CONTENTS

TABLES

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FIGURES

4. STORAGE SYSTEM

The ISFSI for the FSV HTGR is a MVDS system. The MVDS is located northeast and adjacent to the FSV power generation facility boundary, and is surrounded by its own controlled area.

4.1. Location And Layout

The location and layout of the ISFSI is shown on SAR figures 2.1-1, 2.1-2 and 4.0-1. Also illustrated are the roadways, utilities, and water service locations.

4.2. Storage System

4.2.1. MVDS Specifications

The MVDS system consists of a civil structure, FSCs, equipment for handling the FSCs, and standby facilities.

4.2.1.1. Design Specification

4.2.1.1.1. Civil Structure

The civil structure is constructed of reinforced concrete and structural steelwork. American Concrete Institute ACI 349-85: Code Requirements for Nuclear Safety Related Concrete Structures (Ref. 1) is used for design parameters of the concrete while the American Institute of Steel Construction: AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, 9th Edition - 1989 (Ref. 2) is used for the design of structural steel components.

The design of the reinforced concrete by the strength method has been facilitated by the use of the ACI Design Handbook: Strength Design Method, of ACI 318-83 Volumes 1 and 2 (ACI 340.1R-84 and 340.2R-85), Reference 3.

Construction of the concrete is in accordance with ACI 318-83, revised in 1986 (Ref. 4), Building Code Requirements for Reinforced Concrete.

4.2.1.1.2. Vault Module Charge Face Structure

Structural component and weld stress levels are in accordance with Reference 2.

Welding and NDT requirements are in accordance with ANSI/AWS D 1.1 - 1988 (Ref. 5) and Reference 2.

4.2.1.1.3. Fuel Storage Containers

Vessel boundary material testing is in accordance with ASME III DIV I ND2000 - 1986, including addenda through 1988 (Ref. 6).

Fabrication is in accordance with ASME Section III DIV I ND4000 - 1986, including addenda through 1988 (Ref. 7).

NDE examination is in accordance with ASME Section III DIV I ND5000 - 1986, including addenda through 1988 (Ref. 8).

Proof pressure test is in accordance with ASME Section III DIV I ND6000 - 1986, including addenda through 1988 (Ref. 9).

4.2.1.1.4. MVDS Crane

The crane complies with CMAA Specification No. 70 - 1988, Specification for Electric Overhead Traveling Cranes (Ref. 10).

4.2.1.1.5. Container Handling Machine and Shield Plug Handling Devices

The CHM and SPHDs (including the USPHD) comply with Reference 2, with welding standards: ANSI/AWS D14.1 - 1985 Welding of Industrial and Mill Cranes and Other Material Handling Equipment, (Ref. 11). ANSI/ASME NOG-1-1983 Rules For Construction Of Overhead And Gantry Cranes (Ref. 12) was utilized for the CHM raise/lower mechanism.

4.2.1.2. Design Loadings and Input Parameters

In preparing the design, the loadings and other input parameters have been based upon the following codes and standards:

1. American National Standard ANSI/ANS 57.9 - 1984: Design Criteria for an Independent Spent Fuel Storage Installation (dry storage type) Section 6.17 (Ref. 13).

2. NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants" (Ref. 14).

3. Regulatory Guide 1.61: Damping Values for the Seismic Design of Nuclear Power Plants, October 1973 (Ref. 15).

4. Regulatory Guide 1.76: Design Basis Tornado for Nuclear Power Plants, April 1974 (Ref. 16).

5. NUREG-0800 Section 3.5.14, Missiles Generated by Natural Phenomena (Ref. 17).

6. ACI 349-85, Code Requirements for Nuclear Safety Related Concrete Structures (Ref. 1).

7. ANSI A58.1-1982: Minimum Design Loads for Buildings and Other Structures (Ref. 18).

4.2.1.3. Materials of Construction

4.2.1.3.1. Civil Structure

Concrete: 4,000 psi

Cement: Type II Portland: ASTM C150

Aggregates: ASTM C33

Reinforcing Steel: ASTM A615, Gr 60

Structural Steel: ASTM A572, 50 ksi

4.2.1.3.2. Charge Face Structure

Plate: ASTM A516, Gr 70

Liner tubes: ASTM A333, Gr 6

Bolts and Screws: ASTM A325

Concrete: 140 lbs/cu ft. minimum density

4.2.1.3.3. Fuel Storage Containers

Container steel: ASME SA333, Gr 6

Base and flange forgings: ASME SA350, Gr LF2

Container lid: ASME SA350, Gr LF2

Support stool: ASTM A36

Lid fasteners: ASME A320, Gr L7

4.2.1.3.4. Container Handling Machine

Structural fabrication material: ASTM A36 and ASTM A516, Gr 70

Lifting features: ASTM A588

Inner pipe: ASTM A106

4.2.1.3.5. Fuel Storage Container Grapple

Load bearing plate: ASTM A572, Gr 42

Tubing: ASTM A501

Lifting pins: ASTM A434, Gr 4037 Class BB

Jaws: ASTM A541 Class 2A or 3A Forging

Jaw pin and rope clevis pins: ASTM A434, Gr 4037 Class BB

4.2.1.3.6. Fuel Storage Container Raise/Lower Mechanism

Lead Screw: British Standard (BS) 970, 708M40 (AISI/SAE 4140)

Shafts: BS 970, 605M36 (ASTM A434 Gr 4037 Class BB) or BS 970, 817M40 (ASTM A434 Gr 4640 Class BD)

Guide Channels: BS 4360, 50D (ASTM A516, Gr 70)

Plate: BS 4360, 50D (ASTM A516, Gr 70) and BS 4360, 43E (ASTM A516, Gr 60)

Chain: ANSI B29-1

4.2.1.3.7. Shield Plug Lifting Devices & Isolation Valves

Bar: ASTM 588, Gr K

Pipe: ASTM A106, Gr B

Plate: ASTM A36

4.2.1.3.8. Standby Storage Wells

Shell: ASTM A333, Gr 6

Base Forging: ASTM A350, Gr LF2

Flange Forging: ASTM A350, Gr LF2

Storage Well Lid: ASTM A516, Gr 55 or ASTM A350, Gr LF2

Lid Bolts: ASME A320, Gr L7

Hold Down Bolts: ASTM A307

4.2.1.3.9. Cask Load/Unload Port

Material: ASTM A36 and ASTM A516, Gr 70

Seismic restraint pins: ASME A242

4.2.2. Installation Layout

Section 4.1 discusses the general layout of the ISFSI facility. Engineering drawings of the storage site and buildings have been developed, are referenced within the applicable section detailing the various components that comprise the MVDS, and are maintained in accordance with the QA Program described in Section 11.

4.2.3. Storage Installation (ISFSI) Description

The ISFSI for the FSV HTGR is an MVDS system, based primarily on the FWEA MVDS Topical SAR, as discussed in Section 1.

4.2.3.1. Function

The MVDS provides interim storage (designed for a 40 year life) for the FSV HTGR spent fuel and associated spent fuel material in a contained, shielded system.

4.2.3.2. Components

The MVDS consists of a civil structure, FSCs, equipment for handling the FSCs, and standby facilities.

4.2.3.2.1. Civil Structure

The civil structure is shown on Figures 1.1-1, 1.1-2 and 1.1-3. The civil structure consists of the following parts: Vault Modules, TCRB, Charge Hall Structure, Foundation Structure, and Standby Storage Wells. Each of the six vault modules has the capacity for 45 FSCs. Each FSC is designed to hold six fuel elements, six neutron source elements, or twelve reflector elements

<u>Vault Module</u>

The civil structure of the vault module provides a minimum of 3' -6" thick shielding walls around the array of FSCs and the cooling air inlet/outlet duct configuration. The vault module structure is supported by an integral foundation system. Cooling air enters the vault module through a mesh covered opening to prevent the ingress of birds, animals, large debris, etc. The labyrinth arrangement of the inlet structure provides radiological shielding for the stored fuel. Cooling air distribution across the outside of the sealed FSCs is improved by precast concrete collimators set into pockets in the vault module structure air inlet walls. The collimators also provide a contribution to the radiological shielding of the stored fuel. The cooling air leaves the vault module through a second set of concrete collimators, which serve the same functions as those at the inlet, and is exhausted to atmosphere through a concrete cooling air outlet chimney that extends above the charge face.

A steel canopy on the top of the cooling air outlet chimney prevents the ingress of rain and snow. The opening of the outlet duct is fitted with mesh. The ambient cooling air does not come into contact with the fuel in the FSCs so that the internal walls of the vault module will remain clean and not require smooth finishes to facilitate decontamination.

This canopy structure is designed to withstand the maximum tornado wind loading and the cladding is designed to withstand the maximum normal wind of 110 mph.

The floor of the vault module is sloped for drainage and is connected to a gutter that leads to a drain pipe with a valve for sampling, if necessary. Inset and grouted into the vault module floor are the support stools for the FSCs. A construction recess in the top of the vault module walls supports the charge face structure. The charge face structure is illustrated in Figures 4.2-1 and 4.2-2. The charge face structure is set into the vault module to form the roof of the vault and provide lateral support for the array of FSCs. Bearing pads are cast into the concrete vault module recess to transmit charge face structure vertical loads into the civil structure.

Lateral loads are transmitted via concrete walls around the outer edges of the charge face structure.

The charge face structure was shop fabricated, filled with concrete (for shielding) at the site and then positioned in the vault module.

Above and running along each side of the charge face structure, the vault module incorporates embedments to support the MVDS crane rails. The embedments transmit loads from the crane to the civil structure.

Normal access to the MVDS charge face is via a steel stair case.

<u>Transfer Cask Reception Bay</u>

The TCRB is alongside and integral with the vault module structure. The TCRB provides an access area for the loading/unloading of the transfer cask from its transporter (tractor and trailer). A rectangular hatched access opening at the charge face level of the TCRB is provided for movement of the transfer cask to the vault module charge face.

A single road access is provided into the TCRB. This access can be closed with a steel roller shutter door to provide a weather-proof enclosure.

Charge Hall Structure

The charge hall of the MVDS is formed on one side by the vault module cooling air outlet chimney and on the other three sides and the roof by the charge hall structure. The charge hall structure is enclosed by a concrete wall up to +34 ft. level. Above this level is a steel braced and clad structure supported from the concrete walls and the cooling air outlet chimney.

