SAFETY ANALYSIS REPORT

for the

HOLTEC INTERNATIONAL STORAGE, TRANSPORT
AND REPOSITORY CASK SYSTEM
(HI-STAR 100 CASK SYSTEM)

NRC DOCKET NO. 71-9261

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Prepared by

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STORAGE, TRANSPORT, AND REPOSITORY CASK SYSTEM

(HI-STAR CASK SYSTEM)

SAFETY ANALYSIS REPORT

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CHAPTER 1: GENERAL INFORMATION

1.0 GENERAL INFORMATION

This Safety Analysis Report (SAR) for Holtec International's HI-STAR 100 packaging is a compilation of information and analyses to support a United States Nuclear Regulatory Commission (NRC) licensing review as a spent nuclear fuel transportation package (Docket No. 71-9261) under requirements specified in 10CFR71 [1.0.1] and 49CFR173 [1.0.2]. This SAR supports NRC approval and issuance of Certificate of Compliance No. 9261, issued under the provisions and definitions in 10CFR71, Subpart D, for the design Model: HI-STAR 100 as an acceptable Type B(U)F-85 packaging for transport by exclusive use shipment (10CFR71.47).

The HI-STAR 100 packaging complies with the requirements of 10CFR71 for a Type B(U)F-85 package. The HI-STAR 100 packaging does not have a maximum normal operating pressure (MNOP) greater than 700 kPa (100 lb/in^2). The HI-STAR 100 internal design pressure is specified in Table 2.1.1 as 100 psig to calculate bounding stress values. Section 3.4 calculates the MNOP (reported in Table 3.4.15) and demonstrates that the value remains below the design value specified in Table 2.1.1. No pressure relief device is provided on the HI-STAR 100 containment boundary, as discussed in Subsection 1.2.1.8. Therefore, there is no pressure relief device that would allow the release of radioactive material under the tests specified in 10CFR71.73. Analyses that demonstrate that the HI-STAR 100 packaging complies with the requirements of Subparts E and F of 10CFR71 are provided in this SAR. Specific reference to each section of the SAR that is used to specifically address compliance to 10CFR71 is provided in Table 1.0.2. Therefore, the HI-STAR 100 packaging to transport spent nuclear fuel should be designated B(U)F-85.

The HI-STAR 100 transport index for nuclear criticality control is zero, as an unlimited number of packages is subcritical under the procedures specified in 10CFR71.59(a). Section 6.1 provides the determination of the transport index for nuclear criticality control. The transport index based on radiation is in excess of 10 for the HI-STAR 100 Packaging with design basis fuel contents. Therefore, the HI-STAR 100 Packaging must be transported by exclusive use shipment (10CFR71.47).

The HI-STAR 100 packaging design, fabrication, assembly, and testing shall be performed in accordance with Holtec International's quality assurance program. Holtec International's quality assurance program was originally developed to meet NRC requirements delineated in 10CFR50, Appendix B, and was expanded to include provisions of 10CFR71, Subpart H, and 10CFR72, Subpart G, for structures, systems, and components designated as important to safety. NRC approval of Holtec International's quality assurance program is documented by the Quality Assurance Program Approval for Radioactive material Packages (NRC Form 311), Approval Number 0784, Docket No. 71-0784.

This SAR has been prepared in the format and content suggested in NRC Regulatory Guide 7.9 [1.0.3]. The purpose of this chapter is to provide a general description of the design features and transport capabilities of the HI-STAR 100 packaging including its intended use. This chapter provides a summary description of the packaging, operational features, and contents, and provides reasonable assurance that the package will meet the regulations and operating objectives. Table 1.0.1 contains a listing of the terminology and notation used in preparing this SAR.

This SAR was initially prepared prior to the issuance of the draft version of NUREG-1617 [1.0.5]. To aid NRC review, additional tables and references have been added to facilitate the location of information needed to demonstrate compliance with 10CFR71 as outlined by NUREG-1617. Table 1.0.2 provides a matrix of the 10CFR71 requirements as outlined in NUREG-1617, the format requirements of Regulatory Guide 7.9, and reference to the applicable SAR section(s) that address(es) each topic.

The HI-STAR 100 System is a dual purpose system, certified under 10 CFR 71 and 10 CFR 72. The HI-STAR 100 Final Safety Analysis Report (FSAR) [1.0.6] supports Certificate of Compliance No. 1008 for HI-STAR 100 to store spent nuclear fuel at an Independent Spent Fuel Storage Installation (ISFSI) facility under requirements of 10CFR72, Subpart L [1.0.4] (Docket Number 72-1008).

Within this report, all figures, tables and references cited are identified by the double decimal system m.n.i, where m is the chapter number, n is the section number, and i is the sequential number. Thus, for example, Figure 1.1.1 is the first figure in Section 1.1 of Chapter 1 (which is the next section in this chapter).

Revision of this document to Revision 10 was made on a section level. Therefore, if any change occurs on a page, the entire section was updated to Revision 10. The locations of specific text changes are indicated by revision bars in the margin of the page. Figures are controlled individually at the latest SAR revision level for that particular figure. Sections and figures unchanged in the latest SAR revision indicate the revision level corresponding to the last changes made in the section/figure. Drawings are also controlled individually within the Holtec International drawing control system. The revisions of drawings included in Revision 10 of this SAR are the same as those incorporated by reference into CoC No. 9261, Amendment 2.

Revision 10 of this SAR includes information pertaining to the MPC-32 basket. However, the MPC-32 is not certified for transportation at this time. MPC-32 is under review by the NRC and will be certified in a future CoC amendment.

1.0.1 Engineering Change Orders

The changes authorized by the following Holtec Engineering Change Orders (ECOs) are reflected in Revision 10 of this SAR:

MPC-68/68F: ECOs 1021-1, 3, 4, 7, 8, 13, 14, 16, 18 through 20, 22, 27, 29, 33, 34, 39, 41, 44, 46 through 54, and 56; and 71188-43.

MPC-24/24E/24EF: ECOs 1022-3, 6, 9, 10 through 13, 16, 19, 21 through 24, 26, 28, 35, 37 through 41, 43 through 46, and 48 through 51; and 1135-24 through 26, 28 through 33, 36, 39, and 40.

MPC-32: ECOs 1023-3, 5, 7, 10 through 14, 16, 18 through 21, and 24.

HI-STAR overpack: ECOs 1020-6, 7, 9, 11, 12, 14, 15, 19, 22, 23, 25, 29, 31, 33, 34 through 36, 38, 41 through 43, and 45 through 47; and 71188-31 and 33.

Ancillary Equipment: ECOs 1027-27, 31 and 50.

General FSAR changes: ECOs 5014-36, 49, 54, 57, 62, 67,68, 71, 72, 77, 80, 82, 86 through 88, 91, and 94.

Table 1.0.1

TERMINOLOGY AND NOTATION

ALARA is an acronym for As Low As Reasonably Achievable.

AL-STAR™ is the trademark name of the HI-STAR 100 impact limiter.

Boral is a generic term to denote an aluminum-boron carbide cermet manufactured in accordance with U.S. Patent No. 4027377. The individual material supplier may use another trade name to refer to the same product.

Boral™ means Boral manufactured by AAR Advanced Structures.

BWR is an acronym for boiling water reactor.

C.G. is an acronym for center of gravity.

Commercial Spent Fuel or CSF refers to nuclear fuel used to produce energy in a commercial nuclear power plant.

Containment System Boundary means the enclosure formed by the overpack inner shell welded to a bottom plate and top flange plus the bolted closure plate with dual seals and the vent and drain port plugs with seals. It is also called the primary containment boundary when used with the inner (secondary) containment boundary of the MPC-68F and MPC-24EF.

Containment System means the HI-STAR 100 overpack that forms the containment boundary of the packaging intended to contain the radioactive material during transport.

Cooling Time (or post-irradiation cooling time) for a spent fuel assembly is the time between reactor shutdown and the time the spent fuel assembly is loaded into the MPC.

Damaged Fuel Assembly is a fuel assembly with known or suspected cladding defects, as determined by a review of records, greater than pinhole leaks or hairline cracks, empty fuel rod locations that are not filled with dummy fuel rods, or those that cannot be handled by normal means. Fuel assemblies which cannot be handled by normal means due to fuel cladding damage are considered Fuel Debris.

Damaged Fuel Container (or Canister) means a specially designed enclosure for damaged fuel assemblies or fuel debris which permits gaseous and liquid media to escape while minimizing dispersal of gross solid particulates.

Table 1.0.1 (continued)

TERMINOLOGY AND NOTATION

Enclosure Vessel (or MPC Enclosure Vessel) means the pressure vessel defined by the cylindrical shell, baseplate, port cover plates, lid, closure ring, and associated welds that provides confinement for the helium gas contained within the MPC. The Enclosure Vessel (EV) and the fuel basket together constitute the multi-purpose canister.

Exclusive use means the sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.

FSAR is an acronym for Final Safety Analysis Report (10CFR72).

Fuel Basket means a honeycomb structural weldment with square openings which can accept a fuel assembly of the type for which it is designed.

Fuel Debris is ruptured fuel rods, severed fuel rods, loose fuel pellets, or fuel assemblies with known or suspected defects which cannot be handled by normal means due to fuel cladding damage. Fuel debris also includes certain Trojan plant-specific fuel material contained in Trojan Failed Fuel Cans.

HI-STAR 100 overpack or overpack means the cask that receives and contains the sealed multi-purpose canisters containing spent nuclear fuel. It provides the containment boundary for radioactive materials, gamma and neutron shielding, and a set of lifting trunnions for handling. Certain overpack models also include optional pocket trunnions for upending and downending.

HI-STAR 100 System or HI-STAR 100 Packaging consists of the MPC sealed within the HI-STAR 100 overpack with impact limiters installed.

Holtite™ is the trade name for all present and future neutron shielding materials formulated under Holtec International's R&D program dedicated to developing shielding materials for application in dry storage and transport systems. The Holtite development program is an ongoing experimentation effort to identify neutron shielding materials with enhanced shielding and temperature tolerance characteristics. Holtite-A™ is the first and only shielding material qualified under the Holtite R&D program. As such, the terms Holtite and Holtite-A may be used interchangeably throughout this SAR.

Holtite™-A is a trademarked Holtec International neutron shield material.

Table 1.0.1 (continued)

TERMINOLOGY AND NOTATION

Impact Limiter means a set of fully-enclosed energy absorbers that are attached to the top and bottom of the overpack during transport. The impact limiters are used to absorb kinetic energy resulting from normal and hypothetical accident drop conditions. The HI-STAR impact limiters are called AL-STAR.

Important to Safety (ITS) means a function or condition required to transport spent nuclear fuel safely; to prevent damage to spent nuclear fuel, and to provide reasonable assurance that spent nuclear fuel can be received, handled, packaged, transported, and retrieved without undue risk to the health and safety of the public.

Intact Fuel Assembly is defined as a fuel assembly without known or suspected cladding defects greater than pinhole leaks and hairline cracks, and which can be handled by normal means. Fuel assemblies without fuel rods in fuel rod locations shall not be classified as Intact Fuel Assemblies unless dummy fuel rods are used to displace an amount of water greater than or equal to that displaced by the original fuel rod(s).

Load-and-Go is a term used in this SAR that means the practice of loading spent fuel into the HI-STAR 100 System packaging and placing the packaging into transportation service under 10 CFR 71, without first deploying the system at an Independent Spent Fuel Storage Installation (ISFSI) under 10 CFR 72.

Maximum Normal Operating Pressure (MNOP) means the maximum gauge pressure that would develop in the containment system in a period of 1 year under the heat condition specified in 10CFR71.71(c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

Maximum Reactivity means the highest possible k-effective including bias, uncertainties, and calculational statistics evaluated for the worst-case combination of fuel basket manufacturing tolerances.

MGDS is an acronym for Mined Geological Depository System.

MPC Fuel Basket means the honeycombed composite cell structure utilized to maintain subcriticality of the spent nuclear fuel. The number and size of the storage cells depends on the type of spent nuclear fuel to be transported. Each MPC fuel basket has sheathing welded to the storage cell walls for retaining the Boral neutron absorber. Boral is a commercially-available thermal neutron poison material composed of boron carbide and aluminum.

Multi-Purpose Canister (MPC) means the sealed canister consisting of a honeycombed fuel basket for spent nuclear fuel storage, contained in a cylindrical canister shell (the MPC Enclosure Vessel). There are different MPCs with different fuel basket geometries for storing PWR or BWR fuel. All MPCs except the Trojan plant MPCs have identical exterior dimensions. The Trojan plant MPCs have the same outside diameter, but are approximately nine inches shorter than the generic MPC

Table 1.0.1 (continued)

TERMINOLOGY AND NOTATION

design. MPC is an acronym for multi-purpose canister. The MPCs used as part of the HI-STAR 100 Packaging are identical to the MPCs authorized for use in the HI-STAR 100 Storage (Docket No. 72-1008) and HI-STORM 100 Storage (72-1014) [1.0.7] CoCs to the extent that the particular MPC models are authorized for use under both CoCs.

Neutron Shielding means Holtite, a material used in the overpack to thermalize and capture neutrons emanating from the radioactive spent nuclear fuel.

Neutron Sources means specially designed inserts for fuel assemblies that produce neutrons for startup of the reactor. The specific types of neutron sources authorized for transportation in the HI-STAR 100 System are discussed in Section 1.2.3.

Non-fuel Hardware, or NFH, means Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Devices (TPDs), Control Rod Assemblies (CRAs), Axial Power Shaping Rods (APSRs), Wet Annular Burnable Absorbers (WABAs), Rod Cluster Control Assemblies (RCCAs), Control Element Assemblies (CEAs),water displacement guide tube plugs, orifice rod assemblies, and vibration suppressor inserts. The specific types of NFH authorized for transportation in the HI-STAR 100 System are discussed in Section 1.2 of this SAR.

Packaging means the HI-STAR 100 System consisting of a single HI-STAR 100 overpack, a set of impact limiters, and a multi-purpose canister (MPC). It excludes all lifting devices, rigging, transporters, saddle blocks, welding machines, and auxiliary equipment (such as the drying and helium backfill system) used during fuel loading operations and preparation for off-site transportation.

Package means the HI-STAR 100 System plus the licensed radioactive contents loaded for transport.

Planar-Average Initial Enrichment is the average of the distributed fuel rod initial enrichments within a given axial plane of the assembly lattice.

PWR is an acronym for pressurized water reactor.

Reactivity is used synonymously with effective multiplication factor or k-effective.

SAR is an acronym for Safety Analysis Report (10CFR71).

Secondary Containment Boundary means the Enclosure Vessel of the "F" model MPC. The secondary containment boundary of the "F" model MPC provides the separate inner container for the transport of fuel debris. The "F" model MPC, in conjunction with the overpack containment system boundary, is designed to meet the double barrier requirement of 10CFR71.63(b) for plutonium shipments.

Table 1.0.1 (continued)

TERMINOLOGY AND NOTATION

Single Failure Proof means that the handling system is designed so that a single failure will not result in the loss of the capability of the system to safely retain the load.

SNF is an acronym for spent nuclear fuel.

STP is Standard Temperature (298°K) and Pressure (1 atm) conditions.

Transport index means the dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined for fissile material packages as the number determined by multiplying the maximum radiation level in millisievert per hour at one meter (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 ft)), or, for criticality control purposes, the number obtained as described in 10CFR71.59, whichever is larger.

Trojan Damaged Fuel Container (or Canister) is a Holtec damaged fuel container custom-designed for Trojan plant damaged fuel and fuel debris. Trojan plant damaged fuel and fuel debris not loaded into a Trojan Failed Fuel Can must be loaded into a Trojan Damaged Fuel Container.

Trojan Failed Fuel Can (FFC) is a non-Holtec designed Trojan plant-specific damaged fuel container that may be loaded with Trojan plant damaged fuel assemblies, Trojan fuel assembly metal fragments (e.g., portions of fuel rods, grid assemblies, bottom nozzles, etc.), a Trojan fuel rod storage container, a Trojan Fuel Debris Process Can Capsule, or a Trojan Fuel Debris Process Can.

Trojan Failed Fuel Can Spacer is a square, structural steel tube with a baseplate designed to be placed inside one Trojan Failed Fuel Can to occupy any space between the top of the contents and the top of the FFC in order to minimize movement of the FFC contents during transportation.

Trojan Fuel Debris Process Can is a Trojan plant-specific canister containing fuel debris (metal fragments) and was used to process organic media removed from the Trojan plant spent fuel pool during cleanup operations in preparation for spent fuel pool decommissioning. Trojan Fuel Debris Process Cans are loaded into Trojan Fuel Debris Process Can Capsules or directly into Trojan Failed Fuel Cans.

Trojan Fuel Debris Process Can Capsule is a Trojan plant-specific canister that contains up to five Trojan Fuel Debris Process Cans and is vacuumed, purged, backfilled with helium, and then seal-welded closed.

ZR means any zirconium-based fuel cladding material authorized for use in a commercial nuclear power plant reactor. Any reference to Zircaloy fuel cladding in this SAR applies to any zirconium-based fuel cladding material.

Table 1.0.2

HI-STAR 100 SAR CORRELATION WITH 10CFR71 AND REGULATORY GUIDE 7.9

RG 7.9 Section	10CFR Part 71 Section	HI-STAR SAR Section
1.1	71.31(a)(1), 71.31(a)(2), 71.31(a)(3), 71.31(c), 71.33(a)(1), 71.33(a)(3), 71.35(b), 71.37, 71.59	1.0, 1.1, 1.2, 1.5
1.2	71.31(a)(1), 71.33(a)(2), 71.33(a)(4), 71.33(a)(5), 71.33(a)(6), 71.33(b), 71.43(b)	1.2, 1.3, 1.4
None	71.31(a)(2), 71.35(a), 71.41(a)	1.5
1.3	None	Appendices 1.A, 1.B, and 1.C
2.1, 2.2	71.31(a)(1), 71.31(c), 71.33	2.1, 2.2
2.3, 2.4	71.43(d)	2.3, 2.4
2.5	71.45	2.5
2.6, 2.7	71.31(a)(2), 71.35(a), 71.41(a), 71.61, 71.71, 71.73	2.6, 2.7
2.6	71.35(a), 71.41(a), 71.43(f), 71.51(a)(1), 71.55(d)(4), 71.71	2.6
2.7	71.35(a), 71.41(a), 71.73	2.7
None	71.61	2.7
None	71.85(b)	8.1.2.2
2.10	None	2.10
3.1	71.31(a)(1), 71.31(c), 71.33(a)(5), 71.33(a)(6), 71.33(b)(1), 71.33(b)(3), 71.33(b)(5), 71.33(b)(7), 71.33(b)(8), 71.51(c)	Chapters 1 & 2, Sections 3.0, 3.1, 3.4, 3.6
3.2, 3.3	71.31(a)(1), 71.33(a)(5)	Chapters 1 & 2, Sections 3.0, 3.1, 3.4, 3.6
None	71.31(a)(2), 71.35(a), 71.41(a)	3.0, 3.1, 3.4, 3.5, 3.6
None	71.43(g)	3.0, 3.4, 3.6
3.4	71.43(f), 71.51(a)(1), 71.71	3.0, 3.4, 3.6
3.5	71.73	3.0, 3.5, 3.6
3.6	None	N/A
4.1	71.31(a)(1), 71.31(c), 71.33(a)(4), 71.33(a)(5), 71.33(b)(1), 71.33(b)(3), 71.33(b)(5), 71.33(b)(7), 71.43(c), 71.43(d), 71.43(e)	4.0, 4.1, 4.2, 4.3
4.2	71.31(a)(2), 71.35(a), 71.41(a), 71.43(f), 71.43(h), 71.51(a)(1), 71.51(c)	4.2, 4.3

Table 1.0.2 (continued)

HI-STAR 100 SAR CORRELATION WITH 10CFR71 AND REGULATORY GUIDE 7.9

RG 7.9 Section	10CFR Part 71 Section	HI-STAR SAR Section
4.3	71.31(a)(2), 71.35(a), 71.41(a), 71.51(a)(2), 71.51(c)	4.2, 4.3
4.4	71.63	4.2, 4.3, 7.1
4.5	None	-
5.1	71.31(a)(1), 71.31(c), 71.33(a)(5)	5.1
5.2	71.31(a)(1), 71.33(b)(1), 71.33(b)(2), 71.33(b)(3)	5.2
5.3	71.31(a), 71.31(b)	5.3
5.4	71.31(a)(2), 71.35(a), 71.41(a), 71.43(f), 71.47(b), 71.51(a)(1), 71.51(a)(2)	5.1, 5.4, 5.5
5.5	None	Appendices 5.A, 5.B, 5.C
6.1	71.31(a)(1), 71.31(c), 71.33(a)(5), 71.35(b), 71.59(b)	6.1
6.2	71.31(a)(1), 71.33(b)(1), 71.33(b)(2), 71.33(b)(3), 71.83	6.2
6.3	71.31(a)(2), 71.35(a), 71.41(a)	6.3
6.4	71.35, 71.43(f), 71.51(a)(1), 71.55(b), 71.55(d), 71.55(e), 71.59	6.4
6.5	71.31(a)(2), 71.35	6.5, Appendix 6.A
6.6	None	6.2, 6.4, Appendices 6.B, 6.C, 6.D
7.1	71.31(c), 71.35(c), 71.43(g), 71.47(b), 71.47(c), 71.47(d), 71.87, 71.89	7.4, 7.1.3, 7.1.7
7.2	71.35(c)	7.1.7
7.3	71.87(i)	7.1.7
None	71.35(c)	7.1.7
7.4	None	-
8.1	71.31(c), 71.37(b), 71.85(a), 71.85(b), 71.85(c), 71.87(g), 71.93(b)	8.1
8.2	71.31(c), 71.37(b), 71.87(b), 71.87(g), 71.93(b)	8.2

Notes:

"-" There is no HI-STAR SAR section that addresses this.

1.1 INTRODUCTION

HI-STAR 100 (acronym for Holtec International Storage, Transport and Repository) is a spent nuclear fuel (SNF) packaging designed to be in general compliance with the U.S. Department of Energy's (DOE) original design procurement specifications for multi-purpose canisters and large transportation casks [1.1.1], [1.1.2].

The HI-STAR 100 System consists of a sealed, metal multi-purpose canister, herein abbreviated as the "MPC", contained within an overpack with impact limiters. Figure 1.1.1 provides a pictorial view of the HI-STAR 100 System. The HI-STAR 100 System is designed to accommodate a wide variety of spent fuel assemblies in a single overpack design by utilizing different MPC basket designs. The exterior dimensions of all MPCs (except the custom-designed Trojan plant MPCs) are identical to allow the use of a single overpack design. The Trojan plant MPCs are approximately nine inches shorter than the generic Holtec MPC design and have the same outer diameter. Each of the MPCs has different design features (e.g., fuel baskets) to accommodate distinct fuel characteristics. Each MPC is identified by the maximum quantity of fuel assemblies it is capable of receiving. The MPC-24, -24E, and -24EF each can contain a maximum of 24 PWR assemblies; the MPC-32 can contain up to 32 PWR assemblies; and the MPC-68 and -68F each can contain a maximum of 68 BWR fuel assemblies. Figure 1.1.2 depicts the HI-STAR 100 with two of its major constituents, the MPC and the overpack, in a cutaway view. This view does not include depiction of the spacer required for the Trojan version of the MPC-24E/EF design, which is shorter than the Holtec generic MPC-24E/EF design. The spacer is required for the shorter MPC to ensure the design characteristics of the HI-STAR 100 System (e.g., center-of-gravity, MPC lid-to-overpack closure plate gap, etc.) remain bounded by the supporting analyses. See Figure 1.1.5 for a depiction of the Trojan MPC spacer. A drawing of the Trojan MPC spacer is also included in Section 1.4. A summary of the qualification of the spacer for performing its design function is provided in Section 2.7.1.1.

Figure 1.1.2 also indicates that the overpack pocket trunnions are optional appurtenances. Overpack serial numbers 1020-001 through 1020-007 include the pocket trunnions, while later serial number overpacks do not. The impact of this design change on vehicle tie down methods and qualification analyses are discussed in Section 2.5 of this SAR. The pocket trunnions are not part of the qualified vehicle tie-down system for the package. Figure 1.1.3 provides an elevation cross sectional view of an MPC, and Figure 1.1.4 contains an elevation cross sectional view of the HI-STAR 100 overpack.

The HI-STAR 100 System is designed for both storage and transport. The HI-STAR 100 System's multi-purpose design reduces SNF handling operations and thereby enhances radiological protection. Once SNF is loaded and the MPC and overpack are sealed, the HI-STAR 100 System can be positioned on site for temporary or long-term storage or transported directly off-site. The HI-STAR 100 System's ability to both store and transport SNF eliminates repackaging.

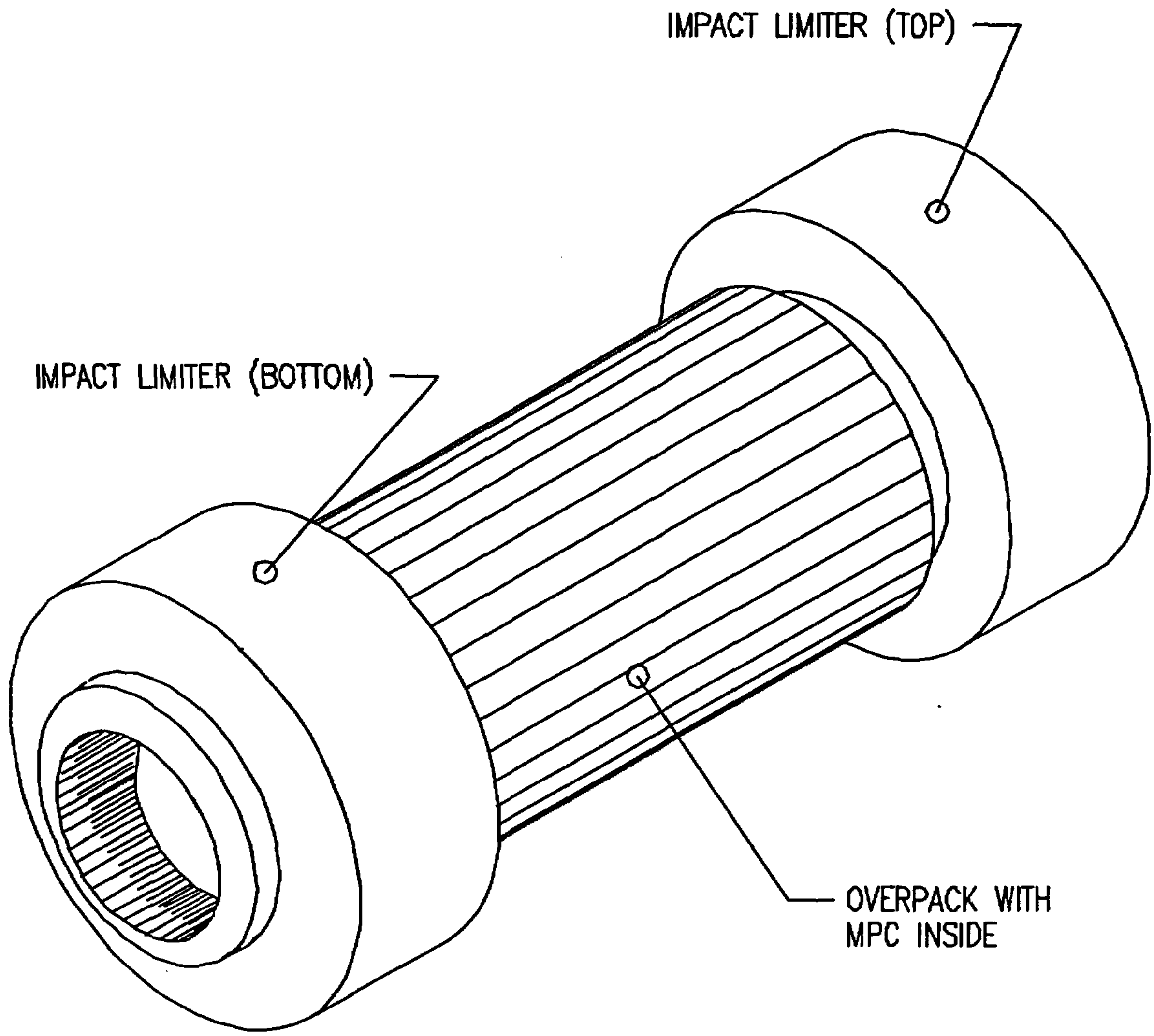

FIGURE 1.1.1; PICTORIAL VIEW OF HI-STAR 100 PACKAGE

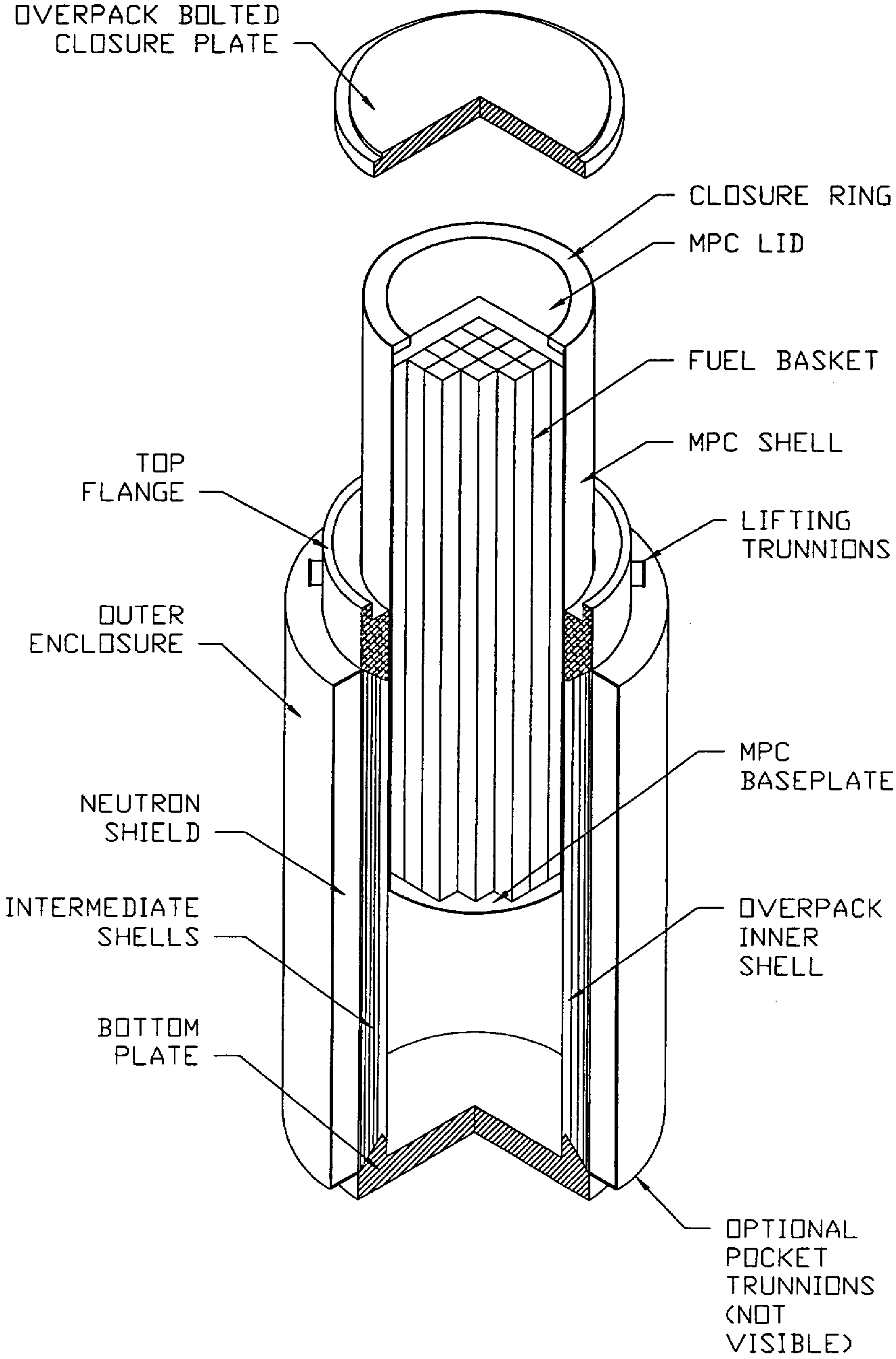

FIGURE 1.1.2; HI-STAR 100 OVERPACK WITH MPC PARTIALLY INSERTED

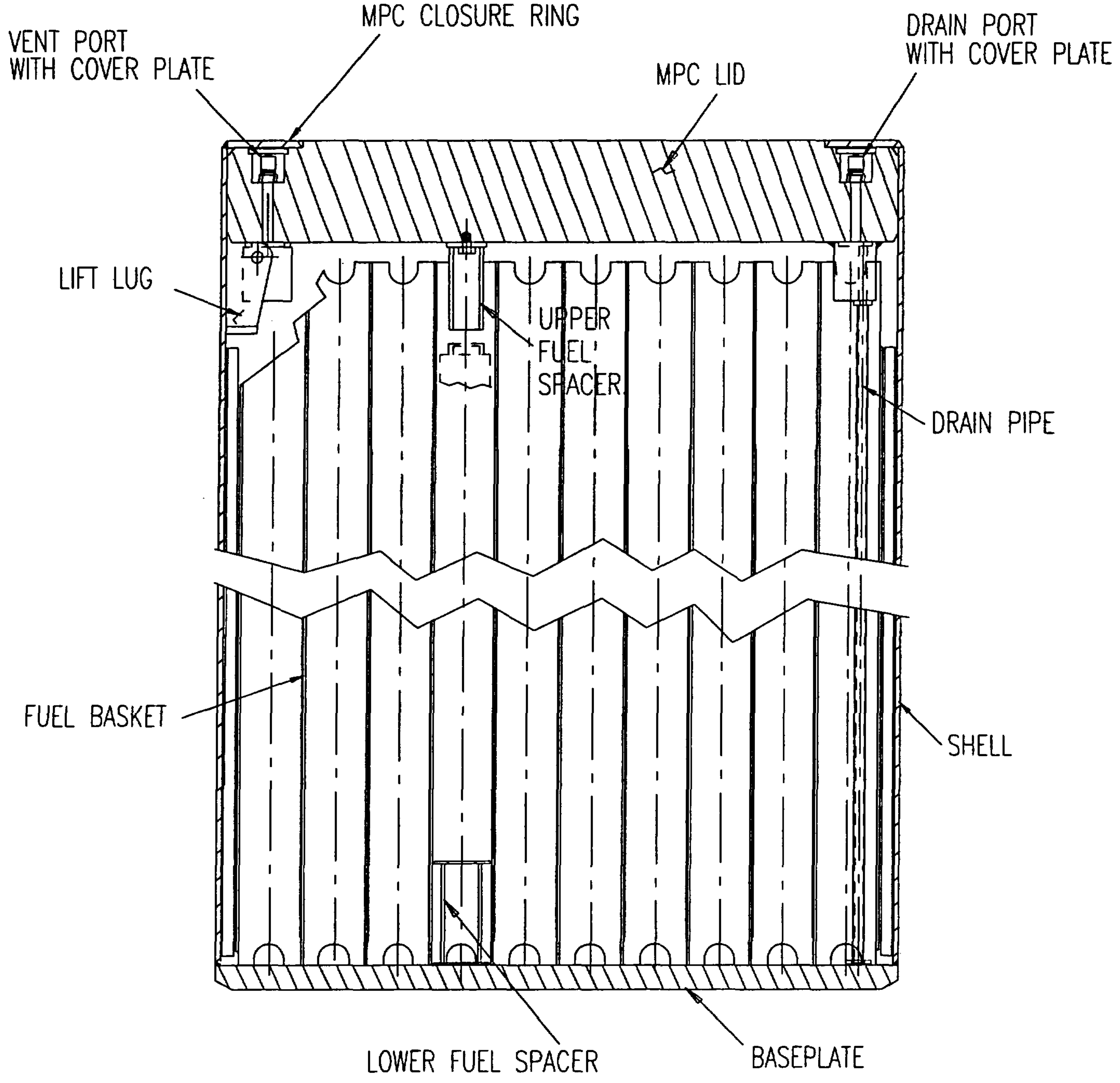

FIGURE 1.1.3; CROSS SECTION ELEVATION VIEW OF MPC

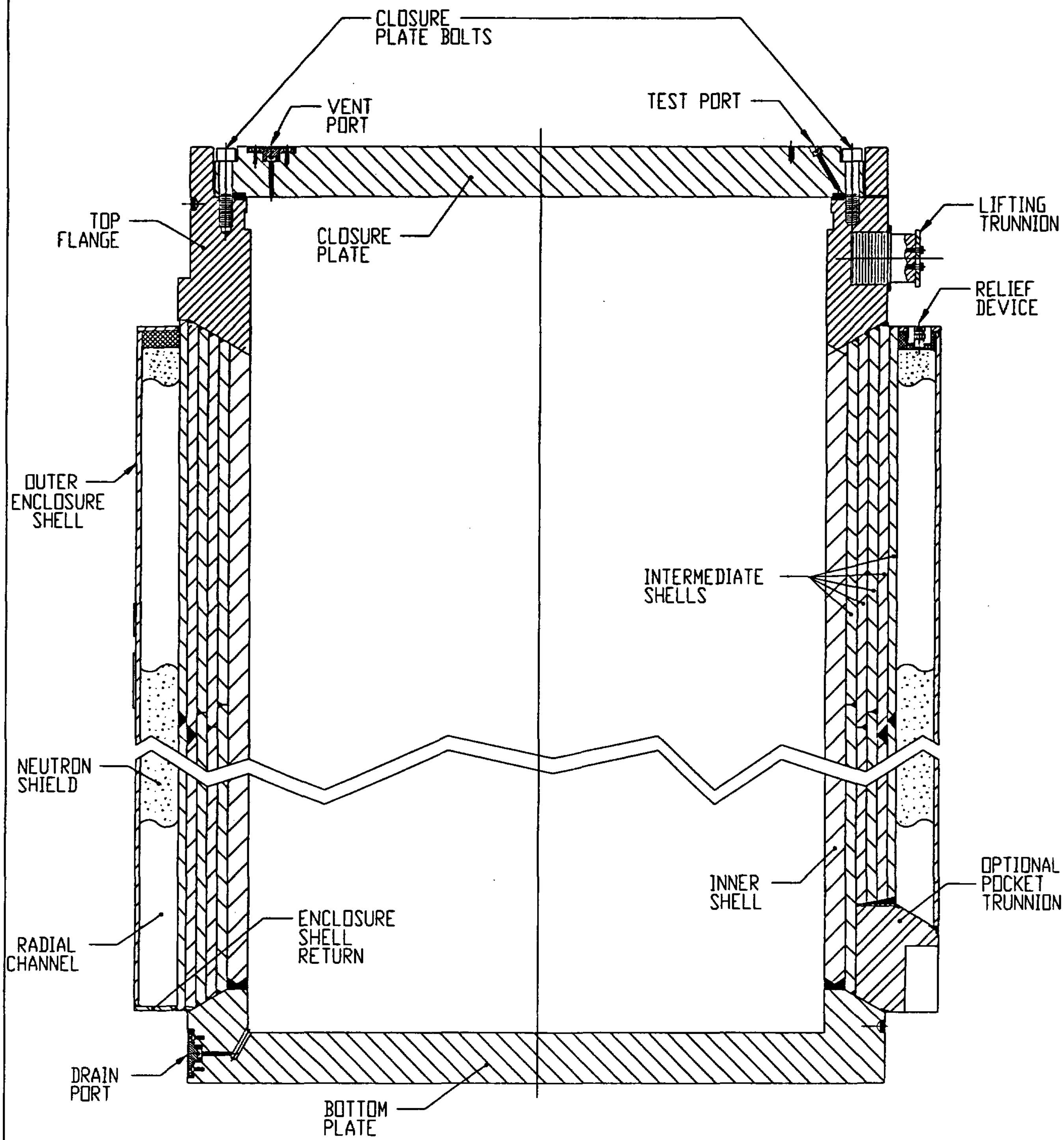

FIGURE 1.1.4; CROSS SECTION ELEVATION VIEW OF OVERPACK

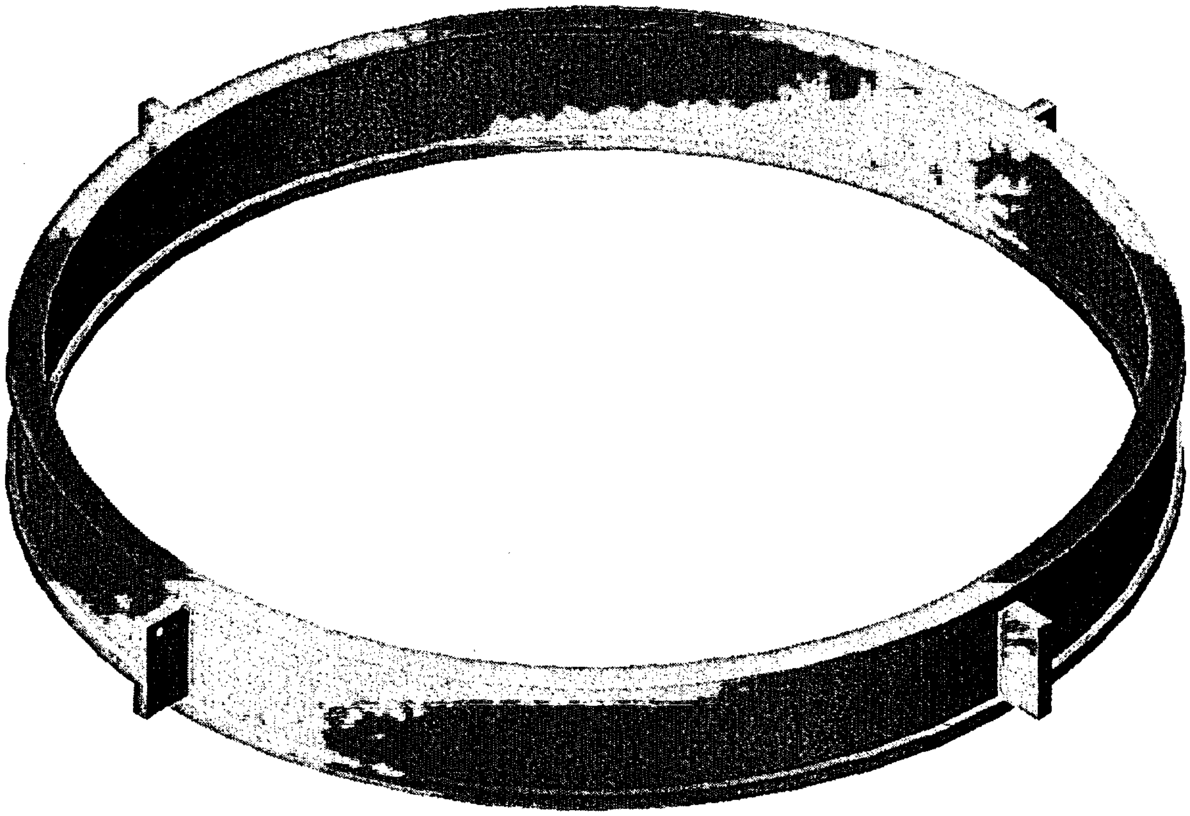

FIGURE 1.1.5; TROJAN MPC SPACER

1.2 PACKAGE DESCRIPTION

1.2.1 Packaging

The HI-STAR 100 System consists of an MPC designed for BWR or PWR spent nuclear fuel, an overpack that provides the containment boundary and a set of impact limiters that provide energy absorption capability for the normal and hypothetical accident conditions of transport. Each of these components is described below, including information with respect to component fabrication techniques and designed safety features. This discussion is supplemented by a set of drawings in Section 1.4. Section 1.3 provides the HI-STAR 100 design code applicability and details any alternatives to the ASME Code.

Before proceeding to present detailed physical data on HI-STAR 100, it is contextual to summarize the design attributes that set it apart from the prior generation of spent fuel transportation packages.

There are several features in the HI-STAR 100 System design that increase its effectiveness with respect to the safe transport of spent nuclear fuel (SNF). Some of the principal features of the HI-STAR 100 System that enhance its effectiveness are:

- the honeycomb design of the MPC fuel basket
- the effective distribution of neutron and gamma shielding materials within the system
- the high heat rejection capability
- the structural robustness of the multi-shell overpack construction

The honeycomb design of the MPC fuel baskets renders the basket into a multi-flanged plate weldment where all structural elements (box walls) are arrayed in two orthogonal sets of plates. Consequently, the walls of the cells are either completely coplanar (no offset) or orthogonal with each other. There is complete edge-to-edge continuity between contiguous cells.

Among the many benefits of the honeycomb construction is the uniform distribution of the metal mass over the body of the basket (in contrast to the "box and spacer disk" construction where the support plates are localized mass points). Physical reasoning suggests that a uniformly distributed mass provides a more effective shielding barrier than can be obtained from a nonuniform (box and spacer disk) basket. In other words, the honeycomb basket is a more effective radiation attenuation device.

The complete cell-to-cell connectivity inherent in the honeycomb basket structure provides an uninterrupted heat transmission path, making the HI-STAR 100 MPC an effective heat rejection device.

The multi-layer shell construction in the overpack provides a natural barrier against crack propagation in the radial direction across the overpack structure. If, during a hypothetical accident (impact) event, a crack was initiated in one layer, the crack could not propagate to the adjacent layer. Additionally, it is highly unlikely that a crack would initiate as the thinner layers are more ductile than a thicker plate.

In this Safety Analysis Report the HI-STAR 100 System design is demonstrated to have predicted responses to accident conditions that are clearly acceptable with respect to certification requirements for post-accident containment system integrity, maintenance of subcriticality margin, dose rates, and adequate heat rejection capability. Table 1.2.18 presents a summary of the HI-STAR 100 System performance against these aspects of post-accident performance at two levels. At the first level, the integrity of the MPC boundary prevents release of radioactive material or helium from the MPC, and ingress of moderator. The integrity of the MPC is demonstrated by the analysis of the response of this high quality, ASME Code, Section III, Subsection NB-designed, pressure vessel to the accident loads while in the overpack. With this demonstration of MPC integrity, the excellent performance results listed in the second column of Table 1.2.18 constitutes an acceptable basis for certification of the HI-STAR 100 System for the safe transport of spent nuclear fuel. However, no credit is taken for MPC integrity for certification of the HI-STAR 100 System for the transport of intact or damaged fuel assemblies. Credit is only taken for the additional containment boundary of the MPC-68F and MPC-24EF for the transport of fuel classified as fuel debris in order to meet the requirements of 10 CFR 71.63(b).

The HI-STAR 100 System provides a large margin of safety. The third column in Table 1.2.18 summarizes the performance if the MPC is postulated to suffer gross failurein the post-accident analysis. Even with this postulated failure, the performance of the HI-STAR 100 System is acceptable for the transport of intact and damaged fuel assemblies, showing the defense-in-depth methodology incorporated into the HI-STAR 100 System.

The containment boundary of the HI-STAR 100 System is shown to satisfy the special requirements of 10CFR71.61 for irradiated nuclear fuel shipments.

To meet the requirements of 10CFR71.63(b) for plutonium shipments, which is considered applicable for the transport of fuel classified as fuel debris, double containment is provided by the containment boundary of the overpack and the secondary containment boundary of the MPC-68F and MPC-24EF, serving as a separate inner container.

1.2.1.1 Gross Weight

The gross weight of the HI-STAR 100 System depends on which of the MPCs is loaded into the HI-STAR 100 overpack for shipment. Table 2.2.1 summarizes the maximum calculated component weights for the HI-STAR 100 overpack, impact limiters, and each MPC loaded to maximum capacity with design basis SNF. The maximum gross transport weight of the HI-STAR 100 System is to be marked on the packaging nameplate.

1.2.1.2 Materials of Construction, Dimensions, and Fabrication

All materials used to construct the HI-STAR 100 System are ASME Code materials, except the neutron shield, neutron poison, optional aluminum heat conduction elements, thermal expansion foam, seals, pressure relief devices, aluminum honeycomb, pipe couplings, and other material classified as Not Important to Safety. The specified materials of construction along with outline dimensions for important-to-safety items are provided in the drawings in Section 1.4.

The materials of construction and method of fabrication are further detailed in the subsections that follow. Section 1.3 provides the codes applicable to the HI-STAR 100 packaging for materials, design, fabrication, and inspection, including NRC-approved alternatives to the ASME Code.

1.2.1.2.1 HI-STAR 100 Overpack

The HI-STAR 100 overpack is a heavy-walled steel cylindrical vessel. A single overpack design is provided that is capable of transporting each type of MPC. The inner diameter of the overpack is approximately 68-3/4 inches and the height of the internal cavity is approximately 191-1/8 inches. The overpack inner cavity is sized to accommodate the MPCs. The outer diameter of the overpack is approximately 96 inches and the height is approximately 203-1/4 inches.

Figure 1.2.1 provides a cross sectional elevation view of the overpack containment boundary. The overpack containment boundary is formed by a steel inner shell welded at the bottom to a bottom plate and, at the top, to a heavy top flange with a bolted closure plate. Two concentric grooves are machined into the closure plate for the seals. The closure plate is recessed into the top flange and the bolted joint is configured to protect the closure bolts and seals in the event of a drop accident. The closure plate has test and vent ports that are closed by a threaded port plug with a seal. The bottom plate has a drain port that is also closed by a threaded port plug with a seal. The containment boundary forms an internal cylindrical cavity for housing the MPC.

The outer surface of the overpack inner shell is buttressed with intermediate shells of gamma shielding that are installed in a manner to ensure a permanent state of contact between adjacent layers. Besides serving as an effective gamma shield, these layers provide additional strength to the overpack to resist puncture or penetration. Radial channels are vertically welded to the outside surface of the outermost intermediate shell at equal intervals around the circumference. These radial channels act as fins for improved heat conduction to the overpack outer enclosure shell surface and as cavities for retaining and protecting the neutron shielding. The enclosure shell is formed by welding enclosure shell panels between each of the channels to form additional cavities. Neutron shielding material is placed into each of the radial cavity segments formed by the radial channels, the outermost intermediate shell, and the enclosure shell panels. The exterior flats of the radial channels and enclosure shell panels form the overpack outer enclosure shell (Figure 1.2.2). Atop the outer enclosure shell, pressure relief devices (e.g., rupture disks) are positioned in a recessed area. The relief devices relieve internal pressure that may develop as a result of the fire accident and subsequent off-gassing of the neutron shield material. Within each radial channel, a layer of silicone sponge is positioned to act as a thermal expansion foam to compress as the neutron shield expands in the axial direction. Appendix 1.C provides material information on the thermal expansion foam. Figure 1.2.2 provides a mid-plane cross section view of the overpack, depicting the inner shell, intermediate shells, radial channels, outer enclosure shell, and neutron shield.

The exposed steel surfaces (except seal seating surfaces) of the overpack and the intermediate shell layers are coated to prevent corrosion. Coating materials are chosen based on the expected service conditions, considering the dual purpose certification status of the HI-STAR 100 System under 10 CFR 72 for spent fuel storage as well as transportation. The coatings applied to the overpack exposed exterior and interior surfaces are specified on the drawings in Section 1.4. The material data on the coatings is provided in Appendix 1.C. The inner cavity of the overpack is coated with a material appropriate to its high temperatures and the exterior of the overpack is coated with a material appropriate for fuel pool operations and environmental exposure. The coating applied to the intermediate shells acts as a surface preservative and is not exposed to the fuel pool or ambient environment.

Lifting trunnions are attached to the overpack top flange for lifting and rotating the cask body between vertical and horizontal positions. The lifting trunnions are located 180° apart in the sides of the top flange. On overpack serial numbers 1020-001 through 1020-007, pocket trunnions are welded to the lower side of the overpack 180° apart to provide a pivoting axis for rotation. The pocket trunnions are slightly off-center to ensure proper rotation direction of the overpack. As shown in Figure 1.1.4, the trunnions do no protrude beyond the cylindrical envelope of the overpack outer enclosure shell. This feature reduces the potential for direct impact on a trunnion in the event of an overpack side impact. After fabrication of HI-STAR overpack serial number 1020-007, the pocket trunnions were deleted from the overpack design.

1.2.1.2.2 Multi-Purpose Canisters

1.2.1.2.2.1 General Description

In this subsection, discussion of those attributes applicable to all of the MPC models is provided. Differences among the models are discussed in subsequent subsections. Specifications for the authorized contents of each MPC model, including non-fuel hardware and neutron sources are provided in Section 1.2.3.

The HI-STAR 100 MPCs are welded cylindrical structures with flat ends. Each MPC is an assembly consisting of a honeycombed fuel basket, a baseplate, a canister shell, a lid with vent and drain ports and cover plates, and a closure ring. The outer diameter of all MPCs and cylindrical height of each generic design MPC is fixed (see discussion in Subsection 1.2.1.2.2.3 regarding Trojan plant-specific MPCs). The number of spent nuclear fuel storage locations in each of the MPCs depends on the fuel assembly characteristics. As the generic MPCs are interchangeable, they correspondingly have identical exterior dimensions. The outer dimension of the MPC is nominally 68-3/8 inches and the length is nominally 190-1/4 inches. Figures 1.2.3-1.2.5 depict the cross sectional views of the different MPCs. Drawings of the MPCs are provided in Section 1.4. Key system data for the HI-STAR 100 System are outlined in Tables 1.2.2 and 1.2.3.

The generic MPC-24/24E/24EF and Trojan plant MPC-24E/EF differ in construction from the MPC-32 and MPC-68/68F in one important aspect: the fuel cells are physically separated from one another by a flux trap between each cell for criticality control (Figures 1.2.3 and 1.2.4). All MPC baskets are formed from an array of plates welded to each other, such that a honeycomb structure is created that resembles a multi-flanged, closed-section beam in its structural characteristics.

The MPC fuel basket is positioned and supported within the MPC shell by a series of basket supports welded to the inside of the MPC shell. In the peripheral area created by the basket, the MPC shell, and the basket supports, optional aluminum heat conduction elements are installed in some early production MPC-68 and MPC-68F models (see Figure 1.2.3). These heat conduction elements are fabricated from thin aluminum alloy 1100 in shapes and a design that allow a snug fit in the confined spaces and ease of installation. The heat conduction elements are along the full length of the MPC basket, except at the drain pipe location, to create a nonstructural thermal connection that facilitates heat transfer from the basket to the shell. In their operating condition, the heat conduction elements conform to, and contact the MPC shell and basket walls. In SAR Revision 10, a refined thermal analysis, described in Chapter 3, has allowed the elimination of these heat conduction elements from the MPC design, thus giving this design feature "optional" status.

Lifting lugs attached to the inside surface of the MPC canister shell serve to permit placement of the empty MPC into the overpack, and are considered non-structural, non-pressure retaining attachments to the MPC pressure boundary. The lifting lugs also serve to axially locate the MPC lid prior to welding. These internal lifting lugs are not used to handle a loaded MPC, since the MPC lid blocks access to the lifting lugs.

The top of the HI-STAR 100 MPC incorporates a redundant closure system. Figure 1.2.6 provides a sketch of the MPC closure details. The MPC lid is a circular plate (fabricated from one piece, or two pieces - split top and bottom) that is edge-welded to the MPC shell. If the two-piece lid design is employed, only the top piece is analyzed as part of the enclosure vessel pressure boundary. The bottom piece acts primarily as a radiation shield and is attached to the top piece with a non-structural, non-pressure retaining weld, as depicted on the MPC enclosure vessel drawing in Section 1.4. The MPC lid is equipped with vent and drain ports that are used to remove moisture and gas from the MPC and backfill the MPC with a specified pressure of inert gas (helium). The vent and drain ports are sealed closed by cover plates welded to the MPC lid before the closure ring is installed. The closure ring is a circular ring edge-welded to the MPC shell and MPC lid. The MPC lid provides sufficient rigidity to allow the entire MPC loaded with SNF to be lifted by the threaded holes in the MPC lid during transfer from the storage-only HI-STORM 100 System to the HI-STAR 100 overpack for transportation. Threaded insert plugs are installed to provide shielding when the threaded holes are not in use.

All MPCs are designed to handle intact fuel assemblies, damaged fuel assemblies, and fuel classified as fuel debris. Damaged fuel and fuel debris must be transported in damaged fuel containers or other approved damaged/failed fuel canister. At this time, only BWR damaged fuel and fuel debris from the Dresden Unit 1 and Humboldt Bay plants is certified for transportation in the MPC-68 and the MPC-68F. Similarly, only PWR damaged fuel and fuel debris from the

Trojan plant is certified for transportation in the Trojan plant-specific MPC-24E and the MPC-24EF. The definitions, and applicable specifications for all authorized contents, including the requirements for canning certain fuel, are provided in Subsection 1.2.3.

Intact SNF can be placed directly into the MPC. Damaged SNF and fuel debris must be placed into a Holtec damaged fuel container or other authorized canister for transportation inside the MPC and the HI-STAR 100 overpack. Figures 1.2.10 through 1.2.11 provide sketches of the containers authorized for transportation of damaged fuel and fuel debris in the HI-STAR 100 System. One Dresden Unit 1 Thoria rod canister, shown in Figure 1.2.11A, is also authorized for transportation in HI-STAR 100.

In order to qualify the MPC-68F and MPC-24EF shells as a secondary containment boundary for the transportation of Dresden Unit 1/Humboldt Bay and Trojan plant fuel debris, respectively, the MPC-68 and MPC-24E enclosure vessels have been slightly modified to further strengthen the lid-to-shell joint area. These fuel debris MPCs are given the "F" suffix (hence, MPC-68F and MPC-24EF)[†]. The differences between the standard and "F-model" MPC lid-to-shell joints are shown on Figure 1.2.17, and include a thickened upper shell, a larger lid-to-shell weld size, and a correspondingly smaller lid diameter. The design of the rest of the enclosure vessel is identical between the standard MPC and the "F-model" MPC.

The MPC-68F and MPC-24EF provide the separate inner container per 10CFR71.63(b) for the HI-STAR 100 System transporting fuel classified as fuel debris to ensure double containment. The overpack containment boundary provides the primary containment boundary.

1.2.1.2.2.2 <u>MPC-24/24E/24EF</u>

The MPC-24 is designed to transport up to 24 PWR intact fuel assemblies meeting the limits specified in Subsection 1.2.3. The MPC 24E is designed to transport up to 24 PWR intact and up to four PWR damaged fuel assemblies in damaged fuel containers. The MPC-24EF is designed to transport up to 24 PWR intact fuel assemblies and up to four PWR damaged fuel assemblies or fuel assemblies classified as fuel debris. At this time, however, generic PWR damaged fuel and fuel debris are not authorized for transportation in the MPC-24E/EF.

All MPC-24-series fuel baskets employ the flux trap design for criticality control, as shown in the drawings in Section 1.4. The fuel basket design for the MPC-24E is an enhanced MPC-24 basket layout designed to improve the fuel storage geometry for criticality control. The fuel basket design of the MPC-24EF is identical to the MPC-24E. The MPC-24E/EF basket designs also employ a higher ^{10}B loading than the MPC-24, as shown in Table 1.2.3. The differences between the MPC-24EF enclosure vessel design and the MPC-24/24E enclosure vessel are discussed in Subsection 1.2.1.2.2.1.

† The drawing in Section 1.4 also denotes an MPC-68FF fuel debris canister design. However, the MPC-68FF is not authorized for use in transportation under the HI-STAR 100 10 CFR 71 CoC.

1.2.1.2.2.3 Trojan Plant MPC-24E/EF

The Trojan plant MPC-24E and -24EF models are designs that have been customized for that plant's fuel and the concrete storage cask being used at the Trojan plant Independent Spent Fuel Storage Installation (ISFSI) (Docket 72-0017). The design features that are unique to the Trojan plant MPCs are specifically noted on the MPC enclosure vessel and MPC-24E/EF fuel basket drawings in Section 1.4. These differences include:

- a shorter MPC fuel basket and cavity length to match the shorter Trojan fuel assembly length
- shorter corner fuel storage cell lengths to accommodate the Trojan Failed Fuel Cans
- a different fuel storage cell and flux trap dimension in the corner cells to accommodate the Trojan Failed Fuel Cans
- a different configuration of the flow holes at the bottom of the fuel basket (rectangular vs. semi-circular)

All other design features in the Trojan MPCs are identical to the generic MPC-24E/EF design. The HI-STAR 100 overpack design has not been modified for the Trojan MPC design.

