7. Place HI-TRAC VW in the spent fuel pool as follows:

If necessary for plant weight limitations, drain the water from the neutron shield jacket. For HI-TRAC VW Version V2, unbolt the HI-TRAC VW from the NSC.

Engage the lift yoke to HI-TRAC VW lifting blocks, remove the MPC lid lifting plugs and attach the MPC lid slings.

Position HI-TRAC VW into the spent fuel pool in accordance with site-approved rigging procedures.

Disengage the lift yoke. Visually verify that the lift yoke is fully disengaged.

Remove the lift yoke, MPC lid and drain line from the pool in accordance with directions from the site's Radiation Protection personnel.

Disconnect the drain line from the MPC lid.

Store the MPC lid components in an approved location. Disengage the lift yoke from MPC lid.

### 9.4.4 MPC Unloading

1. Remove the spent fuel assemblies from the MPC using applicable site procedures. If used, the top DFI will be removed using special handling tools, in order to remove the spent fuel assembly in the cell.

2. Remove any debris or corrosion products from the MPC cells. If used, the bottom DFI may be removed using special handling tools.

### 9.4.5 Post-Unloading Operations

1. Remove HI-TRAC VW and the unloaded MPC from the spent fuel pool as follows:

Engage the lift yoke to the HI-TRAC VW lift blocks.

Apply slight tension to the lift yoke and visually verify proper engagement of the lift yoke to the lift blocks.

Raise HI-TRAC VW until HI-TRAC VW flange is at the surface of the spent fuel pool.

**ALARA Warning:**
Activated debris may have settled on the top face of HI-TRAC VW during fuel unloading.

Measure the dose rates at the top of HI-TRAC VW in accordance with plant radiological procedures and flush or wash the top surfaces to remove any highly-radioactive particles.

Raise the top of HI-TRAC VW and MPC to the level of the spent fuel pool deck.

## 11.3 ESTIMATED ON-SITE CUMULATIVE DOSE ASSESSMENT

This section provides the estimates of the cumulative exposure to personnel performing loading, unloading and transfer operations using the HI-STORM FW system. This section uses the shielding analysis provided in Chapter 5, and the operations procedures provided in Chapter 9.

The dose rates from the HI-STORM FW overpack, MPC lid, and HI-TRAC VW are calculated to determine the dose to personnel during the fuel loading and unloading operations. No assessment is made with respect to background radiation since background radiation can vary significantly by site.

The estimated occupational dose is governed by three principal parameters, namely:

i. The dose rate emanating from the MPC.
ii. Average duration of human activity in the radiation elevated space.
iii. Relative proximity of humans to the radiation source.

The dose rate accreted by the MPC depends on its contents. Regionalized storage has been made mandatory in the HI-STORM FW MPC-37 to reduce its net radiation output. The duration of required human activity and the required human proximity, on the other hand, are dependent on the training level of the personnel, and user friendliness of ancillary equipment and the quality of fit-up of parts that need to be assembled in the radiation field.

To provide a uniform basis for the dose estimates presented in this chapter, the MPC contents data considered, available HI-TRAC VW weight, etc., are set down in Table 11.3.1.

Apart from the operational considerations, the assumptions with regards to the cask content have a significant impact on the estimated dose. Two cask loading scenarios are evaluated and documented here, both very conservative, i.e. in an attempt to indicate what the highest expected dose rates could possibly be. The scenarios are selected as follows:

- The first scenario uses the representative uniform fuel loading discussed in Section 5.4.3. This is loading is conservative, but not bounding. It is conservative since it represents a total cask decay heat load that exceeds the value that is permitted for the cask. But is not bounding, since it utilizes only a single burnup and cooling time combination, and even for the same heat load, there could be other combinations that could result in slightly higher dose rates. Cask dose rates corresponding to this scenarios are documented in Section 5.4, Tables 5.4.11 through 5.4.16. The does rates reported in this chapter for this scenario are directly calculated using the representative fuel loading.

