

## 1.2 GENERAL DESCRIPTION OF HI-STORM UMAX SYSTEM

### 1.2.1 System Characteristics

The HI-STORM UMAX System consists of interchangeable MPCs, which maintain the configuration of the fuel and is the confinement boundary between the stored spent nuclear fuel and the environment; and a storage overpack that provides structural protection and radiation shielding during long-term storage of the MPC. In addition, a transfer cask that provides the structural and radiation protection of an MPC during its loading, unloading, and transfer to the storage overpack is also subject to certification by the USNRC. Description of MPCs and the HI-TRAC transfer cask are provided in Section 1.2 of the HI-STORM FW FSAR. The key parameters for the UMAX MPCs are provided in Table 1.2.2 of the HI-STORM FW FSAR. The principal materials used in the manufacturing of the MPC are listed in the licensing drawings (Section 1.5) and the acceptance criteria are provided in Chapter 10 of HI-STORM FW FSAR. Alloy X description is provided in Appendix 1.A of the HI-STORM FW FSAR. The principal materials used in the manufacturing of the HI-TRAC transfer cask are listed in the licensing drawings in Section 1.5 and the acceptance criteria are provided in Chapter 10 of the HI-STORM FW FSAR. Table 1.2.6 of the HI-STORM FW FSAR provides applicable code paragraphs for manufacturing the HI-TRAC transfer cask.

All structures, systems, and components of the HI-STORM UMAX system, MPCs and HI-TRACs, which are identified as Important-to-Safety (ITS), are specified on the licensing drawings provided in Section 1.5.

The HI-STORM UMAX MPC-37 has an alternative version called, "Type 1." The MPC-37 Type 1 is identical in design and manufacturing to the MPC-37, with the exception of the basket flow holes on the periphery of the basket. In the MPC-37 Type 1, these periphery basket flow holes are not required to be open, additionally the MPC-37 Type 1 is limited to the standard height fuel defined in this FSAR. The MPC-37 Type 1 periphery basket flow holes may be closed by design options and/or a condition that causes restricted flow through the shims, for example, an MPC which has actual or postulated shim support damage. Throughout this FSAR MPC-37 is used to refer to both the MPC-37 and MPC-37 Type 1 unless otherwise differentiated.

### 1.2.2 Constituents of the HI-STORM UMAX Vertical Ventilated Module and ISFSI Structures

The HI-STORM UMAX VVM, shown in the licensing drawing in Section 1.5, provides for storage of the MPC in a vertical configuration inside a subterranean cylindrical cavity entirely below the top-of-grade (TOG) of the ISFSI. The key constituents of a HI-STORM UMAX VVM and ISFSI structures (see Figure 1.2.1 and Figure 1.2.2) are:

#### VVM Components

- a. The Cavity Enclosure Container (CEC)
- b. The Closure Lid

#### ISFSI Structures

- c. The ISFSI Pad

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 1-15                                      |                  |

2.1.4 provide the axial distribution for the radiological source terms for PWR and BWR fuel assemblies based on the axial burnup distribution. The axial burnup distributions are representative of fuel assemblies with the design basis burnup levels considered. These distributions are used for analyses only, and do not provide a criteria for fuel assembly acceptability for storage in the HI-STORM UMAX System.

Non-fuel hardware, as defined in the Glossary, has been evaluated and is also authorized for storage in the PWR MPCs as specified in Table 2.1.1.

### 2.1.7 Criticality Parameters for Design Basis SNF

The criticality analyses for the MPC-37 are performed with credit taken for soluble boron in the MPC water during wet loading and unloading operations. Table 2.1.6 provides the required soluble boron concentrations for this MPC.

### 2.1.8 Summary of Authorized Contents

Tables 2.1.1 through 2.1.3 specify the limits for spent fuel and non-fuel hardware authorized for storage in the HI-STORM FW System. The limits in these tables are derived from the safety analyses described in the following chapters of this FSAR.

### 2.1.9 Permissible Heat Load for MPC-37 and MPC-89

MPC-89 (BWR) and MPC-37 (PWR) canisters are previously licensed in Docket 72-1032 for storage of spent fuel and are permitted for storage in HI-STORM UMAX with permissible heat loads as specified in Table 2.1.7. As shown in Figures 2.1.7 and 2.1.8 for MPC-37 and MPC-89 respectively, each storage location is associated with a unique cell identification number. The permissible heat loads for each cell in the canister for storage in the HI-STORM UMAX VVM are given in Figure 2.1.19 and Figures 2.1.12 through 2.1.18 for MPC-89 and MPC-37 respectively. The permissible aggregate heat load for storage in MPC-37 and MPC-89 are provided in Tables 2.1.8 and 2.1.9 respectively.

MPC-37 Type 1 permissible aggregate heat load is provided in Table 2.1.12 and the permissible per cell heat load is shown in Figure 2.1.26.

### 2.1.10 Permissible Heat Load for MPC-24, MPC-32 and MPC-68

The authorized heat loads in the HI-STORM 100 docket for the MPCs certified for storage in the HI-STORM 100 will be used to determine the acceptability of storing them in HI-STORM UMAX. These analyses will be performed to characterize the thermal behavior of the “UMAX” system; they are not intended to secure certification of the MPCs in docket # 72-1014 at this time.

