

CHAPTER 7*: CONFINEMENT

7.0 INTRODUCTION

Confinement of all radioactive materials in the HI-STORM FW system is provided by the MPC. The design of the HI-STORM FW MPC assures that there are no credible design basis events that would result in a radiological release to the environment. The HI-STORM FW overpack and HI-TRAC VW transfer cask are designed to provide physical protection to the MPC during normal, off-normal, and postulated accident conditions to assure that the integrity of the MPC is maintained. The dry inert atmosphere in the MPC and the passive heat removal capabilities of the HI-STORM FW also assure that the SNF assemblies remain protected from long-term degradation.

A detailed description of the confinement structures, systems, and components important to safety is provided in Chapter 2. The structural adequacy of the MPC is demonstrated by the analyses documented in Chapter 3. The physical protection of the MPC provided by the overpack and the HI-TRAC Transfer Cask is demonstrated by the structural analyses documented in Chapter 3 for off-normal and postulated accident conditions that are considered in Chapter 11. The heat removal capabilities of the HI-STORM FW system are demonstrated by the thermal analyses documented in Chapter 4. Materials evaluation in Chapter 8 demonstrates the compatibility and durability of the MPC materials for long term spent fuel storage.

This chapter describes the HI-STORM FW confinement design and describes how the design satisfies the confinement requirements of 10CFR72 [7.0.1]. It also provides an evaluation of the MPC confinement boundary as it relates to the criteria contained in Interim Staff Guidance (ISG)-18 [7.0.2] and applicable portions of ANSI N14.5-1997 [7.0.3] as justification for reaching the determination that leakage from the confinement boundary is not credible and, therefore, a quantification of the consequence of leakage from the MPC is not required. This chapter is in general compliance with NUREG-1536 [7.0.4] as noted in Chapter 1.

It should be observed that the configuration of the confinement boundary of the MPCs covered by this FSAR is identical to that used in the MPCs in Docket No. 72-1014 (HI-STORM 100 system), including weld joint details and weld types and weld sizes. Therefore, it is reasonable to conclude that the safety evaluation conducted to establish confinement integrity in Docket No. 72-1014 is also applicable herein.

*This chapter has been prepared in the format and section organization set forth in Regulatory Guide 3.61. However, the material content of this chapter also fulfills the requirements of NUREG-1536.

7.1 CONFINEMENT DESIGN CHARACTERISTICS

The confinement against the release of radioactive contents is the all welded MPC. There are no bolted closures or mechanical seals in the MPC confinement boundary.

The confinement boundary of the MPC consists of the following parts:

- MPC shell
- MPC base plate
- MPC lid
- MPC vent and drain port covers
- MPC closure ring
- associated welds

The combination of the welded MPC lid and the welded closure ring form the redundant closure of the MPC and satisfies the requirements of 10 CFR 72.236(e) [7.0.1]. The confinement boundary is shown in the licensing drawing package in Section 1.5. Chapter 2 provides design criteria for the confinement boundary. All components of the confinement boundary are important-to-safety, as specified on the licensing drawings. The MPC confinement boundary is designed, fabricated, inspected and tested in accordance with the applicable requirements of ASME Code, Section III, Subsection NB [7.1.1], with alternatives given in Chapter 2.

7.1.1 Confinement Vessel

The HI-STORM FW system confinement vessel is the MPC. The MPC is designed to provide confinement of all radionuclides under normal, off-normal and accident conditions. The three major components of the MPC vessel are the shell, baseplate, and lid. The shell welds and the shell to baseplate weld are performed at the fabrication facility. The remaining confinement boundary welds are performed in the field (Table 7.1.1).

The MPC lid consists of two sections (referred to as upper and lower) welded together. Only the upper portion of the lid is credited in the confinement boundary. The lid is made intentionally thick by the addition of the lower portion of the lid to minimize radiation exposure to workers during MPC closure operations. The MPC lid has a stepped recess around the perimeter for accommodating the closure ring. The MPC closure ring is welded to the MPC lid on the inner diameter of the ring and to the MPC shell on the outer diameter.

Following fuel loading and MPC lid welding, the MPC lid-to-shell weld is examined by progressive liquid penetrant examinations (a multi-layer liquid penetrant examination), and a pressure test is performed. The MPC lid-to shell weld is not helium leakage tested since the weld meets the guidance of NRC Interim Staff Guidance (ISG)-15 [7.1.2] and criteria of ISG-18 [7.0.2], therefore leakage from the MPC lid-to-shell weld is not considered credible. Table 7.1.2 provides the matrix of ISG-18 criteria and how the Holtec MPC design and associated inspection, testing, and QA

requirements meet each one.

