	1.04	68.89
50 (15.2 m)	1.09	72.20
60 (18.3 m)	1.13	73.53

Gust effect factor 'G' is taken from Section 6.6, and is used in conjunction with an importance factor 1.15 for a Category IV structure from Table 6-2, both of ANSI/ASCE 7-95. The velocity pressure q_z is calculated from:

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

where:

q_z is the velocity pressure at height z
K_z is the velocity pressure exposure coefficient at height z
K_h is the velocity pressure exposure coefficient at height h (roof)
I is the importance factor for Category IV structure
V is the Basic Wind Speed of 150 mph
$K_{zt} = 1.0$
$G = 0.85$
C_p= External Pressuere Coefficient
C_{pi}= Internal External Pressuere Coefficient

Design wind pressure is calculated for the main wind resisting systems and components, from the equations in Table 6-1 of ANSI/ASCE 7-95, based on the appropriate pressure coefficients taken from Figures 6.3 and Table 6-4 of ANSI/ASCE 7-95.

Design wind pressures for the building main frame and components are presented in the following Table 3.2-3. The design pressure for the design basis tornado wind speed of 360 mph (579 km/h) is equal to $(360/150)^2$ x design wind pressure. These values are also presented in Table 3.2-3.

Table 3.2-3
Design Basis Wind/Tornado Wind Pressure

Component	Wind speed mph	Velocity pressure q_z lbs/ft²	Pressure Coefficient C_p	Pressure Coefficient GC_p/GC_{pi}	Design Wind Pressure lbs/ft²	Design Tornado Wind Pressure lbs/ft²
Windward wall 0-15 (0-4.6m)	150	56.3	0.8	0.68	38.28	220.49
20 (6.1 m)	150	59.62	0.8	0.68	40.54	233.51
25 (7.6 m)	150	62.27	0.8	0.68	42.34	243.88
30 (9.1 m)	150	64.92	0.8	0.68	44.15	254.30
40 (12.2 m)	150	68.89	0.8	0.68	46.85	269.86
50 (15.2 m)	150	72.20	0.8	0.68	49.10	282.82
60 (18.3 m)	150	73.53	0.8	0.68	50.00	288.0
Leeward Wall	150	73.53	-0.43	-0.366	-26.88	-154.83
Side Walls	150	73.53	-0.7	0.595	-43.75	-252.00
Roof (55 ft/16.8 m)	150	73.53	-1.3	-1.0	-73.53	-423.53
Internal pressure	150	73.53		±0.18	±13.24	±76.26

3.2.1.3 Ability of Structures to Perform, Despite Failure of the 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 a 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 tornado 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 ductwork, 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 airflow 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 during a tornado watch, to place the system in its safe 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

Tornado missiles have local and global effects. The analyses of local effects on the wall include calculations of depth of penetration, thickness required to protect against perforation and scabbing, kinetic energy, and force of impact. The local effects of tornado missiles are calculated using Modified National Defense Research Committee (MNDRC) (Ref. 3-6) equations shown below. The global effects are evaluated using the classical structural analysis methods.

- **Local Effects of Tornado Generated Missiles on Concrete Structures**

Missile A: (Wood plank 4" x 12" x 144" long, weight 115 lb., striking velocity 186.1 mph.)

Wood plank is a soft missile as compared to the target concrete structure. Therefore, it will crush upon impact rather than penetrate the target. The impact force and kinetic energy are evaluated for later use in global effect evaluations.

Max Kinetic energy of impact $E = 1/2\ mV^2$

Where m = mass =115/32.17 lb. sec^2/ft.
V = impact velocity = 186.1 mph = 272.1 ft/sec.
$E = ½ \times 115/32.17\ (272.1)^2 = 132{,}383$ ft. lbs.

Force of Impact $F = A\,f_u$

Where f_u = ultimate strength of wood ≈ 5.0 ksi
A = cross - sectional area of wood plank = 39.38 in^2

Force of Impact $= F = 5 \times 39.38 = 196.9$ kips. use 197 kips.

Missile B: (6" sch 40 pipe, 15' long, weight 287 lbs. striking velocity 116.7 mph.)

Reference: AISC "Structural Analysis and Design of Nuclear Power Plants", Modified National Defense Research Committee Equations (Ref. 3-6):

A. Penetration into Reinforced Concrete:

$$X = \sqrt{4KNWd\left(\frac{V}{1000d}\right)^{1.8}} \quad \text{for } X/d < 2.0$$

Where:

X = Total Penetration Depth (in.)
W = Weight of missile = 287 lbs.
V = Striking Velocity of Missile = 116.7 mph. = 170.7 ft./sec.
d = Diameter of missile = 6.0 in.
K = Concrete Penetrability Factor = $180 / \sqrt{f'c} = 3.286$
$f'c$ = Concrete Compressive Strength = 3,000 psi
N = Missile Shape Factor = 0.84

$$X = \sqrt{4(3.286)(0.84)(287)(6.0)\left(\frac{170.7}{1000(6.0)}\right)^{1.8}}$$

$X = 5.6$ in.

$X/d = 5.6/6 = 0.933$

B. Concrete Thickness to be Just Perforated (e):

$$e/d = 3.19\, X/\mathrm{d} - 0.718\, (X/d)^2 \quad \text{for } X/\mathrm{d} < 1.35$$

$$= 3.19 \times 0.933 - .718\, (0.933)^2 = 2.35$$

$$e = 2.35 \times 6.0 = 14.11 \text{ in.}$$

C. Concrete Thickness to be Just Scabbed (s) :

$$s/d = 7.91\, X/\mathrm{d} - 5.06\, (X/\mathrm{d})^2 \quad \text{for } X/\mathrm{d} < 0.65$$

$$= 2.12 + 1.36\, X/\mathrm{d} \quad \text{for } X/\mathrm{d} > 0.65$$

$= 2.12 + 1.36 \times 0.933 = 3.39$

$s = 6 \times 3.39 = 20.33$ in.

E_x = External Kinetic Energy = $W(v)^2/2g = 287(170.7)^2/(2\times32.17)$

= 129,977 ft.lb.

For Hard Missile Impact Force $F1 = E_x/X = 129{,}977\times12/5.6$

$\underline{F1 = 278{,}522 \text{ lbs.} = 278.5 \text{ kip}}$

Max. Force at ultimate stress, $F2 = A \times f_u$

Where A = cross-sectional area = 5.58 in^2

f_u = ultimate strength of steel = 60 ksi

$F2 = 5.58\times60 = 334.8$ kip

Use $F = (F1 + F2)/2 = (278.5 + 334.8)/2 = 306.7$ kip

Missile C: <u>(1" steel rod, 3' long; weight 8.82 lbs., V = 114.4 mph.)</u>

A. Penetration into Reinforced Concrete:

$$X = \sqrt{4KNWd\left(\frac{V}{1000d}\right)^{1.8}} \quad \text{for } X/d < 2.0$$

Where:
X = Total Penetration Depth (in.)
W = Weight of missile = 8.82 lbs.
V = Striking Velocity of Missile = 114.4 mph. = 167.3 ft./sec.
d = Diameter of missile = 1.0 in.

K = Concrete Penetrability Factor = $180/\sqrt{f'c} = 3.286$

$f'c$ = Concrete Compressive Strength = 3,000 psi
N = Missile Shape Factor = 0.72

$$X = \sqrt{4(3.286)(0.72)(8.82)(1.0)\left(\frac{167.3}{1000(1.0)}\right)^{1.8}}$$

$X = 1.83$ in.

$X/d = 1.83/1.0 = 1.83$

B. Concrete Thickness to be Just Perforated (e):

$e/d = 3.19\ X/d - 0.718\ (X/d)^2$ for $X/d < 1.35$

$= 1.32 + 01.24\ (X/d)$ for $X/d > 1.35$

$= 1.32 + 1.24 \times 1.83 = 3.59$

$e = 3.59 \times 1 = 3.59$ in.

C. Concrete Thickness to be Just Scabbed (s) :

$s/d = 7.91\ X/d - 5.06\ (X/d)^2$ for $X/d < 0.65$

$= 2.12 + 1.36\ X/d$ for $X/d > 0.65$

$= 2.12 + 1.36 \times 1.83 = 4.61$

$s = 4.61 \times 1.0 = 4.61$ in.

External kinetic Energy = $W(V)^2/2g = 8.82(167.3)^2/2 \times 32.17 = 3{,}837$ ft.lb.

Impact Force = $F = A\ f_u$

A = Cross Sectional Area = 0.785 in^2

f_u = Ultimate Strength of Steel = 60.0 ksi.

$F = 0.785 \times 60 = 47$ kips

Missile D: (Utility Pole, 13.5" diameter, 35'long, weight 1127 lbs., V = 123.4 mph.

Wooden Utility pole is a soft missile. It will crush upon impact rather than penetrate the target.

W = Weight of missile = 1127 lbs., Length of Missile = 35.0 ft.

V = Striking Velocity of Missile = 123.4 mph. = 180.5 ft. sec.

E = External Kinetic Energy = $W\ (V)^2/2g$

$= 1127(180.5)^2/2 \times 32.17 = 570{,}686$ lb.ft.

D = Diameter of missile = 13.5 in.

