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2.1   Fuel Specifications and Loading Conditions (cont'd)

   2.1.3   Regionalized Fuel Loading

   Users may choose to store fuel using regionalized loading in lieu of uniform loading to allow higher heat emitting fuel assemblies to be stored than would otherwise be able to be stored using uniform loading. Figures 2.1-1 through 2.1-4 define the regions for the MPC-24, MPC-24E, MPC-24EF, MPC-32, MPC-32F, MPC-68, MPC-68FF, and MPC-68M models, respectively[1]. Fuel assemblydecay heat limits for regionalized loading are specified in Section 2.4.2 for VENTILATED OVERPACK, and Section 2.4.5 for UNVENTILATED OVERPACK. Fuel assemblies used in regionalized loading shall meet all other applicable limits specified in Tables 2.1-1 through 2.1-3.

2.2   Violations

   If any Fuel Specifications or Loading Conditions of 2.1 are violated, the following actions shall be completed:

   2.2.1   The affected fuel assemblies shall be placed in a safe condition.

   2.2.2   Within 24 hours, notify the NRC Operations Center.

   2.2.3   Within 30 days, submit a special report which describes the cause of the violation, and actions taken to restore compliance and prevent recurrence.

2.3   Not Used

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[1]   These figures are only intended to distinguish the fuel loading regions. Other details of the basket design are illustrative and may not reflect the actual basket design details. The design drawings should be consulted for basket design details.

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2.4   Decay Heat Limits for ZR-Clad Fuel

This section provides the limits on ZR-clad fuel assembly decay heat, burnup, and cooling time for storage in the HI-STORM 100 System. The method to calculate the limits and verify compliance, including examples, is provided in Chapter 12 of the HI-STORM 100 FSAR.

2.4.1   Uniform Fuel Loading Decay Heat Limits for ZR-clad fuel for VENTILATED OVERPACK

Table 2.4-1 provides the maximum allowable decay heat per fuel storage location for ZR-clad fuel in uniform fuel loading for each MPC model.

Table 2.4-1
Maximum Allowable Decay Heat per Fuel Storage Location
(Uniform Loading, ZR-Clad)

MPC Model	Decay Heat per Fuel Storage Location (kW)	
	Intact or Undamaged Fuel Assemblies	Damaged Fuel Assemblies and Fuel Debris
MPC-24	≤ 1.416	Not Permitted
MPC-24E/24EF	≤ 1.416	≤ 1.114
MPC-32/32F	≤ 1.062	≤ 0.718
MPC-68/68FF/68M	≤ 0.500	≤ 0.393

2.4.2 Regionalized Fuel Loading Decay Heat Limits for ZR-Clad Fuel for VENTILATED OVERPACK

The maximum allowable decay heat per fuel storage location for intact or undamaged fuel assemblies in regionalized loading is determined using the following equations:

$Q(X) = 2 \times Q_0 / (1 + X^y)$

$y = 0.23 / X^{0.1}$

$q_2 = Q(X) / (n_1 \times X + n_2)$

$q_1 = q_2 \times X$

Where:

Q_0 = Maximum uniform storage MPC decay heat (34 kW)

X = Inner region to outer region assembly decay heat ratio

  $(0.5 \leq X \leq 3)$

n_1 = Number of storage locations in inner region from Table 2.4-2.

n_2 = Number of storage locations in outer region from Table 2.4-2.

Allowable heat loads for Damaged Fuel and Fuel Debris in regionalized loading are shown in Table 2.4-5.

Optional loading patterns for MPC-68M are shown in Figures 2.4-1 through 2.4-4.

2.4.3   Burnup Limits as a Function of Cooling Time for ZR-Clad Fuel for VENTILATED OVERPACK

The maximum allowable ZR-clad fuel assembly average burnup varies with the minimum required fuel assembly cooling time. Tables 2.4-3 and 2.4-4 provide for each MPC the allowable maximum burnup based on the assembly's particular cooling time.

   2.4.3.1   Linear interpolation of burnups between cooling times is permitted. For example, the allowable burnup for a cooling time of 4.5 years may be interpolated between those burnups calculated for 4 year and 5 years.

   2.4.3.2   Calculated burnup limits shall be rounded down to the nearest integer.

3.   2.4.3.3   Calculated burnup limits greater than 68,200 MWD/MTU for PWR fuel and 65,000 MWD/MTU for BWR must be reduced to be equal to these values~~The maximum allowable fuel assembly average burnup varies with the following parameters:~~

~~Minimum fuel assembly cooling time~~

~~Maximum fuel assembly decay heat~~

~~Minimum fuel assembly average enrichment~~

~~The maximum allowable ZR-clad fuel assembly average burnup for a given MINIMUM ENRICHMENT is calculated as described below for minimum cooling times between 2 and 40 years using the maximum permissible decay heat determined in Section 2.4.1 or 2.4.2. Different fuel assembly average burnup limits may be calculated for different minimum enrichments (by individual fuel assembly) for use in choosing the fuel assemblies to be loaded into a given MPC.~~
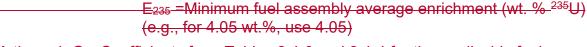
~~2.4.3.1   Choose a fuel assembly minimum enrichment, E_{235}.~~

~~2.4.3.2   Calculate the maximum allowable fuel assembly average burnup for a minimum cooling time between 2 and 40 years using the equation below.~~

~~$Bu = (A \times q) + (B \times q^2) + (C \times q^3) + [D \times (E_{235})^2] + (E \times q \times E_{235}) + (F \times q^2 \times E_{235}) + G$~~

~~Where:~~

~~Bu =   Maximum allowable average burnup per fuel assembly (MWD/MTU)~~

~~q =   Maximum allowable decay heat per fuel storage location determined in Section 2.4.1 or 2.4.2 (kW)~~

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E_{235} = Minimum fuel assembly average enrichment (wt. % ^{235}U) (e.g., for 4.05 wt.%, use 4.05)

A through G = Coefficients from Tables 2.4-3 and 2.4-4 for the applicable fuel assembly array/class and minimum cooling time

2.4.3.3

2.4.3.4   Calculated burnup limits shall be rounded down to the nearest integer.Calculated burnup limits greater than 68,200 MWD/MTU for PWR fuel and 65,000 MWD/MTU for BWR must be reduced to be equal to these values.

2.4.3.5   .Linear interpolation of calculated burnups between cooling times for a given fuel assembly maximum decay heat and minimum enrichment is permitted. For example, the allowable burnup for a cooling time of 4.5 years may be interpolated between those burnups calculated for 4 year and 5 years.

2.4.3.6   Each ZR-clad fuel assembly to be stored must have a MINIMUM ENRICHMENT greater than or equal to the value used in Step 2.4.3.2.

3.4.12.4.4   When complying with the maximum fuel storage location decay heat limits, users must account for the decay heat from both the fuel assembly and any NON-FUEL HARDWARE, as applicable for the particular fuel storage location, to ensure the decay heat emitted by all contents in a storage location does not exceed the limit.

2.4.5   Fuel Loading Decay Heat Limits for UNVENTILATED OVERPACK

Tables 2.4-6a and 2.4-6b provide the maximum allowable decay heat per fuel storage location for MPC-68M in an UNVENTILATED OVERPACK.

A minor deviation from the prescribed loading pattern in an MPC's permissible contents to allow one slightly thermally-discrepant fuel assembly per quadrant to be loaded as long as the peak cladding temperature for the MPC remains below the ISG-11 Rev 3 requirements is permitted for essential dry storage campaigns to support decommissioning.