The design of the roof profile has been determined by considerations of wind and snow effects and the performance of the vault module cooling system.

Foundation Structure

The foundation structure is designed to support the MVDS, considering the imposed loads created by the structure weight, facility operations, environmental conditions and the DBE.

4.2.3.2.2. Standby Storage Wells

The MVDS has been designed to deal with 'off-normal' events.

Standby Storage Wells

Three SSWs are incorporated into the civil structure at one end of one of the MVDS, adjacent to one of the vault modules. The functions of these are as follows:

a. Allows isolation of a defective FSC from its storage position in the vault module.

b. Provides for leak checking of a FSC away from its vault module storage position.

c. Provides basic provision to change fuel elements from a FSC to a spare unit in the unlikely event of FSC failure.

d. Provides basic provision to move individual fuel elements from FSCs and relocate these into a shipping cask ~~for ultimate movement to the Federal Repository~~ if this should be required in the future.

An SSW is illustrated in Figures 4.2-6, 4.2-7 and 4.2-8 and consists of a simple closed-ended liner tube set into an enclosure within the civil structure, which provides necessary radiation shielding. The tube is designed to house a FSC and support its base in a manner identical to that used in the vault module. The top plate at the storage well allows the positioning and bolting of the charge face isolation valve. The SSW can be closed using a charge face shield plug and sealed using a sealing cover plate. A sampling point closed at the charge face level with a self sealing coupling, allows the storage well volume to be leak tested to confirm its integrity. When the SSW is occupied by a loaded FSC, the decay heat is dissipated to the surrounding air. The warmed air circulates to the environment via ducts through the wall of the adjacent vault module. The cooling air does not come into contact with the fuel.

One SSW may be equipped with a spare FSC. The others normally remain empty until a full defective FSC should require removal from a vault module.

4.2.3.2.3. Fuel Storage Containers

The FSC provides a containment boundary for the stored fuel. Figure 4.2-3 illustrates the FSC design, and Table 4.2-1 provides the essential design parameters. Engineering Evaluation EE-DEC-0031, Rev. A (Ref. 19), determined that corrosion on the internal wall of the container due to potential water contained in the graphite fuel elements was not detrimental to the safe function of the FSCs during their 40-year design lifetime.

The DUP of the FSC is designed to enable it to be lifted by the USPHD. The lid of the FSC has a lifting feature on its inner profile to enable the FSC to be handled.

Double metal O-ring seals between the lid and the fuel storage body provide a high integrity and leak checkable sealing arrangement designed to withstand exposure to radiation during the storage period without the need for maintenance. A sealable O-ring interspace tapping allows container sealing to be confirmed.

Shipping cask inner container orientation features are retained in the FSC and allowed engagement of the fuel element spigots during FSC loading using the reactor building fuel handling machine. A location boss on the base of the FSC replicates that of the shipping cask inner container and is used to engage the FSC support stool fixed to the base of the vault module.

Empty FSCs may be stored in the vault modules until required.

The storage environment within the FSC is air, which is compatible with the maximum predicted fuel temperatures and the properties of graphite.

The outside carbon steel body of the FSC is protected from atmospheric corrosion by application during manufacture of a flame sprayed coating of aluminum to all outside surfaces.

In NRC Bulletin 96-04 (Ref. 20), the NRC required ISFSI licensees to review spent FSC materials to determine whether chemical, galvanic or other reactions among these materials, the contents and environment could occur, with consideration for normal, off-normal and accident conditions. In response to NRC Bulletin 96-04 (Ref. 21 and 22), PSCo identified various materials used in the carbon steel FSCs, including an interior primer and grease used with the metal O-rings and concluded that galvanic cell corrosion is a possible localized corrosion mechanism that could theoretically occur, depending on conditions in a FSC. While galvanic cell corrosion was evaluated along with other potential localized corrosion mechanisms in the above noted Engineering Evaluation EE-DEC-0031, Rev. A (Ref. 19), it was considered that small amounts of moisture in the graphite would tend to remain trapped in the graphite, and would not be driven out at the relatively low temperatures that would be expected for fuel blocks stored in the ISFSI (less than 200 degrees F).

In the event that fuel elements having a significant absorbed water inventory were loaded into a FSC, and the water evaporated out of the graphite and condensed onto the inner surfaces of the FSC, it may be possible for sufficient water to collect in the bottom of a FSC such that a galvanic cell would be formed. This would require concentrations of ions in the standing water so that it served as a suitable electrolyte. With a suitable electrolyte, formation of a galvanic cell is theoretically possible, with the carbon steel functioning as the anode and the bottom graphite fuel element as the cathode, since carbon has a lower oxidation potential than iron. The oxidation reaction would result in corrosion of the carbon steel, with positive iron ions entering the electrolyte solution, and the reduction reaction could involve production of hydrogen gas where graphite contacts the electrolyte. It should be noted that there are no potential ignition sources during spent fuel storage operations. Calculations indicate that corrosion of steel by this mechanism, assuming a conservatively high water inventory that evaporates out of the graphite, could not oxidize sufficient iron to prevent the FSC from performing its containment safety function, and from meeting its minimum strength requirements. Any FSC affected by galvanic cell reaction, as well as by general and crevice corrosion mechanisms also considered in Ref. 21 and 22, would continue to maintain its structural integrity.

PSCo considered it extremely unlikely that the conditions conducive to a galvanic cell reaction resulting in the production of hydrogen gas could exist in the FSC, for reasons discussed in Ref. 21 and 22. However, PSCo committed, and DOE commits, to institute controls to assure measures are included in FSC handling procedures to preclude handling of a loaded FSC, or removal of the lid bolts, until such a time as the gas space inside the FSC has been analyzed and determined not to have a combustible gas mixture, or evacuated and purged with air to assure hydrogen concentrations are below flammable levels (Ref. 21 and 22). This will assure that only FSCs that do not contain a flammable concentration of hydrogen are handled and/or transported in the TN-FSV casks. In the unlikely event that testing determines a FSC has a flammable concentration of hydrogen in air, then the FSC will be evacuated and purged with air prior to handling. As stated in Ref. 21 and 22, if no significant hydrogen concentration is detected in the first six storage containers whose internal atmospheres are tested, then it will be assumed the theoretical galvanic reaction is not occurring at a significant rate in the FSCs, and additional FSCs will not be tested.

4.2.3.2.4. Equipment for Handling Fuel Storage Containers

This equipment is described in Section 4.4.

4.2.3.3. Design Bases and Safety Assurance

The design bases and materials of construction are detailed in Section 4.2.1. The structural analysis of the MVDS is described in Appendix A4-1.

4.2.4. Instrumentation and System Description

The MVDS is designed to maintain a safe and secure long-term containment and storage environment for the spent fuel and associated spent fuel material using totally passive components. Therefore, no important to safety instrumentation is required for the operation of the facility.

Monitoring of the fuel confinement boundary provided by the FSC is not necessary because the materials of construction will not significantly degrade during the specified storage period. However, the FSC features that allow comprehensive leak checking immediately following fuel loading into the FSC can be used safely and quickly throughout the storage period, without removing the FSC from the vault module.

No fixed radiation monitors are provided or are necessary for the MVDS. Portable monitors will be used if required during the operation and maintenance of the installation. Radiation monitoring of the MVDS site boundary is discussed in Section 7. Seismic instrumentation is provided and is discussed in Section 5.1.4.

Table 4.2-1. Fuel Storage Container Design Parameters.

[Included in the proprietary version of the SAR]

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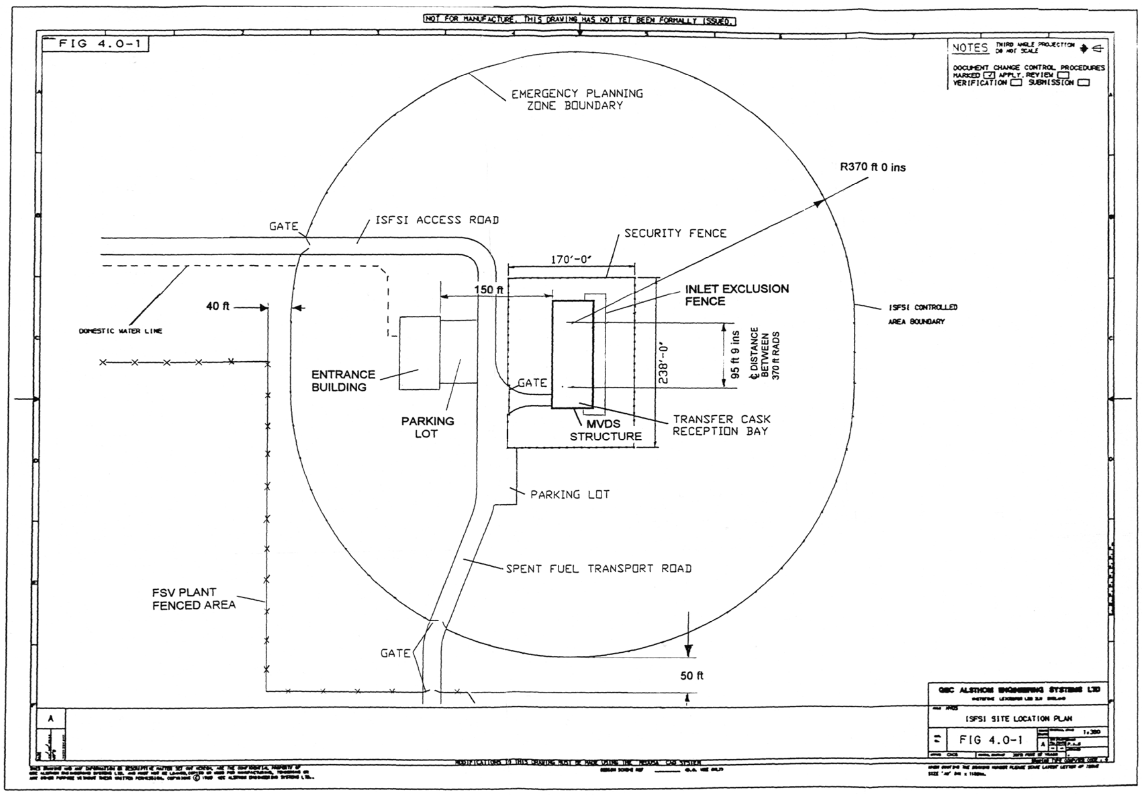

Figure 4.0-1. ISFSI Site Location Plan.