A = Cross Sectional Area = $\pi/4\ (13.5)^2 = 143.14\ in^2$

I = Moment of inertia = $\pi/64\ (13.5)^4 = 1{,}630.44\ in^4$

f_u = Ultimate Strength of Wood = 5.0 ksi

E = Modulus of Elasticity = 2.0×10^6 psi

P_u = Maximum Load at Ultimate stress = $A \times f_u$ = 143.14×5=715.7 kip

From Table 34 of "Formulas for stress and strain" by R.J. Roark, Case 3a.

P' = Critical Load at Buckling = $3.52\ (\pi)^2\ EI\ /\ (l)^2$

$= 3.52 \times \pi^2 \times 2\times10^6 \times 1630.44/(35\times12)^2$

$= 642.2$ kip < 715.7 kip

Impact Force, use F = *642.2 kip*

Missile E: (12" Schedule 40 pipe, 15' long, weight 751 lbs., V = 105.4 mph.)

A. Penetration into Reinforced Concrete:

$$\underline{X =} \sqrt{4KNWd\left(\frac{V}{1000d}\right)^{1.8}} \qquad \text{for } X/d < 2.0$$

Where:

X = Total Penetration Depth (in.)

W = Weight of Missile = 751 lbs.

V = Striking Velocity of Missile = 105.4 mph. = 154.1 ft/sec.

d = Diameter of Missile = 12.0 in.

K = Concrete penetrability Factor = $180/\sqrt{f'c}$ = 3.286

$f'c$ = Concrete Compressive strength = 3,000 psi

N = Missile Shape Factor = 0.84

$$X = \sqrt{4(3.286)(0.84)(751)(12)\left(\frac{154.1}{1000(12)}\right)^{1.8}}$$

$X = 6.26$ in.

$X/d = 6.2/12 = 0.522$

B. Concrete Thickness to be Just Perforated (e) :

$e/d = 3.19\, X/d - 0.718\, (X/d)^2$
$= 3.19\times0.522 - 0.718(0.522)^2 = 1.469$
$e \;= 12\times1.469 = 17.63$ in.

C. Concrete Thickness to be Just Scabbed (s) :

$s/d = 7.91\, X/d - 5.06\, (X/d)^2$
$= 7.91\times0.522 - 5.06\, (0.522)^2 = 2.75$
$s \;= 2.75\times12 = 33.0$ in.

External Kinetic Energy = $W(V)^2/2g = 751(154.1)^2/2 \times 32.17 = 277{,}181$ ft-lbs.

A = Cross Sectional Area = 14.6in^2
f_u = Ultimate Strength of Steel = 60.0 ksi.
P_u = Maximum Load at Ultimate stress = $A \times f_u = 14.6 \times 60 = 876.0$ kip

For Hard Missile, Impact Force $F = E_x/X = 277{,}181 \times 12/6.26$
$= 531{,}338$ lb. = 531.3 kip

Duration of Impulse = $2\times6.26/154.1\times12 = 0.0068$ sec.

As the target is soft (there will be penetration), using engineering judgement

$F = (876.0 + 531.3)\; 1/2 = 703.7$ kip

Missile F: <u>(Automobile, weight 4,000 lbs, velocity 132.3 mph, frontal Area = 20 sq. ft.)</u>

Automobile is a soft missile compared to the target DTS concrete structure. It will crush upon impact rather than penetrate the target.

External Kinetic Energy = $W(V)^2/2g = 4000(193.5)^2/(2 \times 32.17) = 2{,}327{,}774$ ft lbs.

Reference 3-8: J.R. Mcdonald, K.C Mehta, 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.

Force of impact, $F = 0.625\ V mg = 0.625 \times 193.5 \times 4000 = 484{,}000$ lbs. = 484 kip

These results are summarized in response to 3.2-4A.

Table 3.2-4A Summary of Results (Local Impact on Concrete Structures)

Missile	Depth of Penetration (in.)	Perforation Thickness (in.)	Scabbing Thickness (in.)	Kinetic Energy (ft. lbs.)	Force of Impact (Kip)
A. Wood Plank	N/A	N/A	N/A	132,382	197
B. 6" Schedule 40 Pipe	5.6	14.11	20.33	129,977	307
C. 1" Steel Rod	1.83	3.59	4.61	3,837	47
D. Utility Pole	N/A	N/A	N/A	570,686	642
E. 12" Schedule 40 Pipe	6.26	17.63	33.0	277,181	704
F. Automobile	N/A	N/A	N/A	2,327,774	483

N/A: Soft missile will crush rather than penetrate the target

From the above local analysis results, it can be seen that the actual wall thickness of DTS (36 inches) is greater than the thickness required for protection against penetration, perforation and scabbing. Therefore during a tornado generated missile event, there will be penetration of the concrete walls but no perforation or scabbing of it.

- Local Effects of Postulated Tornado Generated Missiles on Steel Structures

The minimum thickness of a steel plate capable of being perforated by the postulated DBT missile is given in Reference 3-8, and is:

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

T = minimum plate thickness (in)
M_m= mass of missile, W/g
W= weight
g= = 9.8 m/s^2 = 32.2 ft/s^2
V_s= Missile Strike Velocity

d_m= Diameter of missile

The Kinetic Energy is calculated based on the following formula:

$K.E. = \frac{1}{2} M_m V_s^2$

And the maximum impact force is calculated based on the following formula:

F= Missile impact area × Ultimate strength of missile or steel

Substituting to the above formulas and solving for the Missiles A, B, C, and E. The results are summarized in the following two tables.

Table 3.2-4B Summary of Results (Local Impact on Steel Structures) (Horizontal Direction)

Missile	Depth of Penetration (in.)	Kinetic Energy (ft. ibs.)	Force of Impact (kips)
A(Wood Plank)	0.546	132,382	197
B(6" Sch 40 Pipe)	0.636	129,977	335
C(1" Steel Rod)	0.365	3,837	47
E(12" Sch 40 Pipe)	0.527	277,181	876

Table 3.2-4C Summary of Results (Local Impact on Steel Structures) (vertical Direction)

Missile	Depth of Penetration (in.)	Kinetic Energy (ft. ibs.)	Force of Impact (kips)
A(Wood Plank)	0.339	64.784	197
B(6" Sch 40 Pipe)	0.395	63.630	335
C(1" Steel Rod)	0.227	1878	47
E(12" Sch 40 Pipe)	0.328	135,692	876

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 (Ref. 3-10) Appendix A.

The following input criteria were used:

1. Design Response Spectra Derivations

The NRC Regulatory Guide 1.60 (Ref. 3-11) response spectra curves with peak ground accelerations of 0.25 g horizontal and 0.17 g vertical were used.

2. Damping

A damping value of 7 percent is taken from Reg. Guide 1.61 (Ref. 3-12) for the reinforced concrete and bolted steel structure for the Safe Shutdown Earthquake (SSE). Regulatory Guide 1.61 damping values are consistent with Regulatory Guide 1.60 seismic spectra. Regulatory Guide 1.61 and nuclear power plant site seismic criteria use the same damping values for smaller or larger sized reinforced concrete or bolted steel structures. Therefore, use of a 7% damping value for design of reinforced concrete and bolted steel structures of DTS is justified. However use of a 7% damping value for the seismic design of equipment is non-conservative. Regulatory Guide 1.61 specifies a damping value of 3% for equipment seismic analysis for the SSE.

Therefore, conservative assumptions have been made in the seismic analysis of DTS structure. These conservative assumptions include:

1) the use of plate elements instead of solid brick elements,
2) the use of wall center line dimensions, and

3) neglecting the rigidity (stiffness) provided by the structural steel beam and plate structure at the roof and mezzanine level.

As a result of these conservative assumptions, seismic responses in terms of accelerations and the resulting floor spectra for equipment (component) qualification are fairly high (severe).

DTS SSC's have been currently qualified for these high seismic accelerations and the floor response spectra. The design bases equipment qualification spectra will be compared against the floor spectra for 3% equipment damping value (or site specific equipment damping value) that will be generated for each site. If the equipment design bases floor spectra envelopes the site specific floor spectra, the DTS equipment will be considered seismically qualified for that site.

If the site specific floor spectra exceed the design bases for a given site, additional analysis will be provided in the site specific application.

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. In Addition, the design adequacy of the DTS SSC's will be assured by the site-specific applicant by comparing the design basis with the characteristics of the applicant's site.

3.2.4 <u>Snow and Ice Loadings</u>

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 7-95 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 349-95 (Ref. 3-13). 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 7-95	Max. Wind Speed: 150 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 design of the DTS structural steel is based on the allowable stress design methods of the AISC manual of steel construction, ninth edition. Load combinations and acceptance criteria (stress limits) are based on the requirements of ANSI/AISC N690-1984 (Ref. 3-14). As there is adequate margin of safety in the design of the structural steel work, the allowable stress design method was selected rather than the more efficient load resistance factor design method. Analysis for tornado generated missiles and heavy load drop effects are based on the empirical/energy balance analysis methods. The resulting DTS load combinations and appropriate load factors for the structural steelwork are presented in Table 3.2-8.

The structural steelwork is made from mild steel (ASTM A36 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 3.4-1. 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.

The control room (trailer) is not important to safety. In accordance with NUREG-1567, 'important to safety' relates only to the basic nuclear safety criteria:

- Maintain subcriticality
- Maintain confinement
- Ensure radiation rates and doses for workers and public do not exceed acceptable levels (and remain ALARA)
- Maintain retrievability
- Heat removal (as necessary to meet the above criteria)

Subcriticality is maintained by keeping the DTS dry. The control system does not perform this function.

