PRESSURE-TEMPERATURE LIMITS FOR CALVERT CLIFFS NUCLEAR POWER PLANT UNIT 2

By
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FINAL REPORT
SwRI Project No. 06-1278-002

Prepared For
Baltimore Gas & Electric Co.
P. O. Box 1472
Baltimore, MD 21203

December 1988

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Approved:

Edward M. Briggs, Director
Department of Structural
and Mechnical Systems

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1. SUMMARY OF RESULTS AND CONCLUSIONS

A detailed analysis was performed for developing new pressure-temperature limit curves for the Calvert Cliffs Unit 2 reactor pressure vessel. The analysis included new neutron transport calculations for 12, 18 and 24 month cycles, development of irradiated material properties based on NRC Regulatory Guide 1.99, Rev. 2, and the generation of heat up and cool down limit curves for every 4 EFPY from 12 EFPY to 40 EFPY conditions.

The SwRI evaluation led to the following conclusions:

1. Based on a calculated neutron spectral distribution, the peak fluxes incident on the Reactor Pressure Vessel (RPV) are 5.04×10^{10} n/cm^2-sec, 4.89×10^{10} n/cm^2-sec and 4.10×10^{10} n/cm^2-sec for 12 month, 18 month and 24 month cycles respectively.
2. Adjusting the calculated flux with respect to the first capsule dosimeter analysis the 12 month and 18 month cycle peak fluxes on the RPV was determined to be 4.72×10^{10} n/cm^2-sec and 4.59×10^{10} n/cm^2-sec respectively.
3. The calculated lead factors for the vessel ID based on surveillance capsule capsule locations are given below:

Cycle Type	0=7° Lead Factor	0=14° Lead Factor
12 month	1.26	0.94
18 month	1.24	0.91
24 month	1.18	0.79

4. The accumulated peak fluence on RPV ID was calculated to be 1.17 x 10^{19} n/cm^2 for the first 7 cycles and 4.28 x 10^{19} n/cm^2 to end-of-life conditions.

5. Displacement per Atom (dpa) for 12 EFPY were calculated to be 2.632 x 10^{-2}, 1.747 x 10^{-2} and 0.5206 x 10^{-2} for RPV ID, 1/4T and 3/4T respectively. For 32 EFPY dpa are 6.498 x 10^{-2}, 4.302 x 10^{-2}, 1.275 x 10^{-2} for RPVID, 1/4T and 3/4T respectively.

6. The 12 EFPY fluence on the RPV was calculated to be 1.69 x 10^{19} n/cm^2. Fluence rate of 1.2933 x 10^{18} (n/cm^2) per year was used to develop fluence value for 16, 20, 24, 28, 32, 36 and 40 EFPYs.

7. The controlling material for RPV operations was determined to be weld 2-203 with Cu = 0.12% and Ni = 1.01%. P-T limit data was developed for 12, 16, 20, 24, 28, 32, 36 and 40 EFPYs. The data also reflects different heat-up and cool down rates.

8. Based on the Reg Guide 1.99, Rev. 2 approach, the end of the life adjusted reference temperature for the controlling material will be 222°F at the RPV ID and 201°F at the 1/4T location.

9. Based on this study the Calvert Cliff Unit 2 reactor vessel has adequate material toughness for continued safe operated to end-of-life irradiation conditions.

2. INTRODUCTION

The long-term degradation of reactor vessel structural material properties due to irradiation is measured by the evaluation of material surveillance capsules removed periodically from the reactor vessel. Combustion Engineering, Inc. has provided the material surveillance program for the Calvert Cliffs Nuclear Power Plant Unit 2. To date, one surveillance capsule has been removed and tested (Reference 1). Typically, the capsules contain Charpy V-notch and tensile specimens in various combinations representing the present materials, weld metal and heat-affected zone (HAZ) material of the vessel beltline region. In addition, the capsules contain iron, nickel, titanium, sulfur, uranium and copper neutron flux monitors and temperature monitors.

The objective of the surveillance program is to correlate changes in vessel material fracture toughness properties with neutron fluence so that the reactor vessel pressure temperature limits can be determined. Recently, the concern about pressurized thermal shock has placed additional requirements to determine the irradiated condition of vessel inner surface. The applicable regulations and documents that address the continued licensibility of reactor vessels include 10 CFR Part 50, Appendices, B, G and H, 10 CFR Part 50.61, NRC Standard Review Plan 5.3.2, Regulatory Guide 1.99, Rev 2 and ASME Boiler and Pressure Vessel Code Section III, Appendix G.

In this report a new neutron flux analysis for the reactor vessel is presented. Based on the analysis, projected vessel fluence conditions were developed for assessing the long term integrity of the vessel. Pressure-temperature limit conditions are presented for 12, 16, 20, 24, 28, 32, 36 and 40 effective full power years of operation.

3. MATERIAL PROPERTY ASSESSMENT

In developing the pressure-temperature limit conditions for reactor vessels, the important material property required is the Reference Temperature - Nil Ductibility Transition (RTNDT) of various vessel pressure boundary materials. The locations within the pressure boundary that are of interest include nozzle area, closure head region and the beltline region. The nozzle and closure head regions are locations of high stress concentrations while the beltline region is subject to neutron embrittlement with time.

Early in the life of the reactor vessel, nozzle and closure head regions tend to control the pressure-temperature limit curves. However, with time the beltline irradiated materials become controlling. In the case of Calvert Cliffs Unit 2, the controlling material for 12 EFPYs and beyond is the beltline region material. Between the nozzle and the closure head region, the closure head region poses greater restrictions on the PT limit curves.

10 CFR 50 "Fracture Toughness Requirements for Light-Water Nuclear Power Reactor" requires the closure head region materials to have, as a minimum, RT_{NDT} + 120° for normal operations and RT_{NDT} + 90° for hydrostatic pressure and leak tests. In the case of non-availability of RT_{NDT} data or where the data is not reliable, the RT_{NDT} for closure region is determined using the method in NRC Standard Review Plan 5.3.2, Branch Technical Position 5-2, MTEB. Based on this method, the RT_{NDT} of the closure head material was assessed to be 60°F.

To provide the submittal to NRC on the Pressurized Thermal Shock issue, Reference 2 extensive materials data information was developed for all the beltline materials (Reference 2). A key information needed is the material chemistry, especially Cu and Ni. The Cu and Ni values for the beltline materials are presented in Table 3.1. These chemistry values are used in Section 5 of this report to develop the irradiated Adjusted Reference Temperature for the critical beltline materials. Figure 3.1 presents the Calvert Cliffs Unit-2 Reactor Pressure Vessel map with all the key beltine welds identified.

Table 3.1. Calvert Cliffs Unit No. 2 Reactor Vessel Beltline Material Properties

ID	Cu (w/o)	Ni (w/o)	Initial RT^{NDT}(°F)
2-203(1) A,B,C	0.12	1.01	-56.0
3-203 A,B,C	0.23	0.23	-80.0
9-203	0.22	0.05	-60.0
D-8906-1	0.15	0.56	10.0
D-8906-2	0.11	0.56	10.0
D-8906-3	0.14	0.55	5.0
D-8907-1	0.15	0.60	-8.0
D-8907-2	0.14	0.66	20.0
D-8907-3	0.11	0.74	-16.0

(1) The value used for Ni is an upper bound due to the lack of available data. The generic initial RT_{NDT} = -56°F, is used for this weld.

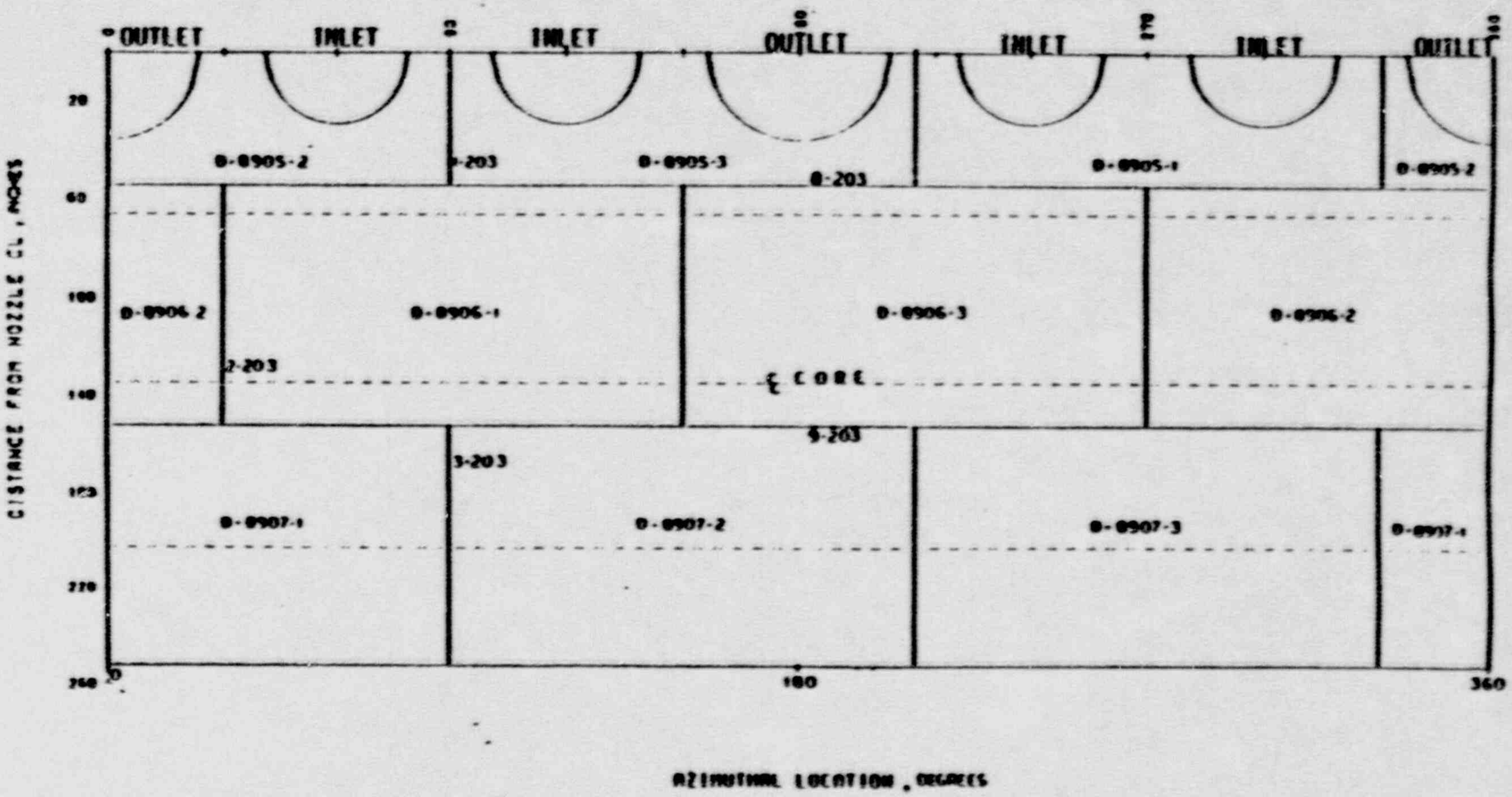


Figure 3.1 Calvert Cliffs Unit-2, Reactor Pressure Vessel Map

4. NEUTRON FLUENCE CALCULATIONS

In this section a detailed neutron transport analysis for the Calvert Cliffs-2 is discussed. A discrete ordinates calculation using the DOT-4 [3] code was performed to obtain the radial (R) and azimuthal (θ) fluence-rate distribution for the geometry is shown in Figure 4.1. As part of the reactor cross section model the details of the surveillance capsule geometry and location has to be modeled. The inclusion of the surveillance capsules in the R-θ model is mandatory to account for the significant perturbation effects from the physical presence of the capsule. Figure 4.2 represents the actual capsule geometry versus the DOT model used in the analysis. The DOT model incorporates a homogenized mixture of inconel and water to simplify the overall model while maintaining the required accuracies for the calculation.

The DOT-4 calculations were performed with the first 33 groups of the 47 group energy structure for the SAILOR [4] cross section library. The 47 group structure is given in Table C.1 of Appendix C. An S8 angular structure and a P_3 Legendre cross-section expansion were used. The fine-group dosimeter cross-sections for the ^{63}Cu (n, α)^{60}Co reaction were obtained from ENDF/B-V file and were collapsed to 47 groups using a fission plus 1/E weighting spectrum. The other reaction cross sections were taken from the SAILOR cross section library. The dosimeter activation cross sections are given in Table C.2 of Appendix C. The DPA cross sections were obtained from MACLIB.

