Acceptance Tests and Maintenance

The acceptance criteria and maintenance program to be applied to the HI-TRAC VW Transfer Cask are described in Chapter 10. The operational controls and limits to be applied to the HI-TRAC VW are contained in Chapter 13. Application of these requirements will assure that the HI-TRAC VW is fabricated, operated, and maintained in a manner that satisfies the design criteria given in this chapter.

Decommissioning

Decommissioning considerations for the HI-STORM FW Systems, including the HI-TRAC VW transfer cask, are addressed in Section 2.4.

2.0.4 Principal Design Criteria for the ISFSI Pad

2.0.4.1 Design and Construction Criteria

In compliance with 10CFR72, Subpart F, "General Design Criteria", the HI-STORM FW cask system is classified as "important-to-safety" (ITS). This FSAR explicitly recognizes the HI-STORM FW System as an assemblage of equipment containing numerous ITS components. For free-standing cask systems, ~~T~~the reinforced concrete pad~~,~~ on which the cask is situated, ~~however,~~ is designated as a "not important to safety" (NITS) structure because of a lack of a physical connection between the cask and the pad.

However, if the seismic event for a given ISFSI site exceeds the threshold limit for a free-standing HI-STORM installation set forth in the CoC, then the cask must be installed in an anchored configuration. In these instances, the cask installation relies on the structural capacity of the ISFSI pad and the anchored embedment to ensure structural safety. Thus, the ISFSI pad in an anchored cask installation is an ITS structure, and its design must consider natural phenomenon, as required by Part 72 regulations. Specifically, the safety category for the ISFSI pad used to secure anchored casks is ITS, Category C.

Because the geological conditions vary widely across the United States, it is not possible to, *a'priori*, define the detailed design of the ISFSI pad. Accordingly, in this FSAR, the limiting requirements on the design and installation of the pad are provided. The user of the HI-STORM FW System bears the responsibility to ensure that all requirements on the pad set forth in this FSAR are fulfilled by the pad design. Specifically, the ISFSI owner must ensure that:

- The pad design complies with the structural provisions of this FSAR.

- The material ~~of~~ used in construction of the pad (viz., the additives used in the pad concrete) are compatible with the ambient environment at the ISFSI site through compliance with Chapter 4 of ACI 318-05.

- The MPC basket is separated from its lateral supports (basket shims) by a small, calibrated gap designed to prevent thermal stressing associated with the thermal expansion mismatches between the fuel basket and the basket support structure. The gap is designed to ensure that the basket remains unconstrained when subjected to the thermal heat generated by the spent nuclear fuel.

The MPC fuel basket maintains the spent nuclear fuel in a subcritical arrangement. Its safe operation is assured by maintaining the physical configuration of the storage cell cavities intact in the aftermath of a non-mechanistic tipover event. This requirement is satisfied if the MPC fuel basket plates undergo a minimal deflection (see Table 2.2.11). The fuel basket strains are shown in Subsection 3.4.4.1.4 to remain essentially elastic, and, therefore, there is no impairment in the recoverability or retrievability of the fuel and the subcriticality of the stored fuel is unchallenged.

The MPC Confinement Boundary contains no valves or other pressure relief devices. In addition, the analyses presented in Subsections 3.4.3, 3.4.4.1.5, and 3.4.4.1.6 show that the MPC Enclosure Vessel meets the stress intensity criteria of the ASME Code, Section III, Subsection NB for all service conditions. Therefore, the demonstration that the MPC Enclosure Vessel meets Subsection NB stress limits ensures that there will be no discernible release of radioactive materials from the MPC.

(ii) Storage Overpack

The HI-STORM FW storage overpack is a steel cylindrical structure consisting of inner and outer low carbon steel shells, a lid, and a baseplate. Between the two shells is a thick cylinder of un-reinforced (plain) concrete. Plain concrete is also installed in the lid to minimize skyshine. The storage overpack serves as a missile and radiation barrier, provides flow paths for natural convection, provides kinematic stability to the system, and acts as a shock absorber for the MPC in the event of a postulated tipover accident. The storage overpack is not a pressure vessel since it contains cooling vents. The structural steel weldment of the HI-STORM FW overpack is designed to meet the stress limits of the ASME Code, Section III, Subsection NF, Class 3 for normal and off-normal loading conditions and Regulatory Guide 3.61 for handling conditions.