Confinement is provided by the DTS structure and the HEPA filters. The HVAC System also provides a negative pressure differential between the inside of the DTS and the environment, such that any air flow is into, rather than out of the DTS. The control system is used to activate the sliding door, but it is also manually locked in place. Therefore accidental or intentional opening of the sliding door, using the control system, is prevented by the manual lock.

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. The HVAC subsystem is designed such that in the event of a failure of the control system, the exhaust system will still be functional. Therefore the control system is not required for confinement.

The control system does not perform the function of ensuring radiation rates and doses for workers and public do not exceed acceptable levels (and remain ALARA). The information provided by radiation monitors is used to set control system interlocks to prevent opening of the DTS if radiation levels are high. However, this is an overcheck and not relied upon exclusively.

The control system is not required to maintain retrievability. The DTS equipment is designed such that the final positioning of the equipment is performed through visual inspection. Provided that there are cameras and lighting available in the DTS, the control system is not required to maintain retrievability of the fuel. This may also be accomplished by either manual operation (jog mode) or by backup equipment which may be manual.

The control system is used for gross positioning of equipment, but not for final positioning which requires visual surveillance. The control system is also used to prevent human operator mistakes. This use is considered a backup safety precaution.

Heat removal is performed by the HVAC system. Even if the cooling system were to fail, the exhaust system is sufficient to maintain system temperatures below the allowable temperatures for 72 hours. This is sufficient time to either repair the cooling system or bring the system into a safe shutdown configuration.

Shielding of cables is provided to prevent electromagnetic interference. The control system will be tested during system qualification to ensure that this shielding is sufficient. Access to the area with portable electronic equipment will be restricted to prevent interference from these sources. Access to the control trailer will be restricted to trained and authorized personnel. Passwords and keys will be required to activate the control system.

It is assumed that the control system is not functional after a design basis seismic event or tornado.

Routine testing of the control system will be performed on a periodic basis. The testing will include verification that all sensors are functional, the interlocks are properly functioning, and the information provided by the control system is accurate. The routine tests will also be performed as part of the dry run prior to first fuel transfer. Procedures for testing the equipment will be developed for each site and be provided as part of the site-specific application.

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 is outlined in Section 3.4. The details of these systems are covered in Chapters 4, 5 and 8.

The equipment design presented below represents a design that will need to be modified dependent on the site conditions and the selection of source and receiving casks. The two load combinations (seismic loading and seismic plus static loading) addressed in the analysis represent the worst case loading for the purpose of establishing the gross structural adequacy and feasibility of the DTS equipment. The design criteria for the equipment, specified in ASME NOG-1 that specifically defines all the loads and their combinations, must be evaluated (as defined in Section NOG-4000) in detail when the site-specific design of the equipment is undertaken.

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. Details of the calculations, with specific references ASME-NOG-1 Sections, are given in Appendix 8A, Sections 8A.2.4 and 8A.2.5. The cask transfer subsystem (both trolleys) are analyzed for the following loads:

- The live load of the cask and trolley under gravity (Normal Operating Load)
- The transverse horizontal derailing load (24% of the live load of the cask plus the trolley dead load). This load is used to size the guidance rollers.
- 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 transfer trolleys have been designed such that deflections do not impair proper operation of machinery as required by ASME NOG-4340. 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.

3.3.3.3 Serviceability

All operating components are designed for ease of serviceability and/or replacement. Commercially procured items are used wherever practical to assure availability when repairing or replacing components

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. However, water has been completely excluded from the DTS. There are neither potable nor sprinkler water supplies to the DTS, and the DTS must be located such that flooding is not a credible accident.
2.

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 the primary confinement are considered Important to Safety. These include the HEPA filters and the related pressure monitoring system, 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 fuel transfer operations, the top of the DTS would be under-shielded.

The cooling components of the HVAC Subsystem are not considered 'Important to Safety'. It has been shown in Chapter 8, that with the loss of the active cooling provided by these components, steady-state temperatures of the confinement boundary components and the fuel handling equipment remain within the allowable operating temperature ranges. The exhaust air temperature monitoring system is designated 'Important to Safety' to enable detection of a cooling component failure, and to permit repair or replacement in a timely manner.

The control subsystem is not considered Important to Safety. The failure of a control system component or a failure of the control system software will not result in a condition that would result in any damage to the fuel and/or a radiation dose rate that exceeds regulatory limits. This is further described in Chapter 8. The control system is not relied upon to initiate or control any protective actions. Initiation of operational steps is by the operator, in conjunction with visual feedback through a monitor. If the operating system were to result in unexpected movement, an emergency stop button is provided which cuts off all power to the operating equipment.

The Cameras and Lighting in the TCA (including all the cables for the CCTV system within the TCA) is considered Important to Safety, because if the cameras were to fail during operations of any design event the operations will have to be suspended, since there will be no visual confirmation of the operations. The cables outside of the DTS and the electrical system are not 'Important to Safety', since fuel operations can be halted until electricity is restored.

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

Table 3.4-1
Structure, Components, or Systems Classified as Important to Safety

System or Component	Safety Function	Classification Category	Features Important to Safety
Concrete Base mat	Structural integrity during normal and accident events, confinement	A	Overall Dimensions, concrete density; reinforcement size, strength, and spacing
DTS Concrete Structure	Structural integrity during normal and accident events, confinement, shielding.	A	Overall Dimensions, concrete density and strength; Reinforcement size, strength and spacing.
Protective Cover (Roof Enclosure Area)	Structural integrity during normal and accident events, confinement, and shielding	A	Overall dimensions, ductility and strength of the structural members, and the confinement capability.
Roof Plate	Shielding, and structural integrity during normal & seismic events .	A	Overall dimensions, ductility and strength of structural members, sealing capability.
Mezzanine Floor	Shielding, structural integrity during normal and seismic events.	A	Overall dimensions, ductility and strength of structural members
Sliding Door	Structural integrity during normal and accident events, confinement, shielding	A	Overall dimensions, density, ductility and strength of structural members
HVAC Subsystem	Confinement	A	HEPA filtration, HEPA filter Monitoring System, Exhaust Air Temperature Monitoring System
Cask Transfer Subsystem	Structural integrity during normal and accident events	A	Trunnion tiedowns, seismic restraints, rails, trolley locking devices

Table 3.4-1
Structure, Components, or Systems Classified as Important to Safety

Fuel Assembly Handling Subsystem	Structural integrity during normal and seismic events	A	Strength of load path items, structural equipment required to move the trolley manually into position (gears, drive shafts, etc)
Shield Plug and Source Cask Lid Handling Subsystem	Structural integrity during normal and seismic events	A	Strength of Load Path Items, structural equipment required to move the trolley manually into position (gears, drive shafts, etc)
Upper Shield Port Covers	Shielding	A	Locking Device (size and strength)
Cameras and Lighting	Provides visibility to the operator for normal and off-normal events, as well as accident recovery.	A	Cameras, Lights, and cables inside of TCA

1. Concrete Base Mat

The concrete basemat supports the DTS (including the Preparation Area) during all design events. The features important to safety include overall dimensions, concrete density and strength, reinforcement size, strength and spacing. The base mat also forms part of the confinement boundary for the Lower Access Area.

2. DTS Concrete Structure

The concrete structure provides structural support for 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 including thickness, concrete density and strength, reinforcement size, strength and spacing.

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 (REA) and the external environment. The plate thickness is considered in the shielding analysis. It also protects the upper crane from weather, high winds, rain, tornadoes, and tornado missiles. Features Important to Safety include the overall dimensions including thickness, the ductility and strength of the structural members, as well as the confinement capability of the REA.

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 normal or seismic events. The Fuel Handling Crane is supported separately on rails. The roof plate is also used for shielding. The roof plate and mezzanine floor plate are protected by the DTS structure during all accident events other than the seismic event. Features Important to Safety include the overall dimensions and the ductility and strength of the structural members.

The mezzanine floor plate also provides a barrier between the lower access area and the TCS. This barrier function is not Important to Safety but is used to minimize the spread of contamination to the Lower Access Area and the Preparation Area.

4. Sliding Door

The sliding door forms a part of the physical confinement barrier between the DTS Lower Access Area and the external environment. It also provides shielding and protection to equipment within the DTS from environmental conditions such as rain, high winds, tornadoes and tornado missiles.

5. HVAC Subsystem

The HVAC Subsystem filters, with the physical confinement barrier (concrete base mat, DTS concrete structure, protective cover and sliding door) 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, which is not Important to Safety. The ventilation system and the cooling system dissipate the heat from the fuel. Steady-state temperatures of the components of the confinement boundary and the fuel handling equipment remain within the allowable range if the cooling, and the ventilating systems fail. The HEPA filter monitoring system is designated as 'Important to Safety', since it monitors the HEPA filters and verifies that the filters are performing 'Important to Safety' function. The exhaust air temperature monitoring system is also designated as 'Important to safety' since this system is used to detect failures of the cooling and heating components of the HVAC system. The system ensures that the operators are notified of failures, so that appropriate corrective actions can be taken in a timely manner.

6. Cask Transfer Subsystem

The Cask Transfer Subsystem protects the casks from tipover during all normal and credible accident events. The features important to safety are the locking pins in the preparation area and lower access area which prevent the trolleys from accidentally moving during

preparation and loading operations, trunnion tiedowns, and seismic restraints including the rails and anti-derailing devices.