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2.4.6 Burnup and Cooling Time Qualifications for the MPC-68M for UNVENTILATED OVERPACK

The burnup and cooling time for every fuel loaded into the MPC-68M must satisfy the following equation:

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

where,
Ct   = Minimum cooling time (years),
Bu   = Assembly-average burnup (MWd/mtU),
A, B, C, D= Polynomial coefficients listed in Table 2.4-9

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Table 2.4-3 (Page 1 of 8)

PWR Fuel Assembly Burnup and Cooling Time Dependent Coefficients Limits for VENTILATED OVERPACK
(ZR-Clad Fuel)

Minimum Cooling Time (years)	Maximum Allowable Burnup, MWd/mtU
MPC-24/24E/24EF	
1.0	5,000
1.4	15,000
1.8	25,000
2.0	35,000
2.2	40,000
2.4	45,000
2.6	50,000
2.8	55,000
3.0	60,000
4.0	69,000
5.0	75,000
MPC-32/32F	
1.0	5,000
1.4	10,000
1.8	20,000
2.0	25,000
2.2	30,000
2.4	35,000
2.6	40,000
3.0	45,000
4.0	60,000
5.0	69,000

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~~Table 2.4-3 (Page 2 of 8)~~

~~PWR Fuel Assembly Cooling Time-Dependent Coefficients~~
~~(ZR-Clad Fuel)~~

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Table 2.4-3 (Page 3 of 8)

PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 14x14C						
	A	B	C	D	E	F	G
2.0	7910.49	1566.52	-112.06	-173.92	1975.67	-202.57	-1582.61
2.25	10090.40	1516.08	-132.53	-164.22	2144.71	-245.91	-1586.24
2.5	12672.30	1230.85	-127.98	-154.40	2293.68	-288.88	-1526.05
2.75	15404.70	785.48	-103.88	-146.02	2435.58	-333.58	-1526.92
3.0	18263.20	174.52	-57.73	-138.13	2539.97	-369.83	-1372.54
4.0	30052.40	-3931.93	484.14	-116.91	2815.30	-467.36	-710.84
5.0	40995.00	-9796.91	1583.72	-113.09	2900.21	-451.56	-204.87
6.0	49804.50	-15620.10	2905.31	-119.64	2970.21	-399.85	-228.44
7.0	56671.50	-20724.30	4228.04	-129.87	3058.54	-347.83	-244.26
8.0	62114.70	-24957.40	5410.68	-135.49	3080.42	-267.82	-216.83
9.0	66532.70	-28492.00	6458.64	-138.92	3102.21	-196.64	-343.21
10.0	70257.00	-31538.30	7424.54	-139.96	3109.64	-131.37	-466.58
11.0	73240.40	-33856.10	8182.60	-139.49	3113.36	-77.52	-528.62
12.0	75830.10	-35829.20	8857.54	-137.30	3097.43	-23.81	-597.83
13.0	78304.00	-37697.30	9499.38	-132.64	3034.49	60.52	-690.28
14.0	80401.00	-39162.40	10022.20	-129.04	3004.11	112.39	-819.41
15.0	82413.50	-40565.20	10547.80	-125.00	2972.01	159.60	-815.35
16.0	84138.60	-41575.10	10920.50	-121.03	2935.91	206.01	-844.59
17.0	85994.20	-42654.40	11295.20	-113.82	2848.12	279.72	-924.47
18.0	87721.10	-43657.50	11664.00	-108.56	2775.07	353.35	-960.97
19.0	89122.20	-44109.80	11806.40	-103.94	2740.54	384.66	-864.21
20.0	90678.60	-44723.70	11996.00	-97.44	2648.86	459.77	-907.84
22.0	93894.70	-46071.00	12444.30	-85.57	2487.47	593.03	-912.09
24.0	96742.60	-46597.20	12482.60	-75.19	2358.14	688.79	-833.76
26.0	99697.50	-47055.90	12472.30	-63.23	2185.39	810.10	-803.84
28.0	102343.00	-46639.70	11970.90	-52.13	2038.03	893.63	-704.66
30.0	105173.00	-46148.00	11326.10	-41.21	1856.73	1002.71	-620.51
35.0	111963.00	-42828.60	8640.91	-13.96	1473.64	1063.44	-455.86
40.0	118574.00	-36526.50	4330.66	12.00	1111.29	892.32	-351.40

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PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 15x15A/B/C						
	A	B	C	D	E	F	G
2.0	6771.99	897.63	-45.95	-155.96	1478.91	-112.57	-571.21
2.25	8543.84	862.70	-53.16	-148.35	1638.47	-142.90	-603.00
2.5	10454.10	757.88	-56.51	-143.91	1802.08	-178.39	-613.38
2.75	12589.40	536.75	-50.58	-136.31	1939.28	-212.48	-598.75
3.0	15043.50	106.18	-18.51	-127.37	2049.65	-242.76	-584.58
4.0	25256.40	-2809.40	320.40	-108.47	2382.23	-339.78	-246.30
5.0	34995.70	-7157.77	1037.70	-104.27	2547.85	-373.57	64.26
6.0	43079.90	-11755.40	1968.81	-110.42	2669.55	-367.08	207.73
7.0	49495.50	-15880.10	2915.99	-117.70	2745.06	-335.00	79.17
8.0	54674.20	-19541.50	3863.26	-124.97	2823.26	-307.52	-139.52
9.0	58746.90	-22465.30	4666.71	-128.88	2870.36	-274.05	-284.74
10.0	62159.00	-24900.00	5358.04	-129.81	2882.28	-231.65	-307.41
11.0	64980.00	-26916.40	5974.92	-128.99	2890.02	-197.70	-320.91
12.0	67449.80	-28657.30	6533.20	-126.96	2889.14	-168.72	-358.64
13.0	69587.80	-30096.10	7005.49	-125.03	2881.70	-138.49	-417.57
14.0	71617.00	-31412.90	7443.05	-120.37	2839.04	-95.47	-497.72
15.0	73320.90	-32442.90	7811.27	-117.59	2836.73	-78.55	-582.44
16.0	75078.70	-33504.10	8184.69	-111.70	2773.08	-28.70	-569.58
17.0	76605.90	-34256.30	8446.38	-106.43	2722.31	10.58	-648.37
18.0	78201.90	-35135.30	8779.71	-102.00	2687.99	34.04	-637.10
19.0	79683.00	-35825.50	9024.65	-96.68	2626.60	78.21	-644.17
20.0	81040.00	-36264.40	9175.96	-90.42	2571.71	105.53	-621.79
22.0	83842.80	-37347.80	9582.93	-79.77	2452.81	179.87	-678.83
24.0	86457.20	-37934.30	9779.99	-69.09	2348.63	223.29	-555.43
26.0	89143.70	-38488.40	9965.70	-58.22	2222.80	276.21	-541.65
28.0	91552.10	-38289.80	9775.89	-47.03	2083.59	328.54	-483.47
30.0	93976.80	-37775.30	9380.97	-35.17	1933.91	367.06	-412.13
35.0	99743.70	-35109.80	7937.17	-10.10	1701.23	242.55	-292.95
40.0	105747.00	-30710.40	5734.70	16.14	1409.70	-19.63	-330.25

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PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 15x15D/E/F/H/I						
	A	B	C	D	E	F	G
2.0	6290.79	883.39	-49.29	-150.42	1348.67	-93.23	-194.84
2.25	7850.16	906.09	-62.37	-145.85	1507.07	-121.33	-234.20
2.5	9917.64	729.63	-57.61	-138.51	1649.34	-150.19	-389.61
2.75	12039.70	498.88	-50.28	-132.19	1776.46	-179.02	-384.86
3.0	14308.20	140.88	-27.37	-126.11	1896.47	-208.80	-424.35
4.0	24246.40	-2585.64	274.38	-105.96	2197.31	-292.15	-98.88
5.0	33660.00	-6672.88	931.23	-104.57	2380.99	-330.06	323.27
6.0	41534.90	-11039.20	1790.84	-111.20	2485.37	-318.04	436.06
7.0	47737.40	-14940.00	2668.46	-119.75	2572.84	-293.94	394.87
8.0	52510.40	-18097.60	3446.19	-126.75	2647.38	-274.16	310.51
9.0	56484.50	-20845.30	4162.00	-129.08	2662.71	-225.75	158.84
10.0	59692.00	-23093.90	4799.05	-130.53	2692.07	-199.57	18.86
11.0	62307.70	-24865.90	5320.34	-130.34	2710.88	-176.52	-96.66
12.0	64497.20	-26247.00	5725.38	-127.89	2691.98	-137.42	-152.99
13.0	66473.70	-27479.90	6111.71	-124.64	2678.39	-110.34	-220.62
14.0	68322.50	-28605.10	6471.87	-120.12	2648.26	-78.83	-317.16
15.0	69880.10	-29416.90	6732.96	-115.83	2620.06	-52.26	-351.02
16.0	71504.30	-30337.40	7046.36	-110.89	2583.27	-22.60	-386.91
17.0	72938.30	-31008.00	7269.02	-105.81	2541.55	5.22	-421.21
18.0	74306.50	-31601.90	7471.26	-100.67	2498.95	31.67	-421.69
19.0	75649.10	-32149.50	7661.36	-95.47	2449.77	61.38	-439.23
20.0	76868.40	-32525.30	7793.09	-90.99	2421.09	73.14	-450.75
22.0	79592.40	-33604.00	8197.86	-78.90	2293.07	142.14	-486.11
24.0	81996.10	-34015.70	8295.91	-67.98	2173.93	196.55	-435.49
26.0	84232.50	-34067.60	8271.85	-57.61	2083.11	215.81	-374.64
28.0	86620.60	-34049.50	8171.94	-45.82	1954.61	249.73	-400.41
30.0	88983.60	-33826.80	8026.95	-34.27	1835.41	255.33	-353.18
35.0	94579.10	-31817.80	7120.43	-8.81	1596.94	131.34	-263.56
40.0	100058.00	-27653.80	5318.64	17.12	1355.45	-187.62	-273.88