As discussed in Chapters 1 and 2, the principal shielding material utilized in the HI-STORM FW overpack is plain concrete. The plain concrete in the HI-STORM FW serves a structural function only to the extent that it may participate in supporting direct compressive or punching loads. The allowable compression/bearing resistance is defined and quantified in ACI -318-05 [3.3.5]. Strength analyses of the HI-STORM FW overpack and its confined concrete have been carried out in Subsections 3.4.4.1.3 and 3.4.4.1.4 to show that the concrete is able to perform its radiation protection function and that retrievability of the MPC subsequent to any postulated accident condition of storage or handling is maintained.

The anchored HI-STORM overpack is positioned on a steel embedment plate engineered into the ISFSI pad such that the bolt circle diameter on the HI-STORM baseplate aligns with the anchoring locations on the ISFSI pad. The HI-STORM is anchored to the steel embedment plate

using pre-tensioned anchor studs threaded into compression blocks to ensure a continuous compressive state of stress at the interface between the cask and the embedment plate. The design and key dimensions of the anchorage system shall comply with the requirements as shown in Figure 3.1.1. ~~typical pad~~The cask baseplate is held in contact with the embedment plate by a series of pre-tensioned anchor studs. The studs are threaded into a "compression block" that serves to induce a high compressive state of stress at the steel-steel interfaces #1 and #2 in Figure 3.1.1. Figure 3.1.1 shows the threaded compression block hole through the block thickness. The thread starting location, relative to interface #2, is set to ensure the proper free-length of the pre-tensioned anchor stud.

Table 3.1.14

KEY INPUT DATA FOR ANSYS MODEL OF MPC ENCLOSURE VESSEL

Item	Value
Overall Height of MPC	195 in (for maximum length BWR fuel) 213 in (for maximum length PWR fuel)
Outside diameter of MPC	75.75 in
MPC upper lid thickness	4.5 in
MPC lower lid thickness	4.5 in
MPC shell thickness	0.5 in
MPC baseplate thickness	3.0 in
Material	Alloy X
Ref. temperature for material properties	Figure 3.4.27 (implemented in ANSYS) Table 3.1.13 (implemented in LS-DYNA)

Table 3.1.15

KEY INPUT DATA FOR ~~TYPICAL~~ ANCHORED HI-STORM FW VERSION E SYSTEM AND THE GOVERNING SEISMIC LOADING

PROPRIETARY INFORMATION WITHHELD PER 10CFRC2.390

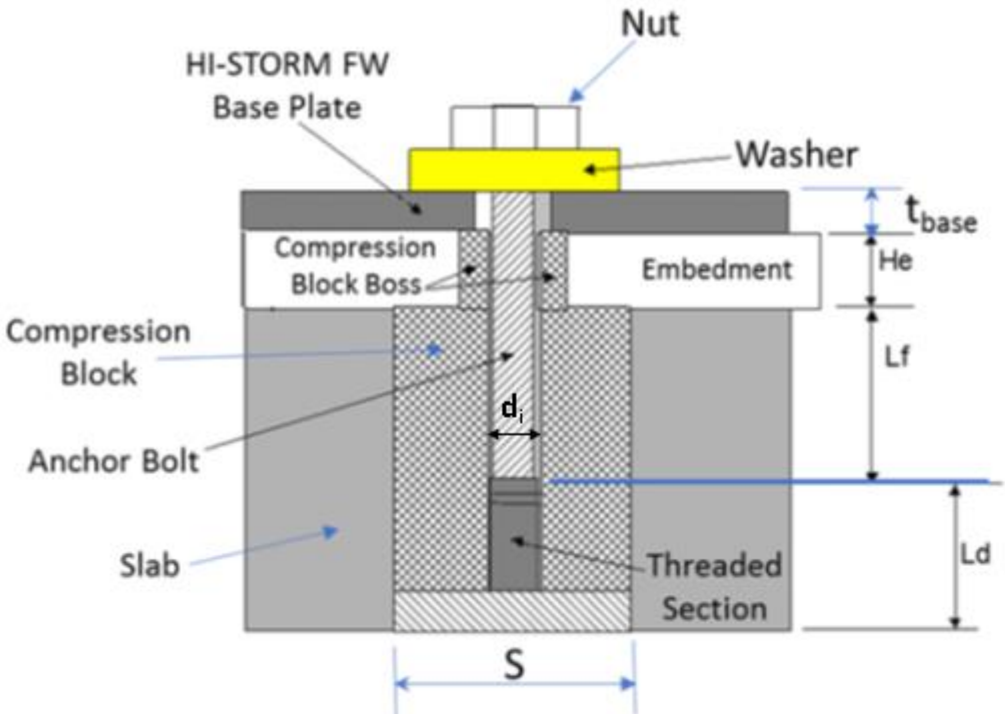


Figure 3.1.1: ~~Typical~~ Cross-Section of Anchorage Securing the Cask to the ISFSI Pad (at Location of Anchor Stud)