Regionalized loading of SNF in two regions are permitted in MPC-24, MPC-32 and MPC-68 models. The definition of the two regions for each MPC model is provided in Table 2.1.10. The inner region (Region 1) and the outer region (Region 2), shown in Figures 2.1.9, 2.1.10 and 2.1.11 for different MPC types have maximum permitted specific heat loads denoted by  $q_1$  and  $q_2$ , respectively. The maximum permitted values of  $q_1$  and  $q_2$  are related through the ratio  $X$ ,

where,

$$X = q_1/q_2.$$

|   |        |
|---|--------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |        |
| HI-2115090                                | Rev. 5 |
| 2-21                                      |        |

TABLE 2.1.8

HI-STORM UMAX MPC-37 PERMISSIBLE HEAT LOADS<sup>Note 5</sup>

| Fuel Type (see Table 2.1.7 for length data) | Description                           | Helium Backfill Pressure Option (Notes 2) | Heat Load per Storage Cell (Note 3) | Permissible Aggregate Heat Load (Note 1), kW |
|---|---------------------------------------|---|-------------------------------------|--|
| Short Fuel                                  | Heat Load Chart 1                     | 1   | Figure 2.1.12                       | 33.88  |
|   | Heat Load Chart 2                     | 2   | Figure 2.1.14                       | 33.70  |
|   | Heat Load Chart 3                     | 1   | Figure 2.1.16                       | 33.53  |
| Standard Fuel                               | Heat Load Chart 1                     | 1   | Figure 2.1.12                       | 33.88  |
|   | Heat Load Chart 2                     | 2   | Figure 2.1.14                       | 33.70  |
|   | Heat Load Chart 3                     | 1   | Figure 2.1.17                       | 35.30  |
| Long Fuel                                   | Heat Load Chart 1                     | 1   | Figure 2.1.13                       | 35.76  |
|   | Heat Load Chart 2                     | 2   | Figure 2.1.15                       | 35.57  |
|   | Heat Load Chart 3                     | 1   | Figure 2.1.18                       | 37.06  |
| Short Fuel                                  | Sub-Design Heat Load                  | 3   | Figure 2.1.19                       | 34.28  |
|   | Threshold Heat Load                   | 3   | Figure 2.1.21                       | 33.46  |
| Standard Fuel                               | Sub-Design Heat Load                  | 3   | Figure 2.1.19                       | 34.28  |
|   | Threshold Heat Load                   | 3   | Figure 2.1.21                       | 33.46  |
| Long Fuel                                   | Sub-Design Heat Load                  | 3   | Figure 2.1.20                       | 36.19  |
|   | Threshold Heat Load                   | 3   | Figure 2.1.21                       | 33.46  |
| 16x16A Fuel (see Table 2.1.2)               | Intact Fuel in up to 37 DFCs (Note 4) | 3   | Figure 2.1-25                       | 32.3   |

Note 1: The aggregate heat load is defined as a sum of all stored fuel assemblies. Thermal evaluations in Chapter 4 are performed with maximum per storage cell heat load in all locations. However, the CoC restricts the permissible aggregate heat load to the value specified in this table.

Note 2: The helium backfill range is in Table 4.4.6.

Note 3: Decay heat limits must be met for all contents in a fuel storage location (i.e., fuel and non-fuel hardware, as applicable).

Note 4: This may include undamaged fuel both in DFCs and not, and damaged fuel in DFCs. These heat load limits apply with one or more undamaged fuel assemblies stored in DFCs.

Note 5: MPC-37 Type 1 Heat Load Limits given in Table 2.1.12.

HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL

HI-2115090

Rev. 5

2-41

TABLE 2.1.12

HI-STORM UMAX MPC-37 TYPE 1 PERMISSIBLE HEAT LOADS

| Fuel Type (see Table 2.1.7 for length data) | Description<br>Helium Backfill Pressure Option<br>(Notes 2) | Heat Load per<br>Storage Cell<br>(Note 3) | Permissible Aggregate<br>Heat Load (Note 1),<br>kW |
|---|---|---|--|
| Standard Fuel                               | Option 1  | Figure 2.1.26                             | 32.3   |

Note 1: The aggregate heat load is defined as a sum of all stored fuel assemblies. Thermal evaluations in Chapter 4 are performed with maximum per storage cell heat load in all locations.

Note 2: The helium backfill range is in Table 4.4.6.

Note 3: Decay heat limits must be met for all contents in a fuel storage location (i.e., fuel and non-fuel hardware, as applicable).

HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL

HI-2115090

Rev. 5

2-44

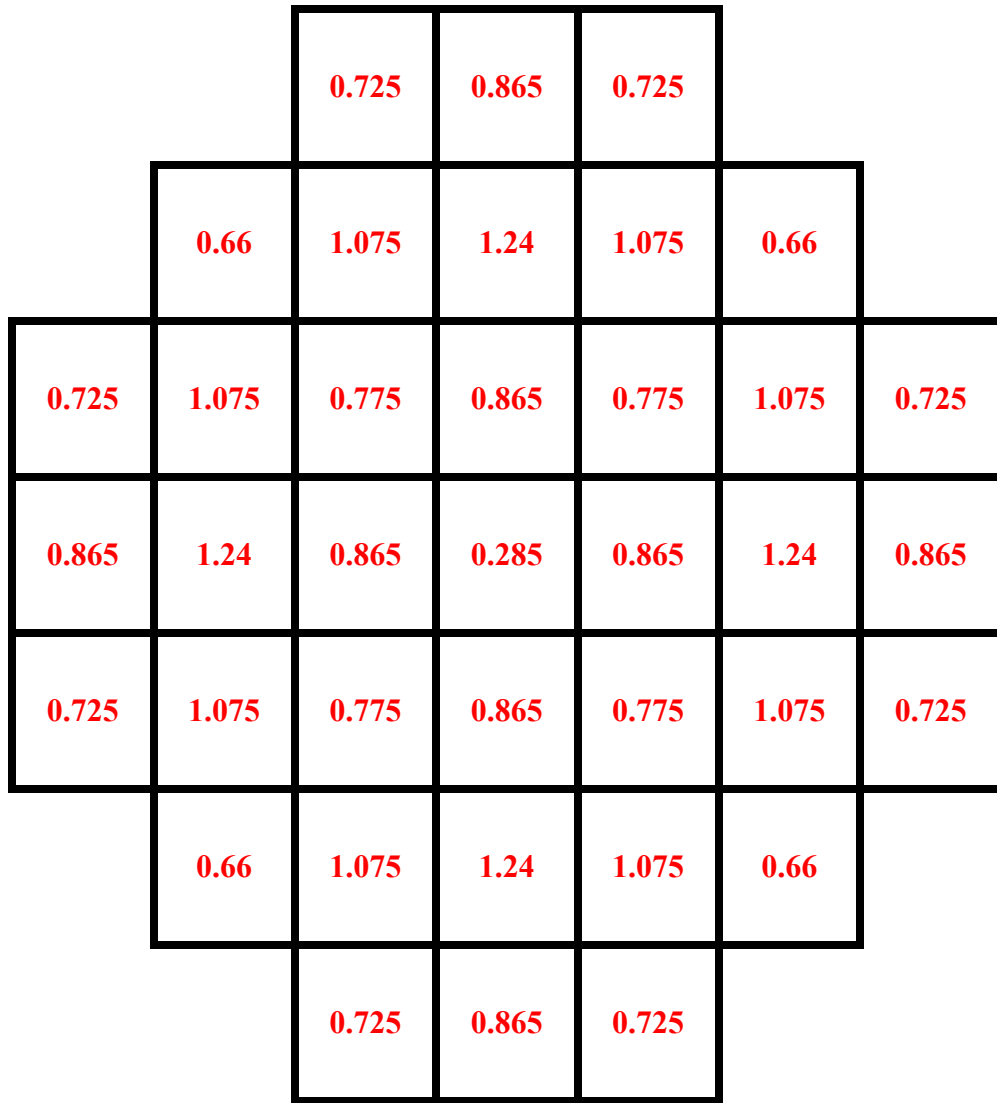


Figure 2.1.26: HI-STORM UMAX MPC-37 Type 1 Heat Permissible Heat Loads for Standard Fuel

(All storage cell heat loads are in kW)

Note that this figure shows the per cell heat load limit for storage. The permissible aggregate heat load may be less than the sum of each individual cell heat load. See Table 2.1.12 for corresponding permissible aggregate heat load and the helium backfill option.

|   |        |
|---|--------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |        |
| HI-2115090                                | Rev. 5 |
| 2-70                                      |        |

examination. These inspection and testing techniques are performed to verify the integrity of the confinement boundary.

The HI-STORM UMAX VVM does not serve a confinement function: It does not feature any safety significant seals. Therefore, leakage of one seal is not evaluated for its consequence to the storage system.

**2.3.3.5 Malfunction of FHD**

The FHD system is a forced helium circulation device used to effectuate moisture removal from loaded MPCs. For circulating helium, the FHD system is equipped with active components requiring external power for normal operation.

Initiating events of FHD malfunction are: (i) a loss of external power to the FHD System and (ii) an active component trip. In both cases a stoppage of forced helium circulation occurs and heat dissipation in the MPC transitions to natural convection cooling.

Although the FHD System is monitored during its operation, stoppage of FHD operations does not require actions to restore forced cooling for adequate heat dissipation. This is because the condition of natural convection cooling evaluated in Section 4.6 of HI-STORM FW FSAR shows that the fuel temperatures remain below off-normal limits. An FHD malfunction is detected by operator response to control panel visual displays and alarms.

**2.3.4 Extreme Environmental Phenomena and Accident Conditions**

The loadings corresponding to the extreme environmental phenomena and accident events, collectively referred to as Faulted States, are discussed as a part of load combinations.

**2.3.4.1 Partial Blockage of MPC Basket Flow Holes**

The MPC is designed to prevent reduction of thermosiphon action due to partial blockage of the MPC basket flow holes by fuel cladding failure, fuel debris and crud. The HI-STORM UMAX System maintains the SNF in an inert environment with fuel rod cladding temperatures below accepted values (Table 2.3.7). Therefore, there is no credible mechanism for gross fuel cladding degradation of fuel classified as undamaged during storage in the HI-STORM UMAX. Fuel classified as damaged fuel or fuel debris are placed in damaged fuel containers. The damaged fuel container is equipped with mesh screens which ensure that the damaged fuel and fuel debris will not escape to block the MPC basket flow holes. The MPC is loaded once for long-term storage and, therefore, buildup of crud in the MPC due to numerous loadings is precluded. Using crud quantities for fuel assemblies reported in an Empire State Electric Energy Research Corporation Report [2.2.3] determines a layer of crud of conservative depth that is assumed to partially block the MPC basket flow holes. The crud depth is listed in Table 2.2.8 of the HI-STORM FW FSAR. The flow holes in the bottom of the fuel basket are designed (as can be seen on the licensing drawings) to ensure that this amount of crud does not block the internal helium circulation.