- The second scenario is truly bounding from a content perspective. It is based on the full evaluations of the regionalized loading scenarios with the bounding cask dose rates presented in the tables in Section 5.1. However, the values here are not based on direct explicit dose calculations. Instead, they are based on the values for the first scenarios, adjusted by suitable

adjustment factors. The factors are established by a comparison of the cask dose rates between the results in Section 5.1 and 5.4. For the dose rates around the HI-TRAC, results near the top of the cask are used to derive this adjustment. For the dose rates from the HI-STORM, dose rates on the side of the cask are compared. The adjustment factors selected this way are also shown in Table 11.3.1.

It is to be noted that both scenarios represent rather extreme cases. Practical experience from the many casks loaded so far show that dose rates significantly below those shown here can be achieved. This not so much the result of a less bounding content of the canisters, but the result of operational improvements of the loading process that reduce durations of the presence of workers near the casks, that increase the distance to the cask areas with higher dose rates, and the use of temporary shielding.

Using Table 11.3.1 data, the dose data for fuel loading (wet to dry storage) is provided in Table 11.3.2.

For each step in Table 11.3.2, the task description, average number of personnel in direct radiation field, exposure duration in direct radiation field and average dose rate are identified. The relative locations refer to all HI-STORM FW overpacks. The dose rate location points around the transfer cask and overpack were selected based on actual experience in loading HI-STORM 100 Overpacks. Cask operators typically work with workers entering and exiting the immediate cask area. To account for this, an average number of workers and average dose rates are used. The tasks involved in each step presented in Table 11.3.2 are not provided in any specific order.

## 11.3.1 Estimated Exposures for Loading and Unloading Operations

Exposures estimates presented in Tables 11.3.2 is expected to bound those for unloading operations. This assessment is based on the similarity of many loading steps versus unloading operations with the elimination of several of the more dose intensive operations (such as weld inspections and leakage testing). Therefore, loading estimates should be viewed as bounding values for the contents considered for unloading operations.

## 11.3.2 Estimated Exposures for Surveillance and Maintenance

Table 11.3.3 provides an estimate of the occupational exposure required for security surveillance and maintenance of an ISFSI. Security surveillance time is based on a daily security patrol around the perimeter of the ISFSI security fence. Users may opt to utilize electronic temperature monitoring of the HI-STORM FW modules or remote viewing methods instead of performing direct visual observation of the modules. The security surveillances can be performed from outside the ISFSI, and the ISFSI fence is typically positioned such that the area outside the fence is not a radiation area. Although the HI-STORM FW system requires only minimal maintenance during storage (e.g., touch-up paint), maintenance will be required around the ISFSI for items such as security equipment maintenance, grass cutting, snow removal, vent system surveillance, drainage system maintenance, and lighting, telephone, and intercom repair, hence most of the maintenance is expected to occur outside the actual cask array.

| Table 11.3.1<br>ASSUMED PARAMETERS FOR DOSE ESTIMATE UNDER SHORT-TERM OPERATIONS AND UNDER LONG-TEM STORAGE | | |
|---|---|---|
| | **Item** | **Value** |
| **1.** | **MPC-Contents (MPC-37)[1]** | **Representative: 45,000 MWD/MTU and 4.5 years**<br><br>**Adjustment Factors for bounding content:**<br>**HI-TRAC 1.2**<br>**HI-STORM 2.0** |
| **2.** | **Weight of HI-TRAC VW Full of Fuel and Water** | **125 tons** |
| **3.** | **HI-STORM Concrete Density** | **150 lb/cubic feet** |

[1] The case of MPC-37 is used but similar results are expected for all MPC types.

| TABLE 11.3.2: ESTIMATED PERSON-MREM DOSE FOR LOADING THE HI-STORM FW SYSTEM | | | | |
|---|---|---|---|---|
| **Task Description (See Chapter 9 for detailed description of operations)** | **Average Number of Personnel in Direct Radiation Field** | **Exposure Duration in Direct Radiation Field (mins)** | **Average Dose Rate at worker location (mrem/hr)** | **Exposure Representative / Bounding (mrem)** |
| Fuel loading and removal of the transfer cask and MPC from the spent fuel pool (includes: fuel loading, fuel assembly identification check, MPC lid installation, Lift Yoke attachment to the HI-TRAC VW, HI-TRAC VW removal from the spent fuel pool, preliminary decontamination, HI-TRAC VW movement to the DAS, Lift Yoke removal and decontamination. Background radiation of 1 mrem/hr assumed. | 3 | 800 | 1.0 | 40.0 / 40.0 |
| MPC preparation for closure (includes: HI-TRAC VW and MPC decontamination, radiation surveys, partial MPC pump down, annulus seal removal, partial lowering of annulus water level, annulus shield ring installation, weld system installation); workers assumed to be on scaffolding near the top of the HI-TRAC. | 3 | 30 | 55.7 | 83.5 / 100.2 |