The objectives of the analyses are to demonstrate that the plastic deformation in the fuel basket is sufficiently limited to permit the stored SNF to be retrieved by normal means and that there is no significant loss of radiation shielding in the storage system. Furthermore, the maximum lateral deflection of the lateral surface of the fuel basket is within the limit assumed in the criticality analyses (~~as discussed in Section 6.3.1 of~~ as discussed in Section 6.3.1 of Chapter 6), and therefore, the lateral deflection does not have an adverse effect on criticality safety.

The tipover event is an artificial construct wherein the HI-STORM FW overpack is assumed to be perched on its edge with its C.G. directly over the pivot point A (Figure 3.4.8). In this orientation, the overpack begins its downward rotation with zero initial velocity. Towards the end of the tip-over, the overpack is horizontal with its downward velocity ranging from zero at the pivot point (point A) to a maximum at the farthest point of impact. The angular velocity at the instant of impact defines the downward velocity distribution along the contact line.

In the following, an explicit expression for calculating the angular velocity of the cask at the instant when it impacts on the ISFSI pad is derived. Referring to Figure 3.4.8, let r be the length AC where C is the cask centroid. Therefore,

$$r = \left(\frac{d^2}{4} + h^2 \right)^{1/2}$$

The mass moment of inertia of the HI-STORM FW system, considered as a rigid body, can be written about an axis through point A, as

$$I_A = I_c + \frac{W}{g} r^2$$

where I_c is the mass moment of inertia about a parallel axis through the cask centroid C, and W is the weight of the cask (W = Mg).

Let $\theta_1(t)$ be the rotation angle between a vertical line and the line AC. The equation of motion for rotation of the cask around point A, during the time interval prior to contact with the ISFSI pad, is