The results of the transport calculations for the RPV fluence analysis are presented in Tables 4.1 through 4.15. Appendix A discusses the determination of space-dependent source distribution for the transport analysis performed for Calvert Cliffs Unit 2. Appendix B is a description of the 3D Flux synthesis method used in this analysis. Appendix C gives the

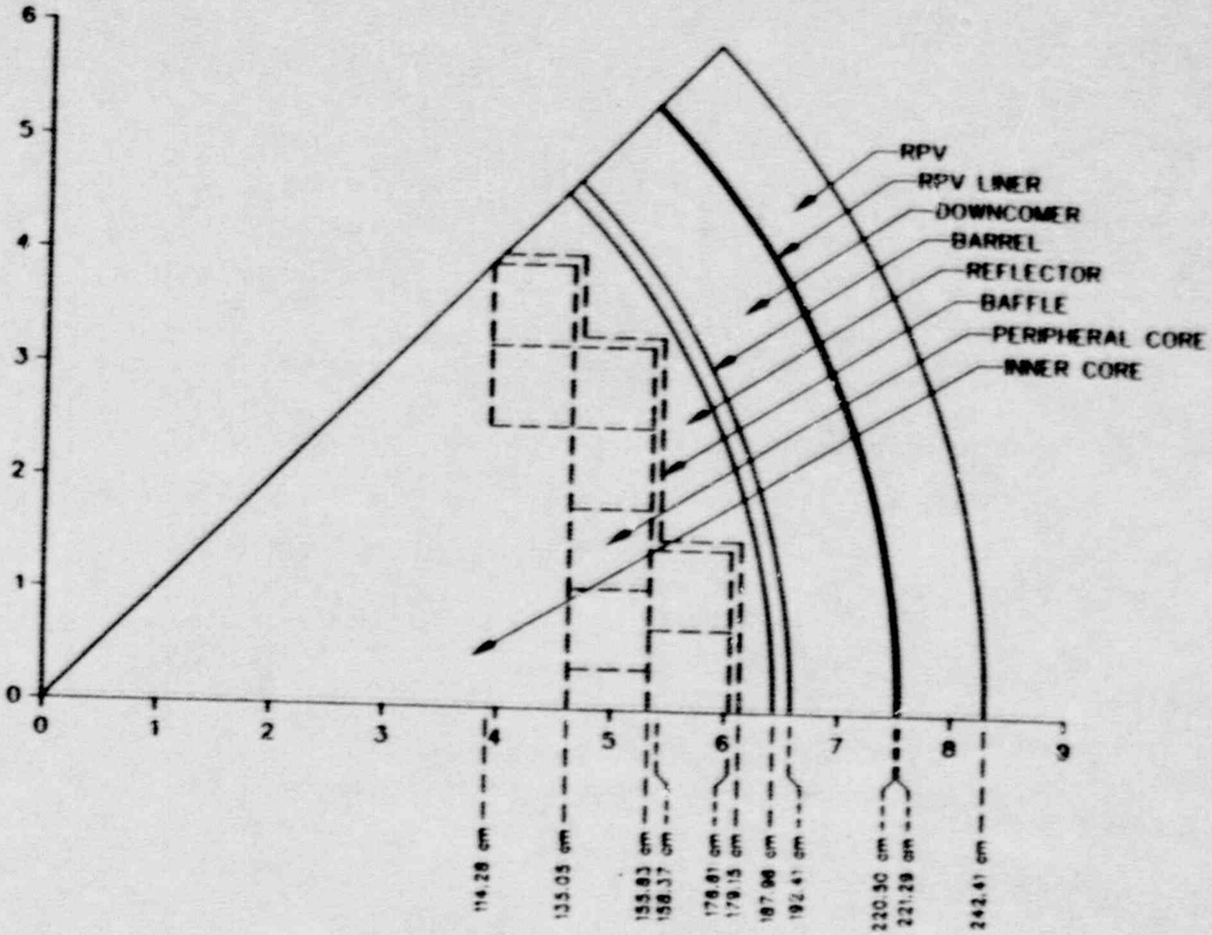
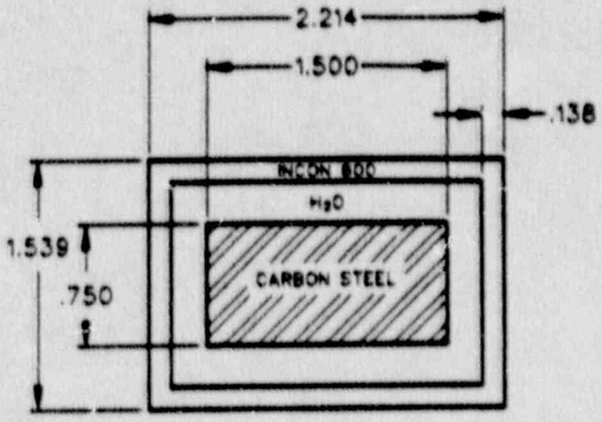


Figure 4.1 Calvert Cliffs Unit-2 DOT-4 RO MODEL*

*(Surveillance Capsules at 7° and 14° are not shown)
(Scale: 1 Large Division = 11.5 inches)

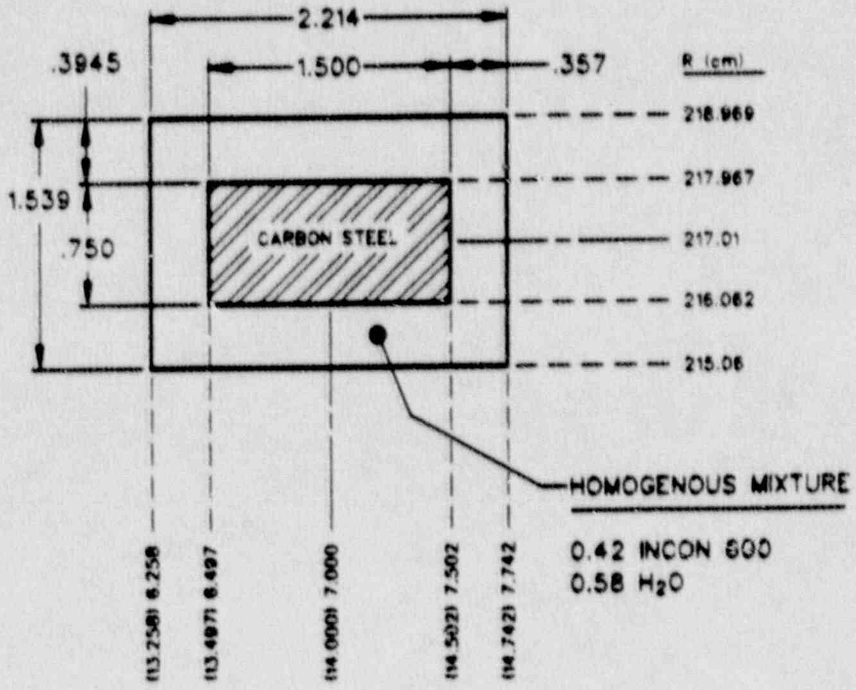
ACTUAL GEOMETRY



AREAS (SQ. IN.)

STEEL	= 1.125
H_2O	= 1.322
INCON 600	= 0.960
TOTAL	= 3.407

DOT MODEL



group structure and the dosimeter cross sections used in the calculations. Appendix D discusses the expressions used in obtaining the measured saturated activities; and Appendix E gives the power time history for cycles 1-8.

The first surveillance capsule (263°) was removed from Unit 2 following cycle 4 after 4.58 EFPYs of operation. A detailed capsule testing and analysis was conducted and reported in Reference (2). The dosimetry and vessel fluence evaluation provided information on the vessel fracture toughness conditions for 3 cycles of 12 months each and one 18 month cycle. Since the removal of the 263° capsule, 18 month cycles have been used for cycles 5-7; and beginning with cycle 8, a 24 month is being employed. A 24 month cycle is planned for future operations.

In order to verify the accuracy of the present calculations, computed results have been compared on an absolute basis with experimental results from the earlier capsule analysis. The average C/E value obtained for the Fe56, Ni58, Cu63, U238, Ti46 and Np237 activities was 1.07. The worst C/E obtained was 1.12 for U238. This good agreement indicates that the transport calculation methodology is accurate and that projected fluences should be reliable. In addition the experimental results can be used to adjust the calculated values to obtain even better agreement for the 12 and 18 month cycles (no experimental data is presently available for 24 month cycles). The adjusted fluence rates, which differs from the original calculated values by only about 10%, were used to obtain the projected RPV fluence.

The transport calculations indicate the maximum fast fluence (E>1 MeV) at the 0-T location of the Calvert Cliffs Unit-2 RPV will be (a) 1.38×10^{19} n/cm^2 at the end of the present cycle (cycle 8), and (b) 4.28×10^{19} n/cm^2 at the end of 32 EFPY, assuming all future cycles to be the 24 month loading configuration.

Table 4.1 Spectrum Averaged Cross Sections at Center of S.C.

Reaction	σeff(b) 12 Month Cycle	σeff(b) 18 Month Cycle	σeff(b) 24 Month Cycle
^{54}Fe(n,p)	0.135	0.135	0.137
^{58}Ni(n,p)	0.171	0.172	0.174
^{63}Cu(n,α)	0.00160	0.00160	0.00165
^{238}U(n,f)	0.452	0.452	0.454
^{46}Ti(n,p)	0.0231	0.0231	0.0236

$$\sigma eff = \frac{\int_0^\infty \sigma(E)\ \phi(E)\ dE}{\int_1^\infty \phi(E)\ dE}$$

Table 4.2-a Absolute Calculated Neutron Fluence Rate Spectra (i.e., group flux) at the Center of 7° Surveillance Capsules (SC) for Calvert Cliffs Unit-2

Group	Upper Energy (MeV)	ϕ $n\text{-}cm^{-2} \cdot s^{-1}$ 12 M	18 M	24 M
1	1.733E+01	1.59292E+07	1.52822E+07	1.27832E+07
2	1.419E+01	6.93740E+07	6.65497E+07	5.56482E+07
3	1.221E+01	2.88874E+08	2.76866E+08	2.29367E+08
4	1.000E+01	5.90160E+08	5.65460E+08	4.66652E+08
5	8.607E+00	1.06918E+09	1.02397E+09	8.40528E+08
6	7.408E+00	2.68699E+09	2.57274E+09	2.10562E+09
7	6.065E+00	3.87362E+09	3.70630E+09	3.01119E+09
8	4.966E+00	6.86589E+09	6.56254E+09	5.26914E+09
9	3.679E+00	4.85415E+09	4.63744E+09	3.70105E+09
10	3.012E+00	3.56590E+09	3.40593E+09	2.71246E+09
11	2.725E+00	4.02853E+09	3.84738E+09	3.06022E+09
12	2.466E+00	1.98716E+09	1.89776E+09	1.50951E+09
13	2.365E+00	5.24276E+08	5.00711E+08	3.98751E+08
14	2.346E+00	2.48412E+09	2.37234E+09	1.88732E+09
15	2.231E+00	5.92853E+09	5.66162E+09	4.50071E+09
16	1.920E+00	6.01068E+09	5.73971E+09	4.55897E+09
17	1.653E+00	7.83818E+09	7.48456E+09	5.94153E+09
18	1.353E+00	1.07824E+10	1.02965E+10	8.17687E+09
19	1.003E+00	6.61976E+09	6.32146E+09	5.02059E+09
20	8.208E-01	3.41830E+09	3.26402E+09	2.58966E+09
21	7.427E-01	7.39563E+09	7.06203E+09	5.60636E+09
22	6.081E-01	6.29429E+09	6.01018E+09	4.77007E+09
23	4.979E-01	6.70364E+09	6.40121E+09	5.08137E+09
24	3.688E-01	6.70364E+09	5.40516E+09	4.29365E+09
25	2.972E-01	9.26295E+09	8.84492E+09	7.02081E+09
26	1.832E-01	7.82055E+09	7.46754E+09	5.92668E+09
27	1.111E-01	5.97356E+09	5.70375E+09	4.52540E+09
28	6.738E-02	5.51274E+09	5.26369E+09	4.17532E+09
29	4.097E-02	2.16627E+09	2.06833E+09	1.64014E+09
30	3.183E-02	9.61249E+09	9.17733E+08	7.27404E+08
31	2.606E-02	1.65836E+09	1.58337E+09	1.25580E+09
32	2.418E-02	1.03785E+09	9.90926E+09	7.86043E+08
33	2.188E-02	2.77008E+09	2.64510E+09	2.09854E+09