The technical analyses described in this SAR were verified in most cases to bound the Trojan-specific design features. Where necessary, Trojan plant-specific evaluations were performed and are summarized in the appropriate SAR section. To accommodate the shorter Trojan plant MPC length in a standard-length HI-STAR 100 overpack, a spacer was designed for installation into the overpack above the Trojan MPC (see Figure 1.1.5 and the drawing in Section 1.4) for transportation in the standard-length HI-STAR 100 overpack. This spacer prevents the MPC from moving more than the MPC was analyzed to move in the axial direction and serves to transfer the axial loads from the MPC lid to the overpack top closure plate within the limits of the supporting analyses. See Section 2.7.1.1 for additional discussion of the spacer used with the Trojan MPC design. Hereafter in this SAR, the Trojan plant-specific MPC design is only distinguished from the generic MPC-24E/EF design when necessary to describe unique evaluations performed for those MPCs.

1.2.1.2.2.4 MPC-32

NOTE: The MPC-32 is not certified for transportation at this time.

The MPC-32 is designed to transport up 32 PWR intact fuel assemblies meeting the specifications in Subsection 1.2.3. Damaged fuel and fuel debris are not permitted to be transported in the MPC-32. The MPC-32 enclosure vessel design is identical to the MPC-24/24E enclosure vessel design as shown on the drawings in Section 1.4. The MPC-32 fuel basket does not employ flux traps for criticality control. Credit for burnup of the fuel is taken in the criticality analyses for accident conditions and to meet the requirements of 10 CFR 71.55(b). Because the MPC is designed to preclude the intrusion of moderator under all normal and credible accident conditions of transport, the moderator intrusion condition analyzed as required by 10 CFR 71.55(b) is a non-mechanistic event for the HI-STAR 100 System.

1.2.1.2.2.5 MPC-68/68F

The MPC-68 is designed to transport up to 68 BWR intact fuel assemblies and damaged fuel assemblies meeting the specifications in Subsection 1.2.3. Zircaloy channels are permitted. At this time, only damaged fuel from the Dresden Unit 1 and Humboldt Bay plants is authorized for transportation in the MPC-68. The MPC-68F is designed to transport only fuel and other authorized material from the Dresden Unit 1 and Humboldt Bay plants meeting the specifications in Subsection 1.2.3. The sole difference between the MPC-68 and MPC-68F fuel basket design is a reduction in the required ^{10}B areal density in the Boral. A reduction in the required ^{10}B areal density of the Boral is possible for the MPC-68F due to limited types of fuel and low enrichments permitted to be transported in this MPC model. The differences between the MPC-68F enclosure vessel design and the MPC-68 enclosure vessel are discussed in Subsection 1.2.1.2.2.1.

1.2.1.2.2.6 Alloy X

The HI-STAR MPC is constructed entirely from stainless steel alloy materials (except for the neutron absorber and aluminum vent and drain cap seal washers in all MPCs, and the aluminum heat conduction elements in the first several production units of MPC-68 and MPC–68F). No carbon steel parts are used in the design of the HI-STAR 100 MPC. Concerns regarding interaction of coated carbon steel materials and various MPC operating environments [1.2.1] are not applicable to the HI-STAR MPCs. All structural components in a HI-STAR MPC will be fabricated of Alloy X, a designation that warrants further explanation.

Alloy X is a fictitious material that should be acceptable as a Mined Geological Depository System (MGDS) waste package and that meets the thermophysical properties set forth in this document.

At this time, there is considerable uncertainty with respect to the material of construction for an MPC that would be acceptable as a waste package for the MGDS. Candidate materials being considered for acceptability by the DOE include:

- Type 316
- Type 316LN
- Type 304
- Type 304LN

The DOE material selection process is primarily driven by corrosion resistance in the potential environment of the MGDS. As the decision regarding a suitable material to meet disposal requirements is not imminent, this application requests approval for use of any one of the four Alloy X materials.

For the MPC design and analysis, Alloy X (as defined in this SAR) may be one of the following materials. Any steel part in an MPC may be fabricated from any of the acceptable Alloy X materials listed below, except that all steel pieces comprising the MPC shell (i.e., the 1/2" thick cylinder) must be fabricated from the same Alloy X stainless steel type:

- Type 316
- Type 316LN
- Type 304
- Type 304LN

The Alloy X approach is accomplished by qualifying the MPC for all mechanical, structural, neutronic, radiological, and thermal conditions using material thermophysical properties that are the least favorable for the entire group for the analysis in question. For example, when calculating the rate of heat rejection to the outside environment, the value of thermal conductivity used is the lowest for the candidate material group. Similarly, the stress analysis calculations use the lowest value of the ASME Code allowable stress intensity for the entire group. Stated differently, we have defined a material, which is referred to as Alloy X, whose thermophysical properties, from the MPC design perspective, are the least favorable of the candidate materials group. The evaluation of the Alloy X constituents to determine the least favorable properties is provided in Appendix 1.A.

The Alloy X approach is conservative because no matter which material is ultimately utilized, the Alloy X approach guarantees that the performance of the MPC will exceed the analytical predictions contained in this document.

1.2.1.3 Impact Limiters

The HI-STAR 100 overpack is fitted with aluminum honeycomb impact limiters, termed AL-STAR™, one at each end, once the overpack is positioned and secured in the transport frame. The impact limiters ensure the inertia loadings during the normal and hypothetical accident conditions of transport are maintained below design levels. The impact limiter design is discussed further in Chapter 2 and drawings are provided in Section 1.4.

1.2.1.4 Shielding

The HI-STAR 100 System is provided with shielding to minimize personnel exposure. The HI-STAR 100 System will be transported by exclusive use shipment to ensure the external radiation requirements of 10CFR71.47 are met. During transport, a personnel barrier is installed to restrict access to the overpack to protect personnel from the HI-STAR 100 exterior surface temperature in accordance with 10CFR71.43(g). The personnel barrier provides a stand-off equal to the exterior radial dimension of the impact limiters. Figure 1.2.8 provides a sketch of the personnel barrier being installed.

The initial attenuation of gamma and neutron radiation emitted by the radioactive spent fuel is provided by the MPC fuel basket structure built from inter-welded plates and Boral neutron poison panels with sheathing attached to the fuel cell walls. The MPC canister shell, baseplate, and lid provide additional thicknesses of steel to further reduce gamma radiation and, to a smaller extent, neutron radiation at the outer MPC surfaces. No shielding credit is taken for the aluminum heat conduction elements installed in some of the early production MPC-68 and MPC-68F units.

The primary HI-STAR 100 shielding is located in the overpack and consists of neutron shielding and additional layers of steel for gamma shielding. Neutron shielding is provided around the outside circumferential surface of the overpack. Gamma shielding is provided by the overpack inner, intermediate and enclosure shells with additional axial shielding provided by the bottom plate and the top closure plate. During transport, the impact limiters will provide incremental gamma shielding and provide additional distance from the radiation source at the ends of the package. An additional circular segment of neutron shielding is contained within each impact limiter to provide neutron attenuation.

1.2.1.4.1 Boral Neutron Absorber

Boral is a thermal neutron poison material composed of boron carbide and aluminum alloy 1100. Boron carbide is a compound having a high boron content in a physically stable and chemically inert form. The boron carbide contained in Boral is a fine granulated powder that conforms to ASTM C-750-80 nuclear grade Type III. The aluminum alloy 1100 is a lightweight metal with high tensile strength that is protected from corrosion by a highly resistant oxide film. The two materials, boron carbide and aluminum, are chemically compatible and ideally suited for long-term use in the radiation, thermal, and chemical environment of a nuclear reactor, spent fuel pool, or dry cask.

The documented historical applications of Boral, in environments comparable to those in spent fuel pools and fuel storage casks, dates to the early 1950s (the U.S. Atomic Energy Commission's AE-6 Water-Boiler Reactor [1.2.2]). Technical data on the material was first printed in 1949, when the report "Boral: A New Thermal Neutron Shield" was published [1.2.3]. In 1956, the first edition of the "Reactor Shielding Design Manual" [1.2.4], contains a section on Boral and its properties.

In the research and test reactors built during the 1950s and 1960s, Boral was frequently the material of choice for control blades, thermal-column shutters, and other items requiring very good thermal-neutron absorption properties. It is in these reactors that Boral has seen its longest service in environments comparable to today's applications.

Boral found other uses in the 1960s, one of which was a neutron poison material in baskets used in the shipment of irradiated, enriched fuel rods from Canada's Chalk River laboratories to Savannah River. Use of Boral in shipping containers continues, with Boral serving as the poison in many cask designs.

Boral has been licensed by the NRC for use in numerous BWR and PWR spent fuel storage racks and has been extensively used in international nuclear installations.

Boral has been exclusively used in fuel storage applications in recent years. Its use in spent fuel pools as the neutron absorbing material can be attributed to its proven performance and several unique characteristics, such as:

- The content and placement of boron carbide provides a very high removal cross section for thermal neutrons.
- Boron carbide, in the form of fine particles, is homogeneously dispersed throughout the central layer of the Boral panels.
- The boron carbide and aluminum materials in Boral do not degrade as a result of long-term exposure to radiation.
- The neutron absorbing central layer of Boral is clad with permanently bonded surfaces of aluminum.
- Boral is stable, strong, durable, and corrosion resistant.

Boral absorbs thermal neutrons without physical change or degradation of any sort from the anticipated exposure to gamma radiation and heat. The material does not suffer loss of neutron attenuation capability when exposed to high levels of radiation dose.

Holtec International's QA Program ensures that Boral is manufactured under the control and surveillance of a Quality Assurance/Quality Control Program that conforms to the requirements of 10CFR71, Subpart H and 10CFR72, Subpart G. Holtec International has procured over 200,000 panels of Boral from AAR Advanced Structures for over 20 projects. Boral has always been purchased with a minimum ^{10}B loading requirement. Coupons extracted from production runs were tested using the "wet chemistry" procedure. The actual ^{10}B loading, out of thousands of coupons tested, has never been found to fall below the design specification. The size of this coupon data base is sufficient to provide confidence that all future procurements will continue to yield Boral with full compliance with the stipulated minimum loading. Furthermore, the surveillance, coupon testing, and material tracking processes that have so effectively controlled the quality of Boral are expected to continue to yield Boral of similar quality in the future. Nevertheless, to add another layer of insurance, only 75% ^{10}B credit of the fixed neutron absorber is assumed in the criticality analysis.

The oxide layer that is created from the reaction of the outer aluminum cladding and the edges of the Boral panels with air and water provides a barrier to further reaction of the aluminum cladding with air or the spent fuel pool water during loading and unloading operations. However, with extended submergence in an MPC filled with water or in the plant's spent fuel pool, the hydrostatic pressure can drive water into the Boral core (comprised of particulate B_4C and aluminum powder) where previously unexposed aluminum powder may react with the water to create hydrogen. The rate of hydrogen generation and the total hydrogen generated is dependent on several variables:

- Aluminum particle size: Aluminum particle size in the Boral core and associated porosity affects the amount of aluminum available for reaction with water. Larger aluminum particles yield less surface area for reaction, but higher porosity for aluminum-water interaction; smaller aluminum particles yield more surface area for reaction, but lower porosity for aluminum-water reaction.

- Presence of trace impurities: The presence of trace impurities in the Boral core due to the manufacturing process (i.e., sodium hydroxide, boron oxide, and iron-oxide) can affect the rate of hydrogen production, both increasing and suppressing the reaction. Sodium dissolved in the water increases the pH and tends to increase the rate of hydrogen production. This is counteracted by the boron oxide, which hydrolyzes to boric acid (H_3BO_3) and reduces the rate of hydrogen production. Trace impurities do not affect the total amount of hydrogen generated.

- Pool water chemistry: Chemicals in the plant spent fuel pool water (e.g., copper, boron) can affect the rate of hydrogen production, both increasing (copper) and suppressing (boron) the reaction.

- MPC loading operations: Operating needs or preferences by individual utilities as to when, and for how long the MPC is kept at varying water depths in the spent fuel pool, and how long the MPC is kept filled with water outside the spent fuel pool can affect the amount of aluminum in the Boral core that may be exposed to water.

Due to the variability in hydrogen generation from the Boral-water reaction, the operating procedures in Chapter 7 require monitoring for combustible gases and either exhausting or purging the space beneath the MPC lid during loading and unloading operations when an ignition event could occur (i.e., when the space beneath the MPC lid is open to the welding or cutting operation).

1.2.1.4.2 Holtite-A™ Neutron Shielding

The specification for the overpack and impact limiter neutron shield material is predicated on functional performance criteria. These criteria are:

- Attenuation of neutron radiation and associated neutron capture to appropriate levels;

- Durability of the shielding material under normal conditions, in terms of thermal, chemical, mechanical, and radiation environments;

- Stability of the homogeneous nature of the shielding material matrix;

- Stability of the shielding material in mechanical or thermal accident conditions to the desired performance levels; and

- Predictability of the manufacturing process under adequate procedural control to yield an in-place neutron shield of desired function and uniformity.

Other aspects of a shielding material, such as ease of handling and prior nuclear industry use, are also considered, within the limitations of the main criteria. Final specification of a shield material is a result of optimizing the material properties with respect to the main criteria, along with the design of the shield system, to achieve the desired shielding results.

Holtite-A is the only approved neutron shield material that fulfills the aforementioned criteria. Holtite-A is a poured-in-place solid borated synthetic neutron-absorbing polymer. Holtite-A is specified with a nominal B_4C loading of 1 weight percent for the HI-STAR 100 System. Appendix 1.B provides the Holtite-A material properties germane to its function as a neutron shield. Holtec has performed confirmatory qualification tests on Holtite-A under the company's QA program.

In the following, a brief summary of the performance characteristics and properties of Holtite-A is provided.

Density

The nominal specific gravity of Holtite-A is 1.68 g/cm^3 as specified in Appendix 1.B. To conservatively bound any potential weight loss at the design temperature and any inability to reach the theoretical density, the density is reduced by 4% to 1.61 g/cm^3. The density used for the shielding analysis is assumed to be 1.61 g/cm^3 to underestimate the shielding capabilities of the neutron shield.

Hydrogen

The nominal weight concentration of hydrogen is 6.0%. However, all shielding analyses conservatively assume 5.9% hydrogen by weight in the calculations.

Boron Carbide

Boron carbide dispersed within Holtite-A in finely dispersed powder form is present in 1% (nominal) weight concentration. Holtite-A may be specified with a B_4C content of up to 6.5 weight percent. For the HI-STAR 100 System, Holtite-A is specified with a nominal B_4C weight percent of 1%.

Design Temperature

The design temperature of Holtite-A is set at 300°F. The maximum spatial temperature of Holtite-A under all normal operating conditions must be demonstrated to be below this design temperature.

Thermal Conductivity

It is evident from Figure 1.2.2 that Holtite-A is directly in the path of heat transmission from the inside of the overpack to its outside surface. For conservatism, however, the design basis thermal conductivity of Holtite-A under heat rejection conditions is set equal to zero. The reverse condition occurs under a postulated fire event when the thermal conductivity of Holtite-A aids in the influx of heat to the stored fuel in the fuel basket. The thermal conductivity of Holtite-A is conservatively set at 1 Btu/hr-ft-°F for all fire accident analyses.

The Holtite-A neutron shielding material is stable at normal design temperatures over the long term and provides excellent shielding properties for neutrons.

1.2.1.4.3 Gamma Shielding Material

For gamma shielding, HI-STAR 100 utilizes carbon steel in plate stock form. Instead of utilizing a thick forging, the gamma shield design in the HI-STAR 100 overpack borrows from the concept of layered vessels from the field of ultra-high pressure vessel technology. The shielding is made from successive layers of plate stock. The fabrication of the shell begins by rolling the inner shell plate and making the longitudinal weld seam. Each layer of the intermediate shells is constructed from two halves. The two halves of the shell are precision sheared, beveled, and rolled to the required radii. The two halves of the second layer are wrapped around the first shell. Each shell half is positioned in its location and while applying pressure using a specially engineered fixture, the halves are tack welded. The beveled edges to be joined are positioned to make contact or have a slight gap. The second layer is made by joining the two halves using two longitudinal welds. Successive layers are assembled in a like manner. Thus, the welding of every successive shell provides a certain inter-layer contact (Figure 1.2.7).

A thick structural component radiation barrier is thus constructed with four key features, namely:

- The number of layers can be increased as necessary to realize the required design objectives.
- The layered construction is ideal to stop propagation of flaws.
- The thinner plate stock is much more ductile than heavy forgings used in other designs.
- Post-weld heat treatment is not required by the ASME Code, simplifying fabrication.

1.2.1.5 Lifting and Tie-Down Devices

The HI-STAR 100 overpack is equipped with two lifting trunnions located in the top flange. The lifting trunnions are designed in accordance with 10CFR71.45, NUREG-0612 [1.2.11], and ANSI N14.6 [1.3.3], manufactured from a high strength alloy, and are installed in threaded openings. The lifting trunnions may be secured in position by optional locking pads, shaped to make conformal contact with the curved overpack. Once the locking pad is bolted in position, the inner diameter is sized to restrain the trunnion from backing out. The two off-center pockets located near the overpack bottom plate on overpack serial numbers 1020-001 through 1020-007 are pocket trunnions. The pocket trunnions were eliminated from the design after serial number 1020-007 was fabricated and are no longer considered qualified tie-down devices. However, the pocket trunnions on these overpacks may still be used for normal handling activities such as upending and downending.

The lifting, upending, and downending of the HI-STAR 100 System requires the use of external handling devices. A lifting yoke is utilized when the cask is to be lifted or set in a vertical orientation. For those overpacks that have been fabricated with the pocket trunnions, transport and rotation cradles may include rotation trunnions that interface with the pocket trunnions to provide a pivot axis. A lift yoke may be connected to the lifting trunnions and the crane hook used for upending or downending the HI-STAR 100 System by rotating on the pocket trunnions for these overpacks. For those overpacks fabricated without pocket trunnions, the overpack must be transferred into the transport saddle with appropriate lift rigging. If an overpack having pocket trunnions is secured to the transport vehicle without engaging the pocket trunnions, plugs are required to be installed in the pocket to provide radiation shielding (see the overpack drawing in Section 1.4).

For transportation, the HI-STAR 100 System is engineered to be mounted on a transport frame secured to the transporter bed. Figure 1.2.8 provides a sketch of the HI-STAR 100 System secured for transport and the drawing in Section 1.4 provides additional details. The transport frame has a lower saddle with attachment points for belly slings around the cask body designed to prevent excessive vertical or lateral movement of the cask during normal transportation. The impact limiters affixed to both ends of the cask are designed to transmit the design basis axial loads into the cradle structure. See Section 2.5 for discussion of the qualification of tie-down devices.

The top of the MPC lid is equipped with four threaded holes that allow lifting of the loaded MPC. These holes allow the loaded MPC to be raised/lowered from the HI-STAR overpack. For users of the HI-STORM 100 Dry Storage System, MPC handling operations are performed using a HI-TRAC transfer cask of the HI-STORM 100 System (Docket No. 72-1014). The HI-TRAC transfer cask allows the sealed MPC loaded with spent fuel to be transferred from the HI-STORM 100 overpack (storage-only) to the HI-STAR 100 overpack, or vice versa. The threaded holes in the MPC lid are designed in accordance with NUREG-0612 and ANSI N14.6 and are plugged during transportation to prevent radiation streaming.

1.2.1.6 Heat Dissipation

The HI-STAR 100 System can safely transport SNF by maintaining the fuel cladding temperature below the limits specified in Table 1.2.3 for normal and accident conditions. These limits have been established consistent with the guidance in NRC Interim Staff Guidance (ISG) document No. 11, Revision 2 (Ref. [1.2.14]). The temperature of the fuel cladding is dependent on the decay heat and the heat dissipation capabilities of the cask. The total heat load per BWR and PWR MPC is identified in Table 1.2.3. The SNF decay heat is passively dissipated without any mechanical or forced cooling.

The HI-STAR 100 System must meet the requirements of 10CFR71.43(g) for the accessible surface temperature limit. To meet this requirement the HI-STAR 100 System is shipped as an exclusive use shipment and includes an engineered personnel barrier during transport.

The primary heat transfer mechanisms in the HI-STAR 100 System are conduction and surface radiation.

The free volume of the MPC and the annulus between the external surface of the MPC and the inside surface of the overpack containment boundary are filled with 99.995% pure helium gas during fuel loading operations. Table 1.2.3 specifies the acceptance criteria for helium fill pressure in the MPC internal cavity. Besides providing an inert dry atmosphere for the fuel cladding, the helium also provides conductive heat transfer across any gaps between the metal surfaces inside the MPC and in the annulus between the MPC and overpack containment boundary. Metal conduction transfers the heat throughout the MPC fuel basket, through the MPC aluminum heat conduction elements (if installed) and shell, through the overpack inner shell, intermediate shells, steel radial connectors and finally, to the outer neutron shield enclosure shell. The most adverse temperature profiles and thermal gradients for the HI-STAR 100 System with each of the MPCs are discussed in detail in Chapter 3. The thermal analysis in Chapter 3 no longer takes credit for the aluminum heat conduction elements and they have been designated as optional equipment.

1.2.1.7 Coolants

There are no coolants utilized in the HI-STAR 100 System. As discussed in Subsection 1.2.1.6 above, helium is sealed within the MPC internal cavity. The annulus between the MPC outer surface and overpack containment boundary is also purged and filled with helium gas.

1.2.1.8 Pressure Relief Systems

No pressure relief system is provided on the HI-STAR 100 packaging containment boundary.

The sole pressure relief devices are provided in the overpack outer enclosure (Figure 1.1.4). The overpack outer enclosure contains the neutron shield material. Normal loadings will not cause the rupture disks to open. The rupture disks are installed to relieve internal pressure in the neutron shield cavities caused by the fire accident. The overpack outer enclosure is not designed as a pressure vessel. Correspondingly, the rupture disks are designed to open at relatively low pressures as stated below.

Relief Device location	Set pressure, psig
Overpack outer enclosure	30, +/- 5

1.2.1.9 Security Seal

The HI-STAR 100 packaging provides a security seal that while intact, provides evidence that the package has not been opened by unauthorized persons. When installed, the impact limiters cover all penetrations into the HI-STAR 100 packaging containment boundary. Therefore, the security seal is placed to ensure that the impact limiters are not removed which thereby ensures that the package has not been opened. As shown on the HI-STAR transport assembly drawing in Section 1.4, security seals are provided on one impact limiter attachment bolt on the top impact limiter and through two adjacent bolts on the bottom impact limiter. A hole is provided in the head of the bolt and the impact limiter. Lockwire shall be threaded through the hole and joined with a security seal.

1.2.1.10 Design Life

The design life of the HI-STAR 100 System is 40 years. This is accomplished by using materials of construction with a long proven history in the nuclear industry and specifying materials known to withstand their operating environments with little to no degradation. A maintenance program, as specified in Chapter 8, is also implemented to ensure the HI-STAR 100 System will exceed its design life of 40 years. The design considerations that assure the HI-STAR 100 System performs as designed throughout the service life include the following:

HI-STAR Overpack

- Exposure to Environmental Effects
- Material Degradation
- Maintenance and Inspection Provisions

MPC

- Corrosion
- Structural Fatigue Effects
- Maintenance of Helium Atmosphere
- Allowable Fuel Cladding Temperatures
- Neutron Absorber Boron Depletion

1.2.2 Operational Features

Table 1.2.7 provides the sequence of basic operations necessary to load fuel and prepare the HI-STAR 100 System for transport. More detailed guidance for transportation-related loading, unloading, and handling operations is provided in Chapter 7 and is supported by the drawings in Section 1.4. A summary of the loading and unloading operations is provided below. Figures 1.2.9 and 1.2.16 provide a pictorial view of the loading and unloading operations, respectively.

1.2.2.1 Applicability of Operating Procedures for the Dual-Purpose HI-STAR 100 System

The HI-STAR 100 System is a dual-purpose system certified for use as a dry storage cask under 10 CFR 72 and a transportation package under 10 CFR 71. In addition, the MPC is certified for use under 10 CFR 72 in the storage-only HI-STORM 100 System (a ventilated concrete cask system). Therefore, it is possible that the HI-STAR 100 overpack and/or the MPC may be loaded, prepared, and sealed under the operating procedures for storage, delineated in the HI-STAR 100 storage FSAR (Docket 72-1008) or the HI-STORM 100 storage FSAR (Docket 72-1014). In those cases, the operating procedures governing MPC and overpack preparation for storage would apply. The MPC and HI-STAR 100 overpack, as applicable, must be confirmed to meet all requirements of the Part 71 Certificate of Compliance before being released for shipment.

For those instances where the MPC is being loaded and shipped off-site in a HI-STAR 100 overpack under 10 CFR 71 without first being deployed at an ISFSI (known as "load-and-go" operations), the operating procedures in Chapter 7 (and summarized below) apply for preparation of the MPC and HI-STAR overpack. For those cases where the MPC is transferred from storage in a HI-STORM overpack to a HI-STAR overpack for shipment, the operating procedures in Chapter 7 (and summarized below) govern the preparation activities for the HI-STAR overpack.

Loading Operations

At the start of loading operations, the overpack is configured with the closure plate removed. The lift yoke is used to position the overpack in the designated preparation area or setdown area for overpack inspection and MPC insertion. The annulus is filled with plant demineralized water and an inflatable annulus seal is installed. The inflatable seal prevents contact between spent fuel pool water and the MPC shell reducing the possibility of contaminating the outer surfaces of the MPC. The MPC is then filled with spent fuel pool water or plant demineralized water (borated as required for MPC-32). The overpack and MPC are lowered into the spent fuel pool for fuel loading using the lift yoke. Pre-selected assemblies are loaded into the MPC and a visual verification of the assembly identification is performed.

While still underwater, a thick shielding lid (the MPC lid) is installed. The lift yoke is remotely engaged to the overpack lifting trunnions and is used to lift the overpack close to the spent fuel pool surface. The MPC lift bolts (securing the MPC lid to the lift yoke) are removed. As the overpack is removed from the spent fuel pool, the lift yoke and overpack are sprayed with demineralized water to help remove contamination.

The overpack is removed from the pool and placed in the designated preparation area. The top surfaces of the MPC lid and the top flange of the overpack are decontaminated. The inflatable annulus seal is removed, and an annulus shield is installed. The annulus shield provides additional personnel shielding at the top of the annulus and also prevents small items from being dropped into the annulus (foreign material exclusion). If used, the Automated Welding System (AWS) is installed. The MPC water level is lowered slightly and the space under the MPC lid is purged or exhausted and monitoring is performed. The MPC lid is seal-welded using the AWS. Liquid penetrant examinations are performed on the root and final passes and ultrasonic examination is also performed on the MPC lid-to-shell weld or, in place of the ultrasonic examination, the weld may be inspected by multiple-pass liquid penetrant examination at approximately every 3/8 inch of weld depth. Then a small volume of the water is displaced with helium gas. The helium gas is used for leakage testing. A helium leakage rate test is performed on the MPC lid confinement weld (lid-to-shell) to verify weld integrity and to ensure that the leakage rates are within acceptance criteria. The MPC water is displaced from the MPC by blowing pressurized helium or nitrogen gas into the vent port of the MPC, thus displacing the water through the drain line. At the appropriate time in the sequence of activities, based on the type of test performed (hydrostatic or pneumatic), a pressure test of the MPC enclosure vessel is performed.

The Forced Helium Dehydration (FHD) System is connected to the MPC and is used to remove residual water from the MPC and reduce the level of moisture in the MPC to acceptable levels. This is accomplished by recirculating dry, heated helium through the MPC cavity to absorb the moisture. When the helium exiting the MPC is determined to meet the required moisture limit, the MPC is considered sufficiently dried for transportation (see Section 3.4.1.1.16 for a description of the FHD System.

Following MPC drying operations, the MPC is backfilled with a predetermined amount of helium gas. The helium backfill ensures adequate heat transfer, provides an inert atmosphere for fuel cladding integrity, and provides the means of future leakage rate testing of the MPC enclosure vessel boundary welds. Cover plates are installed and seal-welded over the MPC vent and drain ports with liquid penetrant examinations performed on the root and/or final passes, depending on the number of weld passes required. That is, if only a single weld pass is required, only a final liquid penetrant examination is performed. The cover plates are helium leakage tested to confirm that they meet the established leakage rate criteria.

The MPC closure ring is then placed on the MPC, aligned, tacked in place, and seal welded, providing redundant closure of the MPC enclosure vessel closure welds. Tack welds are visually examined, and the root and/or final welds (depending on the number of weld passes required) are inspected using the liquid penetrant examination technique to ensure weld integrity. The annulus shield is removed and the remaining water in the annulus is drained. The AWS is removed. The overpack closure plate is installed and the bolts are torqued. The overpack annulus is dried using the vacuum drying system (VDS).

If the MPC being transported is an "F-model" canister, a helium leakage test on the canister must be performed to confirm the integrity of the secondary containment boundary prior to backfilling the overpack annulus.

The overpack annulus is backfilled with helium gas for heat transfer and seal testing. Concentric metallic seals in the overpack closure plate prevent the leakage of the helium gas from the annulus and provide the containment boundary to the release of radioactive materials. The seals on the overpack vent and drain port plugs are leak tested along with the overpack closure plate inner seal. Cover plates with metallic seals are installed over the overpack vent and drain ports to provide redundant closure of the overpack penetrations. A port plug with a metallic seal is installed in the overpack closure plate test port to provide fully-redundant closure of all overpack penetrations.

The overpack is surveyed for removable contamination and secured on the transport vehicle with impact limiters installed, the security seals are attached, and the personnel barrier is installed. The HI-STAR 100 packaging is then ready for transport.

Unloading Operations

The HI-STAR 100 System unloading procedures describe the general actions necessary to prepare the MPC for unloading, cool the stored fuel assemblies in the MPC (if necessary), flood the MPC cavity, remove the lid welds, unload the spent fuel assemblies, and recover the overpack and empty MPC. Special precautions are outlined to ensure personnel safety during the unloading operations, and to prevent the risk of MPC overpressurization and thermal shock to the stored spent fuel assemblies.

After removing the impact limiters, the overpack and MPC are positioned in the designated preparation area. At the site's discretion, a gas sample is drawn from the overpack annulus and analyzed. The gas sample provides an indication of MPC enclosure vessel performance. The annulus is depressurized, the overpack closure plate is removed, and the annulus is filled with plant demineralized water. The annulus shield is installed to protect the annulus from debris produced from the lid removal process. Similarly, overpack top surfaces are covered with a protective fire-retarding blanket.

The Weld Removal System (WRS) is positioned on the MPC lid. The MPC closure ring is core drilled over the locations of the vent and drain port cover plates. The MPC closure ring and vent and drain port cover plates are core drilled to the extent necessary to allow access by the Remote Valve Operating Assemblies (RVOAs). Local ventilation is established around the vent and drain ports. The RVOAs are connected to allow access to the MPC cavity for re-flooding operations.

The MPC cavity gas is verified to be below an appropriate temperature (approximately 200°F) to allow water flooding. Depending on the time since initial fuel loading and the age and burnup of the contained fuel, mechanical cooling of the MPC cavity gas may or may not be required to ensure the cavity gas temperature meets the acceptance criterion. A thermal evaluation should be performed to determine the MPC bulk cavity gas temperature at the time of unloading. Based on that thermal evaluation, if the MPC cavity gas temperature does not already meet the acceptance limit, any appropriate means to cool the cavity gas may be employed to reduce the gas temperature to the acceptance criterion. Typically, this may involve intrusive means, such as recirculation cooling of the MPC cavity helium, or non-intrusive means, such as cooling of the exterior surface of the MPC enclosure vessel with water or air. The thermal evaluation should include an evaluation of the cooling process, if required, to determine the appropriate criteria for the cooling process, such as fluid flow rate(s), fluid temperature(s), and the cooling duration required to meet the acceptance criterion. Following fuel cool-down (if required), the MPC is flooded with water. The WRS is positioned for MPC lid-to-shell weld removal. The WRS is then removed with the MPC lid left in place.

The annulus shield is removed and the inflatable annulus seal is installed and pressurized. The MPC lid is rigged to the lift yoke and the lift yoke is engaged to overpack lifting trunnions. The overpack is placed in the spent fuel pool and the MPC lid is removed. All fuel assemblies are returned to the spent fuel storage racks. The overpack and MPC are returned to the designated preparation area. The annulus water is drained and the MPC and overpack are dispositioned for re-use or waste.

1.2.3 Contents of Package

The HI-STAR 100 packaging is classified as a Type B package under 10CFR71. As the HI-STAR 100 System is designed to transport spent nuclear fuel, the maximum activity of the contents requires that the HI-STAR 100 packaging be classified as Category I in accordance with Regulatory Guide 7.11 [1.2.10]. This section delineates the authorized contents permitted for shipment in the HI-STAR 100 System, including fuel assembly types; non-fuel hardware; neutron sources; physical parameter limits for fuel assemblies and sub-components; enrichment, burnup, cooling time, and decay heat limits; location requirements; and requirements for canning the material.

1.2.3.1 Determination of Design Basis Fuel

The HI-STAR 100 package is designed to transport most types of fuel assemblies generated in the commercial U.S. nuclear industry. Boiling-water reactor (BWR) fuel assemblies have been supplied by General Electric (GE), Siemens (SPC), Exxon Nuclear, ANF, UNC, ABB Combustion Engineering, Allis-Chalmers (AC) and Gulf Atomic. Pressurized-water reactor (PWR) fuel assemblies are generally supplied by Westinghouse, Babcock & Wilcox, ANF, and ABB Combustion Engineering. ANF, Exxon, and Siemens are historically the same manufacturing company under different ownership. Within this report, SPC is used to designate fuel manufactured by ANF, Exxon, or Siemens. Publications such as Refs. [1.2.6], [1.2.7], and [1.2.15] provide a comprehensive description of fuel discharged from U.S. reactors. A central object in the design of the HI-STAR 100 System is to ensure that a majority of SNF discharged from the U.S. reactors can be transported in one of the MPCs.

The cell openings in the fuel basket have been sized to accommodate all BWR and PWR assemblies listed in Refs. [1.2.6], [1.2.7], and [1.2.15], except as noted below. Similarly, the cavity length of the MPC has been set at a dimension that permits transportation of most types of PWR fuel assemblies and BWR fuel assemblies with or without fuel channels. The one exception is as follows:

- The South Texas Units 1 & 2 SNF, and CE 16x16 System 80™ SNF are too long to be accommodated in the available MPC cavity length.

In addition to satisfying the cross sectional and length compatibility, the active fuel region of the SNF must be enveloped in the axial direction by the neutron absorber located in the MPC fuel basket. Alignment of the neutron absorber with the active fuel region is ensured by the use of upper and lower fuel spacers suitably designed to support the bottom and restrain the top of the fuel assembly. The spacers axially position the SNF assembly such that its active fuel region is properly aligned with the neutron absorber in the fuel basket. Figure 1.2.15 provides a pictorial representation of the fuel spacers positioning the fuel assembly active fuel region. Both the upper and lower fuel spacers are designed to perform their function under normal and hypothetical accident conditions of transport. Due to the shorter, custom MPC design for Trojan plant fuel, only lower fuel spacers are needed for certain fuel assemblies that do not contain integral control rod assemblies. This creates the potential for a slight misalignment between the active fuel region of a fuel assembly and the neutron absorber panels affixed to the cell walls of the Trojan MPCs. This condition is addressed in the criticality evaluations described in Chapter 6.

In summary, the geometric compatibility of the SNF with the MPC designs does not require the definition of a design basis fuel assembly. This, however, is not the case for structural, containment, shielding, thermal-hydraulic, and criticality criteria. In fact, the same fuel type in a category (PWR or BWR) may not control the cask design in all of the above-mentioned criteria. To ensure that no SNF listed in Refs. [1.2.6], [1.2.7], and [1.2.15] that is geometrically admissible in the HI-STAR MPC is precluded from loading, it is necessary to determine the governing fuel specification for each analysis criteria. To make the necessary determinations, potential candidate fuel assemblies for each qualification criteria were considered. Table 1.2.8 lists the PWR fuel assemblies evaluated. These fuel assemblies were evaluated to define the governing design criteria for PWR fuel. The BWR fuel assembly designs evaluated are listed in Table 1.2.9. Tables 1.2.10 and 1.2.11 provide the fuel characteristics determined to be acceptable for transport in the HI-STAR 100 System. Each "array/class" listed in these tables represents a bounding set of parameters for one or more fuel assembly types. The array/classes are defined in SAR Section 6.2. Table 1.2.12 lists the BWR and PWR fuel assembly designs that are found to govern for the qualification criteria, namely reactivity, shielding, and thermal. Thermal is broken down into three criteria, namely: 1) fuel assembly effective planar conductivity, 2) fuel basket effective axial conductivity, and 3) MPC density and heat capacity. Substantiating results of analyses for the governing assembly types are presented in the respective chapters dealing with the specific qualification topic. Tables 1.2.10, 1.2.11, and 1.2.21 through 1.2.36 provide the specific limits for all material authorized to be transported in the HI-STAR 100 System. Additional information on the design basis fuel definition is presented in the following subsections.

1.2.3.2 Design Payload for Intact Fuel

Intact fuel assemblies are defined as fuel assemblies without known or suspected cladding defects greater than pinhole leaks and hairline cracks, and which can be handled by normal means. The design payload for intact fuel to be transported in the HI-STAR 100 System is provided in Tables 1.2.10, 1.2.11, and 1.2.22 through 1.2.36. The placement of a single stainless steel clad fuel assembly in an MPC necessitates that all fuel assemblies (stainless steel clad or Zircaloy clad) stored in that MPC meet the maximum heat generation requirements for stainless steel clad fuel. Stainless steel clad fuel assemblies are not authorized for transportation in the MPC-68F or MPC-32.

Fuel assemblies without fuel rods in fuel rod locations cannot be classified as intact fuel unless dummy fuel rods, which occupy a volume equal to or greater than the original fuel rods, replace the missing rods prior to loading. Any intact fuel assembly that falls within the geometric, thermal, and nuclear limits established for the design basis intact fuel assembly can be safely transported in the HI-STAR 100 System.

The fuel characteristics specified in Tables 1.2.10, 1.2.11, and 1.2.21 have been evaluated in this SAR and are acceptable for transport in the HI-STAR 100 System.

1.2.3.3 Design Payload for Damaged Fuel and Fuel Debris

Damaged fuel and fuel debris are defined in Table 1.0.1. The only PWR damaged fuel and fuel debris authorized for transportation in the HI-STAR 100 System is that from the Trojan plant. The only BWR damaged fuel and fuel debris authorized for transportation in the HI-STAR 100 System is that from the Dresden Unit 1 and Humboldt Bay plants.

Damaged fuel may only be transported in the MPC-24E, MPC-24EF, MPC-68, or MPC-68F as shown in Tables 1.2.23 through 1.2.26. Fuel debris may only be transported in the MPC-24EF and the MPC-68F as shown in Tables 1.2.24 and 1.2.26. Damaged fuel and fuel debris must be transported in stainless steel Holtec damaged fuel containers (DFCs) or other approved stainless steel damaged/failed fuel canister in the HI-STAR 100 System. The list of approved damaged/failed fuel canisters and associated SAR figures are provided below:

- Holtec-designed Dresden Unit 1 and Humboldt Bay Damaged Fuel Container(Figure 1.2.10)
- Sierra Nuclear-designed Trojan Failed Fuel Can (Figure 1.2.10A) containing Trojan damaged fuel, fuel debris, or Trojan Fuel debris process cans; or containing Trojan Fuel Debris Process Can Capsules (Figure 1.2.10C), which themselves contain Trojan Fuel Debris Process Cans (Figure 1.2.10B).
- Holtec-designed Damaged Fuel Container for Trojan plan fuel (Figure 1.2.10D)
- Dresden Unit 1's TN Damaged Fuel Container (Figure 1.2.11)
- Dresden Unit 1's Thoria Rod Canister (Figure 1.2.11A)

1.2.3.3.1 BWR Damaged Fuel and Fuel Debris

Dresden Unit 1 (UO_2 fuel rods and MOX fuel rods) and Humboldt Bay fuel arrays (Assembly Classes 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A) are authorized for transportation as damaged fuel in the MPC-68 and damaged fuel or fuel debris in the MPC-68F. No other BWR damaged fuel or fuel debris is authorized for transportation.

The limits for transporting Dresden Unit 1 and Humboldt Bay damaged fuel and fuel debris are given in Table 1.2.23 and 1.2.24. The placement of a single damaged fuel assembly in an MPC-68 or MPC-68F, or a single fuel debris damaged fuel container in an MPC-68F necessitates that all fuel assemblies (intact, damaged, or debris) placed in that MPC meet the maximum heat generation requirements specified in Tables 1.2.23 and 1.2.24.

The fuel characteristics specified in Tables 1.2.11, 1.2.23 and 1.2.24 for Dresden Unit 1 and Humboldt Bay fuel arrays have been evaluated in this SAR and are acceptable for transport as damaged fuel or fuel debris in the HI-STAR 100 System. Because of the long cooling time, small size, and low weight of spent fuel assemblies qualified as damaged fuel or fuel debris, the DFC and its contents are bounded by the structural, thermal, and shielding analyses performed for the intact BWR design basis fuel. Separate criticality analysis of the bounding fuel assembly for the damaged fuel and fuel debris has been performed in Chapter 6.

As Dresden Unit 1 and Humboldt Bay fuel assemblies classified as fuel debris have significant cladding damage, no cladding integrity is assumed. To meet the double containment criteria of 10CFR71.63(b) for plutonium shipments, the MPC-68F provides the secondary containment boundary (separate inner container), while the overpack provides the primary containment boundary.

The fuel characteristics specified in Table 1.2.11 for the Dresden Unit 1 and Humboldt Bay fuel arrays (Assembly Classes 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A) have been evaluated in this SAR and are acceptable for transport as damaged fuel or fuel debris in the HI-STAR 100 System after being placed in a damaged fuel container.

1.2.3.3.2 PWR Damaged Fuel and Fuel Debris

The PWR damaged fuel and fuel debris authorized for transportation in the HI-STAR 100 System is limited to that from the Trojan plant. The limits for transporting Trojan plant damaged fuel and fuel debris in the Trojan MPC-24E/EF are given in Tables 1.2.10, 1.2.25 and 1.2.26. All Trojan plant damaged fuel, and fuel debris listed below is authorized for transportation in the HI-STAR 100 System [1.2.12]:

- Damaged fuel assemblies in Trojan failed fuel cans
- Damaged fuel assemblies in Holtec's Trojan plant PWR damaged fuel container
- Fuel assemblies classified as fuel debris in Trojan failed fuel cans
- Trojan fuel assemblies classified as fuel debris in Holtec's Trojan damaged fuel container
- Fuel debris consisting of loose fuel pellets, fuel pellet fragments, and fuel assembly metal fragments (portions of fuel rods, portions of grid assemblies, bottom nozzles, etc.) in Trojan failed fuel cans
- Trojan fuel debris process cans loaded into Trojan fuel debris process can capsules and then into Trojan failed fuel cans. The fuel debris process cans contain fuel debris (metal fragments) and were used to process organic media removed from the Trojan spent fuel

pool during cleanup operations in preparation for decommissioning the pool. The fuel debris process cans have metallic filters in the can bottom and lid that allowed removal of water and organic media using high temperature steam, while retaining the solid residue from the processed media and fuel debris inside the process can†. Up to five process cans can be loaded into a process can capsule, which is vacuumed, purged, backfilled with helium, and seal-welded closed to provide a sealed containment for the fuel debris.

One Trojan Failed Fuel Can is not completely filled with fuel debris. Therefore, a stainless steel failed fuel can spacer is installed in this FFC to minimize movement of the fuel debris during normal transportation and hypothetical accident conditions. The spacer is a long, square tube with a baseplate that rests atop the fuel debris inside the Trojan FFC. A drawing of the Trojan failed fuel can spacer is provided in Section 1.4. A summary of the structural analysis of the FFC spacer is provided in Section 2.6.1.3.1.3.

1.2.3.4 Structural Payload Parameters

The main physical parameters of an SNF assembly applicable to the structural evaluation are the fuel assembly length, envelope (cross sectional dimensions), and weight. These parameters, which define the mechanical and structural design, are listed in Tables 1.2.22 through 1.2.27 for the various MPC models. The centers of gravity reported in Chapter 2 are based on the maximum fuel assembly weight. Upper and lower fuel spacers (as appropriate) maintain the axial position of the fuel assembly within the MPC basket and, therefore, the location of the center of gravity. The upper and lower spacers are designed to withstand normal and accident conditions of transport. An axial clearance of approximately 2 inches is provided to account for the irradiation and thermal growth of the fuel assemblies. The suggested upper and lower fuel spacer lengths are listed in Tables 1.2.16 and 1.2.17. Due to the custom design of the Trojan MPCs, only lower fuel spacers are required with Trojan plant fuel assemblies not containing non-fuel hardware or neutron sources. In order to qualify for transport in the HI-STAR 100 MPC, the SNF must satisfy the physical parameters listed in Tables 1.2.21 through 1.2.36, as applicable.

1.2.3.5 Thermal Payload Parameters

The principal thermal design parameter for the fuel is the peak fuel cladding temperature, which is a function of the maximum heat generation rate per assembly and the decay heat removal capabilities of the HI-STAR 100 System. The maximum heat generation rate per assembly for the design basis fuel assembly is based on the fuel assembly type with the lowest thermal performance characteristics. The parameters that define this decay heat design basis fuel are listed in Table 1.2.12. The governing thermal parameters to ensure that the range of SNF discussed previously are bounded by the thermal analysis discussed in detail and specified in Chapter 3. By utilizing these bounding thermal parameters, the calculated peak fuel rod cladding temperatures are conservative for the actual spent fuel assemblies, which are apt to have a higher thermal conductivity.

† The Trojan Fuel Debris Process Cans were used in the spent fuel pool cleanup effort conducted as part of plant decommissioning. This project is complete and not associated with certification of Trojan fuel debris for transportation in the HI-STAR 100 System under 10 CFR 71.

The peak fuel cladding temperature limit for normal conditions of transport is 400°C (752°F), which is consistent with the guidance in ISG-11, Revision 2 [1.2.14]. Tables 1.2.21 through 1.2.27 provide the maximum heat generation for all fuel assemblies authorized for transportation in the HI-STAR 100 System. The basis for these limits is discussed in Chapter 3.

Finally, the axial variation in the heat emission rate in the design basis fuel is defined based on the axial burnup distribution. For this purpose, the data provided in Refs. [1.2.8], [1.2.9], and [1.2.12] are utilized and summarized in Table 1.2.15 and Figures 1.2.13, 1.2.13A, and 1.2.14, for reference. These distributions are representative of fuel assemblies with the design burnup levels considered. These distributions are used for analysis only, and do not provide a criteria for fuel assembly acceptability for transport in the HI-STAR 100 System.

1.2.3.6 Radiological Payload Parameters

The principal radiological design criteria are the 10CFR71.47 and 10CFR71.51 radiation dose rate and release requirements for the HI-STAR 100 System. The radiation dose rate is directly affected by the gamma and neutron source terms of the SNF assembly.

The gamma and neutron sources are separate and are affected differently by enrichment, burnup, and cool time. It is recognized that, at a given burnup, the radiological source terms increase monotonically as the initial enrichment is reduced. The shielding design basis fuel assembly is, therefore, evaluated for different combinations of maximum burnup, minimum cooling time, and minimum enrichment. The shielding design basis intact fuel assembly thus bounds all other intact fuel assemblies.

The design basis dose rates can be met by a variety of burnup levels, cooling times, and minimum enrichments. Tables 1.2.21 through 1.2.36 include the burnup and cooling time values that meet the radiological dose rate requirements for all authorized contents to be transported in each MPC model. The allowable maximum burnup, minimum cooling time, and minimum enrichment limits were chosen strictly based on the dose rate requirements. All allowable burnup, cooling time, and minimum enrichment combinations result in calculated dose rates less than the regulatory dose rate limits.

Table 1.2.15 and Figures 1.2.13. 1.2.13A, and 1.2.14 provide the axial distribution for the radiological source term for PWR and BWR fuel assemblies, and for Trojan plant-specific fuel, based on the actual burnup distribution. The axial burnup distributions are representative of fuel assemblies with the design basis burnup levels considered. These distributions are used for analysis only, and do not provide criteria for fuel assembly acceptability for transport in the HI-STAR 100 System.

Thoria rods placed in Dresden Unit 1 Thoria Rod Canisters meeting the requirements of Table 1.2.21 and Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source have been qualified for transport. Up to one Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel, up to a total of 68 may be transported.

1.2.3.7 Criticality Payload Parameters

As discussed earlier, the MPC-68/68F and MPC-32 feature a basket without flux traps. In these fuel baskets, there is one panel of neutron absorber between adjacent fuel assemblies. The MPC-24/24E/24EF employs a construction wherein two neighboring fuel assemblies are separated by two panels of neutron absorber with a water gap between them (flux trap construction). The MPC-24 flux trap basket can accept a much higher enrichment fuel than a non-flux trap basket without taking credit for fuel assembly burnup in the criticality analysis. The maximum initial ^{235}U enrichment for PWR and BWR fuel authorized for transport is specified by fuel array/class in Tables 1.2.10 and 1.2.11, respectively. Trojan plant fuel is limited to a lower maximum initial enrichment of 3.7 wt.% ^{235}U compared to other fuel in its array/class, based on the specific analysis performed for the custom-designed Trojan MPCs containing only Trojan plant fuel.

The MPC-24 Boral ^{10}B areal density is specified at a minimum loading of 0.0267 g/cm^2. The MPC-24E/EF, MPC-32, and MPC-68 Boral ^{10}B areal density is specified at a minimum loading of 0.0372 g/cm^2. The MPC-68F Boral ^{10}B areal density is specified at a minimum loading of 0.01 g/cm^2.

For all MPCs, the ^{10}B loading areal density used for analysis is conservatively established at 75% of the minimum ^{10}B areal density to demonstrate that the reactivity under the most adverse accumulation of tolerances and biases is less than 0.95. The reduction in ^{10}B areal density credit meets NUREG-1617 [1.0.5], which requires a 25% reduction in ^{10}B areal density credit. A large body of sampling data accumulated by Holtec from thousands of manufactured Boral panels indicates the average ^{10}B areal densities to be approximately 15% greater than the specified minimum.

Credit for burnup of the fuel, in accordance with the intent of the guidance in Interim Staff Guidance Document 8 (ISG-8) [1.2.13], is taken in the criticality analysis to allow the transportation of certain PWR fuel assemblies in MPC-32. Burnup credit is a required input to qualify PWR fuel for transportation in the MPC-32, considering the inleakage of moderator (i.e., unborated water) under accident conditions. This hypothetical event is non-credible given the double barrier design engineered into the HI-STAR 100 System with the fully welded MPC enclosure vessel (designed for 60 g's) surrounded by the sealed overpack, which is designed for deep submersion under water (greater than 650 feet submersion) without breach. The details of the burnup credit analyses are provided in Chapter 6, including detailed discussion of how the recommendations of ISG-8 were implemented. Exceptions to some of the recommendations in ISG-8 were necessary (e.g., partial credit for fission products) in order to develop burnup versus enrichment curves that can be practically implemented at the plants. These exceptions are described in Chapter 6.

1.2.3.8 Non-Fuel Hardware and Neutron Sources

BWR fuel is permitted to be stored with or without Zircaloy channels. Control blades and stainless steel channels are not authorized for transportation in the HI-STAR 100 System. Dresden Unit 1 (D-1) neutron sources are authorized for transportation a shown in Tables 1.2.23 and 1.2.24. The D-1 neutron sources are single, long rods containing Sb-Be source material that fits into a water rod location in a D-1 fuel assembly.

Except for Trojan plant fuel, no PWR non-fuel hardware or neutron sources are authorized for transportation in the HI-STAR 100 System. For Trojan plant fuel only, the following non-fuel hardware and neutron sources are permitted for transportation in specific quantities as shown in Tables 1.2.25 and 1.2.26:

- Rod Cluster Control Assemblies (RCCAs) with cladding made of Type 304 stainless steel and Ag-In-Cd neutron absorber material.
- Burnable Poison Rod Assemblies (BPRAs) with cladding made of Type 304 stainless steel and borosilicate glass tube neutron poison material.
- Thimble Plug Devices made of Type 304 stainless steel.
- Neutron source assemblies with cladding made of Type 304 stainless steel - two (2) californium primary source assemblies and four (4) antimony-beryllium secondary source assemblies.

These devices are designed with thin rods of varying length and materials as discussed above, that fit into the fuel assembly guide tubes within the fuel rod lattice. The upper fittings for each device can vary to accommodate the handling tool (grapple) design. During reactor operation, the positions of the RCCAs are controlled by the operator using the control rod drive system, while the BPRAs, TPDs, and neutron sources stay fully inserted.

A complete list of the authorized non-fuel hardware and neutron sources, including appropriate limits on the characteristics of this material, is provided in Tables 1.2.23 through 1.2.36, as applicable.

1.2.3.9 Summary of Authorized Contents

The criticality safety index for the HI-STAR 100 Package is zero. A fuel assembly is acceptable for transport in a HI-STAR 100 System if it fulfills the following criteria.

a. It satisfies the physical parameter characteristics listed in Tables 1.2.10 or 1.2.11, as applicable..

b. It satisfies the cooling time, decay heat, burnup, enrichment, and other limits specified in Tables 1.2.21 through 1.2.36, as applicable.

c. Deleted.

d. Deleted.

A damaged fuel assembly shall be transported in a damaged fuel container or other authorized damaged/failed fuel canister, and shall meet the characteristics specified in Tables 1.2.23 through 1.2.26 for transport in the MPC-68, MPC-68F, MPC-24E, or MPC-24EF. Fuel classified as fuel debris shall be placed in a damaged fuel container or other authorized damaged/failed fuel canister and shall meet the characteristics specified in Tables 1.2.24 or 1.2.26 for transport in the MPC-68F or MPC-24EF.

Stainless steel clad fuel assemblies shall meet the characteristics specified in Tables 1.2.22 through 1.2.33 for transport in the MPC-24, MPC-24E, MPC-24EF, or MPC-68.

MOX BWR fuel assemblies shall meet the requirements of Tables 1.2.23 or 1.2.24 for intact and damaged fuel/fuel debris.

Thoria rods placed in Dresden Unit 1 Thoria Rod Canisters meeting the requirements of Table 1.2.21 and Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source have been qualified for transport. Up to one Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel, up to a total of 68 may be transported.

Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68 or MPC-68F.

Table 1.2.2 summarizes the key system data for the HI-STAR 100 System. Table 1.2.3 summarizes the key parameters and limits for the HI-STAR 100 MPCs. Tables 1.2.10, 1.2.11, and 1.2.21 through 1.2.37 and other tables referenced from these tables provide the limiting conditions for all material to be transported in the HI-STAR 100 System.

Table 1.2.1

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Table 1.2.2

SUMMARY OF KEY SYSTEM DATA FOR HI-STAR 100

PARAMETER	VALUE (Nominal)	
Types of MPCs in this SAR	6	4 for PWR 2 for BWR
MPC capacity	MPC-24	Up to 24 intact ZR or stainless steel clad PWR fuel assemblies
	MPC-24E	Up to 24 intact ZR or stainless steel clad PWR fuel assemblies. Up to four (4) Trojan plant fuel assemblies classified as damaged fuel, each in a Trojan Failed Fuel Can or a Holtec damaged fuel container, and the complement intact fuel assemblies.
	MPC-24EF	Up to 24 intact ZR or stainless steel clad PWR fuel assemblies. Up to four (4) Trojan plant fuel assemblies classified as damaged fuel or fuel debris, each in a Trojan Failed Fuel Can or a Holtec damaged fuel container; or other Trojan fuel debris stored in Trojan Process Cans either placed directly into a Trojan Failed Fuel Can or placed inside Trojan Process Can Capsules and then in Trojan Failed Fuel Cans; and the complement intact fuel assemblies.
	MPC-32	Up to 32 intact ZRclad PWR fuel assemblies.
	MPC-68	Up to 68 intact ZR or stainless steel clad BWR fuel assemblies or damaged ZR clad fuel assemblies* in damaged fuel containers within an MPC-68
	MPC-68F	Up to 4 damaged fuel containers with ZR clad BWR fuel debris* and the complement intact or damaged* ZR clad BWR fuel assemblies within an MPC-68F. *Only damaged fuel and fuel debris from Dresden Unit 1 or Humboldt Bay is authorized for transportation in the MPC-68 and MPC-68F.

Table 1.2.3
KEY PARAMETERS FOR HI-STAR 100 MULTI-PURPOSE CANISTERS

PARAMETER	PWR	BWR
Unloaded MPC weight (lb)	See Table 2.2.1	See Table 2.2.1
Minimum neutron absorber ^{10}B loading (g/cm^2)	0.0267 (MPC-24) 0.0372 (MPC-24E/EF) 0.0372 (MPC-32)	0.0372 (MPC-68) 0.01 (MPC-68F)
Pre-disposal service life (years)	40	40
Design temperature, max./min. (°F)	725°†/-40°††	725°†/-40°††
Design Internal pressure (psig) Normal Conditions Off-normal Conditions Accident Conditions	 100 100 200	 100 100 200
Total heat load, max. (kW)	20.0	18.5
Maximum permissible peak fuel cladding temperature (°F)	752° (normal conditions) 1058° (accident conditions)	752° (normal conditions) 1058° (accident conditions)
MPC internal environment Helium filled (psig)	≥ 0 and ≤ 44.8 psig††† at a reference temperature of 70°F	≥ 0 and ≤ 44.8 psig††† at a reference temperature of 70°F
MPC external environment/overpack internal environment Helium filled initial pressure (psig, at STP)	≥ 10 and ≤ 14	≥ 10 and ≤ 14
Maximum permissible reactivity including all uncertainty and biases	<0.95	<0.95
End closure(s)	Welded	Welded
Fuel handling	Opening compatible with standard grapples	Opening compatible with standard grapples
Heat dissipation	Passive	Passive

† Maximum normal condition design temperature for the MPC fuel basket. A complete listing of design temperatures for all components is provided in Table 2.1.2

†† Temperature based on minimum ambient temperature (10CFR71.71(c)(2)) and no fuel decay heat load.

††† This value represents the nominal backfill value used in the thermal analysis, plus 2 psig operating tolerance. Based on the MPC pressure results in Table 3.4.15 and the pressure limits specified in Table 2.1.1, there is sufficient analysis margin to accommodate this operating tolerance.

Tables 1.2.4 through 1.2.6

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Table 1.2.7

HI-STAR 100 LOADING OPERATIONS DESCRIPTION

Site-specific handling and operating procedures will be prepared, reviewed, and approved by each owner/user.	
1	Overpack and MPC lowered into the fuel pool without closure plate and MPC lid
2	Fuel assemblies transferred to the MPC fuel basket
3	MPC lid lowered onto the MPC
4	Overpack/MPC assembly moved to the decon pit and MPC lid welded in place, examined, pressure tested, and leak tested
5	MPC dewatered, dried, backfilled with helium, and the vent/drain port cover plates and closure ring welded
6	Overpack drained and external surfaces decontaminated
7	Overpack seals and closure plate installed and bolts pre-tensioned
8	Overpack cavity dried, backfilled with helium, and helium leak tested
9	HI-STAR 100 System transferred to transport bay
10	HI-STAR 100 placed onto transport saddles, tied down, impact limiters and personnel barrier installed, and package surveyed for release for transport.