$$I_A \frac{d^2 \theta_1}{dt^2} = Mgr \sin \theta_1$$

This equation can be rewritten in the form

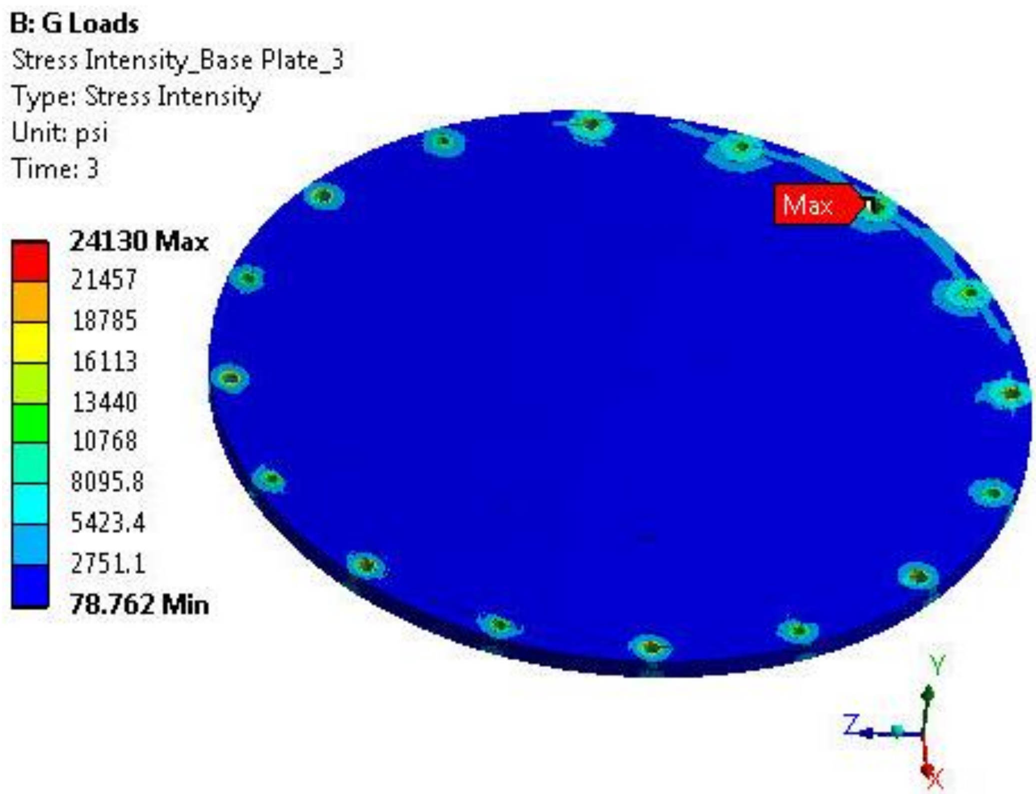
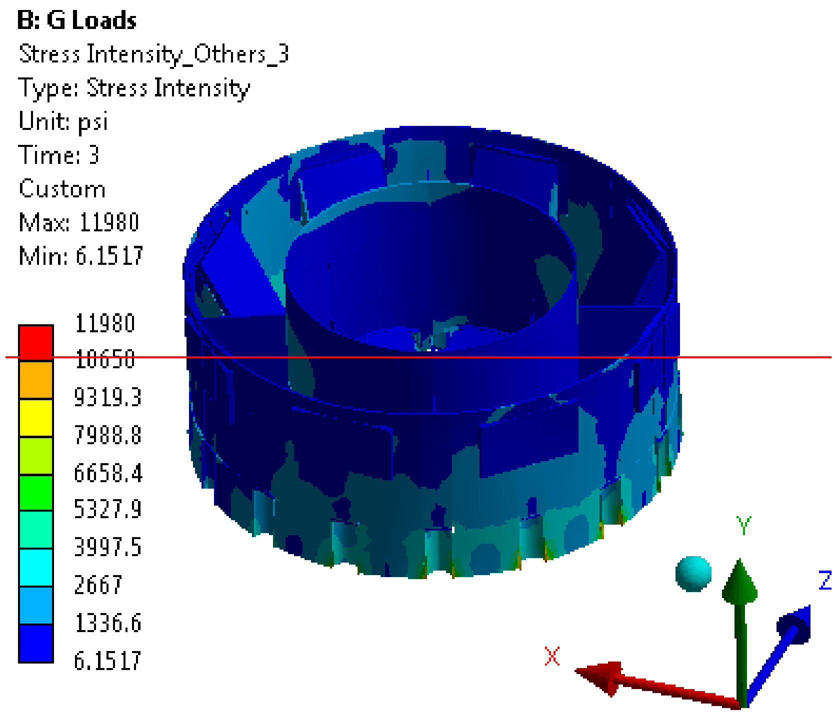


Figure 3.4.44: Stress Intensity Distribution in Base Plate under Seismic Loading (Level D) for Anchored HI-STORM FW Version E


B: G Loads
Stress Intensity_Others_3
Type: Stress Intensity
Unit: psi
Time: 3
Custom
Max: 11980
Min: 6.1517
11980
10650
9319.3
7988.8
6658.4
5327.9
3997.5
2667
1336.6
6.1517
Y
Z
X