Table 4.2-b Absolute Calculated Neutron Fluence Rate Spectra (i.e., group flux) at the Center of 14° Surveillance Capsules (SC) for Calvert Cliffs Unit-2

Group	Upper Energy (MeV)	ϕ $n\text{-}cm^{-2} \cdot s^{-1}$		
		12 M	18 M	24 M
1	1.733E+01	1.36555E+07	1.28002E+07	1.03138E+07
2	1.419E+01	5.90405E+07	5.53381E+07	4.44997E+07
3	1.221E+01	2.39561E+08	2.24094E+08	1.77171E+08
4	1.000E+01	4.82710E+08	4.51223E+08	3.54086E+08
5	8.607E+00	8.59415E+08	8.02627E+08	6.23235E+08
6	7.408E+00	2.13034E+09	1.98863E+09	1.53439E+09
7	6.065E+00	3.00697E+09	2.80412E+09	2.13254E+09
8	4.966E+00	5.19617E+09	4.83870E+09	3.59520E+09
9	3.679E+00	3.62438E+09	3.37305E+09	2.47393E+09
10	3.012E+00	2.64975E+09	2.46516E+09	1.79860E+09
11	2.725E+00	2.98304E+09	2.77488E+09	2.01863E+09
12	2.466E+00	1.46982E+09	1.36719E+09	9.94068E+08
13	2.365E+00	3.88458E+08	3.61376E+08	2.63181E+08
14	2.346E+00	1.83812E+09	1.70987E+09	1.24329E+09
15	2.231E+00	4.38728E+09	4.08118E+09	2.96463E+09
16	1.920E+00	4.44645E+09	4.13607E+09	2.99903E+09
17	1.653E+00	5.79570E+09	5.39088E+09	3.90357E+09
18	1.353E+00	7.99680E+09	7.43919E+09	5.39179E+09
19	1.003E+00	4.91889E+09	4.57636E+09	3.31787E+09
20	8.208E-01	2.53234E+09	2.35556E+09	1.70335E+09
21	7.427E-01	5.50761E+09	5.12462E+09	3.71182E+09
22	6.081E-01	4.68683E+09	4.36098E+09	3.15694E+09
23	4.979E-01	4.98422E+09	4.63761E+09	3.35877E+09
24	3.688E-01	4.23105E+09	3.93799E+09	2.85763E+09
25	2.972E-01	6.89253E+09	6.41386E+09	4.64476E+09
26	1.832E-01	5.82004E+09	5.41600E+09	3.92080E+09
27	1.111E-01	4.44033E+09	4.13191E+09	2.98901E+09
28	6.738E-02	4.09527E+09	3.81070E+09	2.75518E+09
29	4.097E-02	1.60846E+09	1.49660E+09	1.08127E+09
30	3.183E-02	7.13850E+08	6.64133E+08	4.79399E+08
31	2.606E-02	1.23418E+09	1.14840E+09	8.30116E+08
32	2.418E-02	7.72632E+08	7.19027E+08	5.20131E+08
33	2.188E-02	2.06304E+09	1.91978E+09	1.38761E+09

Table 4.3-a Calculated Saturated Midplane Activities in Calvert Cliffs Unit-2 Surveillance Capsules (12 M Cycle)

Dosimeter or Flux	Saturated Activities for 7° Surveillance Capsule, Bq/g			Saturated Activities for 14° Surveillance Capsule, Bq/g		
	R = 216.379cm	R = 217.014cm	R = 217.649cm	R = 216.379cm	R = 217.014cm	R = 217.649cm
$^{54}Fe(n,p)^{54}Mn$	5.95E6	5.36E6	4.78E6	4.58E6	4.13E6	3.70E6
$^{58}Ni(n,p)^{58}Co$	8.45E7	7.62E7	6.81E7	6.48E7	5.86E7	5.25E7
$^{63}Cu(n,\alpha)^{60}Co$	7.40E5	6.66E5	5.98E5	5.95E5	5.36E5	4.82E5
$^{237}Np(n,f)^{137}Cs$	2.25E7	2.11E7	1.92E7	1.68E7	1.58E7	1.44E7
$^{238}U(n,f)^{137}Cs$	4.75E6	4.35E6	3.91E6	3.58E6	3.29E6	2.96E6
$^{46}Ti(n,p)^{46}Sc$	1.66E6	1.49E6	1.33E6	1.31E6	1.18E6	1.05E6
$\phi(E>1.0$ MeV)	6.84E10	6.35E10	5.73E10	5.11E10	4.76E10	4.31E10
$\phi(E>0.1$ MeV)	1.22E11	1.17E11	1.08E11	9.11E10	8.71E10	8.10E10

Table 4.3-b Calculated Saturated Midplane Activities in Calvert Cliffs Unit-2 Surveillance Capsules (18 M Cycle)

	Saturated Activities for 7° Surveillance Capsule, Bq/g			Saturated Activities for 14° Surveillance Capsule, Bq/g		
Dosimeter or Flux	R = 216.379cm	R = 217.014cm	R = 217.649cm	R = 216.379cm	R = 217.014cm	R = 217.649cm
$^{54}\text{Fe}(n,p)^{54}\text{Mn}$	5.69E6	5.12E6	4.57E6	4.27E6	3.84E6	3.44E6
$^{58}\text{Ni}(n,p)^{58}\text{Co}$	8.08E7	7.29E7	6.51E7	6.03E7	5.46E7	4.88E7
$^{63}\text{Cu}(n,\alpha)^{60}\text{Co}$	7.08E5	6.38E5	5.73E5	5.55E5	5.00E5	4.50E5
$^{237}\text{Np}(n,f)^{137}\text{Cs}$	2.15E7	2.01E7	1.84E7	1.56E7	1.47E7	1.34E7
$^{238}\text{U}(n,f)^{137}\text{Cs}$	4.54E6	4.16E6	3.74E6	3.33E6	3.06E6	2.76E6
$^{46}\text{Ti}(n,p)^{46}\text{Sc}$	1.59E6	1.43E6	1.28E6	1.22E6	1.10E6	9.84E5
$\phi(E>1.0$ MeV$)$	6.53E10	6.06E10	5.48E10	4.76E10	4.43E10	4.01E10
$\phi(E>0.1$ MeV$)$	1.17E11	1.11E11	1.03E11	8.48E10	8.11E10	7.54E10

Table 4.3-c Calculated Saturated Midplane Activities in Calvert Cliffs Unit-2 Surveillance Capsules (24 M Cycle)

Dosimeter or Flux	Saturated Activities for 7° Surveillance Capsule, Bq/g			Saturated Activities for 14° Surveillance Capsule, Bq/g		
	R = 216.379cm	R = 217.014cm	R = 217.649cm	R = 216.379cm	R = 217.014cm	R = 217.649cm
^{54}Fe(n,p)^{54}Mn	4.60E6	4.14E6	3.70E6	3.22E6	2.91E6	2.61E6
^{58}Ni(n,p)^{58}Co	6.52E7	5.80E7	5.26E7	4.54E7	4.11E7	3.68E7
^{63}Cu(n,α)^{60}Co	5.82E5	5.24E5	4.71E5	4.32E5	3.89E5	3.51E5
^{237}Np(n,f)^{137}Cs	1.71E7	1.61E7	1.47E7	1.14E7	1.08E7	9.87E6
^{238}U(n,f)^{137}Cs	3.64E6	3.34E6	3.00E6	2.47E6	2.27E6	2.04E6
^{46}Ti(n,p)^{46}Sc	1.30E6	1.16E6	1.04E6	9.36E5	8.42E5	7.56E5
$\phi(E>1.0$ MeV$)$	5.22E10	4.84E10	4.38E10	3.49E10	3.25E10	2.95E10
$\phi(E>0.1$ MeV$)$	9.31E10	8.87E10	8.24E10	6.18E10	5.92E10	5.51E10

Table 4.4 Non-Saturation Factors(h) Used in Dosimeters Activities

Dosimeter	$h_{1\to3}$ (Cycles 1-3)	h_4 (Cycle 4)
Fe54	0.7007	0.6110
Ni58	0.5159	0.7394
Cu63	0.3211	0.1642
Ti46	0.5560	0.7542
U238	0.0699	0.0313

[(a)] h = non-saturation factor

$$= \sum_j P_j(1-e^{-\lambda T_j})\, e^{-\lambda(T-t_j)},$$

where factors P_j, T_j and $T-t_j$ are given in Appendix C.

Table 4.5 Comparison of Unadjusted Calculated and Measured Parameters of Calvert Cliffs-2 Dosimeters Removed Following Cycle 4

Parameter	Measured(1)	Calculated(3)	C/E
Fe54 dosimeter activity (dps/gm)(2)	3.761E6	4.17E6	1.11
Ni58 dosimeter activity (dps/gm)(2)	5.079E7	5.40E7	1.06
Cu63 dosimeter activity (dps/gm)(2)	2.680E5	2.79E5	1.04
U238 dosimeter activity (dps/gm)(2)	3.78E5	4.23E5	1.12
Ti46 dosimeter activity (dps/gm)(2)	1.07E6	1.09E6	1.01

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(1) A_{TOR} values taken from Reference 1.

(2) At center of capsule; time of removal from reactor.

(3) $(A_{TOR})_4$ = dosimeter activity at EOC-4

$$= (A_{TOR})_3 \, e^{-\lambda\tau} + (A_{SAT})_{18M} \, h_4$$

where $(A_{TOR})_3 = (A_{SAT})_{12M} h_{1\to3}$

and $(A_{SAT})_{12M}$, $(A_{SAT})_{18M}$ = saturated activites for 12 and 18 month cycles respectively, and $h_{1\to3}$, h_4 = non-saturation factors from Table 3;
τ = time (d) from EOC3 to EOC4 = 579 days.

Table 4.6 "Measured" Saturated Activities (A_{SAT}) for 12 and 18 Month Cycles, Based on Cycles 1-4 Dosimetry(2)

Dosimeter	Center of S.C. (12 M Cycle)		Center of S.C. (18 M Cycle)	
	A_{TOR}(1)	A_{SAT}(2)	A_{TOR}(1)	A_{SAT}(2)
$^{54}Fe(n,p)^{54}Mn$	3.76E6	4.84E6	3.76E6	4.62E6
$^{58}Ni(n,p)^{58}Co$	5.10E7	7.19E7	5.10E7	6.88E7
$^{63}Cu(n,\alpha)^{60}Co$	2.68E5	6.41E5	2.68E5	6.14E5
$^{238}U(n,f)^{137}Cs$	3.78E5	3.88E6	3.78E5	3.71E6
$^{46}Ti(n,p)^{46}Sc$	1.07E6	1.47E6	1.07E6	1.41E6

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(1) A_{TOR} values taken from Reference 1.