Table 1.2.8

PWR FUEL ASSEMBLIES EVALUATED TO DETERMINE DESIGN BASIS SNF

Assembly Class	**Array Type**
B&W 15x15	All
B&W 17x17	All
CE 14x14	All
CE 16x16	All except System 80™
WE 14x14	All
WE 15x15	All
WE 17x17	All
St. Lucie	All
Ft. Calhoun	All
Haddam Neck (Stainless Steel Clad)	All
San Onofre 1 (Stainless Steel Clad, except MOX)	All
Indian Point 1	All

Table 1.2.9

BWR FUEL ASSEMBLIES EVALUATED TO DETERMINE DESIGN BASIS SNF

Assembly Class	Array Type			
GE BWR/2-3	All 7x7	All 8x8	All 9x9	All 10x10
GE BWR/4-6	All 7x7	All 8x8	All 9x9	All 10x10
Humboldt Bay	All 6x6	All 7x7 (Zircaloy Clad)		
Dresden-1	All 6x6	All 8x8		
LaCrosse (Stainless Steel Clad)	All			

Table 1.2.10
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	14x14A	14x14B	14x14C	14x14D	14x14E
Clad Material (Note 2)	ZR	ZR	ZR	SS	SS
Design Initial U (kg/assy.) (Note 3)	≤ 407	≤ 407	≤ 425	≤ 400	≤ 206
Initial Enrichment (MPC-24, 24E, and 24EF) (wt % ^{235}U)	≤ 4.6 (24) ≤ 5.0 (24E/24EF)	≤ 4.6 (24) ≤ 5.0 (24E/24EF)	≤ 4.6 (24) ≤ 5.0 (24E/24EF)	≤ 4.0 (24) ≤ 5.0 (24E/24EF)	≤ 5.0
Initial Enrichment (MPC-32) (wt % ^{235}U) (Note 5)	N/A	N/A	N/A	N/A	N/A
No. of Fuel Rod Locations	179	179	176	180	173
Fuel Clad O.D. (in.)	≥ 0.400	≥ 0.417	≥ 0.440	≥ 0.422	≥ 0.3415
Fuel Clad I.D. (in.)	≤ 0.3514	≤ 0.3734	≤ 0.3880	≤ 0.3890	≤ 0.3175
Fuel Pellet Dia. (in.)	≤ 0.3444	≤ 0.3659	≤ 0.3805	≤ 0.3835	≤ 0.3130
Fuel Rod Pitch (in.)	≤ 0.556	≤ 0.556	≤ 0.580	≤ 0.556	Note 6
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 144	≤ 102
No. of Guide and/or Instrument Tubes	17	17	5 (Note 4)	16	0
Guide/Instrument Tube Thickness (in.)	≥ 0.017	≥ 0.017	≥ 0.038	≥ 0.0145	N/A

Table 1.2.10 (continued)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	15x15A	15x15B	15x15C	15x15D	15x15E	15x15F
Clad Material (Note 2)	ZR	ZR	ZR	ZR	ZR	ZR
Design Initial U (kg/assy.) (Note 3)	≤ 464	≤ 464	≤ 464	≤ 475	≤ 475	≤ 475
Initial Enrichment (MPC-24, 24E, and 24EF (wt % ^{235}U)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)	≤ 4.1 (24) ≤ 4.5 (24E/24EF)
Initial Enrichment (MPC-32) (wt % ^{235}U) (Note 5)	N/A	N/A	N/A	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rod Locations	204	204	204	208	208	208
Fuel Clad O.D. (in.)	≥ 0.418	≥ 0.420	≥ 0.417	≥ 0.430	≥ 0.428	≥ 0.428
Fuel Clad I.D. (in.)	≤ 0.3660	≤ 0.3736	≤ 0.3640	≤ 0.3800	≤ 0.3790	≤ 0.3820
Fuel Pellet Dia. (in.)	≤ 0.3580	≤ 0.3671	≤ 0.3570	≤ 0.3735	≤ 0.3707	≤ 0.3742
Fuel Rod Pitch (in.)	≤ 0.550	≤ 0.563	≤ 0.563	≤ 0.568	≤ 0.568	≤ 0.568
Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Guide and/or Instrument Tubes	21	21	21	17	17	17
Guide/Instrument Tube Thickness (in.)	≥ 0.0165	≥ 0.015	≥ 0.0165	≥ 0.0150	≥ 0.0140	≥ 0.0140

Table 1.2.10 (continued)
PWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	15x15G	15x15H	16x16A	17x17A	17x17B	17x17C
Clad Material (Note 2)	SS	ZR	ZR	ZR	ZR	ZR
Design Initial U (kg/assy.) (Note 3)	≤420	≤475	≤443	≤467	≤467	≤474
Initial Enrichment (MPC-24, 24E, and 24EF) (wt % ^{235}U)	≤4.0 (24) ≤4.5 (24E/24EF)	≤3.8 (24) ≤4.2 (24E/24EF)	≤4.6 (24) ≤5.0 (24E/24EF)	≤4.0 (24) ≤4.4 (24E/24EF)	≤4.0 (24) ≤4.4 (24E/24EF) (Note 7)	≤4.0 (24) ≤4.4 (24E/24EF)
Initial Enrichment (MPC-32) (wt % ^{235}U) (Note 5)	N/A	≤5.0	N/A	≤5.0	≤5.0	≤5.0
No. of Fuel Rod Locations	204	208	236	264	264	264
Fuel Clad O.D. (in.)	≥0.422	≥0.414	≥0.382	≥0.360	≥0.372	≥0.377
Fuel Clad I.D. (in.)	≤0.3890	≤0.3700	≤0.3320	≤0.3150	≤0.3310	≤0.3330
Fuel Pellet Dia. (in.)	≤0.3825	≤0.3622	≤0.3255	≤0.3088	≤0.3232	≤0.3252
Fuel Rod Pitch (in.)	≥0.563	≥0.568	≥0.506	≥0.496	≥0.496	≥0.502
Active Fuel Length (in.)	≤144	≤150	≤150	≤150	≤150	≤150
No. of Guide and/or Instrument Tubes	21	17	5 (Note 4)	25	25	25
Guide/Instrument Tube Thickness (in.)	≥0.0145	≥0.0140	≥0.0400	≥0.016	≥0.014	≥0.020

Table 1.2.10 (continued)
PWR FUEL ASSEMBLY CHARACTERISTICS

Notes:

1. All dimensions are design nominal values. Maximum and minimum dimensions are specified to bound variations in design nominal values among fuel assemblies within a given array/class.

2. ZR designates any zirconium-based fuel cladding material authorized for use in a commercial power reactor.

3. Design initial uranium weight is the nominal uranium weight specified for each assembly by the fuel manufacturer or reactor user. For each PWR fuel assembly, the total uranium weight limit specified in this table may be increased up to 2.0 percent for comparison with users' fuel records to account for manufacturer's tolerances.

4. Each guide tube replaces four fuel rods.

5. Minimum assembly average burnup is required per Table 1.2.34.

6. This fuel assembly array/class includes only the Indian Point Unit 1 fuel assembly. This fuel assembly has two pitches in different sectors of the assembly. These pitches are 0.441 inches and 0.453 inches.

7. Trojan plant-specific fuel is governed by the limits specified for array/class 17x17B and will be transported in the custom-designed Trojan MPC-24E/EF canisters. The Trojan MPC-24E/EF design is authorized to transport only Trojan plant fuel with a maximum initial enrichment of 3.7 wt.% ^{235}U.

Table 1.2.11
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	**6x6A**	**6x6B**	**6x6C**	**7x7A**	**7x7B**	**8x8A**
Clad Material (Note 2)	ZR	ZR	ZR	ZR	ZR	ZR
Design Initial U (kg/assy.) (Note 3)	≤ 110	≤ 110	≤ 110	≤ 100	≤ 195	≤ 120
Maximum Planar-Average Initial Enrichment (wt % ^{235}U)	≤ 2.7	≤ 2.7 for the UO_2 rods. See Note 4 for MOX rods.	≤ 2.7	≤ 2.7	≤ 4.2	≤ 2.7
Initial Maximum Rod Enrichment (wt % ^{235}U)	≤ 4.0	≤ 4.0	≤ 4.0	≤ 5.5	≤ 5.0	≤ 4.0
No. of Fuel Rod Locations	35 or 36	35 or 36 (up to 9 MOX rods)	36	49	49	63 or 64
Fuel Clad O.D. (in.)	≥ 0.5550	≥ 0.5625	≥ 0.5630	≥ 0.4860	≥ 0.5630	≥ 0.4120
Fuel Clad I.D. (in.)	≤ 0.5105	≤ 0.4945	≤ 0.4990	≤ 0.4204	≤ 0.4990	≤ 0.3620
Fuel Pellet Dia. (in.)	≤ 0.4980	≤ 0.4820	≤ 0.4880	≤ 0.4110	≤ 0.4910	≤ 0.3580
Fuel Rod Pitch (in.)	≤ 0.710	≤ 0.710	≤ 0.740	≤ 0.631	≤ 0.738	≤ 0.523
Active Fuel Length (in.)	≤ 120	≤ 120	≤ 77.5	≤ 80	≤ 150	≤ 120
No. of Water Rods (Note 11)	1 or 0	1 or 0	0	0	0	1 or 0
Water Rod Thickness (in.)	> 0	> 0	N/A	N/A	N/A	≥ 0
Channel Thickness (in.)	≤ 0.060	≤ 0.060	≤ 0.060	≤ 0.060	≤ 0.120	≤ 0.100

Table 1.2.11 (continued)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	8x8B	8x8C	8x8D	8x8E	8x8F	9x9A
Clad Material (Note 2)	ZR	ZR	ZR	ZR	ZR	ZR
Design Initial U (kg/assy) (Note 3)	≤ 185	≤ 185	≤ 185	≤ 185	≤ 185	≤ 177
Maximum Planar-Average Initial Enrichment (wt % ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.2	≤ 4.2	≤ 4.0	≤ 4.2
Initial Maximum Rod Enrichment (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rod Locations	63 or 64	62	60 or 61	59	64	74/66 (Note 5)
Fuel Clad O.D. (in.)	≥ 0.4840	≥ 0.4830	≥ 0.4830	≥ 0.4930	≥ 0.4576	≥ 0.4400
Fuel Clad I.D. (in.)	≤ 0.4295	≤ 0.4250	≤ 0.4230	≤ 0.4250	≤ 0.3996	≤ 0.3840
Fuel Pellet Dia. (in.)	≤ 0.4195	≤ 0.4160	≤ 0.4140	≤ 0.4160	≤ 0.3913	≤ 0.3760
Fuel Rod Pitch (in.)	≤ 0.642	≤ 0.641	≤ 0.640	≤ 0.640	≤ 0.609	≤ 0.566
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Water Rods (Note 11)	1 or 0	2	1 - 4 (Note 7)	5	N/A (Note 12)	2
Water Rod Thickness (in.)	≥ 0.034	> 0.00	> 0.00	≥ 0.034	≥ 0.0315	> 0.00
Channel Thickness (in.)	≤ 0.120	≤ 0.120	≤ 0.120	≤ 0.100	≤ 0.055	≤ 0.120

Table 1.2.11 (continued)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	9x9 B	9x9 C	9x9 D	9x9 E (Note 13)	9x9 F (Note 13)	9x9 G
Clad Material (Note 2)	ZR	ZR	ZR	ZR	ZR	ZR
Design Initial U (kg/assy.) (Note 3)	≤ 177	≤ 177	≤ 177	≤ 177	≤ 177	≤ 177
Maximum Planar-Average Initial Enrichment (wt % ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.2	≤ 4.0	≤ 4.0	≤ 4.2
Initial Maximum Rod Enrichment (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rod Locations	72	80	79	76	76	72
Fuel Clad O.D. (in.)	≥ 0.4330	≥ 0.4230	≥ 0.4240	≥ 0.4170	≥ 0.4430	≥ 0.4240
Fuel Clad I.D. (in.)	≤ 0.3810	≤ 0.3640	≤ 0.3640	≤ 0.3640	≤ 0.3860	≤ 0.3640
Fuel Pellet Dia. (in.)	≤ 0.3740	≤ 0.3565	≤ 0.3565	≤ 0.3530	≤ 0.3745	≤ 0.3565
Fuel Rod Pitch (in.)	≤ 0.572	≤ 0.572	≤ 0.572	≤ 0.572	≤ 0.572	≤ 0.572
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Water Rods (Note 11)	1 (Note 6)	1	2	5	5	1 (Note 6)
Water Rod Thickness (in.)	> 0.00	≥ 0.020	≥ 0.0300	≥ 0.0120	≥ 0.0120	≥ 0.0320
Channel Thickness (in.)	≤ 0.120	≤ 0.100	≤ 0.100	≤ 0.120	≤ 0.120	≤ 0.120

Table 1.2.11 (continued)
BWR FUEL ASSEMBLY CHARACTERISTICS (Note 1)

Fuel Assembly Array/Class	10x10 A	10x10 B	10x10 C	10x10 D	10x10 E
Clad Material (Note 2)	ZR	ZR	ZR	SS	SS
Design Initial U (kg/assy.) (Note 3)	≤ 186	≤ 186	≤ 186	≤ 125	≤ 125
Maximum Planar-Average Initial Enrichment (wt % ^{235}U)	≤ 4.2	≤ 4.2	≤ 4.2	≤ 4.0	≤ 4.0
Initial Maximum Rod Enrichment (wt % ^{235}U)	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
No. of Fuel Rod Locations	92/78 (Note 8)	91/83 (Note 9)	96	100	96
Fuel Clad O.D. (in.)	≥ 0.4040	≥ 0.3957	≥ 0.3780	≥ 0.3960	≥ 0.3940
Fuel Clad I.D. (in.)	≤ 0.3520	≤ 0.3480	≤ 0.3294	≤ 0.3560	≤ 0.3500
Fuel Pellet Dia. (in.)	≤ 0.3455	≤ 0.3420	≤ 0.3224	≤ 0.3500	≤ 0.3430
Fuel Rod Pitch (in.)	≤ 0.510	≤ 0.510	≤ 0.488	≤ 0.565	≤ 0.557
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 83	≤ 83
No. of Water Rods (Note 11)	2	1 (Note 6)	5 (Note 10)	0	4
Water Rod Thickness (in.)	≥ 0.030	> 0.00	≥ 0.031	N/A	≥ 0.022
Channel Thickness (in.)	≤ 0.120	≤ 0.120	≤ 0.055	≤ 0.080	≤ 0.080

Table 1.2.11 (continued)
BWR FUEL ASSEMBLY CHARACTERISTICS

NOTES:

1. All dimensions are design nominal values. Maximum and minimum dimensions are specified to bound variations in design nominal values among fuel assemblies within a given array/class.

2. ZR designates any zirconium-based fuel cladding material authorized for use in a commercial power reactor.

3. Design initial uranium weight is the nominal uranium weight specified for each assembly by the fuel manufacturer or reactor user. For each BWR fuel assembly, the total uranium weight limit specified in this table may be increased up to 1.5 percent for comparison with users' fuel records to account for manufacturer tolerances.

4. $\leq$ 0.635 wt. % ^{235}U and $\leq$ 1.578 wt. % total fissile plutonium (^{239}Pu and ^{241}Pu), (wt. % of total fuel weight, i.e., UO_2 plus PuO_2).

5. This assembly class contains 74 total rods; 66 full length rods and 8 partial length rods.

6. Square, replacing nine fuel rods.

7. Variable.

8. This assembly contains 92 total fuel rods; 78 full length rods and 14 partial length rods.

9. This assembly class contains 91 total fuel rods; 83 full length rods and 8 partial length rods.

10. One diamond-shaped water rod replacing the four center fuel rods and four rectangular water rods dividing the assembly into four quadrants.

11. These rods may also be sealed at both ends and contain ZR material in lieu of water.

12. This assembly is known as "QUAD+." It has four rectangular water cross segments dividing the assembly into four quadrants.

13. For the SPC 9x9-5 fuel assembly, each fuel rod must meet either the 9x9E or the 9x9F set of limits or clad O.D., clad I.D., and pellet diameter.

Table 1.2.12

DESIGN BASIS FUEL ASSEMBLY FOR EACH DESIGN CRITERION

Criterion	MPC-68/68F	MPC-24/24E/24EF/32
Reactivity	SPC 9x9-5 (Array/Class 9x9E/F)	B&W 15x15 (Array/Class 15x15F)
Shielding (Source Term)	GE 7x7	B&W 15x15
Fuel Assembly Effective Planar Thermal Conductivity	GE 11 9x9	W 17x17 OFA
Fuel Basket Effective Axial Thermal Conductivity	GE 7x7	W 14x14 OFA
MPC Density and heat Capacity	GE 7x7	W 14x14 OFA

Tables 1.2.13 and 1.2.14

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Table 1.2.15

NORMALIZED DISTRIBUTION BASED ON BURNUP PROFILE

GENERIC FUEL DISTRIBUTION†			
Interval	**Axial Distance From Bottom of Active Fuel (% of Active Fuel Length)**	**PWR Fuel Normalized Distribution**	**BWR Fuel Normalized Distribution**
1	0% to 4-1/6%	0.5485	0.2200
2	4-1/6% to 8-1/3%	0.8477	0.7600
3	8-1/3% to 16-2/3%	1.0770	1.0350
4	16-2/3% to 33-1/3%	1.1050	1.1675
5	33-1/3% to 50%	1.0980	1.1950
6	50% to 66-2/3%	1.0790	1.1625
7	66-2/3% to 83-1/3%	1.0501	1.0725
8	83-1/3% to 91-2/3%	0.9604	0.8650
9	91-2/3% to 95-5/6%	0.7338	0.6200
10	95-5/6% to 100%	0.4670	0.2200

TROJAN PLANT FUEL DISTRIBUTION††		
Interval	**Axial Distance From Bottom of Active Fuel (% of Active Fuel Length)**	**Normalized Distribution**
1	0% to 5%	0.59
2	5% to 10%	0.89
3	10% to 15%	1.03
4	15% to 20%	1.07
5	20% to 25%	1.09
6	25% to 45%	1.10
7	45% to 70%	1.09
8	70% to 75%	1.07
9	75% to 80%	1.05
10	80% to 85%	1.02
11	85% to 90%	0.96
12	90% to 95 %	0.82
13	95% to 100%	0.56

† References [1.2.8] and [1.2.9]

†† Reference [1.2.12]

Table 1.2.16

SUGGESTED PWR UPPER AND LOWER FUEL SPACER LENGTHS (Note 1)

Fuel Assembly Type	Assembly Length w/o NFH† (in.)	Location of Active Fuel from Bottom (in.)	Max. Active Fuel Length (in.)	Upper Fuel Spacer Length (in.)	Lower Fuel Spacer Length (in.)
CE 14x14	157	4.1	137	9.5	10
CE 16x16	176.8	4.7	150	0	0
BW 15x15	165.7	8.4	141.8	6.7	4.1
W 17x17 OFA	159.8	3.7	144	8.2	8.5
W 17x17S	159.8	3.7	144	8.2	8.5
W 17x17V5H	160.1	3.7	144	7.9	8.5
W 15x15	159.8	3.7	144	8.2	8.5
W 14x14S	159.8	3.7	145.2	9.2	7.5
W 14x14 OFA	159.8	3.7	144	8.2	8.5
Ft. Calhoun	146	6.6	128	10.25	20.25
St. Lucie 2	158.2	5.2	136.7	10.25	8.05
B&W 15x15 SS	137.1	3.873	120.5	19.25	19.25
W 15x15 SS	137.1	3.7	122	19.25	19.25
W 14x14 SS	137.1	3.7	120	19.25	19.25
Indian Point 1	137.2	17.705	101.5	18.75	20.0

Notes: 1. These fuel spacer lengths are not applicable to Trojan plant fuel. Trojan plant fuel spacer lengths are determined uniquely for the custom-designed Trojan MPC-24E/EF, as necessary, based on the presence of non-fuel hardware. They are sized to maintain the active fuel within the envelope of the neutron absorber affixed to the cell walls and allow for an approximate 2-inch gap between the fuel and the MPC lid. See Chapter 6 for discussion of potential misalignments between the active fuel and the neutron absorber.

† NFH is an abbreviation for non-fuel hardware, including control components. Fuel assemblies with control components may require shorter fuel spacers.

Table 1.2.17

SUGGESTED BWR UPPER AND LOWER FUEL SPACER LENGTHS (Note 1)

Fuel Assembly Type	Assembly Length (in.)	Location of Active Fuel from Bottom (in.)	Max. Active Fuel Length (in.)	Upper Fuel Spacer Length (in.)	Lower Fuel Spacer Length (in.)
GE/2-3	171.2	7.3	150	4.8	0
GE/4-6	176.2	7.3	150	0	0
Dresden 1	134.4	11.2	110	18	28.0
Humboldt Bay	95	8	79	40.5	40.5
Dresden 1 Damaged Fuel or Fuel Debris	142.1†	11.2	110	17	16.9
Humboldt Bay Damaged Fuel or Fuel Debris	105.5†	8	79	35.25	35.25
LaCrosse	102.5	10.5	83	37	37.5

Notes: 1. Each user shall specify the fuel spacer lengths based on their fuel length and allowing an approximate 2-inch gap between the fuel and the MPC lid. See Chapter 6 for discussion of potential misalignments between the active fuel and the neutron absorber.

† Fuel length includes the damaged fuel container.

Aspect of Post-Accident Performance	Results with Demonstrated Integrity of MPC Enclosure Vessel	Results with Postulated Gross Failure of MPC Enclosure Vessel
Containment Boundary Integrity	The MPC enclosure vessel is leak tested to 5.0×10^{-6} atm cm^3/s (helium). The overpack containment boundary is standard air leak tested to 4.3×10^{-6} atm cm^3/s (helium). Both boundaries are shown to withstand all hypothetical accident conditions. Therefore, there will be no detectable release of radioactive materials.	The overpack containment boundary is leak tested to 4.3×10^{-6} atm cm^3/s (helium). The overpack containment boundary is shown to withstand all hypothetical accident conditions. Therefore, the overpack containment boundary meets the accident condition leakage rates.
Maintenance of Subcritical Margins (Maximum k_{eff})	The MPC enclosure vessel is seal welded and there is no breach of the MPC. The bolted closure overpack containment boundary has been shown to prevent water immersion. Therefore, the maximum reactivity of the fuel in a dry MPC is less than 0.5.	The bolted closure overpack containment boundary has been shown to prevent water immersion. Therefore, the maximum reactivity of the fuel in a dry MPC is less than 0.5. Assuming the MPC is fully flooded with water, the reactivity is shown to be below the regulatory requirement of 0.95 including uncertainties and bias.
Adequate Shielding	The MPC enclosure vessel boundary has no effect on the dose rates of the HI-STAR 100 System.	Failure of the MPC enclosure vessel to maintain a release boundary has no effect on the dose rates of the HI-STAR 100 System.
Adequate Heat Rejection (Peak Fuel Cladding Temperature)	The MPC enclosure vessel maintains the helium and the peak fuel cladding temperature is demonstrated to remain below 800°F in the post-fire hypothetical accident condition.	Assuming the MPC internal helium fill pressure is released into the overpack containment, the pressure within the small annulus would rise to equalize with the MPC internal pressure. There would be a corresponding slight pressure decrease in the MPC enclosure vessel. The comparatively small volume of the annulus and pressure differential results in the slight pressure change. This will have a negligibly small effect on the peak fuel cladding temperature. The overpack containment boundary is demonstrated to withstand all hypothetical accident conditions. Therefore, there is no credible mechanism for the release of the helium.

Tables 1.2.19 and 1.2.20

INTENTIONALLY DELETED

Table 1.2.21

DESIGN CHARACTERISTICS FOR THORIA RODS IN D-1 THORIA ROD CANISTERS

PARAMETER	MPC-68 or MPC-68F
Cladding Type	ZR
Composition	98.2 wt.% ThO_2, 1.8 wt.% UO_2 with an enrichment of 93.5 wt. % ^{235}U
Number of Rods Per Thoria Canister	$\leq$ 18
Decay Heat Per Thoria Canister	$\leq$ 115 watts
Post-Irradiation Fuel Cooling Time and Average Burnup Per Thoria Canister	Cooling time $\geq$ 18 years and average burnup $\leq$ 16,000 MWD/MTIHM
Initial Heavy Metal Weight	$\leq$ 27 kg/canister
Fuel Cladding O.D.	$\geq$ 0.412 inches
Fuel Cladding I.D.	$\leq$ 0.362 inches
Fuel Pellet O.D.	$\leq$ 0.358 inches
Active Fuel Length	$\leq$ 111 inches
Canister Weight	$\leq$ 550 lbs., including Thoria Rods
Canister Material	Type 304 SS

Table 1.2.22

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24

PARAMETER	VALUE
Fuel Type	Uranium oxide, PWR intact fuel assemblies meeting the limits in Table 1.2.10 for the applicable array/class
Cladding Type	ZR or Stainless Steel (SS) as specified in Table 1.2.10 for the applicable array/class
Maximum Initial Enrichment	As specified in Table 1.2.10 for the applicable array/class
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly	ZR clad: As specified in Table 1.2.28 or Table 1.2.29, as applicable SS clad: As specified in Table 1.2.30
Decay Heat Per Assembly	ZR clad: $\leq$ 833 Watts SS clad: $\leq$ 488 Watts
Fuel Assembly Length	$\leq$ 176.8 in. (nominal design)
Fuel Assembly Width	$\leq$ 8.54 in. (nominal design)
Fuel Assembly Weight	$\leq$ 1,680 lbs
Other Limitations	▪ Quantity is limited to up to 24 PWR intact fuel assemblies. ▪ Non-fuel hardware and neutron sources not permitted. ▪ Damaged fuel assemblies and fuel debris not permitted. ▪ Trojan plant fuel not permitted.

Table 1.2.23

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-68

PARAMETER	VALUE (Note 1)			
Fuel Type(s)	Uranium oxide, BWR intact fuel assemblies meeting the limits in Table 1.2.11 for the applicable array/class, with or without Zircaloy channels	Uranium oxide, BWR damaged fuel assemblies meeting the limits in Table 1.2.11 for array/class 6x6A, 6x6C, 7x7A, or 8x8A, with or without Zircaloy channels, placed in Damaged Fuel Containers(DFCs)	Mixed Oxide (MOX) BWR intact fuel assemblies meeting the limits in Table 1.2.11 for array/class 6x6B, with or without Zircaloy channels	Mixed Oxide (MOX) BWR damaged fuel assemblies meeting the limits in Table 1.2.11 for array/class 6x6B, with or without Zircaloy channels, placed in Damaged Fuel Containers (DFCs)
Cladding Type	ZR or Stainless Steel (SS) as specified in Table 1.2.11 for the applicable array/class	ZR	ZR	ZR
Maximum Initial Planar-Average and Rod Enrichment	As specified in Table 1.2.11 for the applicable array/class	As specified in Table 1.2.11 for the applicable array/class	As specified in Table 1.2.11 for array/class 6x6B	As specified in Table 1.2.11 for array/class 6x6B
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly	ZR clad: As specified in Table 1.2.31 except as provided in Notes 2 and 3 SS clad: Note 4	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTU, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTIHM, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTIHM, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.
Decay Heat Per Assembly	ZR clad: $\leq$ 272 Watts (Note 5) SS clad: $\leq$ 83 Watts	$\leq$ 115 Watts	$\leq$ 115 Watts	$\leq$ 115 Watts

Table 1.2.23 (cont'd)

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-68

PARAMETER	VALUE (Note 1)			
Fuel Assembly Length	≤ 176.2 in. (nominal design)	≤ 135.0 in. (nominal design)	≤ 135.0 in. (nominal design)	≤ 135.0 in. (nominal design)
Fuel Assembly Width	≤ 5.85 in. (nominal design)	≤ 4.70 in. (nominal design)	≤ 4.70 in. (nominal design)	≤ 4.70 in. (nominal design)
Fuel Assembly Weight	≤ 700 lbs (including channels)	≤ 550 lbs, (including channels and DFC)	≤ 400 lbs, (including channels)	≤ 550 lbs, (including channels and DFC)
Quantity per MPC	Up to 68 BWR intact fuel assemblies	Up to 68 BWR damaged and/or intact fuel assemblies	Up to 68 BWR intact fuel assemblies	Up to 68 BWR damaged and/or intact fuel assemblies
Other Limitations	▪ Quantity is limited to up to one (1) Dresden Unit 1 thoria rod canister meeting the specifications listed in Table 1.2.21 plus any combination of Dresden Unit 1 or Humboldt Bay damaged fuel assemblies in DFCs and intact fuel assemblies up to a total of 68. ▪ Stainless steel channels are not permitted. ▪ Fuel debris is not permitted. ▪ Dresden Unit 1 fuel assemblies with one antimony-beryllium neutron source are permitted. The antimony-beryllium neutron source material shall be in a water rod location.			

Notes:

1. A fuel assembly must meet the requirements of any one column and the other limitations to be authorized for transportation.

2. Array/class 6x6A, 6x6C, 7x7A, and 8x8A fuel assemblies shall have a cooling time ≥ 18 years, an average burnup ≤ 30,000 MWD/MTU, and a minimum initial enrichment ≥ 1.8 wt. % ^{235}U.

3. Array/class 8x8F fuel assemblies shall have a cooling time ≥ 10 years, an average burnup ≤ 27,500 MWD/MTU, and a minimum initial enrichment ≥ 2.4 wt. % ^{235}U.

4. SS-clad fuel assemblies shall have a cooling time ≥ 16 years, an average burnup ≤ 22,500 MWD/MTU, and a minimum initial enrichment ≥ 3.5 wt. % ^{235}U.

5. Array/class 8x8F fuel assemblies shall have a decay heat ≤ 183.5 Watts.

Table 1.2.24

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-68F

PARAMETER	VALUE (Notes 1 and 2)			
Fuel Type(s)	Uranium oxide, BWR intact fuel assemblies meeting the limits in Table 1.2.11 for array/class 6x6A, 6x6C, 7x7A, or 8x8A, with or without Zircaloy channels	Uranium oxide, BWR damaged fuel assemblies or fuel debris meeting the limits in Table 1.2.11 for array/class 6x6A, 6x6C, 7x7A, or 8x8A, with or without Zircaloy channels, placed in Damaged Fuel Containers(DFCs)	Mixed Oxide (MOX) BWR intact fuel assemblies meeting the limits in Table 1.2.11 for array/class 6x6B, with or without Zircaloy channels	Mixed Oxide (MOX) BWR damaged fuel assemblies or fuel debris meeting the limits in Table 1.2.11 for array/class 6x6B, with or without Zircaloy channels, placed in Damaged Fuel Containers (DFCs))
Cladding Type	ZR	ZR	ZR	ZR
Maximum Initial Planar-Average and Rod Enrichment	As specified in Table 1.2.11 for the applicable array/class	As specified in Table 1.2.11 for the applicable array/class	As specified in Table 1.2.11 for array/class 6x6B	As specified in Table 1.2.11 for array/class 6x6B
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTU, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTU, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTIHM, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.	Cooling time $\geq$ 18 years, average burnup $\leq$ 30,000 MWD/MTIHM, and minimum initial enrichment $\geq$ 1.8 wt. % ^{235}U.
Decay Heat Per Assembly	$\leq$ 115 Watts	$\leq$ 115 Watts	$\leq$ 115 Watts	$\leq$ 115 Watts

Table 1.2.24 (cont'd)

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-68F

PARAMETER	VALUE (Note 1)			
Fuel Assembly Length	≤ 135.0 in. (nominal design)	≤ 135.0 in. (nominal design)	≤ 135.0 in. (nominal design)	≤ 135.0 in. (nominal design)
Fuel Assembly Width	≤ 4.70 in. (nominal design)	≤ 4.70 in. (nominal design)	≤ 4.70 in. (nominal design)	≤ 4.70 in. (nominal design)
Fuel Assembly Weight	≤ 400 lbs (including channels)	≤ 550 lbs (including channels and DFC)	≤ 400 lbs (including channels)	≤ 550 lbs (including channels and DFC)
Other Limitations	▪ Quantity is limited to up to four (4) DFCs containing Dresden Unit 1 or Humboldt Bay uranium oxide or MOX fuel debris. The remaining fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable: - uranium oxide BWR intact fuel assemblies - MOX BWR intact fuel assemblies - uranium oxide BWR damaged fuel assemblies in DFCs - MOX BWR damaged fuel assemblies in DFCs - up to one (1) Dresden Unit 1 thoria rod canister meeting the specifications listed in Table 1.2.21 ▪ Stainless steel channels are not permitted. ▪ Dresden Unit 1 fuel assemblies with one antimony-beryllium neutron source are permitted. The antimony-beryllium neutron source material shall be in a water rod location.			

Notes:

1. A fuel assembly must meet the requirements of any one column and the other limitations to be authorized for transportation.

2. Only fuel from Dresden Unit 1 and Humboldt Bay plant are permitted for transportation in the MPC-68F.

Table 1.2.25

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24E

PARAMETER	VALUE (Note 1)	
Fuel Type	Uranium oxide PWR intact fuel assemblies meeting the limits in Table 1.2.10 for the applicable array/class	Trojan plant damaged fuel meeting the limits in Table 1.2.10 for array/class 17x17B, placed in a Holtec Damaged Fuel Container (DFC) designed for Trojan plan fuel or a Trojan Failed Fuel Can (FFC)
Cladding Type	ZR or Stainless Steel (SS) assemblies as specified in Table 1.2.10 for the applicable array/class	ZR
Maximum Initial Enrichment	As specified in Table 1.2.10 for the applicable array/class	3.7 wt. % ^{235}U
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly (except Trojan plant fuel and non-fuel hardware)	ZR clad: As specified in Table 1.2 28 or 1.2.29, as applicable SS clad: As specified in Table 1.2.30	Not applicable
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly for Trojan plant fuel	As specified in Table 1.2.35	As specified in Table 1.2.35
Post-irradiation Cooling Time and Burnup for Trojan plant Non-fuel Hardware and Neutron Sources	As specified in Table 1.2.36	Not applicable
Decay Heat Per Assembly (except for Trojan plant fuel)	ZR clad: $\leq$ 833 Watts SS clad: $\leq$ 488 Watts	Not applicable
Decay heat per Assembly for Trojan plant fuel	$\leq$ 725 Watts	$\leq$ 725 Watts

Table 1.2.25 (cont'd)

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24E

PARAMETER	VALUE (Note 1)	
Fuel Assembly Length	$\leq$ 176.8 in. (nominal design)	$\leq$ 169.3 in. (nominal design)
Fuel Assembly Width	$\leq$ 8.54 in. (nominal design)	$\leq$ 8.43 in. (nominal design)
Fuel Assembly Weight	$\leq$ 1680 lbs (including non-fuel hardware)	$\leq$ 1680 lbs (including DFC or Failed Fuel Can)
Other Limitations	▪ Quantity per MPC: up to 24 PWR intact fuel assemblies. For Trojan plant fuel only, up to four (4) damaged fuel assemblies may be stored in fuel storage locations 3, 6, 19, and/or 22. The remaining fuel storage locations may be filled with Trojan plant intact fuel assemblies. ▪ Trojan plant fuel must be transported in the custom-designed Trojan MPCs with the MPC spacer installed (see Figure 1.1.5). Fuel from other plants is not permitted to be transported in the Trojan MPCs. ▪ Except for Trojan plant fuel, the fuel assemblies shall not contain non-fuel hardware. Trojan intact fuel assemblies containing non-fuel hardware may be transported in any fuel storage location. ▪ Trojan plant damaged fuel assemblies must be transported in a Holtec DFC for Trojan plant fuel or a Trojan plant FFC. ▪ One (1) Trojan plant Sb-Be and/or two (2) Cf neutron sources, each in a Trojan plant intact fuel assembly may be transported in any one MPC. Each neutron source may be transported in any fuel storage location. ▪ Fuel debris is not authorized for transportation in the MPC-24E. ▪ Trojan plant non-fuel hardware and neutron sources may not be transported in the same fuel storage location with damaged fuel assemblies.	

Notes:

1. A fuel assembly must meet the requirements of any one column and the other limitations to be authorized for transportation.

Table 1.2.26

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24EF

PARAMETER	VALUE (Note 1)		
Fuel Type	Uranium oxide PWR intact fuel assemblies meeting the limits in Table 1.2.10 for the applicable array/class	Trojan plant damaged fuel meeting the limits in Table 1.2.10 for array/class 17x17B, placed in a Holtec Damaged Fuel Container (DFC)designed for Trojan plant fuel or a Trojan Failed Fuel Can (FFC)	Trojan plant Fuel Debris Process Can Capsules and/or Trojan plant fuel assemblies classified as fuel debris, for which the original fuel assemblies meet the applicable criteria in Table 1.2.10 for array/class 17x17B, placed in a Holtec Damaged Fuel Container (DFC) designed for Trojan plant fuel or a Trojan Failed Fuel Can (FFC)
Cladding Type	ZR or Stainless Steel (SS) assemblies as specified in Table 1.2.10 for the applicable array/class	ZR	ZR
Maximum Initial Enrichment	As specified in Table 1.2.10 for the applicable array/class	$\leq$ 3.7 wt. % ^{235}U	$\leq$ 3.7 wt. % ^{235}U
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly (except Trojan plant fuel and non-fuel hardware)	ZR clad: As specified in Table 1.2 28 or 1.2.29, as applicable SS clad: As specified in Table 1.2.30	Not applicable	Not applicable
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly for Trojan plant fuel	As specified in Table 1.2.35	As specified in Table 1.2.35	As specified in Table 1.2.35

Table 1.2.26 (cont'd)

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24EF

PARAMETER	VALUE (Note 1)		
Post-irradiation Cooling Time and Burnup for Trojan plant Non-fuel Hardware and Neutron Sources	As specified in Table 1.2.36	As specified in Table 1.2.36	As specified in Table 1.2.36
Decay Heat Per Assembly (except for Trojan plant fuel)	ZR clad: ≤ 833 Watts SS clad: ≤ 488 Watts	Not applicable	Not applicable
Decay heat per Assembly for Trojan plant fuel	≤ 725 Watts	≤ 725 Watts	≤ 725 Watts
Fuel Assembly Length	≤ 176.8 in. (nominal design)	≤ 169.3 in. (nominal design)	≤ 169.3 in. (nominal design)
Fuel Assembly Width	≤ 8.54 in. (nominal design)	≤ 8.43 in. (nominal design)	≤ 8.43 in. (nominal design)
Fuel Assembly Weight	≤ 1680 lbs (including non-fuel hardware(	≤ 1680 lbs (including DFC or Failed Fuel Can)	≤ 1680 lbs (including DFC or Failed Fuel Can)

Table 1.2.26 (cont'd)

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-24EF

Other Limitations	▪ Quantity per MPC: Up to 24 PWR intact fuel assemblies. For Trojan plant fuel only, up to four (4) damaged fuel assemblies, fuel assemblies classified as fuel debris, and/or Trojan Fuel Debris Process Can Capsules may be stored in fuel storage locations 3, 6, 19, and/or 22. The remaining fuel storage locations may be filled with Trojan plant intact fuel assemblies. ▪ Trojan plant fuel must be transported in the custom-designed Trojan MPCs with the MPC spacer installed (see Figure 1.1.5). Fuel from other plants is not permitted to be transported in the Trojan MPCs. ▪ Except for Trojan plant fuel, the fuel assemblies shall not contain non-fuel hardware or neutron sources. Trojan intact fuel assemblies containing non-fuel hardware may be transported in any fuel storage location. ▪ Trojan plant damaged fuel assemblies, fuel assemblies classified as fuel debris, and Fuel Debris Process Can Capsules must be transported in a Trojan Failed Fuel Can or a Holtec DFC for Trojan plant fuel. ▪ One (1) Trojan plant Sb-Be and/or two (2) Cf neutron sources, each in a Trojan plant intact fuel assembly may be transported in any one MPC. Each neutron source may be transported in any fuel storage location.

Notes:

1. A fuel assembly must meet the requirements of any one column and the other limitations to be authorized for transportation.

Table 1.2.27

LIMITS FOR MATERIAL TO BE TRANSPORTED IN MPC-32 (Note 1)

PARAMETER	VALUE
Fuel Type	Uranium oxide, PWR intact fuel assemblies meeting the limits in Table 1.2.10 for array/classes 15x15D, E, F, and H and 17x17A, B, and C
Cladding Type	ZR
Maximum Initial Enrichment	As specified in Table 1.2.10
Post-irradiation Cooling Time, Average Burnup, and Minimum Initial Enrichment per Assembly	As specified in Table 1.2.32 or Table 1.2.33, as applicable
Decay Heat Per Assembly	≤ 625 Watts
Minimum Burnup per Assembly	As specified in Table 1.2.34 for the applicable array/class
Fuel Assembly Length	≤ 176.8 in. (nominal design)
Fuel Assembly Width	≤ 8.54 in. (nominal design)
Fuel Assembly Weight	≤ 1,680 lbs
Other Limitations	▪ Quantity is limited to up to 32 PWR intact fuel assemblies in the above-specified array/classes only. ▪ Non-fuel hardware and neutron sources not permitted. ▪ Damaged fuel assemblies and fuel debris not permitted. ▪ Trojan plant fuel not permitted.

NOTES:

1. The MPC-32 is not authorized for transportation in the HI-STAR 100 System at this time.

Table 1.2.28

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-24/24E/24EF; PWR FUEL WITH ZR CLADDING AND WITH NON-ZIRCALOY IN-CORE GRID SPACERS

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
≥ 9	$\leq 24{,}500$	≥ 2.3
≥ 11	$\leq 29{,}500$	≥ 2.6
≥ 13	$\leq 34{,}500$	≥ 2.9
≥ 15	$\leq 39{,}500$	≥ 3.2
≥ 18	$\leq 44{,}500$	≥ 3.4

Table 1.2.29

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-24/24E/24EF;PWR FUEL WITH ZR CLADDING AND WITH ZIRCALOY IN-CORE GRID SPACERS

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
≥ 6	≤ 24,500	≥ 2.3
≥ 7	≤ 29,500	≥ 2.6
≥ 9	≤ 34,500	≥ 2.9
≥ 11	≤ 39,500	≥ 3.2
≥ 14	≤ 44,500	≥ 3.4

Table 1.2.30

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-24/24E/24EF; PWR FUEL WITH STAINLESS STEEL CLADDING

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
$\geq$ 19	$\leq$ 30,000	$\geq$ 3.1
$\geq$ 24	$\leq$ 40,000	$\geq$ 3.1

Table 1.2.31

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-68

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
≥ 8	$\leq 24,500$	≥ 2.1
≥ 9	$\leq 29,500$	≥ 2.4
≥ 11	$\leq 34,500$	≥ 2.6
≥ 14	$\leq 39,500$	≥ 2.9
≥ 19	$\leq 44,500$	≥ 3.0

Table 1.2.32

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-32; PWR FUEL WITH ZR CLADDING AND WITH NON-ZIRCALOY IN-CORE GRID SPACERS (Note 1)

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
$\geq$ 12	$\leq$ 24,500	$\geq$ 2.3
$\geq$ 14	$\leq$ 29,500	$\geq$ 2.6
$\geq$ 16	$\leq$ 34,500	$\geq$ 2.9
$\geq$ 19	$\leq$ 39,500	$\geq$ 3.2
$\geq$ 20	$\leq$ 42,500	$\geq$ 3.4

NOTES:

1. MPC-32 is not authorized for transportation at this time.

Table 1.2.33

FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS FOR TRANSPORTATION IN MPC-32; PWR FUEL WITH ZR CLADDING AND WITH ZIRCALOY IN-CORE GRID SPACERS (Note 1)

ASSEMBLY POST-IRRADIATION COOLING TIME (years)	ASSEMBLY BURNUP (MWD/MTU)	ASSEMBLY ENRICHMENT (wt. % ^{235}U)
≥ 8	$\leq 24{,}500$	≥ 2.3
≥ 9	$\leq 29{,}500$	≥ 2.6
≥ 12	$\leq 34{,}500$	≥ 2.9
≥ 14	$\leq 39{,}500$	≥ 3.2
≥ 19	$\leq 44{,}500$	≥ 3.4

NOTES:

1. MPC-32 is not authorized for transportation at this time.

Table 1.2.34

FUEL ASSEMBLY MINIMUM BURNUP REQUIREMENTS FOR TRANSPORTATION IN MPC-32 (Note 1)

FUEL ASSEMBLY ARRAY/CLASS	MINIMUM BURNUP (B) AS A FUNCTION OF INITIAL ENRICHMENT (E) (Note 2) (GWD/MTU)
15x15D, E, F, and H	Later
17x15A, B, and C	Later

Notes:

1. MPC-32 is not authorized for transportation at this time.
2. E = Initial enrichment from the fuel vendor's data sheet, i.e., for 4.05wt. %, E = 4.05.

Table 1.2.35

TROJAN PLANT FUEL ASSEMBLY COOLING, AVERAGE BURNUP, AND MINIMUM ENRICHMENT LIMITS (Note 1)

Post-irradiation Cooling Time (years)	**Assembly Burnup (MWD/MTU)**	**Assembly Minimum Enrichment (wt. % ^{235}U)**
≥ 16	$\leq 42{,}000$	≥ 3.09
≥ 16	$\leq 37{,}500$	≥ 2.6
≥ 16	$\leq 30{,}000$	≥ 2.1

Notes:

1. Each fuel assembly must only meet one set of limits (i.e., one row).

Table 1.2.36

TROJAN PLANT NON-FUEL HARDWARE AND NEUTRON SOURCE COOLING AND BURNUP LIMITS

Type Of Hardware or Neutron Source	Burnup (MWD/MTU)	Post-irradiation Cooling Time (years)
BPRAs	$\leq$ 15,998	$\geq$ 24
TPDs	$\leq$ 118,674	$\geq$ 11
RCCAs	$\leq$ 125,515	$\geq$ 9
Cf neutron source	$\leq$ 15,998	$\geq$ 24
Sb-Be neutron source with 4 source rods, 16 burnable poison rods, and 4 thimble plug rods	$\leq$ 45,361	$\geq$ 19
Sb-Be neutron source with 4 source rods and 20 thimble plug rods	$\leq$ 88,547	$\geq$ 9