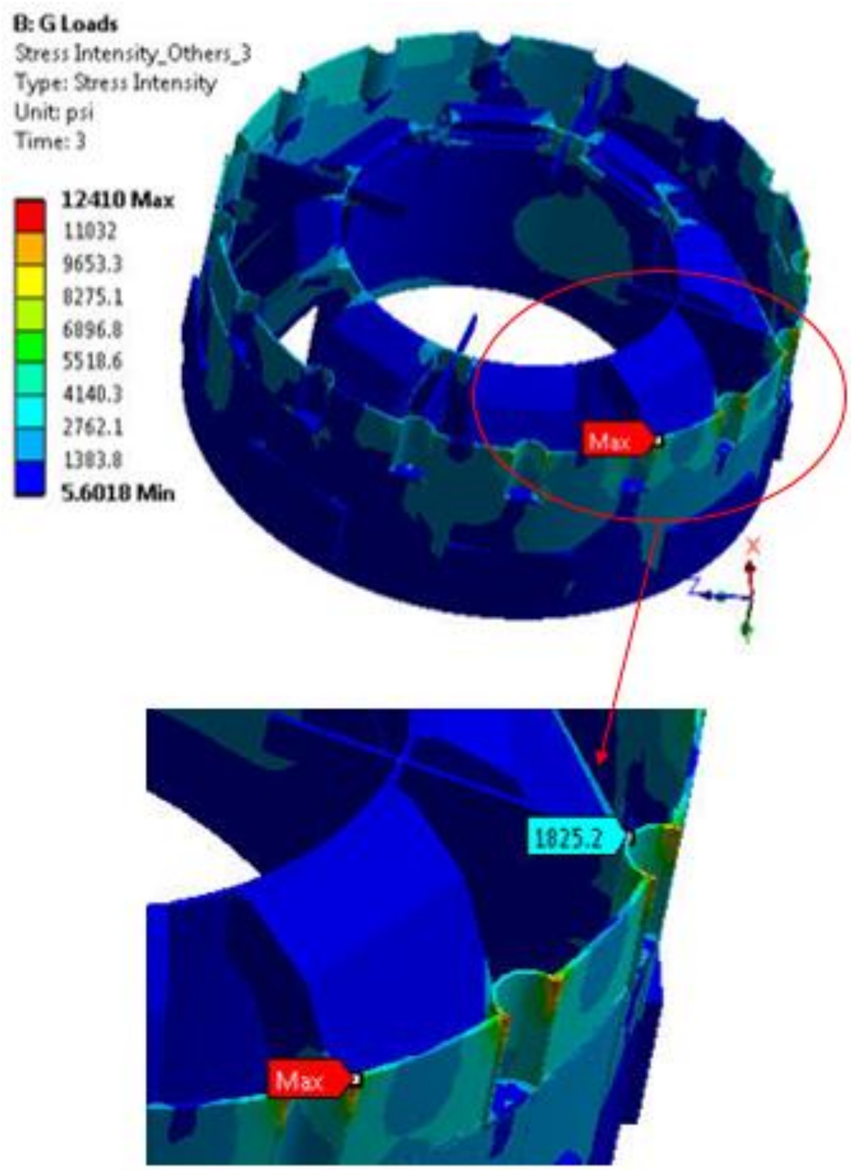


Figure 3.4.45: Stress Intensity Distribution in Other Cask Parts under Seismic Loading (Level D) for Anchored HI-STORM FW Version E