(2) See Appendix D for definition of measured saturated activities

Table 4.7-a Determination of "Adjusted" ϕ (>1) in S.C. for 12 Month Cycles

CENTER FLUX:

Dosimeter	Measured A_{SAT}	Calculated σ_{eff}	Adjusted ϕ (>1)[1]
$^{54}Fe(n,p)^{54}Mn$	4.84E6	0.135	5.73E10
$^{58}Ni(n,p)^{58}Co$	7.19E7	0.171	6.00E10
$^{63}Cu(n,\alpha)^{60}Co$	6.41E5	0.0016	6.11E10
$^{238}U(n,f)^{137}Cs$	3.88E6	0.452	5.65E10
$^{46}Ti(n,p)^{46}Sc$	1.47E6	0.0231	6.25E10
		Average	5.95E10

---

[1] Adjust ϕ (>1) $\equiv \frac{[A_{SAT}] \text{ measured}}{\text{No } [\sigma_{eff}] \text{ calc.}}$

Table 4.7-b Determination of "Adjusted" ϕ (>1) in S.C. for 18 Month Cycles

CENTER FLUX:

Dosimeter	Measured A_{SAT}	Calculated σ_{eff}	Adjusted ϕ (>1)$^{(1)}$
$^{54}Fe(n,p)^{54}Mn$	4.62E6	0.135	5.47E10
$^{58}Ni(n,p)^{58}Co$	6.88E7	0.172	5.71E10
$^{63}Cu(n,\alpha)^{60}Co$	6.14E5	0.0016	5.85E10
$^{238}U(n,f)^{137}Cs$	3.71E6	0.452	5.41E10
$^{46}Ti(n,p)^{46}Sc$	1.41E6	0.0231	6.00E10
		Average	5.69E10

$^{(1)}$Adjust ϕ (>1) = $\frac{[A_{SAT}] \text{ measured}}{\text{No } [\sigma_{eff}] \text{ calc.}}$

Table 4.8 Relative Azimuthal Variation[a] In ϕ (> 1 MeV) Incident on Vessel

J	$\bar{\theta}$	12 M Cycle	18 M Cycle	24 M Cycle
1	1.25000E+00	1.000	1.000	1.000
2	3.75000E+00	0.992	0.987	0.965
3	5.62900E+00	0.963	0.953	0.901
4	6.37750E+00	0.918	0.906	0.847
5	6.64000E+00	0.891	0.878	0.814
6	7.00000E+00	0.870	0.856	0.785
7	7.35950E+00	0.870	0.854	0.774
8	7.62200E+00	0.882	0.864	0.777
9	8.37099E+00	0.901	0.880	0.780
10	9.62500E+00	0.877	0.853	0.740
11	1.08750E+01	0.834	0.808	0.690
12	1.21250E+01	0.784	0.756	0.640
13	1.30040E+01	0.745	0.717	0.608
14	1.33775E+01	0.717	0.690	0.585
15	1.36400E+01	0.690	0.663	0.563
16	1.40000E+01	0.664	0.637	0.541
17	1.43605E+01	0.653	0.626	0.533
18	1.46220E+01	0.654	0.626	0.533
19	1.49300E+01	0.658	0.629	0.536
20	1.55590E+01	0.649	0.620	0.529
21	1.65000E+01	0.624	0.595	0.514
22	1.75000E+01	0.602	0.573	0.501
23	1.85000E+01	0.586	0.557	0.491
24	1.95000E+01	0.577	0.549	0.485
25	2.05000E+01	0.575	0.546	0.483
26	2.15000E+01	0.579	0.549	0.483
27	2.25000E+01	0.586	0.556	0.485
28	2.35000E+01	0.596	0.565	0.488
29	2.45000E+01	0.607	0.576	0.490
30	2.55000E+01	0.617	0.585	0.492
31	2.65000E+01	0.624	0.592	0.491
32	2.75000E+01	0.628	0.596	0.487
33	2.84000E+01	0.629	0.597	0.481
34	2.98118E+01	0.620	0.588	0.468
35	3.09600E+01	0.612	0.581	0.461
36	3.12330E+01	0.611	0.580	0.459
37	3.15847E+01	0.609	0.578	0.456
38	3.20500E+01	0.607	0.576	0.451
39	3.25500E+01	0.604	0.573	0.447
40	3.30500E+01	0.600	0.570	0.442
41	3.35500E+01	0.595	0.566	0.437
42	3.41962E+01	0.589	0.560	0.431
43	3.47000E+01	0.584	0.556	0.428
44	3.49150E+01	0.581	0.553	0.426
45	3.53723E+01	0.573	0.545	0.420
46	3.60720E+01	0.561	0.534	0.413
47	3.71220E+01	0.544	0.518	0.402

48	3.81720E+01	0.527	0.503	0.392
49	3.88720E+01	0.517	0.494	0.385
50	3.95720E+01	0.508	0.486	0.380
51	4.02360E+01	0.501	0.480	0.375
52	4.07750E+01	0.498	0.477	0.373
53	4.12500E+01	0.495	0.475	0.370
54	4.17500E+01	0.493	0.474	0.368
55	4.22500E+01	0.492	0.473	0.366
56	4.27500E+01	0.492	0.473	0.364
57	4.32500E+01	0.492	0.473	0.363
58	4.37500E+01	0.493	0.474	0.363
59	4.42500E+01	0.494	0.475	0.363
60	4.47500E+01	0.494	0.475	0.363

(a) Peak value normalized to unity

Table 4.9 Calculated ϕ (E>1) in Surveillance Capsules and Lead Factors[(1)] for Calvert Cliffs Unit 2

AZIMUTHAL LOCATION: $\theta = 7°$

Cycle Type	RPV Lead Factor	1/4T Lead Factor	3/4T Lead Factor
12 M	1.26	2.11	10.35
18 M	1.24	2.09	10.23
24 M	1.18	1.97	9.74

AZIMUTHAL LOCATION: $\theta = 14°$

Cycle Type	RPV Lead Factor	1/4T Lead Factor	3/4T Lead Factor
12 M	0.94	1.58	7.76
18 M	0.91	1.53	7.48
24 M	0.79	1.32	6.54

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(1) $LF = \dfrac{\phi_{sc}\ (>1)}{\phi_{pv}\ (>1)}$, where ϕ_{sc} is the calculated flux at the center of the surveillance capsule, and ϕ_{pv} is the maximum calculated flux incident at the indicated RPV location.

Table 4.10 Peak ϕ (>1) in RPV of Calvert Cliffs-2

Radial(a) Location	12M Cycle(b) adjusted	12M Cycle(c) calculated	18M Cycle(c) calculated	18 Month(b) adjusted	24M Cycle(c) calculated
IR RPV (R=221.29)	4.72E10	5.04E10	4.89E10	4.59E10	4.10E10
1/4 T (R=225.98)	2.82E10	3.01E10	2.90E10	2.72E10	2.46E10
3/4 T (R=236.93)	5.75E9	6.13E9	5.92E9	5.56E9	4.97E10

(a) RPV liner begins at 220.5
RPV begins at 221.29
RPV ends at 242.41

(b) Obtained by dividing adjusted S.C. flux (see Table 4.7) by lead factor for 7° capsule in Table 4.9.

(c) Obtained by dividing calculated S.C. flux in Table 4.3 by lead factor in Table 4.9. (Note: no experimental data is available for 24 month cycles.)

Table 4.11 DPA Values (Displacements Per Atom Per Second) in RPV of Calvert Cliffs-2 Due to Neutrons with Energies Above 15 KeV

Radial Location	12M	18M	24M
220.895	7.70120E-11	7.44755E-11	6.28325E-11
222.102	7.12429E-11	6.88783E-11	5.80252E-11
223.727	6.20802E-11	5.99981E-11	5.04510E-11
225.351	5.30644E-11	5.12647E-11	4.30195E-11
226.976	4.50996E-11	4.35527E-11	3.64720E-11
228.601	3.82092E-11	3.68842E-11	3.08251E-11
230.225	3.22920E-11	3.11603E-11	2.59904E-11
231.850	2.71842E-11	2.62221E-11	2.18313E-11
233.475	2.27459E-11	2.19337E-11	1.82302E-11
235.099	1.88462E-11	1.81679E-11	1.50774E-11
236.724	1.53725E-11	1.48154E-11	1.22790E-11
238.348	1.22209E-11	1.17754E-11	9.76867E-12
239.973	9.27444E-12	8.93477E-12	7.39050E-12
241.598	6.21949E-12	5.99104E-12	4.95297E-12

Table 4.12-a Calculated Fluence Multigroup-Spectra in Reactor Pressure Vessel at Peak Axial and Azimuthal Location ($\theta = 0°$) for Calvert Cliffs Unit-2 (12M Cycle)

		ϕ $n \cdot cm^{-2} \cdot s^{-1}$		
Group	Upper Energy (MeV)	0-T R=221.29	1/4-T R=225.98	3/4-T R=236.93
1	1.733E+01	0.13903E+08	0.66299E+07	0.11341E+07
2	1.419E+01	0.60230E+08	0.29019E+08	0.49589E+07
3	1.221E+01	0.24316E+09	0.11322E+09	0.17639E+08
4	1.000E+01	0.48806E+09	0.22636E+09	0.33443E+08
5	8.607E+00	0.86725E+09	0.39420E+09	0.53867E+08
6	7.408E+00	0.21627E+10	0.95554E+09	0.11839E+09
7	6.065E+00	0.30616E+10	0.13013E+10	0.14864E+09
8	4.966E+00	0.52688E+10	0.22331E+10	0.25428E+09
9	3.679E+00	0.36265E+10	0.16645E+10	0.21901E+09
10	3.012E+00	0.26524E+10	0.13040E+10	0.18234E+09
11	2.725E+00	0.29983E+10	0.15343E+10	0.22442E+09
12	2.466E+00	0.14882E+10	0.76602E+09	0.11316E+09
13	2.365E+00	0.38856E+09	0.22000E+09	0.36853E+08
14	2.346E+00	0.18615E+10	0.10640E+10	0.18309E+09
15	2.231E+00	0.45795E+10	0.26909E+10	0.46962E+09
16	1.920E+00	0.47468E+10	0.31886E+10	0.68395E+09
17	1.653E+00	0.63481E+10	0.44750E+10	0.10201E+10
18	1.353E+00	0.95161E+10	0.78817E+10	0.23706E+10
19	1.003E+00	0.61356E+10	0.55743E+10	0.21153E+10
20	8.208E-01	0.29275E+10	0.23763E+10	0.81196E+09
21	7.427E-01	0.82006E+10	0.89881E+10	0.42637E+10
22	6.081E-01	0.68423E+10	0.73336E+10	0.36954E+10
23	4.979E-01	0.73867E+10	0.82570E+10	0.41833E+10
24	3.688E-01	0.76526E+10	0.97683E+10	0.58506E+10
25	2.972E-01	0.96759E+10	0.10321E+11	0.54995E+10
26	1.832E-01	0.88561E+10	0.10286E+11	0.59507E+10
27	1.111E-01	0.60800E+10	0.63931E+10	0.35515E+10
28	6.738E-02	0.51275E+10	0.49135E+10	0.25663E+10
29	4.097E-02	0.17987E+10	0.13050E+10	0.64403E+09
30	3.183E-02	0.90129E+09	0.40188E+09	0.19741E+09
31	2.606E-02	0.23025E+10	0.27542E+10	0.17347E+10
32	2.418E-02	0.14558E+10	0.16674E+10	0.11334E+10
33	2.188E-02	0.27861E+10	0.25660E+10	0.14953E+10

Table 4.12-b Calculated Neutron Fluence Multigroup Spectra in Reactor Pressure Vessel at Peak Axial and Azimuthal Location ($\theta = 0$) for Calvert Cliffs Unit-2 (18M Cycle)

		ϕ $n \cdot cm^{-2} \cdot s^{-1}$		
Group	Upper Energy (MeV)	O-T R=221.29	1/4-T R=225.98	3/4-T R=236.93
1	1.733E+01	0.13469E+08	0.64234E+07	0.10976E+07
2	1.419E+01	0.58343E+08	0.28108E+08	0.47986E+07
3	1.221E+01	0.23551E+09	0.10963E+09	0.17062E+08
4	1.000E+01	0.47268E+09	0.21917E+09	0.32348E+08
5	8.607E+00	0.83981E+09	0.38166E+09	0.52098E+08
6	7.408E+00	0.20943E+10	0.92521E+09	0.11452E+09
7	6.065E+00	0.29638E+10	0.12597E+10	0.14373E+09
8	4.966E+00	0.50983E+10	0.21604E+10	0.24572E+09
9	3.679E+00	0.35085E+10	0.16097E+10	0.21155E+09
10	3.012E+00	0.25658E+10	0.12610E+10	0.17610E+09
11	2.725E+00	0.29002E+10	0.14836E+10	0.21672E+09
12	2.466E+00	0.14395E+10	0.74066E+09	0.10927E+09
13	2.365E+00	0.37586E+09	0.21270E+09	0.35580E+08
14	2.346E+00	0.18005E+10	0.10287E+10	0.17675E+09
15	2.231E+00	0.44294E+10	0.26014E+10	0.45340E+09
16	1.920E+00	0.45904E+10	0.30817E+10	0.66008E+09
17	1.653E+00	0.61384E+10	0.43244E+10	0.98444E+09
18	1.353E+00	0.91989E+10	0.76132E+10	0.22864E+10
19	1.003E+00	0.59284E+10	0.53813E+10	0.20388E+10
20	8.208E-01	0.28293E+10	0.22945E+10	0.78276E+09
21	7.427E-01	0.79182E+10	0.86704E+10	0.41066E+10
22	6.081E-01	0.66054E+10	0.70723E+10	0.35582E+10
23	4.979E-01	0.71318E+10	0.79628E+10	0.40280E+10
24	3.688E-01	0.73814E+10	0.94122E+10	0.56296E+10
25	2.972E-01	0.93382E+10	0.99482E+10	0.52924E+10
26	1.822E-01	0.85427E+10	0.99081E+10	0.57241E+10
27	1.111E-01	0.58661E+10	0.61583E+10	0.34158E+10
28	6.738E-02	0.49478E+10	0.47333E+10	0.24680E+10
29	4.097E-02	0.17364E+10	0.12573E+10	0.61938E+09
30	3.183E-02	0.87043E+09	0.38722E+09	0.18986E+09
31	2.606E-02	0.22178E+10	0.26498E+10	0.16663E+10
32	2.418E-02	0.14009E+10	0.16024E+10	0.10876E+10
33	2.188E-02	0.26844E+10	0.24671E+10	0.14349E+10