[Included in the proprietary version of the SAR]

Figure 4.2-1. Charge Face Structure.

[Included in the proprietary version of the SAR]

Figure 4.2-2. Charge Face Structure.

[Included in the proprietary version of the SAR]

Figure 4.2-3. Fuel Storage Container Assy.

Figure 4.2-4. THIS FIGURE IS NOT USED.

Figure 4.2-5. THIS FIGURE IS NOT USED.

[Included in the proprietary version of the SAR]

Figure 4.2-6. Storage Well Tubes Assy.

[Included in the proprietary version of the SAR]

Figure 4.2-7. Storage Well Tubes Assy.

[Included in the proprietary version of the SAR]

Figure 4.2-8. Storage Well Tubes Assy.

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4.3. Transport System

4.3.1. Loading Spent Fuel into the ISFSI

4.3.1.1. Function

The FSV-1 spent fuel shipping casks were used to transfer spent fuel from the Reactor Building to the ISFSI. The fuel loading operation began December 26, 1991, and was completed June 10, 1992.

The components of the system for transport of spent fuel from the Reactor Building to the ISFSI were the FSCs, the transfer casks, and the transfer cask trailers. Use of the existing FSV-1 spent fuel shipping casks as transfer casks precluded the need for Reactor Building or crane modifications.

The FSC was the secondary containment for FSV spent fuel during transport to the ISFSI. The primary containment was the fuel particle coating (TRISO) discussed in Section 3.3.2.1. The FSC is designed to hold six irradiated FSV fuel elements or twelve reflector elements and replicates the functions and features of the FSV-1 licensed spent fuel shipping cask inner container (see Section 4.2.3.2). The FSC fits inside the transfer cask and was loaded with spent fuel elements by the fuel handling machine through an isolation valve in the Reactor Building.

The transfer casks that were used to transport the fuel from the Reactor Building to the ISFSI were the FSV-1 spent fuel shipping casks which were licensed under the provisions of 10 CFR Part 71 (Ref. 23), and were separate from both the 10 CFR Part 50 (Ref. 24) operating license for the FSV Nuclear Generating Station and the 10 CFR Part 72 (Ref. 25) license for the ISFSI. Authorized configurations of the FSV-1 shipping casks for highway transport were controlled by a Certificate of Compliance (Ref. 26), which is issued and renewed by the NRC every five years. The Certificate of Compliance identified several different configurations for transporting radioactive materials. FSV-1 in some of the licensed configurations was approved for transportation of solid nonfissile, irradiated and contaminated hardware, and did not require the use of an impact limiter. FSV-1, Configuration E, was approved for transportation of irradiated FSV fuel elements and required the use of an impact limiter for spent fuel shipments over public highways. Since the transport route from the Reactor Building to the MVDS was totally within owner-controlled property and not on public highways, as shown in Figures 2.1-1 and 2.1-2, the FSV-1, Configuration E, authorized shipping cask configuration that requires impact limiters for highway transport was not utilized when the cask was used as a transfer cask for irradiated fuel elements.

Before a loaded transfer cask was transferred to the ISFSI, the seals were leak-tested under a vacuum to ensure that leakage of radioactive gases from the cask would not occur. Therefore, the only differences between shipping spent fuel offsite in an FSV-1 cask in accordance with its 10 CFR Part 71 authorized spent fuel shipping configuration and transporting it to the ISFSI, using the FSV-1 as a transfer cask, were that the FSC was used instead of the 10 CFR Part 71 inner fuel shipping container, a removable DUP was incorporated, and the impact limiters were not utilized.

4.3.1.2. Components

The transportation system components used in ISFSI spent fuel loading operations, with the exception of the FSC and the removable depleted uranium plug, are discussed in GADR-55 (Ref. 27) and also in the 10 CFR Part 71 (Ref. 23) license for the FSV-1 shipping casks.

FSV's 10 CFR Part 50 (Ref. 24) Appendix B QA program was approved by the NRC to control QA activities related to the FSV-1 fuel shipping casks, and was in effect throughout the ISFSI fuel loading operation. The QA program for transport packages also is renewed at 5 year intervals. Any modifications to these casks which affect components identified in the Certificate of Compliance issued by the NRC require prior approval of the proposed modifications by the NRC.

The fuel transport route is shown in Figures 2.1-1, 2.1-2, and 2.1-3. The sole use for this route is to support the ISFSI, which includes initial fuel loading, security, and maintenance. There are no public uses of this roadway.

4.3.1.3. Design Bases and Safety Assurance

The design bases and safety analyses for the FSV-1 fuel shipping casks are discussed in Reference 27 and remained accurate when these casks were used as transfer casks (even though the FSC was substituted for the inner fuel shipping container, and the impact limiter was not used for this transfer route). The design bases for the FSC are discussed in Section 4.2.1.

There are no backup provisions or interface with the FSV Power Generating Building after the MVDS was loaded and pre-operational testing was completed. See Section 8 for details concerning certain off-normal events. Radiation and contamination control for the transport system are detailed in Reference 27.

4.3.2. Unloading Spent Fuel from the ISFSI

FSV-1 casks are licensed under 10 CFR Part 71 for transport of spent fuel over public highways with six spent fuel elements contained in a stainless steel FSV-1 inner canister that functions as the fission product containment boundary. It was determined that use of the FSV-1 casks for ISFSI defueling operations was not desirable, since individual fuel elements would have to be transferred from the carbon steel FSCs to the stainless steel FSV-1 inner canisters. PSCo licensed new spent fuel shipping casks, designated TN-FSV casks, in which the licensed configuration uses the FSC itself as the inner container, and the cask provides the containment boundary. Title to the two TN-FSV shipping casks was transferred to DOE with the facility transfer. ~~and an application was made to transfer the cask license~~ The Certificate of Compliance for the casks was also~~was~~ transferred to DOE. Defueling will involve transfer of an FSC from a vault module to a TN-FSV cask in the CLUP. At no time during defueling operations at the ISFSI will the integrity of the FSC be broken.

The TN-FSV casks are licensed under 10 CFR Part 71 for transport of loaded FSCs on public highways. The Certificate of Compliance for the TN-FSV casks (Ref. 28) requires these casks to have two impact limiters installed for fuel shipping, one at each end. As was the case with the FSV-1 cask, the seals of the TN-FSV casks are required to be leak tested prior to releasing the cask from the ISFSI for spent fuel shipment. The design bases, design and safety analyses of the TN-FSV casks are described in the TN-FSV SAR (Ref. 29).

4.4. Operating Systems

4.4.1. System for Loading Fuel Storage Containers

The loading of the spent fuel into the FSCs was performed at the FSV Reactor Building. The initial ISFSI fuel loading operation involved the loading of irradiated fuel elements into the FSC that was in the transfer cask, the unloading of the loaded FSC from the transfer cask, and the movement of the FSC to its storage location in the MVDS. Fuel loading operations performed at the MVDS are detailed in Section 4.4.2.

4.4.2. Handling of Fuel Storage Containers at the MVDS

The equipment required for the handling and transfer of loaded and unloaded FSCs consists of:

1. MVDS Crane
2. CLUP and its Isolation Valve
3. SPHDs
4. Charge Face Isolation Valve
5. CHM

All equipment associated with fuel handling and transfer operations is designed as detailed in Section 3. The analysis of the MVDS load/unload equipment is detailed in Appendix A4-2.

Operating descriptions and modes for specific items of equipment are discussed in the following sections. The procedures for handling the FSCs at the MVDS are provided in Section 5.1.1.

4.4.2.1. MVDS Crane

The MVDS crane operates over the MVDS charge face and CLUP and provides all lifting operations necessary to support fuel load/unload. It handles the transfer cask, the CHM, the CLUP hatch cover, the CLUP adaptor plate, the isolation valves and the SPHDs. The crane is equipped with a grapple, illustrated in Figure 4.4-1, for handling the transfer cask. When lifting the CHM, the crane hook couples to the lifting frame of the CHM illustrated in Figure 4.4-2. Dedicated slings are provided for lifting of the other components.

The crane is rated at 110,000 pounds capacity, pendant controlled, electric overhead traveling goliath type, manufactured to CMAA Specification No. 70 (Ref. 10). Its design parameters are shown on Table 4.4-1. It is supported on rails from the MVDS charge hall concrete walls at the +34 ft. level, traverses the length of the building, and spans the charge face.

The gantry and trolley are designed to remain on their respective runways with their wheels prevented from leaving the tracks during a seismic event or tornado. Design allowable stress limits are those indicated in CMAA Specification No. 70 (Ref. 10).

If the crane fails and drops a transfer cask, CLUP adaptor plate, isolation valve or SPHDs, the lifting slings are sized to limit the drop to within acceptable heights. See Table 4.4-2. The crane structure and upper limit of the hoist controls the potential drop height of the CHM. These limits and restraints ensure that no release of radioactivity will occur in the event of any of the items carried by the crane being dropped.

4.4.2.2. Transfer Cask Load/Unload Port and Isolation Valve

The CLUP provides a position in the charge face above the TCRB for the transfer cask to be seated and prepared for unload/load of its FSC. The CLUP is illustrated in Figure 4.4-3 and its design parameters are given in Table 4.4-3. The CLUP isolation valve provides a shielded interface access between the CLUP and the CHM for loading and unloading FSCs.

The CLUP is a carbon steel seating ring and an adaptor plate complete with shield ring. The seating ring is recessed into the charge face onto which the transfer cask can sit via the flange at the top of its body. The seating ring and charge face are slotted to allow the transfer cask to be placed in position by the MVDS crane with minimum lift. The height of lift of the crane hook when lifting the transfer cask is restricted by the dedicated sling length.

The adaptor plate and its shield ring sit in the seating ring around the top of the transfer cask and are positioned by the MVDS crane after the transfer cask has been placed on the seating ring. It provides a continuation of the shield in the slot of the load/unload port and a seating feature for the isolation valve identical to that on the vault module charge face.

The isolation valve sits above the transfer cask at the CLUP at the charge face level. It is handled into position by the MVDS crane employing a dedicated sling to restrict the height of lift. The valve is a gate valve constructed of carbon steel, driven manually by a screw jack. The valve is located and fixed to the CLUP adaptor plate when in use.