7. Fuel Assembly Handling Subsystem

The Fuel Assembly Handling Subsystem protects the fuel from being dropped during all design events. The equipment is also designed such that no components will become projectiles during normal or accident events. The system is designed such that in the event of a seismic event which results from a loss of primary power, the subsystem can be manually activated from outside of the DTS to position the trolley directly above a fuel cell in the source or receiving cask. The power train and load path for vertical movement are redundant. Therefore, in the event of a loss of power or damage due to an accident, the fuel could be lowered back into the source or receiving cask. The features Important to Safety include all load path items and the structural components required to move the trolley into position manually.

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 and the structural components required to move the trolley into position manually.

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.

10. Cameras and Lighting

Various cameras and lights are provided in the TCS which are required to allow transfer operations to be performed successfully. Although the control system is capable of being programmed to locate a fuel cell to remove or install a fuel assembly from/into a cask, it is the visual verification (through the use of cameras and lights) which is relied upon to confirm proper location.

These must also be relied upon during recovery operations to manually place the fuel in the source or receiving cask and to replace the source cask lid and shield plug. Therefore, the cameras, lighting and cables are 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 7-95 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. AISC "Structural Analysis and Design of Nuclear Power Plants"

3-7. Deleted

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. Deleted

3-10. Code of Federal Regulations Chapter 10 Part 100 – Reactor Site Criteria

3-11. U.S. Nuclear Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants, 1973.

3-12. U.S. Nuclear Regulatory Guide 1.61, Damping Values for Seismic Design of Nuclear Power Plants, 1973.

3-13. American Concrete Institute ACI 349-95: Code Requirements for Nuclear Safety Related Concrete Structures - Thermal Effects.

3-14. ANSI/AISC N690-1984 Nuclear Facilities – Steel Safety Related Structures for Design Fabrication and Erection.

3-15 Deleted.

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, and a structure to house the fans and the PLC bench (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 –Fans and HEPA Filters Only)
- Electrical System (Not Important to Safety)
- Air Supply System (Not Important to Safety)
- CCTV and Lighting System (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)
- Overlid with Gripping Device (Important to Safety)
- Receiving and Source Cask Transfer Confinement Port Cover Handling Subsystem (Important to Safety – Upper Shield Port Cover Locking Device Only)
- 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)
- PLC (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 DTS structural walls and the roof exposed to the outside environment have been analyzed and designed to withstand tornado wind loads of $\pm$2.53 psi and tornado differential pressure of $\pm$3 psi, in addition to the tornado generated missile loads. The DTS internal structural steel floor system has been designed for a live load of 250 psf (1.74 psi) and internal tornado wind pressure of $\pm$ 0.53 psi. Design and analysis for these loads are expected to bound any pressure time history loads resulting from an explosion event.

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 Drawing No. 3039-16, Rev. 0. 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 72.2.

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 DTS 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 Drawing No. 3039-1. Structural details of the Concrete Superstructure are presented in Drawing Nos. 3039-15 and 3039-16. Details of the roof plate, weather protective cover and mezzanine plate are shown on Drawing No. 3039-17. Penetration details are shown on Drawing No. 3039-18. Details of the preparation area are shown on Drawing No. 3039-20.

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 10 CFR 72.104 and 10 CFR 72.106. 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. A qualitative thermal assessment of fuel temperatures in a source and receiving cask is presented in Section 8.1.1.1. Factors considered were 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 is concluded that fuel temperatures would remain below the two week temperature limit of 464°F (240°C) during the 10 day design basis turnaround period. Site specific confirmatory analysis will be performed for the actual source and receiving casks to be used.

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. Drawing Nos. 3039-15, Rev. 0, 3039-16, Rev. 0 and 3039-18, Rev. 0 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 fully sealed, by a watertight sealing material such as a Viton gasket, all around the bottom where the protective cover meets the TCA walls, as well as around any hatch doors provided for access into the Roof Enclosure Area, to prevent rain water ingress. It is also designed to stay intact during the design basis seismic event. The protective cover is shown in Drawing No. 3039-17. A sealed access door is provided into the Roof Enclosure Area. The protective cover also provides 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 Drawing No. 3039-17. 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. Drawing No. 3039-17 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 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. The confinement function of the mezzanine plate is not important to safety."

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 Drawing No. 3039-5, Rev. 0. 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. Drawing Nos. 3039-19 and 3039-20 show details of the Preparation Area.

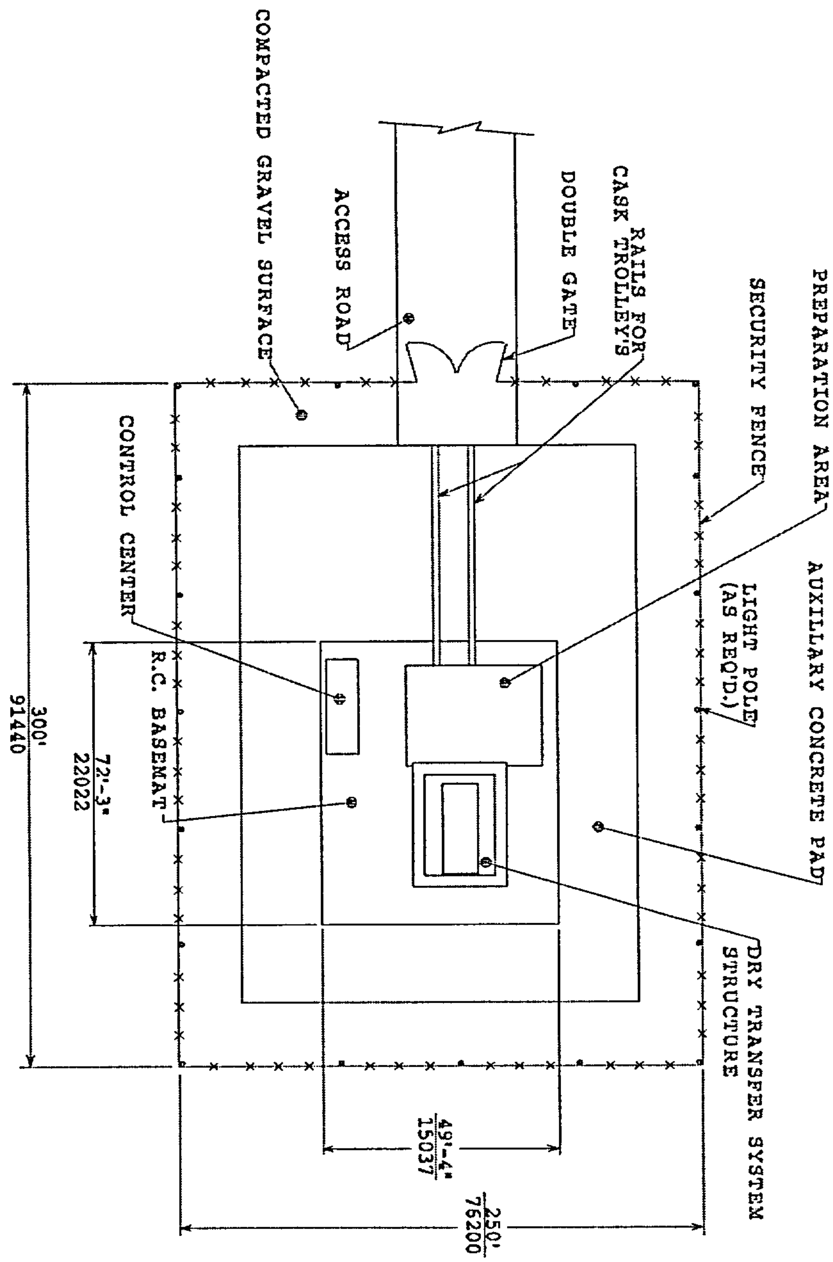
The major functions of the Preparation Area are to:

- 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 filters, the HEPA filter pressure monitoring system and the exhaust air temperature monitoring system, is designated as 'Not Important to Safety'. The equipment does not provide primary confinement, shielding, or protection from design basis events. However, this equipment is necessary for continuous, efficient, normal operations, and therefore described 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/cooling system is separate from the ventilation system. The three areas of the DTS, i.e., the Preparation Area, the Lower Access Area and the TCA are served by the HVAC Subsystem. A listing and the details of the equipment selected is provided in this section. Drawing Nos. 3039-12 and 3039-13 show details of the components of the HVAC Subsystem. The following are the design features 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 maintain the temperatures of the spent fuel, fuel transfer equipment, the DTS structure and associated components.
- All exhausted air passes through a HEPA filter bank consisting of a pre-filter and two HEPA filters in series. The HEPA filters are designated "Important to Safety" and are part of the confinement boundary of the DTS structure.
- Redundant HEPA filter banks are provided with remote switching using isolation dampers.
- The condition of the HEPA filters are monitored by the HEPA filter pressure monitoring system designated "Important to Safety".
- The performance of the heating/cooling system is monitored by the exhaust air temperature monitoring system designated "Important to Safety".
- Redundant readout housings, for the HEPA filter pressure monitoring system and the exhaust air temperature monitoring system, are provided in the Preparation area, and in the protective enclosure for the exhaust fans. The readouts are seismically mounted to the DTS structure.
- Redundant exhaust fans are provided with remote switching using isolation dampers.
- The exhaust fans are housed in a protective enclosure to minimize down time after an accident (ALARA).
- Each area of the DTS, i.e., the Preparation Area, the Lower Access Area and the TCA, is provided with separate heating/cooling systems.