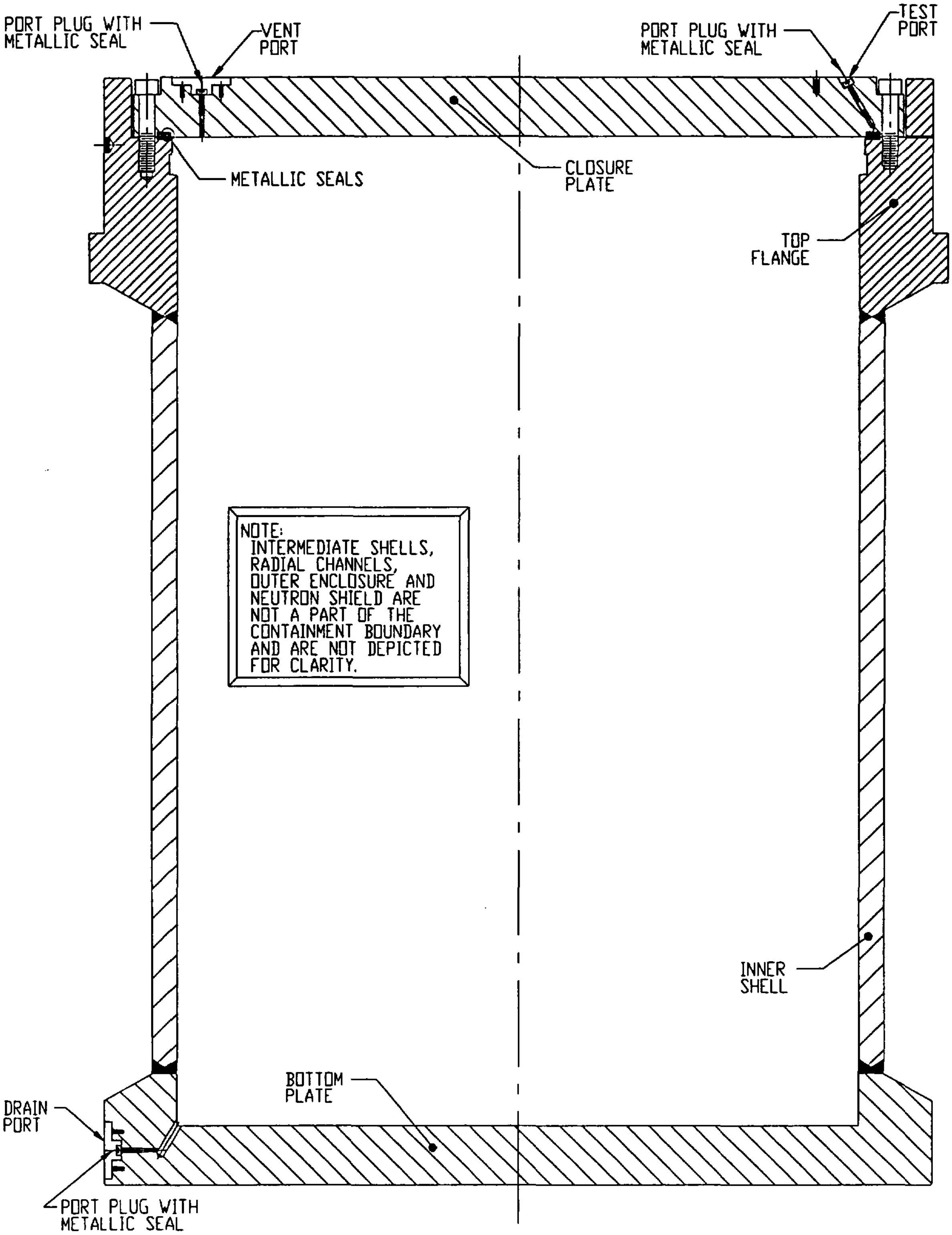


FIGURE 1.2.1; OVERPACK CONTAINMENT BOUNDARY

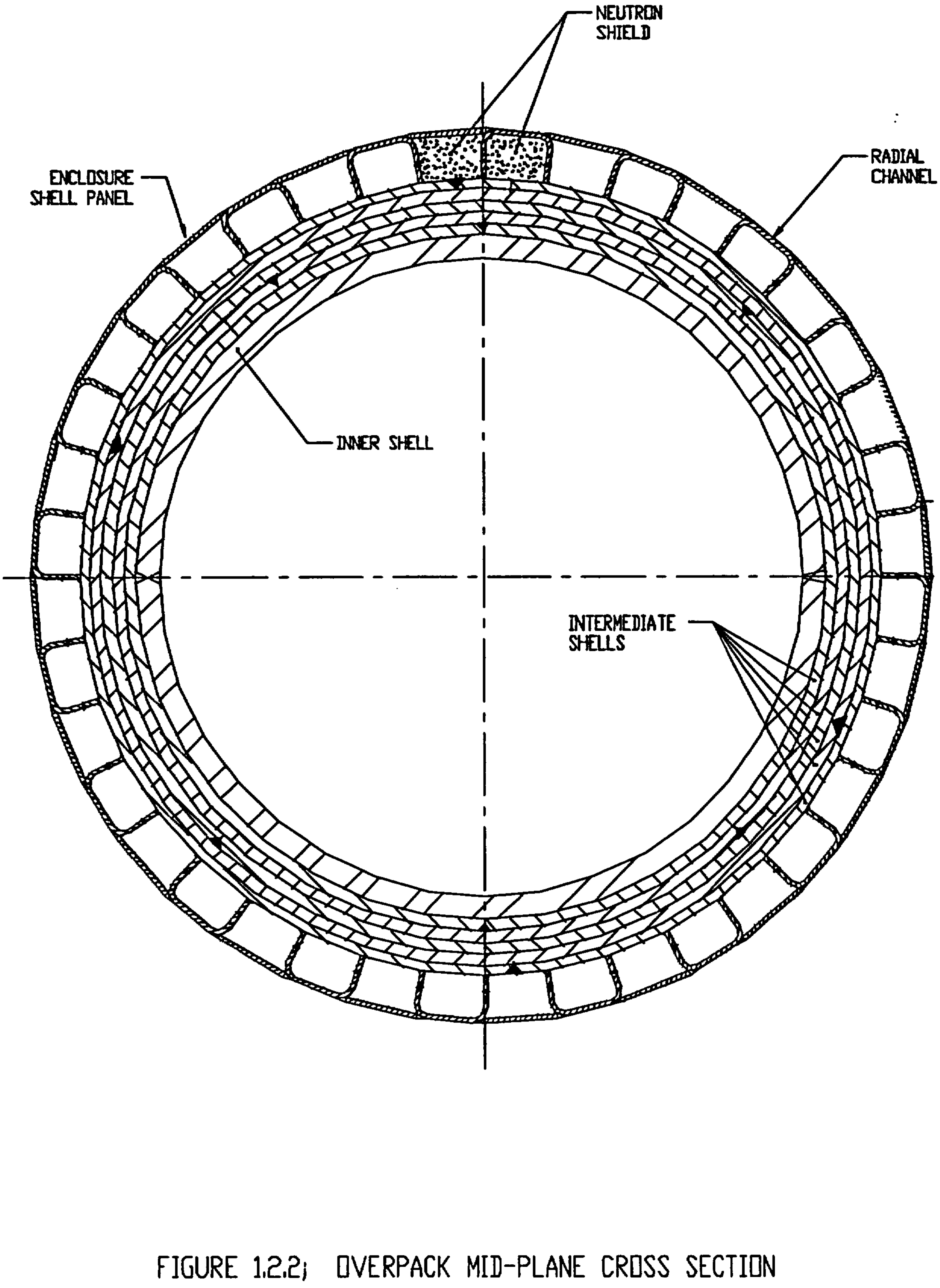


FIGURE 1.2.2; OVERPACK MID-PLANE CROSS SECTION

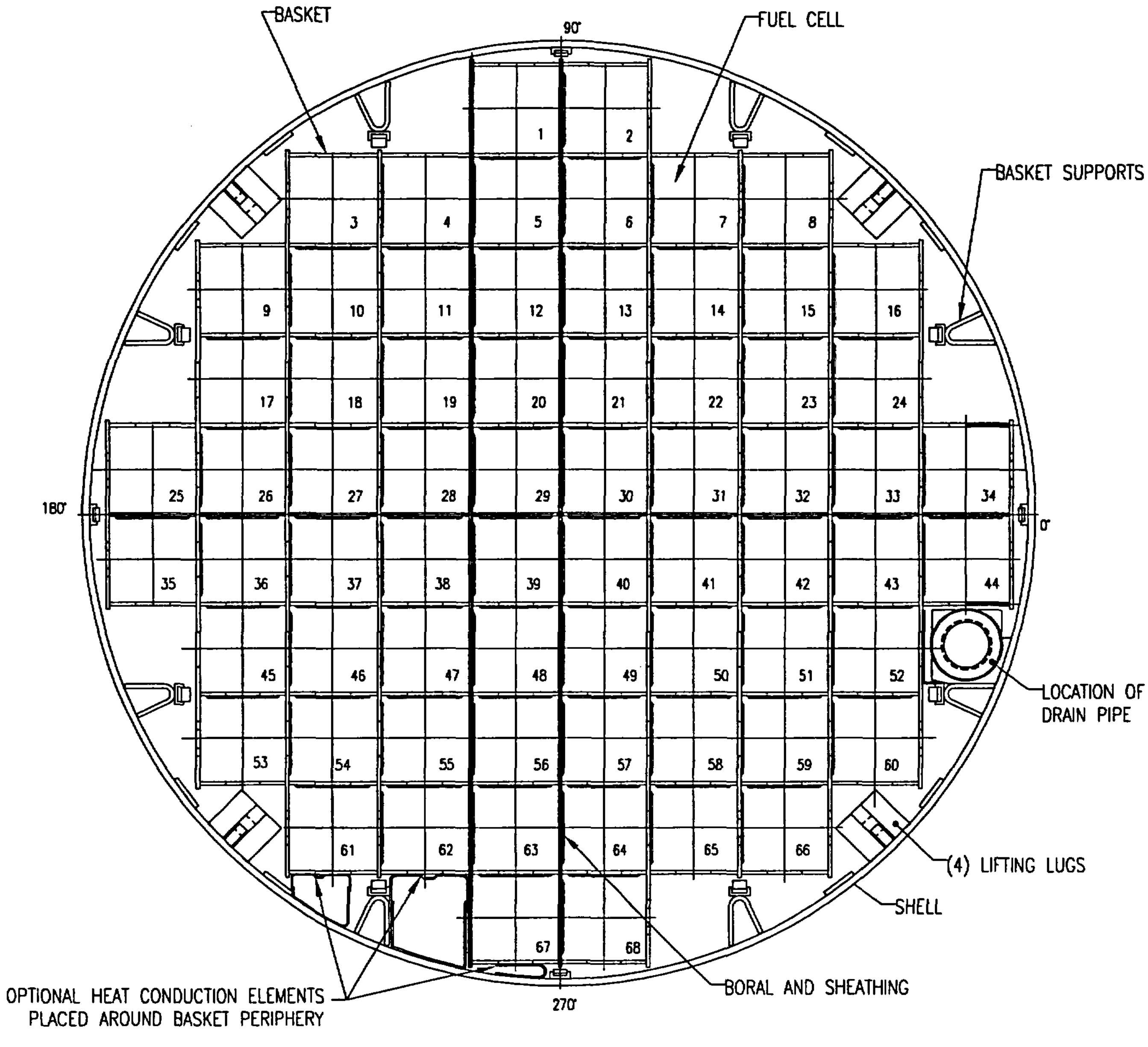


FIGURE 1.2.3; MPC-68/68F CROSS SECTION VIEW

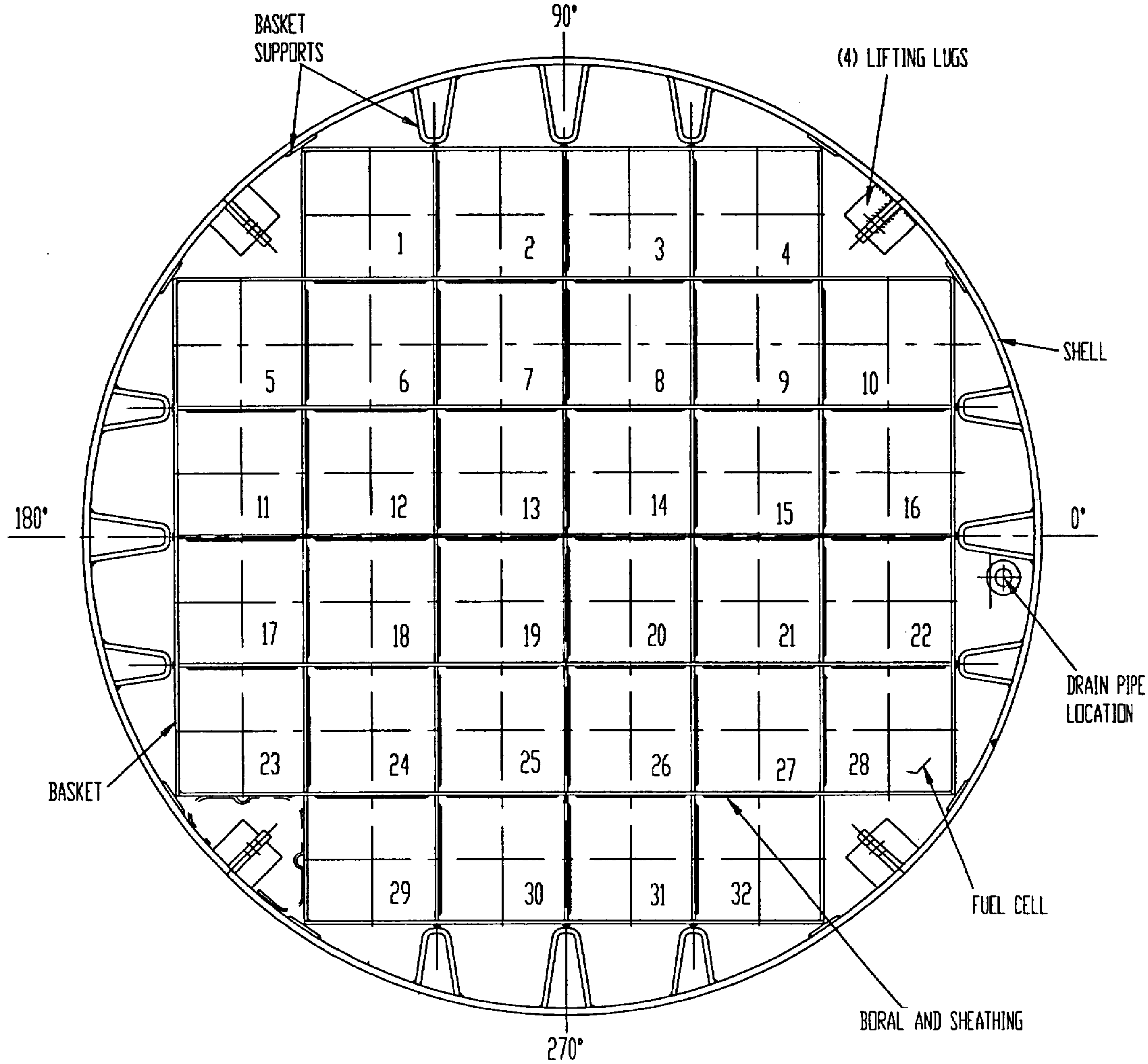


FIGURE 1.2.4; MPC-32 CROSS SECTION VIEW

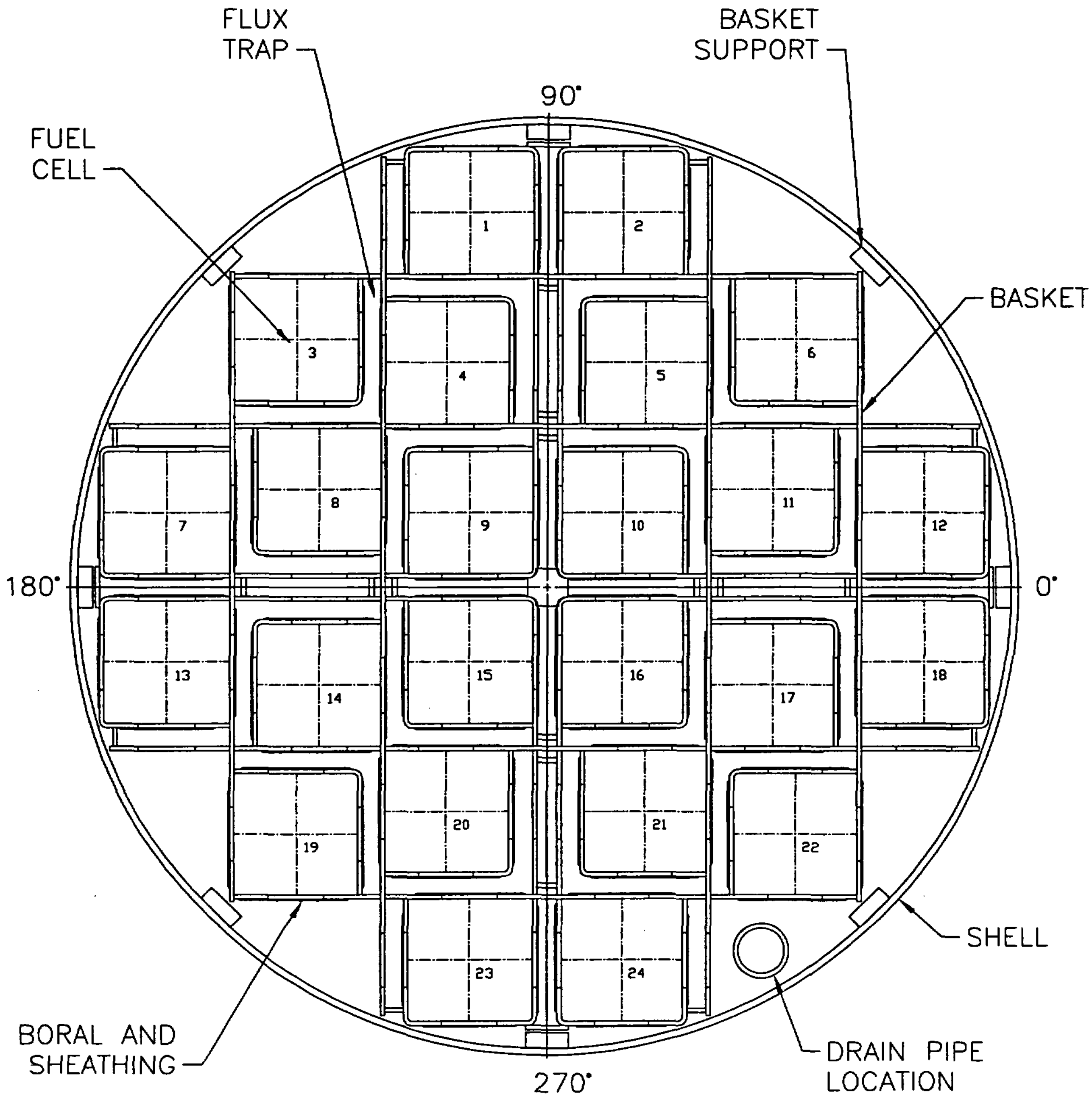


FIGURE 1.2.5; MPC-24/E/EF CROSS SECTION VIEW

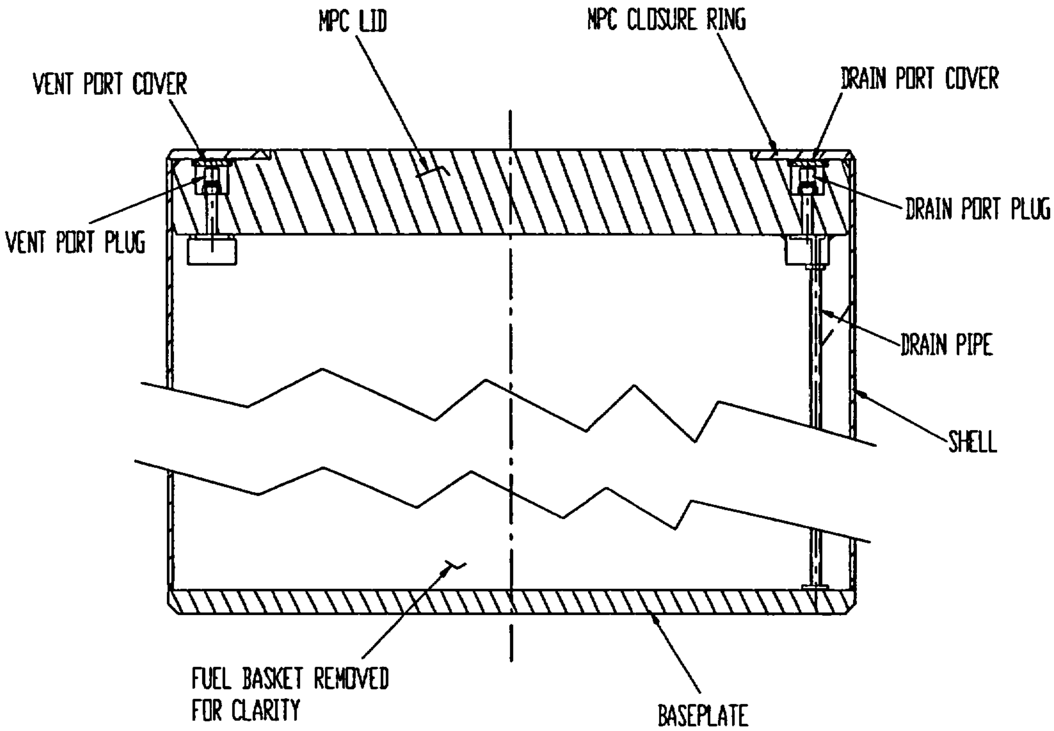
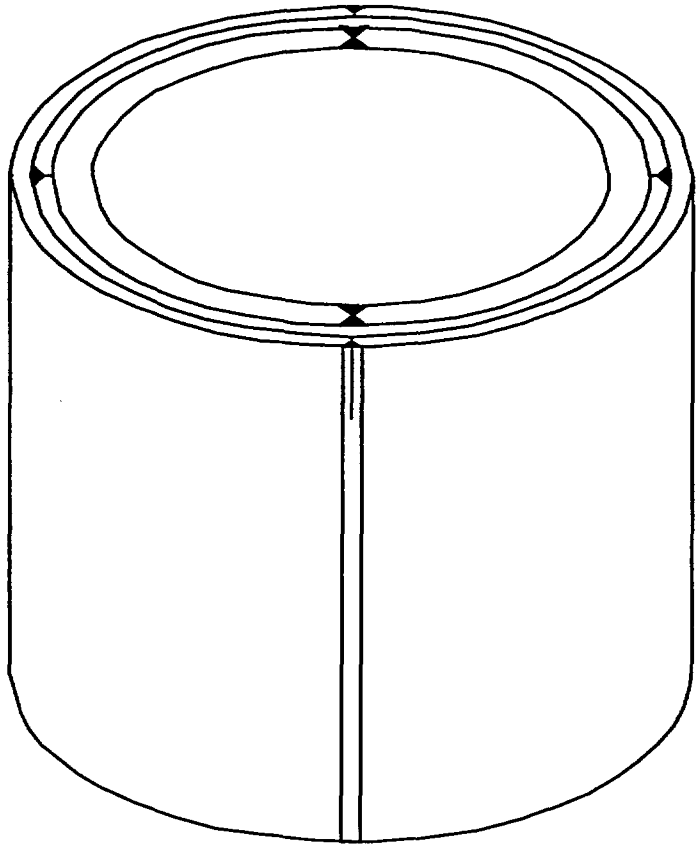
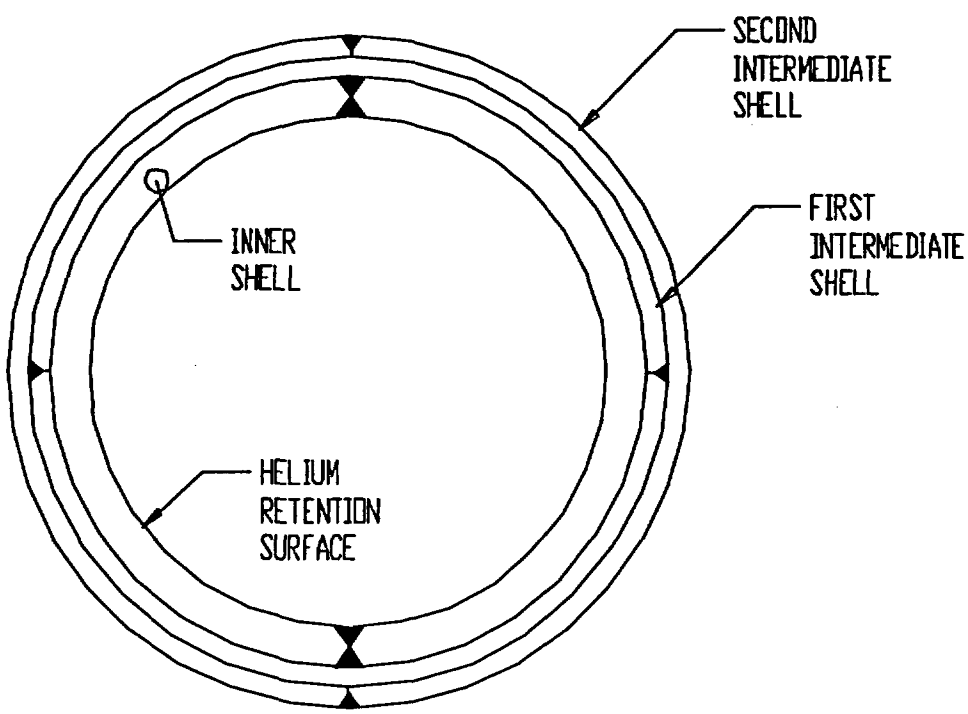


FIGURE 1.2.6; MPC LID AND PORT DETAILS



ISOMETRIC VIEW OF CENTRAL REGION OF THE OVERPACK



CROSS SECTION AT MID-HEIGHT

FIGURE 1.2.7; HI-STAR 100 OVERPACK SHELL LAYERING

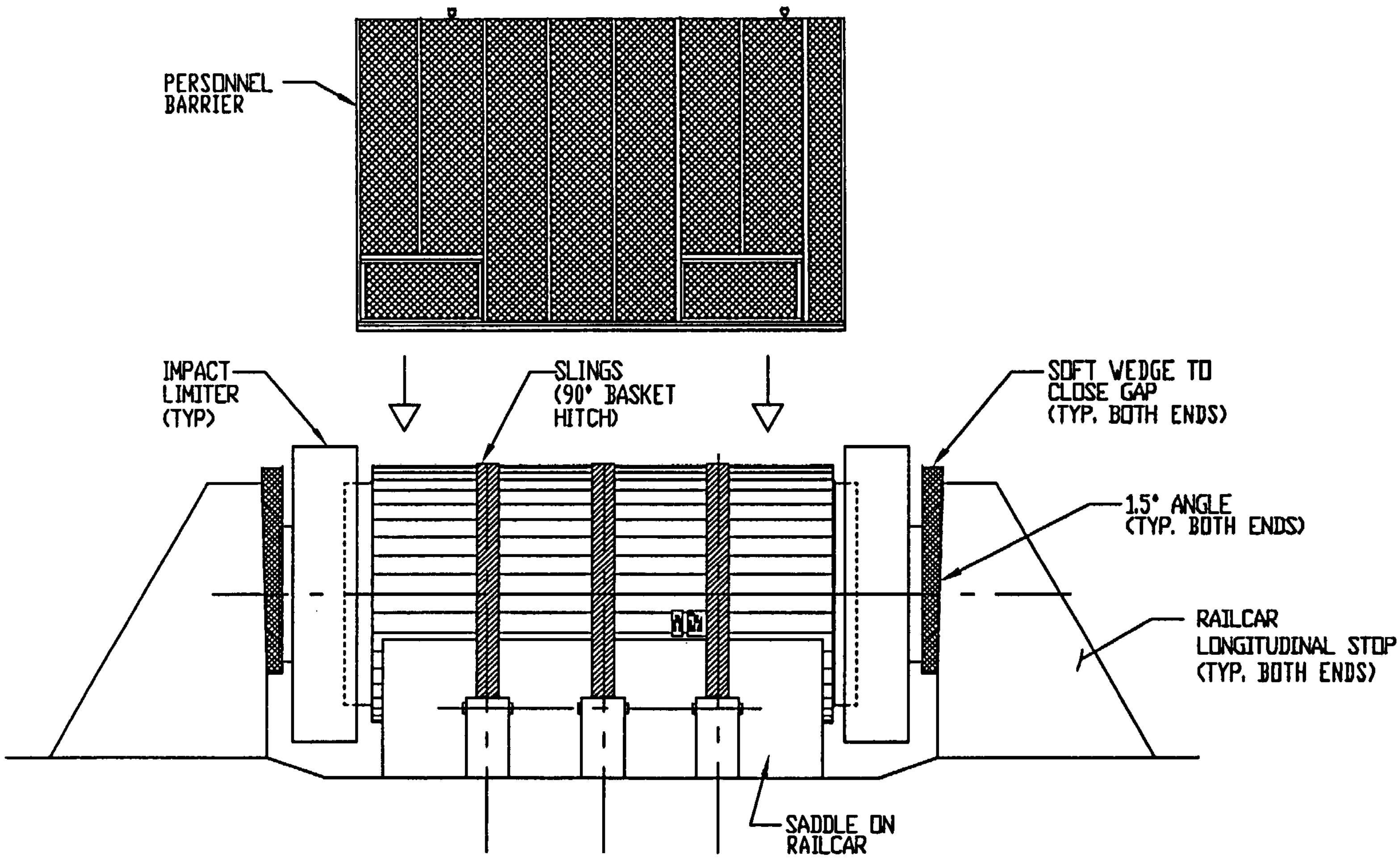


FIGURE 1.2.8; HI-STAR 100 TRANSPORT CONFIGURATION

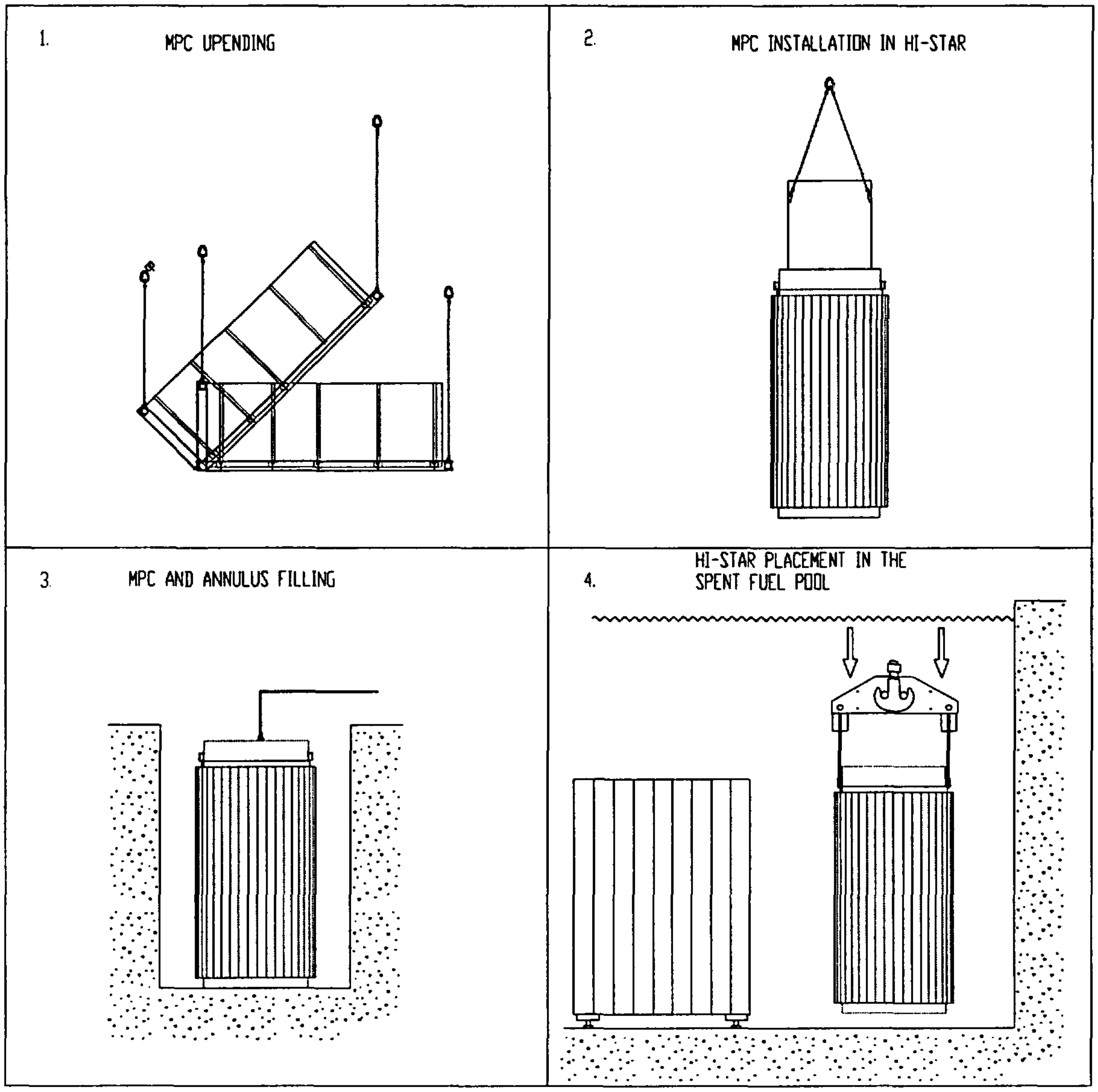


Figure 1.2.9; Major HI-STAR 100 Loading Operations (Sheet 1 of 3)

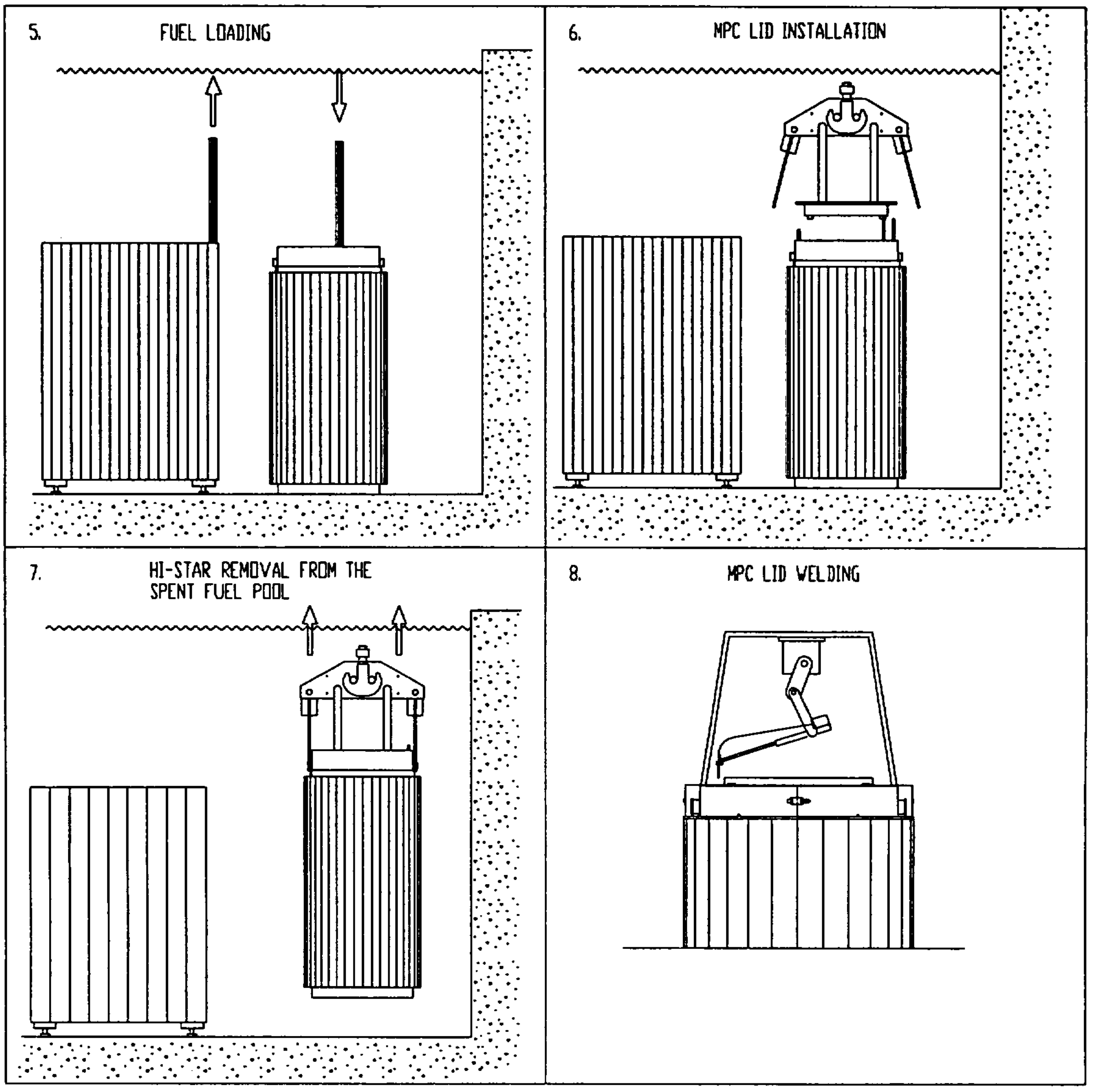


Figure 1.2.9; Major HI-STAR 100 Loading Operations (Sheet 2 of 3)

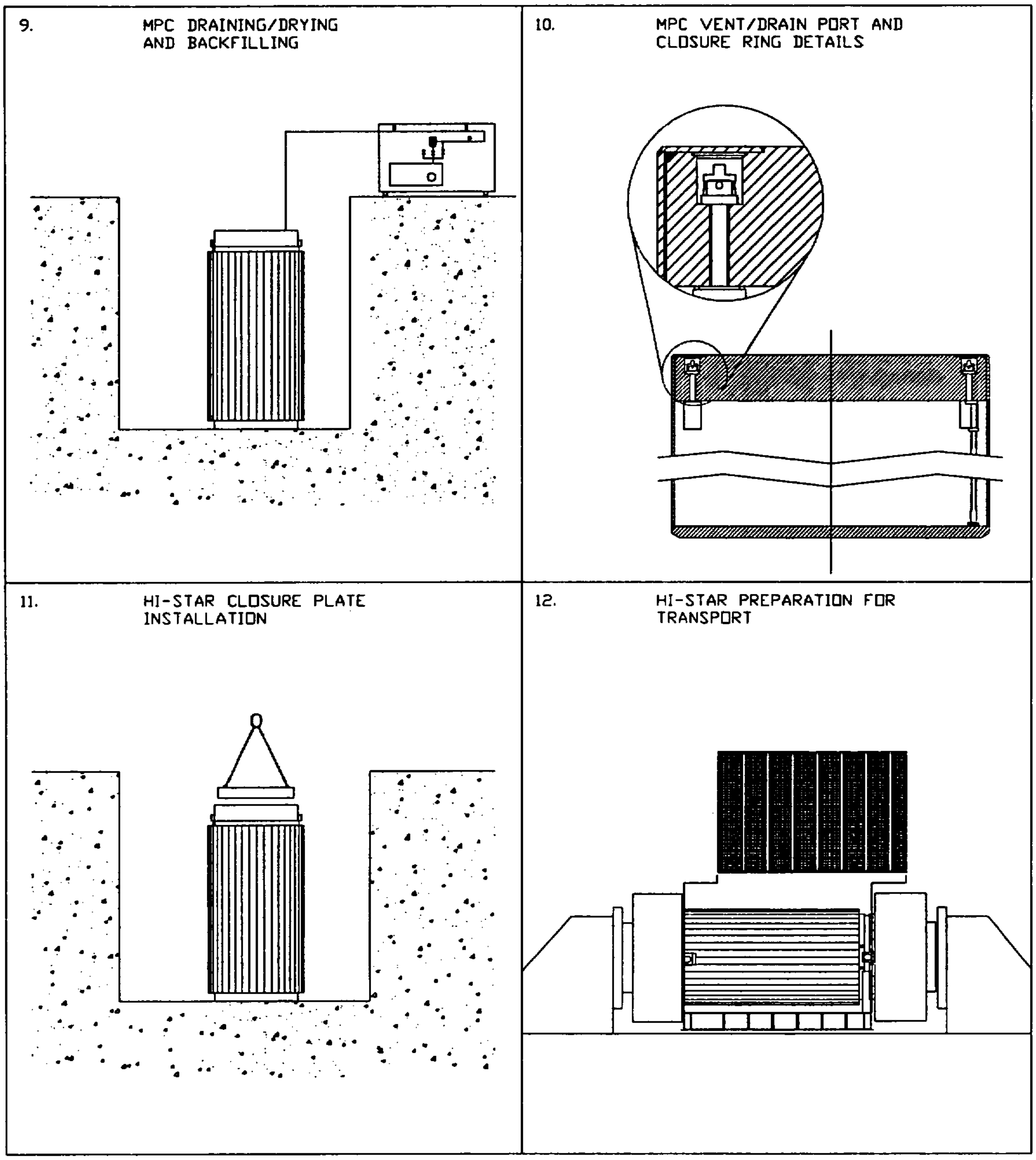


Figure 1.2.9; Major HI-STAR 100 Loading Operations (Sheet 3 of 3)

FIGURE WITHHELD UNDER 10 CFR 2.390

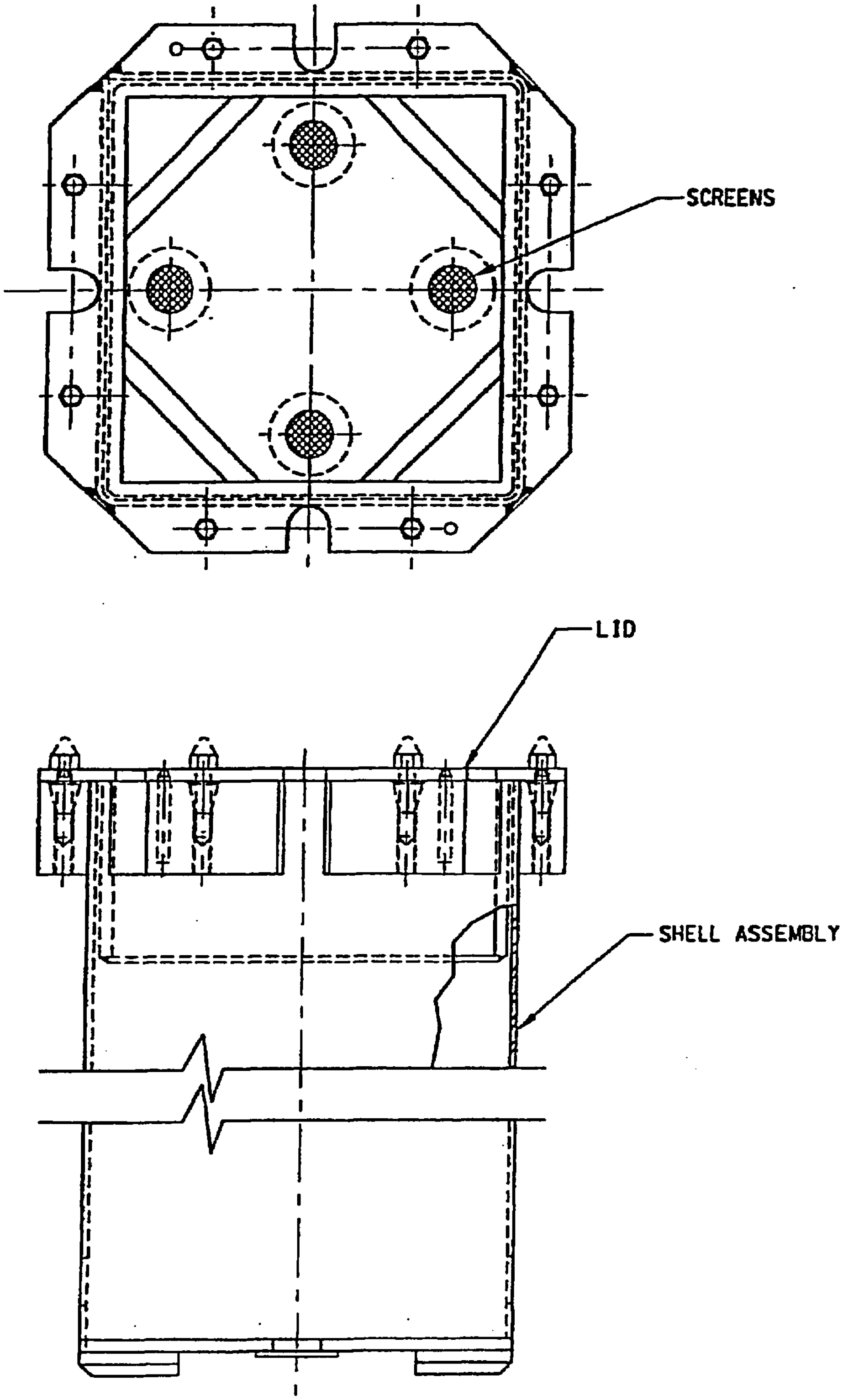


FIGURE 1.2.10A; TROJAN FAILED FUEL CAN

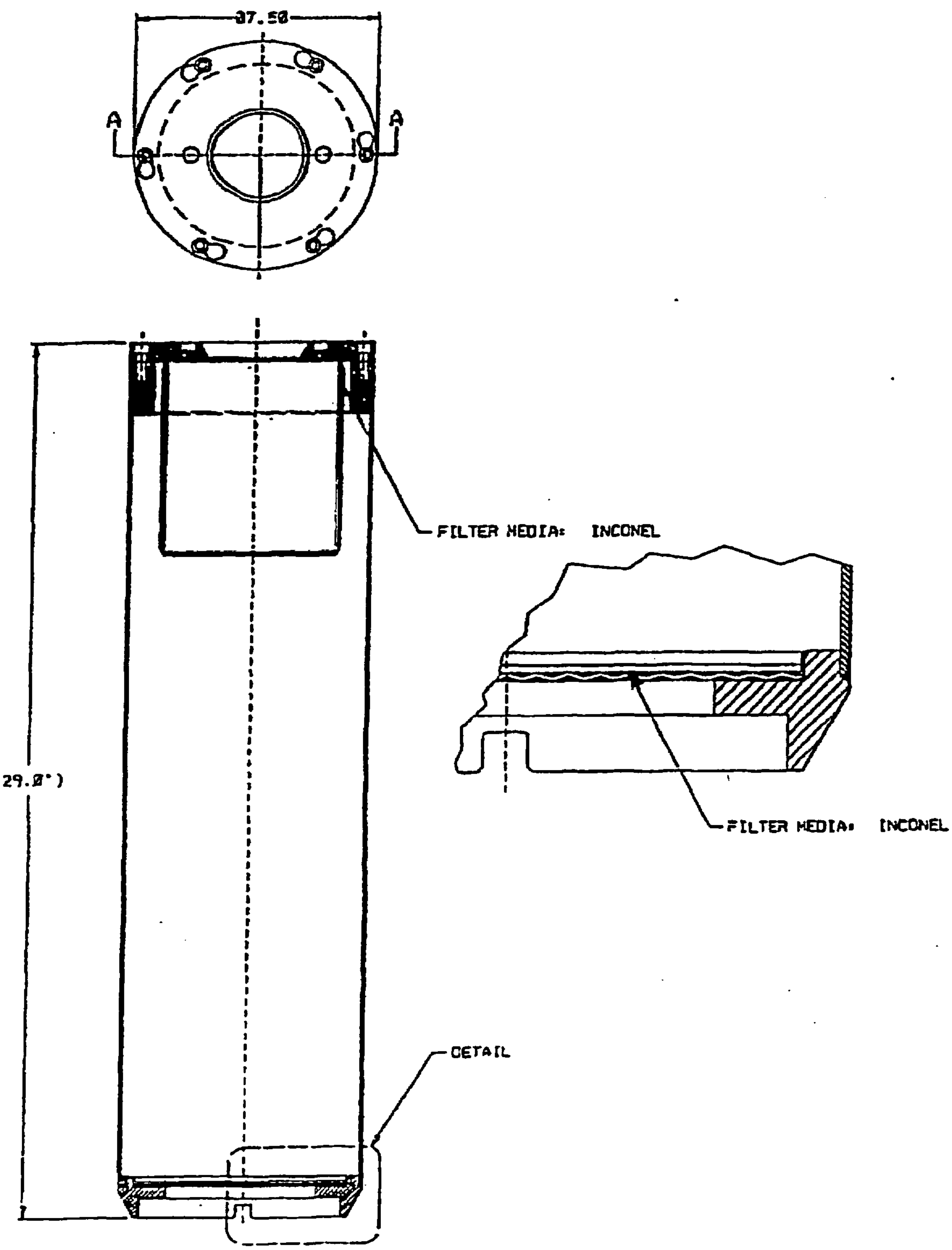


FIGURE 1.2.10B; TROJAN FUEL DEBRIS PROCESS CAN

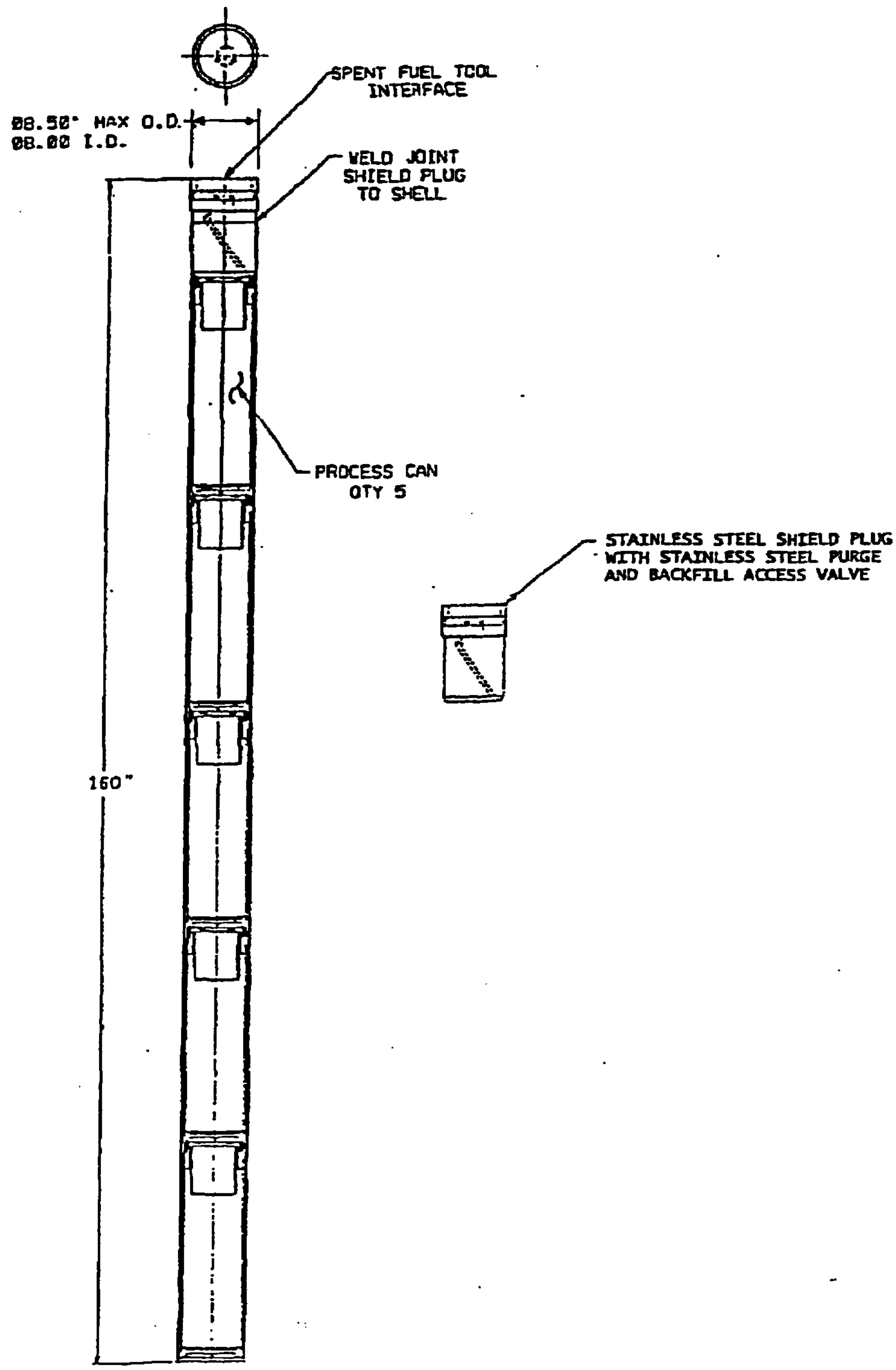


FIGURE 1.2.10C; TROJAN FUEL DEBRIS PROCESS CAN CAPSULE

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE WITHHELD UNDER 10 CFR 2.390

FIGURE 1.2.12

INTENTIONALLY DELETED

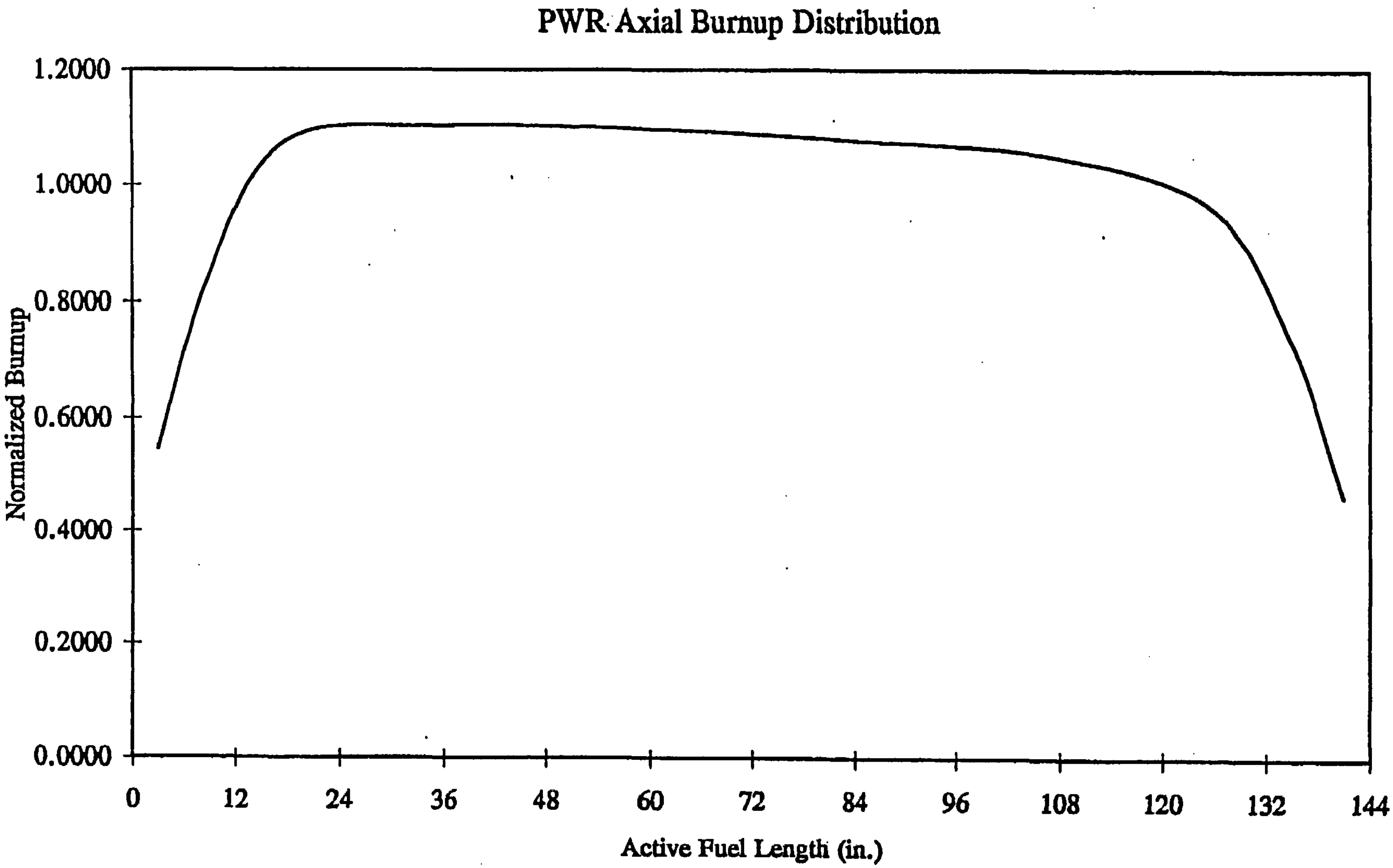


Figure 1.2.13; PWR Axial Burnup Profile with Normalized Distribution

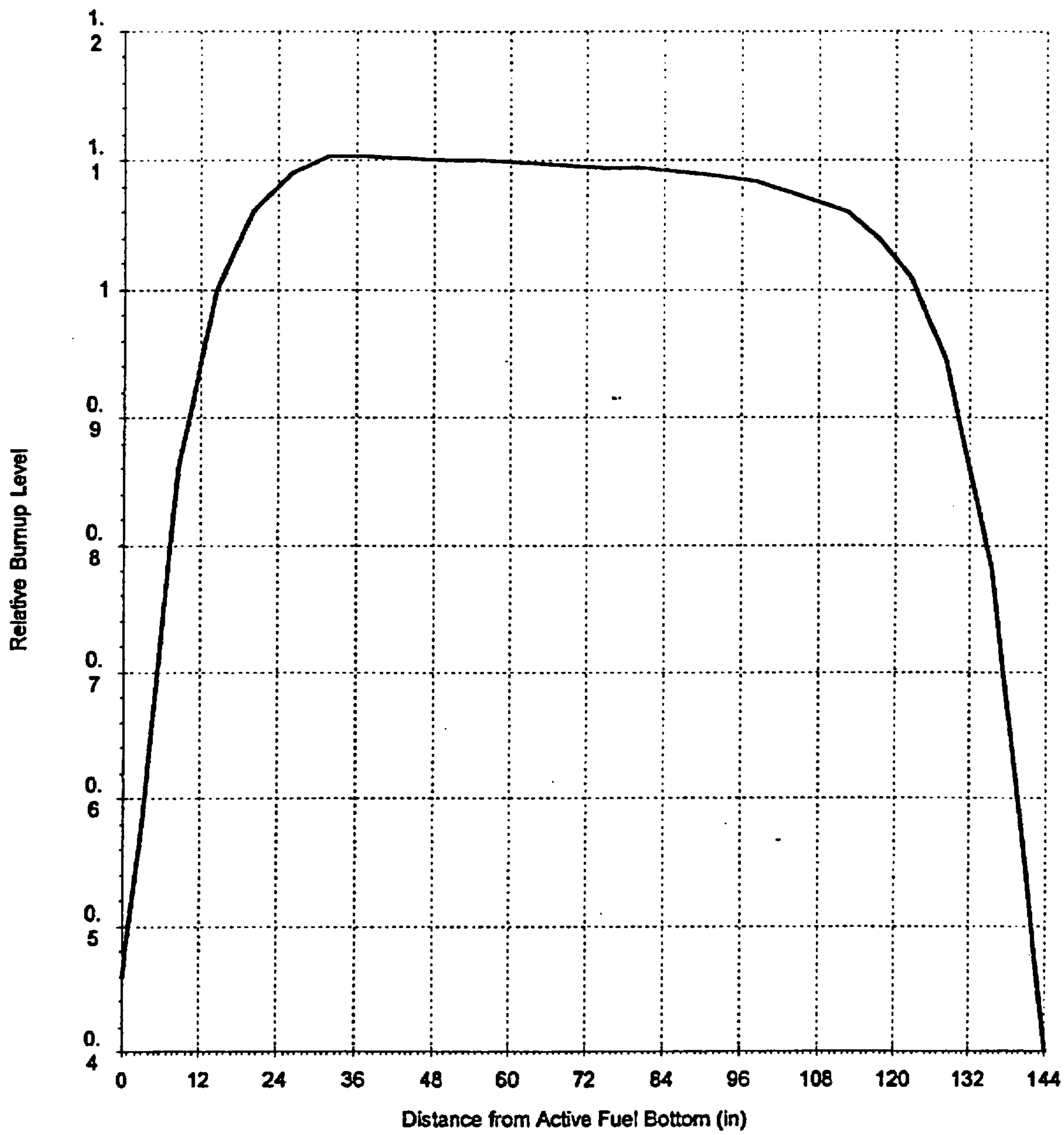


Figure 1.2.13A; Trojan Plant Fuel Axial Burnup Distribution Profile

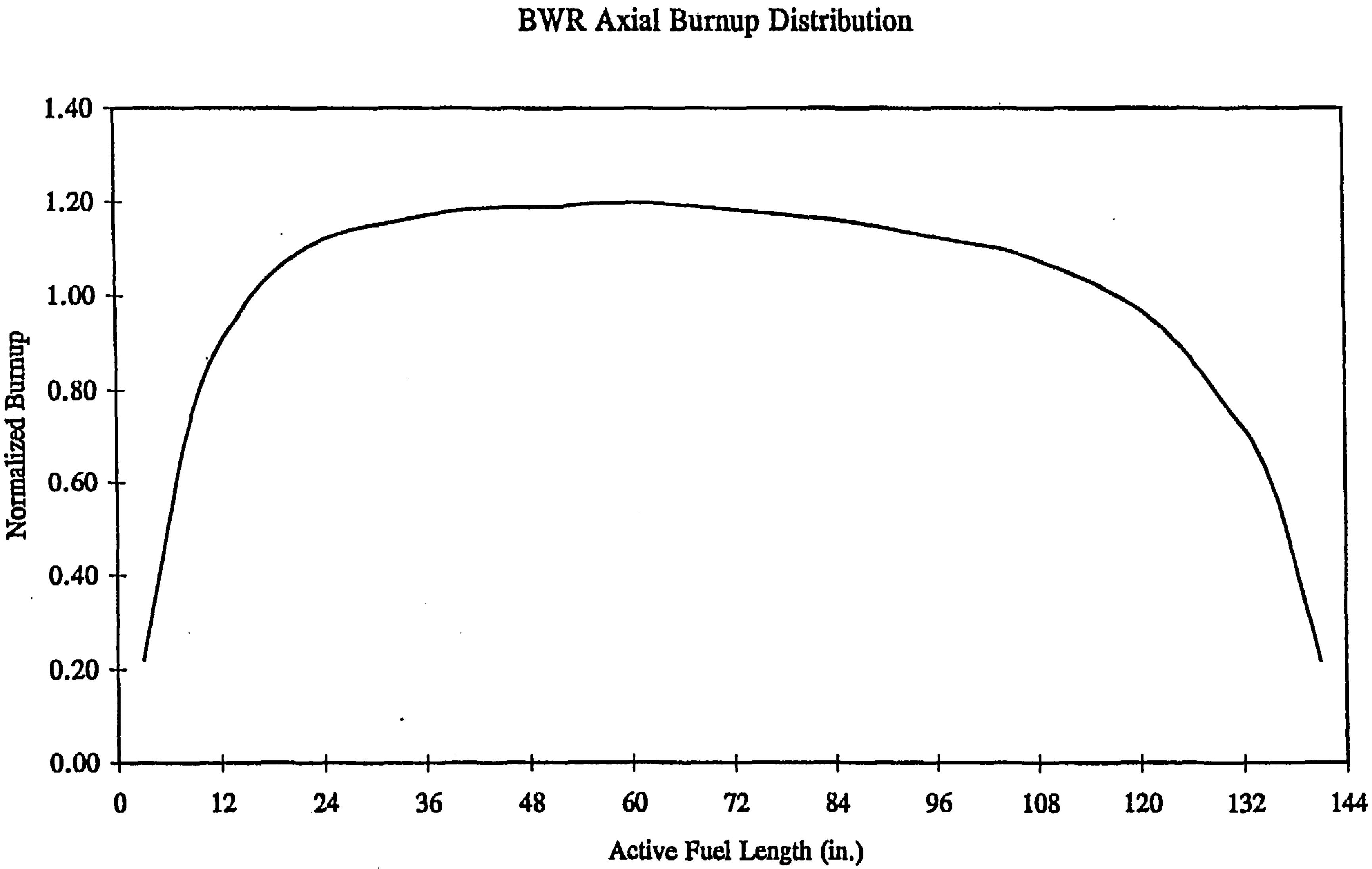


Figure 1.2.14; BWR Axial Burnup Profile with Normalized Distribution

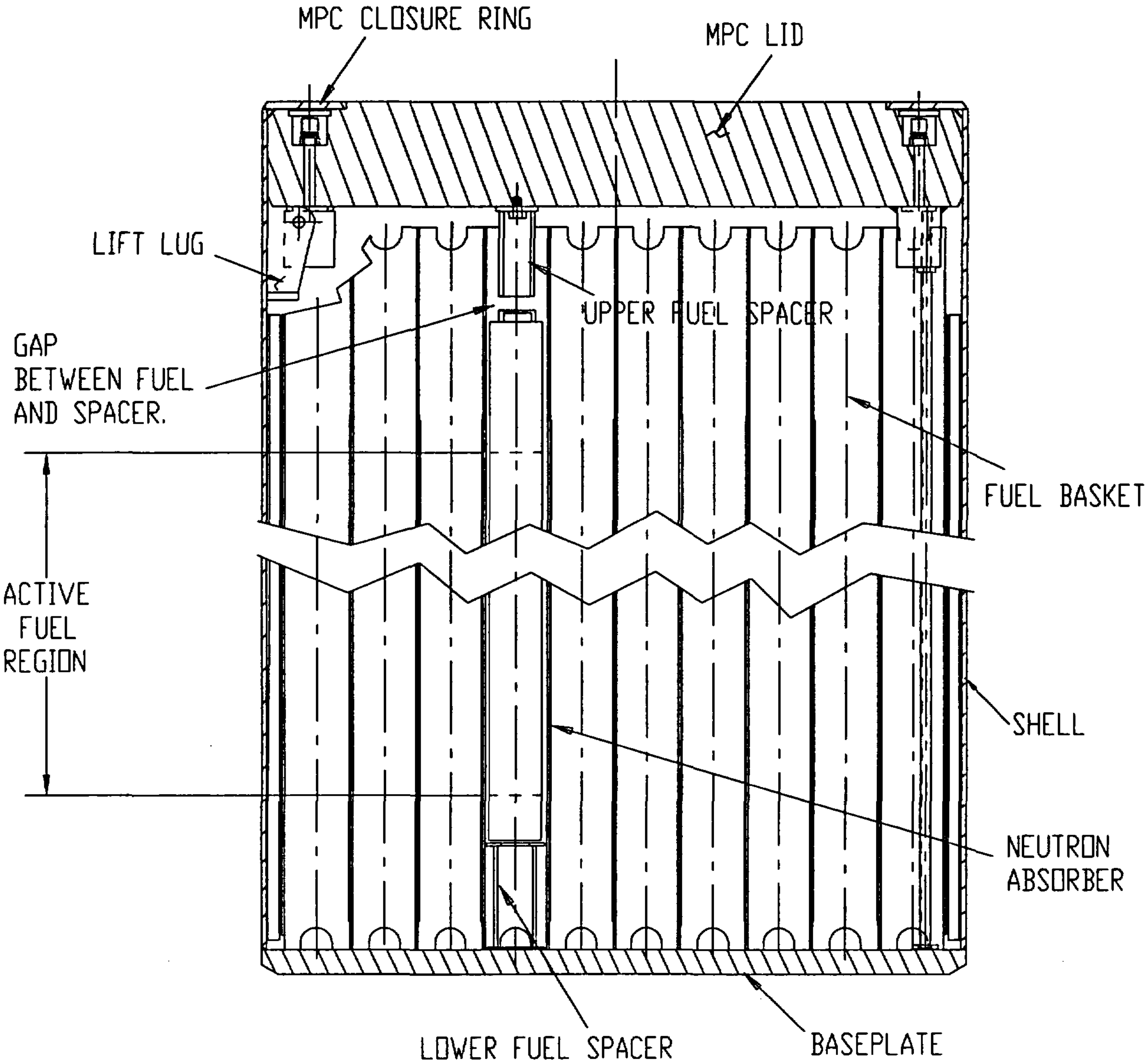


FIGURE 1.2.15; HI-STAR 100 MPC WITH UPPER AND LOWER FUEL SPACERS

G:\SAR DOCUMENTS\HI-STAR SAR\FIGURES\REVISION 10\CHAPTER1\FIG1_2_15R10

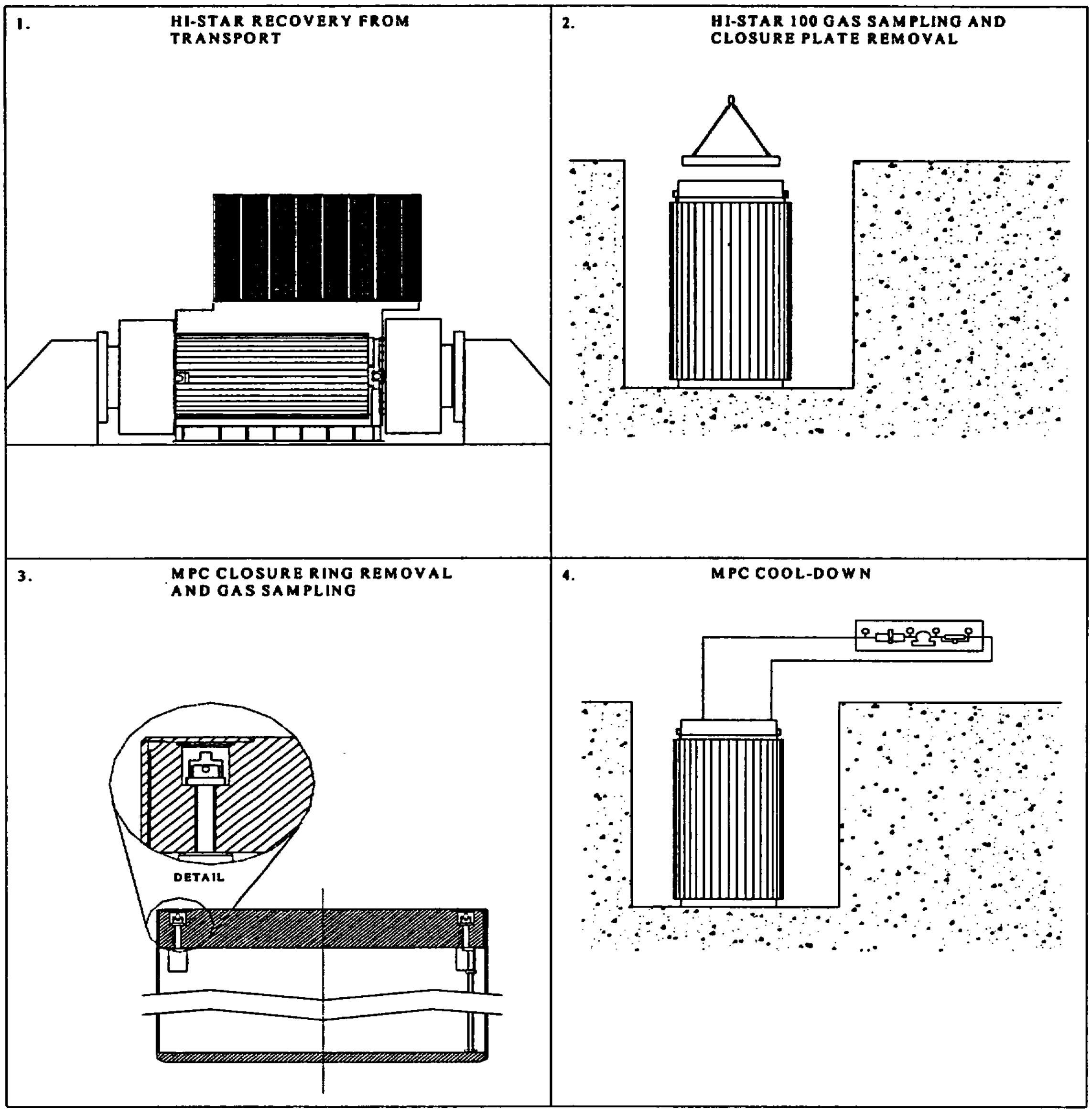


Figure 1.2.16; Major HI-STAR 100 Unloading Operations (Sheet 1 of 3)

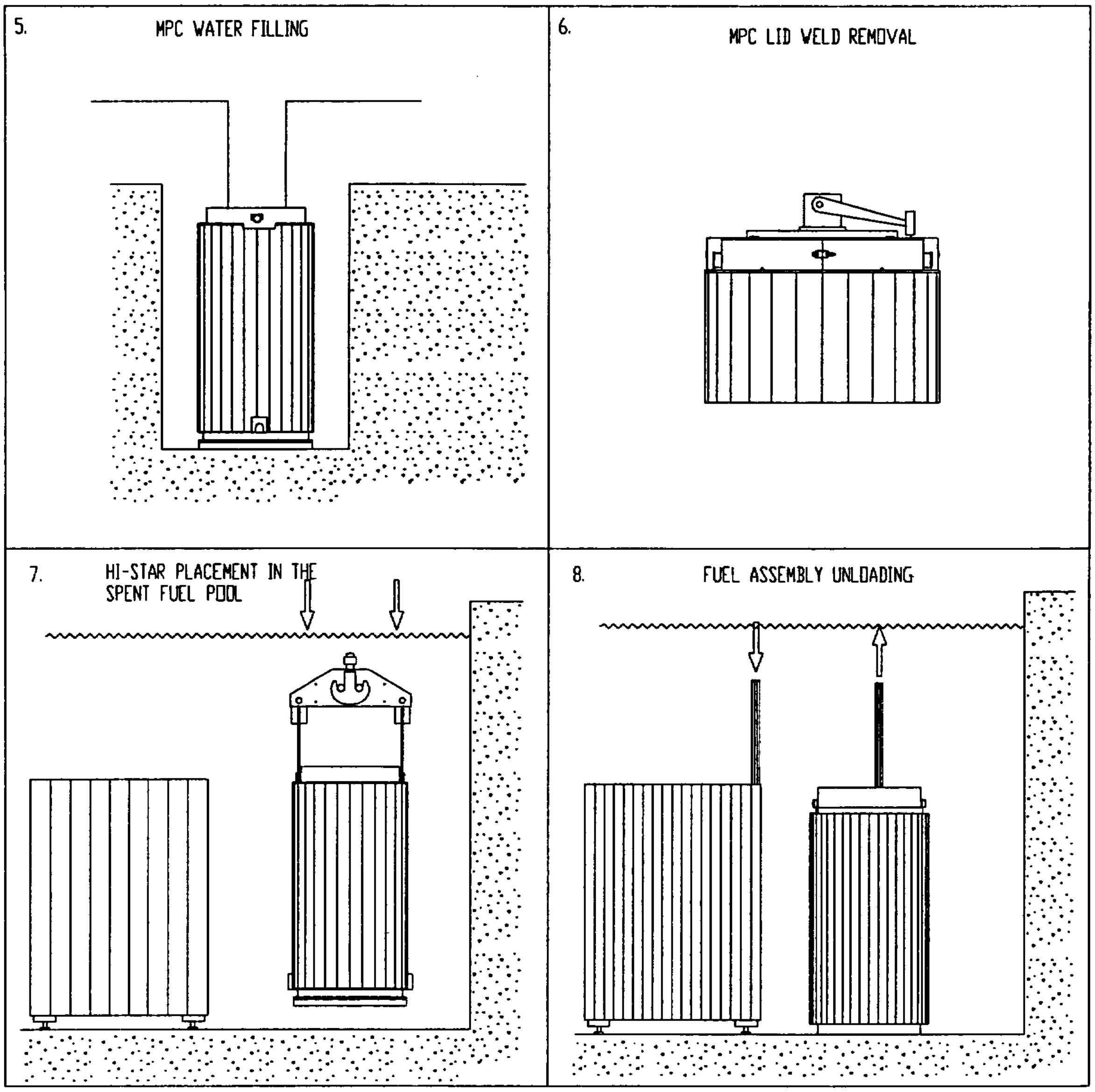


Figure 1.2.16; Major HI-STAR 100 Unloading Operations (Sheet 2 of 3)