The gate and the body of the valve provide a gamma shield over the transfer cask, which is required when the DUP has been removed from the lid of a loaded FSC. The valve is mechanically interlocked so that when the DUP is removed by the USPHD, the USPHD cannot be removed from the valve unless the gate is closed.

The isolation valve design incorporates a feature that interacts with the CHM valve to release its mechanical interlocks, and at the same time links the gates of both valves for the screw jack opening and closing operation. When the CHM is parted from the CLUP isolation valve, with both valves "'closed," the CHM valve is mechanically locked in the closed position. The CHM isolation valve open and closed positions are indicated by limit switches.

4.4.2.3. Shield Plug Handling Devices

Two SPHDs (includes the USPHD) are provided, one for handling the DUP of the FSC lid and other for handling the charge face shield plug. These are illustrated on Figures 4.4-4 and 4.4-5.

The SPHDs are similar in construction and consist of a carbon steel cylinder closed at the top end and open at the bottom. A screwed lifting rod passes through the top of the cylinder and engages the item being handled. The lifting rod is manually operated.

The SPHD is moved into position over its isolation valve by the MVDS crane employing a dedicated sling to restrict the lift height. The SPHD provides shielding from a loaded FSC while either the DUP or the shield plug is being lifted through an open isolation valve. A mechanical interlock prevents a SPHD from being lifted from the isolation valve unless the gate of the valve is closed.

4.4.2.4. Charge Face and its Isolation Valve

The charge face isolation valve provides shielded interface access between the FSC in its storage position in the vault module and the CHM or the SPHD. It is used during the load/unload of FSCs and shield plugs at their vault module positions.

The isolation valve is moved into position on the charge face by the MVDS crane employing a dedicated sling of such a length as to restrict the lift height.

The construction of the valve is identical to that of the CLUP isolation valve described in Section 4.4.2.2 and is illustrated in Figures 4.4-6, 4.4-7 and 4.4-8. The gate of the valve is driven manually and when fully open provides an access hole of 21.25 inches diameter, giving a radial clearance of 0.4 inches on the FSC. The valve is fixed by ~~three~~ bolts and ~~two~~ location dowels in the selected position on the charge face.

The gate and the body of the valve provide a gamma shield over the FSC storage position. The isolation valve is mechanically interlocked so that when the charge face shield plug is being removed by the SPHD, the SPHD cannot be removed from the valve unless the gate is closed.

The design of the isolation valve incorporates a feature that interacts with the CHM valve to release its mechanical interlocks and at the same time links the gates of both valves for opening and closing. When the CHM is parted from the charge face isolation valve, with both valves closed, the CHM valve is mechanically locked in the closed position.

4.4.2.5. Container Handling Machine

The CHM provides the means of raising/lowering FSCs from the transfer cask and lowering/raising these at the vault module storage location. When contained within the CHM, the FSC is fully shielded and the fuel decay heat is dissipated via machine exterior surfaces. The CHM is illustrated in Figures 4.4-9 through 4.4-14 and the major parameters are given in Table 4.4-4. The CHM is moved over the charge face using the MVDS crane.

The CHM consists of four major units, as detailed in Sections 4.4.2.5.1 through 4.4.2.5.4.

4.4.2.5.1. Machine Base

The base of the machine includes an isolation valve and four shock absorber legs.

The CHM isolation valve provides gamma radiation shielding for the base of the CHM. This valve is similar in construction to the isolation valves, except that it has no separate mechanism for actuation. The CHM isolation valve is designed to sit upon, engage and bolt to the isolation valves.

When attached to either of the other two isolation valves, interlock pins couple both the valve gate slides together such that the actuation of the lower valve also operates the CHM isolation valve. When the valves are de-coupled in the closed position, spring loaded pins lock the CHM isolation valve in the closed position, thus ensuring that it cannot be inadvertently opened.

Four legs extend from the CHM isolation valve and straddle the CLUP or charge face isolation valve to which the machine is engaged. Each leg has a built-in shock absorber feature and is designed to give stability to the CHM.

4.4.2.5.2. Machine Body

The body of the CHM is a composite tube with a closing flange mounted plate at its upper end. The body provides the necessary shielding for the FSC during handling in the CHM.

The composite tube is a fabrication of lead encased in carbon steel and has a bore of approximately 22 inches. A lifting frame at the top of the tube provides the lifting feature for the CHM.

4.4.2.5.3. Fuel Storage Container Raise/Lower Mechanism

This mechanism comprises an acme thread leadscrew, drive unit, trunnion mounted nut, guide system, duplex chains, sprockets and equalizing beam, and is designed to be single-failure proof in accordance with Reference 12.

The leadscrew is mounted between bearings on the outside of the machine body, and is driven from the lower end by a motor through a gearbox. The motor is fitted with a brake. A second (standby) brake is provided between the gearbox and the leadscrew.

A nut is provided on the leadscrew. This nut is mounted in a trunnion block which runs between guide channels up the height of the machine body. The helix angle of the leadscrew/nut is chosen to ensure that the nut is self-sustaining.

The FSC grapple is raised/lowered by the leadscrew/nut through two duplex chains. The chains are connected at one end to the top of the grapple and at the other to an equalizing beam mounted at the top of the machine. Each chain runs over a sprocket mounted on the nut trunnion block and over two sprockets mounted on top of the machine body.

Limit switches are housed in the guide channels for position control of the grapple.

4.4.2.5.4. Container Handling Machine Controls and Power Supply

The machine is controlled locally from a control panel on the base of the machine. See Section 5.2 for details.

4.4.2.6. Safety Considerations and Controls

Interlocks are provided between the machine, the CLUP and charge face isolation valves and the MVDS crane.

1. The machine cannot be lifted unless the isolation valves are closed.

2. The isolation valves cannot be closed unless the FSC raise/lower mechanism is fully up.

3. The FSC hoist cannot lower unless the isolation valves are open.

4. The FSC raise/lower mechanism cannot lower if hoist weight sensing indicates that the load is less than the grapple weight.

Further details of the various interlocks, alarms and annunciators are found in Section 5.2.

4.4.3. Decontamination Systems

The ISFSI facility does not contain a decontamination system. There are no active water sources. Any solid or gaseous radioactive material is contained within the FSCs, the CHM, or the glove box apparatus. In the event that some unforeseen activity produces radioactive contamination, it will be decontaminated as required.

4.4.4. Maintenance Systems

The FSCs are high integrity containment vessels designed to ASME Section III requirements. They are proof pressure tested during manufacture and leak tested after being loaded with spent fuel.

In the event that an off-site release is caused by a failed FSC, a special charge face shield plug is provided that allows in-situ access to the FSC leak test valves and is installed at the relevant vault module storage position prior to testing. The leak test probe is shown in Figure 4.4-15. The test that is conducted on the FSC is a leak test of the lid seals.

If the test establishes that the containment boundary is leaking, the FSC will be transferred to a SSW by the CHM. Failure of the lid seals requires the lid to be removed and the seals replaced and retested. If the seals still fail the leak test, the spent fuel would be transferred to a new FSC. The leaking FSC can remain in the SSW for an indefinite period of time. The procedure for this is given in Section 4.4.4.1. Before the spent fuel transfer operation can commence, it is necessary for the FSC grapple to be exchanged for an individual fuel element grapple.

This exchange is made in a glovebox which is mounted to the underside of the CLUP when the transfer cask is not in position. The glovebox is illustrated in Figure 4.4-17. After use, the individual fuel element grapple would be checked for contamination in the glovebox; if it is found to be contaminated, it is then decontaminated in-situ or bagged and dispatched from the MVDS for decontamination.

4.4.4.1. Typical Operation for Transferring Spent Fuel from a Faulty Fuel Storage Container to a New Fuel Storage Container

Starting Conditions: Isolation valve positioned at the vault module storage position containing the faulty FSC; charge face shield plug in position; isolation valve positioned at SSW #1, with shield plug in position. (Procedures for operating personnel are based on the following typical operation).

NOTE: As discussed in section 4.2.3.2, galvanic cell corrosion inside FSCs is theoretically possible, and this reaction could possibly generate hydrogen gas. For this reason, PSCo has committed (Ref. 21), and DOE also commits, that no FSC will be handled, or its lid bolts removed, until a sample of the fuel storage atmosphere has been analyzed and determined not to contain a combustible gas mixture, or evacuated and purged with air to assure hydrogen concentrations are below flammable levels. If analysis identifies a flammable concentration of hydrogen in air, then the FSC will be evacuated and purged with air prior to handling or removal of the lid bolts. If no significant hydrogen concentration is detected in the first six FSCs whose internal atmospheres are tested, then it will be assumed that the theoretical galvanic reaction is not occurring at a significant rate in the FSCs, and additional FSCs will not be tested.

<u>Operations</u>

1. Remove shield plug at storage position using SPHD #1.

2. Remove faulty FSC using CHM and park the CHM.

3. Replace shield plug using SPHD #1.

4. Remove shield plug from SSW #1 using SPHD #1, and transfer and deposit shield plug in its parking position.

5. Place faulty FSC into SSW using CHM, and close isolation valve.

6. Park CHM.

7. Replace the shield plug using SPHD #1.

The lid of the faulty FSC is now removed as follows at SSW #1:

8. Using the pressure test equipment, relieve the FSC internal pressure volume.

9. Remove shield plug from SSW using SPHD #1, transfer and deposit shield plug in its park position.

10. Place FSC depleted uranium plug and the adaptor plate on the FSC lid using SPHD #2 (USPHD).

11. Remove isolation valve #2.

12. Undo and remove FSC bolts using special tool provided. Secure the adaptor plate to the FSC lid.

13. Replace isolation valve #2.

14. Remove FSC lid, depleted uranium plug and adaptor plate using SPHD #2.

15. Transfer and deposit SPHD #2 plus the FSC lid depleted uranium plug and adaptor plate into the park position.

With the FSC in SSW #1 now ready for emptying of its spent fuel, the CHM is made ready to handle the fuel.

1 Attach glovebox beneath the CLUP.

2. Transfer isolation valve #1 from the vault module storage position to the CLUP.

3. Position CHM at the CLUP.

4. Detach FSC grapple in the glovebox.

5. Park CHM away from the CLUP.

6. Remove the FSC grapple using the MVDS crane.

7. Place individual fuel element grapple into the glovebox using crane.

8. Transfer CHM to the CLUP.

9. Attach individual fuel element grapple to CHM raise/lower mechanism.

10. Park CHM.

With the spare FSC in SSW #2 having previously been prepared before this procedure commences by having its lid removed, SSW #2 can have its final preparation and the change over of spent fuel from SSW #1 to SSW #2 can commence.