- Backflow of air is minimized by gravity operated backdraft dampers between the areas of the DTS.

- Two HVAC panels are provided. One in the Preparation Area and the other in the protective enclosure for the exhaust fans. Startup and shutdown of HVAC components including switching between HEPA filter banks and exhaust fans, and fan speed control, are usually performed manually from a panel in the Preparation Area. Loss of the Preparation Area panel will only result in the shut-down of the heating/cooling system components. The panel in the exhaust fan protective enclosure can perform all functions of the panel in the Preparation Area except startup or shutdown of the heating/cooling system. Loss of this panel will result in the loss of the ventilation system; hence it is located in the protective enclosure.

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 a HEPA filter bank 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 filter banks have been incorporated into the design to minimize the potential for failure of the confinement function during normal operating conditions. Each HEPA filter bank has two HEPA filter modules to prevent loss of confinement if one filter blows out. The air flow will be through the primary HEPA filter bank and the primary exhaust fan during normal operating conditions. Gravity operated backdraft dampers are installed between the Lower Access Area and the TCA, the TCA and the HEPA filter banks, and the HEPA filter banks and the exhaust fans to prevent the backflow of air. Motorized dampers can isolate a HEPA filter bank and permit switching to the secondary HEPA filter bank. Another set of motorized dampers can isolate the primary exhaust fan and permit switching to the secondary exhaust fan. Before the filtered exhaust air is released to the atmosphere from the ventilation stack, it is monitored by the Radiation Monitoring Subsystem. Replacement of HEPA filter banks typically would occur at the end of a loading cycle when necessary.

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 4.3-1. 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)
- ASHREA Handbook of Fundamentals (Reference 4.10)

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	Daily varying summer values for a site at 43° latitude (ASHREA Handbook of Fundamentals)
· Humidity	100%

Normal Operating Temperature and Humidity 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

- Transfer Confinement Area 0.036 psi (1 in. water)
- Lower Access Area 0.018 psi (0.5 in. water)
- Preparation Area 0.009 psi (0.25 in. water)

Exhausted Air

Exhaust air flow will be filtered through a HEPA filter bank consisting of a pre-filter and two HEPA filter modules prior to being discharged to the environment. The pre-filter prevents any debris from damaging the more delicate HEPA filter modules. Having two HEPA filters in series prevents the loss of confinement if one filter blows out. The redundant design feature of the HEPA filter banks permits the switching of the air flow from the primary HEPA filter bank to the secondary HEPA filter bank.

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.

4.3.1.4 Operational Description

The HVAC Subsystem consists of two major components, the ventilation system and the heating/cooling system. Each component is discussed in detail below:

Ventilation System

The start-up of the ventilation system is performed using a control panel located in the Preparation Area. This operation is performed prior to the casks being placed in the DTS.

Motorized dampers in the transfer ducts between the three areas of the DTS are manually modulated as required to maintain static pressure 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. Once the position of each damper is set, the damper position is locked. The fan speed is also recorded and will be the pre-set speed during cask handling operations. The need to unlock the dampers and reset the damper positions will occur if the pressure differential in the DTS cannot be maintained within the acceptable range by small changes to the fan speed. Gravity operated backdraft dampers are installed between the Lower Access Area and the TCA, the TCA and the HEPA filter banks, and the HEPA filter banks and the exhaust fans to prevent the backflow of air.

The typical start-up sequence for the ventilation system is as follows, and may be customized for the site specific equipment:

1. Unlock all motorized dampers in the DTS.
2. Close all dampers.
3. Open the primary exhaust fan isolation control damper.
4. Activate primary exhaust fan. Ramp the fan speed up via its variable frequency drive to a speed which will maintain the static pressure setpoint for the TCA. The TCA static pressure is sensed by the TCA static pressure sensor.
5. Open the damper between the Lower Access Area and the TCA. Adjust opening to achieve the static pressure setpoint for the Lower Access Area, which is sensed by the Lower Access Area static pressure sensor. Increase fan speed as necessary to maintain the static pressure setpoint for the TCA during the adjustment of the opening of the Lower Access Area damper.
6. Open damper between the Preparation Area and the Lower Access Area. Adjust opening to achieve the static pressure setpoint for the Preparation Area, which is sensed by the Preparation Area static pressure sensor. Increase fan speed as necessary to maintain the static pressure setpoint for the TCA during the adjustment of the opening of the Preparation Area damper.
7. Make minor adjustments to all dampers as necessary to achieve the nominal pressure setpoint in all areas. Activate mechanical locks on damper positions.
8. Record fan speed.
9. Transfer control of the fan speed to the HVAC Control System.

During cask handling conditions, 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 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 component of the control system to maintain the exhaust fan speed at its pre-set speed and prevent the Control Subsystem from trying to re-establish the pressure set-points. 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.

When normal fuel transfer operations are initiated, the contol system will activate a PLC that adjusts the fan speed to maintain the negative pressure in the TCA. The HVAC Control System reacts to small changes in the infiltration of air into the TCA by speeding up or slowing down the fan as necessary to maintain pressure differential setpoint. The variation is fan speed is controlled to stay within a pre-determined range based on the pre-set fan speed.

In the event that the primary exhaust fan fails, the Control Subsystem senses the complete loss of pressure differentials in the DTS, resulting in an alarm being triggered on the control system panel. Loss of the exhaust fan (ventilation system) will result in the loss of the secondary confinement provided by the negative pressure differentials, and not of the confinement boundary provided by the DTS structure and the HEPA filters. Also the cooling system will continue to operate to maintain the normal operating temperature in the DTS. The design of the

HVAC system permits corrective action to be performed once the DTS is in "safe mode" and all the fuel is in the casks.

Switching from the primary exhaust fan to the secondary exhaust fan is performed manually by the operator using the control system. The electric power to the primary fan is shut down. The motorized primary fan isolation damper is closed, and the secondary fan isolation damper opened. Electric power to the secondary exhaust fan is turned on. The fan speed is adjusted to maintain the appropriate pressure differentials in the DTS. The control of the speed is switched to the HVAC Control System.

In the event that the primary HEPA filter bank is required to be switched, this operation is performed manually by the operator using the control system. The electric power to the exhaust fan is shut down. The motorized isolation dampers across the primary HEPA filter bank are closed. The isolation damper across the secondary HEPA filter bank are opened. The electric power to the exhaust fan is turned on. The fan speed is adjusted to maintain the appropriate pressure differentials in the DTS. The control of the speed is switched to the HVAC Control System.

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).

Exhaust Air Temperature Monitoring System

The exhaust air temperature is monitored by a redundant pair of calibrated temperature gages, one located in the Preparation Area, and the second in the protective enclosure for the exhaust fans. The temperature gage housings are seismically mounted to the DTS structure. The monitoring is designated "important to safety" and will detect the failure of the cooling and heating components of the HVAC system. The temperature of the exhausted air should be within ±10°F of the temperature setpoint in the TCA.

Otherwise, an alarm on the control system panel will alert the operator to a possible malfunction of the heating/cooling system in the TCA. As stated in Section 3.3.2.2, the DTS is designed to operate within a temperature range of 40°F to 130°F. Fuel transfer operations may continue unless there is a risk that the temperature differential across the concrete wall will exceed the 70°F limit established for the DTS , i.e., the temperature difference between the exhausted air and the ambient is less than 70°F. Otherwise, the fuel transfer operations will cease and the fuel returned to the casks. The lid/shield plug will be installed on the casks. Repairs to TCA heating/cooling system may then be initiated. The Lower Access Area heating/cooling system will continue to maintain temperatures in the area (with the casks) at the setpoint.

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.

4.3.1.6 Control of the HVAC Subsystem

The HVAC Subsytem is controlled through the used a typical commercial panel located in the Preparation Area. This panel allows the operator to perform the following functions:

1. Start and shut down the exhaust fans, and the heating/cooling systems in each area.
2. Operate isolation dampers for the HEPA filters and the exhaust fans.
3. Operate dampers for control air flow through the DTS.
4. Control the speed of the exhaust fans.
5. Set temperatures in the DTS.

This control panel will also display the static pressure and temperature in the DTS areas, the exhaust fan speeds, the pressure differentials across the HEPA filters, and the exhaust air temperature.

A second control panel is provided in the protective enclosure for the exhaust fans. This panel has limited capabilities and will allow the operator to:

1. Start and shut down the exhaust fans to a pre-set speed.
2. Operate the isolation dampers for the HEPA filters and the exhaust fans.

Calibrated gages (DTS static pressures, HEPA filter pressure differentials and exhaust temperature) designated "important to safety" are housed in the enclosure.

These are used to monitor the negative pressures in the DTS areas, the HEPA filter condition, and the temperature of the exhaust air.

The only operation that is controlled by the Control Subsystem is the control of the exhaust fan speed within a pre-determined range to maintain the negative static pressure in the TCA. This occurs only during fuel transfer operations. During other operations including cask handling, the Control Subsystem sets the exhaust fan speed to a pre-set speed. All other operations of the HVAC Subsystem are controlled using typical commercial HVAC controls. The "important to safety" feature of the HVAC is the confinement function provided by the HVAC HEPA filters. The HEPA filters are monitored to detect failure as discussed below. The HVAC Subsystem consists of two major components, the ventilation system and the heating/cooling system. The HVAC Subsystem provides the following inputs to the Control Subsystem:

1. Static pressures in the Preparation Area, the Lower Access Area and the TCA.
2. Exhaust fan speed (primary and secondary).
3. Pressure differentials across HEPA filters (2 per bank, 4 total)
4. Exhaust air temperature.