After the MPC lid weld is ensured to be acceptable the vent and drain port cover plates are welded in place, examined by the liquid penetrant method and a helium leakage test of each of the vent and drain port cover plate welds is performed. These welds are tested in accordance to the leakage test methods and procedures of ANSI N 14.5 [7.0.3] to the “leaktight” criterion of the standard. Finally, the MPC closure ring which also covers the vent and drain cover plates is installed, welded, and inspected by the liquid penetrant method. Chapters 9, 10, and 13 provide procedural guidance, acceptance criteria, and operating controls, respectively, for performance and acceptance of non-destructive examination of all welds made in the field.

After moisture removal and prior to sealing the MPC vent and drain ports, the MPC cavity is backfilled with helium. The helium backfill provides an inert, non-reactive atmosphere within the MPC cavity that precludes oxidation and hydride attack on the SNF cladding. Use of a helium atmosphere within the MPC contributes to the long-term integrity of the fuel cladding, reducing the potential for release of fission gas or other radioactive products to the MPC cavity. Helium also aids in heat transfer within the MPC and helps reduce the fuel cladding temperatures. The inert atmosphere in the MPC, in conjunction with the thermal design features of the MPC and storage cask, assures that the fuel assemblies are sufficiently protected against degradation, which might otherwise lead to gross cladding ruptures during long-term storage.

The confinement boundary welds completed at the fabrication facility (i.e., the MPC longitudinal and circumferential shell welds and the MPC shell to baseplate weld) are referred to as the shop welds. After visual and liquid penetrant examinations, the shop welds are volumetrically inspected by radiography. The MPC shop welds are multiple-pass (6 to 8 passes) austenitic stainless steel welds. Helium leakage testing of the shop welds is performed as described in Table 10.1.1.

7.1.2 Confinement Penetrations

Two penetrations (the MPC vent and drain ports) are provided in the MPC lid for MPC draining, moisture removal and backfilling during MPC loading operations, and also for MPC re-flooding during unloading operations. No other confinement penetrations exist in the MPC.

The MPC vent and drain ports are sealed by cover plates that are integrally welded to the MPC lid. No credit is taken for the sealing action provided by the vent and drain port cap joints. The MPC closure ring covers the vent and drain port cover plate welds and the MPC lid-to-shell weld, providing the redundant closure of these penetrations. The redundant closure of the MPC satisfies the requirements of 10CFR72.236(e) [7.0.1].

7.1.3 Seals and Welds

Section 7.1.1 describes the design of the confinement boundary welds. The welds forming the confinement boundary is summarized in Table 7.1.1.

The use of multi-pass welds with surface liquid penetrant inspection of root, intermediate, and final passes renders the potential of a leak path through the weld between the MPC lid and the shell to be non-credible. The vent and drain port cover plate welds are helium leak tested in the field, providing added assurance of weld integrity. Additionally after fuel loading, a Code pressure test is performed on the MPC lid-to-shell weld to confirm the structural integrity of the weld.

The ductile stainless steel material used for the MPC confinement boundary is not susceptible to delamination or other failure modes such as hydrogen-induced weld degradation. The closure weld redundancy assures that failure of any single MPC confinement boundary closure weld will not result in release of radioactive material to the environment. Section 10.1 provides a summary of the closure weld examinations and tests.

7.1.4 Closure

The MPC is an integrally welded pressure vessel without any unique or special closure devices. All closure welds are examined using the liquid penetrant technique to ensure their integrity. Additionally, the vent and drain port cover plate welds are each helium leakage tested to be “leaktight” in accordance with the leakage test methods and procedures of ANSI N14.5-1997 [7.0.3]. Since the MPC uses an entirely welded redundant closure system with no credible leakage, no direct monitoring of the closure is required.

Table 7.1.1 MPC CONFINEMENT BOUNDARY WELDS		
MPC Weld Location	Weld Type†	ASME Code Category (Section III, Subsection NB)
Shell longitudinal seam	Full Penetration Groove (shop weld)	A
Shell circumferential seam	Full Penetration Groove (shop weld)	B
Baseplate to shell	Full Penetration Groove (shop weld)	C
MPC lid to shell	Partial Penetration Groove (field weld)	C
MPC closure ring to shell	Fillet (field weld)	††
Vent and drain port covers to MPC lid	Partial Penetration Groove (field weld)	D
MPC closure ring to MPC lid	Partial Penetration Groove (field weld)	C
MPC closure ring to closure ring radial weld	Partial Penetration Groove (field weld)	††

† The tests and inspections for the Confinement Boundary welds are listed in Section 10.1

†† This joint is governed by NB-5271 (liquid penetrant examination).