1 Place isolation valve #1 on SSW #2.

2 Remove SSW #2 shield plug using SPHD #1.

3 Place CHM over SSW #1.

4 Lift individual fuel element into CHM.

5 Transfer CHM to SSW #2.

6 Lower individual fuel element into SSW #2.

7 Position CHM at its parking position.

8 Position spent fuel element alignment tool on isolation valve #1 at SSW #2.

9 Align fuel element in the FSC with location pins.

10 Remove individual fuel element alignment tool.

11 Repeat operation five more times.

NOTE: Operations concerning the alignment tool are optional since this tool is necessary for properly aligning 6 fuel elements or 12 reflector elements in a FSC at the MVDS. If the tool is not used, it is acceptable to have less than 6 fuel elements or 12 reflector elements loaded into a FSC.

The sealing of the FSC containing spent fuel elements and its transfer to the vault module storage position now takes place as follows:

1 Park CHM

2 Replace FSC lid and DUP complete with adaptor plate onto the FSC in SSW #2 using SPHD #2.

3 Remove isolation valve #1 from SSW #2.

4. Unfasten adaptor plate.

5. Replace isolation valve #1.

6. Remove adaptor plate using SPHD #2.

7. Remove isolation valve #1.

8. Secure lid to the FSC using special tool provided.

9. Replace isolation valve #1.

10. Replace SSW #2 shield plug using SPHD #1.

The CHM individual fuel element grapple can now be exchanged in the glovebox beneath the CLUP for the FSC grapple as follows:

1 Place isolation valve #1 over the CLUP.

2 Transfer the CHM to the CLUP.

3 Remove and bag the individual fuel element grapple in the glovebox beneath the CLUP.

4 Attach the FSC grapple to its raise/lower mechanism.

5 Park the CHM.

6 Transfer isolation valve #1 to SSW #2.

7 Remove SSW #2 shield plug using SPHD #1.

8 Transfer the CHM to SSW #2.

9 Remove the loaded FSC with the CHM.

10 Park the CHM.

11 Replace the shield plug using SPHD #1.

12 Transfer isolation valve #1 to the vault module, FSC storage position.

13 Remove the shield plug using SPHD #1.

14 Place the CHM on the storage position and lower the FSC into place.

15 Remove the CHM and place in the park position.

16 Replace the shield plug using SPHD #1.

The faulty FSC can then be discharged from the MVDS using the CHM through the CLUP for ~~packaging and disposal~~dispositioning.

4.4.5. Utility Supplies and Systems

The utility supplies and systems for the ISFSI facility are electricity, communications, and domestic water as required. The electrical supply is from the 13 -kV distribution line from the Vasquez substation. The domestic water serves the Administration Building only, is not required for operation of the MVDS, and is provided from the Weld County Water District system. Engineering plans and drawings for these systems are maintained.

The MVDS cooling system is passive and does not require electrical power. During transfer cask load/unload operations, the MVDS system requires an electrical power supply for the CHM and TCRB operations. The electrical power source is a 220 kVa 13 kV/480 Volt, three phase padmount transformer supplied by a 13 kV distribution line. Backup power, for security purposes only, is supplied. Loss of electrical power to the MVDS will not degrade safety during normal operations, off-normal operations, and accident conditions.

Table 4.4-1. MVDS Crane Design Parameters.

[Included in the proprietary version of the SAR]

Table 4.4-1. MVDS Crane Design Parameters (continued).

[Included in the proprietary version of the SAR]

Table 4.4-2. MVDS Crane, Limits of Drop.

[Included in the proprietary version of the SAR]

Table 4.4-3. Cask Load/Unload Port Design Parameters.

[Included in the proprietary version of the SAR]

Table 4.4-4. Container Handling Machine Design Parameters.

[Included in the proprietary version of the SAR]

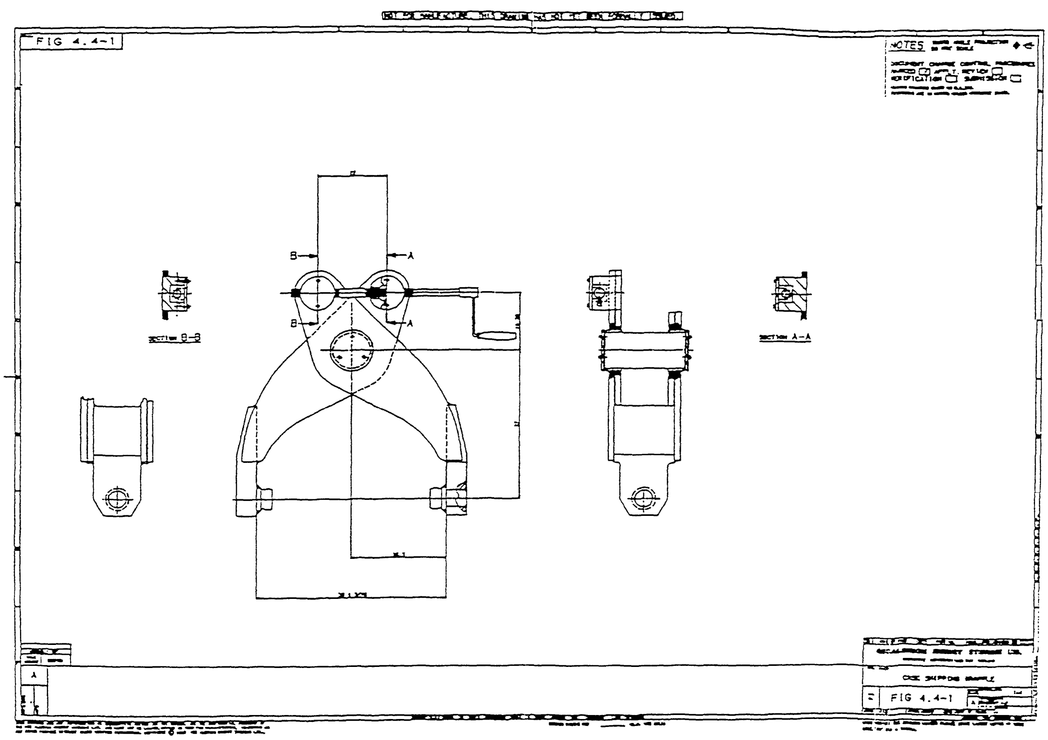

Figure 4.4-1. Cask Shipping Grapple.

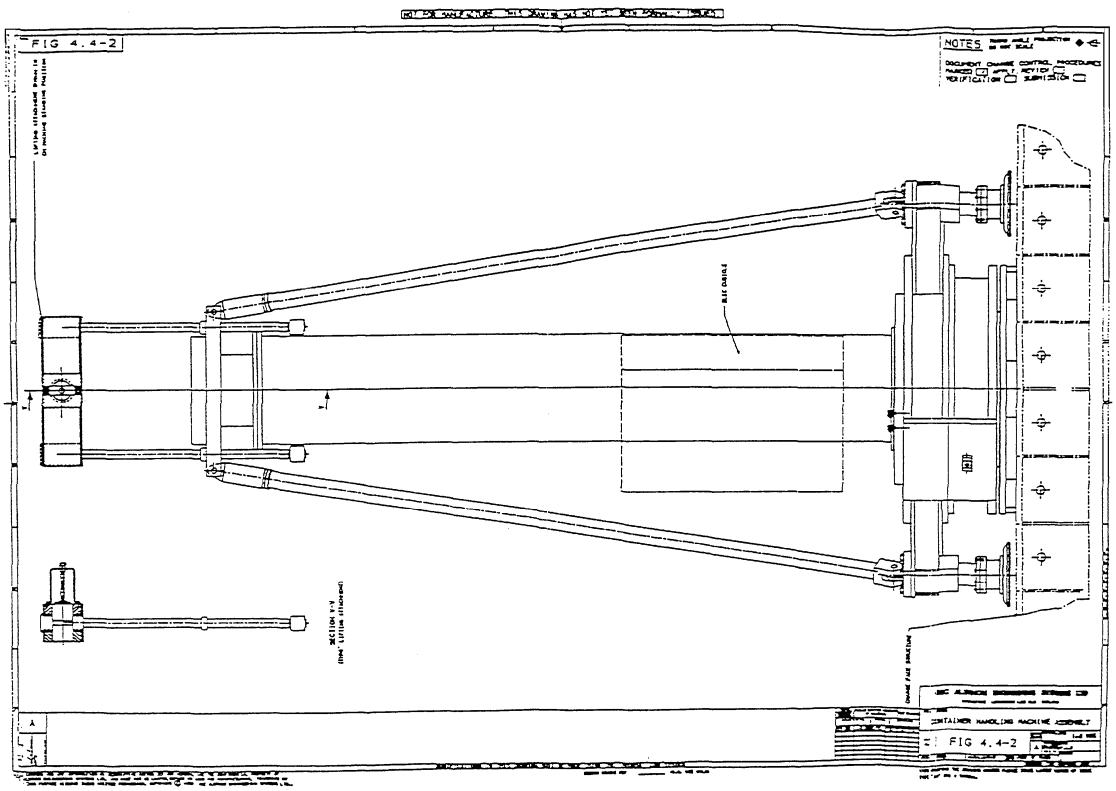

Figure 4.4-2. Container Handling Machine Assembly.