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PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 16X16A						
	A	B	C	D	E	F	G
2.0	7213.94	1062.48	-60.18	-163.16	1632.73	-137.39	-660.90
2.25	9068.86	1052.65	-73.90	-157.12	1812.61	-174.53	-682.57
2.5	11282.40	881.74	-74.10	-149.28	1970.43	-212.23	-710.99
2.75	13602.30	625.18	-68.06	-143.44	2124.68	-253.65	-734.52
3.0	16226.30	143.97	-32.51	-136.73	2255.52	-291.73	-699.79
4.0	27528.60	-3346.42	393.54	-115.66	2587.71	-397.43	-273.55
5.0	38357.70	-8605.59	1312.06	-110.58	2719.25	-409.35	60.77
6.0	47353.00	-14184.20	2511.45	-117.96	2810.98	-373.58	26.38
7.0	54492.70	-19227.40	3751.22	-126.74	2889.14	-321.58	-84.61
8.0	60159.30	-23487.00	4884.62	-133.44	2918.29	-242.53	-126.66
9.0	64663.30	-26994.20	5900.01	-137.02	2946.64	-181.25	-285.69
10.0	68346.00	-29851.40	6755.60	-138.49	2958.18	-120.30	-384.11
11.0	71361.10	-32184.10	7502.54	-138.40	2964.72	-68.91	-497.04
12.0	74014.20	-34136.30	8127.59	-135.73	2938.32	-7.78	-627.98
13.0	76326.40	-35820.10	8697.58	-132.72	2908.57	49.64	-715.32
14.0	78450.30	-37288.70	9197.21	-128.85	2871.70	104.32	-771.96
15.0	80439.10	-38636.00	9667.15	-124.14	2815.86	168.64	-851.14
16.0	82142.00	-39610.20	10013.20	-120.20	2790.66	203.72	-859.48
17.0	83886.70	-40590.10	10336.30	-114.04	2714.78	270.50	-870.62
18.0	85580.90	-41545.60	10677.80	-108.53	2648.66	332.69	-921.15
19.0	87028.10	-42030.60	10787.80	-102.57	2576.39	390.15	-880.17
20.0	88490.60	-42584.60	10956.70	-97.67	2529.96	430.91	-912.08
22.0	91586.50	-43770.60	11272.60	-85.21	2343.82	579.90	-878.01
24.0	94293.80	-44158.40	11248.70	-74.44	2224.40	656.22	-824.58
26.0	97086.50	-44420.30	11078.90	-62.82	2045.62	784.53	-737.98
28.0	99965.10	-44515.00	10777.60	-51.29	1871.32	897.77	-719.30
30.0	102352.00	-43418.60	9831.79	-40.46	1725.50	957.49	-626.62
35.0	109039.00	-40353.50	7075.81	-12.07	1286.03	1106.60	-531.72
40.0	115345.00	-34020.20	2448.15	13.49	928.92	963.44	-395.64

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PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 17x17A/16x16B/C						
	A	B	C	D	E	F	G
2.0	7482.84	749.18	-32.06	-153.69	1490.54	-111.64	-301.94
2.25	9138.06	783.14	-45.73	-148.43	1678.27	-147.42	-271.38
2.5	11115.90	682.88	-49.46	-143.38	1855.10	-184.65	-248.90
2.75	13492.40	392.81	-34.32	-137.63	2018.42	-224.60	-364.95
3.0	15985.10	3.54	-9.05	-128.84	2149.50	-260.42	-263.00
4.0	27326.30	-3316.13	388.73	-110.89	2545.62	-376.10	-60.44
5.0	38630.20	-8729.17	1335.65	-109.86	2754.84	-407.49	244.70
6.0	48364.20	-14788.30	2652.90	-117.55	2878.88	-375.72	252.15
7.0	56144.10	-20415.70	4068.96	-128.12	2970.68	-312.43	-145.42
8.0	62319.20	-25122.10	5332.37	-133.94	2986.20	-212.65	-192.32
9.0	67097.40	-28916.30	6441.26	-139.07	3028.70	-142.12	-304.90
10.0	71141.80	-32210.80	7461.17	-140.60	3037.68	-63.75	-484.40
11.0	74293.50	-34623.40	8214.63	-140.16	3026.35	11.71	-567.89
12.0	77101.60	-36783.10	8922.19	-138.37	3008.48	83.17	-677.97
13.0	79705.10	-38760.90	9576.13	-134.21	2949.33	173.71	-820.83
14.0	81840.20	-40208.40	10063.30	-130.61	2915.99	236.79	-867.80
15.0	83845.30	-41560.10	10535.80	-126.12	2867.51	306.60	-940.08
16.0	85751.10	-42671.70	10876.60	-120.77	2799.15	386.28	-990.12
17.0	87613.20	-43744.30	11214.60	-114.75	2722.88	466.15	-1028.96
18.0	89198.60	-44487.50	11451.40	-110.00	2673.61	522.32	-974.28
19.0	90843.80	-45204.50	11637.70	-103.89	2591.93	602.99	-1048.14
20.0	92361.20	-45701.20	11710.50	-98.45	2507.40	689.65	-1034.50
22.0	95455.20	-46715.70	11886.10	-86.86	2353.10	835.28	-1006.44
24.0	98319.40	-46988.20	11622.80	-74.63	2169.86	995.06	-941.81
26.0	101240.00	-47039.80	11136.00	-62.32	1971.79	1168.97	-907.73
28.0	103863.00	-46243.10	10186.30	-51.51	1822.28	1270.39	-758.20
30.0	106638.00	-45299.90	9011.04	-39.38	1598.42	1447.93	-698.69
35.0	113059.00	-40056.10	4113.55	-12.17	1169.02	1660.44	-557.52
40.0	119131.00	-30799.70	-3521.78	14.35	791.94	1564.09	-401.82

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Table 2.4-3 (Page 8 of 8)

PWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 17x17B/C						
	A	B	C	D	E	F	G
2.0	6766.33	744.89	-33.96	-154.11	1387.05	-99.30	-455.94
2.25	8406.78	735.84	-42.13	-148.76	1546.40	-127.76	-412.22
2.5	10326.00	618.40	-42.67	-140.84	1696.17	-158.83	-428.21
2.75	12425.70	400.95	-35.11	-134.79	1833.92	-190.65	-448.69
3.0	14787.40	16.36	-8.09	-128.41	1953.16	-221.24	-426.08
4.0	25076.00	-2855.35	319.19	-107.73	2268.19	-307.82	-118.54
5.0	34842.80	-7144.52	1015.11	-107.42	2457.65	-342.14	294.08
6.0	43259.40	-11920.40	1970.81	-113.08	2547.52	-316.78	82.08
7.0	49884.40	-16230.60	2962.56	-122.92	2650.94	-291.11	127.95
8.0	55105.20	-19804.80	3845.74	-128.64	2682.52	-232.47	-61.87
9.0	59268.90	-22820.00	4674.45	-133.56	2742.72	-203.91	-265.03
10.0	62653.20	-25227.80	5347.65	-134.19	2744.28	-150.34	-229.28
11.0	65528.50	-27328.80	5990.85	-134.07	2759.67	-117.12	-349.73
12.0	67925.00	-28930.10	6470.25	-131.66	2738.04	-69.75	-467.93
13.0	70014.00	-30295.30	6903.21	-128.41	2714.49	-27.74	-580.42
14.0	71939.40	-31542.90	7318.09	-124.70	2688.09	8.93	-630.83
15.0	73678.50	-32578.30	7669.57	-120.41	2659.19	41.04	-637.54
16.0	75313.80	-33488.20	7973.96	-115.46	2610.74	86.53	-708.01
17.0	76870.20	-34276.40	8238.11	-110.15	2563.22	123.29	-739.52
18.0	78338.30	-34971.50	8477.60	-104.26	2505.00	166.49	-731.14
19.0	79849.90	-35703.80	8726.57	-99.14	2447.13	211.29	-756.38
20.0	81109.20	-36047.10	8827.48	-93.99	2404.21	235.46	-751.74
22.0	83793.40	-36898.90	9088.73	-82.74	2281.57	313.80	-704.73
24.0	86424.70	-37453.70	9205.18	-70.11	2134.35	393.96	-654.44
26.0	88971.30	-37671.00	9134.01	-58.64	1983.82	478.46	-659.93
28.0	91497.60	-37723.60	9032.79	-47.61	1861.20	520.75	-564.47
30.0	93706.20	-36961.70	8512.11	-37.17	1743.83	543.52	-523.93
35.0	99798.50	-34670.70	6911.55	-9.53	1376.43	593.61	-406.67
40.0	105384.00	-29185.20	3708.34	16.92	1086.25	354.06	-343.59

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BWR Fuel Assembly Burnup and Cooling Time Dependent Coefficients Limits for VENTILATED OVERPACK
(ZR-Clad Fuel)

Minimum Cooling Time (years)	Maximum Allowable Burnup, MWd/mtU
MPC-68/68FF/68M	
1.0	10,000
1.2	15,000
1.4	20,000
2.0	25,000
2.2	30,000
2.4	35,000
2.6	40,000
3.0	50,000
4.0	62,000
5.0	65,000
6.0	70,000

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 8x8B						
	A	B	C	D	E	F	G
1.0	5872.87	4876.54	-344.60	-182.28	2276.71	-160.55	-2884.11
1.25	7240.18	6669.72	-674.77	-191.67	3008.15	-265.92	-1737.98
1.5	9133.59	8738.93	-1206.18	-186.94	3586.01	-573.93	-1179.83
1.75	12212.40	10285.80	-1758.81	-183.81	4183.48	-839.00	-1095.35
2.0	15913.80	11664.70	-2480.99	-179.56	4694.73	-1100.00	-1003.87
2.25	20652.00	12023.80	-3025.66	-174.12	5204.92	-1412.29	-979.17
2.5	26986.10	10399.30	-3032.60	-163.94	5594.88	-1694.85	-1213.71
2.75	33074.30	8670.65	-3129.69	-156.84	5959.94	-1975.74	-1054.90
3.0	39987.50	5388.94	-2722.03	-146.15	6189.85	-2184.18	-1039.58
4.0	68821.60	-18071.10	4016.97	-119.21	6655.64	-2578.72	-677.77
5.0	95032.70	-50959.00	18228.50	-113.67	6737.08	-2341.46	-253.74
6.0	117864.00	-88879.60	39468.80	-128.75	6937.68	-1918.61	-203.01
7.0	133919.00	-117151.00	56431.30	-139.69	6960.80	-1212.83	-123.38
8.0	147621.00	-142952.00	73246.80	-143.67	6879.18	-441.73	-342.11
9.0	158036.00	-165478.00	90946.70	-167.32	7480.35	-551.45	-378.22
10.0	166796.00	-181378.00	101771.00	-165.98	7346.03	114.50	-504.04
11.0	174312.00	-195869.00	112810.00	-165.26	7291.07	642.48	-648.03
12.0	180736.00	-207916.00	122412.00	-163.34	7243.01	1055.04	-742.81
13.0	187002.00	-219945.00	132127.00	-159.70	7084.08	1641.84	-903.88
14.0	192382.00	-229413.00	139613.00	-156.32	7001.62	2085.84	-972.60
15.0	196087.00	-233618.00	142299.00	-151.48	6860.06	2570.55	-883.73
16.0	202268.00	-249608.00	159974.00	-162.80	7359.57	1999.93	-1048.13
17.0	206376.00	-256109.00	166401.00	-159.20	7309.03	2257.68	-1062.93
18.0	209117.00	-255071.00	162389.00	-151.82	7125.28	2596.49	-891.61
19.0	213124.00	-261295.00	168674.00	-146.82	7004.96	2966.11	-951.40
20.0	217047.00	-267281.00	175609.00	-141.96	6943.62	3118.99	-1012.59
22.0	223569.00	-268761.00	171389.00	-127.42	6436.52	4175.11	-877.23
24.0	233533.00	-291046.00	200512.00	-131.73	6830.33	3613.57	-988.74
26.0	238557.00	-284966.00	188216.00	-118.63	6424.02	4316.86	-862.50
28.0	245385.00	-285588.00	185055.00	-105.51	6116.61	4651.69	-844.39
30.0	254559.00	-295608.00	196106.00	-100.36	6027.39	4465.31	-886.90
35.0	272231.00	-295589.00	203313.00	-71.05	5259.94	4464.18	-744.47
40.0	290782.00	-286198.00	204311.00	-50.38	4868.38	2364.75	-614.59

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 8x8C/D/E						
	A	B	C	D	E	F	G
1.0	5499.81	5105.94	-397.34	-189.28	2307.05	-157.92	-2489.82
1.25	673.01	7033.27	-751.51	-192.95	3068.21	-286.64	-1564.51
1.5	9164.56	8675.52	-1179.12	-194.38	3726.15	-623.94	-1216.26
1.75	12495.50	10090.50	-1732.25	-187.02	4238.65	-847.44	-1136.06
2.0	16663.00	10889.80	-2211.52	-182.17	4831.25	-1175.27	-1260.49
2.25	21598.90	10980.20	-2691.18	-176.65	5300.72	-1453.46	-1219.04
2.5	27348.40	10071.30	-2967.33	-165.41	5680.31	-1735.86	-1252.79
2.75	33467.10	8232.39	-2999.52	-158.56	6061.56	-2033.93	-1086.98
3.0	40382.30	4849.42	-2525.53	-148.53	6314.10	-2257.89	-1075.95
4.0	68954.10	-18263.30	4048.93	-123.13	6850.62	-2734.70	-652.59
5.0	96324.30	-53730.10	19778.60	-114.90	6841.59	-2381.30	-353.71
6.0	118229.00	-89906.60	39997.30	-134.45	7190.60	-2120.86	-143.41
7.0	134948.00	-119919.00	58227.10	-143.18	7200.03	-1397.69	-170.37
8.0	149092.00	-147517.00	76590.50	-149.16	7110.00	-528.97	-313.19
9.0	159771.00	-170139.00	93968.00	-170.19	7649.69	-595.38	-403.04
10.0	168715.00	-187828.00	107088.00	-172.19	7651.82	-46.57	-555.81
11.0	176169.00	-201821.00	117349.00	-170.83	7550.84	552.84	-651.76
12.0	182662.00	-214445.00	127628.00	-169.36	7519.56	997.32	-756.73
13.0	189114.00	-227085.00	137699.00	-166.11	7388.07	1583.27	-844.97
14.0	195273.00	-239345.00	148361.00	-160.79	7228.22	2124.28	-1017.11
15.0	199939.00	-249862.00	159949.00	-174.10	7782.47	1566.35	-1026.32
16.0	204899.00	-258274.00	166856.00	-167.77	7534.06	2227.05	-1070.51
17.0	209356.00	-265290.00	173458.00	-161.96	7463.49	2386.89	-1040.14
18.0	213546.00	-272476.00	180667.00	-158.41	7387.49	2763.66	-1098.37
19.0	217506.00	-277100.00	183949.00	-150.21	7155.18	3240.82	-1107.07
20.0	219837.00	-275266.00	179705.00	-145.05	7009.96	3638.55	-1007.16
22.0	228092.00	-285272.00	186688.00	-133.55	6672.08	4473.64	-1122.87
24.0	237213.00	-304032.00	211958.00	-136.95	7000.92	4086.48	-1049.61
26.0	242060.00	-297359.00	199620.00	-125.83	6734.22	4465.79	-972.10
28.0	249432.00	-299622.00	196900.00	-111.26	6222.03	5440.43	-914.71
30.0	263307.00	-334844.00	247655.00	-111.83	6452.32	4775.31	-1191.53
35.0	273393.00	-291765.00	178985.00	-83.84	5736.80	4650.87	-621.35
40.0	293153.00	-283353.00	175255.00	-57.06	4937.79	3684.27	-559.25

