A, B, C, D = Polynomial coefficients listed in Table 2.1.9 or Table 2.1.10

Minimum cooling time must also meet limits specified in Tables 2.1.1a and 2.1.1b. If the calculated *Ct* is less than the cooling time limits in Tables 2.1.1a or 2.1.1b, the minimum cooling time in table is used.

For the assembly array/class 10x10J in the MPC-89, an adjustment to the assembly-average burnup used in the above equation is required. This is discussed in Section 2.1.6.4.

For MPC-37 and MPC-89, the coefficients for above equation for the assembly in an individual cell depend on the heat load limit in that cell, Table 2.1.10 lists the coefficients for several heat load limit ranges. Note that the heat load limits are only used for the lookup of the coefficients in that table, and do not imply any equivalency. Specifically, meeting heat load limits is not a substitute for meeting burnup and cooling time limits, and vice versa.

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 2.1.1b.

2.1.6.2 Radiological Parameters for Spent Fuel and Non-fuel Hardware in MPC-37P and MPC-44

MPC-37P is authorized to store CE15x15 spent fuel with burnup - cooling time combinations as given in Table 2.1.12. MPC-44 is authorized to store 14x14 spent fuel with burnup - cooling time combinations as given in Table 2.1.12.

The burnup and cooling time for every fuel assembly loaded into the MPC-37P and MPC-44 must satisfy the following equation:

$$Ct = A \cdot Bu^4 + B \cdot Bu^3 + C \cdot Bu^2 + D\,Bu + E$$

where,

Ct = Minimum cooling time (years),

Bu = Assembly-average burnup (MWd/mtU),

A, B, C, D, E = Polynomial coefficients listed in Table 2.1.12.

2.1.6.3 Alternative Radiological Parameters for Spent Fuel in the MPC-37 and MPC-37P

As an alternative to the radiological parameters for the MPC-37 and MPC-37P defined in Sections 2.1.6.1 and 2.1.6.2, it is permissible to use the parameters in Tables 2.1.13 and 2.1.14. These tables also define minimum cooling time as a function of burnup, but instead of specifying

those through polynomials, the limits are directly specified in the tables. All assemblies in a single MPC must either meet the limits from Subsections 2.1.6.1 and 2.1.6.2, or the limits in those tables. A combination is not permitted.

2.1.6.4 Radiological Parameters for Assembly Array/Class 10x10J lLoaded according to the Patterns in Tables 1.2.4a, 1.2.4.b or 1.2.4.c

For array/class 10x10J, modified or additional requirements must be met, to account for the higher uranium mass of this assembly type compared to the design basis assembly. This is to ensure that when any cask is loaded with one or more 10x10J assemblies, dose rates around the cask are still below a cask loaded with design basis fuel. The adjustment or requirements depends on the storage pattern that is used, as discussed below.

When loading assemblies corresponding to array/class 10x10J according to Table 1.2.4b, i.e. in one of the alternative patterns in Figure 1.2.6 or 1.2.7, the burnup of the assembly used in the equation needs to be increased before use. This will result in a larger required cooling time, hence reduced source terms, that offsets the effect of the higher uranium mass. The level of increase is specified in a note to Table 2.1.10. This increase is only required for the array/class 10x10J, not for any other assemblies, even if they are located in the same basket and pattern.

When loading assemblies corresponding to array/class 10x10J according to Table 1.2.4a, the explicit burnup and cooling time combination requirements from Table 2.1.15 must be applied. This table already considers the effect of the increase uranium mass, so no further adjustments are necessary. This table only applies to the array/class 10x10J, not to any other assemblies, even if they are located in the same basket and pattern, and such other assemblies do not have any corresponding burnup and cooling time requirements.
For assembly class 10x10J loaded in the MPC-89 according to Table 1.2.4a the radiological parameters in Table 2.1.156 must be applied.

assembly is acceptable for loading in the MPC-89, but it is limited to the cells depicted in Figure 2.1.2

Fuel Assembly Number 2 is not acceptable for loading in the MPC-89. Fuel Assembly 2 is limited to the cell locations for DFCs in the MPC-89 (Figure 2.1.2). These cells, which are a subset of Region 3, have a decay heat limit lower than the decay heat of the assembly. This assembly will need additional cooling time (reduction in decay heat) to be acceptable for loading in the MPC-89.

Fuel Assembly Number 3 is acceptable for loading in Regions 1, 2 or 3 of the MPC-89.

Fuel Assembly Number 4 is acceptable for loading in Region 2 of the MPC-89 only. The fuel assembly is limited to these locations due to the total heat load of the fuel assembly.

Example 3

In this example, it will be assumed that the MPC-89 is being loaded with array/class 10x10J fuel in the alternative storage patterns in Table 1.2.4b (Figures 1.2.6 and 1.2.7).

Table 13.2.3 provides four hypothetical fuel assemblies in the 10x10J array/class that will be evaluated for acceptability. The decay heat values and the fuel classification in Table 13.2.3 are determined by the user. The other information is taken from the fuel assembly and reactor operating records.