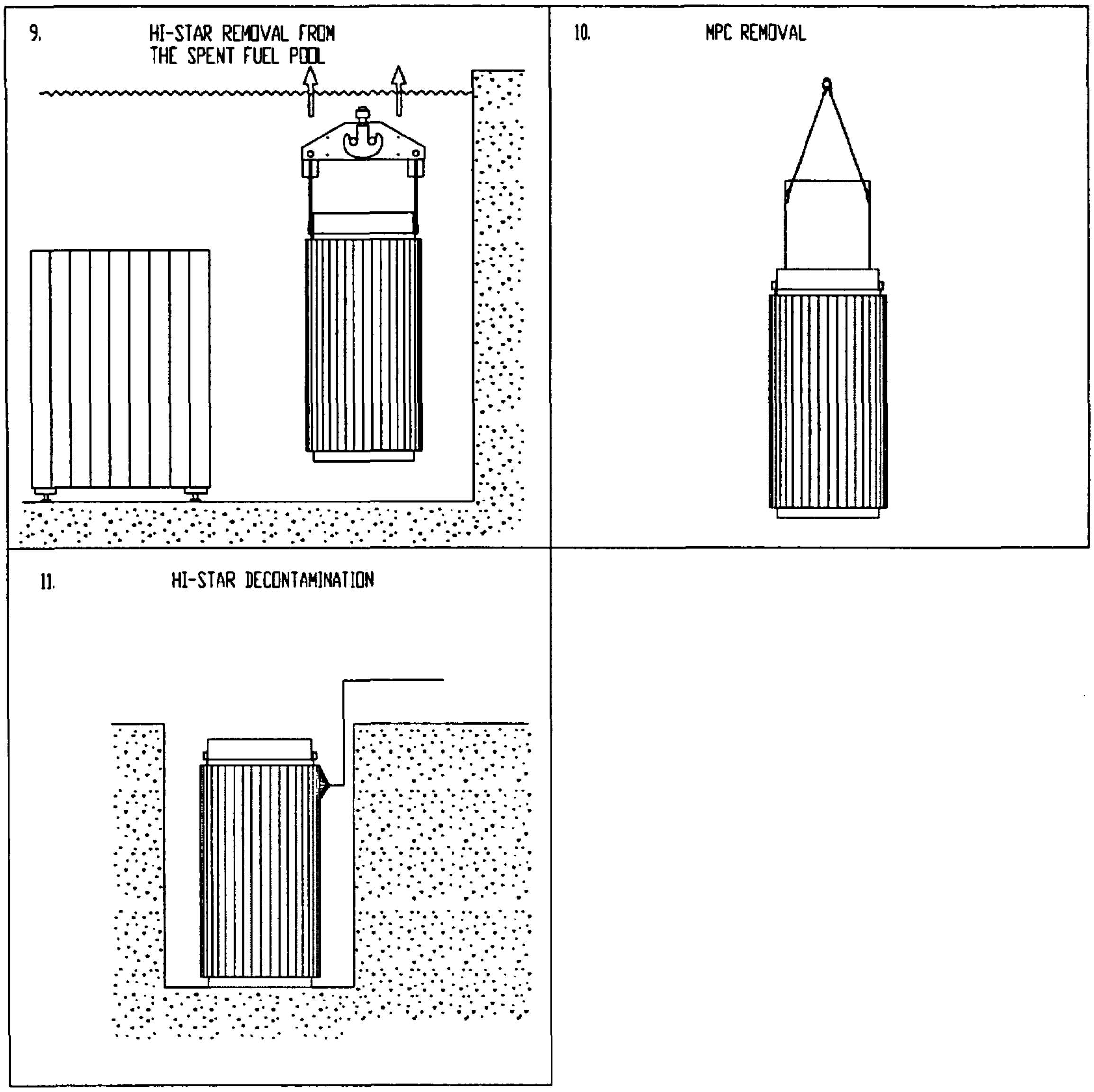
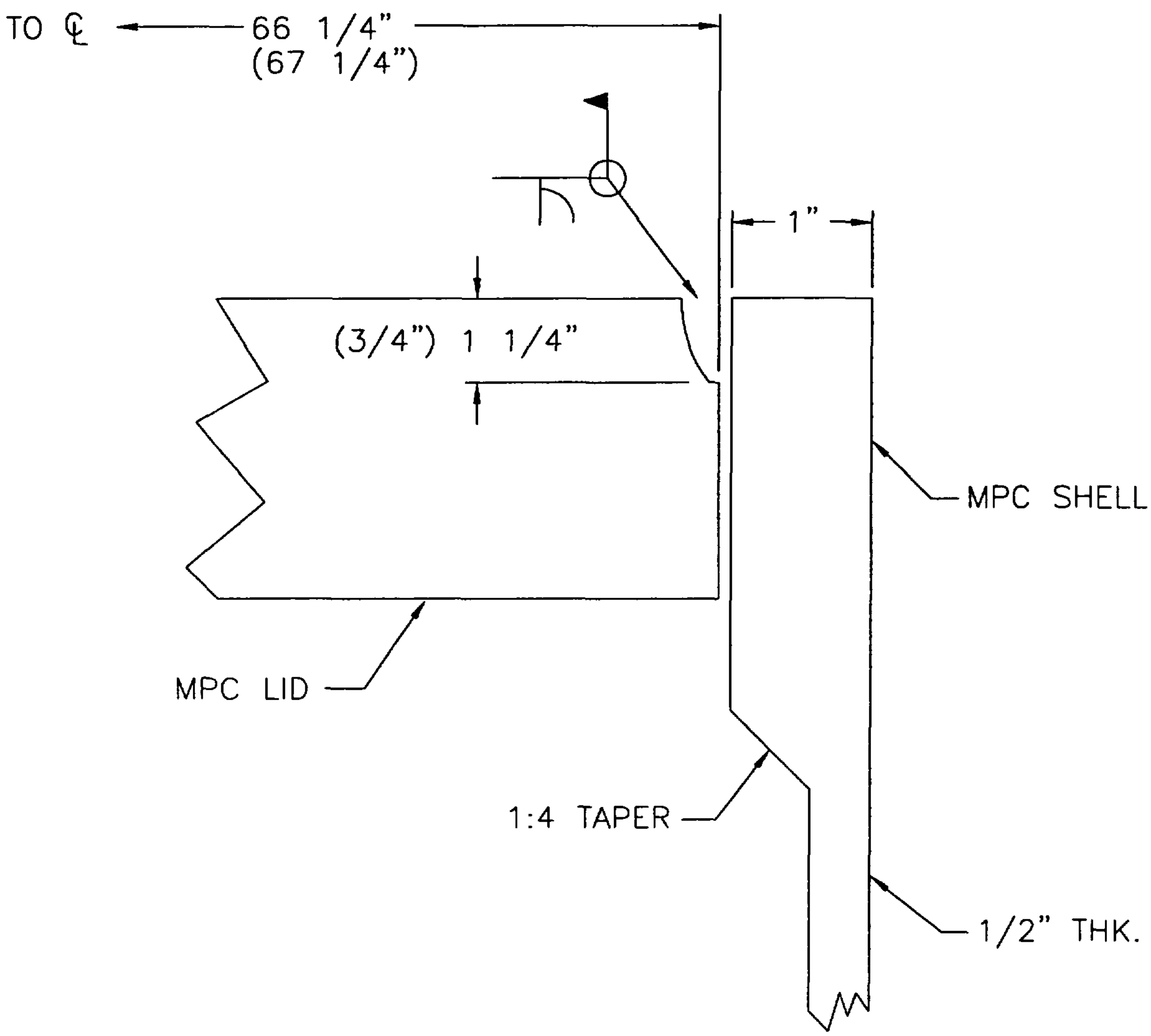


Figure 1.2.16; Major HI-STAR 100 Unloading Operations (Sheet 3 of 3)



NOTES: 1. Standard MPC dimensions in parentheses.
2. Standard MPC shell thickness is 1/2" along its entire length.
3. Figure is not to scale.
4. All dimensions are nominal.

Figure 1.2.17; Fuel Debris MPC ("F" Model)

1.3 DESIGN CODE APPLICABILITY

The ASME Boiler and Pressure Vessel Code (ASME Code), 1995 Edition with Addenda through 1997 [1.3.1], is the governing code for the construction of the HI-STAR 100 System, as clarified in Table 1.3.2. The ASME Code is applied to each component consistent with the function of the component. Table 1.3.3 lists each structure, system and component (SSC) of the HI-STAR 100 System that are labeled Important to Safety (ITS), along with its function and governing Code. Some components perform multiple functions and in those cases, the most restrictive Code is applied. In accordance with NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components" [1.3.2] and according to importance to safety, components of the HI-STAR 100 System are classified as A, B, C, or NITS (not important to safety) in Table 1.3.3. Table 1.3.3 may not include all NITS items associated with the HI-STAR 100 Package.

Table 1.3.1 lists the applicable ASME Code section and paragraph for material procurement, design, fabrication and inspection of the components of the HI-STAR 100 System that are governed by the ASME Code. The ASME Code section listed in the design column is the section used to define allowable stresses for structural analyses.

Table 1.3.2 lists the alternatives to the ASME Code for the HI-STAR 100 System and the justification for those alternatives.

The MPC is classified as important to safety. The MPC structural components include the internal fuel basket and the enclosure vessel. The fuel basket is designed and fabricated as a core support structure, in accordance with the applicable requirements of Section III, Subsection NG of the ASME Code, with certain NRC-approved alternatives, as discussed in Table 1.3.2. The enclosure vessel is designed and fabricated as a Class 1 component pressure vessel in accordance with Section III, Subsection NB of the ASME Code, with certain NRC-approved alternatives, as discussed in Table 1.3.2. The principal exceptions are the MPC lid, vent and drain cover plates, and closure ring welds to the MPC lid and shell, as discussed in Table 1.3.2. In addition, the threaded holes in the MPC lid are designed in accordance with the requirements of ANSI N14.6 [1.3.3] for critical lifts to facilitate vertical MPC transfer.

The MPC closure welds are partial penetration welds that are structurally qualified by analysis, as presented in Chapter 2. The MPC closure ring welds are inspected by performing a liquid penetrant examination of the root pass (if more than one weld pass is required) and final weld surface, in accordance with the requirements contained in Section 8.1. The MPC lid weld may be examined by either volumetric or multi-layer liquid penetrant examination. If volumetric examination is used, it shall be the ultrasonic method and shall include a liquid penetrant examination of the root and final weld layers. If multi-layer liquid penetrant examination is used alone, at a minimum, it must include the root and final weld layers and each approximately 3/8 inch of weld to detect critical weld flaws. The integrity of the MPC lid weld is further verified by performing a pressure test (hydrostatic or pneumatic) and a helium leak test in accordance with the requirements contained in Section 8.1.

The structural analysis of the MPC, in conjunction with the redundant closures and nondestructive examination, pressure testing, and helium leak testing performed during MPC fabrication and MPC closure, provides assurance of canister closure integrity in lieu of the specific weld joint requirements of the ASME Code, Section III, Subsection NB.

The HI-STAR overpack is classified as important to safety. The HI-STAR overpack top flange, closure plate, inner shell, and bottom plate are designed and fabricated in accordance with the requirements of ASME Code, Section III, Subsection NB, to the maximum extent practical (see Table 1.3.2). The remainder of the HI-STAR overpack steel structure is designed and fabricated in accordance with the requirements of ASME Code, Section III, Subsection NF, to the maximum extent practical (see Table 1.3.2).

Table 1.3.1

HI-STAR 100 ASME BOILER AND PRESSURE VESSEL CODE APPLICABILITY

HI-STAR 100 Component	Material Procurement	Design	Fabrication	Inspection
Overpack containment boundary	Section II; and Section III, Subsection NB, NB-2000	Section III, Subsection NB, NB-3200	Section III, Subsection NB, NB-4000	Section III, Subsection NB, NB-5000 and Section V
Overpack intermediate shells, radial channels, outer enclosure	Section II; and Section III, Subsection NF	Section III, Subsection NF, NF-3300	Section III, Subsection NF, NF-4000	Section III, Subsection NF, NF-5360 and Section V
MPC helium retention boundary	Section II; and Section III, Subsection NB, NB-2000	Section III, Subsection NB, NB-3200	Section III, Subsection NB, NB-4000	Section III, Subsection NB, NB-5000 and Section V
MPC fuel basket	Section II; and Section III, Subsection NG, NG-2000 for core support structures (NG-1121)	Section III, Subsection NG, NG-3300 and NG-3200 for core support structures (NG-1121)	Section III, Subsection NG, NG-4000 for core support structures (NG-1121)	Section III, Subsection NG, NG-5000 and Section V for core support structures (NG-1121)
Lifting Trunnions	Section II; and Section III, Subsection NF, NF-2000	ANSI N14.6	Section III, Subsection NF, NF-4000	ANSI 14.6 See Chapter 8
MPC Basket Supports (Angled Plates)	Section II, and Section III, Subsection NG, NG-2000 for internal structures (NG-1122)	Section III, Subsection NG, NG-3300 and NG-3200 for internal structures (NG-1122)	Section III, Subsection NG, NG-4000 for internal structures (NG-1122)	Section III, Subsection NG, NG-5000 and Section V for internal structures (NG-1122)
Damaged Fuel Container	Section II, and Section III, Subsection NG, NG-2000	Section III, Subsection NG, NG-3300 and NG-3200	Section III, Subsection NG, NG-4000	Section III, Subsection NG, NG-5000 and Section V

Table 1.3.2

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC, MPC basket assembly, and HI-STAR overpack steel structure.	Subsection NCA	General Requirements. Requires preparation of a Design Specification, Design Report, Overpressure Protection Report, Certification of Construction Report, Data Report, and other administrative controls for an ASME Code stamped vessel.	Because the MPC, overpack, and transfer cask are not ASME Code stamped vessels, none of the specifications, reports, certificates, or other general requirements specified by NCA are required. In lieu of a Design Specification and Design Report, the HI-STAR SAR includes the design criteria, service conditions, and load combinations for the design and operation of the HI-STAR 100 System as well as the results of the stress analyses to demonstrate that applicable Code stress limits are met. Additionally, the fabricator is not required to have an ASME-certified QA program. All important-to-safety activities are governed by the NRC-approved Holtec QA program. Because the cask components are not certified to the Code, the terms "Certificate Holder" and "Inspector" are not germane to the manufacturing of NRC-certified cask components. To eliminate ambiguity, the responsibilities assigned to the Certificate Holder in the various articles of Subsections NB, NG, and NF of the Code, as applicable, shall be interpreted to apply to the NRC Certificate of Compliance (CoC) holder (and by extension, to the component fabricator) if the requirement must be fulfilled. The Code term "Inspector" means the QA/QC personnel of the CoC holder and its vendors assigned to oversee and inspect the manufacturing process.

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from drawings in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) Thermaline 450 and Carboline 890 were the product names at the time of initial licensing. Chemically identical products with different names are permitted. For example, Carboline 890 was re-named Carboguard 890 in 2000, with no change to the coating material and is , therefore, acceptable for use where Carboline 890 is specified.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC	NB-1100	Statement of requirements for Code stamping of components.	MPC vessel is designed and will be fabricated in accordance with ASME Code, Section III, Subsection NB to the maximum practical extent, but Code stamping is not required.
MPC	NB-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec approved suppliers with Certified Material Test Reports (CMTRs) in accordance with NB-2000 requirements.
MPC basket supports and lift lugs	NB-1130	NB-1132.2(d) requires that the first connecting weld of a nonpressure-retaining structural attachment to a component shall be considered part of the component unless the weld is more than 2t from the pressure-retaining portion of the component, where t is the nominal thickness of the pressure-retaining material. NB-1132.2(e) requires that the first connecting weld of a welded nonstructural attachment to a component shall conform to NB-4430 if the connecting weld is within 2t from the pressure-retaining portion of the component.	The MPC basket supports (nonpressure-retaining structural attachments) and lift lugs (nonstructural attachments used exclusively for lifting an empty MPC) are welded to the inside of the pressure-retaining MPC shell, but are not designed in accordance with Subsection NB. The basket supports and associated attachment welds are designed to satisfy the stress limits of Subsection NG and the lift lugs and associated attachment welds are designed to satisfy the stress limits of Subsection NF, as a minimum. These attachments and their welds are shown by analysis to meet the respective stress limits for their service conditions. Likewise, non-structural items, such as shield plugs, spacers, etc. if used, can be attached to pressure-retaining parts in the same manner.
MPC, MPC basket assembly, and HI-STAR overpack steel structure.	NB-3100 NG-3100 NF-3100	Provides requirements for determining design loading conditions, such as pressure, temperature, and mechanical loads.	These requirements are not applicable. The HI-STAR SAR, serving as the Design Specification, establishes the service conditions and load combinations for the storage system.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC	NB-3350	NB-3352.3 requires, for Category C joints, that the minimum dimensions of the welds and throat thickness shall be as shown in Figure NB-4243-1.	The MPC shell-to-baseplate weld joint design (designated Category C) may not include a reinforcing fillet weld or a bevel in the MPC baseplate, which makes it different than any of the representative configurations depicted in Figure NB-4243-1. The transverse thickness of this weld is equal to the thickness of the adjoining shell (1/2 inch). The weld is designed as a full penetration weld that receives VT and RT or UT, as well as final surface PT examinations. Because the MPC shell design thickness is considerably larger than the minimum thickness required by the Code, a reinforcing fillet weld that would intrude into the MPC cavity space is not included. Not including this fillet weld provides for a higher quality radiographic examination of the full penetration weld. From the standpoint of stress analysis, the fillet weld serves to reduce the local bending stress (secondary stress) produced by the gross structural discontinuity defined by the flat plate/shell junction. In the MPC design, the shell and baseplate thicknesses are well beyond that required to meet their respective membrane stress intensity limits.
MPC, MPC basket assembly, and HI-STAR overpack steel structure	NB-4120 NG-4120 NF-4120	NB-4121.2, NG-4121.2, and NF-4121.2 provide requirements for repetition of tensile or impact tests for material subjected to heat treatment during fabrication or installation.	In-shop operations of short duration that apply heat to a component, such as plasma cutting of plate stock, welding, machining, coating, and pouring of Holtite are not, unless explicitly stated by the Code, defined as heat treatment operations. For the steel parts in the HI-STAR 100 System components, the duration for which a part exceeds the off-normal temperature limit shall be limited to 24 hours in a particular manufacturing process (such as the Holtite pouring process).

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC and HI-STAR overpack steel structure	NB-4220 NF-4220	Requires certain forming tolerances to be met for cylindrical, conical, or spherical shells of a vessel.	The cylindricity measurements on the rolled shells are not specifically recorded in the shop travelers, as would be the case for a Code-stamped pressure vessel. Rather, the requirements on inter-component clearances (such as the MPC-to-overpack) are guaranteed through fixture-controlled manufacturing. The fabrication specification and shop procedures ensure that all dimensional design objectives, including inter-component annular clearances are satisfied. The dimensions required to be met in fabrication are chosen to meet the functional requirements of the dry storage components. Thus, although the post-forming Code cylindricity requirements are not evaluated for compliance directly, they are indirectly satisfied (actually exceeded) in the final manufactured components.
MPC Lid and Closure Ring Welds	NB-4243	Full penetration welds required for Category C Joints (flat head to main shell per NB-3352.3)	MPC lid and closure ring are not full penetration welds. They are welded independently to provide a redundant seal. Additionally, a weld efficiency factor of 0.45 has been applied to the analyses of these welds.
MPC Lid-to-Shell Weld	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required.	Only UT or multi-layer liquid penetrant (PT) examination is permitted. If PT alone is used, at a minimum, it will include the root and final weld layers and each approximately 3/8 inch of weld depth.
MPC Closure Ring, Vent and Drain Cover Plate Welds	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required.	Root (if more than one weld pass is required) and final liquid penetrant examination to be performed in accordance with NB-5245. The MPC vent and drain cover plate welds are leak tested. The closure ring provides independent redundant closure for vent and drain cover plates.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC Enclosure Vessel and Lid	NB-6111	All completed pressure retaining systems shall be pressure tested.	The MPC vessel is seal welded in the field following fuel assembly loading. The MPC vessel shall then be pressure tested as defined in Chapter 8. Accessibility for leakage inspections preclude a Code compliant pressure test. All MPC vessel welds (except closure ring and vent/drain cover plate) are inspected by volumetric examination, except that the MPC lid-to-shell weld shall be verified by volumetric or multi-layer PT examination. If PT alone is used, at a minimum, it must include the root and final layers and each approximately 3/8 inch of weld depth. For either UT or PT, the maximum undetectable flaw size must be demonstrated to be less than the critical flaw size. The critical flaw size must be determined in accordance with ASME Section XI methods. The critical flaw size shall not cause the primary stress limits of NB-3000 to be exceeded. The inspection results, including relevant findings (indications) shall be made a permanent part of the user's records by video, photographic, or other means which provide an equivalent retrievable record of weld integrity. The video or photographic records should be taken during the final interpretation period described in ASME Section V, Article 6, T-676. The vent/drain cover plate welds are confirmed by helium leakage testing and liquid penetrant examination and the closure ring weld is confirmed by liquid penetrant examination. The inspection of the weld must be performed by qualified personnel and shall meet the acceptance requirements of ASME Code Section III, NB-5350 for PT or NB-5332 for UT.
MPC Enclosure Vessel	NB-7000	Vessels are required to have overpressure protection.	No overpressure protection is provided. The function of MPC vessel is as a helium retention boundary. MPC vessel is designed to withstand maximum internal pressure considering 100% fuel rod failure and maximum accident temperatures.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC Enclosure Vessel	NB-8000	States requirements for nameplates, stamping and reports per NCA-8000.	HI-STAR 100 System to be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. Code stamping is not required. QA data package to be in accordance with Holtec approved QA program.
Overpack Containment Boundary	NB-1100	Statement of requirements for Code stamping of components.	Overpack containment boundary is designed, and will be fabricated in accordance with ASME Code, Section III, Subsection NB to the maximum practical extent, but Code stamping is not required.
Overpack Containment Boundary	NB-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec approved suppliers with CMTRs per NB-2000.
Overpack Containment Boundary	NB-7000	Vessels are required to have overpressure protection.	No overpressure protection is provided. Function of overpack vessel is as a radionuclide containment boundary under normal and hypothetical accident conditions. Overpack vessel is designed to withstand maximum internal pressure and maximum accident temperatures.
Overpack Containment Boundary	NB-8000	States requirements for nameplates, stamping and reports per NCA-8000.	HI-STAR 100 System to be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. Code stamping is not required. QA data package to be in accordance with Holtec's approved QA program.
MPC Basket Assembly	NG-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec approved supplier with CMTRs in accordance with NG-2000 requirements.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
MPC Basket Assembly	NG-4420	NG-4427(a) allows a fillet weld in any single continuous weld to be less than the specified fillet weld dimension by not more than 1/16 inch, provided that the total undersize portion of the weld does not exceed 10 percent of the length of the weld. Individual undersize weld portions shall not exceed 2 inches in length.	Modify the Code requirement (intended for core support structures) with the following text prepared to accord with the geometry and stress analysis imperatives for the fuel basket: For the longitudinal MPC basket fillet welds, the following criteria apply: 1) The specified fillet weld throat dimension must be maintained over at least 92 percent of the total weld length. All regions of undersized weld must be less than 3 inches long and separated from each other by at least 9 inches. 2) Areas of undercuts and porosity beyond that allowed by the applicable ASME Code shall not exceed 1/2 inch in weld length. The total length of undercut and porosity over any 1-foot length shall not exceed 2 inches. 3) The total weld length in which items (1) and (2) apply shall not exceed a total of 10 percent of the overall weld length. The limited access of the MPC basket panel longitudinal fillet welds makes it difficult to perform effective repairs of these welds and creates the potential for causing additional damage to the basket assembly (e.g., to the neutron absorber and its sheathing) if repairs are attempted. The acceptance criteria provided in the foregoing have been established to comport with the objectives of the basket design and preserve the margins demonstrated in the supporting stress analysis. From the structural standpoint, the weld acceptance criteria are established to ensure that any departure from the ideal, continuous fillet weld seam would not alter the primary bending stresses on which the design of the fuel baskets is predicated. Stated differently, the permitted weld discontinuities are limited in size to ensure that they remain classifiable as local stress elevators ("peak stress", F, in the ASME Code for which specific stress intensity limits do not apply).
MPC Basket Assembly	NG-8000	States requirements for nameplates, stamping and reports per NCA-8000.	The HI-STAR 100 System will be marked and identified in accordance with 10CFR71 and 10CFR72 requirements. No Code stamping is required. The MPC basket data package will be in conformance with Holtec's QA program.
Overpack Intermediate Shells	NF-2000	Requires materials to be supplied by ASME-approved material supplier.	Materials will be supplied by Holtec approved supplier with CMTRs in accordance with NF-2000 requirements.

Table 1.3.2 (continued)

LIST OF ASME CODE ALTERNATIVES FOR HI-STAR 100 SYSTEM

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
Overpack Containment Boundary	NB-2330	Defines the methods for determining the T_{NDT} for impact testing of materials.	T_{NDT} shall be defined in accordance with Regulatory Guides 7.11 and 7.12 for the containment boundary components.
Overpack Containment Boundary	NF-3320 NF-4720	NF-3324.6 and NF-4720 provide requirements for bolting.	These Code requirements are applicable to linear structures wherein bolted joints carry axial, shear, as well as rotational (torsional) loads. The overpack bolted connections in the structural load path are qualified by design based on the design loadings defined in the SAR. Bolted joints in these components see no shear or torsional loads under normal storage conditions. Larger clearances between bolts and holes may be necessary to ensure shear interfaces located elsewhere in the structure engage prior to the bolts experiencing shear loadings (which occur only during side impact scenarios). Bolted joints that are subject to shear loads in accident conditions are qualified by appropriate stress analysis. Larger bolt-to-hole clearances help ensure more efficient operations in making these bolted connections, thereby minimizing time spent by operations personnel in a radiation area. Additionally, larger bolt-to-hole clearances allow interchangeability of the lids from one particular fabricated cask to another.

Table 1.3.3

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

OVERPACK (1, 2)

Primary Function	**Component** (3)	**Safety Class** (4)	**Codes/Standards (as applicable to component)**	**Material**	**Strength (ksi)**	**Special Surface Finish/Coating**	**Contact Matl. (if dissimilar)**
Containment	Inner Shell	A	ASME Section III; Subsection NB	SA203-E	Table 2.3.4	Paint inside surface with Thermaline 450 (Note 5). External surface to be coated with a surface preservative.	NA
Containment	Bottom Plate	A	ASME Section III; Subsection NB	SA350-LF3	Table 2.3.4	Paint inside surface with Thermaline 450 (Note 5).	NA
Containment	Top Flange	A	ASME Section III; Subsection NB	SA350-LF3	Table 2.3.4	Paint inside surface with Thermaline 450. Paint outside surface with Carboline 890 (Note 5).	NA
Containment	Closure Plate	A	ASME Section III; Subsection NB	SA350-LF3	Table 2.3.4	Paint inside surface with Thermaline 450. Paint outside surface with Carboline 890 (Note 5).	NA
Containment	Closure Plate Bolts	A	ASME Section III; Subsection NB	SB637-N07718	Table 2.3.5	NA	NA
Containment	Port Plug	A	Non-code	SA193-B8	Not required	NA	NA
Containment	Port Plug Seal	A	Non-code	Alloy X750	Not required	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from drawings in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) Thermaline 450 and Carboline 890 were the product names at the time of initial licensing. Chemically identical products with different names are permitted. For example, Carboline 890 was re-named Carboguard 890 in 2000, with no change to the coating material and is , therefore, acceptable for use where Carboline 890 is specified.

TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

OVERPACK [1,2]

Primary Function	Component [3]	Safety Class [4]	Codes/Standards (as applicable to component)	Material	Strength (ksl)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Containment	Closure Plate Seal	A	Non-code	Alloy X750	Not required	NA	NA
Containment	Port Cover Seal	B	Non-code	Alloy X750	Not required	NA	NA
Shielding	Intermediate Shells	B	ASME Section III; Subsection NF	SA516-70	Table 2.3.2	Internal surfaces to be coated with a silicone encapsulant (dow corning SYLGARD 567 or equivalent) for surface preservation. Exposed areas of fifth intermediate shell to be painted with Carboline 890 (Note 5).	NA
Shielding	Neutron Shield	B	Non-code	Holtite-A	Not required	NA	Holtite/CS
Shielding	Plugs for Drilled Holes	NITS	Non-code	SA193-B7	Not required	NA	NA
Shielding	Removable Shear Ring	B	ASME Section III; Subsection NF	SA203-E	Table 2.3.4	Paint external surface with Carboline 890 (Note 5).	NA
Shielding	Pocket Trunnion Plug Plate	C	Non-code	SA240-304	Not required	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from drawings in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) Thermaline 450 and Carboline 890 were the product names at the time of initial licensing. Chemically identical products with different names are permitted. For example, Carboline 890 was re-named Carboguard 890 in 2000, with no change to the coating material and is , therefore, acceptable for use where Carboline 890 is specified.

TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

OVERPACK (1,2)

Primary Function	Component (3)	Safety Class (4)	Codes/Standards (as applicable to component)	Material	Strength (ksi)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Heat Transfer	Radial Channels	B	ASME Section III; Subsection NF	SA515-70	Table 2.3.3	Paint outside surface with Carboline 890 (Note 5).	NA
Rotation Pivot and Shielding	Pocket Trunnion	B	Non-Code	SA705-630 or SA564-630	Table 2.3.5	NA	NA
Structural Integrity	Lifting Trunnion	A	ANSI N14.6	SB637-N07718	Table 2.3.5	NA	NA
Structural Integrity	Backing Strip	B	Non-code	A569	Not required	NA	NA
Structural Integrity	Relief DeviceCoupling	NITS	Non-code	C/S	Not required	NA	NA
Structural Integrity	Relief Device	C	Non-code	Commercial	Not required	NA	Brass-C/S
Structural Integrity	Relief Device Pipe	C	Non-code	SA-106	Not required	NA	NA
Structural Integrity	Relief Device Plate	C	Non-code	A569	Not required	NA	NA
Structural Integrity	Removable Shear Ring Bolt	C	Non-code	SA193-B7	Not required	NA	NA
Structural Integrity	Thermal Expansion Foam	NITS	Non-code	Silicone Foam	Not required	NA	NA
Structural Integrity	Closure Bolt Washer	NITS	Non-code	SA240-304	Not required	NA	NA
Structural Integrity	Enclosure Shell Panels	B	ASME Section III; Subsection NF	SA515-70	Table 2.3.3	Paint outside surface with Carboline 890 (Note 5).	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from drawings in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) Thermaline 450 and Carboline 890 were the product names at the time of initial licensing. Chemically identical products with different names are permitted. For example, Carboline 890 was re-named Carboguard 890 in 2000, with no change to the coating material and is , therefore, acceptable for use where Carboline 890 is specified.

TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

OVERPACK [1,2]

Primary Function	Component [3]	Safety Class [4]	Codes/Standards (as applicable to component)	Material	Strength (ksi)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Structural Integrity	Enclosure Shell Return	B	ASME Section III; Subsection NF	SA515-70	Table 2.3.3	Paint outside surface with Carboline 890 (Note 5).	NA
Structural Integrity	Port Cover	B	ASME Section III; Subsection NF	SA203E	Table 2.3.4	Paint outside surface with Carboline 890 (Note 5).	NA
Structural Integrity	Port Cover Bolt	C	Non-code	SA193-B7	Not required	NA	NA
Operations	Trunnion Locking Pad and End Cap Bolt	C	Non-code	SA193-B7	Not required	NA	NA
Operations	Lifting Trunnion End Cap	C	Non-code	SA516-70 or SA515 Gr. 70	Table 2.3.2	Paint exposed surfaces with Carboline 890 (Note 5).	NA
Operations	Lifting Trunnion Locking Pad	C	Non-code	SA516-70	Table 2.3.2	Paint exposed surfaces with Carboline 890 (Note 5).	NA
Operations	Nameplate	NITS	Non-code	S/S	Not required	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from drawings in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) Thermaline 450 and Carboline 890 were the product names at the time of initial licensing. Chemically identical products with different names are permitted. For example, Carboline 890 was re-named Carboguard 890 in 2000, with no change to the coating material and is , therefore, acceptable for use where Carboline 890 is specified.

Table 1.3.3 (cont'd)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

MPC (1, 2)

Primary Function	**Component (3)**	**Safety Class (4)**	**Codes/Standards (as applicable to component)**	**Material**	**Strength (ksi)**	**Special Surface Finish/Coating**	**Contact Matl. (if dissimilar)**
Helium Retention (Secondary Containment)	Shell	A	ASME Section III; Subsection NB	Alloy X (5)	See Appendix 1.A	NA	NA
Helium Retention (Secondary Containment)	Baseplate	A	ASME Section III; Subsection NB	Alloy X	See Appendix 1.A	NA	NA
Helium Retention (Secondary Containment)	Lid (One-piece design and top portion of optional two-piece design)	A	ASME Section III; Subsection NB	Alloy X	See Appendix 1.A	NA	NA
Helium Retention (Secondary Containment)	Closure Ring	A	ASME Section III; Subsection NB	Alloy X	See Appendix 1.A	NA	NA
Helium Retention (Secondary Containment)	Port Cover Plates	A	ASME Section III; Subsection NB	Alloy X	See Appendix 1.A	NA	NA
Criticality Control	Basket Cell Plates	A	ASME Section III; Subsection NG; core support structures (NG-1121)	Alloy X	See Appendix 1.A	NA	NA
Criticality Control	Boral	A	Non-code	NA	NA	NA	Aluminum/SS
Shielding	Drain and Vent Shield Block	C	Non-code	Alloy X	See Appendix 1.A	NA	NA
Shielding	Plugs for Drilled Holes	NITS	Non-code	Alloy X	See Appendix 1.A	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from Bill of Materials in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) For details on Alloy X material, see Appendix 1.A.

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TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

MPC [1,2]

Primary Function	Component [3]	Safety Class [4]	Codes/Standards (as applicable to component)	Material	Strength (ksi)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Shielding	Bottom portion of optional two-piece MPC lid design	B	Non-code	Alloy X	See Appendix 1.A	NA	NA
Heat Transfer	Optional Heat Conduction Elements	B	Non-code	Aluminum; Alloy 1100	NA	Sandblast Specified Surfaces	Aluminum/SS
Structural Integrity	Upper Fuel Spacer Column	B	ASME Section III; Subsection NG (only for stress analysis)	Alloy X	See Appendix 1.A	NA	NA
Structural Integrity	Sheathing	A	Non-code	Alloy X	See Appendix 1.A	Aluminum/SS	NA
Structural Integrity	Shims	NITS	Non-code	Alloy X	See Appendix 1.A	NA	NA
Structural Integrity	Basket Supports (Angled Plates)	A	ASME Section III; Subsection NG; internal structures (NG-1122)	Alloy X	See Appendix 1.A	NA	NA
Structural Form	Basket Supports (Flat Plates)	NITS	Non-code	Alloy X	See Appendix 1.A	NA	NA
Structural Integrity	Upper Fuel Spacer Bolt	NITS	Non-code	A193-B8	Per ASME Section II	NA	NA
Structural Integrity	Upper Fuel Spacer End Plate	B	Non-code	Alloy X	See Appendix 1.A	NA	NA

Notes:
1) *There are no known residuals on finished component surfaces.*
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from Bill of Materials in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) For details on Alloy X material, see Appendix 1.A.

TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

MPC [1,2]

Primary Function	Component [3]	Safety Class [4]	Codes/Standards (as applicable to component)	Material	Strength (ksi)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Structural Integrity	Lower Fuel Spacer Column	B	ASME Section III; Subsection NG (only for stress analysis)	S/S	See Appendix 1.A	NA	NA
Structural Integrity	Lower Fuel Spacer End Plate	B	Non-code	Alloy X	See Appendix 1.A	NA	NA
Structural Integrity	Vent Shield Block Spacer	C	Non-code	Alloy X	See Appendix 1.A	NA	NA
Structural Integrity	Trojan MPC Spacer	B	Non-code	304 S/S	Per ASME Section II	NA	NA
Structural Integrity	Trojan Failed Fuel Can Spacer	B	ASME Section III, Subsection NF	304 or 304LN S/S	Per ASME Section II	NA	NA
Operations	Vent and Drain Tube	C	Non-code	S/S	Per ASME Section II	Thread area surface hardened	NA
Operations	Vent & Drain Cap	C	Non-code	S/S	Per ASME Section II	NA	NA
Operations	Vent & Drain Cap Seal Washer	NITS	Non-code	Aluminum	NA	NA	Aluminum/SS
Operations	Vent & Drain Cap Seal Washer Bolt	NITS	Non-code	Aluminum	NA	NA	NA
Operations	Reducer	NITS	Non-code	Alloy X	See Appendix 1.A	NA	NA
Operations	Drain Line	NITS	Non-code	Alloy X	See Appendix 1.A	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from Bill of Materials in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) For details on Alloy X material, see Appendix 1.A.

TABLE 1.3.3 (continued)

MATERIALS AND COMPONENTS OF THE HI-STAR 100 SYSTEM

MPC [1,2]

Primary Function	Component [3]	Safety Class [4]	Codes/Standards (as applicable to component)	Material	Strength (ksi)	Special Surface Finish/Coating	Contact Matl. (if dissimilar)
Operations	Damaged Fuel Container	C	ASME Section III; Subsection NG	Primarily 304 S/S	See Appendix 1.A	NA	NA
Operations	Trojan Failed Fuel Can	C	ASME Section III; Subsection NG	304 S/S	Per ASME Section II	NA	NA
Operations	Drain Line Guide Tube	NITS	Non-code	S/S	NA	NA	NA

Notes:
1) There are no known residuals on finished component surfaces.
2) All welding processes used in welding the components shall be qualified in accordance with the requirements of ASME Section IX. All welds shall be made using welders qualified in accordance with ASME Section IX. Weld material shall meet the requirements of ASME Section II and the applicable Subsection of ASME Section III. For parts beyond the purview of ASME Section III, compliance with Section IX and Section II of the Code shall be observed to the extent practicable.
3) Component nomenclature taken from Bill of Materials in Chapter 1.
4) A,B and C denote important to safety classifications as described in NUREG/CR-6407. NITS stands for Not Important To Safety.
5) For details on Alloy X material, see Appendix 1.A.

1.4 DRAWINGS

The following drawings provide sufficient detail to describe the HI-STAR 100 packaging.

The classification of all components important to safety in accordance with Regulatory Guide 7.10 and NUREG/CR-6407 is provided in Table 1.3.3. Operational information, such as bolt torque and pressure-relief specifications are provided in Chapters 7 and 8. The maximum weight of the package and the maximum weight of the contents is provided in Table 2.2.1.

The following HI-STAR 100 System design drawings are provided in this section

Drawing Number/Sheet	Description	Rev.
3913	Licensing Drawing for HI-STAR 100 Overpack Assembly	5
3923	Licensing Drawing for MPC Enclosure Vessel	8
3925	Licensing Drawing for MPC-24E/EF Fuel Basket Assembly	4
3926	Licensing Drawing for MPC-24 Fuel Basket Assembly	5
3927	Licensing Drawing for MPC-32 Fuel Basket Assembly	6
3928	Licensing Drawing for MPC-68/68F/68FF Fuel Basket Assembly	4
5014-C1765 Sht 1/7†	HI-STAR 100 Impact Limiter	1
5014-C1765 Sht 2/7†	HI-STAR 100 Bottom Impact Limiter	1
5014-C1765 Sht 3/7†	HI-STAR 100 Top Impact Limiter	1
5014-C1765 Sht 4/7†	HI-STAR 100 Top Impact Limiter	1
5014-C1765 Sht 5/7†	HI-STAR 100 Top Impact Limiter Detail of Item #6	1
5014-C1765 Sht 6/7†	HI-STAR 100 Impact Limiter Honeycomb Details	1
5014-C1765 Sht 7/7†	HI-STAR 100 Bottom Impact Limiter	0
3930	HI-STAR 100 Assembly For Transport	1
4111	Licensing Drawing for Trojan MPC Spacer Ring	0
4119	Licensing Drawing for Holtec Damaged Fuel Container for Trojan Plant Fuel	1

† These drawing titles include the term "CoC No. 9261, Appendix B." Rather than appending the drawings directly to the CoC, they are incorporated into the CoC by reference. The "Appendix B" will be removed from each drawing as part of its next normal revision.

Drawing Number/Sheet	Description	Rev.
4122	Licensing Drawing for Trojan FFC Spacer	0
PFFC-001	Failed Fuel Can Assembly	8
PFFC-002	Failed Fuel Can Shell and Lid Assembly	7

CLIENT	GENERAL

LICENSING DRAWING PACKAGE COVER SHEET

PROJECT NO. 1020	P.O. NO. N/A
DRAWING PACKAGE I.D. 3913	TOTAL SHEETS 9

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	HI-STAR 100 OVERPACK
2	ELEVATION VIEW
3	DETAIL OF TOP FLANGE AT 0° & 180°
4	DETAIL OF CLOSURE PLATE BOLT HOLE & BOLT
5	TOP PLAN VIEW "D" - "D".
6	MID-PLANE SECTION "E" - "E"
7	TEST VENT & DRAIN PORT DETAILS
8	DETAIL "H"
9	POCKET TRUNNION DETAIL

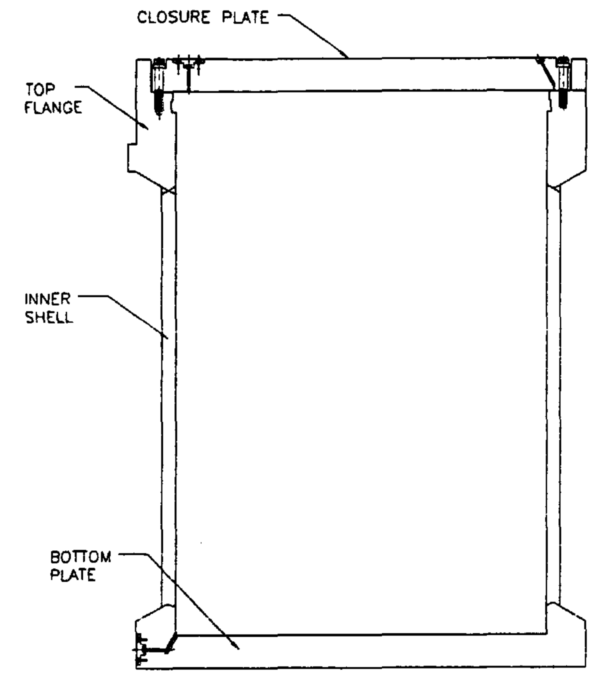
REVISION LOG

REV.	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREP. BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1020-41	D. Butler	05/28/02	83767
1	ALL SHEETS	1020-42	S. CAIN	10/21/02	58786
2	SHEETS 1, 2, & 6	1020-43	S. CAIN	11/18/02	16412
3	SHEETS 1, 2, 5, 6 & 9	1020-45	T.F.O.	5/19/03	57621
4	SHEETS 1 & 9	1020-46	T.F.O.	7/10/03	78609
5	SHEETS 9	1020-47	T.F.O.	7/31/03	53374

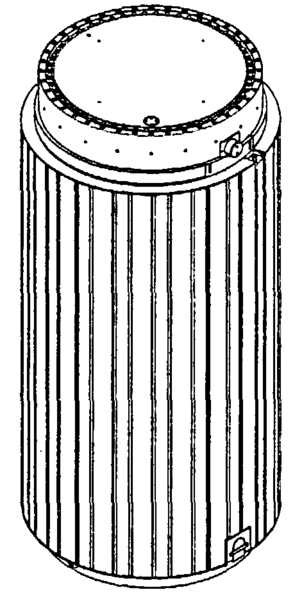
† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
3. ALL CATEGORY A, B, AND C JOINTS (NB-3351) IN THE CONTAINMENT BOUNDARY SHALL BE FULL PENETRATION WELDS.
4. OVERPACK INNER DIAMETER SHALL BE VERIFIED TO BE AT LEAST 1/16" GREATER THAN THE MAXIMUM OUTER MPC SHELL DIAMETER BY THE USE OF AN APPROPRIATELY SIZED TEST GAGE. GRINDING OR MACHINING THE INNER OVERPACK SURFACES IS PERMITTED TO ENSURE ADEQUATE CLEARANCE.
5. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997 IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE OVERPACK IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NB FOR THE CONTAINMENT BOUNDARY, AND SUBSECTION NF FOR THE BALANCE OF THE STRUCTURE, AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
6. ALL WELDS REQUIRE VISUAL EXAMINATION. ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. PRESSURE (CONTAINMENT) BOUNDARY COMPONENTS SHALL MEET THE MATERIAL ACCEPTANCE CRITERIA OF NB-2000. ALL SUPPORT STRUCTURE (NON-CONTAINMENT) MATERIAL SHALL MEET THE ACCEPTANCE CRITERIA OF NF-2000.
8. WELDING PROCEDURES AND WELDER QUALIFICATIONS SHALL BE PER ASME SECTION IX AND ASME SECTION III (SUBSECTION NB FOR PRESSURE (CONTAINMENT) BOUNDARY WELDS AND SUBSECTION NF FOR NON-CONTAINMENT BOUNDARY WELDS).
9. POCKET TRUNNION PLUGS SHALL BE INSTALLED DURING TRANSPORT, IF POCKET TRUNNIONS ARE NOT IN USE (SEE SHEET 9).
10. THE NEUTRON SHIELD ENCLOSURE SHALL INCLUDE OVERPRESSURE PROTECTION. THE MAXIMUM SET PRESSURE OF THE PRESSURE RELIEF DEVICES IS 35 PSIG.
11. ALL SEALING SURFACES SHALL BE STAINLESS STEEL OVERLAID.
12. DRAWING IS NOT TO SCALE.
13. ADDITIONAL HOLES MAY BE ADDED BY THE FABRICATOR FOR LIFTING AND HANDLING WITH APPROVAL BY THE DESIGNER. HOLES NOT USED FOR TRANSPORTATION SHALL BE PLUGGED WITH STEEL.
14. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSES. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
15. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS APPLICABLE.
16. THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND FSAR TABLE 2.2.6 (STORAGE).
17. HOLTITE-A NEUTRON SHIELDING MATERIAL HAS CRITICAL CHARACTERISTICS OF (ALL VALUES NOMINAL): 1 WT % B C, 6 WT % HYDROGEN, AND A SPECIFIC GRAVITY OF 1.68 GM/CC. OTHER CONSTITUENTS OF HOLTITE-A SHALL BE AS DESCRIBED IN HOLTEC PROPRIETARY REPORT HI-2002396, REV. 3.
18. OVERPACK INNER CAVITY TO BE COATED WITH THERMALINE 450 OR IDENTICAL SUBSTITUTE. OVERPACK EXTERNAL SURFACES (EXCEPT THREADED HOLES AND SEALING SURFACES) TO BE COATED WITH CARBOLINE 890 OR IDENTICAL SUBSTITUTE.
19. FOR NON-CODE WELDS, THE PROVISIONS OF EITHER ASME IX OR AWS MAY BE FOLLOWED.
20. TOLERANCES FOR THE THICKNESS OF ASME CODE OVERPACK MATERIAL ARE SPECIFIED IN ASME SECTION II.
21. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
22. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THIS DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



HI-STAR CONTAINMENT BOUNDARY



HI-STAR 100 OVERPACK ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	HI-STAR 100 OVERPACK
PROJECT NO.	1020
P.O. NO.	N/A
DRAWING NO.	3913
SHEET	1
TOTAL SHEETS	9
FILE PATH	C:\DRAWINGS\1020\3913\

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION HI-STAR 100 OVERPACK ELEVATION VIEW			
COMPANION DRAWINGS	SIZE D	DRAWING NO. 3913	SHEET 2	REV 5
	SCALE NTS	FILE PATH. G:\DRAWINGS\1020\3913		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: HI-STAR 100 OVERPACK DETAIL OF TOP FLANGE AT 0° & 180°			
COMPANION DRAWINGS	SIZE: D	DRAWING NO.: 3913	SHEET: 3	REV: 5
	SCALE: NTS	FILE PATH: C:\DRAWINGS\1020\3913		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL DESCRIPTION HI-STAR 100 OVERPACK CLOSURE PLATE BOLT HOLE & BOLT			
COMPANION DRAWINGS	SIZE D	DRAWING NO. 3913	SHEET 4	REV 5
	SCALE NTS	FILE PATH G:\DRAWINGS\1020\3913		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: HI-STAR 100 OVERPACK TOP PLAN VIEW "D" – "D"			
COMPANION DRAWINGS	SIZE: D	DRAWING NO: 3913	SHEET: 5	REV: 5
	SCALE: NTS	FILE PATH: C:\DRAWINGS\1020\3913		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

COMPANION DRAWINGS

CLIENT: GENERAL

DESCRIPTION: HI-STAR 100 OVERPACK MID-PLANE SECTION "E" - "E"

SIZE	DRAWING NO.	SHEET	REV
D	3913	6	5

SCALE: NTS

FILE PATH:

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL
	DESCRIPTION HI-STAR 100 OVERPACK TEST, VENT AND DRAIN PORT DETAILS
COMPANION DRAWINGS	SIZE: D — DRAWING NO.: 3913 — SHEET: 7 — REV: 5
	SCALE: NTS — FILE PATH: G:\DRAWINGS\1020\3913

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION HI-STAR 100 OVERPACK DETAIL "H"			
COMPANION DRAWINGS	SIZE D	DRAWING NO. 3913	SHEET 8	REV 5
	SCALE NTS	FILE PATH		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: POCKET TRUNNION DETAIL			
COMPANION DRAWINGS	SIZE: D	DRAWING NO.: 3913	SHEET: 9	REV: 5
	SCALE: NTS	FILE PATH: G:\DRAWINGS\1020\3913		

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT: GENERAL

PROJECT NO. 5014	P.O. NO. N/A
DRAWING PACKAGE I.D. 3923	TOTAL SHEETS 5

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	MPC ENCLOSURE VESSEL GENERAL ARRANGEMENT
3	MPC ENCLOSURE VESSEL ELEVATION DETAILS
4	MPC ENCLOSURE VESSEL LID DETAILS
5	MPC FUEL SPACER DETAILS

REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	5014-57	S.CAIN	5/30/02	59761
1	SHEETS 2 & 4	5014-62	S.CAIN	6/17/02	13107
2	ALL	5014-62, REV. 1	S.CAIN	8/1/02	97257
3	SHEETS 3 & 4	5014-71	S.CAIN	10/9/02	82001
4	SHEET 4	1021-50	S.CAIN	11/26/02	28576
5	SHEET 4	5014-62, REV. 2	S.CAIN	12/13/02	94731
6	SHEETS 2 & 4	1021-51, REV. 0	S.CAIN	2/12/03	57439
7	ALL	5014-87	T.F.O.	5/19/03	30375
8	SHEETS 1 & 3	5014-94	T.F.O.	7/10/03	26573

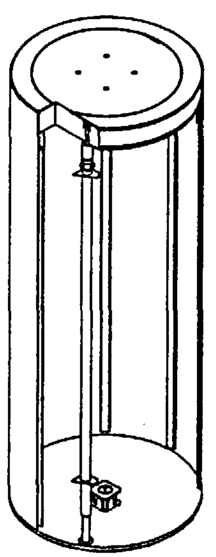
† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSES. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997 IS THE GOVERNING CODE FOR THE MPC ENCLOSURE VESSEL, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE MPC ENCLOSURE VESSEL IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NB WITH CERTAIN APPROVED CODE ALTERNATIVES AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. (8) ALL MPC ENCLOSURE VESSEL STRUCTURAL MATERIALS ARE "ALLOY X" UNLESS OTHERWISE NOTED. ALLOY X IS ANY OF THE FOLLOWING STAINLESS STEEL TYPES: 316, 316LN, 304, AND 304LN. ALLOY X MATERIAL MUST COMPLY WITH ASME SECTION II, PART A. WELD MATERIAL COMPLIES WITH ASME SECTION II, PART C. MPC ENCLOSURE VESSEL WALL (I.E. CYCLINDER SHELL) WILL BE FABRICATED OF PIECES MADE FROM THE SAME TYPE OF STAINLESS STEEL.
6. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING AS REQUIRED. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY, AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. UNLESS OTHERWISE NOTED, FULL PENETRATION WELDS MAY BE MADE FROM EITHER SIDE OF A COMPONENT.
8. FUEL BASKET SUPPORTS ARE ILLUSTRATIVE. ACTUAL FUEL BASKET SUPPORT ARRANGEMENTS ARE SHOWN ON THE INDIVIDUAL FUEL BASKET DRAWINGS.
9. DIFFERENCES BETWEEN THE GENERIC MPC ENCLOSURE VESSEL AND THE TROJAN PLANT MPC ENCLOSURE VESSEL ARE SPECIFICALLY NOTED (FOR PART 71 USE ONLY).
10. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS APPLICABLE.