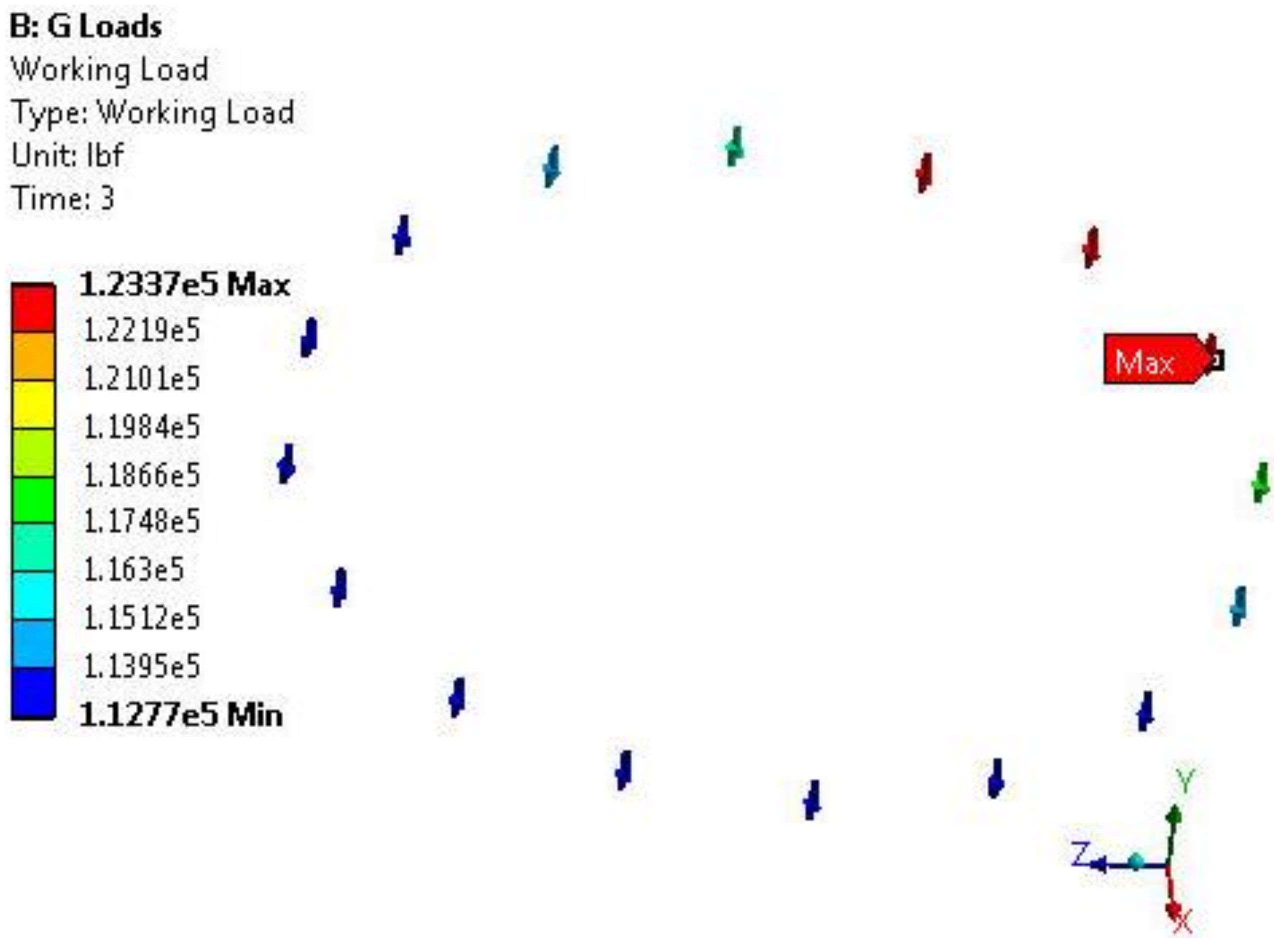


Figure 3.4.46: Demand on the Anchor Stud under Seismic Loading (Level D) for Anchored HI-STORM FW Version E

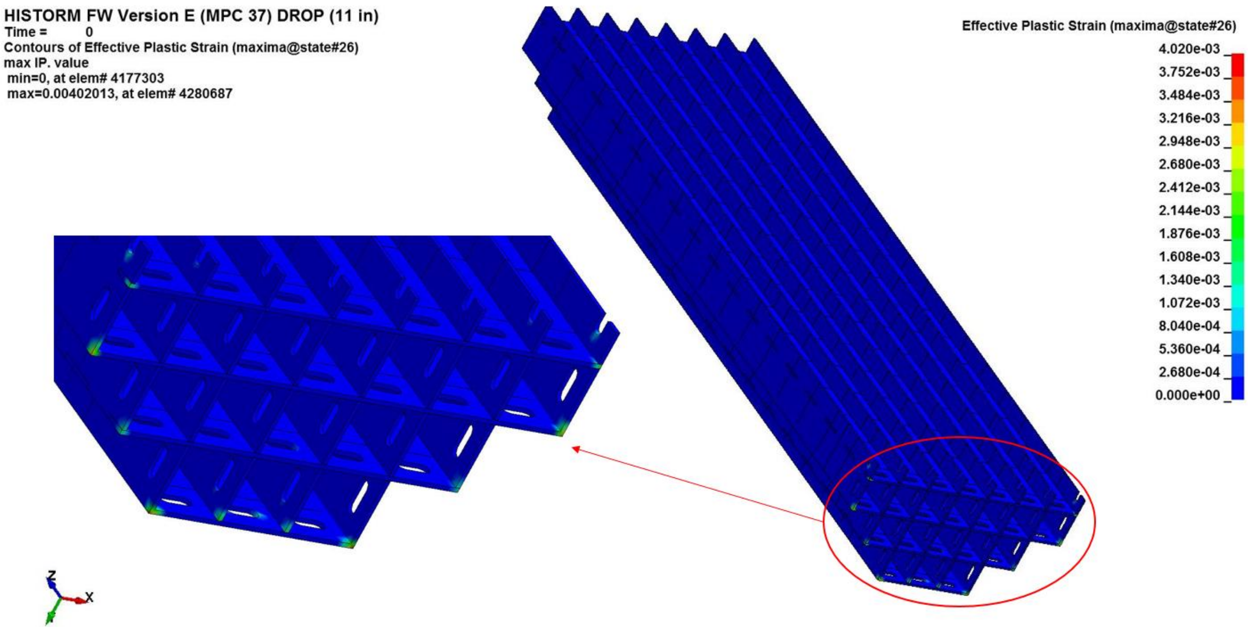


Figure 3.4.54: Maximum Plastic Strain in MPC-37 Basket under HI-STORM FW Version E drop