**MPC-37 Type 1 is designed to allow the periphery basket holes to be closed under all design basis scenarios.**

|   |  |        |
|---|--|--------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |  |        |
| HI-2115090                                |  | Rev. 5 |
| 2-79                                      |  |        |

| Table 4.1.2   |               |                                   |
|---|---------------|-----------------------------------|
| PEAK CLADDING TEMPERATURE RESULTS FOR LONG-TERM NORMAL STORAGE FOR MPC-32, MPC-37 <sup>1</sup> AND MPC-89 IN HI-STORM UMAX SYSTEM**   |               |                                   |
| MPC Types   |               | Fuel Cladding Temperature °C (°F) |
| MPC-37<br>(Heat Load Chart 1)   | Short Fuel    | <b>367 (693)*</b>                 |
|   | Standard Fuel | 357 (675)                         |
|   | Long Fuel     | 351 (664)                         |
| MPC-37<br>(Heat Load Chart 2)   | Short Fuel    | 363 (685)                         |
|   | Standard Fuel | 355 (671)                         |
|   | Long Fuel     | 346 (655)                         |
| MPC-37<br>(Heat Load Chart 3)   | Short Fuel    | 359 (678)                         |
|   | Standard Fuel | 364 (687)                         |
|   | Long Fuel     | 353 (667)                         |
| MPC-37  | 16x16A Fuel   | 295 (563)***                      |
| MPC-89  |               | 357 (675)                         |
| MPC-32 (X=3)  |               | 366 (691)                         |
| <p>* Based on the results in this table, MPC-37 with short fuel under Heat Load Chart 1 is selected as the governing thermal configuration and is used to perform all the licensing basis calculations for HI-STORM UMAX System.</p> <p>** The PCT results documented in this table are for normal storage conditions under quiescent (no wind) conditions.</p> <p>*** The PCT result for 16x16A fuel assembly type documented herein corresponds to an MPC-37 with up to 37 DFCs and loaded to heat load chart specified in Table 2.1.8.</p> |               |                                   |

<sup>1</sup> Evaluation of MPC-37 Type 1 canister addressed in Table 4.4.19.

- b. The temperatures of structural members in the VVM, which are made of either carbon steel or stainless steel, is well below their allowable values set down in the Chapter 2 (presented in Table 2.3.7).
- c. The temperature of shielding concrete mass and insulation (both non-structural members) are also well within their stipulated limits set forth in Table 2.3.7

The modest metal temperatures reached in “UMAX” insure that the components of the system will not suffer long term degradation from elevated temperature effects such as creep, alloy phase transformation, recrystallization of the materials’ grain structure, and the like. Therefore, safety of long term storage from the thermal standpoint is assured.

#### 4.4.11 Effects of Optional Shielding

To reduce the occupational dose during loading operation, an optional stainless steel ring can be implemented. The location and specification of shielding ring are given in the drawing package listed in Section 1.5. To study the effect of this optional shielding ring, MPC-37 with short fuel under heat load chart 1, is re-evaluated for normal long-term storage condition under quiescent conditions. The PCT, maximum component temperatures of MPC and HI-STORM UMAX VVM are reported in Table 4.4.18. The MPC cavity pressure is also reported in Table 4.4.12. These results comply with the temperature and pressure limits reported in Tables 2.3.7 and 2.3.5, respectively. Comparing Table 4.4.18 with the MPC-37 in Table 4.4.2 shows that the impact of this shielding ring is insignificant.

#### 4.4.12 MPC-37 Type 1 Thermal Evaluation

The HI-STORM UMAX Chapter 1 defines an alternative MPC-37 canister called “Type 1” for storage of spent nuclear fuel. The Type 1 canister is identical to MPC-37 with the exception that the basket flow holes located on its periphery are not required in the design. This exception is limited to standard height fuel MPC-37 canisters defined in this FSAR. The permissible cell and aggregate heat load for “Type 1” canister is defined in Table 2.1.12 and Figure 2.1.26. Thermal evaluation of MPC-37 Type 1 canister is addressed in the following.

Thermal evaluation of MPC-37 Type 1 deploys the same FLUENT thermal model articulated in this section with the exception that basket flow holes are closed. To this model the permissible heat loads defined above are applied and steady state thermal solution obtained under long term normal storage. Maximum storage temperatures of limiting components are tabulated in Table 4.4.19. A review of MPC-37 Type 1 temperatures supports the following conclusions:

- Fuel cladding temperatures bounded by Design Basis MPC-37 with short fuel storage (See Table 4.4.2)
- Basket temperatures bounded by Design Basis MPC-37 with short fuel storage (See Table 4.4.2)

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 4-29                                      |                  |



- MPC shell confinement boundary temperatures bounded by Design Basis MPC-37 with short fuel storage (See Table 4.4.2)
- MPC confinement boundary pressures bounded by Design Basis MPC-37 with short fuel storage (See Table 4.4.7)

The evaluation above supports safe long term storage of spent fuel in the MPC-37 Type 1 canister in HI-STORM UMAX. Evaluation of MPC-37 Type 1 under short term operations and off-normal and accident events are addressed in Sections 4.5 and 4.6.

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 4-30                                      |                  |

Table 4.4.19

MPC-37 TYPE 1 LONG-TERM NORMAL STORAGE TEMPERATURES AND PRESSURE

| <b>Component<sup>Note 1</sup></b>      | <b>Temperature<br/>°C (°F)</b> |
|--|--------------------------------|
| Fuel Cladding                          | 321 (610)                      |
| MPC Basket                             | 302 (576)                      |
| Aluminum Basket Shims                  | 223 (433)                      |
| MPC Shell                              | 191 (376)                      |
| Closure Lid Concrete <sup>1</sup>      | 84 (183)                       |
| MPC Cavity Pressure (psig)             |                                |
| Normal Condition                       |                                |
| Intact Rods                            | 87.8                           |
| 1% Rods Rupture                        | 88.9                           |
| Note 1: Limiting components tabulated. |                                |

<sup>1</sup> Maximum section average temperature reported.