Table 4.12-c Calculated Neutron Fluence Rate Multigroup Spectra in Reactor Pressure Vessel and Azimuthal Location (θ = 0°) for Calvert Cliffs Unit-2 (24M Cycle)

		ϕ $n \cdot cm^{-2} \cdot s^{-1}$		
Group	Upper Energy (MeV)	O-T R=221.29	1/4-T R=225.98	3/4-T R=236.93
1	1.733E+01	0.11591E+08	0.55590E+07	0.94675E+06
2	1.419E+01	0.50126E+08	0.24272E+08	0.41304E+07
3	1.221E+01	0.20170E+09	0.94309E+08	0.14620E+08
4	1.000E+01	0.40426E+09	0.18826E+09	0.27671E+08
5	8.607E+00	0.71675E+09	0.32716E+09	0.44461E+08
6	7.408E+00	0.17856E+10	0.79253E+09	0.97652E+08
7	6.065E+00	0.25196E+10	0.10759E+10	0.12216E+09
8	4.966E+00	0.43157E+10	0.18363E+10	0.20776E+09
9	3.679E+00	0.29651E+10	0.13650E+10	0.17838E+09
10	3.012E+00	0.21668E+10	0.10684E+10	0.14832E+09
11	2.725E+00	0.24476E+10	0.12560E+10	0.18237E+09
12	2.466E+00	0.12148E+10	0.62695E+09	0.91920E+08
13	2.365E+00	0.31728E+09	0.17998E+09	0.29906E+08
14	2.346E+00	0.15190E+10	0.87010E+09	0.14851E+09
15	2.231E+00	0.37360E+10	0.22003E+10	0.38106E+09
16	1.920E+00	0.38682E+10	0.26024E+10	0.55363E+09
17	1.653E+00	0.51700E+10	0.36495E+10	0.82514E+09
18	1.353E+00	0.77353E+10	0.64101E+10	0.19110E+10
19	1.003E+00	0.49740E+10	0.45179E+10	0.16982E+10
20	8.208E-01	0.23761E+10	0.19283E+10	0.65267E+09
21	7.427E-01	0.66195E+10	0.72511E+10	0.34081E+10
22	6.081E-01	0.55162E+10	0.59050E+10	0.29483E+10
23	4.979E-01	0.59595E+10	0.66488E+10	0.33378E+10
24	3.688E-01	0.61390E+10	0.78256E+10	0.46495E+10
25	2.972E-01	0.77868E+10	0.82842E+10	0.43738E+10
26	1.832E-01	0.71057E+10	0.82270E+10	0.47195E+10
27	1.111E-01	0.48838E+10	0.51122E+10	0.28142E+10
28	6.728E-02	0.41218E+10	0.39300E+10	0.20325E+10
29	4.097E-02	0.14498E+10	0.10448E+10	0.51013E+09
30	3.183E-02	0.72818E+09	0.32185E+09	0.15640E+09
31	2.606E-02	0.18316E+10	0.21863E+10	0.13643E+10
32	2.418E-02	0.11519E+10	0.13152E+10	0.88646E+09
33	2.188E-02	0.22205E+10	0.20290E+10	0.11692E+10

Table 4.13 Radial Gradient of Fast Fluence Rate [ϕ (E > 1)] Through RPV, at Peak Azimuthal and Axial Locations in Calvert Cliffs-2

$\bar{R}^{(1)}$ (cm)	ϕ (E > 1 MeV) $n \cdot cm^{-2} \cdot s^{-1}$		
	12M	18M	24M
220.895	5.19E10	5.02E10	4.24E10
222.102	4.72E10	4.57E10	3.36E10
223.727	3.98E10	3.84E10	3.24E10
225.351	3.25E10	3.14E10	2.64E10
226.976	2.62E10	2.53E10	2.13E10
228.601	2.10E10	2.03E10	1.70E10
230.225	1.67E10	1.61E10	1.35E10
231.850	1.32E10	1.28E10	1.07E10
233.475	1.04E10	1.01E10	8.42E9
235.099	8.16E9	7.87E9	6.58E9
236.724	6.33E9	6.10E9	5.10E9
238.348	4.83E9	4.66E9	3.89E9
239.973	3.58E9	3.45E9	2.88E9
241.598	2.43E9	2.34E9	1.95E9

Table 4.14 Fluence in RPV after 12 EFPY for Calvert Cliffs-2

Location	Fluence neutrons.cm^{-2}
RPV IR (R=221.29)	1.69E19
1/4T (R=225.98)	1.01E19
3/4T (R=236.93)	2.05E18

Table 4.15 Determination of RPV Peak Fluence for Calvert Cliffs-2

Cycles	Full Power Days	Accumulated Fluence(3) neutrons.cm^{-2}
1-3 (12 month)	1165.94	4.76E18
4 (18 month)	508.53	2.02E18
5-7 (18 month)	1242.92	4.93E18
8 (24 month)(1)	586.17	2.08E18
9-EOL (24 month)(2)	8184.44	2.90E19
Totals	11688.00	4.28E19

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(1) Projected value based on estimated EFPD/cycle for cycle 8

(2) Projected, based on 32 EFPY lifetime

(3) 12 month and 18 month cycle fluence rate based on adjusted flux values in Table 6; 24 month values based on calculated fluxes from Table 4.10.

5. ADJUSTED REFERENCE TEMPERATURE DETERMINATION

NRC Regulatory Guide 1.99, Revision 2, provides the approach for computing the adjusted reference nil-ductility temperatures for beltline materials. The adjusted reference temperature (ART) is given by

$$\text{ART} = \text{Initial RTNDT} + \Delta RT_{NDT} + \text{Margin} \qquad (1)$$

where

$$\Delta RT_{NDT} = [CF] f^{(0.28 - 0.1 \log f)} \qquad (2)$$

and

CF = chemistry factor specified in Reg. Guide 1.99, Rev. 2.

f = fluence (10^{19} n/cm^2, E > 1 MeV)

$\text{Margin} = 2\sqrt{\sigma_I^2 + \sigma_\Delta^2}$

where σ_I = initial standard deviation of data = 0°F

σ_Δ = 28°F for welds and 17°F for plate materials

Table 5.1a and b presents an evaluation of the ART of beltline materials for 12 EFPY and 32 EFPY respectively. From this table it is clear that the weld 2-203 is the controlling material for the pressure vessel. The ART of weld 2-203 at various irradiation conditions are used in developing the various P-T limit curves.

Fluence at various depths is given by,

$$f = f \text{ surface } (e^{-0.24X}) \qquad (3)$$

The through thickness attenuation of ΔRT_{NDT} is calculated by using equation (2).

The ΔRT_{NDT} values for the various depths for the controlling weld 2-203 for 12, 16, 20, 24, 28, 32, 36 and 40 EFPYs are presented in table 5.2. Table 5.3 presents ART at 1/4T and 3/4T locations for the various EFPY.

Table 5.1(a). ART Evaluation for Beltline Materials for 12 EFPY

	Chemistry			Initial	ΔRT_{NDT}	Margin	
Material	Cu	Ni	C.F.	RT_{NDT}°F	Surface °F	°F	ART
Weld 2-203	0.12	1.01	161	-56	184	56	184
3-203	0.23	0.23	120	-80	137	56	113
9-203	0.22	0.05	101	-60	116	56	112
Plate D-8906-1	0.15	0.56	107	10	122	34	166
D-8906-3	0.14	0.55	98	5	112	34	141
D-8907-1	0.15	0.6	110	-8	126	34	152
D-8907-2	0.14	0.66	102	20	117	34	171

NOTE: D8906-2 and D8907-3 are not included because they are bounded by the chemistry and initial RT_{NDT} by D8906-1 and D8907-2, respectively.

Table 5.1(b). ART Evaluation for Beltline Materials for 32 EFPY

	Chemistry			Initial	ΔRT_{NDT}	Margin	
Material	Cu	Ni	C.F.	RT_{NDT}°F	Surface °F	°F	ART
Weld 2-203	0.12	1.01	161	-56	222	56	222
3-203	0.23	0.23	120	-80	165	56	189
9-203	0.22	0.05	101	-60	139	56	135
Plate D-8906-1	0.15	0.56	107	10	147	34	191
D-8906-3	0.14	0.55	98	5	135	34	174
D-8907-1	0.15	0.6	110	-8	151	34	177
D-8907-2	0.14	0.66	102	20	140	34	194

Table 5.2. ΔRT_{NDT} vs EFPY for Controlling Weld 2-203

EFPY	ΔRT_{NDT} Surface °F	ΔRT_{NDT} (1/4 T) °F	ΔRT_{NDT} (3/4 T) °F
12	184	161	115
16	196	173	127
20	204	183	136
24	211	190	144
28	216	196	151
32	222	201	157
36	224	206	162
40	228	210	166

Table 5.3. Adjusted Reference Temperatures (ART) at 1/4 T and 3/4 T for Controlling Weld 2-203

EFPY	ART (1/4 T) °F	ART (3/4 T) °F
12	161	115
16	173	127
20	183	136
24	190	144
28	196	151
32	201	157
36	206	162
40	210	166

6. HEAT-UP AND COOL-DOWN LIMITS

The adjusted reference temperature (ART) for 12, 16, 20, 24, 28, 32, 36 and 40 EFPYs were presented in Section 5. These ART values were used to develop the pressure-temperature limit conditions for the EFPYs described above. An inhouse computer program PTLIMT was used. The generic procedures for PTLIMT are described in Appendix D.

The following pressure vessel constants were employed as input data in the Calvert Cliffs Unit 2 analysis:

Vessel Inner Radius, ri = 86.81 in.
Vessel Outer Radius, r_o = 95.43 in.
Operating Pressure, P_o = 2235 psig
Initial Temperature, T_f = 550°F
Effective Coolant Flow Rate, Q = 128.8×10^6 lbm/hr
Effective Flow Area, A = 39.83 ft^2
Effective Hydraulic Diameter, D = 22.44 in.

Heat-up limits were computed for heat-up rates of 40°F/hr, 50°F/hr, 60°F/hr and 70°F/hr. Cool-down curves were computed for cool-down rates of 0°F/hr, 20°F/hr. 50°F/hr, and 100°F/hr.