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 9x9A						
	A	B	C	D	E	F	G
1.0	6052.38	5071.10	-377.23	-189.39	2329.15	-150.71	-2461.49
1.25	7809.20	6767.24	-685.64	-190.94	3101.92	-385.33	-1625.56
1.5	9828.98	8472.94	-1182.05	-192.73	3783.44	-633.02	-1099.88
1.75	12766.50	10646.50	-1862.96	-187.66	4368.12	-896.69	-910.37
2.0	16564.30	12063.20	-2586.67	-184.87	4976.49	-1228.06	-894.91
2.25	22071.80	11834.70	-3015.91	-174.88	5443.22	-1518.94	-1014.33
2.5	27866.60	10993.50	-3286.54	-168.71	5965.88	-1909.06	-1027.88
2.75	34375.10	9004.62	-3367.62	-158.97	6305.05	-2182.06	-933.24
3.0	41566.50	5392.11	-2800.23	-149.79	6613.45	-2462.36	-904.38
4.0	72006.50	-20264.40	4921.01	-123.85	7211.86	-3004.62	-603.22
5.0	100197.00	-57315.80	21669.60	-118.72	7356.33	-2796.24	-243.52
6.0	124367.00	-99348.10	46264.80	-136.71	7648.05	-2394.38	-67.58
7.0	143009.00	-134740.00	68824.10	-143.35	7544.90	-1403.30	-173.80
8.0	157479.00	-165996.00	92255.30	-168.05	8114.30	-1315.88	-266.71
9.0	169636.00	-191379.00	110928.00	-172.50	8069.55	-500.37	-450.57
10.0	179282.00	-211202.00	125969.00	-172.12	7976.57	283.36	-617.13
11.0	187512.00	-228637.00	140325.00	-172.16	7928.03	894.69	-760.39
12.0	195321.00	-245580.00	154682.00	-170.38	7824.20	1596.02	-863.97
13.0	202110.00	-263050.00	173293.00	-187.18	8470.09	1003.55	-953.17
14.0	208171.00	-274758.00	183332.00	-179.75	8249.83	1717.21	-1103.07
15.0	213590.00	-284590.00	191650.00	-175.64	8098.33	2289.04	-1165.13
16.0	218091.00	-292503.00	199557.00	-171.84	8035.82	2659.38	-1119.03
17.0	223491.00	-302449.00	208733.00	-164.92	7833.36	3192.21	-1255.80
18.0	226523.00	-304524.00	209895.00	-162.71	7829.04	3410.57	-1091.33
19.0	231702.00	-312496.00	215730.00	-153.73	7552.13	4052.91	-1189.12
20.0	236531.00	-324776.00	232293.00	-164.72	8073.05	3368.73	-1233.57
22.0	244888.00	-335452.00	241932.00	-150.44	7566.26	4642.58	-1160.69
24.0	252171.00	-340795.00	244542.00	-141.18	7321.23	5355.16	-1142.40
26.0	259438.00	-343494.00	244340.00	-129.66	7094.56	5645.82	-1119.92
28.0	268823.00	-359239.00	266068.00	-130.16	7204.93	5605.85	-1064.30
30.0	277221.00	-363922.00	268930.00	-116.96	6799.84	6219.78	-1037.79
35.0	294285.00	-351643.00	245914.00	-99.35	6404.25	5923.44	-713.23
40.0	324174.00	-389397.00	319233.00	-77.68	5933.52	3992.56	-1188.62

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 9x9B						
	A	B	C	D	E	F	G
1.0	5578.48	5425.38	-432.11	-186.86	2357.62	-150.45	-2405.55
1.25	7982.03	6676.90	-642.60	-194.99	3183.10	-399.01	-1919.75
1.5	9842.92	8943.64	-1222.01	-189.84	3845.90	-652.60	-1360.01
1.75	12927.50	10582.20	-1802.08	-190.88	4502.57	-94.36	-1169.95
2.0	17186.80	11657.20	-2441.58	-183.45	5049.98	-1246.51	-1156.40
2.25	21800.20	12295.50	-3074.77	-180.94	5660.86	-1631.58	-1064.82
2.5	28010.00	11198.70	-3349.88	-169.84	6074.18	-1943.73	-1220.46
2.75	34607.80	9092.75	-3327.98	-161.55	6476.70	-2279.47	-1090.70
3.0	41425.40	6300.12	-3202.59	-151.95	6782.84	-2566.85	-1000.46
4.0	71942.80	-18734.90	3920.65	-125.38	7367.52	-3119.27	-631.75
5.0	101151.00	-57291.00	21182.10	-118.05	7377.24	-2721.50	-361.88
6.0	125823.00	-99944.80	45636.60	-136.47	7588.00	-2124.69	-262.67
7.0	144638.00	-135378.00	67687.60	-143.88	7447.72	-995.76	-340.94
8.0	159872.00	-168383.00	91921.20	-168.66	7933.70	-673.04	-395.74
9.0	172305.00	-194121.00	110332.00	-172.16	7831.09	301.31	-634.37
10.0	181683.00	-213140.00	124418.00	-173.36	7740.03	1165.16	-753.12
11.0	190922.00	-232977.00	140095.00	-171.28	7581.53	2053.29	-1027.00
12.0	198213.00	-248066.00	152236.00	-170.70	7492.96	2781.03	-1087.99
13.0	205947.00	-268590.00	173240.00	-187.42	8096.44	2390.78	-1199.48
14.0	211867.00	-280583.00	184192.00	-183.14	8023.23	2903.27	-1325.04
15.0	217071.00	-289407.00	190649.00	-177.77	7760.30	3819.17	-1355.68
16.0	221340.00	-294404.00	193178.00	-173.59	7653.54	4235.81	-1282.26
17.0	227205.00	-306489.00	204027.00	-164.96	7309.81	5290.73	-1440.44
18.0	231085.00	-310612.00	206608.00	-160.03	7176.88	5715.32	-1383.11
19.0	236345.00	-320398.00	215697.00	-153.84	7020.00	6284.82	-1522.44
20.0	240125.00	-328538.00	227545.00	-170.25	7836.24	5008.11	-1382.77
22.0	245672.00	-325279.00	216287.00	-158.18	7517.98	5919.63	-1187.15
24.0	256479.00	-345503.00	236771.00	-144.07	6970.57	7508.12	-1317.75
26.0	260950.00	-331434.00	205388.00	-130.57	6497.58	8638.70	-1076.78
28.0	269984.00	-343628.00	218366.00	-134.58	6861.68	8165.52	-1062.58
30.0	278259.00	-348285.00	221391.00	-123.31	6538.19	8720.28	-1076.88
35.0	297697.00	-344053.00	202586.00	-105.06	6094.38	9194.58	-852.15
40.0	331243.00	-401432.00	313358.00	-81.82	5561.33	7636.50	-1470.42