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 4-48                                      |                  |

Cask cooldown and reflood evaluation in the HI-STORM FW FSAR Section 4.5.5 [4.1.2] is incorporated by reference.

**4.5.6 Maximum Internal Pressure**

After fuel loading and vacuum drying, but prior to installing the MPC closure ring, the MPC is initially filled with helium. During handling and on-site transfer operations in the HI-TRAC VW transfer cask, the gas temperature will correspond to the thermal conditions within the MPC analyzed in Section 4.5.4.3. Based on this analysis the MPC internal pressure is computed under the assumption of maximum helium backfill specified in Table 4.4.6 and confirmed to comply with the short term operations pressure limit in Table 2.3.5. The results are tabulated in Table 4.5.3.

**4.5.7 Evaluation of MPC-37 Type 1 in HI-TRAC VW Transfer Cask**

As evaluated in Section 4.4.12 the temperature of fuel and canister internals under MPC-37 Type 1 thermal loadings is bounded by Design Basis thermal loadings. This evaluation supports the conclusion that its temperatures in HI-TRAC VW transfer cask are reasonably bounded by Design Basis loadings evaluated in this section.

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 4-54                                      |                  |

[  
**PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10 CFR 2.390**

]

**4.6.2.6 Jacket Water Loss**

The thermal evaluation of normal on-site transfer in HI-TRAC VW discussed in Sub-Section 4.5.4 is bounded by the normal on-site transfer evaluation of HI-TRAC VW in the HI-STORM FW FSAR Section 4.5.4 [4.1.2]. Therefore, HI-TRAC VW jacket water loss accident evaluated in the HI-STORM FW FSAR Section 4.6.2 [4.1.2] is incorporated by reference.

**4.6.3 MPC-37 Type 1 Evaluation Under Off-Normal and Accident Events**

Off-normal and accident events defined in herein are limited duration transient events wherein fuel, canister and internals experience bounded temperature excursions relative to baseline storage temperatures. The maximum temperatures reached under such temperature excursions are principally a function of baseline temperatures  $T_o$ , thermal inertia  $I$  of the system and cask heat load  $Q$ . As evaluated in Section 4.4,  $T_o$  is bounded by Design Basis storage temperatures,  $I$  is unaffected by “Type 1” canister design and  $Q$  is bounded by Design Basis cask heat loads. In this manner it follows that temperature excursion under MPC-37 Type 1 storage in the UMAX is reasonably bounded by Design Basis off-normal and accident event evaluations in this section.

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 4-63                                      |                  |

of the ISFSI, this places the boundary at least 22 feet from the center of the module. Calculations were conservatively performed with the 6.5 ft remaining fill (soil is used in the model) around a loaded VVM instead of the 10.75 ft required by the RPS. The dose rates at the surface of the excavation are presented in table 5.4.4 for both MPC-32 and MPC-37. This dose rate is very low, specifically lower than the dose rates at 1 m from the inlet/outlet vents of the modules. The dose rates at a construction site might therefore be dominated by the dose rates from the inlet/outlet vents, and depending on the loading condition of the operating part of the ISFSI, temporary shielding might be used to reduce dose rates to the construction site. It is to be noted that 6.5 feet of soil is considered for this purpose without any concrete enclosure wall.

**5.4.2 Design Basis Dose Rate Limits**

As discussed in Appendix 13.A, Section B 5.3, dose rate measurements are to be performed, amongst other locations, on top of the lid of every loaded cask, and compared with calculated values. Generally, for design basis conditions, dose rate locations should be away from discontinuities such as inlet and outlet vents, where small differences in locations could result in larger dose rate differences and hence invalidate the comparison. Based on this, dose rate locations are selected to be over the annulus between the MPC and the VVM. For the standard HI-STORM UMAX and lid design, the results shown in Tables 5.4.2 and 5.4.3 together with the information in Figure 5.3.2 show that this would be location “K”, with a dose rate of about 1 mrem/hr. Dose rates in the corresponding location have also been evaluated for the Version B lid, and found to be essentially the same as that shown in Tables 5.4.2 and 5.4.3 for location “K”. Based on this, the value listed in Table 5.4.6 is specified. This value is slightly larger than the highest expected value, to assure that measurement and location uncertainties will not result in inadvertent failure of the comparison. It should be noted that this value is an overall bounding limit, which is used in addition to a site specific limit that typically will be significantly lower, and hence be the more limiting condition.

The standard lid is essentially rotational symmetric, and hence the azimuthal orientation of the 4 required dose rate locations is not critical. The Version B lid is not round, and hence the shielding configurations vary azimuthally. However, evaluations show that even for that lid, the dose rates over the annulus are also essentially azimuthally constant. Overall it is therefore recommended to have the dose rate locations at 0, 90, 180 and 270 degree of the lid. For the Version B lid, although the calculations show no relevant azimuthal variation, this would keep the locations away from the inlet and any potential disturbance of the comparison. However, based on operational or other requirements, a different orientation may be selected.

Finally, an important aspect is that the locations of the calculations to determine the limits and the locations where the measurements are taken are as close as possible to each other, so that a valid comparison is made. This needs to be recognized when selecting and identifying the locations.

For the side of the HI-TRAC VW, evaluations are performed in the HI-STORM FW, Chapter 5 [5.0.3]. The dose rate limit based on those evaluations is specified in Table 5.4.6.