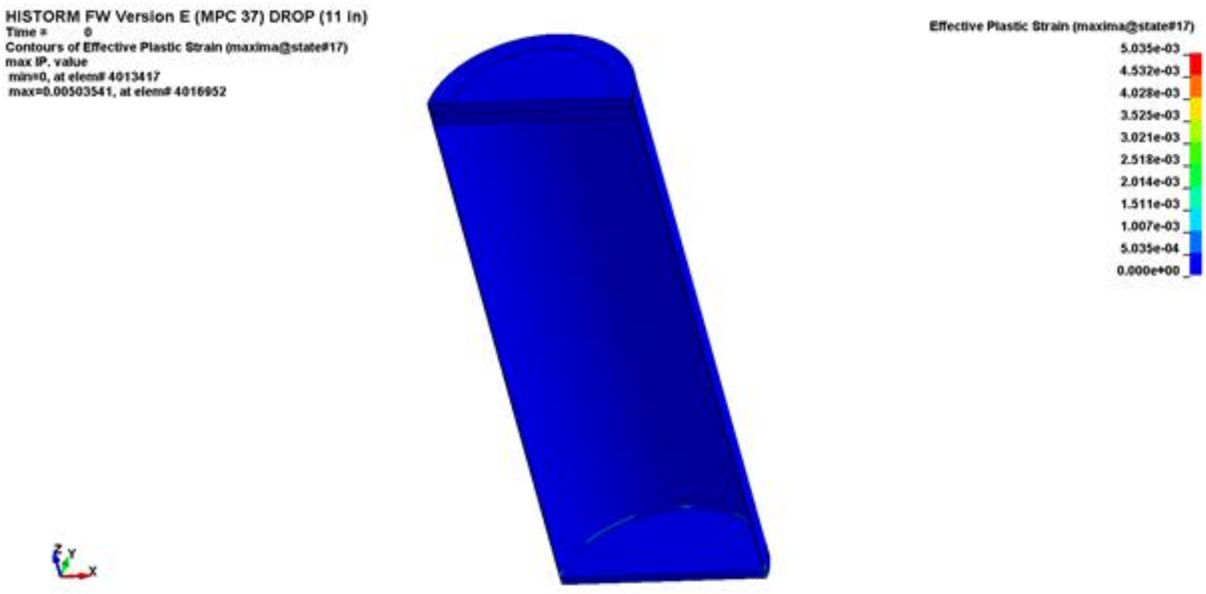


Figure 3.4.55~~Figure 3.4.55~~: Maximum Plastic Strain in MPC-37 Enclosure Vessel under HI-STORM FW Version E drop