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 9x9C/D						
	A	B	C	D	E	F	G
1.0	5464.88	5428.10	-438.30	-184.75	2311.58	-146.87	-2296.51
1.25	7470.50	6970.15	-717.25	-187.88	3079.06	-374.49	-1640.55
1.5	9709.06	8904.78	-125.72	-190.25	3758.72	-621.81	-1207.57
1.75	12213.40	11153.30	-1982.54	-189.94	4409.97	-917.68	-845.16
2.0	16691.80	11823.60	-2447.14	-185.99	5008.36	-1243.90	-1059.30
2.25	21740.60	12301.10	-3136.66	-173.22	5422.51	-1511.79	-1061.56
2.5	27709.70	11300.00	-3398.46	-167.10	5898.90	-1850.17	-1171.40
2.75	33988.10	9774.59	-3696.16	-158.15	6268.38	-2155.04	-974.14
3.0	41117.20	6515.41	-3381.03	-148.32	6548.78	-2413.74	-948.98
4.0	71428.60	-18297.80	3576.44	-123.51	7125.21	-2923.50	-632.21
5.0	100397.00	-56458.80	20611.70	-115.75	7125.58	-2528.06	-313.97
6.0	124283.00	-97234.10	43750.10	-135.36	7393.89	-2038.45	-178.07
7.0	142677.00	-131502.00	64937.90	-142.42	7276.64	-994.67	-255.89
8.0	158111.00	-164750.00	89150.00	-165.13	7682.79	-614.18	-382.56
9.0	169539.00	-187815.00	105688.00	-170.16	7701.54	95.21	-536.66
10.0	179168.00	-207560.00	120407.00	-172.05	7615.14	907.40	-757.15
11.0	187428.00	-224318.00	133228.00	-170.11	7472.64	1710.47	-885.30
12.0	195546.00	-241540.00	147050.00	-166.19	7281.30	2560.85	-1135.94
13.0	202256.00	-258699.00	164971.00	-182.40	7906.42	2044.37	-1182.19
14.0	207838.00	-268927.00	173192.00	-178.93	7770.91	2703.98	-1224.09
15.0	213979.00	-281611.00	184781.00	-172.75	7552.21	3409.13	-1276.86
16.0	217809.00	-285839.00	187221.00	-168.56	7458.11	3805.42	-1317.69
17.0	223749.00	-297214.00	196642.00	-160.86	7141.47	4676.19	-1362.21
18.0	226075.00	-295937.00	193130.00	-157.66	7127.19	4895.03	-1291.13
19.0	230997.00	-304670.00	201281.00	-150.53	6907.85	5558.32	-1353.07
20.0	238022.00	-324930.00	227066.00	-158.32	7284.25	5103.45	-1464.16
22.0	243676.00	-322706.00	217208.00	-147.77	6978.74	5979.30	-1239.05
24.0	251683.00	-332524.00	227486.00	-137.48	6744.91	6651.45	-1261.39
26.0	256408.00	-321812.00	204514.00	-125.79	6394.39	7373.18	-1135.32
28.0	264537.00	-330729.00	215269.00	-131.03	6864.20	6415.84	-1014.55
30.0	273958.00	-341208.00	225146.00	-115.29	6196.43	7947.39	-1073.39
35.0	292385.00	-333153.00	204415.00	-98.00	5956.86	7222.98	-860.79
40.0	329247.00	-419504.00	371883.00	-71.42	4943.73	7633.01	-1618.27

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 9x9E/F						
	A	B	C	D	E	F	G
1.0	5714.25	5122.01	-403.48	-185.29	2270.44	-155.62	-2262.37
1.25	7108.39	6936.62	-728.46	-194.88	3064.64	-395.01	-1260.12
1.5	9860.40	8382.32	-1120.78	-188.06	3633.63	-600.75	-1040.69
1.75	12950.70	9922.89	-1671.50	-186.14	4214.90	-858.89	-884.98
2.0	16854.60	11084.70	-2322.04	-181.73	4769.99	-1147.12	-810.29
2.25	21630.80	11546.20	-2940.96	-172.49	5228.13	-1436.00	-839.61
2.5	27849.90	10029.20	-2985.66	-164.15	5650.51	-1736.59	-1040.92
2.75	34540.60	7548.11	-2786.62	-154.38	5990.92	-2013.50	-935.15
3.0	41307.10	4337.80	-2362.16	-146.82	6295.85	-2275.82	-884.96
4.0	70768.40	-20480.20	5197.61	-121.39	6876.47	-2797.83	-537.40
5.0	98180.80	-56583.30	21720.10	-115.24	7004.63	-2612.66	-168.15
6.0	120573.00	-94683.40	43765.30	-134.45	7390.91	-2400.88	20.85
7.0	138493.00	-128353.00	65326.00	-141.23	7368.45	-1657.87	2.12
8.0	151304.00	-154813.00	84923.70	-165.48	7997.42	-1799.73	-3.75
9.0	162835.00	-178601.00	102770.00	-169.20	8012.87	-1222.27	-178.21
10.0	173089.00	-200396.00	119704.00	-169.43	7906.04	-489.94	-481.35
11.0	180227.00	-213998.00	130552.00	-169.48	7924.61	-143.28	-537.04
12.0	188058.00	-230819.00	144797.00	-165.45	7782.15	482.35	-705.69
13.0	193490.00	-240795.00	153382.00	-163.80	7756.04	834.76	-753.66
14.0	199338.00	-255751.00	170303.00	-178.59	8424.78	16.81	-795.55
15.0	204471.00	-264530.00	177215.00	-172.61	8186.47	708.91	-873.25
16.0	209807.00	-275635.00	189071.00	-167.97	8087.71	1042.99	-936.73
17.0	214452.00	-282609.00	194830.00	-159.86	7819.12	1616.41	-906.17
18.0	217197.00	-283928.00	195786.00	-157.56	7869.81	1568.69	-890.15
19.0	221266.00	-288837.00	199363.00	-149.64	7592.40	2213.50	-965.82
20.0	225737.00	-295774.00	205279.00	-143.23	7337.40	2875.11	-876.23
22.0	234598.00	-314227.00	231133.00	-148.51	7825.76	2021.35	-879.15
24.0	242046.00	-320606.00	235951.00	-134.75	7367.58	2926.98	-913.50
26.0	247960.00	-318479.00	229552.00	-123.51	7133.33	3171.11	-783.22
28.0	261521.00	-352854.00	278305.00	-120.41	7120.21	3024.72	-1121.44
30.0	264913.00	-340198.00	263913.00	-111.92	6968.28	2888.33	-788.23
35.0	288082.00	-360268.00	293412.00	-86.40	6220.44	2894.70	-961.02
40.0	298948.00	-303570.00	215523.00	-55.72	5417.82	785.23	-415.39

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 9x9G						
	A	B	C	D	E	F	G
1.0	6976.18	5184.24	-373.54	-181.54	2360.15	-124.29	-2514.26
1.25	9143.56	6689.33	-616.47	-187.09	3235.36	-396.20	-1745.46
1.5	11054.30	9053.26	-1217.15	-187.98	3963.72	-671.80	-1106.16
1.75	12609.90	11584.70	-206.04	-188.84	4708.46	-1026.29	-782.65
2.0	18157.70	12664.10	-2736.69	-182.35	5344.31	-1383.11	-916.79
2.25	23646.70	12752.10	-3248.16	-178.95	5971.94	-1793.73	-925.78
2.5	29660.10	12309.80	-3821.64	-169.21	6473.09	-2183.65	-879.92
2.75	36525.80	10358.80	-3962.11	-162.46	6968.29	-2613.38	-863.49
3.0	44006.40	7030.85	-3698.49	-153.38	7336.54	-2971.63	-809.92
4.0	77288.30	-21207.50	4543.15	-125.70	8058.78	-3705.78	-537.87
5.0	110686.00	-69960.20	29062.30	-130.54	8442.77	-3626.36	-336.85
6.0	137786.00	-118830.00	58088.00	-136.52	8339.36	-2532.48	-201.40
7.0	160795.00	-169293.00	94340.50	-161.16	8672.27	-1671.25	-379.07
8.0	177763.00	-207034.00	122389.00	-170.18	8619.96	-400.24	-562.99
9.0	193108.00	-243101.00	150849.00	-171.94	8368.05	1156.18	-881.11
10.0	205042.00	-275555.00	181997.00	-195.35	9071.69	1098.87	-1083.51
11.0	215280.00	-300568.00	204362.00	-194.55	8934.09	2200.13	-1266.10
12.0	223585.00	-319189.00	220301.00	-191.69	8775.21	3201.84	-1325.62
13.0	230947.00	-335777.00	234994.00	-189.96	8659.97	4110.52	-1472.39
14.0	239135.00	-355478.00	253619.00	-183.93	8406.36	5194.67	-1726.13
15.0	245572.00	-374776.00	278406.00	-203.34	9278.36	4194.86	-1666.34
16.0	251881.00	-387322.00	288544.00	-193.80	8836.24	5557.89	-1689.56
17.0	257861.00	-401610.00	304798.00	-189.68	8737.81	6220.47	-1840.71
18.0	262232.00	-408488.00	311370.00	-185.11	8602.16	6925.67	-1728.75
19.0	265329.00	-406025.00	301388.00	-178.52	8347.70	7730.36	-1689.95
20.0	271234.00	-419055.00	315509.00	-171.72	8067.36	8751.47	-1705.40
22.0	283895.00	-451199.00	356261.00	-175.40	8389.72	8926.87	-1890.66
24.0	288388.00	-437401.00	323902.00	-164.80	8075.31	9968.86	-1575.02
26.0	299757.00	-459004.00	349014.00	-154.15	7793.16	11086.10	-1690.60
28.0	312233.00	-487890.00	389532.00	-156.41	8001.62	11248.70	-1695.28
30.0	317451.00	-470929.00	352843.00	-144.12	7616.90	12129.50	-1519.49
35.0	340908.00	-472938.00	320383.00	-126.33	6958.19	14189.40	-1265.87
40.0	355826.00	-406707.00	181832.00	-109.88	6567.54	13350.90	-690.33