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 5-38                                      |                  |

| Table 5.4.6                   |              |
|-------------------------------|--------------|
| DESIGN BASIS DOSE RATE LIMITS |              |
| Location                      | Value        |
| Side of HI-TRAC               | 3500 mrem/hr |
| VVM lid (over the annulus)    | 3 mremr/hr   |

|   |                  |
|---|------------------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |                  |
| HI-2115090                                | Proposed Rev. 5A |
| 5-46                                      |                  |

v. Confinement

There is no effect on the confinement function of the MPC as a result of this event since the structural integrity of the confinement boundary is unaffected.

vi. Radiation Protection

Since there is minimal reduction, if any, in shielding and no effect on the confinement capabilities as discussed above, there is no effect on occupational or public exposures as a result of this accident event.

**12.2.1.3 Fire Accident Corrective Actions**

Upon detection of a fire adjacent to a loaded HI-STORM UMAX VVM, the ISFSI owner shall take the appropriate immediate actions necessary to extinguish the fire. Following the termination of the fire, a visual and radiological inspection of the equipment shall be performed.

If damage to the HI-STORM UMAX VVM as the result of a fire event is widespread, and/or as radiological conditions require (based on dose rate measurements), the MPC shall be removed from the HI-STORM UMAX VVM in accordance with the procedure set down in Chapter 9. However, the thermal analysis described herein demonstrates that only a limited amount of lid concrete which is behind the steel enclosure exceeds its design temperature. The HI-STORM UMAX VVM may be returned to service after appropriate restoration (reapplication of coatings, etc.) if there is no significant increase in the measured dose rates (i.e., the shielding effectiveness of the overpack is confirmed) and if the visual inspection is satisfactory.

There is no effect on the function of criticality control features of the MPC as a result of this accident event.

Based on the foregoing evaluation, it is concluded that the overpack fire accident does not affect the safe operation of the HI-STORM UMAX VVMs.

**12.2.1.4 Conclusion**

Based on the above evaluation, it is concluded that the Design Basis Fire accident does not affect the safe operation of the HI-STORM UMAX System.

**12.2.2 Partial Blockage of MPC Basket Vent Holes**

Partial blockage of MPC basket vent holes evaluated in the HI-STORM FW FSAR Section 12.2.5 [4.1.2] is incorporated by reference **for the MPC-37 and MPC-89.**

|   |        |
|---|--------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |        |
| HI-2115090                                | Rev. 5 |
| 12-15                                     |        |

For the MPC-37 Type 1, closed periphery MPC Basket Holes are part of the normal design of the system, and blockage of the remaining MPC Basket Flow Holes remains non-credible as described in the HI-STORM FW FSAR Section 12.2.5 [4.1.2].

**12.2.3 Tornado (Load Case 02 in Section 2.4)**

**12.2.3.1 Causal Factors**

Tornado and high winds are principally caused by the uneven heating of the earth’s atmosphere, coupled with gravitational forces and the rotation of the earth. The HI-STORM UMAX System will be deployed in an open area environment and thus will be subject to ambient environmental conditions throughout the storage period. Additionally, the transfer of the MPC between the HI-TRAC VW transfer cask and the storage overpack may be performed at the unsheltered ISFSI concrete pad. It is therefore possible that the HI-STORM UMAX storage system may experience the extreme environmental conditions resulting in the impact from a tornado-borne projectile.

**12.2.3.2 Tornado Analysis**

A tornado event is characterized by high wind velocities and tornado-generated missiles. The reference missiles considered in this FSAR (see Table 2.3.3) are of three sizes: small, medium, and large. A small projectile, upon collision with a cask, would tend to penetrate it. A large projectile, such as an automobile, on the other hand, would tend to cause deformation.

Because of its underground construction, the HI-STORM UMAX is not subject to overturning action by the tornado wind. The effect of tornado missiles propelled by high velocity winds that attempt to penetrate the exposed portions of the HI-STORM UMAX must, however, be considered.

The tornado analysis for a HI-TRAC VW transfer cask evaluated in the HI-STORM FW FSAR Section 12.2.6 [4.1.2] is incorporated by reference.

The evaluation of effects on structural, thermal, criticality, confinement, and radiation protection performance on the HI-STORM UMAX system is summarized below.

i. Structural

Analyses presented in Chapter 3 show that the impact of large and intermediate tornado missiles (see Table 2.3.3) on the HI-STORM UMAX closure lid does not result in the perforation of the lid or result in a structural collapse of the lid. The sole effect of the tornado missile impact on the HI-STORM UMAX VVM is some minor global deformation of the VVM Closure Lid under the large missile and some localized deformation of the VVM Closure Lid under the intermediate missile. All Design Basis missiles are found to be stopped by the VVM assembly before reaching the MPC stored inside. Therefore, MPC damage by impact from a Design Basis Missile is ruled out.

|   |        |
|---|--------|
| HOLTEC INTERNATIONAL COPYRIGHTED MATERIAL |        |
| HI-2115090                                | Rev. 5 |
| 12-16                                     |        |



## B 3.1 SFSC Integrity

## B 3.1.2 SFSC Heat Removal System

---

BASES

---

**BACKGROUND** The SFSC Heat Removal System is a passive, air-cooled, convective heat transfer system that ensures heat from the **fuel contained in the** MPC canister is transferred to the environs by the “chimney effect.” Air is drawn into the inlet duct **vents** and travels down **through the ducts to** the space between the Cavity Enclosure Container (CEC) and the Divider Shell, through the cut-outs at the bottom of the Divider Shell, up the space between the Divider Shell and the MPC, and out through the outlet duct **and vent**. The MPC transfers its heat from its surface to the air via natural convection. The buoyancy created by the heating of the air creates a chimney effect.