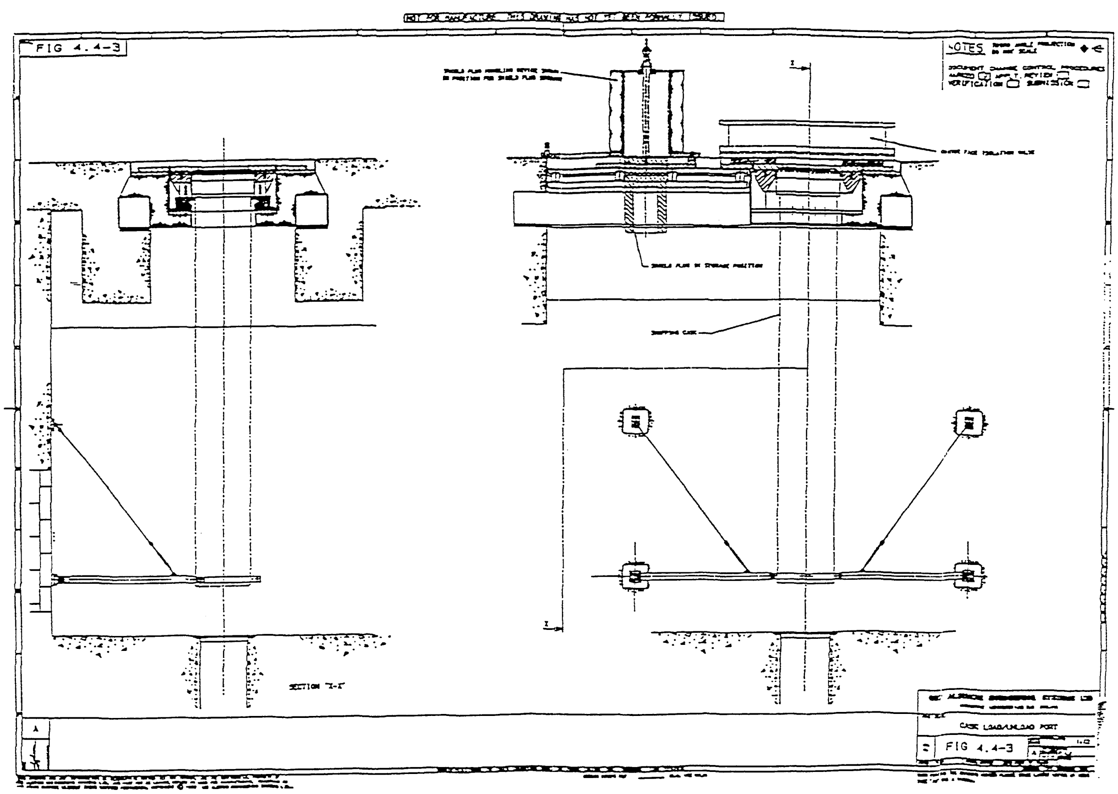

Figure 4.4-3. Cask Load/Unload Port.

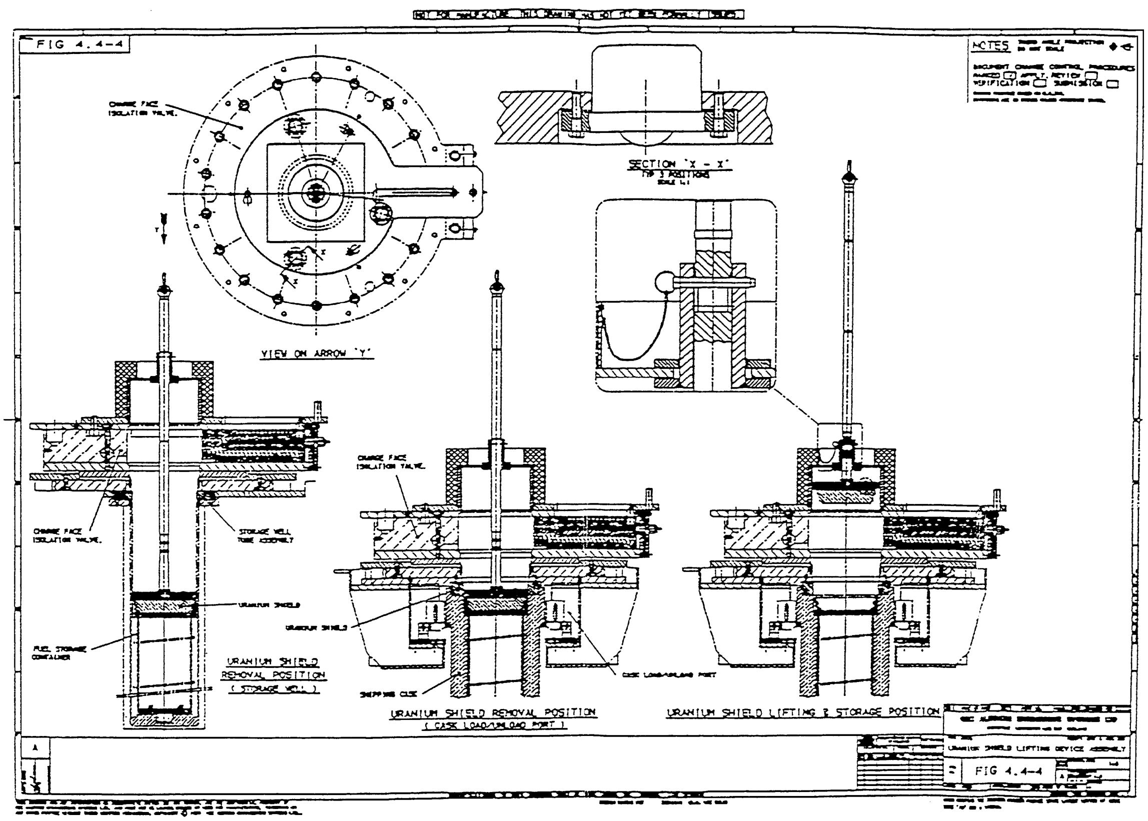

Figure 4.4-4. Uranium Shield Lifting Device Assembly.

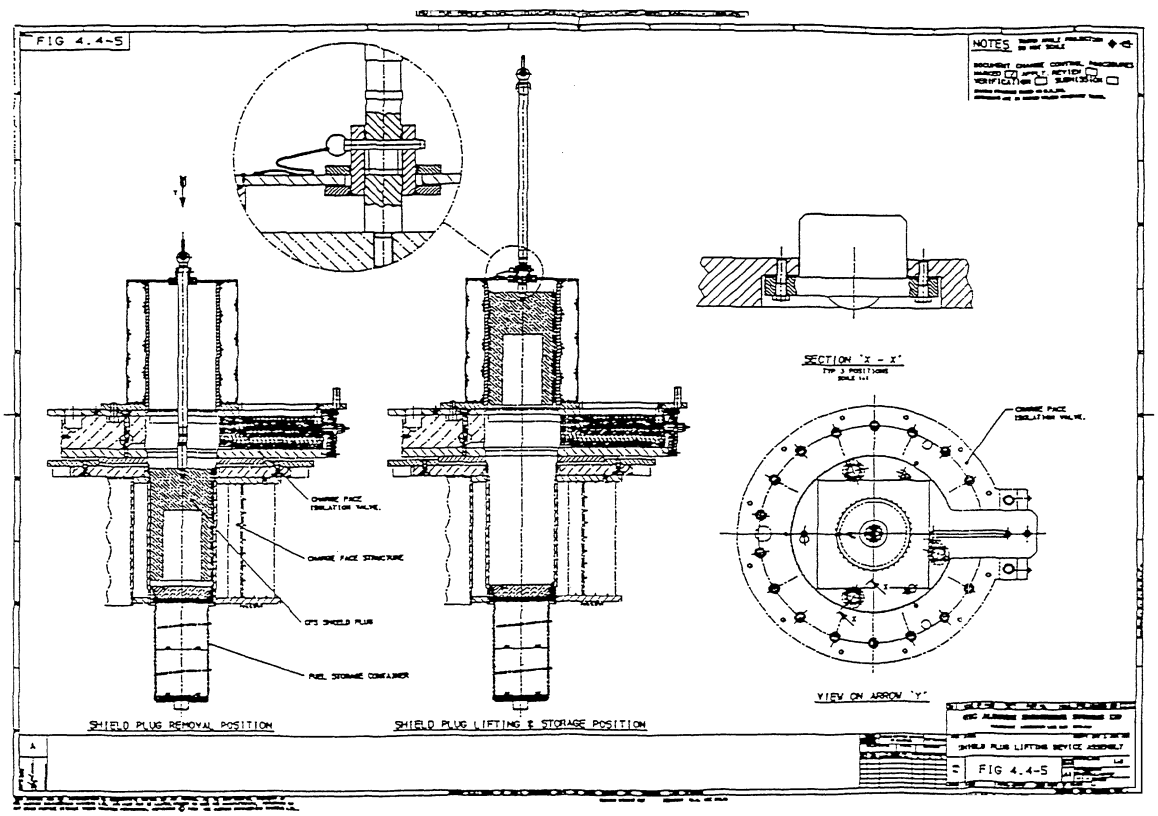

Figure 4.4-5. Shield Plug Lifting Device Assembly.

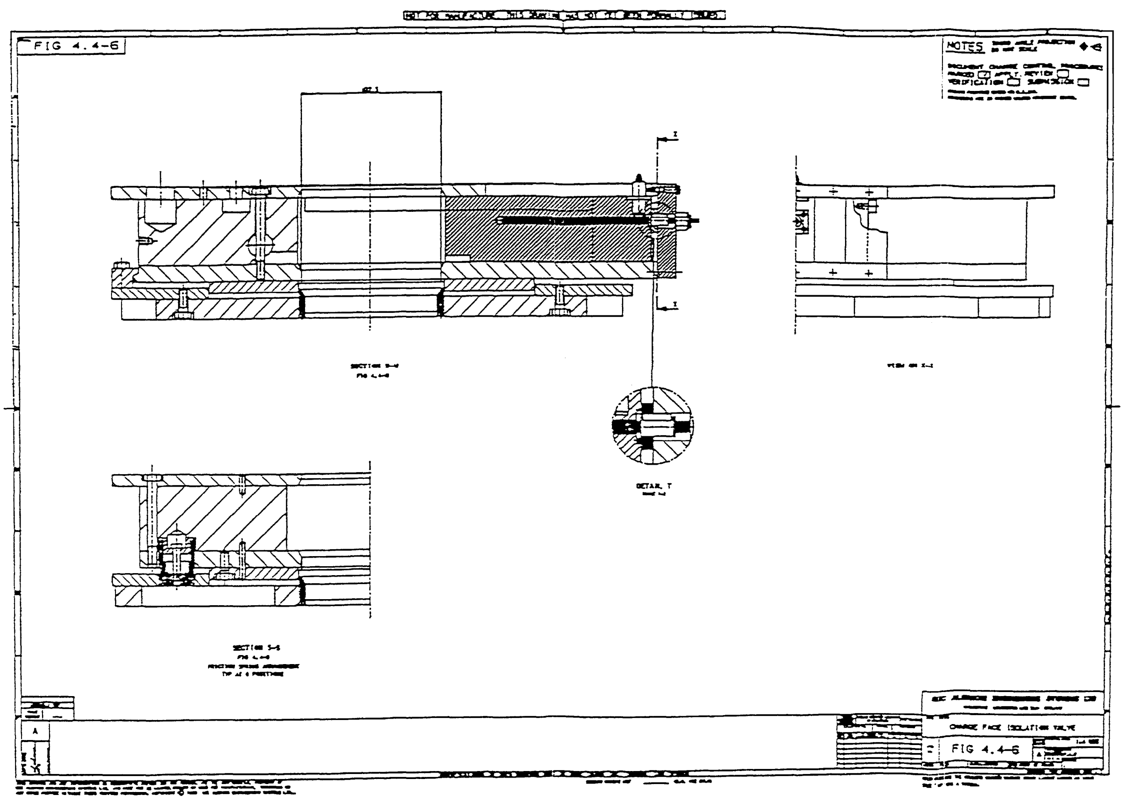

Figure 4.4-6. Charge Face Isolation Valve.