Note that the acceptability evaluations below only apply to assembly array/class 10x10J. Other assemblies, even if they are located in the same cask and pattern, would be evaluated using the polynomial coefficients in Table 2.1.10 with no additional adjustment.

Fuel Assembly Number 1 is acceptable for loading, but only when using the storage patterns in Figures 1.2.6b and 1.2.7b. The assembly is damaged, i.e. must be placed in a DFC, and only the locations permitted for a DFC in the patterns can be used. The assembly is not acceptable for loading in the storage patterns in Figures 1.2.6a and 1.2.7a because the heat load of the fuel assembly exceeds the assembly decay heat limit for the storage cells permitted for DFCs. Figures 1.2.6b and 1.2.7b provide the storage patterns with the higher decay heat limits in all DFC cells than the decay heat of the assembly. Assuming the maximum allowable heat load limit of 1.46 kW in Figure 1.2.7b, the minimum required cooling time is calculated as discussed in Paragraph 2.1.6.1, using the polynomial coefficients in Table 2.1.10 with the appropriate adjustment per Note 2 of Table 2.1.10. The determined minimum cooling time of 1.24 years is lower than the assembly cooling time, hence it is acceptable for loading in MPC-89 using the storage patterns in Figures 1.2.6b and 1.2.7b.

Fuel Assembly Number 2 is not acceptable for loading. This assembly is not acceptable for loading in the storage patterns in Figures 1.2.6 and 1.2.7 because the heat load of the fuel assembly exceeds the assembly decay heat limit for the storage cells permitted for DFCs.

Fuel Assembly Number 3 is acceptable for loading. The calculations of the minimum required cooling time, which are performed as discussed in Paragraph 2.1.6.1, using the polynomial coefficients in Table 2.1.10 with the appropriate adjustment per Note 2 of Table 2.1.10, demonstrate that Fuel Assembly 3 would be acceptable for loading into any cell of the storage patterns in Figures 1.2.6 and 1.2.7 that is permitted for fuel storage. However, some cells in Figure 1.2.7 have a decay heat limit lower than the decay heat of the assembly. Therefore, Fuel Assembly 3 is acceptable for loading in all storage cells of Figure 1.2.6 as well as all storage cells with a decay heat limit not less than the assembly decay heat of Figure 1.2.7, except the storage cells required to be empty.

Fuel Assembly Number 4 is acceptable for loading. Fuel Assembly 4 is acceptable for loading in the storage cells of Figures 1.2.6 and 1.2.7 with a decay heat limit higher than the decay heat of the assembly. The calculated minimum required cooling times for these cells, which are determined as discussed in Paragraph 2.1.6.1, using the polynomial coefficients in Table 2.1.10 with the appropriate adjustment per Note 2 of Table 2.1.10, are lower than the assembly cooling time.

Example 4

In this example, it will be assumed that the MPC-89 is being loaded with array/class 10x10J fuel in the regionalized storage pattern in Figure 1.2.2 with heat loads from Table 1.2.4a.

The same four hypothetical assemblies as those for Example 3 are used, shown in Table 13.2.3.

Note that the acceptability evaluations below only apply to assembly array/class 10x10J. Other assemblies, even if they are located in the same cask and pattern, do not have a corresponding table with any explicit burnup and cooling time requirements, hence they would be evaluated as outlined in Example 2, and only the general limits (maximum burnup, minimum cooling time) listed in Table 2.1.1a would apply.

Fuel Assembly Number 1 is not acceptable for loading. Fuel Assembly 1 is limited to the cell locations for DFCs in MPC-89 (Figure 2.1.2). These cells, which are a subset of Region 3, have a decay heat limit higher than the decay heat of the assembly. However, the fuel assembly burnup and cooling time do not satisfy the Region 3 qualification requirements in Table 2.1.15. Therefore, the assembly is not acceptable for loading in MPC-89 and requires additional cooling time to be acceptable for loading under Table 1.2.4a.

Fuel Assembly Number 2 is not acceptable for loading. Fuel Assembly 2 is limited to the cell locations for DFCs in MPC-89 (Figure 2.1.2). These cells, which are a subset of Region 3, have a decay heat limit lower than the decay heat of the assembly. Therefore, the assembly is not acceptable for loading in MPC-89 and requires additional cooling time (reduction in decay heat) to be acceptable for loading under Table 1.2.4a.

Fuel Assembly Number 3 is acceptable for loading. The decay heat of Fuel Assembly 3 is lower than the decay heat limits in Regions 1, 2 and 3 of Table 1.2.4a. Also, the fuel assembly burnup

and cooling time satisfy the qualification requirements for Regions 1, 2 and 3 in Table 2.1.15. Therefore, it is acceptable for loading in Regions 1, 2 or 3 of MPC-89 under Table 1.2.4a.

Fuel Assembly Number 4 is acceptable for loading. Fuel Assembly 4 is acceptable for loading in Region 2 of MPC-89 only. The fuel assembly is limited to these locations due to the decay heat of the fuel assembly. The fuel assembly burnup and cooling time satisfy the qualification requirements for Region 2 in Table 2.1.15.