NOTES CONT:

11. (8) THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND FSAR TABLE 2.2.6 (STORAGE).
12. (8) DELETED
13. (8) LOCAL GRINDING OF THE MPC SHELL SHALL NOT RESULT IN GREATER THAN 10% LOSS IN BASE METAL THICKNESS OVER ANY AREA WHICH EXCEEDS 4 INCHES IN THE LONGITUDINAL OR CIRCUMFERENTIAL DIRECTION. FOR THE WELD AREA AND ADJACENT BASE METAL, AN ADDITIONAL ALLOWANCE OF 0.02" LOSS IN NOMINAL BASE METAL THICKNESS IS ALLOWED OVER THE ENTIRE LENGTH OF THE WELD. THE SUM OF ALL AREAS OF LOCAL METAL LOSS SHALL NOT EXCEED 10% OF THE OVERALL INSIDE SURFACE AREA OF THE MPC SHELL. FINAL THICKNESSES IN LOCAL AREAS OF GRINDING SHALL BE CONFIRMED BY UT EXAMINATION, AS APPROPRIATE.
14. FOR NON-CODE WELDS, THE PROVISIONS OF EITHER ASME IX OR AWS MAY BE FOLLOWED.
15. TOLERANCES FOR THICKNESS OF ASME CODE MPC ENCLOSURE VESSEL MATERIAL ARE SPECIFIED IN ASME SECTION II.
16. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
17. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THIS DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



MPC ENCLOSURE VESSEL ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	MPC ENCLOSURE VESSEL
PROJECT NO. 5014	DRAWING NO. 3923
P.O. NO. N/A	SHEET 1 / TOTAL SHEETS 5

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC ENCLOSURE VESSEL GENERAL ARRANGEMENT			
COMPANION DRAWINGS: 3925, 3926, 3927, 3928	SIZE: D	DRAWING NO: 3923	SHEET: 2	REV: 8
	SCALE: NONE	FILE PATH: [illegible]		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC ENCLOSURE ENCLOSURE VESSEL ELEVATION DETAILS			
COMPANION DRAWINGS: 3925, 3926, 3927, 3928	SIZE: D	DRAWING NO.: 3923	SHEET: 3	REV: 8
	SCALE: NONE	FILE PATH: G:\DRAWINGS\5014\3923		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL DESCRIPTION MPC ENCLOSURE VESSEL LID DETAILS
COMPANION DRAWINGS: 3925, 3926, 3927, 3928	SIZE D | DRAWING NO. 3923 | SHEET 4 | REV 8 SCALE NONE | FILE PATH: G:\DRAWINGS\5014\3923

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: FUEL SPACER DETAILS			
COMPANION DRAWINGS: 3925, 3926, 3927, 3928	SIZE: D	DRAWING NO: 3923	SHEET: 5	REV: 8
	SCALE: NONE	FILE PATH:		

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT	GENERAL
PROJECT NO. 1022	P.O. NO. N/A
DRAWING PACKAGE I.D. 3925	TOTAL SHEETS 4

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	FUEL BASKET ARRANGEMENT
3	FUEL BASKET LAYOUT AND WELD DETAILS
4	FUEL BASKET SUPPORT DETAILS

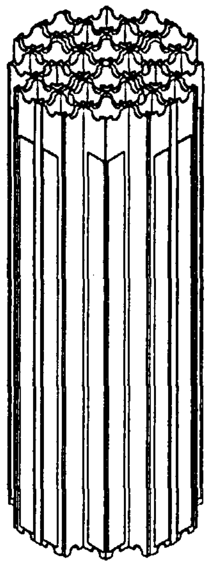
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1022-38	SLC	5/30/02	17385
1	ALL	1022-38, REV. 1	SLC	8/28/02	69345
2	SHEETS 2 & 3	1022-30, REV. 0 & 5014-82, REV. 0	SLC	4/23/03	61822
3	SHEETS 1, 2, & 4	1022-48	SLC	5/19/03	40190
4	SHEETS 1, 3, & 4	1022-51	SLC	7/11/03	34515

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSIS. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE MPC FUEL BASKET IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. ALL MPC BASKET STRUCTURAL MATERIALS COMPLY WITH THE REQUIREMENTS OF ASME SECTION II, PART A. WELD MATERIAL COMPLIES WITH THE REQUIREMENTS OF ASME SECTION II, PART C.
6. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING AS REQUIRED. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY, AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. FABRICATOR MAY ADD WELDS TO STITCH WELDS AT THEIR DISCRETION.
8. DO NOT MAKE A CONTINUOUS SEAL WELD BETWEEN THE SHEATHING AND THE CELL WALL.
9. ALL STRUCTURAL MATERIALS ARE "ALLOY X" UNLESS OTHERWISE NOTED. ALLOY X IS ANY OF THE FOLLOWING STAINLESS STEEL TYPES: 316, 316LN, 304, AND 304LN.
10. DIFFERENCES BETWEEN THE GENERIC MPC-24E/EF BASKET AND THE TROJAN PLANT MPC-24E/EF BASKET ARE SPECIFICALLY NOTED.
11. BORAL PANELS ARE INTENDED TO HAVE NO SIGNIFICANT FLAWS. HOWEVER, TO ACCOUNT FOR MANUFACTURING DEVIATIONS OCCURING DURING INSTALLATION OF THE PANELS INTO THE MPC FUEL BASKET, BORAL DAMAGE OF UP TO THE EQUIVALENT OF A 1" DIAMETER HOLE IN EACH PANEL HAS BEEN ANALYZED AND FOUND TO BE ACCEPTABLE. ADDITIONALLY, LOCALIZED BORAL DAMAGE ALONG ONE EDGE OF A PANEL ONLY IS PERMITTED IF:
    - A) THE TOTAL AREA OF DAMAGE DOES NOT EXCEED 5 SQ. IN. AND;
    - B) THE DAMAGE IS LOCATED WITHIN THE TOP OR BOTTOM 27" OF THE PANEL AND;
    - C) THE DAMAGE DOES NOT EXTEND FARTHER THAN 1" FROM THE EDGE OF THE PANEL AND;
    - D) NO MORE THAN EIGHT PANELS WITHIN A BASKET HAVE THIS CONDITION.
12. THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND FSAR TABLE 2.2.6 (STORAGE).
13. DELETED.
14. TOLERANCES FOR THICKNESS OF ASME CODE MATERIAL ARE SPECIFIED IN ASME SECTION II.
15. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS CLARIFIED IN THE (F)SAR.
16. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
17. THE MPC-24E/EF IS CERTIFIED FOR STORAGE AND TRANSPORTATION OF INTACT AND DAMAGED PWR FUEL AND PWR FUEL CLASSIFIED AS FUEL DEBRIS, AS SPECIFIED IN COCs 72-1014, AND 71-9261.
18. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THE DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



MPC-24E/EF FUEL BASKET ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	MPC-24E/EF FUEL BASKET ASSEMBLY
PROJECT NO.	1022
P.O. NO.	N/A
DRAWING NO.	3925
SHEET	1
TOTAL SHEETS	4
FILE PATH	G:\DRAWINGS\1022\3925

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION MPC-24E/EF FUEL BASKET ARRANGEMENT			
COMPANION DRAWINGS 3923	SIZE D	DRAWING NO. 3925	SHEET 2	REV 4
	SCALE NONE	FILE PATH		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION MPC-24E/EF FUEL BASKET LAYOUT AND WELD DETAILS			
COMPANION DRAWINGS 3923	SIZE D	DRAWING NO 3925	SHEET 3	REV 4
	SCALE NONE	FILE PATH G:\DRAWINGS\1022\3925		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL
	DESCRIPTION MPC-24E/24EF FUEL BASKET SUPPORTS
COMPANION DRAWINGS: 3923	SIZE: D · DRAWING NO. 3925 · SHEET 4 · REV 4
	SCALE: NONE · FILE PATH: G:\DRAWINGS\1022\3925

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT GENERAL

PROJECT NO. 1022	P.O. NO. N/A
DRAWING PACKAGE I.D. 3926	TOTAL SHEETS 4

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	FUEL BASKET ARRANGEMENT
3	FUEL BASKET LAYOUT AND WELD DETAILS
4	FUEL BASKET SUPPORTS

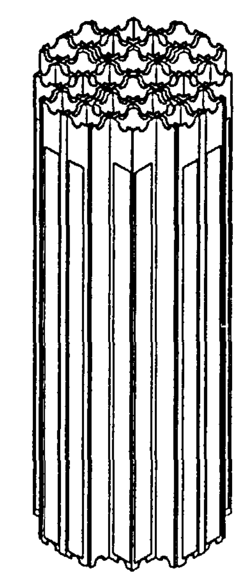
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1022-38	SLC	5/30/02	74916
1	ALL	1022-38, REV. 1	SLC	8/28/02	37611
2	SHEET 1	1022-43, REV. 0	SLC	10/9/02	84086
3	SHEET 3	5014-82, REV. 0	SLC	3/25/03	70654
4	SHEETS 1, 2, & 4	1022-48	SLC	5/19/03	13075
5	SHEETS 1, 3, & 4	1022-51	SLC	7/11/03	81349

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSIS. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE MPC FUEL BASKET IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. ALL MPC BASKET STRUCTURAL MATERIALS COMPLY WITH THE REQUIREMENTS OF ASME SECTION II, PART A. WELD MATERIAL COMPLIES WITH THE REQUIREMENTS OF ASME SECTION II, PART C.
6. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE EXAMINATIONS ARE NOTED ON THE DRAWING, AS REQUIRED. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY, AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. FABRICATOR MAY ADD WELDS TO STITCH WELDS AT THEIR DISCRETION.
8. DO NOT MAKE A CONTINUOUS SEAL WELD BETWEEN THE SHEATHING AND THE CELL WALL.
9. ALL STRUCTURAL MATERIALS ARE "ALLOY X" UNLESS OTHERWISE NOTED. ALLOY X IS ANY OF THE FOLLOWING STAINLESS STEEL TYPES: 316, 316 LN, 304, AND 304 LN.
10. BORAL PANELS ARE INTENDED TO HAVE NO SIGNIFICANT FLAWS. HOWEVER, TO ACCOUNT FOR MANUFACTURING DEVIATIONS OCCURING DURING INSTALLATION OF THE PANELS INTO THE MPC FUEL BASKET, BORAL DAMAGE OF UP TO THE EQUIVALENT OF A 1" DIAMETER HOLE IN EACH PANEL HAS BEEN ANALYZED AND FOUND TO BE ACCEPTABLE.
11. THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND FSAR TABLE 2.2.6 (STORAGE).
12. FOR HI-STAR STORAGE, ALUMINUM HEAT CONDUCTION ELEMENTS ARE REQUIRED.
13. 4 DELETED.
14. TOLERANCES FOR THICKNESS OF ASME CODE MATERIAL ARE SPECIFIED IN ASME SECTION II.
15. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS CLARIFIED IN THE (F)SAR.
16. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
17. THE MPC-24 IS CERTIFIED FOR STORAGE AND TRANSPORTATION OF INTACT PWR FUEL, AS SPECIFIED IN COCs 72-1008, 72-1014, AND 71-9261.
18. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THE DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



MPC-24 FUEL BASKET ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	MPC-24 FUEL BASKET ASSEMBLY
PROJECT NO. 1022	DRAWING NO. 3926
P.O. NO. N/A	SHEET 1 / TOTAL SHEETS 4

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC 24 FUEL BASKET ARRANGEMENT			
COMPANION DRAWINGS: 3923	SIZE: D	DRAWING NO: 3926	SHEET: 2	REV: 5
	SCALE: NONE	FILE PATH: G:\DRAWINGS\1022\3926		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT	GENERAL
	DESCRIPTION	MPC-24 FUEL BASKET LAYOUT AND WELD DETAILS
COMPANION DRAWINGS: 3923	SIZE D	DRAWING NO. 3926 / SHEET 3 / REV 5
	SCALE NONE	FILE PATH: G:\DRAWINGS\1022\3926

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION MPC 24 FUEL BASKET SUPPORTS			
COMPANION DRAWINGS 3923	SIZE D	DRAWING NO 3926	SHEET 4	REV 5
	SCALE NONE	FILE PATH:		

CLIENT GENERAL

PROJECT NO. 1023	P.O. NO. N/A
DRAWING PACKAGE I.D. 3927	TOTAL SHEETS 4

LICENSING DRAWING PACKAGE COVER SHEET

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	FUEL BASKET ARRANGEMENT
3	FUEL BASKET LAYOUT AND WELD DETAILS
4	FUEL BASKET SUPPORTS

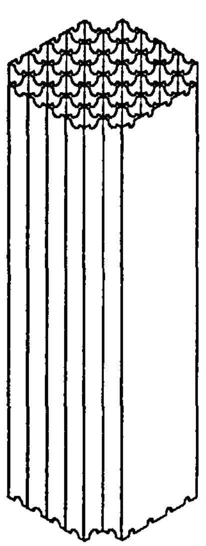
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1023-10	S.CAIN	5/28/02	94474
1	ALL	1023-10, REV. 1	S.CAIN	8/27/02	25046
2	SHEET 3	1023-3, REV. 1	S.CAIN	9/6/02	62849
3	SHEET 2 & 3	5014-82, REV. 0 1023-13, REV. 1, 1023-14, REV. 1	S.CAIN	3/18/03	12916
4	SHEET 3	5014-86, REV. 0	S.CAIN	3/25/03	46879
5	ALL	1023-18, 1023-21	S.CAIN	5/19/03	60888
6	ALL	1023-24	S.CAIN	7/11/03	67743

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSIS. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE MPC FUEL BASKET IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. ALL MPC BASKET STRUCTURAL MATERIALS COMPLY WITH THE REQUIREMENTS OF ASME SECTION II, PART A. WELD MATERIAL COMPLIES WITH THE REQUIREMENTS OF ASME SECTION II, PART C.
6. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING AS REQUIRED. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE PROVIDED IN THE APPLICABLE CODES AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. FABRICATOR MAY ADD WELDS TO STITCH WELDS AT THEIR DISCRETION.
8. DO NOT MAKE A CONTINUOUS SEAL WELD BETWEEN THE SHEATHING AND THE CELL WALL.
9. ALL STRUCTURAL MATERIALS ARE "ALLOY X" UNLESS OTHERWISE NOTED. ALLOY X IS ANY OF THE FOLLOWING STAINLESS STEEL TYPES: 316, 316 LN, 304, AND 304 LN.
10. BORAL PANELS ARE INTENDED TO HAVE NO SIGNIFICANT FLAWS. HOWEVER, TO ACCOUNT FOR MANUFACTURING DEVIATIONS OCCURING DURING INSTALLATION OF THE PANELS INTO THE MPC FUEL BASKET, BORAL DAMAGE OF UP TO THE EQUIVALENT OF A 1" DIAMETER HOLE IN EACH PANEL HAS BEEN ANALYZED AND FOUND TO BE ACCEPTABLE.
11. THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND FSAR TABLE 2.2.6 (STORAGE).
12. DELETED. (6)
13. TOLERANCES FOR THICKNESS OF ASME CODE MATERIAL ARE SPECIFIED IN ASME SECTION II.
14. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS CLARIFIED IN THE (F)SAR.
15. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
16. THE MPC-32 IS CERTIFIED FOR STORAGE AND TRANSPORTATION OF INTACT PWR FUEL, AS SPECIFIED IN COCs 72-1014, AND 71-9261.
17. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THE DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



MPC-32 FUEL BASKET ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	MPC-32 FUEL BASKET ASSEMBLY
PROJECT NO.	1023
P.O. NO.	N/A
DRAWING NO.	3927
SHEET	1
TOTAL SHEETS	4
FILE PATH	G:\DRAWINGS\1023\3927

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL DESCRIPTION MPC-32 FUEL BASKET ARRANGEMENT
COMPANION DRAWINGS 3923	SIZE D · DRAWING NO. 3927 · SHEET 2 · REV 6 SCALE NONE · FILE PATH: G:\DRAWINGS\1023\3927

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC-32 FUEL BASKET LAYOUT AND WELD DETAILS			
COMPANION DRAWINGS: 3923	SIZE: D	DRAWING NO.: 3927	SHEET: 3	REV: 6
	SCALE: NONE	FILE PATH: G:\DRAWINGS\1023\3927		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION MPC-32 FUEL BASKET SUPPORTS			
COMPANION DRAWINGS 3923	SIZE D	DRAWING NO 3927	SHEET 4	REV 6
	SCALE NONE	FILE PATH		

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT	GENERAL
PROJECT NO. 1021	P.O. NO. N/A
DRAWING PACKAGE I.D. 3928	TOTAL SHEETS 4

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	FUEL BASKET ARRANGEMENT
3	FUEL BASKET LAYOUT AND WELD DETAILS
4	FUEL BASKET SUPPORTS

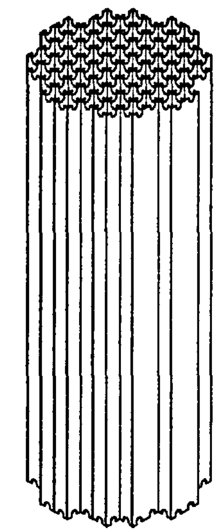
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1021-41	S.CAIN	5/28/02	67360
1	ALL	1021-41, REV. 1	S.CAIN	8/27/02	76629
2	SHEETS 2 & 3	5014-82, REV. 0	S.CAIN	3/25/03	24329
3	SHEETS 1, 2, 3, & 4	1021-52, 1021-54	S.CAIN	5/19/03	72132
4	ALL	1021-56	S.CAIN	7/11/03	26801

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. DIMENSIONAL TOLERANCES ON THIS DRAWING ARE PROVIDED TO ENSURE THAT THE EQUIPMENT DESIGN IS CONSISTENT WITH THE SUPPORTING ANALYSIS. HARDWARE IS FABRICATED IN ACCORDANCE WITH THE DESIGN DRAWINGS, WHICH MAY HAVE MORE RESTRICTIVE TOLERANCES, TO ENSURE COMPONENT FIT-UP. DO NOT USE WORST-CASE TOLERANCE STACK-UP FROM THIS DRAWING TO DETERMINE COMPONENT FIT-UP.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE MPC FUEL BASKET IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. ALL MPC BASKET STRUCTURAL MATERIALS COMPLY WITH THE REQUIREMENTS OF ASME SECTION II, PART A. WELD MATERIAL COMPLIES WITH THE REQUIREMENTS OF ASME SECTION II, PART C.
6. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING AS REQUIRED. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY, AS CLARIFIED IN THE APPLICABLE SAFETY ANALYSIS REPORTS.
7. FABRICATOR MAY ADD WELDS TO STITCH WELDS AT THEIR DISCRETION.
8. DO NOT MAKE A CONTINUOUS SEAL WELD BETWEEN THE SHEATHING AND THE CELL WALL.
9. ALL STRUCTURAL MATERIALS ARE "ALLOY X" UNLESS OTHERWISE NOTED. ALLOY X IS ANY OF THE FOLLOWING STAINLESS STEEL TYPES: 316, 316LN, 304, AND 304LN.
10. BORAL PANELS ARE INTENDED TO HAVE NO SIGNIFICANT FLAWS. HOWEVER, TO ACCOUNT FOR MANUFACTURING DEVIATIONS OCCURING DURING INSTALLATION OF THE PANELS INTO THE MPC FUEL BASKET, BORAL DAMAGE OF UP TO THE EQUIVALENT OF A 1" DIAMETER HOLE IN EACH PANEL HAS BEEN ANALYZED AND FOUND TO BE ACCEPTABLE.
11. THIS COMPONENT IS CLASSIFIED AS ITS-A BASED ON THE HIGHEST CLASSIFICATION OF ANY SUBCOMPONENT. SUBCOMPONENT CLASSIFICATIONS ARE PROVIDED IN SAR TABLE 1.3.3 (TRANSPORTATION) AND TABLE 2.2.6 (STORAGE).
12. DELETED.
13. TOLERANCES FOR THICKNESS OF ASME CODE MATERIAL ARE SPECIFIED IN ASME SECTION II.
14. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITHIN THE LIMITS SPECIFIED IN THE ASME CODE, AS CLARIFIED IN THE (F)SAR.
15. REFER TO THE COMPONENT COMPLETION RECORD (CCR) FOR THE COMPLETE LIST OF APPROVED DESIGN DEVIATIONS FOR EACH INDIVIDUAL SERIAL NUMBER.
16. THE MPC-68/68F IS CERTIFIED FOR STORAGE AND TRANSPORTATION OF INTACT AND DAMAGED BWR FUEL AND BWR FUEL CLASSIFIED AS FUEL DEBRIS, AS SPECIFIED IN COCs 72-1008, 72-1014, AND 71-9261. THE MPC-68FF IS CERTIFIED ONLY FOR STORAGE OF INTACT AND DAMAGED BWR FUEL AND BWR FUEL CLASSIFIED AS FUEL DEBRIS IN THE HI-STORM 100 SYSTEM UNDER COC 72-1014.
17. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THE DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



MPC-68/68F/68FF FUEL BASKET*
ISOMETRIC VIEW

*MPC-68FF IS NOT CERTIFIED FOR TRANSPORTATION UNDER 10CFR71

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	MPC-68/68F/68FF FUEL BASKET
PROJECT NO.	1021
P.O. NO.	N/A
DRAWING NO.	3928
SHEET	1
TOTAL SHEETS	4

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT GENERAL			
	DESCRIPTION MPC-68/68F/68FF FUEL BASKET			
COMPANION DRAWINGS 3923	SIZE D	DRAWING NO 3928	SHEET 2	REV 4
	SCALE NONE	FILE PATH G:\DRAWINGS\1021\3928		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC-68/68F/68FF FUEL BASKET LAYOUT AND WELD DETAILS			
COMPANION DRAWINGS: 3923	SIZE: D	DRAWING NO.: 3928	SHEET: 3	REV: 4
	SCALE: NONE	FILE PATH: G:\DRAWINGS\10213928		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: MPC 68/68F/68FF FUEL BASKET SUPPORTS			
COMPANION DRAWINGS: 3923	SIZE: D	DRAWING NO: 3928	SHEET: 4	REV: 4
	SCALE: NONE	FILE PATH: [illegible]		

BILL OF MATERIAL (FULL SCALE)

ITEM NO.	QTY.	MATERIAL	DESCRIPTION
1	N/A	ALUMINUM HONEYCOMB	SEE SHEET 6
2	1	SEE NOTE 4	1 3/8 THK. INNER STIFFENING CYLINDER
3	1	SEE NOTE 2	1/8 THK. ENCLOSURE END DISK
4	1	SEE NOTE 2	1/8 THK. ENCLOSURE SIDE PLATE FOR B.I. OR 1/8 THK. ENCLOSURE SIDE PLATE FOR T.I.
5	1	SEE NOTE 2	1/8 THK. ANNULAR DISK
6	1	SEE NOTE 4	1 7/8 THK. OUTER STIFFENING CYL. FOR B.I. OR 1 7/8 THK. OUTER STIFF. CYL. FOR T.I.
7	1	SEE NOTE 4	1 THK. X END PLATE/SHIELDING DISK FOR B.I. OR 1/4 THK. X END PLATE/SHIELDING DISK FOR T.I.
8	16	SEE NOTE 4	1/2 THK. OUTER GUSSET
9	16	SEE NOTE 4	1/2 THK. INNER GUSSET
10	1	HOLTITE - A	2 1/2 THK. HOLTITE-A WITH 1 WT. % B_4C (SEE NOTE 5)
11	1	SEE NOTE 2	1/4 THK. DISK
12	16	SA-193-B8S	1 3/4"- 8 UNC X 25 1/4 LG. SOCKET HEAD CAP SCREW WITH 2 5/16" LG. USEABLE THREAD AT END FOR B.I. ONLY; W/STD. WASHER (PLUS TEFLON GASKET(S)).
13	N/A	ALUMINUM HONEYCOMB	SEE SHEET 6
14	1	SEE NOTE 4	1 THK. PLATE
ITEM	15, 16,	17 & 18 DELETED	
19	1	A569 or A366	1/8 THK. CYLINDER
20	1	SEE NOTE 4	1 5/8 THK. PLATE FOR T.I.
21	40	SA-193-B7	2 1/4 DIA. BAR FOR T.I.
22A	10	SA-193-B8S	1 - 8 UNC X 2 5/8 LG. SOCKET HEAD SCREW WITH 1 5/16" LG. THREADED END FOR T.I.; W/2 3/4 O.D. WASHER & 2 O.D. X 1 1/4 LG. RUBBER BUSHING. (70 SHORE A DUROMETER)
22B	10	SA-193-B8S	1 - 8 UNC X 2 5/8 LG. SOCKET HEAD SCREW WITH 1 5/16" LG. THREADED END FOR T.I.; W/2 3/4 O.D. WASHER.
23	N/A	ALUMINUM HONEYCOMB	SEE SHEET 6
24	1	SEE NOTE 2	1/8 THK. DISK
25	1	SEE NOTE 2	1/8 THK. CYLINDER
26	1	SEE NOTE 2	1/8 THK. CYLINDER
27	N/A	ALUMINUM HONEYCOMB	SEE SHEET 6
28	.	.	N/A
29	8	SA-479-304	PER DET. DWG.C1765 SHT.2
30	8	SA516-70	SUPPORT CAP

LEGEND: T.I. = TOP IMPACT LIMITER AND B.I. = BOTTOM IMPACT LIMITER

NOTES:
1) HATCH LINES IN ALUMINUM HONEYCOMB SHOW ORIENTATION OF PRINCIPAL CRUSH AXES.
2) PLATE AND SHEET MATERIAL IS ASME SECTION II SA-240 TYPE 304 (UNS NO. S30400) STAINLESS STEEL.
3) ALL DIMENSIONS ARE NOMINAL.
4) ALL SHEET (GAGED) METAL TO BE A569 AND ALL PLATE TO BE ASME SECTION II SA516-70.
5) UNLESS OTHERWISE NOTED ALL DIMENSIONING UNITS ARE INCHES.
6) HOLTITE-A IS A NEUTRON SHIELD MATERIAL WITH 1 WT NOM..% B_4C, 6.0 NOM. WT.% H, AND A DENSITY OF 1.68 g/cm^3 NOM.
7) CRITICAL DIMENSIONS (INDICATED BY AN "*") ARE ESSENTIALL TO ASSURE EQUIPMENT FUNCTIONALITY.

DATE	REV.	DESCRIPTION	PREP. BY:	CHECKED BY:	P.M. APPROVED	QA APPROVED
NOV 19-99	1	REVISED AS SHOWN	S.GEB 11-18-99			
FEB 18-99	0	FOR APPROVAL	C.Y. 2-18-99	B.G.U. 2-18-99	B.G. 2-18-99	V.G. 2-18-99

REVISION

HOLTEC INTERNATIONAL

EQUIPMENT DESIGN
ANALYSIS
CONSULTING

DESCRIPTION
HI-STAR 100 IMPACT LIMITER
CoC No. 9261, APPENDIX B

CLIENT VARIOUS

COMPANION DRAWINGS NONE

REV. 1

PROJECT No.5014

DRAWING No. C1765 SHT. 1 OF 7

P.O. No. VARIOUS

e\DRAWINGS\5014\5014\IMPACT\C1765-1.RI

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 BOTTOM IMPACT LIMITER CoC No. 9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 1
PROJECT No.5014	DRAWING No.
P.O. No. VARIOUS	C1765 SHT. 2 OF 7

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 TOP IMPACT LIMITER CoC No. 9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 1
PROJECT No.5014 P.O. No. VARIOUS	DRAWING No. C1765 SHT. 3 OF 7

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 TOP IMPACT LIMITER CoC No.9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 1
PROJECT No.5014	DRAWING No.
P.O. No. VARIOUS	C1765 SHT. 4 OF 7

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 TOP IMPACT LIMITER DETAIL OF ITEM #6 CoC No. 9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 1
PROJECT No.5014	DRAWING No. C1765 SHT. 5 OF 7
P.O. No. VARIOUS	

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 IMPACT LIMITER HONEYCOMB DETAILS CoC No. 9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 1
PROJECT No.5014	DRAWING No.
P.O. No. VARIOUS	C1765 SHT. 6 OF 7

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL	EQUIPMENT DESIGN ANALYSIS CONSULTING
DESCRIPTION HI-STAR 100 BOTTOM IMPACT LIMITER CoC No. 9261, APPENDIX B	
CLIENT VARIOUS	
COMPANION DRAWINGS NONE	REV. 0
PROJECT No.5014	DRAWING No.
P.O. No. VARIOUS	C1765 SHT. 7 OF 7

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT	GENERAL		
PROJECT NO.	1020	P.O. NO.	N/A
DRAWING PACKAGE I.D.	3930	TOTAL SHEETS	3 △1

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	HI-STAR 100 ASSEMBLY FOR TRANSPORT
3	HI-STAR 100 TRANSPORT CONFIGURATION △1

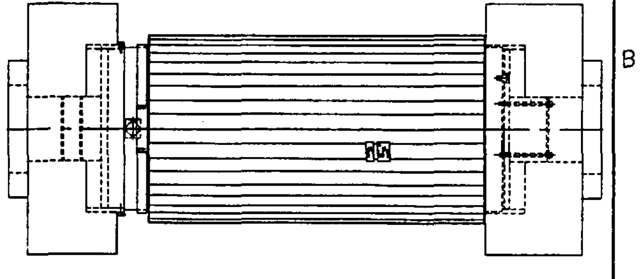
REVISION LOG

REV.	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREP. BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1020-41	T.F.O.	5/28/02	32824
1	SHEETS 1, 2 & 3	1020-45	T.F.O.	5/19/03	95850

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES AS DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. △1 ALL DIMENSIONS ARE NOMINAL EXCEPT AS NOTED. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.



HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	GENERAL
DESCRIPTION	HI-STAR 100 ASSEMBLY FOR TRANSPORT
PROJECT NO.	1020
P.O. NO.	N/A
DRAWING NO.	3930
SHEET	1
TOTAL SHEETS	3 △1
FILE PATH:	[illegible]

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL			
	DESCRIPTION: HI-STAR 100 ASSEMBLY FOR TRANSPORT			
COMPANION DRAWINGS	SIZE: D	DRAWING NO.: 3930	SHEET: 2	REV: 1
	SCALE: NTS	FILE PATH:		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: GENERAL
	DESCRIPTION: HI-STAR 100 TRANSPORT CONFIGURATION
COMPANION DRAWINGS	SIZE: D · DRAWING NO.: 3930 · SHEET: 3 · REV: 1
	SCALE: NTS

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT PORTLAND GENERAL ELECTRIC

PROJECT NO. 1135 | P.O. NO. N/A

DRAWING PACKAGE I.D. 4111 | TOTAL SHEETS 2

DESIGN DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	ASSEMBLY DRAWING AND DETAILS

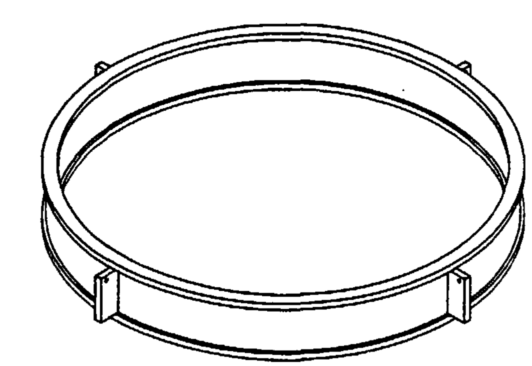
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	ECO-1135-39	T.F.O.	5/19/03	42662

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THIS DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSIS DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
3. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997 IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE HOLTEC TROJAN MPC-24E/EF SPACER RING IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCRIBED IN THE SAR. NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
4. ALL WELDS REQUIRE VISUAL EXAMINATION (VT). ADDITIONAL NDE INSPECTIONS ARE NOTED ON THE DRAWING AS REQUIRED. NDE TECHNIQUES AND ACCEPTABLE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY, AS CLARIFIED IN THE SAFETY ANALYSIS REPORT.
5. THIS COMPONENT IS CLASSIFIED AS ITS-B.
6. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZE WELDS ARE ACCEPTABLE WITH THE LIMITS SPECIFIED IN THE ASME CODE, AS APPLICABLE.
7. TOLERANCES ON THICKNESS OF MATERIAL ARE SPECIFIED IN ASME SECTION II.
8. ALL MATERIAL IS TYPE 304 STAINLESS STEEL.
9. DIMENSIONS NOTED AS NOMINAL ("NOM.") IN THIS DRAWING ARE FOR INFORMATION ONLY, IN ORDER TO INDICATE THE GENERAL SIZE OF THE COMPONENT OR PART. NOMINAL DIMENSIONS HAVE NO SPECIFIC TOLERANCE, BUT ARE MET THROUGH FABRICATION IN ACCORDANCE WITH OTHER DIMENSIONS THAT ARE TOLERANCED AND INSPECTED. NOMINAL DIMENSIONS ARE NOT SPECIFICALLY VERIFIED DURING THE FABRICATION PROCESS.



HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN CENTER
MARLTON, NJ 08053

CLIENT	PORTLAND GENERAL ELECTRIC
DESCRIPTION	TROJAN MPC-24E/EF SPACER RING
PROJECT NO.	1135
P.O. NO.	N/A
DRAWING NO.	4111
SHEET	1
TOTAL SHEETS	2
FILE PATH	G:\DRAWINGS\1135\4111

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLIENT: PORTLAND GENERAL ELECTRIC DESCRIPTION: TROJAN MPC-24E/EF SPACER RING
COMPANION DRAWINGS: 3913	SIZE: D · DRAWING NO: 4111 · SHEET: 2 · REV: 0 SCALE: NTS · FILE PATH: G:\DRAWINGS\1139\4111

CLIENT	PORTLAND GENERAL ELECTRIC COMPANY
PROJECT NO. 1135	P.O. NO. NQI82902
DRAWING PACKAGE I.D. 4119	TOTAL SHEETS 4

LICENSING DRAWING PACKAGE COVER SHEET

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	ASSEMBLY DRAWING AND BILL OF MATERIALS
3	LID AND LOCKING ASSEMBLY OF DAMAGED FUEL CONTAINER
4	LOWER CONTAINER OF DAMAGED FUEL CONTAINER

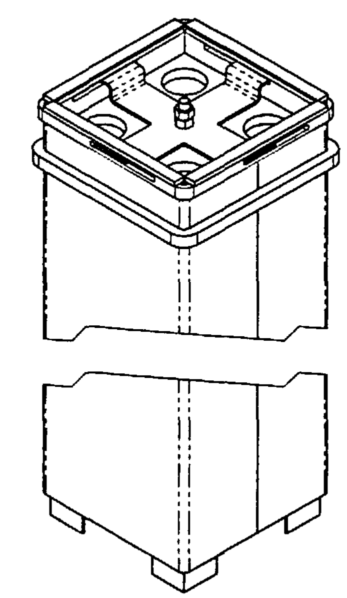
REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1135-39	SLC	5/19/03	92815
1	SHEET 3	1135-40	SLC	7/10/03	77740

† THE VALIDATION IDENTIFICATION RECORD (VIR) NUMBER IS A COMPUTER GENERATED RANDOM NUMBER WHICH CONFIRMS THAT ALL APPROPRIATE REVIEWS OF THIS DRAWING ARE DOCUMENTED IN COMPANY'S NETWORK.

GENERAL NOTES:

1. THE EQUIPMENT DESIGN DOCUMENTED IN THE DRAWING PACKAGE HAS BEEN CONFIRMED BY HOLTEC INTERNATIONAL TO COMPLY WITH THE SAFETY ANALYSES DESCRIBED IN THE SAFETY ANALYSIS REPORT.
2. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
3. THE ITS CATEGORY OF A COMPONENT IS THE HIGHEST ITS LEVEL OF ALL PARTS THAT MAKE UP THE COMPONENT.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE HOLTEC DAMAGED FUEL CONTAINER FOR TROJAN PLANT SNF IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NG AS DESCRIBED IN THE SAR. NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. WELDING PROCEDURES AND WELDER QUALIFICATIONS SHALL BE PER ASME SECTION IX AND ASME SECTION III, SUBSECTION NG.
6. MATERIALS USED IN FABRICATION SHALL MEET THE REQUIREMENTS OF ASME SECTION II PART A. WELD MATERIAL SHALL MEET THE REQUIREMENTS OF ASME SECTION II PART C.
7. ALL WELDS REQUIRE VISUAL EXAMINATION (VT).
8. ALL MATERIAL IS TYPE 304 STAINLESS STEEL, EXCEPT BOLTS (SA 193 B8-CLASS 2) HEX NUTS (SA 194 Gr. 8); AND WASHERS (ANY TYPE S/S)
9. ALL WELD SIZES ARE MINIMUMS. LARGER WELDS ARE PERMITTED. LOCAL AREAS OF UNDERSIZED WELDS ARE ACCEPTABLE WITHIN THE LIMITS OF THE ASME CODE, AS APPLICABLE.



DAMAGED FUEL CONTAINER ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN DRIVE WEST
MARLTON, NJ 08053

CLIENT	PORTLAND GENERAL ELECTRIC COMPANY
DESCRIPTION	DAMAGED FUEL CONTAINER FOR TROJAN PLANT SNF
PROJECT NO.	1135
P.O. NO.	NQI82902
DRAWING NO.	4119
SHEET	1
TOTAL SHEETS	4

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT PORTLAND GENERAL ELECTRIC COMPANY			
	DESCRIPTION DAMAGED FUEL CONTAINER FOR TROJAN PLANT SNF			
COMPANION DRAWINGS -	SIZE D	DRAWING NO. 4119	SHEET 2	REV 1
	SCALE NONE	FILE PATH G:\DRAWINGS\1138\4119		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: PORTLAND GENERAL ELECTRIC COMPANY			
	DESCRIPTION: DAMAGED FUEL CONTAINER FOR TROJAN PLANT SNF			
COMPANION DRAWINGS: -	SIZE: D	DRAWING NO: 4119	SHEET: 3	REV: 1
	SCALE: NONE	FILE PATH: G:\DRAWINGS\1138\4119		

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN DRIVE WEST MARLTON, NJ 08053	CLIENT: PORTLAND GENERAL ELECTRIC COMPANY			
	DESCRIPTION: DAMAGED FUEL CONTAINER FOR TROJAN PLANT SNF			
COMPANION DRAWINGS: -	SIZE: D	DRAWING NO.: 4119	SHEET: 4	REV: 1
	SCALE: NONE	FILE PATH: G:\DRAWINGS\1125\4119		

LICENSING DRAWING PACKAGE COVER SHEET

CLIENT	PORTLAND GENERAL ELECTRIC COMPANY
PROJECT NO. 1135	P.O. NO. N/A
DRAWING PACKAGE I.D. 4122	TOTAL SHEETS 2

LICENSING DRAWING PACKAGE CONTENTS:

SHEET	DESCRIPTION
1	COVER SHEET
2	SPACER FOR FAILED FUEL CAN

REVISION LOG

REV	AFFECTED DRAWING SHEET NUMBERS	SUMMARY OF CHANGES/ AFFECTED ECOs	PREPARED BY	APPROVAL DATE	VIR# †
0	INITIAL ISSUE	1135-39	SLC	5/19/03	20482

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GENERAL NOTES:

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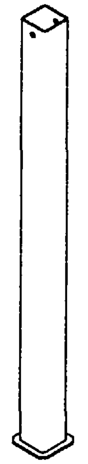
2. THIS COMPONENT IS ITS, CATEGORY B.
3. THE REVISION LEVEL OF EACH INDIVIDUAL SHEET IN THIS PACKAGE IS THE SAME AS THE REVISION LEVEL OF THIS COVER SHEET. A REVISION TO ANY SHEET(S) IN THIS PACKAGE REQUIRES UPDATING OF REVISION NUMBERS OF ALL SHEETS TO THE NEXT REVISION NUMBER.
4. THE ASME BOILER AND PRESSURE VESSEL CODE (ASME CODE), 1995 EDITION WITH ADDENDA THROUGH 1997, IS THE GOVERNING CODE FOR THE HI-STAR 100 SYSTEM, WITH CERTAIN APPROVED ALTERNATIVES AS LISTED IN SAR TABLE 1.3.2 (TRANSPORTATION) AND FSAR TABLE 2.2.15 (STORAGE). THE TROJAN FAILED FUEL CAN SPACER IS CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, SUBSECTION NF AS DESCRIBED IN THE SAR (TRANSPORTATION) AND FSAR (STORAGE). NEW OR REVISED ASME CODE ALTERNATIVES REQUIRE PRIOR NRC APPROVAL BEFORE IMPLEMENTATION.
5. FINAL LENGTH OF SPACER SHALL BE ESTABLISHED AFTER THE FFC IS FILLED, ALLOWING AN APPROXIMATE 2" AXIAL CLEARANCE INSIDE THE FFC.
6. MATERIALS USED IN FABRICATION SHALL MEET THE REQUIREMENTS OF ASME SECTION II, PART A. WELD MATERIAL SHALL MEET THE REQUIREMENTS OF ASME SECTION II, PART C.
7. THE FUEL SPACER COLUMN SHALL BE TYPE 304 OR 304LN STAINLESS STEEL WITH TENSILE STRENGTH = 75 ksi, YIELD STRENGTH = 30 ksi, AND CHEMICALS PER ASTM A554. THE FUEL SPACER PLATE MAY BE ANY TYPE STAINLESS STEEL.
8. NDE TECHNIQUES AND ACCEPTANCE CRITERIA ARE GOVERNED BY ASME SECTIONS V AND III, RESPECTIVELY.
9. TOLERANCES ON THICKNESS OF ASME CODE MATERIAL ARE SPECIFIED IN ASME SECTION II.



FUEL SPACER
ISOMETRIC VIEW

HOLTEC INTERNATIONAL
HOLTEC CENTER
555 LINCOLN CENTER
MARLTON, NJ 08053

CLIENT	PORTLAND GENERAL ELECTRIC COMPANY
DESCRIPTION	SPACER FOR FAILED FUEL CAN
PROJECT NO.	1135
P.O. NO.	N/A
DRAWING NO.	4122
SHEET	1
TOTAL SHEETS	2
FILE PATH:	G:\DRAWINGS\1135\4122

FIGURE WITHHELD UNDER 10 CFR 2.390

HOLTEC INTERNATIONAL HOLTEC CENTER 555 LINCOLN CENTER MARLTON, NJ 08053	CLIENT: PORTLAND GENERAL ELECTRIC COMPANY			
	DESCRIPTION: SPACER FOR FAILED FUEL CAN			
COMPANION DRAWINGS: -	SIZE: D	DRAWING NO. 4122	SHEET 2	REV 0
	SCALE: NONE	FILE PATH: [illegible]		

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONAL ± 1/8
DECIMALS ANGLES
.X = ±.125 ± 1°
.X = ±.03
.XX = ±.01
.XXX = ±.005

WEIGHT 265 LBS	JOB NO. PCE-01	SIERRA NUCLEAR CORP. SNC SCOTTS VALLEY CALIFORNIA	
CAD FILE NAME PFFC0101R8	SIZE		
DESIGNER TOM SANTOS	DATE 6/18/99		
CHECKED		SAFETY CLASSIFICATION IMPORTANT TO SAFETY	
PROJECT ENGINEER		TITLE FAILED FUEL CAN ASSEMBLY	
PROJECT MANAGER			
QUALITY ASSURANCE			
FABRICATION MANAGER			
SCALE NONE	DRAWING NO. PFFC-001	SHEET 1/1	REVISION 8

NEXT ASSEMBLY N/A

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONAL ± 1/8
DECIMALS ANGLES
X = ±.125 ± 1°
.X = ±.03
.XX = ±.01
.XXX = ±.005

NEXT ASSEMBLY PFFC-001

WEIGHT 265 LBS	JOB NO. PGE-01	SIERRA NUCLEAR CORP. SNC SCOTTS VALLEY CALIFORNIA
CAD FILE NAME PFFC0201R7	SIZE	
DESIGNER TOM SANTOS	DATE 6/18/99	
CHECKED	6/24/99	SAFETY CLASSIFICATION IMPORTANT TO SAFETY
PROJECT ENGINEER	6/21/99	TITLE FAILED FUEL CAN SHELL AND LID ASSEMBLY
PROJECT MANAGER	6/21/99	
QUALITY ASSURANCE	6/21/99	
FABRICATION MANAGER	6/21/99	
SCALE NONE	DRAWING NO. PFFC-002	SHEET 1/2 REVISION 7

FIGURE WITHHELD UNDER 10 CFR 2.390

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONAL ± 1/8
DECIMALS ANGLES
.X = ±.125 ± 1°
.X = ±.03
.XX = ±.01
.XXX = ±.005

WEIGHT N/A	JOB NO. PGE-01	SIERRA NUCLEAR CORP. SNC SCOTTS VALLEY CALIFORNIA
CAD FILE NAME PFFC0202R7	SIZE	
DESIGNER TOM SANTOS	DATE 8/18/99	
CHECKED		SAFETY CLASSIFICATION IMPORTANT TO SAFETY
PROJECT ENGINEER		TITLE FAILED FUEL CAN SHELL AND LID ASSEMBLY
PROJECT MANAGER		
QUALITY ASSURANCE		
FABRICATION MANAGER		
SCALE NONE	DRAWING NO. PFFC-002	SHEET 2/2 REVISION 7

NEXT ASSEMBLY PFFC-001

1.5 Compliance with 10CFR71

The HI-STAR 100 packaging complies with the requirements of 10CFR71 for a Type B(U)F-85 package. Analyses which demonstrate that the HI-STAR 100 packaging complies with the requirements of Subparts E and F of 10CFR71 are provided in this SAR. Specific reference to each section of the SAR that is used to specifically address compliance is provided in Table 1.0.2. The HI-STAR 100 packaging complies with the general standards for all packages, 10CFR71.43, as demonstrated in Section 2.4. Under the tests specified in 10CFR71.71 (normal conditions of transport) the HI-STAR 100 packaging is demonstrated to sustain no degradation in its safety function allowing the HI-STAR 100 packaging to meet the requirements of 10CFR71, Paragraphs 71.45, 71.51, and 71.55. Under the tests specified in 10CFR71.73 (hypothetical accident conditions) and 10CFR71.61 (special requirement for irradiated nuclear fuel shipments), the degradation sustained by the HI-STAR 100 packaging is shown not to cause the HI-STAR 100 packaging to exceed the requirements of 10CFR71, Paragraphs 71.51, 71.55, and 71.63(b).

The HI-STAR 100 packaging meets the structural, thermal, containment, shielding and criticality requirements of 10CFR71, as described in Chapters 2 through 6. The operational procedures and acceptance tests and maintenance program provided in Chapters 7 and 8 ensure compliance with the requirements of 10CFR71.

The following is a summary of the information provided in Chapter 1 that is directly applicable to verifying compliance with 10CFR71:

- The HI-STAR 100 packaging has been described in sufficient detail to provide an adequate basis for its evaluation.

- Drawings provided in Section 1.4 contain information that provides an adequate basis for evaluation of the HI-STAR 100 packaging against the 10CFR71 requirements. Each drawing is identified, consistent with the text of the SAR, and contains keys or annotation to explain and clarify information on the drawing.

- Section 1.0 includes a reference to the NRC-approved Holtec International quality assurance program for the HI-STAR 100 packaging.

- Section 1.3 identifies the applicable codes and standards for the HI-STAR 100 packaging design, fabrication, assembly, and testing.

- The HI-STAR 100 packaging meets the general requirements of 10CFR71.43(a) and 10CFR71.43(b), as demonstrated by the drawings provided in Section 1.4 and the discussion provided in Subsection 1.2.1.9, respectively.

- The drawings provided in Section 1.4 provide a detailed packaging description that can be evaluated for compliance with 10CFR71 for each technical discipline.

- Any restrictions on the use of the HI-STAR 100 packaging are specified in Subsection 1.2.3 and Chapter 7.

1.6 REFERENCES

[1.0.1] 10CFR Part 71, "Packaging and Transportation of Radioactive Materials", Title 10 of the Code of Federal Regulations, Office of the Federal Register, Washington, D.C.

[1.0.2] 49CFR173, "Shippers - General Requirements For Shipments and Packagings", Title 49 of the Code of Federal Regulations, Office of the Federal Register, Washington, D.C.

[1.0.3] Regulatory Guide 7.9, "Standard Format and Content of Part 71 Applications for Approval of Packaging for Radioactive Material", Proposed Revision 2, USNRC, May 1986.

[1.0.4] 10CFR Part 72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation", Title 10 of the Code of Federal Regulations, Office of the Federal Register, Washington, D.C.

[1.0.5] NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel",, U.S. Nuclear Regulatory Commission, March 2000.

[1.0.6] HI-STAR 100 Final Safety Analysis Report, Holtec Report No. HI-2012610, Revision 1, Docket No. 72-1008.

[1.0.7] HI-STORM 100 Final Safety Analysis Report, Holtec Report No. HI-2002444, Revision 1, Docket No. 72-1014.

[1.1.1] U.S. Department of Energy, "Multi-Purpose Canister (MPC) Subsystem Design Procurement Specification", Document No. DBG000000-01717-6300-00001, Rev. 5, January 11, 1996.

[1.1.2] U.S. Department of Energy, "MPC Transportation Cask Subsystem Design Procurement Specification", Document No. DBF 000000-01717-6300-00001, Rev. 5, January 11, 1996.

[1.2.1] U.S. NRC Information Notice 96-34, "Hydrogen Gas Ignition During Closure Welding of a VSC-24 Multi-Assembly Scale Basket".

[1.2.2] Directory of Nuclear Reactors, Vol. II, Research, Test & Experimental Reactors, International Atomic Energy Agency, Vienna, 1959.

[1.2.3] V.L. McKinney and T. Rockwell III, Boral: A New Thermal-Neutron Shield, USAEC Report AECD-3625, August 29, 1949.

[1.2.4] Reactor Shielding Design Manual, USAEC Report TID-7004, March 1956.

[1.2.5] Deleted.

[1.2.6] ORNL/TM-10902, "Physical Characteristics of GE BWR Fuel Assemblies", by R.S. Moore and K.J. Notz, Martin Marietta (1989).

[1.2.7] U.S. DOE SRC/CNEAF/95-01, Spent Nuclear Fuel Discharges from U.S. Reactors 1993, Feb. 1995.

[1.2.8] S.E. Turner, "Uncertainty Analysis - Axial Burnup Distribution Effects," presented in "Proceedings of a Workshop on the Use of Burnup Credit in Spent Fuel Transport Casks", SAND-89-0018, Sandia National Laboratory, Oct., 1989.

[1.2.9] Commonwealth Edison Company, Report No. NFS-BND-95-083, Chicago, Illinois.

[1.2.10] Regulatory Guide 7.11, "Fracture Toughness Criteria of Base Material for Ferritic Steel Shipping Cask Containment Vessels with a Maximum Wall Thickness of 4 Inches (0.1m)", U.S. Nuclear Regulatory Commission, Washington, D.C., June 1991.

[1.2.11] NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants", U.S. Nuclear Regulatory Commission, Washington, D.C., July 1980.

[1.2.12] Trojan ISFSI Safety Analysis Report, Revision 3, USNRC Docket 72-0017.

[1.2.13] NRC Interim Staff Guidance Document No. 8, "Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transportation and Storage Casks", Revision 2.

[1.2.14] NRC Interim Staff Guidance Document No. 11, "Cladding Considerations for the Transportation and Storage of Spent Fuel", Revision 2.

[1.2.15] DOE/RW-0184, Volume 3, "Characteristics of Spent Fuel, High Level Waste, and Other Radioactive Wastes Which May Require Long-Term Isolation," Appendix 2.A, "Physical Descriptions of LWR Fuel Assemblies," U.S. Department of Energy, Office of Civilian Radioactive Waste Management, December 1987.

[1.3.1] American Society of Mechanical Engineers, "Boiler and Pressure Vessel Code", 1995 with Addenda through 1997.

[1.3.2] NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety", U.S. Nuclear Regulatory Commission, Washington D.C., February 1996.

[1.3.3] ANSI N14.6-1993, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 Kg) or More", June 1993.

APPENDIX 1.A: ALLOY X DESCRIPTION

1.A ALLOY X DESCRIPTION

1.A.1 Alloy X Introduction

Alloy X is used within this licensing application to designate a group of stainless steel alloys. Alloy X can be any one of the following alloys:

- Type 316
- Type 316LN
- Type 304
- Type 304LN

Qualification of structures made of Alloy X is accomplished by using the least favorable mechanical and thermal properties of the entire group for all MPC mechanical, structural, neutronic, radiological, and thermal conditions. The Alloy X approach is conservative because no matter which material is ultimately utilized, the Alloy X approach guarantees that the performance of the MPC will meet or exceed the analytical predictions.

This appendix defines the least favorable material properties of Alloy X.

1.A.2 Alloy X Common Material Properties

Several material properties do not vary significantly from one Alloy X constituent to the next. These common material properties are as follows:

- density
- specific heat
- Young's Modulus (Modulus of Elasticity)
- Poisson's Ratio

The values utilized for this licensing application are provided in their appropriate chapters.

1.A.3 Alloy X Least Favorable Material Properties

The following material properties vary between the Alloy X constituents:

- Design Stress Intensity (S_m)
- Tensile (Ultimate) Strength (S_u)
- Yield Strength (S_y)
- Coefficient of Thermal Expansion (α)
- Coefficient of Thermal Conductivity (k)

Each of these material properties are provided in the ASME Code Section II [1.A.1]. Tables 1.A.1

through 1.A.5 provide the ASME Code values for each constituent of Alloy X along with the least favorable value utilized in this licensing application. The ASME Code only provides values to -20°F. The design temperature of the MPC is -40°F to 725°F as stated in Table 1.2.3. Most of the above-mentioned properties become increasingly favorable as the temperature drops. Conservatively, the values at the lowest design temperature for the HI-STAR 100 System have been assumed to be equal to the lowest value stated in the ASME Code. The lone exception is the thermal conductivity. The thermal conductivity decreases with the decreasing temperature. The thermal conductivity value for -40°F is linearly extrapolated from the 70°F value using the difference from 70°F to 100°F.

The Alloy X material properties are the minimum values of the group for the design stress intensity, tensile strength, yield strength, and coefficient of thermal conductivity. Using minimum values of design stress intensity is conservative because lower design stress intensities lead to lower allowables that are based on design stress intensity. Similarly, using minimum values of tensile strength and yield strength is conservative because lower values of tensile strength and yield strength lead to lower allowables that are based on tensile strength and yield strength. When compared to calculated values, these lower allowables result in factors of safety that are conservative for any of the constituent materials of Alloy X. Further discussion of the justification for using the minimum values of coefficient of thermal conductivity is given in Chapter 3. The maximum and minimum values are used for the coefficient of thermal expansion of Alloy X. The maximum and minimum coefficients of thermal expansion are used as appropriate in this submittal. Figures 1.A.1-1.A.5 provide a graphical representation of the varying material properties with temperature for the Alloy X materials.

1.A.4 References

[1.A.1] ASME Boiler & Pressure Vessel Code Section II, 1995 ed. with Addenda through 1997.

Table 1.A.1

ALLOY X AND CONSTITUENT DESIGN STRESS INTENSITY (S_m) vs. TEMPERATURE

Temp. (^{o}F)	Type 304	Type 304LN	Type 316	Type 316LN	Alloy X (minimum of constituent values)
-40	20.0	20.0	20.0	20.0	20.0
100	20.0	20.0	20.0	20.0	20.0
200	20.0	20.0	20.0	20.0	20.0
300	20.0	20.0	20.0	20.0	20.0
400	18.7	18.7	19.3	18.9	18.7
500	17.5	17.5	18.0	17.5	17.5
600	16.4	16.4	17.0	16.5	16.4
650	16.2	16.2	16.7	16.0	16.0
700	16.0	16.0	16.3	15.6	15.6
750	15.6	15.6	16.1	15.2	15.2
800	15.2	15.2	15.9	14.9	14.9

Notes:

1. Source: Table 2A on pages 314, 318, 326, and 330 of [1.A.1].

2. Units of design stress intensity values are ksi.

Table 1.A.2

ALLOY X AND CONSTITUENT TENSILE STRENGTH (S_u) vs. TEMPERATURE

Temp. (^oF)	Type 304	Type 304LN	Type 316	Type 316LN	Alloy X (minimum of constituent values)
-40	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)
100	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)	75.0 (70.0)
200	71.0 (66.2)	71.0 (66.2)	75.0 (70.0)	75.0 (70.0)	71.0 (66.2)
300	66.0 (61.5)	66.0 (61.5)	73.4 (68.5)	70.9 (66.0)	66.0 (61.5)
400	64.4 (60.0)	64.4 (60.0)	71.8 (67.0)	67.1 (62.6)	64.4 (60.0)
500	63.5 (59.3)	63.5 (59.3)	71.8 (67.0)	64.6 (60.3)	63.5 (59.3)
600	63.5 (59.3)	63.5 (59.3)	71.8 (67.0)	63.1 (58.9)	63.1 (58.9)
650	63.5 (59.3)	63.5 (59.3)	71.8 (67.0)	62.8 (58.6)	62.8 (58.6)
700	63.5 (59.3)	63.5 (59.3)	71.8 (67.0)	62.5 (58.4)	62.5 (58.4)
750	63.1 (58.9)	63.1 (58.9)	71.4 (66.5)	62.2 (58.1)	62.2 (58.1)
800	62.7 (58.5)	62.7 (58.5)	70.9 (66.2)	61.7 (57.6)	61.7 (57.6)

Notes:

1. Source: Table U on pages 437, 439, 441, and 443 of [1.A.1].
2. Units of tensile strength are ksi.
3. Values in parentheses are for SA-336 forging material (Types F304, F304LN, F316, and F316LN) that are used solely for the one-piece MPC lids. Other values correspond to SA-240 plate material.

Table 1.A.3

ALLOY X AND CONSTITUENT YIELD STRESSES (S_y) vs. TEMPERATURE

Temp. (°F)	Type 304	Type 304LN	Type 316	Type 316LN	Alloy X (minimum of constituent values)
-40	30.0	30.0	30.0	30.0	30.0
100	30.0	30.0	30.0	30.0	30.0
200	25.0	25.0	25.8	25.5	25.0
300	22.5	22.5	23.3	22.9	22.5
400	20.7	20.7	21.4	21.0	20.7
500	19.4	19.4	19.9	19.4	19.4
600	18.2	18.2	18.8	18.3	18.2
650	17.9	17.9	18.5	17.8	17.8
700	17.7	17.7	18.1	17.3	17.3
750	17.3	17.3	17.8	16.9	16.9
800	16.8	16.8	17.6	16.6	16.6

Notes:

1. Source: Table Y-1 on pages 518, 519, 522, 523, 530, 531, 534, and 535 of [1.A.1].

2. Units of yield stress are ksi.

Table 1.A.4

ALLOY X AND CONSTITUENT COEFFICIENT OF THERMAL EXPANSION vs. TEMPERATURE

Temp. (°F)	Type 304 and Type 304LN	Type 316 and Type 316LN	Alloy X Maximum	Alloy X Minimum
-40	8.55	8.54	8.55	8.54
100	8.55	8.54	8.55	8.54
150	8.67	8.64	8.67	8.64
200	8.79	8.76	8.79	8.76
250	8.90	8.88	8.90	8.88
300	9.00	8.97	9.00	8.97
350	9.10	9.11	9.11	9.10
400	9.19	9.21	9.21	9.19
450	9.28	9.32	9.32	9.28
500	9.37	9.42	9.42	9.37
550	9.45	9.50	9.50	9.45
600	9.53	9.60	9.60	9.53
650	9.61	9.69	9.69	9.61
700	9.69	9.76	9.76	9.69
750	9.76	9.81	9.81	9.76
800	9.82	9.90	9.90	9.82

Notes:

1. Source: Table TE-1 on pages 590 and 591 of [1.A.1].
2. Units of coefficient of thermal expansion are in./in.-°F x 10^{-6}.