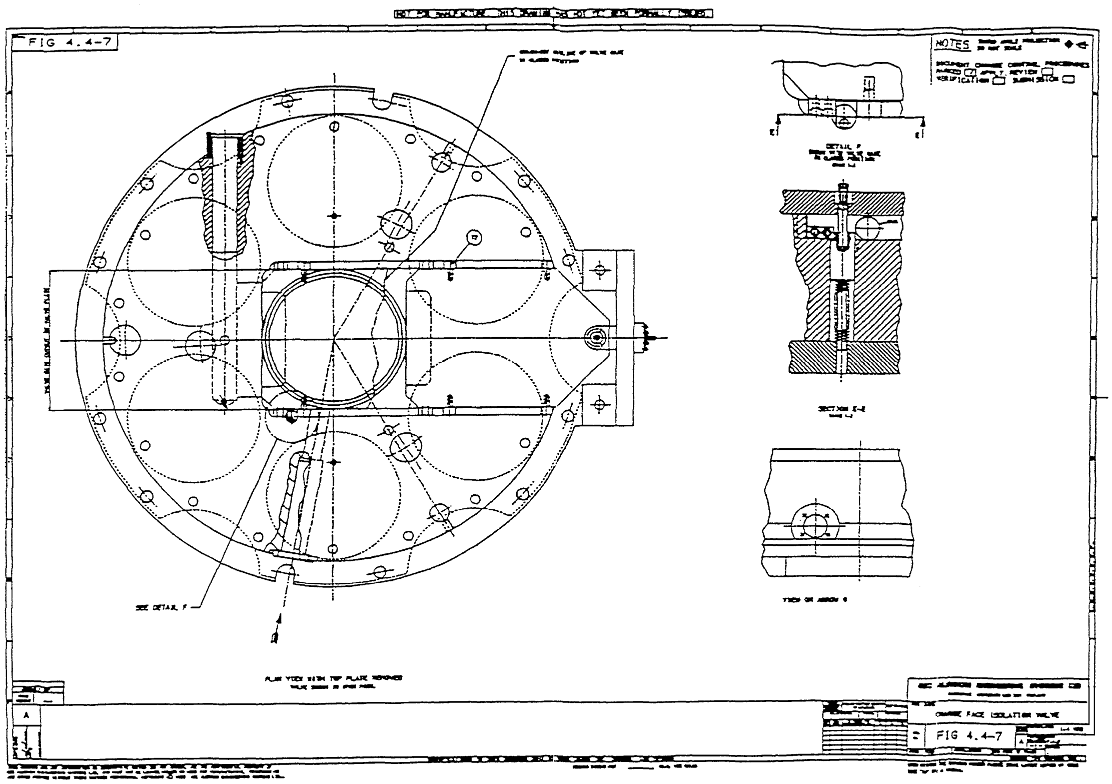

Figure 4.4-7. Charge Face Isolation Valve.

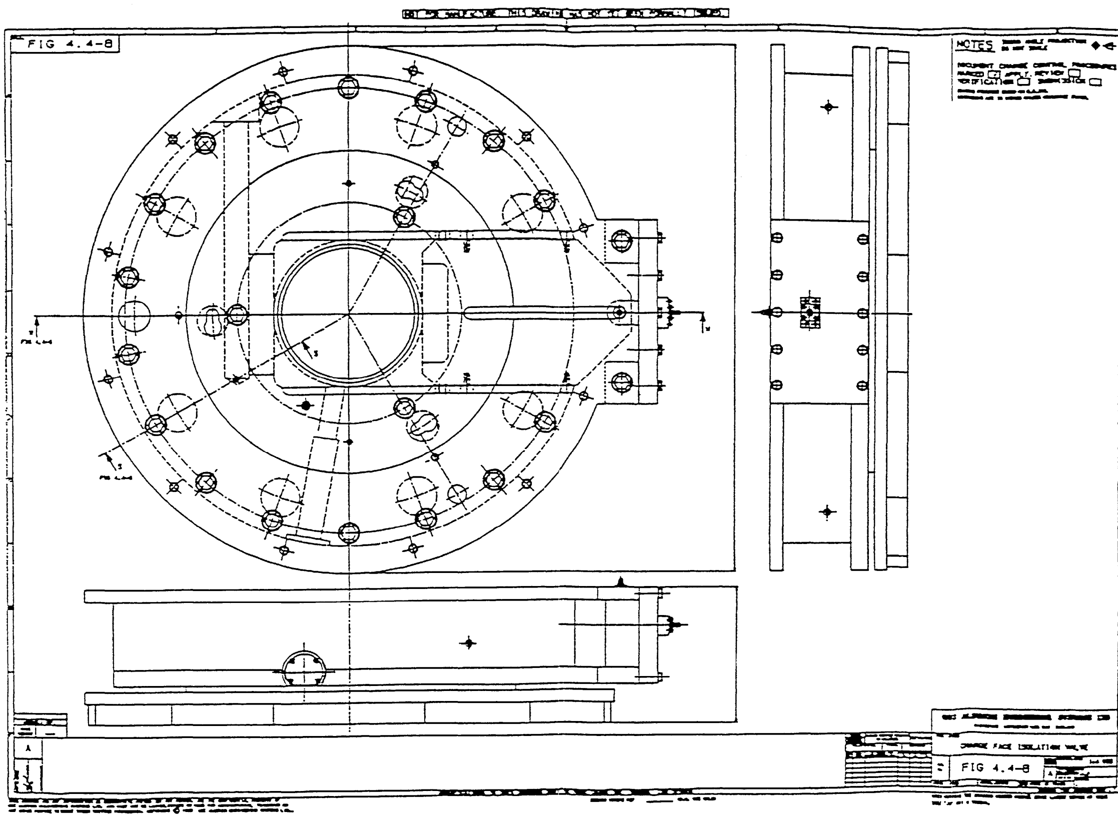

Figure 4.4-8. Charge Face Isolation Valve.

[Included in the proprietary version of the SAR]

Figure 4.4-9. Container Handling Machine Assembly.

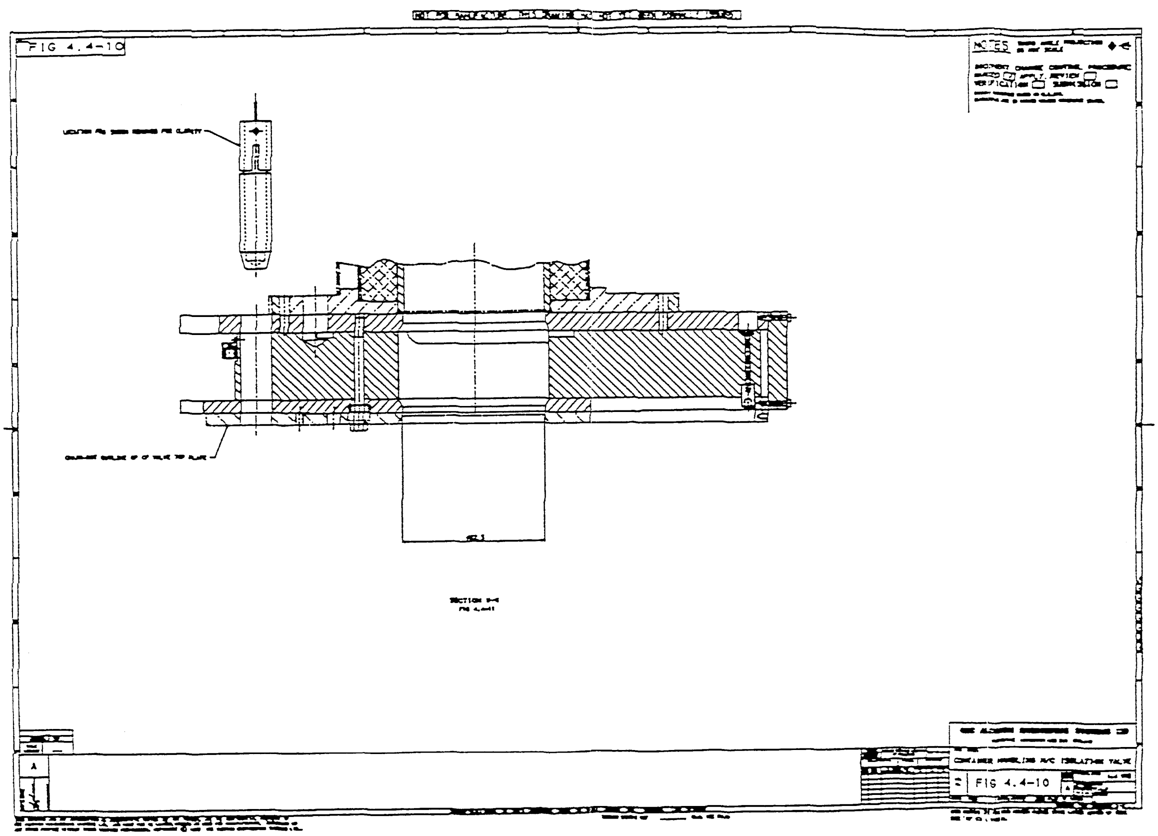

Figure 4.4-10. Container Handling M/C Isolation Valve.