**APPLICABLE SAFETY ANALYSIS** The thermal analyses of the SFSC take credit for the decay heat from the spent fuel assemblies being ultimately transferred to the ambient environment. Transfer of heat away from the fuel assemblies **and the MPC** ensures that the fuel cladding and other SFSC component temperatures do not exceed applicable limits. Under normal storage conditions, the inlet and outlet duct screens are unobstructed and full air flow occurs.

Analyses have been performed for half and complete obstruction of the inlet ducts **and associated** screens. Blockage of half of the inlet ducts reduces air flow through the VVM and decreases heat transfer from the MPC. Under this off-normal condition, no SFSC components exceed the short term temperature limits.

The complete blockage of all inlet air ducts stops normal air cooling of the MPC. The MPC will continue to **transfer** heat to the relatively cooler subgrade **and limited recirculation in and out of the outlet duct will continue**. **However,** with the loss of normal air cooling, the SFSC component temperatures will increase toward their respective short-term temperature limits. None of the components reach their temperature limits over the duration **(32 hours)** of the analyzed event.

(continued)

|               |   |
|---------------|---|
| BASES         |   |
| LCO           | <p>The SFSC Heat Removal System must be verified to be operable to preserve the assumptions of the thermal analyses. Operability is defined as <b>either</b> 50% or more of the inlet vent duct areas are unblocked and available for flow <b>or when differential temperature requirements are met</b>. Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environs at a sufficient rate to maintain fuel cladding and other SFSC component temperatures within design limits.</p> <p>The intent of this LCO is to address those occurrences of air duct screen blockage that can be reasonably anticipated to occur from time to time at the ISFSI (i.e., Design Event I and II class events per ANSI/ANS-57.9). These events are of the type where corrective actions can usually be accomplished within one operating shift to restore the heat removal system to operable status (e.g., removal of loose debris).</p> <p>This LCO is not intended to address low frequency, unexpected Design Event III and IV class events (ANSI/ANS-57.9) such as design basis accidents and extreme environmental phenomena that could potentially block one or more of the air ducts for an extended period of time (i.e., longer than the total Completion Time of the LCO). This class of events is addressed <b>by site procedures</b> as required the CoC.</p> |
| APPLICABILITY | <p>The LCO is applicable during STORAGE OPERATIONS <b>after the lid is installed on the VVM</b>. Once <b>installed</b>, the heat removal system must be operable to ensure adequate dissipation of the decay heat from the fuel assemblies. <b>Prior to lid installation, adequate cooling is available due to the configuration without the lid, which results in larger flow areas than those in the lid and vents.</b></p>   |
| ACTIONS       | <p>A note has been added to the ACTIONS which states that, for this LCO, separate Condition entry is allowed for each SFSC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each SFSC not meeting the LCO. Subsequent SFSCs that don't meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.</p> <p>(continued)</p>  |

---

**BASES****ACTIONS**  
(continued)**A.1**

Although the heat removal system remains operable, the blockage should be cleared expeditiously. **If temperature measurements are used to declare operability, no inspection of the vents is required, but if any blockage is identified it should be removed.**

**B.1**

If the heat removal system has been determined to be inoperable, it must be restored to operable status within eight hours. Eight hours is a reasonable period of time to take action to remove the obstructions in the air flow path.

**C.1**

If the heat removal system cannot be restored to operable status within eight hours, the VVM and the fuel may experience elevated temperatures. Therefore, dose rates are required to be measured to verify the effectiveness of the radiation shielding provided by the concrete. This Action must be performed immediately and repeated every twelve hours thereafter to provide timely and continued evaluation of the effectiveness of the concrete shielding. As necessary, the system user shall provide additional radiation protection measures such as temporary shielding. The Completion Time is reasonable considering the expected slow rate of deterioration, if any, of the concrete under elevated temperatures.

**C.2.1**

In addition to Required Action C.1, efforts must continue to restore cooling to the SFSC. Efforts must continue to restore the heat removal system to operable status by removing the air flow obstruction(s) unless optional Required Action C.2.2 is being implemented.

This Required Action must be complete in 24 hours. The Completion Time is consistent with the thermal analyses of this event, which show that all component temperatures remain below their short-term temperature limits up to 32 hours after event initiation.

**The Completion Time reflects the 8 hours to complete Required Action B.1 and the appropriate balance of time consistent with the applicable analysis results. The event is assumed to begin at the time the SFSC heat removal system is declared inoperable. This is reasonable considering the low probability of all inlet ducts becoming simultaneously blocked.**

---

(continued)

---

**BASES****ACTIONS**  
(continued)**C.2.2**

In lieu of implementing Required Action C.2.1, transfer of the MPC into a TRANSFER CASK will place the MPC in an analyzed condition and ensure adequate fuel cooling until actions to correct the heat removal system inoperability can be completed. Transfer of the MPC into a TRANSFER CASK removes the SFSC from the LCO Applicability since STORAGE OPERATIONS does not include times when the MPC resides in the TRANSFER CASK.

An engineering evaluation must be performed to determine if any deterioration which prevents the VVM from performing its design function. If the evaluation is successful and the air inlet duct screens have been cleared, the VVM heat removal system may be considered operable and the MPC transferred back into the VVM. Compliance with LCO 3.1.2 is then restored. If the evaluation is unsuccessful, the user must transfer the MPC into a different, fully qualified VVM to resume STORAGE OPERATIONS and restore compliance with LCO 3.1.2

In lieu of performing the engineering evaluation, the user may opt to proceed directly to transferring the MPC into a different, fully qualified VVM or place the TRANSFER CASK in the spent fuel pool or dry unloading facility and unload the MPC.

The Completion Time of 24 hours reflects the Completion Time from Required Action C.2.1 to ensure component temperatures remain below their short-term temperature limits for the respective decay heat loads.