Figures 6.1 and 6.2 presents the heat up and cool down limit curves respectively for 12 EFPY. These figures were developed based on the NRC Standard Review Plan (5.3.2). In Figure 6.1, the lowest service temperatures, minimum bolt-up temperature (70°F) and inservice leak test curves are incorporated. In developing the heat-up and cool down curves, instrument error margins of -60 psig for pressure measurements and +10°F for temperature monitoring have been included. These margins have been used industry-wide to

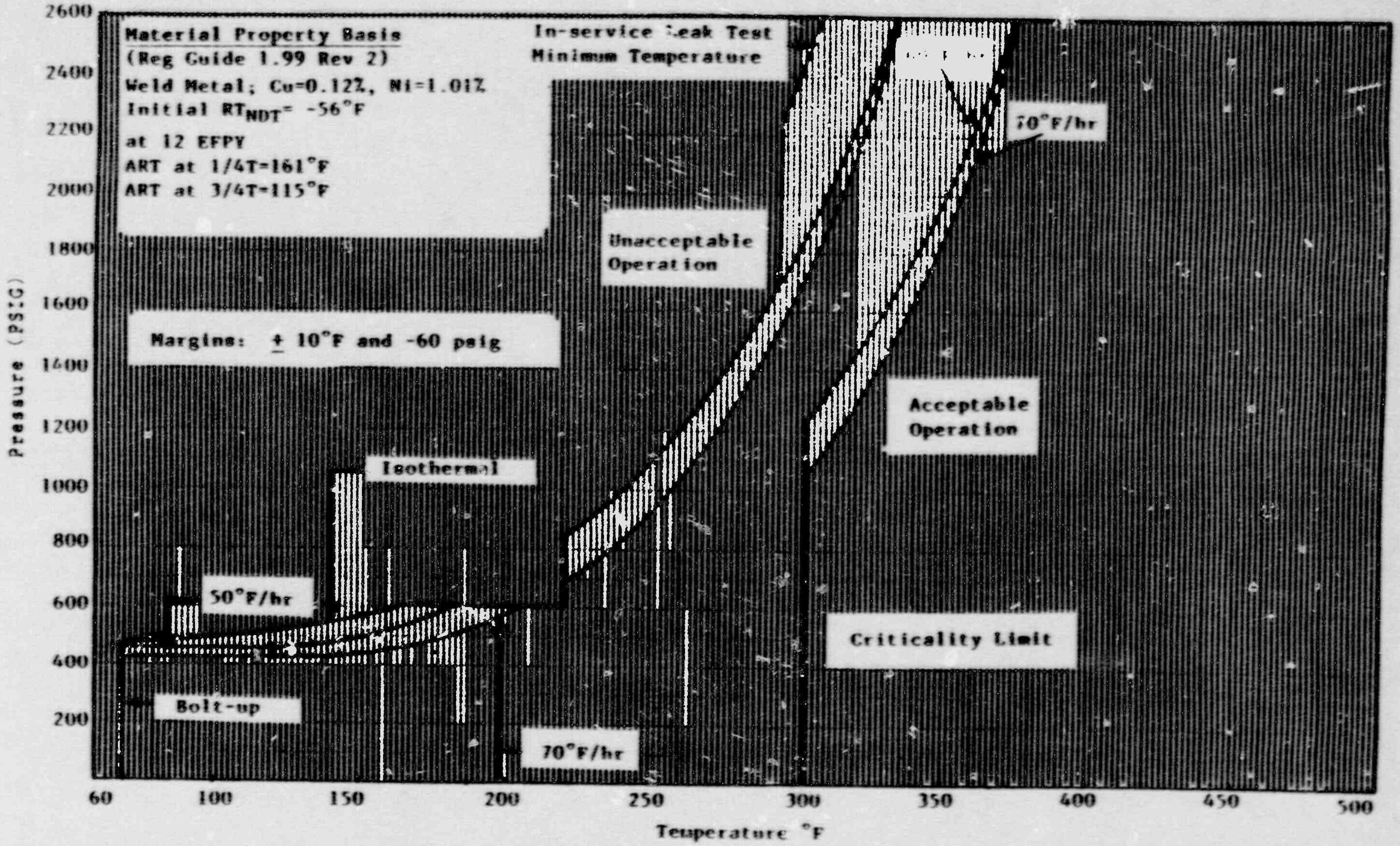

Figure 6.1 Heat-Up Pressure-Temperature Limitation Curves for Calvert Cliff Unit 2 Reactor Vessel (12 EFPY)

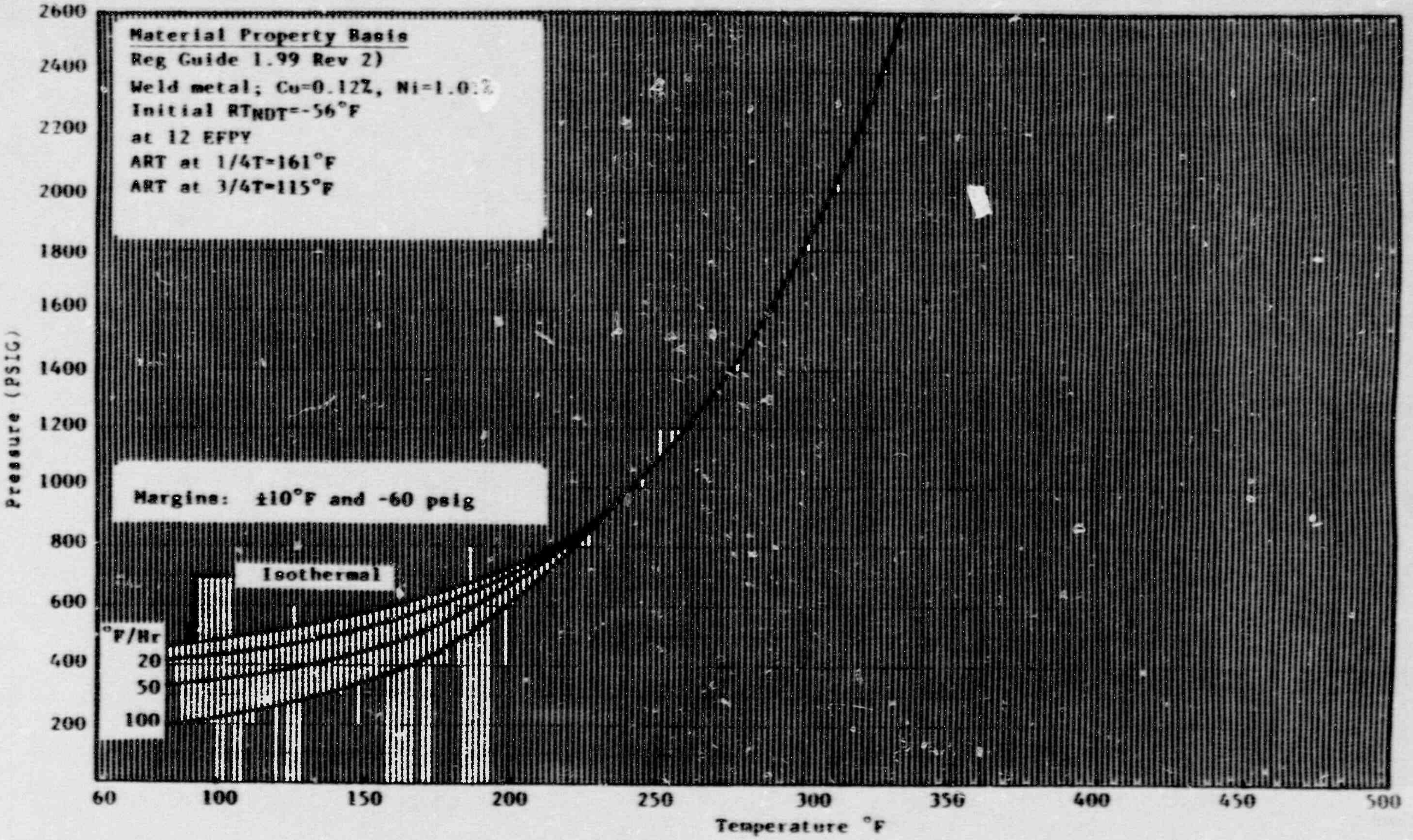

Figure 6.2 Cool-down Pressure-Temperature Limitation Curve for Calvert Cliff Unit 2 Reactor Vessel (12 EFPY)

allow for possible errors in measuring instruments and account for variations between bulk temperatures and local (near beltline) temperatures.

Appendix E presents the tables containing heat-up and cool-down data for 16, 20, 24, 28, 32, 36 and 40 EFPYs. Appendix F contains the P-T limit tables for varying cooldown rates for 12 EFPY. Appendix G presents the P-T limit tables for isothermal conditions.

References

1. Norris, E. B., "Reactor Vessel Material Surveillance Program for Calvert Cliffs Unit 2 Analysis of 263° Capsule," Final Report, SwRI Project 06-7524, September 1985.

2. JAT (BG&E) letter to NRC, January 23, 1986 and Don Wright's (BG&E) Calculations, January 15, 1986.

3. Rhoades, W. A., Childs, R. L., "An Updated Version of the DOT-4 One- and Two-Dimensional Neutron/Photon Transport Code", ORNL-5851, Oak Ridge National Laboratory, Oak Ridge, TN, July, 1982.

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APPENDIX A

Determination of Space-Dependent Source Distribution for Transport Analysis of Calvert Cliffs-2

PEG/CALVERT

Appendix A. Determination of Space-Dependent Source Distribution for Transport Analysis of Calvert Cliffs-2

The space-dependent source distribution used in the transport calculations was obtained by combining the assembly-wise power distribution with relative pinwise power values for the peripheral assemblies (i.e., XY Zones 9, 18, 26, 34, 42, 49 in Figure 1). The relative assembly-wise power distributions for the 12, 18, and 24 month cycles are shown in Figure A.1. These values were obtained by averaging BOC, MOC, and EOC absolute assembly powers provided by Baltimore Gas and Electric as representative for the appropriate cycles and then dividing the average assembly power. (The 24 month cycle distribution corresponds to a projected MOC core.) Note that all interior assemblies are approximated as having a unity relative power (i.e., producing the average power). Since the interior elements contribute a negligible amount to the RPV fluence, this approximation is very adequate. The absolute assembly power distributions provided by BG&E for each type of cycle is given by Table A.1.(1)

The power density is assumed flat within the interior assemblies, but is represented with a pinwise variation for the boundary assemblies, which account for virtually all of the RPV fluence. Baltimore Gas and Electric has confirmed that the relative pin-power variation within the peripheral assemblies is similar for Calvert Cliffs Units 1 and 2;(2) therefore the same relative pin-power values obtained for the previous Unit 1 analysis(3) were also used in the present Unit 2 calculations. Examination of the BOC, MOC, and EOC relative pin powers provided by BG&E shows that the MOC distribution is a good approximation for the average over the cycle, and hence was used as the representative pinwise variation. The relative pin power in the peripheral assemblies are very similar for the 12 and 18 month cycles, and therefore the 18 month is used for both (the assembly-wise distributions are different, however). Tables A.3-A.4 give the relative pinwise variations for configuration in Figure A.1 (given in "FIDO FORMAT").

The combination of the assembly and pinwise powers results in an absolute space-dependent power density defined for the quarter core. The power density values are converted to a source density by multiplying by the factor,

$$7.84 \times 10^{16} \ \frac{\text{neutrons/s}}{\text{MW}}$$

The 1/4 core XY source distribution is then mapped onto the 1/8 core Rθ mesh used in DOT by utilizing an interpolating program previously developed for this purpose.

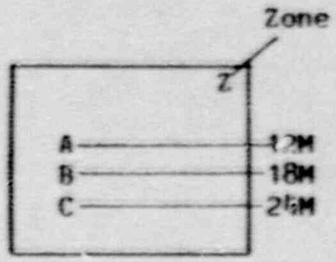
REFERENCES

(1) J. B. Couch, letter to M. L. Williams from Baltimore Gas and Electric dated January 7, 1988.

(2) J. B. Couch, personal communication to M. L. Williams, January 6, 1988.

(3) P. Nair, M. L. Williams, "Pressure-Temperature Limits for Calvert Cliffs Nuclear Power Plant Unit 1", Southwest Research Institute, Final Report.

Figure A.1 Relative Power Distributions (Assembly-wise) for 12, 18, and 24 Month Cycles for Calvert Cliffs Unit 2



45°

43 1.0	44 1.0	45 1.0	46 1.0	47 1.0	48 1.0	49 .82 .75 .42		
35 1.0	36 1.0	37 1.0	38 1.0	39 1.0	40 1.0	41 1.16 1.00 1.07	42 .75 .68 .40	
27 1.0	28 1.0	29 1.0	30 1.0	31 1.0	32 1.0	33 1.08 1.06 1.09	34 .98 .91 .87	
19 1.0	20 1.0	21 1.0	22 1.0	23 1.0	24 1.0	25 1.00 1.14 1.26	26 1.10 .91 .85	
10 1.0	11 1.0	12 1.0	13 1.0	14 1.0	15 1.0	16 .85 1.08 1.07	17 1.06 .98 1.13	.71 .65 .36
1 1.0	2 1.0	3 1.0	4 1.0	5 1.0	6 1.0	7 1.15 .96 1.29	8 .85 1.07 .90	9 .86 .84 .80