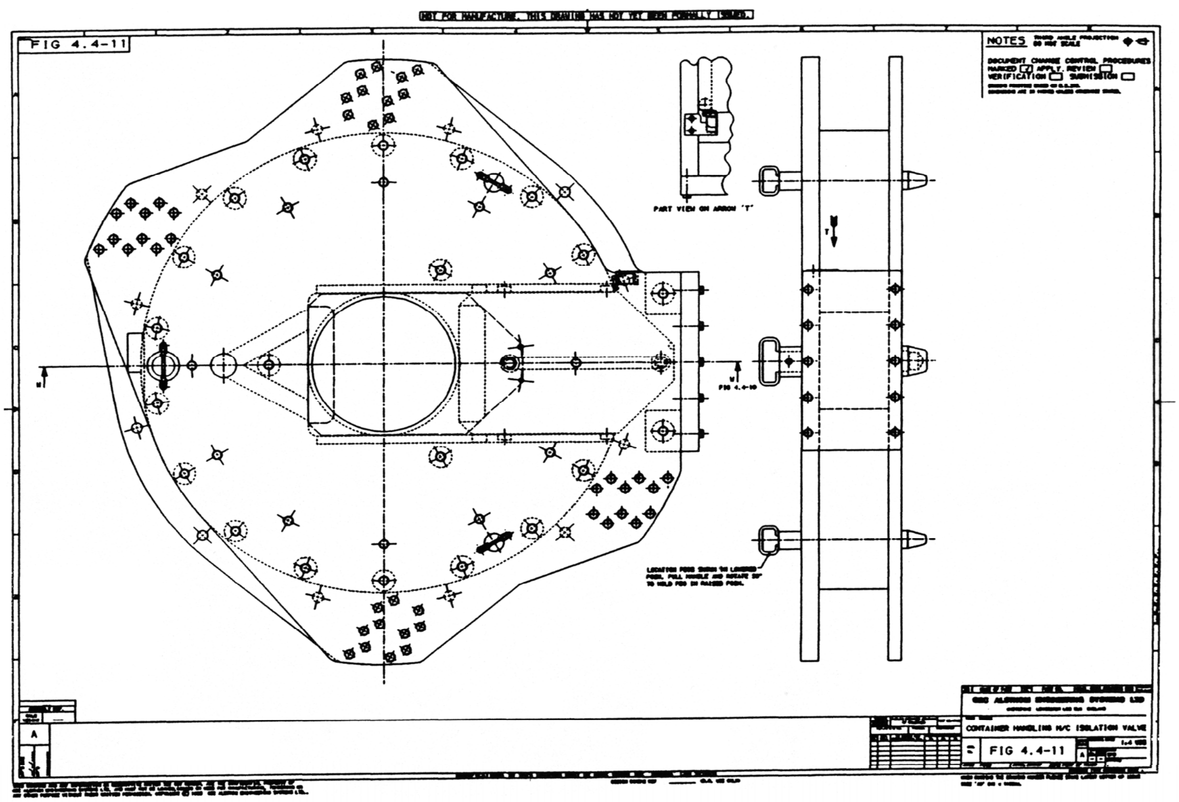

Figure 4.4-11. Container Handling M/C Isolation Valve.

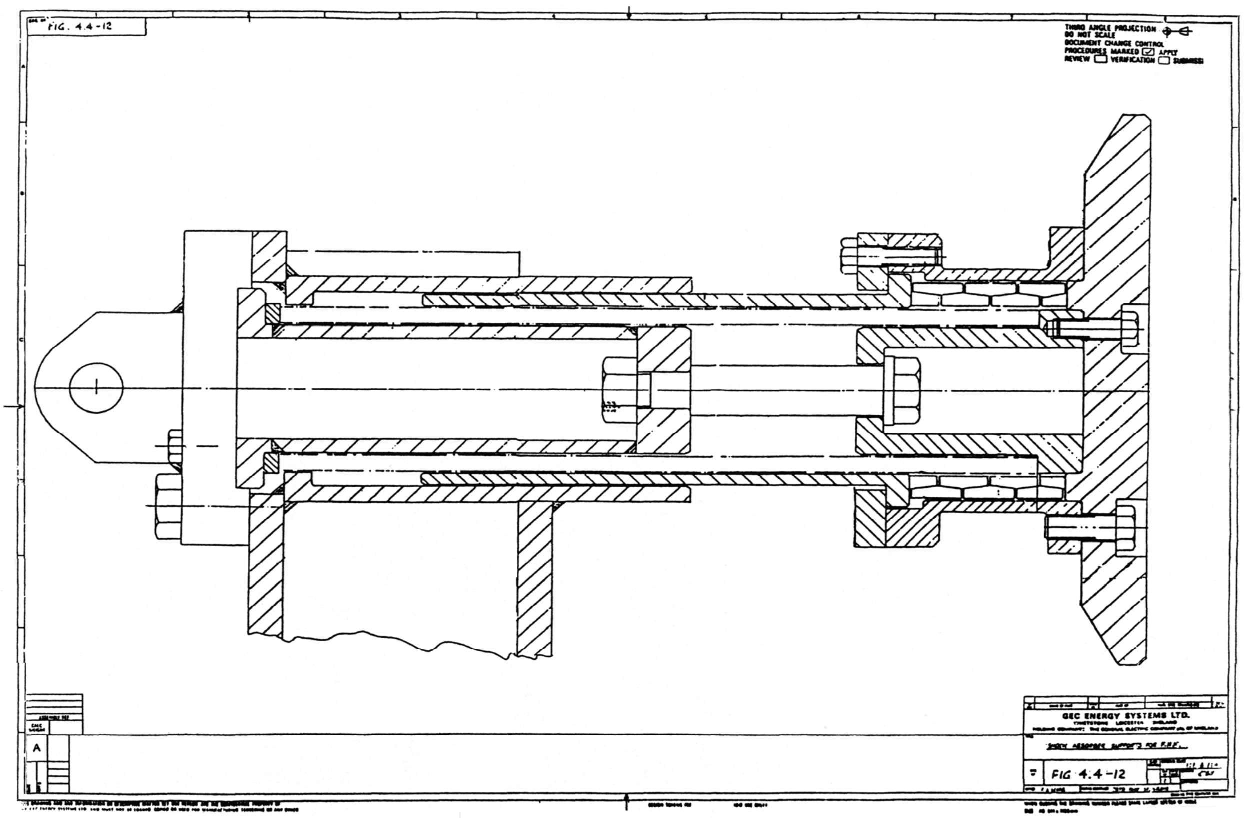

Figure 4.4-12. Shock Absorber Supports For Fuel Handling Machine.

[Included in the proprietary version of the SAR]

Figure 4.4-13. Raise Lower Mechanism.

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Figure 4.4-14. Container Grapple Mods.

[Included in the proprietary version of the SAR]

Figure 4.4-15. Fuel Storage Container Leak Test Equipment.

Figure 4.4-16. THIS FIGURE IS NOT USED

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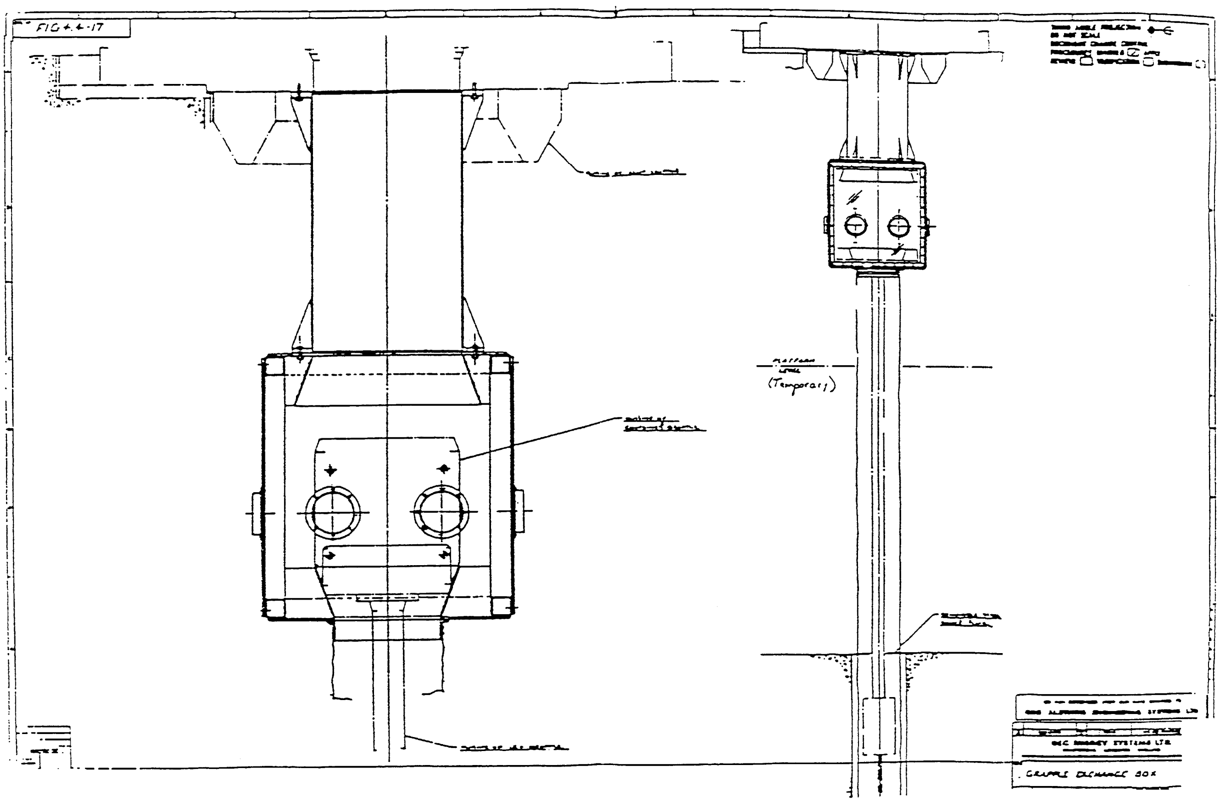

Figure 4.4-17. Grapple Exchange Box.

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4.6. APPENDIX A4-1

STRUCTURAL ANALYSIS OF THE MVDS

[Included in the proprietary version of the SAR]

4.7. APPENDIX A4-2

ANALYSIS OF LOAD/UNLOAD EQUIPMENT

[Included in the proprietary version of the SAR]