Ventilation System Control

The start-up of the ventilation system is performed using a control panel located in the Preparation Area. The start-up is performed manually by the operator by controlling the motorized dampers in the transfer ducts between the areas of the DTS and the exhaust fan speed to achieve the setpoint static pressures in each area. This is discussed in detail in Section 4.3.1.4, "Operational Description". After the ventilation system is at steady-state, the positions of the motorized dampers will be locked and the fan speed recorded to establish the pre-set speed. This constant pre-set speed will be maintained during non-fuel transfer operations, e.g., cask handling, DTS maintenance. The control of the fan speed is transferred to the Control Subsystem.

When normal fuel transfer operations are initiated, the Control Subsystem PLC adjusts the fan speed to maintain the negative pressure in the TCA. The control system reacts to small changes in the infiltration of air into the TCA by speeding up or slowing down the fan as necessary to maintain pressure differential setpoint. The PLC 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. If the PLC fails, the exhaust fan will be automatically shut down, and an alarm triggered to alert the operator. The exhaust fan can be manually turned on using the panels in the DTS. If the negative pressure in the TCA cannot be maintained at its setpoint, an alarm will be triggered on the control panel, and the fan speed set to the pre-set value.

Temperature Controls

The temperature controls for each area of the DTS are typical commercial controls and not part of the Control Subsystem. Prior to each fuel transfer campaign, the performance of the temperature control in each area will be confirmed. Failure of the TCA temperature controls during fuel transfer operations will be detected by the exhaust air temperature monitoring system which initiates an alarm on the control system panel.

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 set-point 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.

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.

Monitoring of HEPA Filters

The monitoring of the HEPA filters is an "Important to Safety" function, and is necessary to evaluate the status of the confinement function provided by the HEPA filters. The DTS is provided with a primary and secondary HEPA filter banks. Each bank has two HEPA filter modules. Differential pressure sensors are provided across each HEPA filter module (two sensors per bank) which can be read at two redundant locations, and also by the control system. The housings for the readouts are seismically mounted to the DTS structre, in the protective enclosure for the exhaust fans, and in the Preparation Area. Pressure readings outside the acceptable range will be manually verified prior to initiating corrective action to switch to the secondary HEPA filter bank.

The acceptable pressure differentials 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. A decision would be made at this time whether to switch to the secondary HEPA filter bank and the appropriate time to replace the filter module.

The monitoring system for the HEPA filter will detect a damaged (blown out) filter module (low air-flow resistance) and a clogged filter (high air flow resistance). Emergency maintenance can be performed by directing all air-flow through one HEPA filter bank while the other HEPA filter bank is being replaced. There are two HEPA filter banks, and the motorized dampers can isolate a HEPA filter bank for replacement of the filter.

4.3.1.7 Design Calculations

The DTS heating/cooling loads 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 provides input to the DTS Control Subsystem. These inputs include the following:

1. Static pressures in the Preparation Area, the Lower Access Area and the TCA.
2. Exhaust fan speed (primary and secondary).
3. Pressure differentials across HEPA filters (2 per bank, 4 total)
4. Exhaust air temperature.

During normal fuel transfer operations only, the Control Subsystem controls the exhaust fan speed within a pre-determined range to maintain the negative static pressure setpoint in the TCA.

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 minimize the duration during which a loss of secondary confinement could occur due to 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 in the Lower Access Area, protected from the effects of wind, tornadoes, and tornado missiles. Pressure monitors are installed across each HEPA filter 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 exhaust fans are housed in a protective enclosure, and protective from the effects of wind, tornadoes, and tornado missiles. This permits quick replacement of the exhaust fans if failure occurs after a design basis accident event.

The HVAC Subsystem failure mode analysis is listed in Table 4.3-1.

Table 4.3-1 HVAC Subsystem Failure Mode Analysis

Failure Mode	Detection	Probable Cause	Consequences	Recovery
Blow out of a HEPA filter in primary HEPA filter bank.	Reduction of pressure across HEPA filter. This will trigger an alarm on the Control Subsystem panel.	Manufacturing defect in HEPA filter. The filter bank consists of a pre-filter and two HEPA filters as shown in Figure 4-3-5.	None. Second HEPA filter in bank will maintain confinement function of the DTS	Return DTS to safe mode condition where all fuel is in the casks and lid/shield plug is in place. Manually shut down the exhaust fan only (not the heating/cooling system). Activate the motorized dampers for the HEPA filter banks, and switch from primary to secondary HEPA filter bank. Startup exhaust fan and adjust speed to obtain the static pressure setpoint in the TCA. Verify pressures across the individual HEPA filters in the secondary bank are within acceptable values. Resume normal operations in the DTS. Replace defective HEPA filter bank when the loading cycle is complete and the casks are removed from the Lower Access Area.
Clogged HEPA filter in primary HEPA filter bank.	Increase in pressure across a HEPA filter. This will trigger an alarm on the Control Subsystem panel.	Pre-filter/HEPA filter clogged due to excess dust or particulate.	None. Confinement function of HEPA filter bank continues to remain functional	Same as above.
Failure of primary exhaust fan.	Loss of negative pressure differentials in DTS. This will trigger an alarm on the Control Subsystem panel.	Failure of an exhaust fan component.	None. Confinement function of HEPA filter bank continues to remain functional	Return DTS to safe mode condition where all fuel is in the casks and lid/shield plug is in place. Manually shut down the exhaust fan only (not the heating/cooling system). Activate motorized dampers and switch from primary to secondary exhaust fan. Startup exhaust fan and adjust speed to obtain the static pressure setpoint in the TCA. Resume normal operations in the DTS. Replace defective exhaust fan when the loading cycle is complete and the casks are removed from the Lower Access Area.
Loss of cooling system in TCA.	Exhaust air temperature sensor will increase and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the cooling system	None. Temperatures in the TCA will increase but will remain within the normal operating temperature range because of the continued operation of the cooling system in the Lower Access Area and the upper crane enclosure.	Continue normal operations until the loading cycle is complete, and the casks are removed from the Lower Access Area. Repair defective cooling system.

Table 4.3-1 HVAC Subsystem Failure Mode Analysis
(continued)

Failure Mode	Detection	Probable Cause	Consequences	Recovery
Loss of cooling system in Lower Access Area.	Exhaust air temperature sensor will increase and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the cooling system.	None. Decay heat released in the Lower Access Area will be transferred to the TCA along with the air flow. The cooling system in the TCA will dissipate this heat.	Continue normal operations until the loading cycle is complete, and the casks are removed from the Lower Access Area. Repair defective cooling system.
Loss of heating system in TCA	Exhaust air temperature sensor will decrease and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the heating system.	None. Pre-heated air from the Lower Access Area will continue to keep temperatures in the TCA within the normal operating temperature range.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair defective heating system
Loss of heating system in Lower Access Area.	Exhaust air temperature sensor will decrease and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the heating system	None. The heating system in the TCA will continue to provide heat to maintain normal operating temperatures.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair defective heating system
Loss of control of static pressure in TCA.	Pressure differential in TCA not within set limits. This will trigger an alarm on the Control Subsystem panel.	Failure of PLC controlling the exhaust fan speed.	None. PLC will automatically shutdown fan. Exhaust fan can be manually started up to run at the preset speed.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair problem.

Table 4.3-1 HVAC Subsystem Failure Mode Analysis
(continued)

Failure Mode	Detection	Probable Cause	Consequences	Recovery
Loss of cooling system in Lower Access Area.	Exhaust air temperature sensor will increase and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the cooling system.	None. Decay heat released in the Lower Access Area will be transferred to the TCA along with the air flow. The cooling system in the TCA will dissipate this heat.	Continue normal operations until the loading cycle is complete, and the casks are removed from the Lower Access Area. Repair defective cooling system.
Loss of heating system in TCA	Exhaust air temperature sensor will decrease and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the heating system.	None. Pre-heated air from the Lower Access Area will continue to keep temperatures in the TCA within the normal operating temperature range.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair defective heating system
Loss of heating system in Lower Access Area.	Exhaust air temperature sensor will decrease and will trigger an alarm on the Control Subsystem panel.	Failure of a component of the heating system	None. The heating system in the TCA will continue to provide heat to maintain normal operating temperatures.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair defective heating system
Loss of control of static pressure in TCA.	Pressure differential in TCA not within set limits. This will trigger an alarm on the Control Subsystem panel.	Failure of PLC controlling the exhaust fan speed.	None. PLC will automatically shutdown fan. Exhaust fan can be manually started up to run at the preset speed.	Continue normal operations until the loading cycle is complete and the casks are removed from the Lower Access Area. Repair problem.
Loss of electric power	All components of the HVAC Subsystem will shut down.	Loss of primary electric power.	None. Confinement function of HEPA filter bank continues to remain functional.	Switch to secondary power supply. Startup the exhaust fan, HEPA filter pressure monitoring system, and the exhaust air temperature monitoring system. Return DTS to safe mode condition where all fuel is in the casks, and lid/shield plug is in place.