**TABLE 11.3.2: ESTIMATED PERSON-MREM DOSE FOR LOADING THE HI-STORM FW SYSTEM**

| Task Description (See Chapter 9 for detailed description of operations) | Average Number of Personnel in Direct Radiation Field | Exposure Duration in Direct Radiation Field (mins) | Average Dose Rate at worker location (mrem/hr) | Exposure Representative / Bounding (mrem) |
|---|---|---|---|---|
| MPC Closure (includes MPC lid to shell welding, weld inspection). Assumes welding machine uses standard Holtec pedestal which provides additional shielding. Holtec auxiliary shielding methods and equipment assumed. Assumes operators are present for 10% of the total duration. | 2 | 185 | 55.7 | 34.3 / 41.2 |
| MPC Preparation for Storage (includes: MPC hydrostatic testing, draining, drying and backfill, vent and drain port cover plate installation, welding, weld inspection and leakage testing). Holtec auxiliary shielding methods and equipment assumed. Assumes operators are present for 20% of the total duration. | 2 | 170 | 175.4 | 198.7 / 238.4 |
| MPC Closure Ring Installation (includes: closure ring to MPC shell welding, weld inspection and leakage testing of the MPC primary closure). Holtec auxiliary shielding methods and equipment assumed (lead blankets, water shields, etc.) Assumes operators are present for 10% of the total duration. | 2 | 80 | 229.4 | 61.2 / 73.4 |

**TABLE 11.3.2: ESTIMATED PERSON-MREM DOSE FOR LOADING THE HI-STORM FW SYSTEM**

| Task Description (See Chapter 9 for detailed description of operations) | Average Number of Personnel in Direct Radiation Field | Exposure Duration in Direct Radiation Field (mins) | Average Dose Rate at worker location (mrem/hr) | Exposure Representative / Bounding (mrem) |
|---|---|---|---|---|
| HI-STORM FW system preparation for receiving MPC (includes: HI-STORM FW overpack positioning at transfer location, HI-STORM lid removal, Mating Device installation on HI-STORM FW overpack). | 3 | 160 | 0 | 0 / 0 |
| MPC Transfer (attachment of MPC lifting device, movement of HI-TRAC VW to transfer location, placement of HI-TRAC VW in Mating Device, bottom lid removal, MPC lowering, HI-TRAC VW removal, MPC lift device removal). Holtec auxiliary shielding methods and equipment assumed. Assumes operators are present for 10% of the total duration. | 3 | 120 | 148 | 88.8 / 106.6 |
| HI-STORM FW overpack movement to the ISFSI (will include: movement of the HI-STORM FW overpack from the fuel building to placement of the HI-STORM FW overpack on the ISFSI pad, disconnecting transporter, attachment of HI-STORM FW lid, attachment of thermal monitoring system). Holtec auxiliary shielding methods and equipment assumed. Assumes operators are present for 50% of the total duration. | 3 | 220 | 37.3 | 205.2 / 410.4 |

| TABLE 11.3.2: ESTIMATED PERSON-MREM DOSE FOR LOADING THE HI-STORM FW SYSTEM | | | | |
|---|---|---|---|---|
| **Task Description (See Chapter 9 for detailed description of operations)** | **Average Number of Personnel in Direct Radiation Field** | **Exposure Duration in Direct Radiation Field (mins)** | **Average Dose Rate at worker location (mrem/hr)** | **Exposure Representative / Bounding (mrem)** |
| TOTAL EXPOSURE (person-mrem) | | | | 711.6 / 1010.2 |