Table 7.1.2	
COMPARISON OF HOLTEC MPC DESIGN WITH ISG-18 GUIDANCE	
DESIGN/QUALIFICATION GUIDANCE	HOLTEC MPC DESIGN
The canister is constructed from austenitic stainless steel.	The MPC enclosure vessel is constructed entirely from austenitic stainless steel (Alloy X). Alloy X is defined as Type 304, 304LN, 316, or 316LN material.
The canister closure welds meet the guidance of ISG-15 (or approved alternative), Section X.5.2.3.	The MPC lid-to-shell closure weld meets ISG-15, Section X.5.2.3 for austenitic stainless steels. UT examination is permitted and NB-5332 acceptance criteria are required. An optional multi-layer PT examination is also permitted. The multi-layer PT is performed at each approximately 3/8" of weld depth, which corresponds to the critical flaw size.
The canister maintains its confinement integrity during normal conditions, anticipated occurrences, and credible accidents and natural phenomena as required in 10CFR72.	The MPC is shown by analysis to maintain confinement integrity for all normal, off-normal, and accident conditions, including natural phenomena. The MPC is designed to ensure that the Confinement Boundary will not leak during any credible accident event and under the non-mechanistic tip-over scenario.
Records documenting the fabrication and closure welding of canisters shall comply with the provisions 10CFR72.174 and ISG-15. Record storage shall comply with ANSI N45.2.9.	Records documenting the fabrication and closure welding of MPCs meet the requirements of ISG-15 via controls required by the FSAR and HI-STORM FW CoC. Compliance with 10CFR72.174 and ANSI N.45.2.9 is achieved via Holtec QA program and implementing procedures.
Activities related to inspection, evaluation, documentation of fabrication, and closure welding of canisters shall be performed in accordance with an NRC-approved quality assurance program.	The NRC has approved Holtec's Quality Assurance program under 10CFR71. That same QA program has been adopted for activities governed by 10CFR72 as permitted by 10 CFR 72.140(d)

7.2 REQUIREMENTS FOR NORMAL AND OFF-NORMAL CONDITIONS OF STORAGE

Once sealed and transferred into the HI-STORM FW overpack there is no mechanism under normal and off-normal conditions of storage for the confinement boundary to be breached. Chapter 3 shows that all confinement boundary components are maintained within their Code-allowable stress limits during normal and off-normal storage conditions. Chapter 4 shows that the peak confinement boundary component temperatures and pressures are within the design basis limits for all normal and off-normal conditions of storage. Since the MPC confinement vessel remains intact, the design temperatures and pressure are not exceeded, and leakage from the MPC confinement boundary as discussed in Section 7.1 is not credible, there can be no release of radioactive material during normal and off-normal conditions of storage.

The MPC is dried and helium backfilled prior to sealing and no significant moisture or other gases remain inside the MPC. Therefore, a credible mechanism for any radiolytic decomposition that could cause an increase in the MPC internal pressure is absent. The potential for the explosive level of gases due to radiological decomposition in the MPC is eliminated by excluding foreign materials in the MPC.

7.3 CONFINEMENT REQUIREMENTS FOR HYPOTHETICAL ACCIDENT CONDITIONS

The analysis in Chapter 3 and results discussed in Chapter 12 demonstrates that the MPC remains intact during and after all postulated accident conditions; therefore there can be no release of radioactive material causing any additional dose contribution to the site boundary during these events.

7.4 REFERENCES

- [7.0.1] 10CFR72, Code of Federal Regulations, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater than Class C Waste,” USNRC, Washington, DC.
- [7.0.2] Interim Staff Guidance-18, “The Design/Qualification of Final Closure Welds on Austenitic Stainless Steel Canisters as Confinement Boundary for Spent Fuel Storage and Containment Boundary for Spent Fuel Transportation,” USNRC, Washington, DC, May 2003.
- [7.0.3] ANSI N14.5-1997, “American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment,” American National Standards Institute, Washington, DC, 1997.
- [7.0.4] NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems", USNRC, Washington, DC, January, 1997.
- [7.1.1] ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, Class 1 Components, American Society of Mechanical Engineers, New York, NY, 2007 Edition.
- [7.1.2] Interim Staff Guidance-15, “Materials Evaluation”, USNRC, Washington, DC, January 2001.
- [7.1.3] Holtec Proprietary Report HI-2022850, Revision 0, “Summary Report on MPC Leak Tightness Test”, April 2002.