Table 4.3-2

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)

4.3.2 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". This is because the loss of power does not result in the following conditions immediately: an unsafe storage of the spent fuel, damage to the fuel, or a situation where the spent fuel cannot be retrieved, handled or stored, without undue risk to the health and safety of the public (NUREG-1567). There is sufficient time before any of these conditions occur, to recover power or switch to a secondary power source.

The Electrical System consists of the primary power system and a secondary power source.. Failure of the primary power supply, for a time to be specified in the site license, will result in the operator switching over to the secondary power source.

Loss of electrical power results in an immediate "fail safe" shutdown of the DTS systems including the HVAC Subsystem. Although the HVAC Subsystem is classified as important to safety, the only components that are 'Important to safety' are the HEPA filters, the HEPA filter pressure monitoring system, and the exhaust air temperature monitoring system (See Subsection 4.1). Loss of power will not result in the loss of primary confinement provided by the HEPA filters. As stated in Subsection 4.3.1, the loss of the ventilation system has no detrimental effect on the confinement boundary or the fuel handling equipment in the DTS.

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

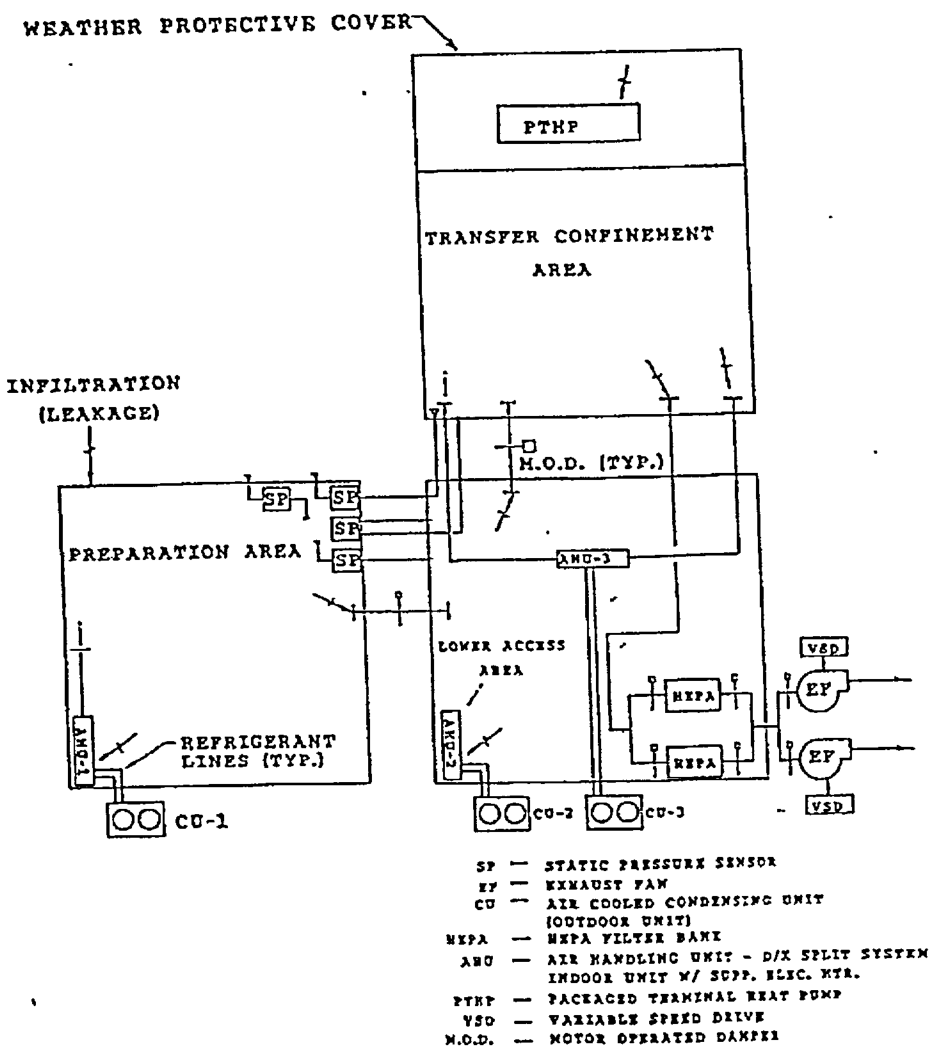


Figure 4.3-2

HVAC Subsystem Lower Access Area and Preparation Area Plan View

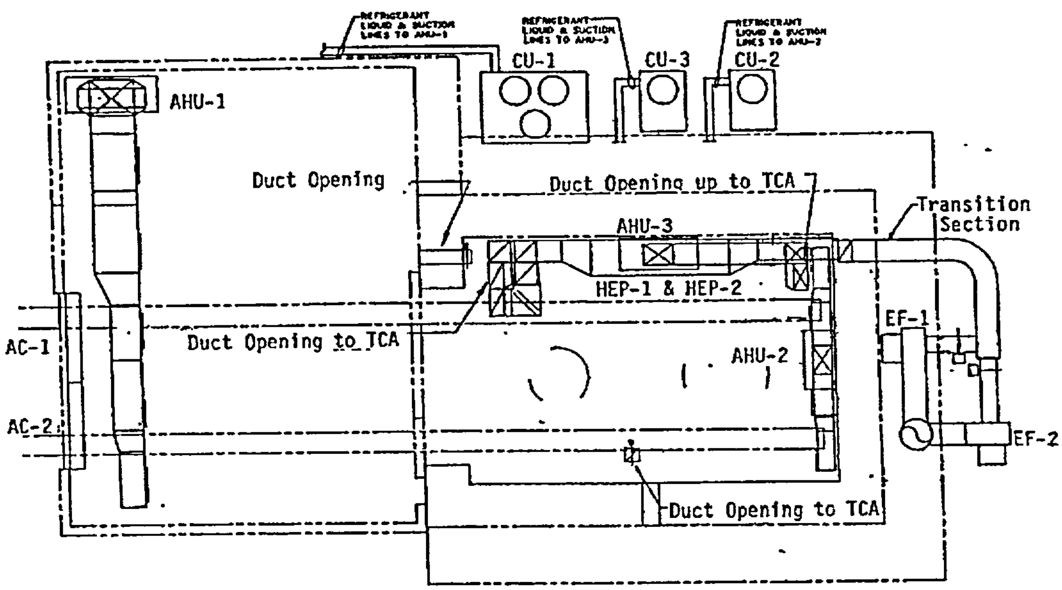


Figure 4.3-3

HVAC Subsystem Elevation Section of Lower Access Area and TCA

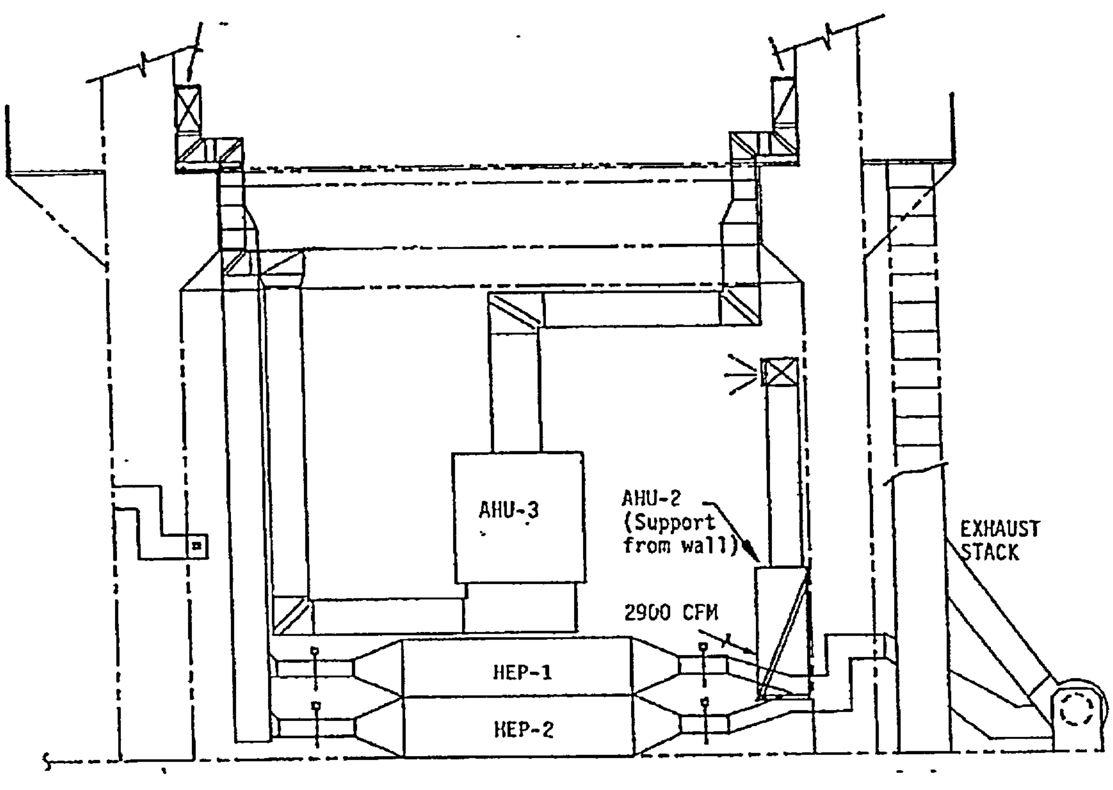
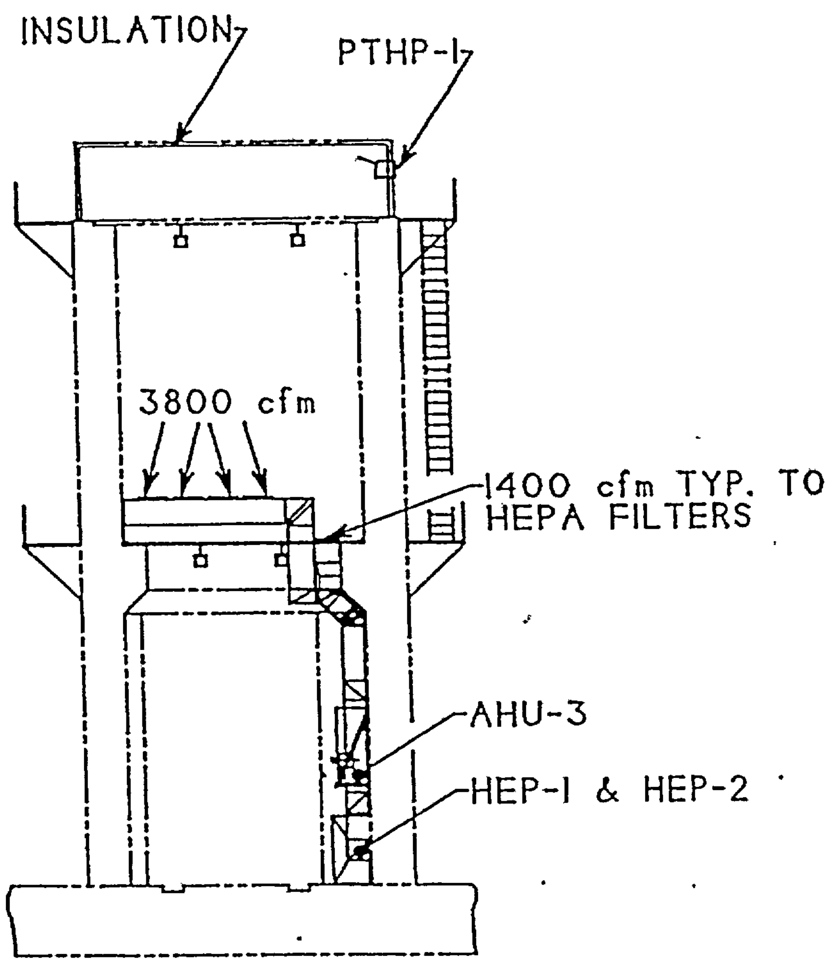