Table A.1. Absolute Assembly Powers (MW_{th}) for Calvert Cliffs-2

Zone	12 Month Cycle	18 Month Cycle	24 Month Cycle
•• 1	3.11	3.11	3.11
• 2	6.22	6.22	6.22
• 3	6.22	6.22	6.22
• 4	6.22	6.22	6.22
• 5	6.22	6.22	6.22
• 6	6.22	6.22	6.22
• 7	7.16	5.96	8.02
• 8	5.26	6.68	5.58
9	10.60	10.41	10.00
• 10	6.22	6.22	6.22
11	12.44	12.44	12.44
12	12.44	12.44	12.44
13	12.44	12.44	12.44
14	12.44	12.44	12.44
15	12.44	12.44	12.44
16	10.60	13.43	13.27
17	13.16	12.17	14.10
18	8.82	8.02	4.45
• 19	6.22	6.22	6.22
20	12.44	12.44	12.44
21	12.44	12.44	12.44
22	12.44	12.44	12.44
23	12.44	12.44	12.44
24	12.44	12.44	12.44
25	12.44	14.12	15.62
26	13.72	11.36	10.53
• 27	6.22	6.22	6.22
28	12.44	12.44	12.44
29	12.44	12.44	12.44
30	12.44	12.44	12.44
31	12.44	12.44	12.44
32	12.44	12.44	12.44
33	13.41	13.15	13.53
34	12.16	11.36	10.76
• 35	6.22	6.22	6.22
36	12.44	12.44	12.44
37	12.44	12.44	12.44
38	12.44	12.44	12.44
39	12.44	12.44	12.44
40	12.44	12.44	12.44
41	14.45	12.48	13.26
42	9.35	8.48	5.02
• 43	6.22	6.22	6.22
44	12.44	12.44	12.44
45	12.44	12.44	12.44
46	12.44	12.44	12.44
47	12.44	12.44	12.44
48	12.44	12.44	12.44

49	10.15	9.36	5.21
50	0.0	0.0	0.0

(*) indicates 1/2-assembly zone
(**) indicates 1/4-assembly zone

Table A.2. Relative Pin Powers for 18 Month Cycle

```
105R1. 1.22 1.19 1.19 1.17 1.11 1.05 .99 .97 .93 .88 .84 .76 .67 .58
105R1. 1.2 1.30 1.41 1.38 1.21 1.03 .97 .95 .91 .96 .99 .91 .74 .58
105R1. 1.23 1.43 0.0 0.00 1.33 1.04 .97 .95 .92 1.05 0.00 0.00 .82 .59
105R1. 1.23 1.42 0.00 0.00 1.32 1.04 .98 .95 .92 1.05 0.00 0.00 .82 .58
105R1. 1.21 1.28 1.38 1.35 1.20 1.04 1.00 .99 .92 .96 .98 .89 .72 .57
105R1. 1.17 1.12 1.11 1.09 1.06 1.15 1.22 1.20 1.03 .86 .79 .72 .63 .55
105R1. 1.15 1.08 1.08 1.06 1.06 1.26 0.00 0.00 1.13 .86 .77 .69 .61 .58
105R1. 1.12 1.06 1.05 1.05 1.05 1.25 0.00 0.00 1.10 .84 .76 .68 .60 .54
105R1. 1.14 1.08 1.08 1.06 1.04 1.12 1.19 1.152 .99 .93 .76 .69 .61 .54
105R1. 1.16 1.22 1.32 1.29 1.15 .99 .96 .93 .87 .91 .93 .85 .69 .54
105R1. 1.17 1.34 0.00 0.00 1.26 .99 .92 .89 .86 .99 0.00 0.00 .77 .55
105R1. 1.16 1.34 0.00 0.00 1.25 .98 .90 .88 .85 .98 0.00 0.00 .77 .55
105R1. 1.13 1.21 1.31 1.29 1.13 .96 .89 .87 .84 .89 .93 .85 .69 .54
105R1. 1.13 1.11 1.12 1.10 1.04 .98 .92 .89 .86 .83 .79 .72 .64 .56
105R1. 1.12 1.10 1.102 1.083 1.028 .97 .912 .881 .847 .814 .777 .711 .62
0.54
105R1. 1.1 1.17 1.27 1.24 1.09 .92 .86 .83 .8 .85 .875 .802 .647 .501
105R1. 1.11 1.27 0. 0. 1.17 .91 .84 .814 .786 .90 0. 0. .692 .488
105R1. 1.1 1.25 0. 0. 1.15 .896 .83 .8 .77 .878 0. 0. .668 .469
105R1. 1.065 1.11 1.19 1.16 1.02 .87 .83 .8 .75 .778 .79 .72 .57 .439
105R1. 1.03 .965 .95 .927 .89 .956 1. .969 .82 .677 .62 .554 .477 .401
105R1. .997 .93 .908 .893 .885 1.044 0. 0. .885 .659 .585 .516 .447 .387
   91R1. 1.228 1.198 1.210 1.201 1.163 1.127 1.097
         1.115 1.118 1.129 1.143 1.130 1.095 1.086
 .981 .91 .874 .85 .833 .98 0. 0. .855 .635 .563 .497 .432 .376
   91R1. 1.211 1.298 1.416 1.406 1.258 1.099 1.064
         1.073 1.078 1.205 1.319 1.302 1.165 1.048
 .972 .9 .87 .837 .8 .848 .884 .87 .733 .6 .542 .482 .415 .359
   91R1. 1.239 1.431 0.000 0.000 1.389 1.120 1.074
         1.071 1.086 1.312 0.000 0.000 1.262 1.047
 .968 .99 1.03 .989 .855 .722 .679 .66 .61 .626 .625 .56 .447 .344
   91R1. 1.246 1.437 0.000 0.000 1.398 1.133 1.092
         1.078 1.086 1.305 0.000 0.000 1.241 1.029
 .96 1.06 0. 0. .91 .688 .626 .607 .57 .64 0. 0. .47 .33
   91R1. 1.224 1.305 1.421 1.414 1.277 1.135 1.124
         1.100 1.079 1.179 1.271 1.238 1.092 0.976
 .925 1.02 0. 0. .855 .642 .579 .561 .527 .596 0. 0. .439 .306
   91R1. 1.205 1.159 1.166 1.164 1.151 1.242 1.335
         1.296 1.173 1.052 1.027 0.986 0.934 0.919
```

Table A.2. Continued

```
.867 .873 .9 .85 .71 .58 .53 .52 .48 .495 .504 .454 .357 .274
  91R1. 1.195 1.144 1.139 1.143 1.158 1.352 0.000
        0.000 1.273 1.052 0.998 0.941 0.886 0.863
.805 .72 .674 .63 .58 .532 .494 .48 .438 .404 .372 .333 .286 .248
 91R1.0 1.193 1.142 1.138 1.142 1.157 1.348 0.000
        0.000 1.246 1.022 0.965 0.917 0.868 0.832  14Z
 91R1.0 1.220 1.171 1.176 1.172 1.155 1.240 1.325
        1.279 1.143 1.011 0.973 0.920 0.850 0.794  14Z
 91R1.0 1.256 1.333 1.448 1.436 1.290 1.138 1.118
        1.081 1.041 1.115 1.174 1.113 0.939 0.771  14Z
 91R1.0 1.295 1.484 0.000 0.000 1.423 1.143 1.092
        1.055 1.037 1.213 0.000 0.000 1.026 0.757  14Z
 91R1.0 1.300 1.429 0.000 0.000 1.425 1.139 1.081
        1.042 1.027 1.204 0.000 0.000 1.012 0.743  14Z
 91R1.0 1.380 1.364 1.481 1.464 1.301 1.125 1.078
        1.036 1.010 1.094 1.156 1.090 0.905 0.724  14Z
 91R1.0 1.292 1.262 1.274 1.261 1.209 1.156 1.111
        1.062 1.031 1.008 0.984 0.923 0.833 0.747  14Z
 91R1. 1.294 1.261 1.271 1.256 1.201 1.145 1.084 1.05 1.027 1.004 .977
    .915 .825  .741   14Z
 91R1. 1.265 1.351 1.465 1.444 1.280 1.099 1.039 1.092 .981 1.058 1.109
   1.037 .858 .689  14Z
 91R1. 1.273 1.466 0.0 0.0 1.39 1.1 1.028 .992 .976 1.136 0.0 0.0 .923
 .675  14Z

 91R1. 1.259 1.45 0.0 0.0 1.377 1.094 1.028 .992 .969 1.121 0. 0. .9
 .654  14Z
 91R1. 1.217 1.297 1.408 1.391 1.24 1.082 1.047 1.012 6 1.01 1.042
   .963 .785 .622  14Z
 91R1. 1.179 1.134 1.137 1.128 1.104 1.197 1.277 1.234 1.065 .897 .837
   .674 .598  14Z
91R1.  1.147 1.098 1.093 1.092 1.1 1.312 0.0 0.0 1.16 .887 .805 .73 .654
   .59  14Z
91R1. 1.147 1.095 1.088 1.086 1.093 1.302 0. 0. 1.152 .882 .8 .725 .649
   .584  14Z
91R1. 1.172 1.121 1.119 1.107 1.081 1.17 1.242 1.202 1.037 .87 .808 .735
   .647 .573  14Z
91R1. 1.204 1.272 1.371 1.348 1.197 1.04 .999 .969 .915 .956 .979 .9 .73
   .575   14Z
91R1. 1.239 1.41 0. 0. 1.314 1.035 .963 .933 .904 1.036 0. 0. .812 .583
 14Z
```

Table A.2. Continued

```
91R1. 1.243 1.414 0. 0. 1.308 1.024 .945 .914 .89 1.027 0. 0. .807 .578
 14Z
91R1. 1.222 1.29 1.387 1.355 1.186 1.005 .937 .904 .874 .932 .967 .891
    .722 .564  14Z
91R1. 1.232 1.188 1.185 1.158 1.094 1.029 .965 .928 .894 .861 .823 .754
    .662 .577  14Z
 91R1.
 1.206 1.169 1.167 1.14 1.077 1.013 0.951 0.915 0.877 0.843 0.805 0.737
 0.649 0.567
 14Z   91R1.0
 1.179 1.248 1.338 1.304 1.139 0.964 0.899 0.865 0.83 0.86 0.906 0.833
 0.675 0.529
 14Z   91R1.
 1.184 1.348 0.0 0.0 1.228 0.955 0.882 0.847 0.815 0.933 0.0 0.0 6.723
0.516
 14Z   91R1.
 1.166 1.324 0.0 0.0 1.204 0.938 0.87 0.834 0.797 0.907 6.0 0.0 0.696
.495
 14Z   91R1.0
 1.117 1.173 1.254 1.218 1.065 0.911 0.869 0.833 0.774 0.802 0.817 0.74
 0.594 0.461
 14Z   91R1.0
 1.069 1.011 0.994 0.967 0.928 0.991 1.041 0.996 0.842 0.694 0.636 0.57
 0.493 0.429
 14Z   91R1.0
 1.024 0.964 0.94 0.921 0.909 1.069 0.0 0.0 0.879 0.669 0.594 0.525 .457
 0.399
14Z   91R1.0
 1.002 0.94 0.913 0.89 0.876 1.028 0.0 0.0 0.877 0.652 0.577 0.51 0.444
 0.39
 14Z   91R1.0
 0.993 0.929 0.902 0.87 0.83 0.883 0.921 0.893 0.732 0.613 0.557 0.496
0.431 0.376
 14Z   91R1.0
```

Table A.2. Continued

```
 0.987 1.016 1.064 1.019 0.883 0.747 0.703 0.678 0.626 0.641 0.642 0.58
 0.464 0.363
  14Z  91R1.0
 0.98 1.082 0. 0. 0.926 0.706 0.643 0.617 0.582 0.655 0. 0. 0.49 .348
   14Z  91R1.0
 0.943 1.034 0.0 0.0 0.868 0.653 0.59 0.564 0.534 0.605 0.0 0.0 0.455
.322
   14Z  91R1.0
 0.879 0.878 0.907 0.853 0.716 0.585 0.535 0.513 0.478 0.499 0.511 0.46
 0.368 0.286
   14Z  91R1.0
 .813 .713 .669 .629 .575 .529 .491 .472 .434 .403 .374 .337
 0.293 0.258   14Z
77R1. 1.29 1.25 1.25 1.22 1.17 1.12 1.08 1.05 1.03 1.01 1.00 .96 .90 .83
28Z
77R1. 1.25 1.32 1.43 1.40 1.24 1.07 1.03 .99 .97 1.05 1.12 1.07 .90 .73
28Z
77R1. 1.25 1.43 0.00 0.00 1.33 1.06 1.01 .97 .95 1.12 0.00 0.00 .94 .69
28Z
77R1. 1.22 1.40 0.00 0.00 1.31 1.04 .99 .95 .92 1.07 0.00 0.00 .89 .65
28Z
77R1. 1.17 1.24 1.33 1.31 1.16 1.01 .98 .94 .89 .94 .98 .92 .75 .60
28Z
77R1. 1.12 1.07 1.06 1.04 1.01 1.06 1.13 1.07 .93 .80 .76 .70 .62 .56
28Z
77R1. 1.07 1.02 1.00 .99 .98 1.13 0.00 0.00 .97 .77 .70 .64 .58 .52
28Z
77R1. 1.05 .99 .97 .96 .94 1.06 0.00 0.00 .95 .74 .68 .62 .55 .51
28Z
77R1. 1.03 .97 .95 .92 .89 .94 .99 .95 .82 .69 .64 .59 .52 .47
28Z
77R1. 1.02 1.05 1.11 1.07 .94 .81 .77 .74 .69 .72 .73 .67 .55 .44
29Z
77R1. 1.01 1.12 0.00 0.00 .98 .76 .70 .68 .64 .53 0.00 0.00 .57 .42
28Z
77R1. .97 1.07 0.00 0.00 .92 .70 .64 .62 .59 .67 0.00 0.00 .53 .38
28Z
77R1. .90  .90 .94 .89 .76 .62 .58 .55 .52 .55 .57 .53 .42 .34
28Z
77R1. .83 .74 .69 .66 .61 .56 .52 .51 .47 .44 .42 .38 .39 .38
   28Z
```