**C.2.3**

In lieu of implementing Required Action C.2.2, an engineering evaluation may be performed (or a previous evaluation may be referenced) to determine if any components exceed a temperature which would prevent it from performing its design function. If the evaluation shows none of the components exceed such a temperature, and the air flow obstructions have been cleared, the SFSC heat removal system can be considered operable and the MPC remains in the VVM. Compliance with LCO 3.1.2 is then restored.

(continued)

---

**BASES****SURVEILLANCE  
REQUIREMENTS****SR 3.1.2**

The long-term integrity of the stored fuel is dependent on the ability of the SFSC to reject heat from the MPC to the environment. There are two options for implementing SR 3.1.2, either of which is acceptable for demonstrating that the heat removal system is OPERABLE.

Visual observation that all air inlet duct screens are unobstructed ensures that the SFSC is operable. If greater than 50% of the air inlet duct screens are blocked the heat removal system **may be inoperable (see temperature measurement discussion below for an alternative option for evaluating system condition)**.

While 50% or less blockage of the total air inlet duct screen area does not constitute inoperability of the heat removal system, corrective actions should be taken promptly to remove the obstruction and restore full flow. Visual observation of air outlet duct screen blockage does not constitute inoperability of the heat removal system; however, corrective action should be taken to promptly remove the obstruction.

As an alternative, **monitoring of the VVM differential temperature can be performed and this is both direct and quantitative. This can be accomplished either through local manual means or remotely displayed readings of air temperature monitoring instrumentation.** Blocked air inlet duct screens will reduce air flow and increase the outlet duct air temperature. Based on the analyses, if the temperature difference between the ambient air and the outlet duct air meets the criteria in the **SR**, adequate air flow is occurring to provide assurance of long term fuel cladding integrity.

The Frequency of 24 hours is reasonable based on the time necessary for SFSC components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of blockage of air ducts.

---

**REFERENCES**

1. FSAR Chapter 4
  2. ANSI/ANS 57.9-1992
-

## B 5.0 Administrative Controls and Programs (LCO) APPLICABILITY

## B 5.3 Radiation Protection Program

BASES

- B.5.3.1 5.3.1 requires that the licensee appropriately includes provisions in their radiation protection program to account for the dry storage system from loading through unloading. These provisions should also include the requirements included in Section 5.3 of the CoC.
- B.5.3.2 5.3.2 includes the requirements of 10CFR72.212(b)(2)(i)(c) for a documented evaluation that the dose limits of 10CFR72.104(a) are met. This evaluation should utilize the site-specific ISFSI layout, the planned number of casks, and the cask contents to demonstrate compliance with 10CFR72.104
- B.5.3.3 In accordance with 5.3.3, licensees should use the analysis performed in 5.3.2 to also establish dose rate limits at the top of the VVM (above the annulus, in accordance with the measurement location specified in 5.3.8), the side of the transfer cask (mid-height, in accordance with the measurement location specified in 5.3.8), and the outlet vents on the VVM. If measured dose rates exceed these limits, it could be an indication of a loading error that may require corrective actions. These calculated limits are used in comparison with the measured values in 5.3.8.
- B.5.3.4 5.3.4 contains additional dose rate limits for a loaded VVM and transfer cask. These dose rate limits are set at a value above the maximum expected dose rates at the locations described in 5.3.8, from a system loaded with design basis fuel. If measured dose rates exceed these limits, it could be an indication of a design or loading error that may require corrective actions. Section 5.4.2 of this FSAR contains additional discussions on the selection of the location and dose rate limits.
- B.5.3.5 5.3.5 provides the requirement that the licensee measure dose rates at the locations outlined in 5.3.8 and compare them to the lower of the two limits established in Section 5.3.3 or 5.3.4. This ensures that the most conservative limit is used.
- B.5.3.6 5.3.6 establishes corrective actions that shall be taken in the event of measured dose rates that exceed the lower of the two limits in Section 5.3.3 or 5.3.4. These corrective actions include verifying that contents were loaded correctly, performing analyses to ensure 10CFR72.104 dose limits are met, and determining the cause of the higher dose rate.
- B.5.3.7 5.3.7 states that any evaluation under 5.3.6 that shows that 10CFR72.104 dose rate limits will not be met will prevent the MPC from being installed in the VVM or it will be removed from the VVM. This control ensures that the site continues to meet all regulatory requirements.

---

**BASES**

---

**B 5.3.8**

5.3.8 establishes locations for surface dose rate measurements. Compliance with 10CFR72.104 dose limits are confirmed with a comparison between these measured dose rates and the dose limits of the system set by calculation and maximum limits in 5.3.3 and 5.3.4 as described in 5.3.5. The measurement locations specified in 5.3.8 ensure the measured dose rates are compared with the analysis described in 5.3.3 at the same geometric location. Showing that the calculated dose rates at the same location provides assurance that the calculated dose (from 5.3.2) bound the actual doses at the site boundary, and therefore assures compliance with 10CFR72.104(a).

Even though comparison of dose rates can occur across any location, the locations chosen in 5.3.8 were based on positions where higher dose rates are expected. Higher dose rates provide better measurements to protect against measurement inaccuracy and the additional actions of 5.3.6 and 5.3.7 for compliance to 10CFR72.104.

**B.5.3.9**

5.3.9 establishes a “Radiation Protection Space” around the HI-STORM UMAX ISFSI, down to the depth of the Support Foundation Pad. This RPS only applies during construction activities, and provides assurance that there is no loss of shielding due to an event occurring during construction activities adjacent to the HI-STORM UMAX.

---