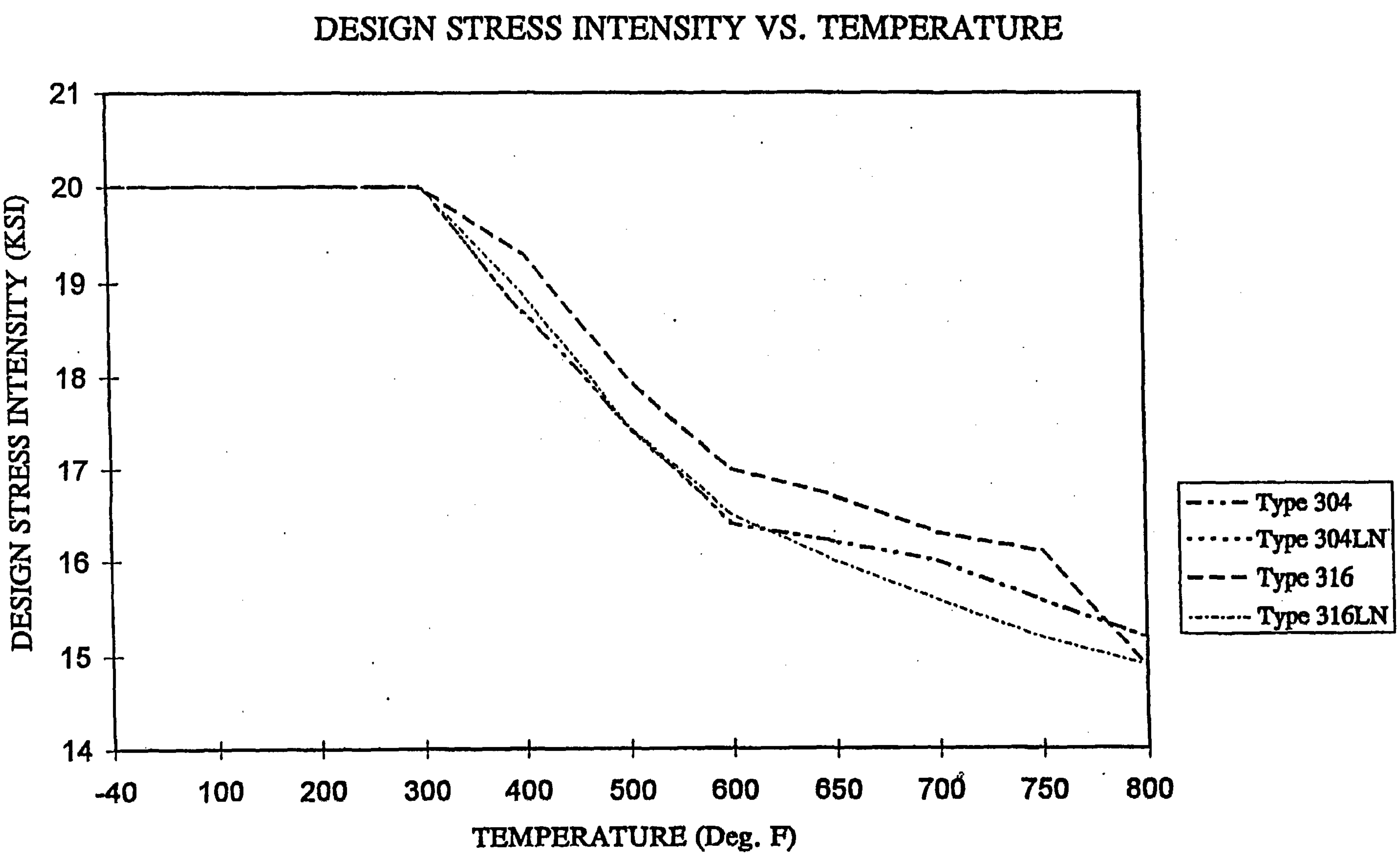
Table 1.A.5

ALLOY X AND CONSTITUENT THERMAL CONDUCTIVITY vs. TEMPERATURE

Temp. (°F)	Type 304 and Type 304LN	Type 316 and Type 316LN	Alloy X (minimum of constituent values)
-40	8.23	6.96	6.96
70	8.6	7.7	7.7
100	8.7	7.9	7.9
150	9.0	8.2	8.2
200	9.3	8.4	8.4
250	9.6	8.7	8.7
300	9.8	9.0	9.0
350	10.1	9.2	9.2
400	10.4	9.5	9.5
450	10.6	9.8	9.8
500	10.9	10.0	10.0
550	11.1	10.3	10.3
600	11.3	10.5	10.5
650	11.6	10.7	10.7
700	11.8	11.0	11.0
750	12.0	11.2	11.2
800	12.2	11.5	11.5

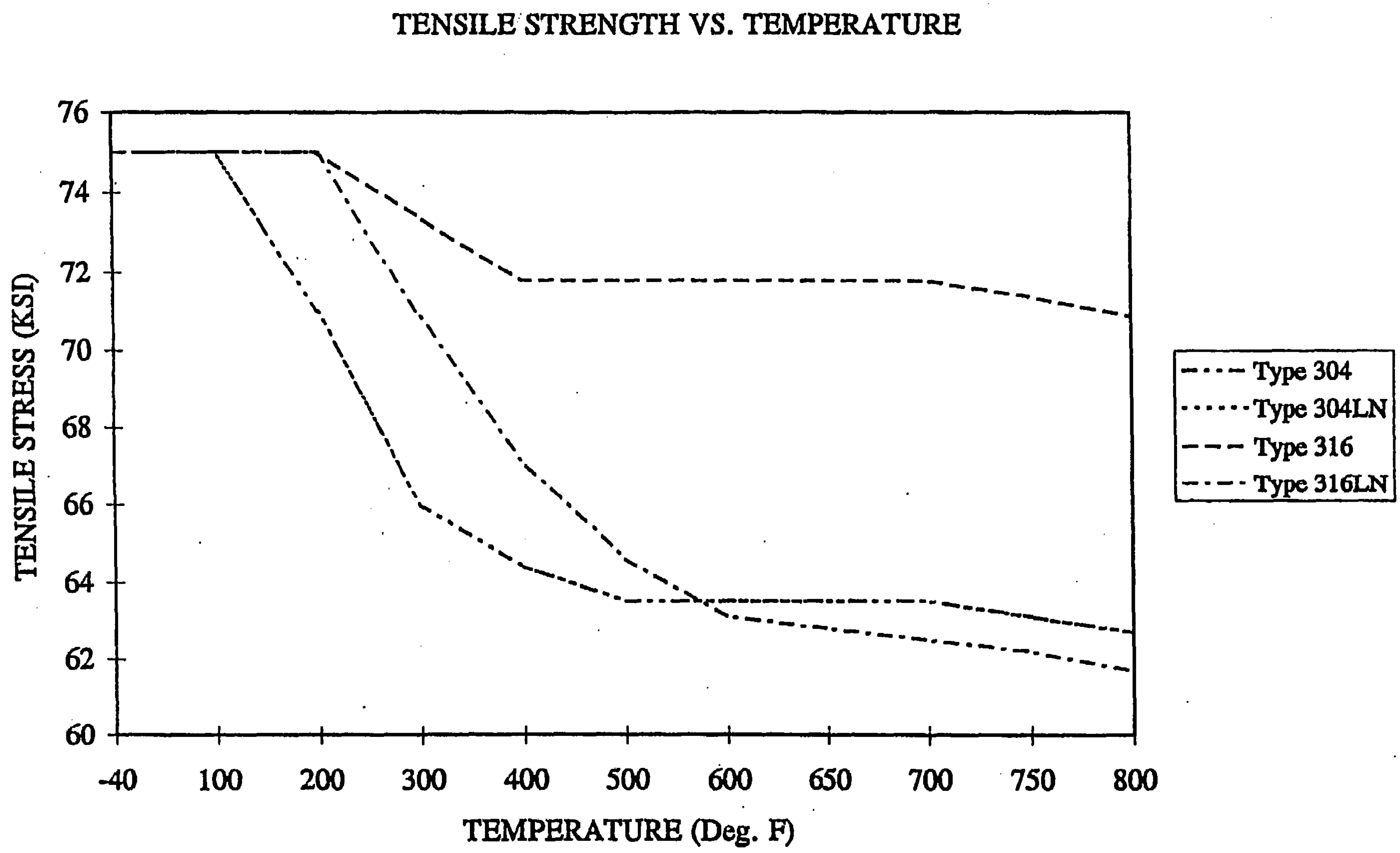
Notes:

1. Source: Table TCD on page 606 of [1.A.1].
2. Units of thermal conductivity are Btu/hr-ft-°F.



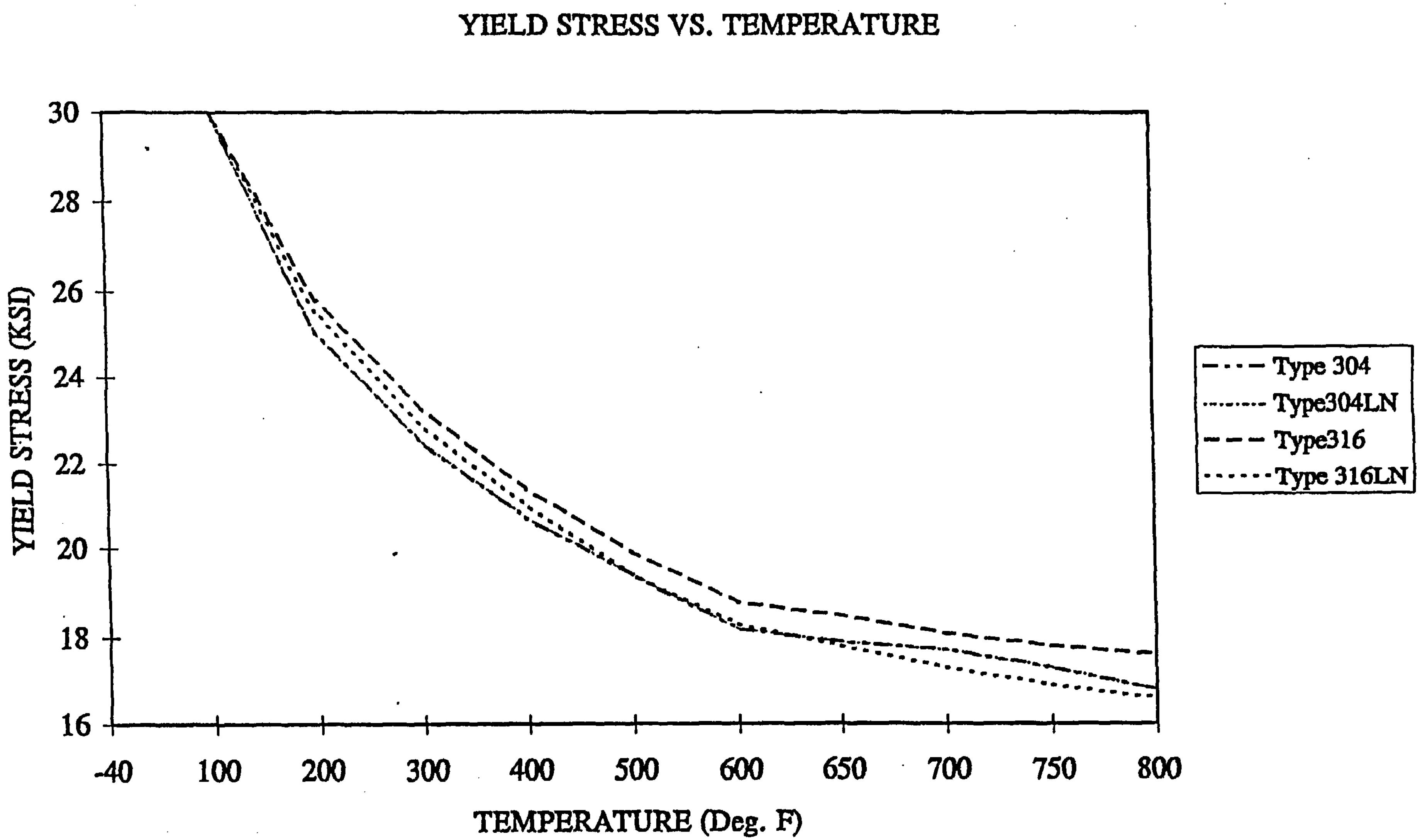
SOURCE: TABLE 1.A.1

FIGURE 1.A.1; DESIGN STRESS INTENSITY VS. TEMPERATURE



SOURCE: TABLE 1.A.2

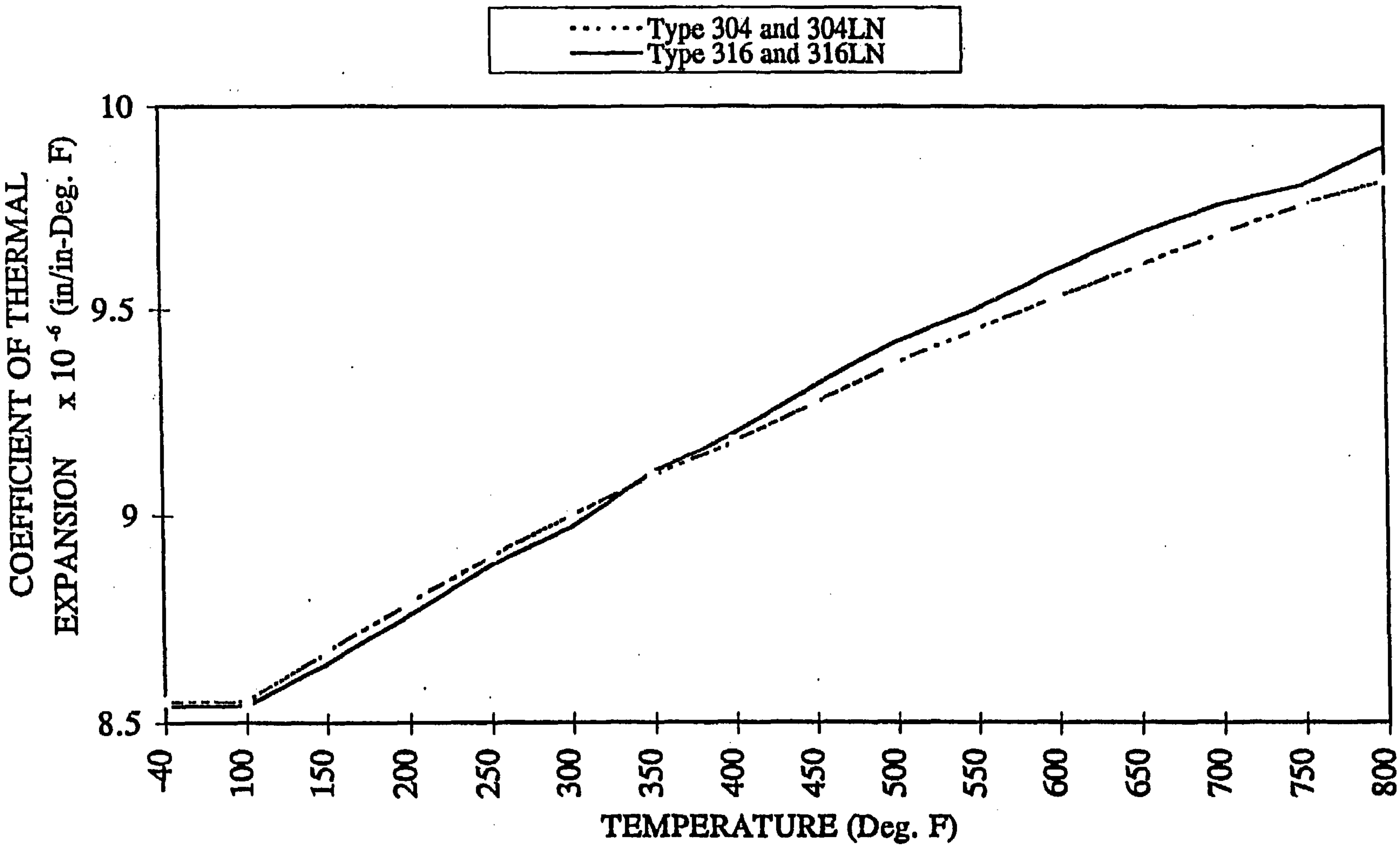
FIGURE 1.A.2; TENSILE STRENGTH VS. TEMPERATURE



SOURCE: TABLE 1.A.3

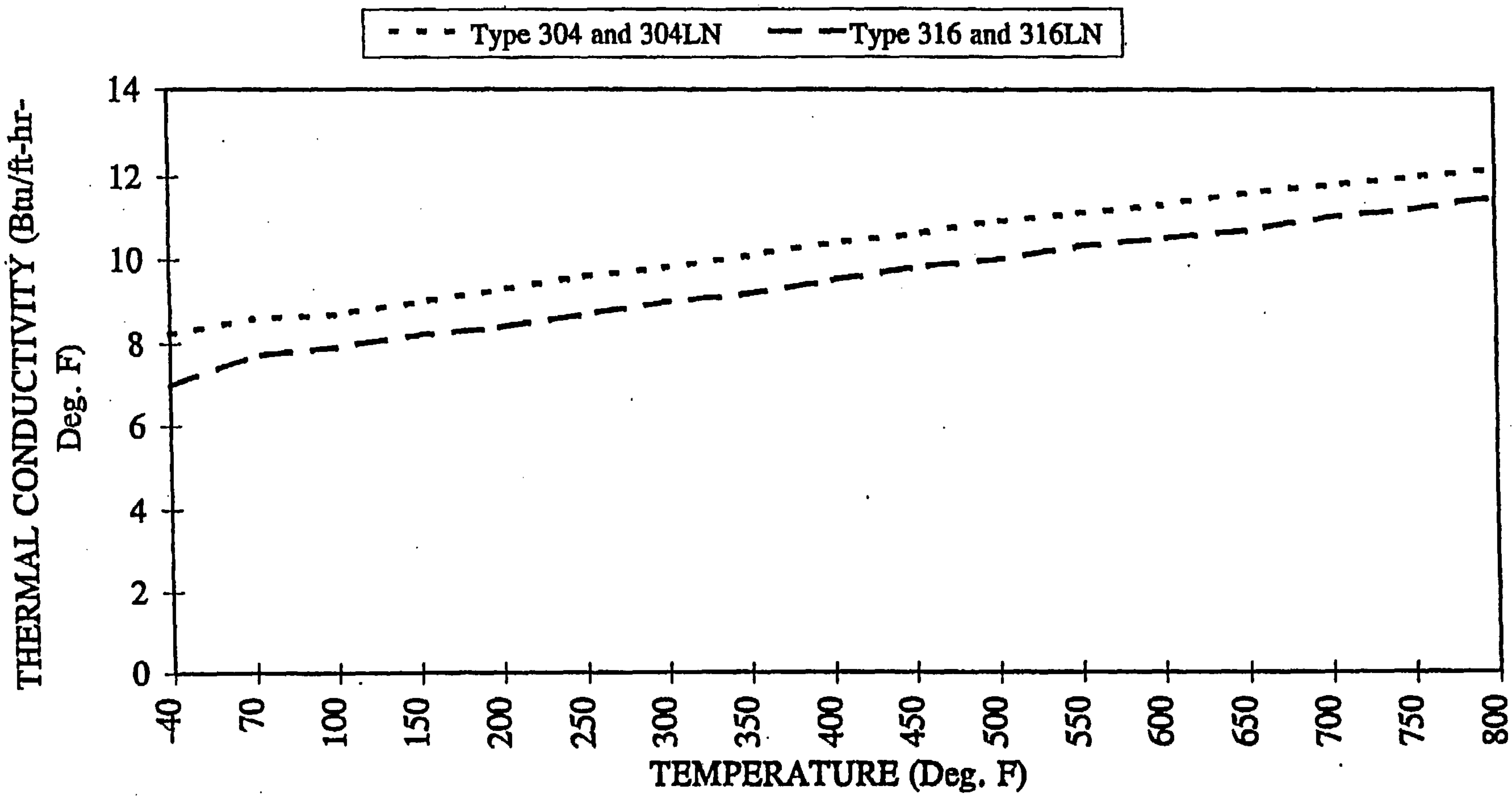
FIGURE 1.A.3; YIELD STRESS VS. TEMPERATURE

COEFFICIENT OF THERMAL EXPANSION VS. TEMPERATURE



SOURCE: TABLE 1.A.4 FIGURE 1.A.4; COEFFICIENT OF THERMAL EXPANSION VS. TEMPERATURE

THERMAL CONDUCTIVITY VS. TEMPERATURE



SOURCE: TABLE 1.A.5

FIGURE 1.A.5; THERMAL CONDUCTIVITY VS. TEMPERATURE

APPENDIX 1.B: HOLTITE ™ MATERIAL DATA

The information provided in this appendix describes the neutron absorber material, Holtite-A for the purpose of confirming its suitability for use as a neutron shield material in spent fuel storage casks. Holtite-A is one of a family of Holtite neutron shield materials denoted by the generic name Holtite™. It is currently the only neutron shield material approved for installation in the HI-STAR 100 cask. It is chemically identical to NS-4-FR which was originally developed by Bisco, Inc. and used for many years as a shield material with B_4C or Pb added.

Holtite-A contains aluminum hydroxide ($Al(OH)_3$) in an epoxy resin binder. Aluminum hydroxide is also known by the industrial trade name of aluminum tri-hydrate or ATH. ATH is often used commercially as a fire-retardant. Holtite-A contains approximately 62% ATH supported in a typical 2-part epoxy resin as a binder. Holtite-A contains 1% (nominal) by weight B_4C, a chemically inert material added to enhance the neutron absorption property. Pertinent properties of Holtite-A are listed in Table 1.B.1.

The essential properties of Holtite-A are:

1. the hydrogen density (needed to thermalize neutrons),

2. thermal stability of the hydrogen density, and

3. the uniformity in distribution of B_4C needed to absorb the thermalized neutrons.

ATH and the resin binder contain nearly the same hydrogen density so that the hydrogen density of the mixture is not sensitive to the proportion of ATH and resin in the Holtite-A mixture. B_4C is added as a finely divided powder and does not settle out during the resin curing process. Once the resin is cured (polymerized), the ATH and B_4C are physically retained in the hardened resin. Qualification testing for B_4C throughout a column of Holtite-A has confirmed that the B_4C is uniformly distributed with no evidence of settling or non-uniformity. Furthermore, an excess of B_4C is specified in the Holtite-A mixing and pouring procedure as a precaution to assure that the B_4C concentration is always adequate throughout the mixture.

The specific gravity specified in Table 1.B.1 does not include an allowance for weight loss. The specific gravity assumed in the shielding analysis includes a 4% reduction to conservatively account for potential weight loss at the design temperature of 300°F or an inability to reach theoretical density. Tests on the stability of Holtite-A were performed by Holtec International. The results of the tests are summarized in Holtec Proprietary Reports HI-2002396, "Holtite-A Development History and Thermal Performance Data" and HI-2002420, "Results of Pre- and Post-irradiation Test Measurements." The information provided in these reports demonstrates that Holtite-A possesses the necessary thermal and radiation stability characteristics to function as a reliable shielding material in the HI-STAR 100 overpack.

The Holtite-A is encapsulated in the HI-STAR 100 overpack and therefore should experience a very small weight reduction during the design life of the HI-STAR 100 System.

The data and test results confirm that Holtite-A remains stable under design thermal and radiation conditions, the material properties meet or exceed that assumed in the shielding analysis, and the B_4C remains uniformly distributed with no evidence of settling or non-uniformity.

Based on the information described above, Holtite-A meets all of the requirements for an acceptable neutron shield material.

Table 1.B.1

REFERENCE PROPERTIES OF HOLTITE-A NEUTRON SHIELD MATERIAL

PHYSICAL PROPERTIES	
% ATH	62 (nominal)
Specific Gravity	1.68 g/cc (nominal)
Max. Continuous Operating Temperature	300°F
Hydrogen Density	0.096 g/cc minimum
Radiation Resistance	Excellent
CHEMICAL PROPERTIES (Nominal)	
wt% Aluminum	21.5
wt% Hydrogen	6.0 (nominal)
wt% Carbon	27.7
wt% Oxygen	42.8
wt% Nitrogen	2.0
wt% B_4C	1.0 (nominal)

PAGES 1.B-4 THROUGH 1.B-20

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APPENDIX 1.C: MISCELLANEOUS MATERIAL DATA

The information provided in this appendix specifies the thermal expansion foam (silicone sponge), paint, and anti-seize lubricant properties and demonstrates their suitability for use in spent nuclear fuel storage casks. The following is a listing of the information provided.

- HT-800 Series, Silicone Sponge, Bisco Products Technical Data Sheet
- Thermaline 450, Carboline, Product Data Sheet and Application Instructions
- Carboline 890, Carboline, Product Data Sheet and Application Instructions
- FEL-PRO Technical Bulletin, N-5000 Nickel Based-Nuclear Grade Anti-Seize Lubricant

HT-870 silicone sponge is specified as a thermal expansion foam to be placed in the overpack outer enclosure with the neutron shield. Due to differing thermal expansion of the neutron shield and outer enclosure carbon steel, the silicone sponge is provided to compress and allow the neutron shield material to expand. The compression-deflection physical properties are provided for the silicone sponge.

Silicone has a long and proven history in the nuclear industry. Silicone is highly resistant to degradation as a result of radiation at the levels required for the HI-STAR 100 System. Silicone is inherently inert and stable and will not react with the metal surfaces or neutron shield material. Additionally, typical operating temperatures for silicone sponges range from -50° F to 400° F.

Thermaline 450 is specified to coat the inner cavity of the overpack and Carboline 890 is specified to coat the external surfaces of the overpack. As can be seen from the product data sheets, the paints are suitable for the design temperatures (see Table 2.2.3) and chemical environment. Chemically identical substitutes are permitted (i.e., Carboguard 890 in lieu of Carboline 890).

Nuclear grade anti-seize lubricant, N-5000, from FEL-PRO is specified as the lubricant for the overpack closure bolts. The lubricant is formulated to have the lowest practical levels of halogens, sulfur, and heavy metals. NEVER-SEEZ NGBT provides equivalent properties to FEL-PRO N-5000 and is also acceptable for use on the HI-STAR 100 System.

Bisco Products
A Dow Corning Subsidiary

Technical Data

HT-800 SERIES

Specification Grade
Silicone Sponge

PHYSICAL PROPERTIES

PROPERTY	SPECIFICATION			TEST METHOD
	HT-870 (Soft)	HT-800 (Medium)	HT-820 (Firm)	
Density	12 - 24 pcf	16 - 28 pcf	20 - 32 pcf	ASTM D-3574
Compression Force @ 25% Deflection	2 - 7 psi	6 - 14 psi	12 - 20 psi	ASTM D-1056
Compression Set (Maximum)	10%	10%	10%	ASTM D-1056 (Compressed 50%for 22 hrs. @ 100°C)
Water Absorption (Maximum)	10%	5%	5%	ASTM D-1056

Available Industry Specifications:

AMS-3195 (HT-800)
AMS-3196 (HT-820)
UL-94 (Limited to specific classes, densities, thicknesses and colors)

Data is based on laboratory tests and should not be used for writing specifications. Each user should run independent tests to confirm material suitability for each specific application.

Bisco Products and Dow Corning neither represent nor test this material for medical device applications or for pharmaceutical end-use.

2300 East Devon Avenue • Elk Grove Village, Illinois 60007-6120 • Toll Free: 800/237-2068

product data sheet

carboline®

THERMALINE 450

VOC

SELECTION DATA

GENERIC TYPE: A glass flake filled, phenolic modified, amine cured epoxy novalac.

GENERAL PROPERTIES: A dense cross-linked polymer which exhibits outstanding barrier protection against a variety of chemical exposures. Excellent resistance to wet/dry cycling conditions at elevated temperatures. Designed to coat the exterior of insulated piping. It is also suitable for coating non-insulated piping and equipment exposed to chemical attack. The glass flakes help provide excellent abrasion resistance, permeation resistance and internal reinforcement.

- Temperature resistance to 450°F
- Excellent abrasion resistance
- Excellent overall chemical resistance
- Excellent thermal shock resistance

RECOMMENDED USES: Typically used as a one coat system to coat pipes and tanks that will be insulated. May also be used to coat non-insulated pipe, structural steel, equipment or concrete that may be subjected to severe chemical attack, abrasion or other abuse typical of a chemical plant environment.

TYPICAL CHEMICAL RESISTANCE:

Exposure	Splash & Spillage	Fumes
Acids	Excellent	Excellent
Alkalies	Excellent	Excellent
Solvents	Excellent	Excellent
Salt	Excellent	Excellent
Water	Excellent	Excellent

TEMPERATURE RESISTANCE (Under insulation):
Continuous: 425°F (218°C)
Excursions to: 450°F (232°C)

At 200°F (93°C) coating discoloration may be observed without loss of film integrity.

SUBSTRATES: Apply over properly prepared steel.

COMPATIBLE COATINGS: Normally applied directly to substrate. May be applied over epoxies and phenolics as recommended. May be topcoated with epoxies, polyurethanes or other finish coats as recommended.

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SPECIFICATION DATA

0928

THEORETICAL SOLIDS CONTENT OF MIXED MATERIAL:

	By Volume
THERMALINE 450	70 ± 2%

VOLATILE ORGANIC CONTENT (VOC):
The following are nominal values:
As supplied: 2.13 lbs./gal. (255 gm./liter).

Thinner	Fluid Ounces/Gal.	Pounds/ Gallon	Grams/ Liter
213	13	2.56	307

RECOMMENDED DRY FILM THICKNESS:
8-10 mils (200-250 microns) to be achieved in 1 or 2 coats.

THEORETICAL COVERAGE PER MIXED GALLON:*
1,117 mil sq. ft. (27.9 sq.m/l at 25 microns)
139 sq. ft at 8 mils (3.5 sq. m/l at 200 microns)
111 sq. ft at 10 mils (2.8 sq.m/l at 250 microns)

*Mixing and application losses will vary and must be taken into consideration when estimating job requirements.

STORAGE CONDITIONS: Store indoors.
Temperature: 40-110°F (4-43°C) Humidity: 0-90%

SHELF LIFE: 24 months when stored indoors at 75°F (24°C)

COLOR: Red (0500) and Gray (5742)

GLOSS: Low *(Epoxies lose gloss, discolor and eventually chalk in sunlight exposure.)*

ORDERING INFORMATION

Prices may be obtained from your Carboline Sales Representative or Carboline Customer Service Department.

APPROXIMATE SHIPPING WEIGHT:

	1's	5's
THERMALINE 450	12 lbs. (5.5 kg)	58 lbs. (26.3 kg)
Thinner 213	8.4 lbs. (3.8 kg)	41 lbs. (18.6 kg)

FLASH POINT: (Setaflash)

THERMALINE 450 Part A:	53°F	(12°C)
THERMALINE 450 Part B:	>200°F	(>93°C)
Thinner 213	22°F	(-6°C)

APPLICATION INSTRUCTIONS

THERMALINE 450

These instructions are not intended to show product recommendations for specific service. They are issued as an aid in determining correct surface preparation, mixing instructions and application procedure. It is assumed that the proper product recommendations have been made. These instructions should be followed closely to obtain the maximum service from the materials.

0928

SURFACE PREPARATION: Remove all oil or grease from surface to be coated with Thinner 2 or Surface Cleaner 3 (refer to Surface Cleaner 3 instructions) in accordance with SSPC-SP 1.

STEEL:

Not Insulated: Abrasive blast to a Commercial Finish in accordance with SSPC-SP 6 and obtain a 2-3 mil (50-75 micron) blast profile.

Under Insulation: Abrasive blast to a Near White Finish in accordance with SSPC-SP 10 and obtain a 2-3 (50-75 micron) blast profile.

MIXING: Power mix each component separately, then combine and power mix in the following proportions.

Allow 30 minutes induction time at 75°F (24°C) prior to use.

	1 Gal. Kit	5 Gal. Kit
THERMALINE 450 Part A:	0.8 gals.	4.0 gals.
THERMALINE 450 Part B:	0.2 gals.	1.0 gals.

THINNING: May be thinned up to 13 oz/gal with Thinner 213.

Use of thinners other than those supplied or approved by Carboline may adversely affect product performance and void product warranty, whether express or implied.

POT LIFE: Three hours at 75°F (24°C) and less at higher temperatures. Pot life ends when coating loses body and begins to sag.

APPLICATION CONDITIONS:

	Material	Surfaces	Ambient	Humidity
Normal	65-85°F (18-29°C)	65-85°F (18-29°C)	65-85°F (18-29°C)	30-60%
Minimum	55°F (13°C)	50°F (10°C)	50°F (10°C)	0%
Maximum	90°F (32°C)	110°F (43°C)	100°F (38°C)	85%

Do not apply when the surface temperature is less than 5°F or 3°C above the dew point.

Special thinning and application techniques may be required above or below normal conditions.

SPRAY: The following spray equipment has been found suitable and is available from manufacturers such as Binks, DeVilbiss and Graco.

Conventional: Pressure pot equipped with dual regulators, 1/2" I.D. minimum material hose, .110" I.D. fluid tip and appropriate air cap.

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Airless:

Pump Ratio:	30:1 (min)*
GPM Output:	3.0 (min)
Material Hose:	1/2" I.D. (min)
Tip Size:	.035"-.041"
Output psi:	2200-2500

*Teflon packings are recommended and are available from the pump manufacturer.

BRUSH: For striping of welds, touch-up of small areas only. Use a natural bristle brush, applying full strokes. Avoid rebrushing.

ROLLER: Not recommended.

DRYING TIMES: These times are based on a dry film thickness of 10 mils (250 microns). Higher film thickness, insufficient ventilation or cooler temperatures will require longer cure times and could result in solvent entrapment and premature failure.

Surface Temperature	Dry To Handle	Dry to Topcoat	Final Cure
50°F (10°C)	18 hours	48 hours	21 days
60°F (16°C)	12 hours	32 hours	14 days
75°F (24°C)	6 hours	16 hours	7 days
90°F (32°C)	3 hours	8 hours	4 days

If the final cure time has been exceeded, the surface must be abraded by sweep blasting prior to the application of any additional coats.

EXCESSIVE HUMIDITY OR CONDENSATION ON THE SURFACE DURING CURING MAY RESULT IN A SURFACE HAZE OR BLUSH; ANY HAZE OR BLUSH MUST BE REMOVED BY WATER WASHING BEFORE RECOATING.

VENTILATION & SAFETY: WARNING: VAPORS MAY CAUSE EXPLOSION. When used in enclosed areas, thorough air circulation must be used during and after application until the coating is cured. The ventilation system should be capable of preventing the solvent vapor concentration from reaching the lower explosion limit for the solvents used. In addition to insuring proper ventilation, fresh air respirators or fresh air hoods must be used by all application personnel. Where flammable solvents exist, explosion-proof lighting must be used. Hypersensitive persons should wear clean, protective clothing, gloves and/or protective cream on face, hands and all exposed areas.

CLEANUP: Use Thinner 2.

CAUTION: READ AND FOLLOW ALL CAUTION STATEMENTS ON THIS PRODUCT DATA SHEET AND ON THE MATERIAL SAFETY DATA SHEET FOR THIS PRODUCT.

CAUTION: CONTAINS FLAMMABLE SOLVENTS. KEEP AWAY FROM SPARKS AND OPEN FLAMES. WORKMEN IN CONFINED AREAS MUST WEAR FRESH AIRLINE RESPIRATORS. HYPERSENSITIVE PERSONS SHOULD WEAR GLOVES OR USE PROTECTIVE CREAM. ALL ELECTRICAL EQUIPMENT AND INSTALLATIONS SHOULD BE MADE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. IN AREAS WHERE EXPLOSION HAZARDS EXIST, WORKMEN SHOULD BE REQUIRED TO USE NONFERROUS TOOLS AND TO WEAR CONDUCTIVE AND NONSPARKING SHOES.

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350 Hanley Industrial Ct. • St. Louis, MO 63144-1599

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CARBOLINE® 890

VOC

SELECTION DATA

GENERIC TYPE: Cross-linked epoxy.

GENERAL PROPERTIES: CARBOLINE 890 is a self priming, high solids, high gloss, high build epoxy mastic. It can be applied by spray, brush, or roller over hand or power tool cleaned steel and is compatible with most existing coatings and tightly adhered rust. The cured film provides a tough, cleanable surface and is available in a wide variety of colors.

- Single coat corrosion protection.
- Excellent chemical resistance.
- Good flexibility and lower stress upon curing than most epoxy coatings.
- Excellent tolerance of damp (not wet) substrates.
- Very good abrasion resistance.
- Suitable replacement for Carbomastic 801.

RECOMMENDED USES: Recommended where a high performance, chemically resistant epoxy coating is desired. Offers outstanding protection for interior floors, walls, piping, equipment and structural steel or as an exterior coating for railcars, structural steel and equipment in various corrosive environments. Industrial environments include Chemical Processing, Offshore Oil and Gas, Food Processing, Pharmaceutical, Water and Waste Water Treatment, Pulp and Paper and Power Generation among others. May be used as a two coat system direct to metal or concrete for Water and Municipal Waste Water immersion. Acceptable for use in incidental food contact areas and as a lining for hopper cars carrying food grade plastic pellets when processed according to FDA criteria (ref: FDA 21 CFR 175.300). Consult Carboline Technical Service Department for other specific uses.

NOT RECOMMENDED FOR: Strong acid or solvent exposures, immersion service other than water, exterior weathering where color retention is desired, such as a finish for tank exteriors or over chlorinated rubber and latex coatings.

TYPICAL CHEMICAL RESISTANCE:

Exposure	Immersion	Splash & Spillage	Fumes
Acids	NR	Very Good	Very Good
Alkalies	NR	Excellent	Excellent
Solvents	NR	Very Good	Excellent
Salt Solutions	Excellent	Excellent	Excellent
Water	Excellent	Excellent	Excellent

TEMPERATURE RESISTANCE: (Non-Immersion)

Continuous:	250°F (121°C)
Non-continuous:	300°F (149°C)

At temperatures above 225°F, coating discoloration and loss of gloss can be observed, without loss of film integrity.

SUBSTRATES: Apply over suitably prepared metal, concrete, or other surfaces as recommended.

COMPATIBLE COATINGS: May be applied directly over inorganic zincs, weathered galvanizing, epoxies, phenolics or other coatings as recommended. A test patch is recommended before use over existing coatings. A mist coat of CARBOLINE 890 is required when applied over inorganic zincs to minimize bubbling. May be topcoated with polyurethanes or acrylics to upgrade weathering resistance. Not recommended over chlorinated rubber or latex coatings. Consult Carboline Technical Service Department for specific recommendations.

SPECIFICATION DATA

0986

THEORETICAL SOLIDS CONTENT OF MIXED MATERIAL:*

	By Volume
CARBOLINE 890	75% ± 2%

VOLATILE ORGANIC CONTENT:*
As Supplied: 1.78 lbs./gal. (214 grams/liter)
Thinned:

Thinner	Fluid Ounces/Gal.	Pounds/ Gallon	Grams/ Liter
2	8	2.08	250
2	13	2.26	271
33	16	2.38	285

*Varies with color

RECOMMENDED DRY FILM THICKNESS PER COAT:
4-6 mils (100-150 microns).
6-8 mils (150-200 microns) DFT for a more uniform gloss over inorganic zincs, or for use over light rust.

In more severe environments a second coat of 4-6 mils (100-150 microns) is recommended.

Dry film thickness in excess of 10 mils (250 microns) per coat is not recommended. Excessive film thickness over inorganic zinc may increase damage during shipping or erection.

THEORETICAL COVERAGE PER MIXED GALLON:
1203 mil sq. ft. (30 sq. m/l at 25 microns)
241 sq. ft. at 5 mils (6.0 sq. m/l at 125 microns)

Mixing and application losses will vary and must be taken into consideration when estimating job requirements.

STORAGE CONDITIONS: Store Indoors
Temperature: 40-110°F (4-43°C) Humidity: 0-100%

SHELF LIFE: 36 months when stored at 75°F (24°C).

COLORS: Available in Carboline Color Chart colors. Some colors may require two coats for adequate hiding.

GLOSS: High gloss (Epoxies lose gloss, discolor and eventually chalk in sunlight exposure).

ORDERING INFORMATION

Prices may be obtained from your Carboline Sales Representative or Carboline Customer Service Department.

APPROXIMATE SHIPPING WEIGHT:

	2 Gal. Kit	10 Gal. Kit
CARBOLINE 890	29 lbs. (13 kg)	145 lbs. (66 kg)

	1's	5's
THINNER #2	8 lbs. (4 kg)	39 lbs. (18 kg)
THINNER #33	9 lbs. (4 kg)	45 lbs. (20 kg)

FLASH POINT: (Setaflash)

CARBOLINE 890 Part A	89°F (32°C)
CARBOLINE 890 Part B	71°F (22°C)
THINNER #2	24°F (-5°C)
THINNER #33	89°F (32°C)

June 96 Replaces December 95

APPLICATIONS INSTRUCTIONS
CARBOLINE® 890

These instructions are not intended to show product recommendations for specific service. They are issued as an aid in determining correct surface preparation, mixing instructions and application procedure. It is assumed that the proper product recommendations have been made. These instructions should be followed closely to obtain the maximum service from the materials.

0986

SURFACE PREPARATION: Remove all oil or grease from surface to be coated with Thinner #2 or Surface Cleaner #3 (refer to Surface Cleaner #3 instructions) in accordance with SSPC-SP 1.

Steel: For mild environments Hand Tool or Power Tool Clean in accordance with SSPC-SP 2, SSPC-SP 3 or SSPC-SP 11 to produce a rust-scale free surface.

For more severe environments, abrasive blast to a Commercial Finish in accordance with SSPC-SP 6 and obtain a 1½ - 3 mil (40-75 micron) blast profile.

For immersion service, abrasive blast to a Near White Metal Finish in accordance with SSPC-SP10 and obtain a 1½ - 3 mil (40-75 micron) blast profile.

Concrete: Must be cured at least 28 days at 70°F (21°C) and 50% R.H. or equivalent time. Remove fins and other protrusions by stoning, sanding or grinding. Abrasive blast to open all surface voids and remove all form oils, incompatible curing agents, hardeners, laitance and other foreign matter and produce a surface texture similar to that of a medium grit sandpaper. Voids in the concrete may require surfacing. Blow or vacuum off sand and dust.

MIXING: Power mix separately, then combine and power mix in the following proportions:

	2 Gal. Kit	10 Gal. Kit
CARBOLINE 890 Part A	1 gallon	5 gallons
CARBOLINE 890 Part B	1 gallon	5 gallons

THINNING: For spray applications, may be thinned up to 13 oz./gal. with Thinner #2. For hot and windy conditions, or for brush and roller application, may be thinned up to 16 oz./gal. with Thinner #33.

Use of thinners other than those supplied or approved by Carboline may adversely affect product performance and void product warranty, whether express or implied.

POT LIFE: Three hours at 75°F (24°C) and less at higher temperatures. Pot life ends when material loses film build.

APPLICATION CONDITIONS:

	Material	Surfaces	Ambient	Humidity
Normal	60-85°F (16-29°C)	60-85°F (16-29°C)	60-90°F (16-32°C)	0-80%
Minimum	50°F (10°C)	50°F (10°C)	50°F (10°C)	0%
Maximum	90°F (32°C)	125°F (52°C)	110°F (43°C)	90%

Do not apply or cure the material when the surface temperature is less than 5°F or 3°C above the dew point.

Special thinning and application techniques may be required above or below normal conditions.

SPRAY: This is a high solids coating and may require slight adjustments in spray techniques. Wet film thicknesses are easily and quickly achieved. The following spray equipment has been found suitable and is available from manufacturers such as Binks, DeVilbiss and Graco.

Conventional: Pressure pot equipped with dual regulators, 3/8" I.D. minimum material hose, .070" I.D. fluid tip and appropriate air cap.

June 96 Replaces December 95

Airless:

Pump Ratio:	30:1 (min.)*
GPM Output:	3.0 (min.)
Material Hose:	3/8" I.D. (min.)
Tip Size:	.017-.021"
Output psi:	2100-2300
Filter Size:	60 mesh

*Teflon packings are recommended and are available from the pump manufacturer.

BRUSH OR ROLLER: Use medium bristle brush, or good quality short nap roller. Avoid excessive rebrushing and rerolling. Two coats may be required to obtain desired appearance, hiding and recommended DFT. For best results, tie-in within 10 minutes at 75°F (24°C).

DRYING TIMES: These times are based on a 5 mils (125 microns) dry film thickness. Higher film thicknesses, insufficient ventilation or cooler temperatures will require longer cure times and could result in solvent entrapment and premature failure.

Dry to Touch 2 1/2 hours at 75°F (24°C)
Dry to Handle 6 1/2 hours at 75°F (24°C)

Surface Temperature	Recoating With Itself	Dry to Topcoat	Final Cure
50°F (10°C)	12 hours	24 hours	3 days
60°F (16°C)	8 hours	16 hours	2 days
75°F (24°C)	4 hours	8 hours	1 day
90°F (32°C)	2 hours	4 hours	16 hours

Excessive humidity or condensation on the surface during curing can interfere with the cure, can cause discoloration and may result in a surface haze or blush. Any haze or blush must be removed by water washing before recoating. During high humidity conditions, it is recommended that the application be done while temperatures are increasing. For best results over "damp" surfaces, apply by brush or roller.

Maximum Recoat or Topcoat Times at 75°F (24°C):
With Epoxies - 30 days
With Polyurethanes - 90 days

If the maximum recoat time has been exceeded, surface must be abraded by sweep blasting prior to the application of any additional coats.

Minimum cure time before immersion service is 5 days at 75°F (24°C) surface temperature. Cure at temperatures below 60°F (16°C) is not recommended for immersion service.

VENTILATION & SAFETY: WARNING: VAPORS MAY CAUSE EXPLOSION. When used as a tank lining or in enclosed areas, thorough air circulation must be used during and after application until the coating is cured. The ventilation system should be capable of preventing the solvent vapor concentration from reaching the lower explosion limit for the solvents used. In addition to ensuring proper ventilation, fresh air respirators or fresh air hoods must be used by all application personnel. Where flammable solvents exist, explosion-proof lighting must be used. Hypersensitive persons should wear clean, protective clothing, gloves and/or protective cream on face, hands and all exposed areas.

CLEANUP: Use Thinner # 2.

CAUTION: READ AND FOLLOW ALL CAUTION STATEMENTS ON THIS PRODUCT DATA SHEET AND ON THE MATERIAL SAFETY DATA SHEET FOR THIS PRODUCT.

CAUTION: CONTAINS FLAMMABLE SOLVENTS. KEEP AWAY FROM SPARKS AND OPEN FLAMES. IN CONFINED AREAS, WORKMEN MUST WEAR FRESH AIRLINE RESPIRATORS. HYPERSENSITIVE PERSONS SHOULD WEAR GLOVES OR USE PROTECTIVE CREAM. ALL ELECTRIC EQUIPMENT AND INSTALLATIONS SHOULD BE MADE AND GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. IN AREAS WHERE EXPLOSION HAZARDS EXIST, WORKMEN SHOULD BE REQUIRED TO USE NONFERROUS TOOLS AND TO WEAR CONDUCTIVE AND NONSPARKING SHOES.

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FEL-PRO®
Technical Bulletin

N-5000 NICKEL BASED - NUCLEAR GRADE ANTI-SEIZE LUBRICANT

N-5000 is a nickel based nuclear grade anti-seize lubricant produced under 100% controlled conditions for highest purity and traceability. It is formulated to have the lowest practical levels of halogens, sulfur, and heavy metals, including copper. N-5000 has a general composition of nickel and graphite flake in petroleum carrier. All ingredients are selected for extreme purity. It meets or exceeds the following specifications, appendix A of NEDE-31295P, "BWR Operator's Manual for Materials and Processes", Westinghouse Material Specification 53701WQ, and 10CFR Ch1, Part 21, and Part 50, appendix B.

Special Features:
- High purity- made from highest purity ingredients.
- Traceability- each can marked.
- Free from copper- less than 50 ppm copper.
- Testing- each batch tested before packaging.
- Certifications- 3 copies with each case.

Recommended applications:
- Bolts, studs, valves, pipe fittings, slip fits and press fits in electric power generating plants, chemical plants, pharmaceutical plants, paper mills, and other locations where stainless steel fasteners are used.

Operational Benefits:
- Before assembly - certifications and traceability.
- During assembly - prevents high friction, galling,
- and seizing. Promotes uniform and predictable clamping.
- During operation - high purity prevents stress corrosion.
- Disassembly - prevents seizing, galling, destruction of threads.

Typical Physical Properties:

Composition	Nickel and Graphite in Petroleum Oil
Appearance	Silver-Gray paste
Specific gravity	[illegible]
Flash point (ASTM D 92-85)	424°F/218°C
Torque coefficient k (Steel nuts and Bolts)	0.15
(Type 304 Stainless)	0.18
Maximum use temperature	1800°F/982°C

Quality Control Physical Properties:

Weight per gallon (ASTM D 1475-85)	Range 9.5 - 10.4
Penetration (ASTM D 217-88 unworked)	300 - 380

Purity:

Impurities - Elemental and Combined	Test Method Type	References ASTM OR (SM16)	Controlled Maximum	Average Values
Halogens Chlorine Bromine Iodine	Parr Bomb, Turbidimetric	D808-87, C69979	50 ppm	18 ppm
Fluorine	Parr Bomb, Specific ION Electrode	D3761-84	200 ppm	7 ppm
Sulfur	Parr Bomb, Turbidimetric	D129-64, D1266-87	100 ppm	9 ppm
Lead	Wet Digestion, AAS	(302D), D3559-84	25 ppm	1ppm
admium	Wet Digestion, AAS	(302D), D3557-84	2 ppm	0.2 ppm
n	Wet Digestion, AAS	(302D), E37-76	25 ppm	9 ppm
Zinc	Wet Digestion, AAS	(302D), D1691-84	25 ppm	1 ppm
Copper	Wet Digestion, AAS	(302D), D1688-84	50 ppm	12 ppm
Mercury	Wet Digestion, Cold Vapor AAS	(302D), D3223-80	2 ppm	0.04 ppm

Directions for use:

- Before or during assembly, wipe brush onto threads and other joint surfaces needing protection.
- Do not overuse, as excess will be pushed off.
- Use full strength, do not thin.

Packaging:

Part Number	Net Contents	Type Container	Units/Case	Shipping Wt/Case
51243	8 oz. (227 g)	Can-brush top	12	9 lb. (4. Kg.)
51245	8 lb. (3.6 kg)	Can	2	18 lb. (8. Kg.)
51246	2 lb. (908 g)	Can	12	29 lb. (13. Kg.)
51269	1 lb. (454 g)	Can-brush top	12	16 lb. (7. Kg.)
51346	1 oz. (28 g)	Tube	48	6 lb. (2.7 Kg.)

N-5000 has an unlimited shelf life when stored at room temperature in the original unopened container.

FOR INDUSTRIAL USE ONLY.
WASH THOROUGHLY AFTER HANDLING.
KEEP OUT OF REACH OF CHILDREN.
SEE MATERIAL SAFETY DATA For immediate answers to your technical questions, in the United States or Canada call the **Technical Support Line** at **1-800-992-9799.** International customers call (303) 289-5651, or fax (303) 289-5283

For a Material Safety Data Sheet or Technical Bulletin on this or any Fel-Pro product call our toll-free **FAX FOR THE INFO** line 24 hours a day, 7 days a week, in the United States or Canada call **800-583-3069.** International customers call (303) 289-5651, or fax (303) 289-5283.

Except as expressly stipulated, Fel-Pro's liability, expressed or implied, is limited to the stated selling price of any defective goods.

N-5000 8/97

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APPENDIX 1.D

COMMENT RESOLUTION LETTERS

(83 TOTAL PAGES INCLUDING THIS PAGE)

#F 5014
2

HOLTEC INTERNATIONAL

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BY FAX AND FEDEX

January 15, 1999

Mr. Mark S. Delligatti
Senior Project Manager
Spent Fuel Licensing Section, SFPO, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter A

References: 1. Holtec Project No. 5014

2. Meeting Between NRC/SFPO and Holtec International held January 13, 1999

Dear Mr. Delligatti,

We are pleased to note that the Spent Fuel Project Office (SFPO) staff has completed it acceptance review of Revision 7 of Holtec International's Safety Analysis Report (SAR) submitted in support of our application for a 10CFR71 Certificate of Compliance (CoC) for the HI-STAR 100 System. This Comment Resolution Letter (CRL), first in the expected series of letters to document the responses to the SFPO's questions in an expedited and interactive mode, provides a synopsis of the January 13, 1999 meeting commitments. The SFPO's requests and Holtec's commitments thereto are listed below by reference to the appropriate SAR Chapters.

Chapter 1 – General Information

A.1.1 Fuel data in Tables 1.2.10 and 1.2.11 must be reviewed for consistency with HI-STAR storage Technical Specification Tables 2.1-2 and 2.1-3. Examples of differences include the absence of maximum planar average enrichments limits in SAR Table 1.2.1 and the U-235 mass for BWR assembly array/class 6X6C fuel is different.

Commitment

SAR Tables 1.2.10 and 1.2.11 will be reviewed against the HI-STAR storage technical specifications and appropriate corrections will be made. Draft Revision 8 SAR pages will be provided to the NRC by **February 1, 1999.**

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A.1.2 Throughout the SAR, reference is made to NUREG-1536. The correct Standard Review plan to reference for transportation is draft NUREG-1617.

Commitment

Holtec will thoroughly review all chapters of the SAR for references to NUREG-1536. If the reference is correct in context for the dual purpose system, it may be left in the SAR with an additional entry made to provide the appropriate reference to draft NUREG-1617. These changes will be incorporated in Revision 8 of the SAR, to be submitted to the NRC by February 22, 1999.

A.1.3 Several drawings included with SAR Revision 7 are a different revision level than those in Revision 9 of the HI-STAR 100 TSAR.

Commitment and Comment

The drawing revisions in Revision 8 of the SAR are correct. A small number of HI-STAR 100 drawings have been revised since the submittal of Revision 8 of the HI-STAR 100 TSAR in August, 1998. These revisions were made to incorporate lessons learned from the HI-STAR 100 prototype fabrication, clarify a number of Bill-of-Material items, and to reflect the current weld inspection requirements for the MPC lid-to-shell weld (i.e., allowing a multi-layer PT examination in lieu of volumetric examination). Upon receipt of the HI-STAR 100 storage CoC, Holtec will submit a conforming revision to the TSAR which will include updating any drawings affected by these revisions. This TSAR revision will be submitted within 90 days of receipt of the HI-STAR 100 storage CoC. Additionally, a list of the differences between the drawings in the HI-STAR TSAR and the HI-STAR SAR will be provided in a comment resolution letter to be submitted by February 8, 1999.

A.1.4 Table 1.2.1 lists the maximum weight of a loaded HI-STAR 100 as 254,617 lbs. This is greater than the design load for the overpack's lifting trunnions. Please clarify how the general licensees are to ensure the trunnions are not loaded beyond their design limit when lifting a loaded HI-STAR during any phase of loading operations.

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Commitment

A review of this SAR table revealed that 3,600 lbs of the total weight is from the lift rig itself. While the lift rig weight may be subtracted from the load on the trunnions, the user's crane will be required to have the capacity to lift the rigging as well as the loaded HI-STAR. Holtec will review SAR Chapters 1 and 2 and the operating procedures in SAR Chapter 7 to ensure appropriate guidance is provided to licensees to ensure neither the HI-STAR trunnions nor the cranes lifting the HI-STAR are loaded beyond their design capacity. Draft Revision 8 of SAR Table 1.2.1 and other affected SAR sections will be provided to the NRC by **February 3, 1999.**

A.1.5 In Table 1.3.3, specify the surface preservative to be authorized for use as a corrosion *inhibitor between the overpack intermediate shells.*

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.1.6 On SAR page 1.2-20, the description of the mesh size for the screen in the Damaged Fuel Container is inconsistent with the Bill-of-Material.

Commitment

The SAR text will be revised to match the Bill-of-Material. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.1.7 Drawing 1765, Sheet 6 shows the nominal impact limiter crush strengths. Holtec needs to ensure the nominal crush strength, including tolerances does not cause make the impact limiter crush strength to exceed the values used in the ¼ scale drop tests.

Commitment

Nominal values of impact limiter crush strength (F_c) will be specified in Drawing 1765 such that the range of F_c (sum of nominal plus tolerance) will not exceed the actual

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values of F_c used in the ¼ scale drop tests. Draft Revision 8 SAR pages and draft drawings changes will be submitted to the NRC by **February 3, 1999.**

A.1.8 On SAR page 1.3-1, the MPC lid-to-shell weld inspection specifies that sufficient intermediate layers are to be inspected by liquid penetrant (PT) examination to detect critical weld flaws. Specify the critical weld flaw size and the required number of weld passes to be inspected by the PT method.

Commitment

See the commitment under item A.2.6.

Chapter 2 – Structural Evaluation

A.2.1 Some allowable stresses in SAR Tables 2.1.3, 2.1.11, and 2.1.12 exceed the ultimate stresses for the materials. The SAR needs to be reviewed and revised where appropriate to ensure the stress criteria of Regulatory Guide (RG) 7.6 are met and all loading combinations of RG 7.8 have been considered.

Commitment

The SAR tables were reviewed with the NRC reviewer at the January 13, 1999 meeting and all stresses were found to be below the ultimate stresses for the material. No further action is required. Chapter 2 of the SAR will be reviewed against RG 7.6 and 7.8 to ensure the appropriate stress limits and loading combinations have been used in the HI-STAR 100 structural analyses. The revised SAR will make explicit commitments to Reg. Guide 7.6 for the containment boundary and document compliance with the stress limits and brittle fracture criteria therein. The adherence of the SAR to Reg. Guide 7.8 load combinations will be documented in the revised SAR with sufficient explanatory material to demonstrate explicit compliance. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.2 The outer two shells of the HI-STAR 100 overpack provide protection for the containment boundary. As such, these two shells should meet the criteria of ASME, Section III, Subsection NF, Class 1 rather than Class 3.

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Commitment

The two outermost intermediate shells (which are welded with single bevel full penetration weld), shall meet the stress intensity limits and brittle fracture criteria for Section III, Subsection NF, Class 1 plate and shell structures. Affected pages of the SAR will be revised. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.3 Figure 2.1.10 does not contain sufficient information describing how the loads are applied for the CG-over-corner drop analysis. Details are needed on loads, load application, and resultant stresses for the HI-STAR 100 structural components. (MPC shell and baseplate and the overpack forgings, endplates, bolts, etc).

Commitment

A complete stress analysis of the HI-STAR 100 overpack under the C.G.-Over-Corner drop scenario will be presented in the SAR. The maximum values of primary, membrane, local membrane, and primary bending stress intensities in the overpack will be summarized in the SAR. The axial stress in the lid bolts will be shown to remain below the bolt material's nominal yield strength. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.4 More information is required on the applied load distributions for side drop analyses.

Commitment

The presentation of the result of the side drop analyses in the SAR will be reviewed and changes made where necessary to add additional information. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

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A.2.5 The justification for not analyzing the oblique drop is inadequate.

Commitment

The value of the peak deceleration (a_{max}) as a function of the oblique drop angle will be computed at 15° intervals up to the C.G.-Over-Corner orientation. The maximum predicted value of the a_{max} from the parametric study shall be used in the stress analysis of item A.2.3 above to bound all oblique drop scenarios. Draft Revision 8 SAR pages will be submitted to the NRC by **February 5, 1999.**

A.2.6 Figures 2.H.5.14 through 2.H.5.21 in Appendix 2.H showing the drop test data are not in the appropriate time scale to show the data necessary for evaluating the drop test. The time scale should be of shorter duration.

Commitment

Acceleration test data shall be re-plotted to improve its readability during the time when the impact load is maximum (before its sharp attenuation). Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.7 The actual location of the accelerometer placement on the overpack ¼ scale model needs to be provided. The filtered data should be superimposed over the unfiltered data.

Commitment

The precise locations of accelerometers will be shown in Appendix 2.H of the SAR. The filtered and unfiltered data will be superimposed on the same plot. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.8 The sensitivity of the test data to filter frequency should be determined for the end drop. A minimum filter frequency of 500 Hz or the preferred filter of 550 Hz should be used.

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Commitment

Filtering will be performed at 550 Hz for the case of the end drop to evaluate the sensitivity of the predicted peak acceleration to the filter frequency. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

A.2.9 The critical flaw size for the MPC lid-to-shell weld must be defined. A fracture mechanics analysis would be acceptable.

Commitment

A computation for the acceptable crack flaw size in the MPC lid weld will be prepared which determines the critical flaw size and number of passes for the multi-layer PT examination of the weld. A telephone call with the reviewer will be required to discuss the approach to such an analysis considering the material under consideration is stainless steel. The calculation and appropriate draft revisions to the SAR text will be submitted to the NRC by **February 10, 1999.**

A.2.10 The thermal stresses for a transient condition where a cask at steady state conditions is moved to a relatively cold ambient location should be analyzed.

Commitment

An integrity evaluation of the containment boundary under the postulate of a sudden drop in the ambient temperature (e.g., from 100°F to -40°F in one hour) will be performed. The thermal stresses in the containment boundary will be shown to not exceed Level A service limits for Section III Class 1 components. Appropriate revisions to the SAR text will be submitted to the NRC by **February 10, 1999.**

Chapter 3 – Thermal Evaluation

A.3.1 In a fire accident, the Holtite-A will overheat. The offgassing created by the overheating of the neutron shield material needs to be addressed. (This may affect the structural chapter also).

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Commitment

The HI-STAR 100 overpack is equipped with two rupture disks to relieve any internal pressure above the set limit. The text of SAR Chapters 2 and 3 will be revised to address this issue. Draft Revision 8 SAR pages will be submitted to the NRC by **February 8, 1999.**

A.3.2 Provide a summary of cask hot normal transportation condition temperatures after eliminatıng credit for the "Rayleigh Effect" (Nussault Number) in the MPC basket periphery.

Commitment

The analysis will be performed as requested and the results provided to the NRC in a comment resolution letter by **February 8, 1999.**

A.3.3 Provide clarification in the SAR as to the fraction of heat transmitted from the overpack through the top and bottom.

Commitment

The HI-STAR 100 thermal model takes no credit for heat transfer through the overpack impact limiters. The SAR text will be reviewed and clarification provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 8, 1999.**

A.3.4 What is the maximum temperature of the accessible surfaces of the casks? 10CFR71.43(g) requires the maximum temperature at all accessible surfaces of the package to be less than 185° F.

Commitment

Access to the sides of the HI-STAR 100 overpack is restricted through the use of a personnel barrier. Access is possible to the impact limiters at the top and bottom of the cask. A specific analysis will be run to determine the impact limiter surface temperature by allowing heat transfer through the top and bottom of the cask. The text of the SAR

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will be revised to include this information. Draft Revision 8 SAR pages will be submitted to the NRC by **February 8, 1999.**

A.3.5 EPRI Report TR-106440 should be used for the short term fuel cladding temperature limit for stainless steel clad fuel as the basis.

Commitment

SAR Chapters 2 and 3 will be changed to incorporate this reference and the new temperature limit. Draft Revision 8 SAR pages will be submitted to the NRC by **February 8, 1999.**

A.3.6 The pressure value tables need to be revised to include the average bulk gas temperatures used in the pressure calculation.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

Chapter 4 – Containment

A.4.1 The SAR text references the 1987 edition of ANSI N 14.5. This should be the 1997 edition.

Commitment

The 1997 edition was used. Draft Revision 8 of the HI-STAR SAR pages are provided in Attachment 2 to this letter.

A.4.2 In section 4.1.5, the description of fuel debris should be revised to match that used in the HI-STAR 100 storage Technical Specifications.

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Commitment

The SAR will be revised to be consistent with the HI-STAR 100 storage Technical Specifications. Draft Revision 8 SAR pages are provided in Attachment 2 to this letter.

A.4.3 On SAR page 4.1-5, the description of the mesh size for the screen in the Damaged Fuel Container is inconsistent with the Bill-of-Material.

Commitment

The SAR text will be revised to match the Bill-of-Material. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

Chapter 5 – Shielding Evaluation

A.5.1 Provide the coordinates and dimensions of the dose point locations depicted in Figures 5.1.1 and 5.1.2.

Commitment

The coordinates and dimensions of the dose point locations for the shielding model used in SAR Chapter 5 are provided in Attachment 1 to this letter.

A.5.2 Provide a calculation showing the azimuthal variation in dose rate around the circumference of the cask on contact and at 2 meters to account for the fact that the fuel basket is not cylindrical.

Commitment

The calculation will be provided to the NRC by **close of business January 20, 1999.** Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

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A.5.3 Demonstrate that gamma source term energies outside of the range of 0.7 to 3.0 MeV do not add a significant contribution to the total dose rate. Address the full range of cooling times.

Commitment

The calculation will be provided to the NRC by **close of business January 20, 1999**. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999**.

A.5.4 Provide dose rate values for 11, 13, and 14 years cooling time in Chapter 5 for the MPC-24 and MPC-68.

Commitment

Chapter 5 will be revised to add dose rates for the additional cooling times shown in SAR Chapter 1 for the MPC-24 and MPC-68. Draft Revision 8 SAR pages will be submitted to the NRC by **January 27, 1999**.

A.5.5 Describe how the impact limiters were modeled in the shielding analyses. The text on the top of SAR page 5.3-1 appears to conflict with the text on page 5.3-2.

Commitment

The SAR text will be clarified to accurately describe the modeling of the impact limiters for both normal and accident conditions. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999**.

A.5.6 It is not clear from SAR Figure 5.3.10 and the text of Section 5.3 which types of steel make up which portions of the model.

Commitment

The figure and text will be reviewed and clarified as necessary to clearly describe the steel types assumed in the model. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999**.