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 10x10A/B/G						
	A	B	C	D	E	F	G
1.0	5723.53	4982.96	-365.36	-189.50	2319.36	-173.73	-2587.84
1.25	7460.31	6576.80	-660.70	-190.93	3005.93	-368.19	-1663.24
1.5	8981.27	8950.03	-1364.94	-188.17	6329.28	-596.80	-988.51
1.75	12283.70	10322.70	-1785.67	-185.78	4201.56	-850.07	-879.86
2.0	16284.00	11316.60	-2373.42	-183.95	4757.49	-1129.72	-908.53
2.25	21494.10	11161.90	-2738.06	-174.87	5233.98	-1435.08	-1029.88
2.5	27378.90	10122.70	-3001.13	-163.37	5590.72	-1687.18	-1133.76
2.75	33997.50	7667.21	-2796.85	-154.59	5934.47	-1960.21	-1063.93
3.0	40669.30	4604.85	-2427.68	-146.64	6233.46	-2224.40	-1023.08
4.0	69456.60	-19048.60	4510.80	-121.07	6769.53	-2693.26	-595.32
5.0	96363.50	-53810.50	20060.80	-115.15	6852.01	-2455.28	-235.29
6.0	118075.00	-89649.00	40101.30	-135.03	7207.34	-2199.03	-31.82
7.0	135465.00	-121448.00	59891.00	-141.81	7176.22	-1464.52	-84.35
8.0	149172.00	-147759.00	77477.10	-146.29	7123.94	-720.75	-270.69
9.0	160098.00	-171854.00	96698.30	-168.49	7716.07	-861.33	-341.94
10.0	168703.00	-188210.00	108590.00	-170.65	7707.01	-369.98	-413.26
11.0	176895.00	-205123.00	122221.00	-167.56	7590.63	267.07	-597.28
12.0	183500.00	-217775.00	132403.00	-165.29	7503.92	748.16	-696.44
13.0	189527.00	-229054.00	141757.00	-162.77	7481.92	1050.96	-848.98
14.0	195892.00	-241671.00	152138.00	-155.37	7192.81	1854.09	-983.23
15.0	199561.00	-249322.00	161820.00	-172.75	7962.69	824.80	-863.19
16.0	204447.00	-258563.00	171271.00	-167.33	7839.02	1163.01	-928.77
17.0	209187.00	-266807.00	178586.00	-160.49	7588.94	1870.46	-983.28
18.0	212908.00	-270532.00	180865.00	-155.48	7487.99	2077.63	-955.84
19.0	216478.00	-274912.00	185127.00	-150.92	7417.63	2302.50	-949.30
20.0	219761.00	-276790.00	185299.00	-144.53	7207.71	2794.21	-860.04
22.0	230330.00	-297894.00	208958.00	-142.95	7317.84	2710.62	-1141.54
24.0	235204.00	-296597.00	207242.00	-136.96	7299.78	2658.68	-881.02
26.0	243035.00	-302622.00	210474.00	-120.72	6753.85	3686.66	-891.14
28.0	250446.00	-307503.00	216130.00	-107.51	6366.92	4185.55	-863.84
30.0	265199.00	-348982.00	280458.00	-107.22	6539.80	3562.03	-1192.36
35.0	273468.00	-298369.00	203934.00	-79.97	5875.23	3082.40	-627.85
40.0	292898.00	-285148.00	187876.00	-50.41	4835.07	2436.15	-509.94

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BWR Fuel Assembly Cooling Time-Dependent Coefficients
(ZR-Clad Fuel)

Cooling Time (years)	Array/Class 10x10C						
	A	B	C	D	E	F	G
1.0	6190.24	5096.25	-384.43	-186.75	2340.62	-151.36	-2528.72
1.25	7815.16	6793.15	-675.23	-193.97	3174.53	-405.81	1662.94
1.5	10010.30	8798.90	-1199.94	-193.60	3870.99	-669.85	-1247.50
1.75	13229.50	10326.80	-1757.80	-189.26	4471.71	-940.69	-1117.18
2.0	17325.30	11490.30	-2423.96	-183.30	5030.60	-1243.75	-1042.41
2.25	22130.00	11951.30	-2993.28	-179.73	5638.45	-1641.98	-1049.38
2.5	28141.40	10893.00	-3249.42	-171.97	6092.80	-1970.42	-1042.25
2.75	35001.90	8485.77	-3132.08	-161.49	6464.02	-2288.54	-1064.03
3.0	41817.40	5588.18	-2935.15	-152.37	6778.27	-2580.33	-960.42
4.0	72503.80	-20126.90	4676.40	-126.12	7389.26	-3161.51	-598.75
5.0	101686.00	-58844.80	22172.30	-118.88	7430.83	-2824.08	-314.90
6.0	125964.00	-100714.00	46115.40	-137.38	7670.65	-2280.40	-139.13
7.0	145279.00	-138063.00	69971.00	-145.81	7593.29	-1239.47	-240.17
8.0	160736.00	-171770.00	94922.90	-169.48	8074.18	-936.98	-413.14
9.0	173109.00	-198050.00	114195.00	-173.24	7952.04	107.22	-587.69
10.0	183348.00	-219689.00	130706.00	-174.38	7886.25	887.26	-747.19
11.0	192349.00	-239413.00	146643.00	-173.03	7738.68	1801.89	-960.79
12.0	198722.00	-251849.00	156661.00	-174.40	7779.41	2247.21	-1024.32
13.0	206317.00	-271870.00	177242.00	-191.21	8405.58	1825.60	-1138.70
14.0	212647.00	-284224.00	187282.00	-183.63	8103.28	2759.09	-1219.61
15.0	218920.00	-297923.00	200391.00	-179.50	7978.82	3335.37	-1313.57
16.0	223379.00	-304963.00	206476.00	-175.76	7922.23	3689.54	-1328.16
17.0	228676.00	-314595.00	214380.00	-168.29	7569.76	4728.35	-1384.57
18.0	233175.00	-321606.00	220636.00	-164.63	7582.84	4872.65	-1394.73
19.0	238334.00	-334048.00	236292.00	-170.69	7886.97	4618.40	-1403.78
20.0	242429.00	-340497.00	242818.00	-172.36	8094.92	4434.37	-1437.97
22.0	251428.00	-353397.00	253878.00	-156.59	7500.41	6060.21	-1412.04
24.0	257957.00	-354461.00	249954.00	-147.71	7305.10	6634.39	-1346.94
26.0	272010.00	-391459.00	299301.00	-145.25	7227.25	7258.81	-1619.05
28.0	273995.00	-368436.00	261102.00	-136.90	7071.78	7562.48	-1159.20
30.0	279666.00	-356857.00	232864.00	-125.34	6696.43	8273.08	-973.58
35.0	297242.00	-340805.00	191056.00	-108.66	6404.77	8127.91	-777.55
40.0	330405.00	-398218.00	299749.00	-84.01	5531.03	7980.06	-1232.79

TABLE 2.4-6a
MPC-68M HEAT LOAD DATA for UNVENTILATED OVERPACK

Number of Regions: 2			
Number of Storage Cells: 68			
Maximum Total Heat Load (kW): 25			
Maximum Section Heat Load (kW): 3.125 (Note 1)			
Region No.	Decay Heat Limit per Cell, kW	Number of Cells per Region	Decay Heat Limit per Region, kW
1 (Inner)	0.368	32	11.765
2 (Outer)	0.368	36	13.325
Note 1: Figure 2.1-4 identifies the MPC basket regions and cell locations, and Table 2.4-7 identifies the cells included in each Heat Load for each section.			