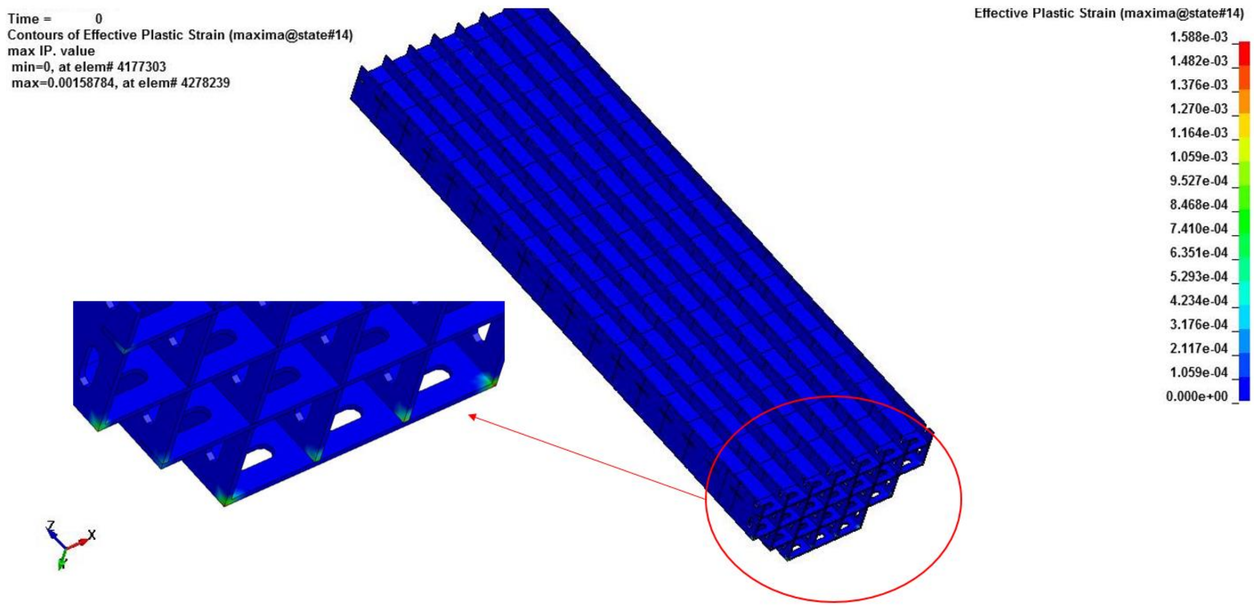


Figure 3.4.61~~2~~: Maximum Plastic Strain in MPC-37 Basket under HI-TRAC VW drop ~~(with loaded MPC-37)~~

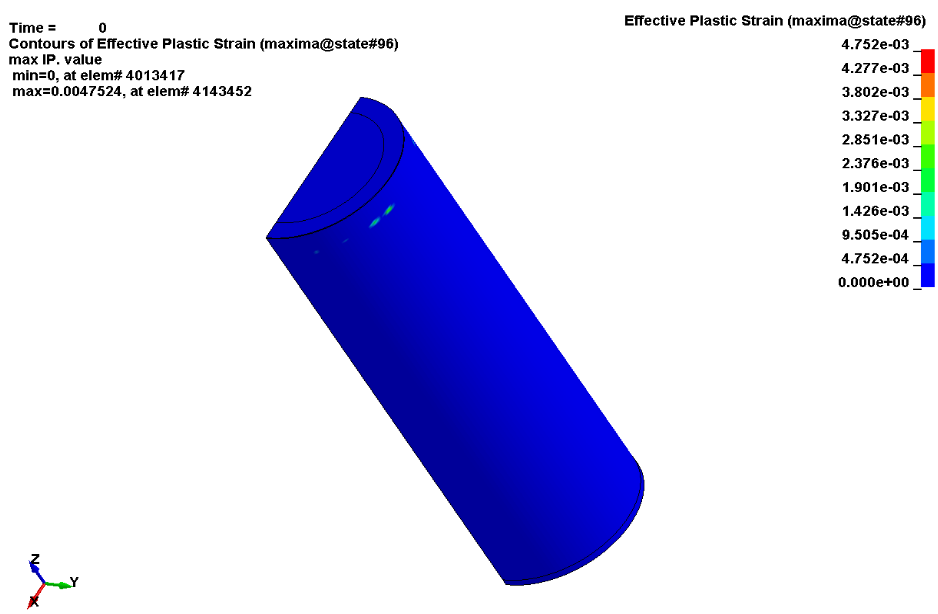


Figure 3.4.62~~3~~: Maximum Plastic Strain in MPC-37 Enclosure Vessel under HI-TRAC VW drop ~~(with loaded MPC-37)~~

BASES

ACTIONS (continued)

C.2.3

In lieu of implementing Required Action C.2.2, an engineering evaluation may be performed to demonstrate that all component and content temperatures remain below accident condition temperature limits in Table 2.2.3 and the MPC internal pressure remains below the accident condition pressure limits in Table 2.2.1. The evaluation would be performed either (1) by using the cask thermal model described in Chapter 4 of this FSAR or (2) by comparison to a previously-evaluated similar condition (i.e., a previous evaluated bounding blockage event). If performing a new evaluation (Option 1 above) the model inputs would be modified to reflect actual or bounding expected site conditions including bounding expected amount of blockage, actual decay heat load, and actual or expected ambient temperature. Efforts must continue to restore the SFSC heat removal system to operable status by removing the air flow obstruction(s). If the evaluation shows none of the components exceed the temperatures determined above, the MPC can remain in the OVERPACK. Once the air flow obstructions have been cleared, the SFSC heat removal system is declared operable, and compliance with LCO 3.1.2 is then restored.

(continued)