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A.5.7 The dose rate at the pocket trunnions in Table 5.4.15 is above 10 mrem/hr.

Commitment

The dose rate at this point will be re-analyzed. The modeling assumptions will be discussed with the NRC reviewer before the analysis is performed. A proposed refinement in the calculations will be provided in a Comment Resolution Letter by **January 20, 1999**. A conference call will be held to discuss this issue with the reviewer by **January 21, 1999.** Upon agreement on the assumptions from the conference call, the calculation will be performed and the results transmitted to the NRC by **January 25, 1999.** Draft Revision 8 SAR pages will be submitted to the NRC **February 3, 1999.**

A.5.8 Provide a discussion of the dose rate gradient an the surface of the overpack at dose location 3.

Commitment

The discussion will be provided in a Comment Resolution Letter by **January 20, 1999.** A conference call will be held to discuss this issue with the reviewer by **January 21, 1999.** Changes to the SAR, if necessary will be provided by **February 3, 1999.**

Chapter 6 – Criticality Evaluation

A.6.1 SAR Section 6.1 needs to clearly summarize the maximum k_{eff} considering all biases and uncertainties from the calculations used to demonstrate compliance with Part 71 (71.55(b), (d), and (e) and 71.59(a).1 and (a).2). Refer to NUREG 1617, Section 6.5.1.3.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **January 27, 1999.**

A.6.2 The single package evaluation in SAR section 6.4.2.1.1 needs to be revised to show a single package is subcritical when the 2 ½ in inner shell is closely and fully reflected by

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water or justify that the reflection provided by the surrounding 6 inches of steel is greater than or equivalent to water.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **January 27, 1999.**

A.6.3 Remove the suggestion in SAR page 6.1-5 that flooding or reflection with unborated water is a conservatism.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **January 27, 1999.**

Chapter 7 – Operating Procedures

A.7.1 The operating procedures don't appear to address the items required to be verified per 10CFR71.87 prior to shipment. In particular, 10CFR71.87(g) requires verification that the neutron absorber is present and in proper condition. Note that both immediate shipment and shipment after some time in storage need to be addressed with unique requirements for shipment after storage clearly described.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 5, 1999.**

A.7.2 There is no recognition in the operating procedures that the package may be shipped after some time in storage. Consider what extra steps are needed if shipping takes place after the package is in storage for some period of time (e.g., leakage testing requirements for the MPC-68F)

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Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 5, 1999.**

A.7.3 Step 25.k of the operating procedures needs to specify the minimum number of multi-layer PT exams required based on the minimum flaw size calculated.

Commitment

The requested information will be provided based on the results of item A.2.6 above. Draft Revision 8 SAR pages will be submitted to the NRC by **February 10, 1999.**

A.7.4 The warning at step 12 in Section 7.1.5 needs to be clarified to address the maximum trunnion loading issue (see item A.1.4).

Commitment

The operating procedures will be revised appropriately to address this issue based on the response to item A.1.4. Draft Revision 8 SAR pages will be submitted to the NRC by **February 5, 1999.**

A.7.5 Step 26.k in the operating procedures should be revised to include PT as an additional test to be re-performed after a weld is repaired.

Commitment

The requested information will be provided. Draft Revision 8 SAR pages will be submitted to the NRC by **February 5, 1999.**

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Chapter 8 – Acceptance Criteria and Maintenance Program

A.8.1 Section 8.1.1.1, item 3 needs to specify the critical flaw size.

Commitment

The requested information will be provided based on the results of item A.2.6 above. Draft Revision 8 SAR pages will be submitted to the NRC by **February 10, 1999.**

A.8.2 The text of Section 8.1.2.1 may be affected by the resolution of the trunnion loading issue (item A.1.4).

Commitment

The Chapter 8 SAR text will be revised as necessary to address this issue based on the response to item A.1.4. If revisions are necessary, draft Revision 8 SAR pages, will be submitted to the NRC by **February 3, 1999.**

A.8.3 Table 8.1.3 may need revision to specify the number of intermediate PTs required for the multi-layer PT examinations.

Response

Table 8.3.1 is a summary of the required NDE inspections showing the applicable Code requirements. A more appropriate location for this information is Section 8.1.1.1, item 3. The affected text will be revised based on the results of item A.2.6. Draft Revision 8 SAR pages will be submitted to the NRC by **February 10, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

ORIGINAL SIGNED BY BG

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

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Document I.D.: 5014251

Attachments: 1. Coordinates and dimensions of dose point locations.

2. Draft SAR Revision 8 pages 4.1-4, 4.1-5, 4.2-15, and 4.4-1

Approvals:

Brian Gutherman
Licensing Manager

K P Singh
K. P. Singh, Ph.D.
President and CEO

Technical Concurrence:

Dr. Everett Redmond (Shielding)

Dr. John Wagner (Criticality)

Mr. Stephen Agace (Operations)

Dr. Alan Soler (Structural Analysis) — Alan Soler

Dr. Indresh Rampall (Thermal Analysis) — Indresh Rampall

Ms. Joy Russell (Containment) — Brian Gutherman for Joy Russell

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BY FAX AND FEDEX

January 16, 1999

Mr. Mark S. Delligatti
Senior Project Manager
Spent Fuel Licensing Section, SFPO, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter A (errata)

References: 1. Holtec Project No. 5014

2. Letter, B. Gilligan, Holtec to M. Delligatti, NRC, dated January 15, 1999, Document ID 5014251

Dear Mr. Delligatti,

Upon reviewing the above-referenced letter to the NRC regarding HI-STAR 100 commitments, we have discovered an editorial error for which a correction is provided here. Commitments A.7.3, A.8.1, and A.8.3 cross-reference an incorrect commitment number from Chapter 2. Each of these commitments should cross-reference Commitment A.2.9, not A.2.6. Attached are markups of the affected pages from the Reference 2 letter showing the correct cross-reference. We regret any inconvenience this error may have caused.

If you have any questions or comments, please contact us.

Sincerely,

Brian Gutherman
Licensing Manager

cc: B. Gilligan
S. Agace

Document I.D.: 5014252

Attachment: Corrected pages from Holtec Letter of January 15, 1999 (Document ID 5014251)

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January 20, 1999

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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter B

References:
1. Holtec Project No. 5014
2. Comment Resolution Letter A from Holtec to NRC dated January 15, 1999
3. Errata to Comment Resolution Letter A, dated January 16, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide information in accordance with commitments A.2.9, A.5.2, A.5.3, A.5.7, and A.5.8 cited in Comment Resolution Letter (CRL) A (Reference 2). In addition, this CRL documents additional questions and commitments recently discussed with the Spent Fuel Project Office staff.

Commitment A.2.9

A position paper describing the proposed Holtec methodology for determining the critical weld flaw size in the MPC lid-to-shell weld and the results are provided as Attachment 1 to this letter.

Commitment A.5.2

The calculation of the azimuthal variation in dose rate is provided in Attachment 2 to this letter.

Commitment A.5.3

The evaluation of gamma source energies outside the range of 0.7 MeV to 3.0 MeV is provided in Attachment 2 to this letter.

Commitment A.5.7

A description of the proposed refinement of the calculation of the dose rate at the pocket trunnions is provided in Attachment 2 to this letter.

Commitment A.5.8

A discussion of the dose rate gradient at the surface of the overpack at dose location 3 is provided in Attachment 2 to this letter.

As requested in our Reference 2 letter, Holtec wishes to discuss the shielding information provided herein with the SFPO staff reviewer before completing the resolution of these comments. A conference call as soon as possible would be appreciated.

NEW ITEMS

General: In the Reference 3 letter, three examples of an incorrect cross-reference in the Reference 2 letter were identified. Upon further review, one additional example of the same erroneous cross-reference was discovered. Commitment A.1.8 incorrectly references Commitment A.2.6. This cross-reference should be A.2.9.

B.1.1 The footnote marker in the "BWR" column, "Design Temperature" row of Table 1.2.3 should be a double dagger, not a triple dagger.

Commitment

This item will be corrected and submitted with Revision 8 of the SAR to be submitted to the NRC by February 22, 1999.

B.2.1 Provide additional information in the Safety Analysis report (SAR) to verify compliance with 10CFR71.45(a) and 10CFR71.45(b)(3) regarding the design of lifting attachments and tie-down devices under excessive loads.

Commitment

Additional information will be added to the SAR to demonstrate compliance with the cited regulations. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

B.2.1 Provide additional information in the SAR Section 2.5.2.7.3 to clarify the loading, boundary conditions, and stress distribution for the pocket trunnion recess (refer to drawing 1399, Sheet 3)

Commitment

Additional information will be added to the SAR to clarify the information as requested. Draft Revision 8 SAR pages will be submitted to the NRC by **February 3, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014253

Attachments: 1. Holtec International Proprietary Position Paper DS-213, "Acceptable Flaw Size in MPC Lid-to-Shell Welds".

2. Shielding Information Related to Commitments A.5.2, A.5.3, A.5.7, and A.5.8

3. Affidavit Pursuant to 10CFR2.790

Approvals:

FOR BRIAN GUTHERMAN
Brian Gutherman
Licensing Manager

K. P. Singh, Ph.D.
President and CEO

Technical Concurrence:

Dr. Everett Redmond (Shielding)

Dr. Alan Soler (Structural Analysis)

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BY FAX AND OVERNIGHT MAIL

January 22, 1999

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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter C

References: 1. Holtec Project No. 5014

2. Phone Calls Between SFPO Staff and Holtec, held January 21 and 22, 1999

3. Comment Resolution Letter A, dated January 15, 1999

4. Comment Resolution Letter B, dated January 16, 1999

Dear Mr. Delligatti,

The purpose of this letter is to document questions from the Spent Fuel Project Office staff regarding the Holtec HI-STAR 100 System Safety Analysis Report (SAR) and Holtec's commitments to respond to those questions. These questions were received over the course of several telephone calls held January 21 and 22, 1999. **The submittal dates for Commitment C.5.3 in this letter supersede the draft SAR page submittal dates for Commitments A.5.2 through A.5.8 made in Comment Resolution Letter A (Ref. 3).** We are also providing an editorial correction to Comment Resolution Letter B (Ref. 4).

C.3.6 The bulk gas temperatures for the pressure values to be provided under commitment A.3.6 need to be submitted by February 1, 1999.

Commitment

The draft Revision 8 SAR pages will be provided by **February 1, 1999**

C.5.1 The staff requested verification that in Table 5.4.15 the dose rate at two meters for the neutron shield and the channel were the same.

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Response

The dose rates shown in Table 5.4.15 at two meters for the neutron shield and the channel are the same. No further action is required.

C.5.2 The staff requested that Inconel grid spacers be included in the dose rate assessment. Justification for the cobalt impurity level assumed in the Inconel grid spacers must be provided. A value of 4700 ppm is acceptable based on DOE data, or another value may be used with adequate supporting justification.

Commitment

Holtec will provide the NRC with its proposed cobalt impurity level in Inconel grid spacers via telephone call at 10:00 AM on **January 26, 1999** with a confirming letter to follow.

C.5.3 The staff requested that minimum enrichments be specified in the CoC.

Commitment

Holtec will provide minimum enrichments, burnups, and cooling times used in the shielding analyses via draft Revision 8 SAR pages by **noon January 29, 1999**. Draft Revision 8 SAR pages showing dose rates at all dose locations for all burnups and cooling times from SAR Chapter 1 will be provided to the NRC by **February 8, 1999**. SAR Tables 5.5.1 and 5.5.3 will include peak dose rates. The balance of the dose rate tables will present average dose rates. Draft Revision 8 SAR text pages reflecting these changes and those listed below will be provided by **February 10, 1999**.

- Azimuthal variation of dose rate around the circumference of the cask (Commitment A.5.2)
- Source strength data (Commitment A.5.3)
- Description of how the impact limiters were modeled in the normal and hypothetical accident condition shielding analyses (Commitment A.5.5)
- Description of steel types used in the shielding model (Commitment A.5.6)

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- Dose rates at the pocket trunnions (Commitment A.5.7)
- Discussion of the dose rate gradient at dose location 3 (Commitment A.5.8)
- Location of the hypothetical accident two-meter dose location

Correction

Commitment B.2.1 is listed twice in Comment Resolution Letter B (Ref. 4). The second B.2.1 should be B.2.2.

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing
Document I.D.: 5014254

Approvals:

Brian Gutherman
Licensing Manager

K. P. Singh, Ph.D.
President and CEO

Technical Concurrence:

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Dr. Indresh Rampall (Thermal Evaluation)

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January 27, 1999

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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter D

References:
1. Holtec Project No. 5014
2. Phone Calls Between SFPO Staff and Holtec, held January 26 and 27, 1999
3. Holtec Comment Resolution Letter "A", B. Gilligan to NRC, M. Delligatti, dated January 15, 1999
4. Holtec Comment Resolution Letter "B", B. Gilligan to NRC, M. Delligatti, dated January 22, 1999
5. Holtec Comment Resolution Letter "C", B. Gilligan to NRC, M. Delligatti, dated January 22, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide information in accordance with previous commitments to the Spent Fuel Project Office staff regarding the Holtec HI-STAR 100 System Safety Analysis Report (SAR). Where draft Revision 8 SAR pages are provided, the commitment number to which they apply is noted on the top of each page. In addition, new questions and commitments arising from telephone calls held January 26 and 27, 1999 are provided. Please refer to Comment Resolution Letters (CRL) A, B, and C (Refs 3 – 5) for the detailed description of each question and commitment statement for which the responses are provided below. This letter meets commitment C.5.2 of CRL "C" (Ref. 5). Note that Commitment D.5.1 modifies one commitment date for Commitment C.5.3 based on discussions with the SFPO staff and NRC Project Manager.

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<u>Commitment A.2.1</u>

Enclosed please find draft Revision 8 of SAR Section 2.1.2 which has been revised to clarify stress limits and load combinations as a result of our review of Regulatory Guides 7.6 and 7.8

<u>Commitments A.2.6, A.2.7, and A.2.8</u>

Enclosed please find draft Revision 8 of SAR pages 2.H-14 through 2.H-18 and Figures 2.H.5.14 through 2.H.5.21A which discuss and depict the cask drop test data, respectively. Rather than revise the previous figures, new Figures 2.H.5.15A, 15B, 15C, 17A, 19A, and 21A were developed to address the issues which are the subjects of these commitments. The entire series of figures is enclosed for continuity.

<u>Commitment B.2.1</u>

Enclosed please find draft Revision 8 of SAR Section 2.5.3 and Appendix 2.B which address compliance with 10CFR71.45(a) and 10CFR71.45(b)(3) regarding the design of lifting attachments and tie down devices under excessive loads.

<u>Commitment B.2.2</u>

Enclosed please find the following draft Revision 8 of SAR documents which clarify the loading, boundary conditions, and stress distributions for the pocket trunnion recess:

- Revised SAR Section 2.5.2.7
- Revised SAR Section 2.5.2.7.3
- New SAR Section 2.5.2.7.4
- New Figures 2.5.10 and 2.5.11
- New Appendix 2.AN

<u>Commitment A.3.6</u>

Enclosed please find draft Revision 8 of SAR Table 3.4.15 which provides the MPC cavity bulk gas temperatures added to compliment the temperature data previously presented in the table.

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<u>Commitment A.4.3</u>

Enclosed please find draft Revision 8 of SAR page 4.1-5 which clarifies the description of the screen mesh for the Damaged Fuel Container.

<u>Commitment A.6.1</u>

Enclosed please find draft Revision 8 of SAR pages 6.1-6, 6.1-11, and 6.4-4 which summarize the maximum k_{eff} considering all biases and uncertainties from the calculations to demonstrate compliance with 10CFR71.55 and 71.59.

<u>Commitment A.6.2</u>

Enclosed please find draft Revision 8 of SAR pages 6.4-3 and 6.4-17 which discuss the criticality evaluation considering water surrounding the containment boundary of the cask.

<u>Commitment A.6.3</u>

Enclosed please find draft Revision 8 of SAR pages 6.1-4, 6.1-5, 6.4-2, and 6.4-6 which have been revised to remove the assertion that flooding or reflection with unborated water is a conservatism.

NEW ITEMS

D.5.1: The use of a cobalt-59 impurity level less than 4700 ppm in Inconel grid spacers must be justified or the value of 4700 ppm must be used. Alternatives include a condition of the Certificate of Compliance to require users to verify that the cobalt impurity level in their fuel is less than that assumed in the analysis prior to loading fuel, or two sets of analyses can be presented for fuel with, and without Inconel grid spacers, respectively.

<u>Commitment</u>

A cobalt-59 impurity level of 4700 ppm will be used as a bounding case for modeling Inconel grid spacers in the shielding analysis. Holtec is currently considering the feasibility of providing two sets of shielding data for fuel assemblies with and without

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Inconel grid spacers. Minimum enrichments, burnups, and cooling times used in the BWR shielding analyses will be submitted to the NRC by **noon January 29, 1999.**

Minimum enrichments, burnups, and cooling times used in the PWR shielding analyses will be submitted to the NRC, and Holtec will inform the NRC of its decision on whether to pursue two sets of shielding analyses by the close of business **February 2, 1999.** If we proceed with the second set of shielding analyses for fuel without Inconel grid spacers, minimum enrichments, burnups, and cooling times used in those PWR shielding analyses will be submitted to the NRC by **noon February 5, 1999.** Other commitment dates for Commitment C.5.3 remain the same.

D.5.2: Clarify SAR Section 5.2.3 regarding the distribution of uranium mass over the 144-in assumed active fuel length.

Commitment

SAR Section 5.2.3 will be revised to clarify this information. Draft Revision 8 of SAR pages reflecting these changes will be submitted by **February 10, 1999.**

D.5.3: For the stainless steel fuel, provide dose rates at dose locations other than dose point 2.

Commitment

Dose rates at additional dose point locations will be provided in a Comment Resolution Letter by **February 8, 1999.** Draft Revision 8 of SAR pages reflecting these changes will be submitted by **February 10, 1999.**

D.5.4: Revise Figure 5.3.10 or add a new figure to provide the dimensions of the impact limiter modeled in the shielding analysis.

Commitment

The dimensions will be provided in a Comment Resolution Letter by **noon January 28, 1999.** Final SAR Revision 8, to be submitted by **February 22, 1999** will incorporate these changes.

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D.5.5: The fuel mixtures on page 5.C-20 (MCNP input data) are different than the data in Table 5.3.2.

Commitment

The table is incorrect. A corrected draft Revision 8 of SAR Table 5.3.2 will be submitted to the NRC by **February 10, 1999.**

D.7.1: Revise SAR Section 7.3 to refer to 49CFR173.428 instead of §173.443

Commitment

The affected SAR pages will be revised and submitted to the NRC with Revision 8 of the SAR by **February 22, 1999.**

D.8.1: The shielding effectiveness test described in SAR Section 8.1.5.2, which is taken from the HI-STAR 100 storage TSAR may not be comprehensive enough for a transportation package. Because the regulations impose dose rate limits "at any point on the package", taking measurements at twelve locations around the circumference may not be adequate. Other applications have been approved with license conditions for shielding tests performed in 6" X 6" test grids.

Commitment

Holtec will research other Certificates of Compliance for this information. The NRC reviewer will discuss this issue with management and advise Holtec. If more stringent shielding test requirements are necessary, Holtec will submit draft revised Revision 8 SAR pages to the NRC by **February 10, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing
Document I.D.: 5014255

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K. P. Singh /mp

K. P. Singh, Ph.D.
President and CEO

Enclosures: As Stated

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Dr. Indresh Rampall (Thermal Evaluation)	for Dr. Indresh Rampall
Ms. Joy Russell (Containment Evaluation)	for Joy Russell
Dr. John Wagner (Criticality Evaluation)	
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ENCLOSURES TO DOCUMENT 5014255

DRAFT REVISION 8 SAR PAGES

62 PAGES TOTAL

C

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January 28, 1999

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter E

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter D, dated January 27, 1999

Dear Mr. Delligatti,

Attached please find three pages showing the dimensions of the HI-STAR 100 System impact limiter as modeled in the shielding analysis. This information is provided in accordance with Commitment D.5.4. Figure 5.3.10 will be revised to include this information in Revision 8 of the HI-STAR 100 System Safety Analysis Report to be submitted to the NRC by February 22, 1999. If you have any questions or comments, please contact us.

Sincerely,

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Document I.D.: 5014256
Attachment: As Stated

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter F

References:
1. Holtec Project No. 5014
2. Comment Resolution Letter C, dated January 22, 1999
3. Comment Resolution Letter D, dated January 27, 1999

Dear Mr. Delligatti,

The Boiling Water Reactor (BWR) minimum enrichments, burnups, and cooling times used in the HI-STAR 100 System shielding analysis are provided in the table below. These enrichment, burnup, and cooling time combinations are applicable to all BWR assembly classes with the exception of LaCrosse, Dresden 1 6x6, and Humboldt Bay 6x6 assembly classes. This information is provided in accordance with Commitment C.5.3 (Ref. 2) as modified by Commitment D.5.1 (Ref. 3). This information will be included in Revision 8 of the HI-STAR 100 System Safety Analysis Report to be submitted to the NRC by February 22, 1999.

BWR Enrichment, Burnup, and Cooling Times

Minimum Enrichment (wt% U-235)	Maximum Burnup (MWD/MTU)	Minimum Cooling Time (years)
2.1	24,500	8
2.4	29,500	9
2.6	34,500	12
2.9	39,500*	15

* The maximum allowed burnup for this enrichment in SAR Chapter 1 will be specified slightly lower based on decay heat considerations.

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February 1, 1999

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter G

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter A, dated January 15, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide the NRC with information in accordance with Holtec International's Commitment A.1.1 from Comment Resolution Letter "A" (Ref. 2). Attached please find draft Revision 8 HI-STAR 100 Safety Analysis Report (SAR) pages 1.2-34 through 1.2-40. These changes have been made to align the fuel description in SAR Chapter 1 with the descriptions in the Technical Specifications contained in the proposed Certificate of Compliance for HI-STAR 100 storage, currently in proposed rulemaking. In addition, generic note 1 for these tables has been modified based on feedback from the Holtec Users' Group to provide clarification for implementation. With the NRC's concurrence, Holtec will propose the same change for the HI-STAR 100 storage application through the public comment process.

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014259

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February 2, 1999

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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter H

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter A, dated January 15, 1999

3. Comment Resolution Letter B, dated January 20, 1999

4. Comment Resolution Letter D, dated January 27, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide information to the NRC in accordance with prior commitments made by Holtec International regarding the Spent Fuel Project Office's (SFPO) ongoing review of our HI-STAR 100 System under 10CFR71. In addition, one new item resulting from a conversation held between Holtec and the SFPO staff today is included.

Commitment A.2.9

The following update to Commitment A.2.9 is applicable. Holtec's Position Paper D-213 regarding critical weld flaw size in the MPC lid-to-shell weld, submitted to the NRC in Comment Resolution Letter B (Ref. 3), was discussed with the SFPO staff reviewers. The staff asked Holtec for information to supplement the linear fracture mechanics evaluation presented in the position paper with an analysis methodology similar to the one used in the NEI document dated October 20, 1998. Additionally, a specific dimension for, and number of liquid penetrant examinations (i.e., root, final, and intermediate weld layers) needs to be included in the conclusions of the position paper. Appropriate editorial changes to the SAR need to be made.

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Position Paper DS-213 will be revised to consider the methodology outlined in the NEI position paper and submitted to the NRC by **February 8, 1999**. As advised by the SFPO staff, draft revised SAR pages are not necessary to resolve this issue and will not be submitted per Commitments A.1.8, A.2.9, A.7.3, A.8.1, and A.8.3 (Ref. 2). Instead, affected SAR pages will be revised and submitted with Revision 8 of the SAR by **February 22, 1999.**

Commitment D.5.1

The Pressurized Water Reactor (PWR) minimum enrichments, burnups, and cooling times used in the HI-STAR 100 System shielding analysis are provided in the table below. These enrichment, burnup, and cooling time combinations are applicable to all PWR assembly classes with the exception of Haddam Neck and San Onofre 1 assembly classes. This information satisfies Commitment D.5.1 (Ref. 4).

PWR Enrichment, Burnup, and Cooling Times for Fuel with Inconel Grid Spacers in the Active Fuel Region

Minimum Enrichment (wt% U-235)	Maximum Burnup (MWD/MTU)	Minimum Cooling Time (years)
2.3	24,500	10
2.6	29,500	12
2.9	34,500	14
3.2	37,500	15

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PWR Enrichment, Burnup, and Cooling Times for Fuel with Zircaloy Grid Spacers in the Active Fuel Region

Minimum Enrichment (wt% U-235)	Maximum Burnup (MWD/MTU)	Minimum Cooling Time (years)
2.3	24,500	7
2.6	29,500	8
2.9	34,500	10
3.2	39,500	12
3.4	44,500*	15

* The maximum allowed burnup for this enrichment in SAR Chapter 1 will be specified slightly lower based on decay heat considerations.

NEW ITEM

H.5.1: SAR Figure 5.3.10 shows a length of 170.125 inches for the vertical dimension of the outside of the enclosure shell housing the neutron shield. The design drawings show 173.125 for the same dimension. The 170.125 inch length appears to be the height of the neutron shield, excluding the thermal expansion foam. Where do the design drawings show the thermal expansion foam material dimension? Please clarify.

Commitment

The vertical dimension of the outside of the enclosure shell housing the neutron shield is 173.125 inches per Design Drawing 1397, Sheet 1. The top and bottom plates (enclosure shell returns, BOM item 17) are one half inch thick and the thermal expansion foam depth is two inches. This creates the three inch difference between the outside dimension of the enclosure shell and the neutron shield material vertical height. The 2-inch depth of foam material is shown on Design Drawing 1398, Sheet 2 at Section D-D. The editorial change to SAR Figure 5.3.10 will be made and submitted with Revision 8 of the SAR by February 22, 1999.

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If you have any questions or comments, please contact us.

Sincerely,

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Document I.D.: 5014260

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February 3, 1999

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter I

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter A, dated January 15, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide on-time responses per our undertaking in Comment Resolution Letter A (Ref. 2) to the Spent Fuel Project Office (SFPO) in support of the ongoing review of our HI-STAR 100 System under 10CFR71. In addition, one new item resulting from a conversation held between Holtec and the SFPO staff today is included.

Commitment A.1.4

Draft Revision 8 Safety Analysis Report (SAR) Tables 1.2.1 and 2.2.3 are provided as Attachment 1 to this letter. These changes demonstrate that the maximum weight *applied to the trunnions* is less than 250,000 lbs. Previously, in addition to the weight of the lift yoke (3,600 lbs.) being included in the maximum lifted weight on crane hook over fuel pool, the MPC weight used was that of the MPC-32 (89,057 lbs.) which bounds the weight of the MPC-24 and MPC-68. Since the MPC-32 has been removed from the application, the weight has been revised to reflect the heaviest MPC in the SAR which is the MPC-68 at 87,241 lbs. The resulting weight on the trunnions is 249,460 as shown on the revised Tables 1.2.1 and 2.2.3.

The total lifted weight *on the crane hook* over the fuel pool is 253,060 lbs. This weight is clearly specified in Tables 1.2.1 and 2.2.3. In SAR Chapter 7, Section 7.1.5, Step 13, a warning is given to alert the user that the weight of the system being removed from the fuel pool may exceed 250,000 lbs and that users may elect to pump a measured quantity of water from the MPC prior to removal from the fuel pool. The warning also refers to Tables 7.1.1 and 7.1.2 where the weights are described for the various components in each major operations sequence. Draft

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Revision 8 SAR Tables 7.1.1 and 7.1.2 are also provided in Attachment 1 to this letter to correspond with the Table 1.2.1 and 2.3.3 revisions.

<u>Commitment A.1.5</u>

Draft Revision 8 SAR Table 1.3.3 is provided as Attachment 2 to this letter to specify the surface preservative between to the intermediate shells. The surface preservative is a silicone encapsulant, Dow Corning SYLGARD 567 or equivalent.

<u>Commitment A.1.6</u>

Draft Revision 8 SAR page 1.2-20 is provided as Attachment 3 to this letter to read "250 x 250 fine mesh screens" in lieu of "250 micron fine mesh screens."

<u>Commitment A.1.7</u>

Design Drawing 1765, Sheet 6 specifies the nominal crush strength for the aluminum honeycomb in the impact limiter. SAR Subsection 8.1.4.3 states that the tolerance on the crush strength is ± 7%. The nominal crush strength was specified such that the maximum crush strength (i.e., nominal plus 7%) would be approximately 95% of the crush strength used in the ¼ scale drop tests. Therefore, the nominal crush strength, including tolerances, will not exceed the crush strength values used in the ¼ scale drop tests.

To illustrate this, the following table provides the nominal crush strength specified on Drawing 1765, Sheet 6, the maximum crush strength including tolerances, and the average crush strength used in the ¼ scale drop tests.

Impact Limiter Section Type from Drawing 1765, Sheet 6	Nominal Crush Strength for Full-Scale (psi)	Maximum Crush Strength for Full-Scale (psi)	Average Crush Strength for ¼ Scale Drop Tests (psi)
Section Type 1	1700	1819	1943
Section Type 2	700	749	783
Section Type 3	2300	2461	2583
Section Type 4	1100	1177	1350
Section Type 5	2300	2461	2583

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As depicted above, the maximum crush strength for the full scale impact limiter will not exceed the crush strength used in the ¼ scale drop tests. No changes are necessary to the drawings or SAR as a result of this commitment.

Commitment A.2.2

The outermost two layers of the intermediate shells have been re-classified to meet the stress intensity limits of ASME Section III, Subsection NF, Class 1 in lieu of Class 3. Draft Revision 8 SAR Tables 2.1.5 and 2.1.15 are provided as Attachment 4 to this letter to show the allowable stress intensities for the outermost two intermediate shells under normal conditions. Note that the allowable limits for hypothetical accidents for NF components are the same for both Class 1 and Class 3. Therefore, no change in safety factors occurs for any accident evaluation. Also, draft Revision 8 SAR Table 2.1.23 is provided in Attachment 4 to specify the appropriate Charpy requirements for the outermost two intermediate shells.

Large margins currently exist for the intermediate shells under normal conditions. SAR Section 2.6 is being reviewed and updated to meet other commitments; any page changes required as a result of changing the outermost two intermediate shells to Class 1 from Class 3 will be provided by **February 12, 1999**.

Commitment A.8.2

The calculated maximum weight on the HI-STAR 100 trunnions has been revised per Commitment A.1.4 to be less than 250,000 lbs. Therefore, no changes to SAR Section 8.1.2.1 are required.

NEW ITEM

I.5.1: The NRC staff requested additional clarification be provided in the SAR regarding fuel spacers and the axial position of fuel assemblies. In addition, the staff requested additional discussion on the density of Holtite assumed during normal conditions and the depletion of ^{10}B in the Holtite over the life of the cask.

Commitment

Additional clarification will be added to the SAR as requested. Draft Revision 8 SAR pages will be submitted to the NRC by **February 12, 1999**.

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If you have any questions or comments, please contact us.

Sincerely,

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Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014261

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BY OVERNIGHT MAIL

February 5, 1999

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Senior Project Manager
Spent Fuel Licensing Section, SFPO, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter J

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter A, dated January 15, 1999

3. Comment Resolution Letter C, dated January 22, 1999

4. Comment Resolution Letter I, dated February 3, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide responses per our previous commitments in Comment Resolution Letters A, C and I (Refs. 2, 3, and 4) to the Spent Fuel Project Office (SFPO) in support of the ongoing review of our HI-STAR 100 System under 10CFR71. In addition, new items resulting from a conversation held between Holtec and the SFPO staff on February 4, 1999 are included.

Commitments A.2.3 and A.2.4

Draft Revision 8 SAR Section 2.6 and 2.7 excerpts are provided as Attachment 1 to this letter. These revisions provide an expanded discussion of the finite element models with text and figures in SAR Section 2.6. This revised text serves as a lead-in to the discussion in SAR Section 2.7. In Section 2.7, we are providing an expanded description of the applied loads for the side drop and oblique drop events. Additional figures to compliment the text are provided so that the impact limiter applied and reaction loads are clearly described.

Please note that SAR Revision 7 already includes stress analysis results for the CG-over-corner case. We will expand the discussion (e.g., stress results, safety factors) for specific areas of the overpack in draft Revision 8 SAR pages to be submitted by **February 12, 1999.** We will also provide a complete set of new results for the 30-degree (from horizontal) oblique drop event. As

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demonstrated in the discussion of Commitment A.2.5 below, the 30-degree oblique drop is the worst case. Draft Revision 8 SAR Table 2.1.9 (included in Attachment 1) includes two additional cases covering this new drop condition.

Commitment A.2.5

Revised SAR pages 2.H-23 through 2.H-25 and new Figures 2.H.7.1 through 2.H.7.3 are provided as Attachment 2 to this letter. This information provides a comparison of the deceleration, maximum total crush, and available crush stroke of three variations of an oblique drop of the overpack (30, 45, and 60 degrees from horizontal) to determine the worst case for further stress analysis. The results show the 30-degree drop to be the worst case, warranting a detailed stress analysis.

Commitment C.5.3

Draft Revision 8 Safety Analysis Report pages 5.1-6 through 5.1-14, 5.2-12 through 5.2-14, 5.2-17 through 5.2-22, 5.4-9 through 5.4-20, and 5.4-23 through 5.4-28 are provided as Attachment 3 to this letter. These revisions show the calculated dose rates for the HI-STAR 100 System considering recent revisions made to fuel burnup, cooling time, and source terms in the shielding analyses.

Commitments A.7.1 and A.7.2

SAR Section 7.4 has been revised to address the procedural requirements for preparing the HI-STAR 100 overpack for transport following a period of storage. Draft Revision 8 SAR Section 7.4 is provided as Attachment 4 to this letter. Former SAR Sections 7.4 and 7.5 will be re-numbered to 7.5 and 7.6, respectively as a result of this change. Draft Revision 8 SAR page 8.1-15 is also provided to specifically address the requirement in 10CFR71.87(g) to ensure the neutron absorber is present and in proper condition. The wording used here is similar to that used in a recently approved exemption to the requirements of 10CFR72.124(b) for the HI-STAR 100 storage application to show that this check is not necessary.

Commitment A.7.4

Draft Revision 8 SAR pages 7.1-13 and 7.2-7 are provided as Attachment 5 to this letter. The existing warning has been modified to instruct the users to ensure that plant-specific lifting devices are qualified to lift the expected load. A previous resolution to Commitment A.1.4 (Ref.

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4) established that the maximum calculated weight applied to the trunnions is less than 250,000 lbs.

Commitment A.7.5

Draft Revision 8 SAR page 7.1-19 is provided as Attachment 6 to this letter. Loading operations Step 26.k now requires a liquid penetrant examination after weld repairs.

Commitment A.8.1

Draft Revision 8 SAR pages 8.1-14 and 8.1-23 are provided as Attachment 7 to this letter. New Subsection 8.1.5.2.1, "Pre-Transport Shielding Tests" has been added to address shielding effectiveness testing required to meet 10 CFR 71.47. These tests are to be performed prior to transporting HI-STAR 100 package to confirm the effectiveness of the neutron and gamma shielding.

NEW ITEMS

J.2.1: Perform an analysis to demonstrate that the HI-STAR 100 design basis deceleration of 60 g's for an end drop is within the buckling limit for the fuel rods being licensed for transport. The analysis should demonstrate that the fuel being licensed is bounded by the analysis.

Commitment

Holtec will perform an analysis to define the worst case fuel assembly or assemblies with respect to the buckling limit under an end drop hypothetical accident. Using the worst case assembly or assemblies, analysis will be performed to demonstrate that under the design basis deceleration of 60 g's, the worst case fuel assembly rods will not buckle. Draft Revision 8 SAR pages will be submitted to the NRC by **February 12, 1999.**

J.7.1: On SAR pages 7.1-14 (warning) and 7.1-29 (note), dose rates are specified to verify the correct fuel assemblies have been loaded. These actions may not be appropriate for a transport license.

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Commitment

Holtec will evaluate the validity of these statements for the procedures in the SAR. Changes, if required, will be incorporated into Revision 8 of the SAR to be submitted the NRC by **February 22, 1999.** Please note that the proposed Certificate of Compliance Holtec intends to submit for the HI-STAR 100 Transportation certification will include a requirement that licensee loading procedures include a loading plan and independent verification that only authorized fuel assemblies have been loaded into the MPC in accordance with the CoC.

J.7.2: Revise the operating procedures to include a discussion of the 2 mrem/hr requirement for any normally occupied space (10CFR71.47(b)(4)).

Commitment

Holtec will revise the affected operating procedures and incorporate the changes into Revision 8 of the SAR to be submitted to the NRC by **February 22, 1999.**

J.7.3: SAR page 7.1-30, Step 7.f should be revised to specify that the radiation surveys should check potential streaming paths and areas of higher dose rates.

Commitment

The affected step will be revised and incorporated into Revision 8 of the SAR to be submitted to the NRC by **February 22, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

for Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014262

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Dr. Alan Soler (Structural Evaluation)	
Mr. Steve Agace (Operations)	
Mr. Mark Soler (Acceptance Criteria and Maintenance)	

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BY OVERNIGHT MAIL

February 8, 1999

Mr. Mark S. Delligatti
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U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter K

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter A, dated January 15, 1999

3. Comment Resolution Letter C, dated January 22, 1999

4. Comment Resolution Letter H, dated February 2, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide responses per our previous commitments in Comment Resolution Letters A, C, and H (Refs. 2, 3 and 4) to the Spent Fuel Project Office (SFPO) in support of the ongoing review of our HI-STAR 100 System under 10CFR71.

Commitment A.1.3

To incorporate lessons learned in the prototype fabrication of the HI-STAR 100 overpack and MPC, revisions to the Design Drawings have been made between the HI-STAR 100 Topical Safety Analysis Report (TSAR), Revision 9 and the HI-STAR 100 Safety Analysis Report (SAR), Revision 7. Provided below is a detail description of each of the changes.

Dwg. 1396, Sheet 1 has been revised from Revision 9 to 11 to include the following changes:

- At location E-5, "see note 2 on this sheet" has been added to the inspection criteria of the MPC lid-to-shell weld.

- Note 2 has been added to read "As an alternative to volumetric examination (UT) of the MPC lid-to-shell weld, a multi-layer liquid penetrant (PT) examination may be performed. Multi-layer PT shall include examination of the root and final weld layers, and sufficient

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intermediate layers to detect critical weld flaws." (Please note that this drawing note will be revised again for SAR Revision 8 to reflect the resolution of Commitment A.2.9 regarding the critical weld flaw size and number of intermediate PT examinations).

- The tolerance on the chamfer of the MPC baseplate has been changed from +/- 0.5 degrees to "(REF)".

Dwg. 1397, Sheet 1 has been revised from Revision 13 to 14 to include the following changes:

- Added "(see dwg. 1765, sht. 7 of 7 for orientation)" to the call-out for the impact limiter attachment holes and impact limiter alignment holes. Previously, there was no orientation for the holes given.

Dwg. 1402, Sheet 1 has been revised from Revision 10 to 12 to include the following changes:

- At location E-5, "see note 2 on this sheet" has been added to the inspection criteria of the MPC lid-to-shell weld.

- Note 2 has been added to read "As an alternative to volumetric examination (UT) of the MPC lid-to-shell weld, a multi-layer liquid penetrant (PT) examination may be performed. Multi-layer PT shall include examination of the root and final weld layers, and sufficient intermediate layers to detect critical weld flaws." (Please note that this drawing note will be revised again for SAR Revision 8 to reflect the resolution of Commitment A.2.9 regarding the critical weld flaw size and number of intermediate PT examinations).

- The tolerance on the chamfer of the MPC baseplate has been changed from +/- 0.5 degrees to "(REF)".

BM-1476, Sheets 1 and 2 have been revised from revision 11 to 12 to include the following changes:

- Deleted the term "MIN." after 2 ½" in the description of Item 2, inner shell, because the thickness of plate in the HI-STAR 100 overpack is to be governed by the ASME Code.

- Revised the description of Item 24 to read "Holtite-A" in lieu of "NS-4-FR" to remain consistent with the HI-STAR 100 TSAR and SAR nomenclature.

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- Added "or SA-53" to the material description of Item 38 which is an equivalent material description for the pipe.

Commitment A.2.9

Holtec International Position Paper DS-213, Revision1, is provided as Attachment 2 to this letter. This revised position paper adds a supplemental analysis using a methodology similar to the one discussed in the October 20, 1998 NEI position paper regarding dry storage cask weld cracks. The results of the analysis demonstrate that an assumed 3/8 inch weld flaw size, around the entire circumference of the MPC lid, will not propagate. Therefore, only one intermediate weld layer liquid penetrant (PT) examination is required in addition to the root and final layer PTs. This information will be added to the applicable drawings and text sections in SAR Revision 8, to be submitted to the NRC by **February 22, 1999.**

Commitment A.2.10

New SAR Section 3.4.3.1 has been added and existing SAR Section 2.6.2.3 has been revised to address the thermal and structural effects, respectively, of a scenario where a loaded overpack is transported from a hot ambient environment to a cold ambient environment. Draft Revision 8 SAR pages for the affected SAR sections are provided as Attachment 3 to this letter.

Commitment A.3.1

The offgassing created by the overheating of the Holtite-A neutron shield material during a fire accident has been evaluated. Draft Revision 8 SAR pages discussing this accident are provided as Attachment 4 to this letter. Please note that the Bill-of-Materials will be revised in SAR Revision 8 to specify rupture disks with larger diameter openings to provide sufficient relieving capacity.

Commitment A.3.2

The HI-STAR 100 SAR in Subsection 3.4.1.1.5 describes the "Rayleigh Effect" in the large peripheral regions of the MPC basket. This effect is caused by local convection cells formed as a result of gravity acting on heat flow-induced temperature gradients in these fluid filled regions when the HI-STAR cask is postulated to be in a perfectly horizontal condition. An additional thermal analysis has been performed wherein the gravity is postulated to be completely absent. In this condition, the fluid in these peripheral regions will be completely motionless (i.e. "Rayleigh Effect" is absent) and the means of heat dissipation is limited to conduction and

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radiation. Tables A.3.2.1 and A.3.2.2 for the MPC-24 basket and MPC-68 basket designs, respectively, are provided as Attachment 5 to this letter. These tables summarize the normal transport condition maximum temperatures under this condition and compare the results with normal condition limits. The basket, cladding and overpack containment boundary temperatures are all within stipulated limits under the postulated zero gravity condition.

Commitment A.3.3

The HI-STAR 100 thermal model takes no credit for heat transfer through the overpack impact limiters. A statement clarifying this conservative assumption has been added to Section 3.4.2 of the HI-STAR 100 SAR. Draft Revision 8 SAR page is provided as Attachment 6 to this letter.

Commitment A.3.4

Access to the HI-STAR 100 overpack enclosure shell is restricted by the use of a personnel barrier (See Holtec Drawing 1809 in Chapter 1 of HI-STAR SAR). Access is possible to the impact limiter exposed surfaces. A new Subsection 3.4.2.1 has been added to Chapter 3 of the SAR to address this issue. In this subsection, the HI-STAR 100 System thermal model for normal transport is solved by including heat dissipation through the impact limiters. A conservatively bounding analysis has been performed by applying the thermal conductivity of aluminum to the honeycomb material encased in the impact limiters. In this manner heat transport to the exposed surfaces from the hot ends of the cask is maximized and accessible surface temperatures over estimated. The draft Revision 8 SAR pages are provided as Attachment 7 to this letter. The maximum exposed surface temperatures are 142°F and 139°F for the MPC-24 and MPC-68 basket designs.

Commitment A.3.5

High temperature creep rupture data presented in EPRI Report TR-106440 has been referenced as the basis for short term temperature limits for stainless steel cladding. The draft Revision 8 SAR pages are provided as Attachment 8 to this letter.

Commitment C.5.3

Draft Revision 8 SAR Tables 5.5.1 and 5.5.3 are provided as Attachment 9 to this letter. These tables present the maximum normal and accident dose rates for the MPC-24 and MPC-68, respectively.

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If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014263

Attachments: 1. Affidavit Pursuant to 10 CFR 2.790

Others As Stated

<u>Approvals:</u>

Brian Gutherman
Licensing Manager

K. P. Singh /mP

K. P. Singh, Ph.D.
President and CEO

<u>Technical Concurrence:</u>

Dr. Indresh Rampall (Thermal Evaluation) — Indresh Rampall

Dr. Alan Soler (Structural Evaluation) — Alan Soler

Dr. Everett Redmond II (Shielding Evaluation)

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BY FAX AND OVERNIGHT MAIL

February 10, 1999

Mr. Mark S. Delligatti
Senior Project Manager
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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter L

References: 1. Holtec Project No. 5014

2. Comment Resolution Letter D, dated January 27, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide responses per our previous commitments in Comment Resolution Letter D (Ref. 2) to the Spent Fuel Project Office (SFPO) in support of the ongoing review of our HI-STAR 100 System under 10CFR71. In addition, new commitments resulting from a phone conversation held this morning are included.

Commitments D.5.2 and D.5.3

Draft Revision 8 SAR Sections 5.2.3 and 5.4.4 are provided in Attachment 1 to this letter. These sections discuss the evaluation of stainless steel clad fuel. Draft Revision 8 SAR Tables 5.2.18 through 5.2.22 and 5.4.22 through 5.4.24 are also provided in Attachment 1. These tables provide the calculated source terms and dose rates for the stainless steel clad fuel.

The minimum ^{235}U enrichment for the damaged and MOX fuel has been lowered to 1.8 wt.% ^{235}U. Draft Revision 8 SAR Sections 5.4.2 and 5.4.3 and Tables 5.2.2, 5.2.6, and 5.2.14 through 5.2.17 are provided in Attachment 1. These sections and tables provide the discussion and calculated results for the damaged and MOX fuel.

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NEW ITEMS

L.1.1: Bolt torque values need to be on the Design Drawings or added as a license condition.

Commitment

The bolt torques will be added to the Design Drawings included in the proposed Certificate of Compliance to be submitted to the NRC by **February 22, 1999.**

L.1.2: Drawing 1765, Sheet 7 has a reference to a pin and cap detail to Drawing 1546, which is not included in the SAR.

Commitment

There are two references to the pin and cap details to which this note is referring. The details of the full scale pin and cap may be found on Sheet 2 of Drawing 1765, which can be found in the SAR. The details for the ¼ scale model are shown on Drawing 1546, Sheet 1. The reference on Drawing 1765, Sheet 7 will be clarified and submitted with SAR Revision 8 by **February 22, 1999.**

L.1.3: The minimum 6 foot distance between the bottom impact limiter and the edge of the transport vehicle should be specified in the Certificate of Compliance as a condition of transportation.

Commitment

The 6 foot distance will be added as a condition in the proposed Certificate of Compliance to be submitted to the NRC by **February 22, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

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Document I.D.: 5014264

Attachment: As Stated

Approvals:

Brian Gutherman
Licensing Manager

K. P. Singh, Ph.D.
President and CEO

Technical Concurrence:

Dr. Everett Redmond II (Shielding Evaluation)

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February 11, 1999

Mr. Mark S. Delligatti
Senior Project Manager
Spent Fuel Licensing Section, SFPO, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter M

Reference: Holtec Project No. 5014

Dear Mr. Delligatti,

The purpose of this letter is to provide information and to document commitments resulting from phone conversations held between Holtec International and the Spent Fuel Project Office (SFPO) over the past two days. Attachment 1 to this letter provides source term inventories from the ORIGEN computer code for the MPC-24, -68, and –68F used in the containment analyses. They are identified at the top of each inventory list by "BW15X15", "7X7", and "6X6", respectively. Please note that this computer output is information which is commercially sensitive to Holtec International and is treated by us with strict confidentiality. This information is of the type described in 10CFR2.790(b)(4). Its proprietary status is noted at the bottom of each page of output data. The affidavit provided as Attachment 2 to this letter sets forth the bases for which the information is required to be withheld by the NRC from further disclosure, consistent with these considerations and pursuant to the provisions of 10CFR2.790(b)(1). It is therefore requested that the proprietary information enclosed be withheld from public disclosure in accordance with applicable NRC regulations.

NEW ITEMS

M.4.1: Safety Analysis Report (SAR) Table 4.2.5 appears to have a different A_2 value for crud (Co-60) than provided in Table A-1 of Appendix A to 10 CFR 71.

Commitment

The A_2 value for crud in SAR Table 4.2.5 will be modified to match the value used in the containment evaluation (10.8), which agrees with the value in Table A-1 of Appendix A to 10 CFR 71. Draft Revision 8 SAR pages will be provided to the NRC by **February 12, 1999.**

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M.4.2: SAR Table 4.2.2 includes isotopes not included in Table A-1 of Appendix A to 10 CFR 71. Please provide clarification of how the isotopic inventory used in the containment analysis was developed and what value of A_2 was used for each isotope.

Commitment

As requested by the NRC, the following methodology will be used to develop the radionuclide inventories for the containment analyses:

1. All isotopes constituting 0.01% of inventory or greater (per NUREG-6487);

2. Isotopes from the ORIGEN output which have an A_2 value from Table A-1 of Appendix A to 10 CFR 71 less than 1.0;

3. Isotopes having half-lives less than 10 days may be neglected since they are included with the parent isotope in Table A-1; and

4. For those isotopes not having an A_2 value in Table A-1, the default values in Table A-2 of Appendix A to 10 CFR 71 will be used.

Draft Revision 8 SAR pages will be submitted to the NRC by **February 12, 1999.**

M.4.3: The containment analyses must include Kr-85 with other gaseous isotopes. Kr-85 should not be evaluated on its own. Additionally, the A_2 value for Kr-85 must be ten times the A_2 value presented in Table A-1 of Appendix A to 10 CFR 71.

Commitment

The containment analysis will be re-evaluated with Kr-85 included in the gaseous mixture. The effective A_2 value for the mixture will be determined as requested. Draft Revision 8 SAR pages will be submitted to the NRC by **February 12, 1999.**

M.4.4: Provide the equivalent diameter and volumetric leak rate used in the containment analyses.

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Commitment

The additional information requested will be added to the SAR Draft Revision 8 SAR pages will be submitted to the NRC by **February 12, 1999.**

M.4.5: SAR Appendix 4A appears to have a typographical error in some of the equations (missing pi symbol).

Commitment

Appendix 4A will be reviewed and any editorial changes made. These changes will be included in the submittal of SAR Revision 8 to be submitted to the NRC by **February 22, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014265

Attachments: 1. ORIGEN Computer Output of Isotopic Inventories

2. Affidavit Pursuant to 10 CFR 2.790

Approvals:

Brian Gutherman
Licensing Manager

K. P. Singh, Ph.D.
President and CEO

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Technical Concurrence:

Dr. Everett Redmond II (Shielding Evaluation) — Everett Redmond II

Ms. Joy Russell (Containment Evaluation) — Joy Russell

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February 12, 1999

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter N

References:
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2. Holtec Comment Resolution Letter A, dated January 15, 1999
3. Holtec Comment Resolution Letter D, dated January 27, 1999
4. Holtec Comment Resolution Letter I, dated February 3, 1999
5. Holtec Comment Resolution Letter J, dated February 5, 1999
6. Holtec Comment Resolution Letter M, dated February 11, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide information in accordance with Holtec International's commitments in Comment Resolution Letters (CRL) "A", "D", "I", "J", and "M" (Refs. 2 through 6). In addition, one new commitment resulting from a phone conversation with the Spent Fuel Project Office today is included.

Commitments A.2.3 and A.2.4

Draft Revision 8 Safety Analysis Report (SAR) Section 2.7 excerpts are provided as Attachment 1 to this letter. The revisions to Section 2.7 provide expanded discussion (e.g., stress results, safety factors) for the CG-over-corner drop analyses. These revisions complement the information provided in CRL "J" (Ref. 5).

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Commitment J.2.1

Draft Revision 8 SAR Section 2.9 is provided as Attachment 2 to this letter. This section has been revised to add discussion on fuel buckling under the hypothetical accident drop loading.

Commitments M.4.1 through M.4.4

Draft Revision 8 SAR pages are provided as Attachment 3 to this letter. These changes address the requested revisions to the isotopic inventories used in the containment analysis.

Chapter 5, Shielding Evaluation

Draft Revision 8 SAR pages from Chapter 5 are provided as Attachment 4 to this letter. The following specific items have changes and are provided in Attachment 4.

Sections 5.1, 5.1.1, and 5.1.2 - minor changes (table numbers etc.)
Figure 5.1.1 - minor change to bottom impact limiter
Sections 5.2.1 and 5.2.2
Sections 5.2.5.1 and 5.2.5.2 - removed reference to Table 5.2.23
Tables 5.2.1, 5.2.2, 5.2.15, 5.2.18, and 5.2.23
Sections 5.3.1, 5.3.1.1, and 5.3.2
Parts of Table 5.3.2 and Table 5.3.3
Figures 5.3.11 and 5.3.12
Section 5.4 - minor changes
Section 5.4.1
Tables 5.4.14 and 5.4.15
Figure 5.4.1
Section 5.5 - minor change to last paragraph

Commitment D.7.1

Draft Revision 8 SAR Section 7.3 is provided as Attachment 5 to this letter. This section has been revised to implement the requirements of 49 CFR 173.428.

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NEW ITEM

N.2.1: Provide additional information on the slap-down analysis which clarifies the loadings, stresses, etc.

Commitment

The requested clarifications will be provided as draft Revision 8 SAR pages by **February 15, 1999.**

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014267

Attachments: As Stated

Approvals:

Brian Gutherman
Licensing Manager

K P Singh
K. P. Singh, Ph.D.
President and CEO

Technical Concurrence:

Dr. Everett Redmond II (Shielding Evaluation) — Everett Redmond II

Ms. Joy Russell (Containment Evaluation) — Joy Russell

Mr. Steve Agace (Operations) — S. Agace

Dr. Alan Soler (Structural Evaluation) — Alan Soler

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BY FAX AND OVERNIGHT MAIL

February 15, 1999

Mr. Mark S. Delligatti
Senior Project Manager
Spent Fuel Licensing Section, SFPO, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter O

References: 1. Holtec Project No. 5014

2. Holtec Comment Resolution Letter N, dated February 12, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide information in accordance with Holtec International's commitment in Comment Resolution Letters (CRL) "N" (Ref. 2).

Commitment N.2.1

Draft Revision 8 Safety Analysis Report (SAR) Section 2.7 excerpts; Tables 2.1.9, 2.7.3, 2.7.5, and 2.AE.27; and Figure 2.7.18 are provided as Attachment 1 to this letter. These revisions provide the additional information regarding the slapdown analysis.

If you have any questions or comments, please contact us.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014269

Attachment: As Stated

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Dr. Alan Soler (Structural Evaluation)

for A. Soler

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February 17, 1999

Mr. Mark S. Delligatti
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11555 Rockville Pike
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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter P

References: 1. Holtec Project No. 5014

2. Holtec Comment Resolution Letter O, dated February 15, 1999

Dear Mr. Delligatti,

The purpose of this letter is to provide additional clarifying information to supplement the information provided in the above-referenced Comment Resolution Letter (CRL) and to document a commitment made in a telephone conversation with the Spent Fuel Project Office (SFPO) held this morning. As discussed with the SFPO during a telephone conversation yesterday, all of the finite element analyses for the HI-STAR 100 hypothetical accident conditions were re-run to include an enhancement to the computer model which more accurately predicts the response of the overpack during the drop accidents. The results of these runs were presented in draft Revision 8 Safety Analysis Report (SAR) Table 2.7.5 submitted with the above-referenced CRL.

The reason for re-running the hypothetical accident finite element analyses is twofold:

1. In performing the new analyses of oblique drops, a minor discrepancy in the element generation portion of the ANSYS model was discovered. This led to spurious reactions being developed in directions that were not physically meaningful in the case of oblique impact simulation. To ensure absolute quality assurance and precision in the results data provided in the SAR, all hypothetical drop accident cases were re-run using the corrected model, and all affected SAR tables updated.

2. In the simulations performed for SAR Revision 7, the secondary stress intensities due to thermal gradients (in the "heat" condition) were retained in the simulation and reported as if they were primary stress intensities. In the Revision 8 tabular results, these secondary thermal stress intensities were eliminated in the calculation of safety factors since only

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primary stress intensities are required. This is noted in the text of SAR Section 2.7 where the models are discussed. Specifically, in subsection 2.7.1 (last paragraph before subsection 2.7.1.1), it is noted that stress intensities arising from the thermal gradients in the "heat" condition of transport are not included in the safety factor evaluation.

NEW ITEM

P.8.1: The proposed requirements for verifying neutron shield integrity include reference to compliance with 10 CFR 71.47. Compliance with this regulation is already addressed in the operating procedures in SAR Chapter 7. The acceptance test in Chapter 8 should address verification of the integrity of the poured Holtite-A neutron shield one time prior to first use (shipment).

<u>Commitment</u>

Proposed new SAR Section 8.1.5.2.1 and reference to 10 CFR 71.47 will be deleted. A one-time neutron shield verification test has been added to subsection 8.1.5.2 and Table 8.1.2 has been revised accordingly. The SAR now requires users to implement procedures to verify the integrity of the poured neutron shield. Draft Revision 8 SAR pages showing these changes are provided as Attachment 1 to this letter.

If you have any questions or comments, please contact us.

Sincerely,

for Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014270

Attachment: As Stated

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Technical Concurrence:

Dr. Everett Redmond II (Shielding Evaluation)

Dr. Alan Soler (Structural Evaluation) for A. Soler

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February 18, 1999

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U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter Q

References: 1. Holtec Project No. 5014

Dear Mr. Delligatti,

The purpose of this letter is to provide information discussed in telephone conversations with the Spent Fuel Project Office (SFPO) held yesterday afternoon and this morning. Attachment 1 to this letter is draft Revision 8 changes to Safety Analysis Report (SAR) Section 2.7 which show the MPC-68F calculations for the MPC lid-to-shell (LTS) weld stresses under a hypothetical corner drop event.

These calculations were performed using the existing 0.75 inch LTS weld depth and 0.5 inch MPC shell thickness. We believe these calculations show sufficient margin to failure for the weld to ensure continued lid-to-shell weld joint integrity in the wake of a top-down corner drop event. Please consider the review of this information as a starting point for further discussions for achieving the SFPO's acceptance of the MPC-68F lid-to-shell weld configuration.

We highly appreciate the diligence and sense of purpose exhibited by the SFPO staff in this matter.

Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014271

Attachment: As Stated

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K. P. Singh, Ph.D.
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February 19, 1999

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Subject: USNRC Docket No. 71-9261
HI-STAR 100 Safety Analysis Report, TAC No. L22085
Comment Resolution Letter R

References: 1. Holtec Project No. 5014

Dear Mr. Delligatti,

The purpose of this letter is to provide information in response to our telephone conversation with the Spent Fuel Project Office (SFPO) held this morning. The MPC-68F shell and lid-to-shell weld designs have been slightly modified to reduce the stresses resulting from a CG-over-corner top-end drop accident. For the MPC-68F only, the thickness of the top of the MPC shell has been increased to 1.0 inch and the lid-to-shell groove weld thickness has been increased to 1 1/4 inches. Attachment 1 to this letter includes updated draft Revision 8 changes to Safety Analysis Report (SAR) Section 2.7 which show the MPC-68F calculations for the MPC lid-to-shell (LTS) weld stresses under this hypothetical corner drop event.

These changes were made to strengthen the weld and shell to meet the stress acceptance limits for this event suggested by the SFPO structural reviewer. The design change is illustrated in SAR Figure 2.7.22 (attached), which clearly indicates that the required modification is conceptually quite straightforward. We have discussed the change with each of the SAR chapter authors and have established that only the structural evaluation (Section 2.7) needs to be updated. Upon SFPO concurrence with the draft material presented herein, the affected Design Drawings and Safety Analysis Report section will be revised and submitted within 24 hours.

Please note that we recognize the schedule burden the SFPO staff is under in preparing the Safety Evaluation Report for this application. We deeply appreciate your continued efforts in reaching this crucial milestone in the licensing process.

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Sincerely,

Bernard Gilligan
Project Manager, HI-STAR/HI-STORM Licensing

Document I.D.: 5014272

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Licensing Manager	President and CEO

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