Figure 4.3-4

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



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
HVAC Details and Schedules

Rev. 1
September, 2002

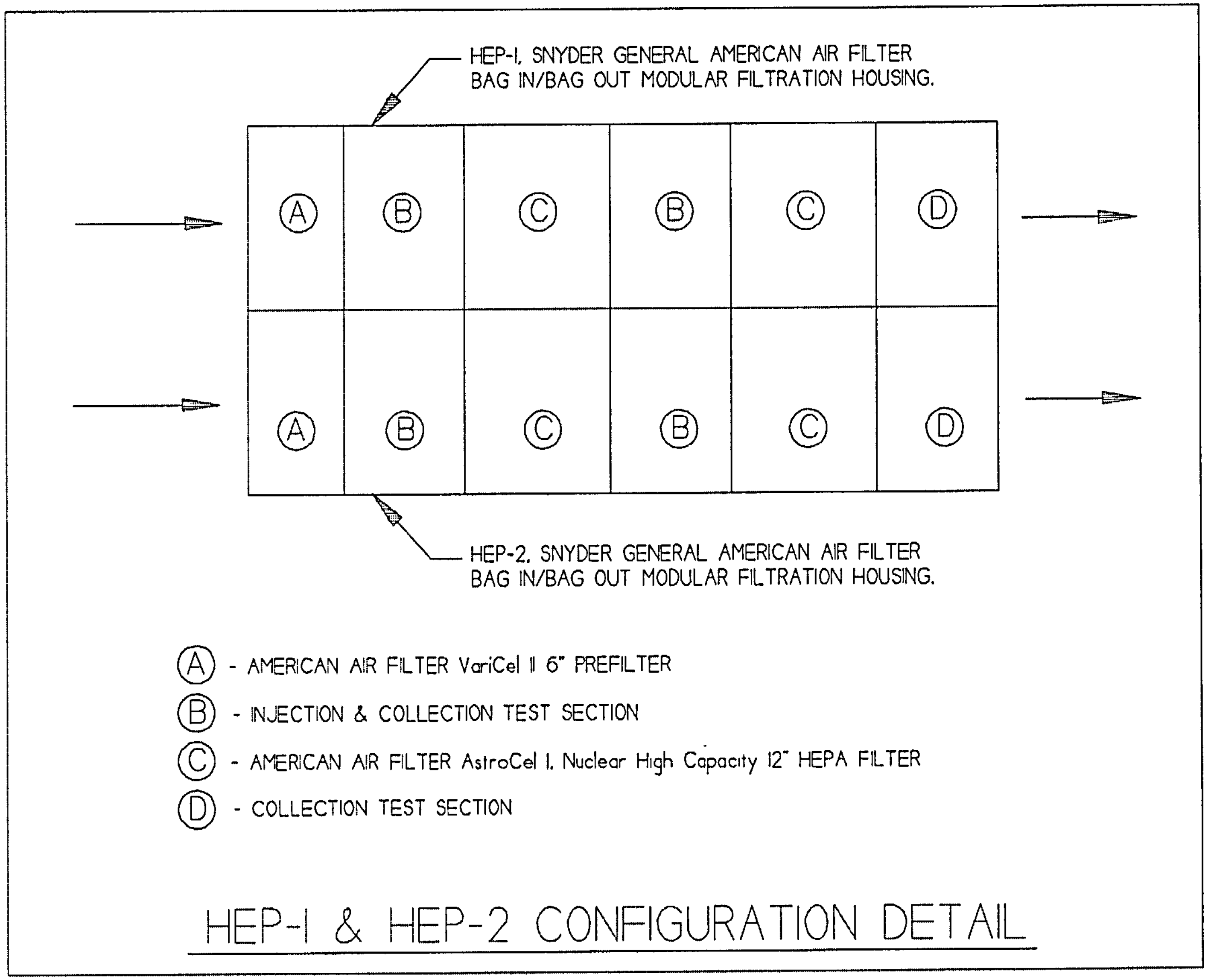
Figure 4.3-5 (Continued)

HVAC Details and Schedules

AIR HANDLING UNIT SCHEDULE																
			FAN DATA						REFRIGERATION COIL					ELECTRIC HEATING COIL		REMARKS
TAG	MANUFACTURER	MODEL	CFM	RPM	ESP	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	PTHP120IE-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 chosen 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.

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

*** 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 ****************

1. PREPARATION AREA SYS# 1 PEAK TIME 3 PM JUN. (24 X 32) = 768 SF

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

*** 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:

DRY BULB TEMPERATURE: 81.23
WET BULB TEMPERATURE: 67.00

ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 50.00

RELATIVE HUMIDITY(%): 48.03
ENTHALPY: 31.60 BTU/LBM

LEAVING COOLING COIL CONDITIONS:

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

LEAVING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 100.00

LUCHINI MILFORT & GOODELL PROJECT: EPRI DRY XFER FACILITY
78 BEAVER ROAD CLIENT: N.T.S
WETHERSFIELD, CT 06109 DATE: 06/22/95

FULL COMMERCIAL HVAC LOADS PROGRAM DESIGNER: D. ROVATTI
(LOWER ACCESS AREA & TRANSFER CONFINEMENT AREA)

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

*** 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. 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:

DRY BULB TEMPERATURE: 85.22
WET BULB TEMPERATURE: 70.79
RELATIVE HUMIDITY(%): 49.65
ENTHALPY: 34.75 BTU/LBM

ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 50.00

LEAVING COOLING COIL CONDITIONS: LEAVING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 65.00
WET BULB TEMPERATURE: 64.52
RELATIVE HUMIDITY(%): 97.54
ENTHALPY: 29.78 BTU/LBM

DRY BULB TEMPERATURE: 99.28

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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 # 2 (AHU-2 (L.A.A)) ZONE SUMMARY ***************

ZN. ZONE - DESCRIPTION FLOOR  HTG.LOSS  SEN.GAIN  LAT.GAIN  HTG.CFM  CLG.CFM
NO. PEAK  TIME & MONTH  AREA  O.A. CFM  O.A. CFM  EXH. CFM  CFM/SF.  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
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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 # 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:

DRY BULB TEMPERATURE: 86.23
WET BULB TEMPERATURE: 71.08
RELATIVE HUMIDITY(%): 48.07

ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 50.00

ENTHALPY: 35.00 BTU/LBM

LEAVING COOLING COIL CONDITIONS:

DRY BULB TEMPERATURE: 65.00
WET BULB TEMPERATURE: 64.52
RELATIVE HUMIDITY(%): 97.54
ENTHALPY: 29.78 BTU/LBM

LEAVING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 50.00

*** 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:

DRY BULB TEMPERATURE: 86.23
WET BULB TEMPERATURE: 71.08

ENTERING HEATING COIL CONDITIONS:

DRY BULB TEMPERATURE: 50.00

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		