TABLE 2.4-6b
MPC-68M REQUIREMENTS ON DEVELOPING REGIONALIZED HEAT LOAD PATTERNS
for UNVENTILATED OVERPACK (See Figure 2.1-4)

1. Total MPC aggregate Heat Load must be equal to 25 kW
2. Maximum Section Heat Load must be equal to 3.125 kW, calculated per Table 2.4-7, and pattern must be 1/8th symmetric
3. Maximum Heat Load per Cell in Region 1 is 0.368 kW
4. Maximum Heat Load per Cell in Region 2 is 0.735 kW
5. Pattern-specific Heat Load in a storage cell may need to be adjusted to meet items 1 and 2
6. Pattern-specific Heat Load for storage cells may be determined by reducing the allowable heat load in any Region 1 cell in Table 2.4-6a by a certain amount (Δ) and adding the same Δ to a single cell or distributed amongst multiple cells in Region 2. i.e. Any reduction of total allowable heat load in Region 1 must be compensated by an equivalent addition in Region 2.

General Notes –
1. Any assembly with a Heat Load less than the limits defined above can be loaded in the applicable cell, provided it meets all other CoC requirements.
2. DFCs/DFIs are permitted in locations denoted in Table 2.4-8 with the applicable Heat Load penalties identified therein.

TABLE 2.4-7

SECTION HEAT LOAD CALCULATIONS FOR MPC-68M for UNVENTILATED OVERPACK

Section	Equation for Section Heat Load[1]
Section 1	$Q_{21} + Q_{13} + Q_{14} + Q_6 + Q_7 + Q_8 + Q_2 + \frac{1}{2}Q_{30} + \frac{1}{2}Q_{22} + \frac{1}{2}Q_{15}$
Section 2	$Q_{31} + Q_{32} + Q_{23} + Q_{33} + Q_{24} + Q_{16} + Q_{34} + \frac{1}{2}Q_{30} + \frac{1}{2}Q_{22} + \frac{1}{2}Q_{15}$
Section 3	$Q_{41} + Q_{42} + Q_{51} + Q_{43} + Q_{52} + Q_{60} + Q_{44} + \frac{1}{2}Q_{40} + \frac{1}{2}Q_{50} + \frac{1}{2}Q_{59}$
Section 4	$Q_{49} + Q_{58} + Q_{57} + Q_{64} + Q_{65} + Q_{66} + Q_{68} + \frac{1}{2}Q_{40} + \frac{1}{2}Q_{50} + \frac{1}{2}Q_{59}$
Section 5	$Q_{48} + Q_{56} + Q_{55} + Q_{61} + Q_{62} + Q_{63} + Q_{67} + \frac{1}{2}Q_{39} + \frac{1}{2}Q_{47} + \frac{1}{2}Q_{54}$
Section 6	$Q_{38} + Q_{46} + Q_{37} + Q_{36} + Q_{45} + Q_{53} + Q_{35} + \frac{1}{2}Q_{39} + \frac{1}{2}Q_{47} + \frac{1}{2}Q_{54}$
Section 7	$Q_{28} + Q_{27} + Q_{18} + Q_9 + Q_{17} + Q_{26} + Q_{25} + \frac{1}{2}Q_{29} + \frac{1}{2}Q_{19} + \frac{1}{2}Q_{10}$
Section 8	$Q_{20} + Q_{11} + Q_{12} + Q_3 + Q_4 + Q_5 + Q_1 + \frac{1}{2}Q_{29} + \frac{1}{2}Q_{19} + \frac{1}{2}Q_{10}$

Notes

1.) Q_{X-Y} is the heat load in kW in cell ID (X-Y), identified in Figure 2.1-4

Table 2.4-8

DFC and DFI Storage Locations with Heat Load penalties for MPC-68M for UNVENTILATED OVERPACK

MPC Type	DFC/DFI (Note 1)	Locations/Storage Cell Numbers (Note 2)	Heat Load Penalty (Note 3)	Min. Soluble Boron Content
MPC-68M	DFI	1, 2, 3, 8, 9, 16, 25, 34, 35, 44, 53, 60, 61, 66, 67, 68	25%	N/A
	DFC		25%	
	DFC or DFI		DFCs – 25% DFIs – 25%	

Notes
1: Damaged fuel assemblies or fuel debris can be loaded in DFCs while only damaged fuel assemblies that can be handled by normal means can be loaded in DFIs.
2: DFCs/DFIs are allowed for storage in certain basket peripheral locations as defined herein. Basket storage cell numbers are identified in Figure 2.1-4 for the MPC-68M.
3: Heat load penalties are applicable to ONLY those cells where DFCs/DFIs are located and are applied to the allowable undamaged fuel assembly decay heat limit in that storage cell location. The penalties remain the same for all regionalized patterns and discrete loading patterns.

TABLE 2.4-9
Burnup and Cooling Time Fuel Qualification Requirements for MPC-68M for
UNVENTILATED OVERPACK

Cell Decay Heat Load Limit (kW)	Polynomial Coefficients, see Subsection 2.4.5			
	A	B	C	D
≤ 0.382	9.44656e-14	-8.01992e-09	2.79524e-04	-4.10441e-01
0.382 < decay heat ≤ 1.625	8.59250e-15	-1.40950e-09	9.57523e-05	-1.02585e+00

DESIGN FEATURES (continued)

Component	Reference ASME Code Section/Article	Code Requirement	Alternative, Justification & Compensatory Measures
Table 3-1 (page 5 of 9) **LIST OF ASME CODE ALTERNATIVES FOR HI-STORM 100 CASK SYSTEM**			
MPC Lid to Shell Weld	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required	Only UT or multi-layer liquid penetrant (PT) examination is permitted. If PT alone is used, at a minimum, it will include the root and final weld layers and each approximately 3/8 inch of weld depth.
MPC Closure Ring, Vent and Drain Cover Plate Welds	NB-5230	Radiographic (RT) or ultrasonic (UT) examination required	Root (if more than one weld pass is required) and final liquid penetrant examination to be performed in accordance with NB-5245. The closure ring provides independent redundant closure for vent and drain cover plates. Vent and drain port cover plate welds are helium leakage tested. As an alternative, the helium leakage test does not have to be performed if the REDUNDANT PORT COVER DESIGN is used.

DESIGN FEATURES (continued)

3.4   Site-Specific Parameters and Analyses

Site-specific parameters and analyses that will require verification by the system user are, as a minimum, as follows:

1.   The temperature of 80° F is the maximum average yearly temperature for the VENTILATED OVERPACK. The temperature of 70°F is the maximum average yearly temperature for the UNVENTILATED OVERPACK.

2.   The allowed temperature extremes, averaged over a 3-day period, shall be greater than -40° F and less than 125° F.

3.   a.   For storage in freestanding OVERPACKs, the resultant horizontal acceleration (vectorial sum of two horizontal Zero Period Accelerations (ZPAs) at a three-dimensional seismic site), G_H, and vertical ZPA, G_V, on the top surface of the ISFSI pad, expressed as fractions of 'g', shall satisfy the following inequality:

$$G_H + \mu G_V \leq \mu$$

where μ is either the Coulomb friction coefficient for the cask/ISFSI pad interface or the ratio r/h, where 'r' is the radius of the cask and 'h' is the height of the cask center-of-gravity above the ISFSI pad surface. The above inequality must be met for both definitions of μ, but only applies to ISFSIs where the casks are deployed in a freestanding configuration. Unless demonstrated by appropriate testing that a higher coefficient of friction value is appropriate for a specific ISFSI, the value used shall be 0.53. If acceleration time-histories on the ISFSI pad surface are available, G_H and G_V may be the coincident values of the instantaneous net horizontal and vertical accelerations. If instantaneous accelerations are used, the inequality shall be evaluated at each time step in the acceleration time history over the total duration of the seismic event.

If this static equilibrium based inequality cannot be met, a dynamic analysis of the cask/ISFSI pad assemblage with appropriate recognition of soil/structure interaction effects shall be performed to ensure that the casks will not tip over or undergo excessive sliding under the site's Design Basis Earthquake.

(continued)

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