Table A.3. Relative Pin Powers for 24 Month Cycle

```
105R1.0    1.063 1.047 1.039 1.009 0.956 0.899 0.849
  0.805 0.766 0.731 0.691 0.632 0.551 0.458
105R1.0    1.071 1.076 1.179 1.146 0.982 0.900 0.843
  0.798 0.764 0.748 0.786 0.722 0.569 0.465
105R1.0    1.087 1.200 0.000 0.000 1.076 0.906 0.839
  0.793 0.766 0.832 0.000 0.000 0.640 0.474
105R1.0    1.090 1.196 0.000 0.000 1.089 0.902 0.838
  0.793 0.763 0.826 0.000 0.000 0.634 0.471
105R1.0    1.075 1.057 1.149 1.116 0.960 0.891 0.846
  0.802 0.757 0.729 0.759 0.694 0.549 0.456
105R1.0    1.053 1.006 0.984 0.955 0.919 0.899 0.954
  0.907 0.768 0.700 0.646 0.584 0.512 0.439
105R1.0    1.035 0.980 0.947 0.921 0.903 0.987 0.000
  0.000 0.848 0.689 0.620 0.557 0.492 0.426
105R1.0    1.016 0.967 0.935 0.908 0.890 0.972 0.000
  0.000 0.833 0.675 0.606 0.544 0.480 0.416
105R1.0    1.009 0.972 0.950 0.919 0.882 0.862 0.913
  0.866 0.729 0.661 0.607 0.547 0.479 0.411
105R1.0    1.017 1.005 1.088 1.051 0.899 0.830 0.784
  0.739 0.693 0.663 0.686 0.625 0.493 0.410
105R1.0    1.025 1.121 0.000 0.000 0.995 0.816 0.751
  0.705 0.673 0.723 0.000 0.900 0.548 0.407
105R1.0    1.013 1.110 0.000 0.000 0.977 0.796 0.727
  0.680 0.651 0.703 0.000 0.000 0.534 0.396
105R1.0    0.989 0.982 1.060 1.015 0.853 0.768 0.787
  0.660 0.626 0.609 0.637 0.582 0.458 0.376
105R1.0    0.976 0.951 0.925 0.878 0.812 0.747 0.692
  0.645 0.607 0.575 0.541 0.494 0.430 0.361
105R1.0    .711 .685 .646 .603 .562 .521 .482
  .444 .407 .372 .338 .304 .267 .224
105R1.0    .697 .000 .661 .615 .547 .506 .465
  .427 .391 .356 .336 .304 .000 .217
105R1.0    .670 .672 .000 .000 .550 .486 .444
  .406 .371 .351 .000 .000 .254 .205
105R1.0    .640 .637 .000 .000 .530 .465 .423
  .386 .353 .335 .000 .000 .238 .192
105R1.0    .612 .581 .573 .541 .000 .442 .399
  .365 .336 .000 .288 .256 .214 .180
```

Table A.3. Continued

```
105R1.0    .586 .553 .520 .488 .453 .412 .389
  .357 .316 .289 .260 .230 .200 .167
105R1.0    .563 .526 .491 .457 .421 .400 .000
  .000 .308 .270 .242 .213 .185 .156
91R1.0    1.14 1.11 1.09 1.06 1.02 .97 .93
  .90 .86 .84 .80 .76 .72 .67
  .539 .500 .463 .429 .395 .376 .000
  .000 .286 .250 .223 .196 .170 .143
91R1.0    1.13 1.12 1.17 1.14 1.02 .96 .91
  .87 .84 .83 .85 .80 .71 .66
  .516 .477 .441 .409 .378 .344 .325
  .296 .259 .233 .207 .182 .158 .132
91R1.0    1.14 1.20 0.00 0.00 1.08 .95 .89
  .85 .83 .86 0.00 0.00 .74 .64
  .492 .454 .437 .406 .000 .328 .296
  .267 .241 .000 .198 .175 .146 .122
91R1.0    1.13 1.18 0.00 0.00 1.07 .93 .88
  .84 .81 .84 0.00 0.00 .72 .63
  .467 .449 .000 .000 .353 .308 .276
  .247 .221 .205 .000 .000 .140 .113
91R1.0    1.10 1.08 1.13 1.09 .97 .92 .87
  .83 .80 .77 .78 .74 .65 .60
  .442 .427 .000 .000 .327 .284 .254
  .226 .202 .187 .000 .000 .129 .103
91R1.0    1.08 1.04 1.01 .98 .94 .91 .92
  .88 .79 .74 .70 .65 .61 .57
  .414 .000 .363 .329 .286 .257 .230
  .205 .182 .162 .150 .133 .000 .093
91R1.0    1.06 1.02 .98 .95 .92 .95 0.00
  0.00 .82 .72 .67 .62 .57 .53
  .366 .331 .300 .273 .247 .223 .200
  .178 .158 .140 .124 .109 .095 .079
91R1.0 1.06 1.01 .97 .94 .91 .94 0.00
  0.00 .81 .71 .65 .60 .55 .49
14Z  91R1.0    1.06 1.01 .98 .94 .90 .87 .88
  .84 .74 .69 .64 .59 .53 .46
14Z  91R1.0    1.07 1.03 1.07 1.03 .91 .86 .81
  .77 .72 .69 .68 .63 .53 .45
14Z  91R1.0    1.07 1.11 0.00 0.00 .98 .85 .79
  .75 .71 .72 0.00 0.00 .56 .44
```

Table A.3. Continued

```
14Z  91R1.0    1.06 1.10 0.00 0.00 .97 .84 .78
   .74 .70 .71 0.00 0.00 .55 .44
14Z  91R1.0    1.05 1.02 1.05 1.01 .90 .83 .78
   .73 .69 .66 .66 .60 .50 .42
14Z  91R1.0    1.04 1.00 .97 .93 .87 .82 .77
   .73 .68 .64 .60 .55 .49 .41
         14Z  91R1.0 1.137 1.102 1.083 1.048 0.990 0.93 0.878
           0.833 0.794 0.761 0.723 0.666 0.589 0.506
         14Z 91R1.0  1.128 1.113 1.209 1.171 1.002 0.918 0.859
           0.814 0.781 0.766 0.808 0.745 0.594 0.497
         14Z 91R1.0  1.127 1.230 0.000 0.000 1.113 0.920 0.852
           0.807 0.780 0.849 0.000 0.000 0.661 0.495
         14Z 91R1.0  1.166 1.211 0.000 0.000 1.102 0.914 0.851
           0.806 0.776 0.840 0.000 0.000 0.648 0.482
         14Z 91R1.0  1.066 1.058 1.155 1.124 0.969 0.903 0.861
           0.817 0.770 0.741 0.771 0.705 0.556 0.457
         14Z 91R1.0  1.027 0.996 0.980 0.956 0.925 0.914 0.981
           0.935 0.786 0.711 0.653 0.590 0.514 0.433
         14Z 91R1.0  1.001 0.962 0.938 0.917 0.907 1.008 0.000
           0.000 0.871 0.699 0.625 0.560 0.491 0.517
         14Z 91R1.0  0.986 0.947 0.922 0.901 0.891 0.990 0.000
           0.000 0.854 0.684 0.610 0.546 0.479 0.408
         14Z 91R1.0  0.983 0.950 0.931 0.906 0.876 0.866 0.930
           0.884 0.739 0.664 0.607 0.547 0.477 0.404
         14Z 91R1.0  0.991 0.979 1.063 1.030 0.885 0.823 0.783
           0.740 0.693 0.661 0.683 0.621 0.489 0.404
         14Z 91R1.0  1.000 1.089 0.000 0.000 0.973 0.801 0.741
           0.697 0.666 0.716 0.000 0.000 0.542 0.401
         14Z 91R1.0  0.990 1.075 0.000 0.900 0.949 0.775 0.711
           0.667 0.640 0.692 0.000 0.900 0.525 0.389
         14Z 91R1,0  0.964 0.943 1.016 0.974 0.822 0.742 0.686
           0.642 0.610 0.594 0.622 0.568 0.446 0.367
         14Z 91R1.0  0.945 0.906 0.880 0.840 0.782 0.723 0.672
           0.629 0.592 0.561 0.527 0.479 0.417 0.351
14Z  91R1.0  .676 .640 .605 .570 .534 .497 .461
.425 .390 .356 .322 .288 .253 .212
14Z  91R1.0  .652 .618 .608 .572 .514 .476 .439
.403 .369 .335 .315 .283 .239 .201
14Z  91R1.0  .632 .622 0.0 0.0 .513 .455 .417
.382 .348 .328 0.0 0.0 .235 .190
14Z  91R1.0  .612 .600 0.0 0.0 .490 .432 .395
```

Table A.3. Continued

```
 .361 .329 .310 0.0 0.0 .221 .178
  14Z  91R1.0  390 .553 .539 .502 .446 .408 .373
 .341 .311 .283 .265 .237 .199 .167
  14Z  91R1.0  .565 .527 .491 .455 .419 .384 .366
 .335 .294 .267 .240 .213 .185 .155
  14Z  91R1.0  .541 .501 .464 .429 .394 .376 0.0
 0.0 .208 .251 .224 .198 .171 .144
  14Z  91R1.0  .517 .477 .440 .405 .372 .355 0.0
 0.0 .270 .234 .208 .183 .158 .133
  14Z  91R1.0  .493 .453 .417 .383 .351 .322 .306
 .278 .242 .216 .191 .169 .146 .123
  14Z  91R1.0  .468 .429 .410 .376 .331 .302 .274
 .248 .222 .197 .182 .161 .135 .113
  14Z  91R1.0  .441 .420 0.0 0.0 .323 .281 .253
 .227 .203 .187 0.0 0.0 .129 .104
  14Z  91R1.0  .412 .392 0.0 0.0 .299 .259 .231
 .207 .184 .170 0.0 0.0 .118 .094
  14Z  91R1.0  .378 .344 .326 .298 .259 .232 .208
 .185 .165 .147 .136 .121 .101 .084
  14Z  91R1.0  .338 .301 .272 .249 .225 .203 .182
 .162 .145 .129 .114 .100 .087 .072
 14Z  77R1.0 .841 .791 .752 .714 .673 .631 .592
   .554 .517 .482 .446 .408 .367 .322
 28Z 77R1.0 .815 .772 .767 .725 .650 .604 .562
   .524 .488 .454 .436 .400 .345 .296
 28Z 77R1.0 .793 .784 .000 .000 .653 .577 .532
   .494 .459 .443 .000 .000 .336 .275
 28Z 77R1.0 .767 .754 .000 .000 .621 .546 .502
   .465 .431 .415 .000 .000 .313 .256
 28Z 77R1.0 .734 .685 .673 .630 .558 .512 .472
   .436 .404 .373 .357 .325 .278 .237
 28Z 77R1.0 .697 .643 .600 .560 .518 .478 .460
   .426 .378 .348 .318 .287 .254 .218
 28Z 77R1.0 .658 .604 .560 .521 .483 .466 .006
   .000 .368 .323 .293 .263 .232 .199
 28Z 77R1.0 .618 .568 .526 .488 .452 .436 .000
   .000 .342 .298 .269 .240 .211 .182
 28Z 77R1.0 .582 .537 .497 .460 .425 .392 .376
   .346 .303 .273 .245 .219 .193 .165
```

Table A.3. Continued

```
28Z 77R1.0 .549 .508 .491 .453 .399 .365 .334
  .305 .276 .248 .231 .207 .176 .150
28Z 77R1.0 .516 .498 .000 .000 .389 .338 .306
  .277 .250 .233 .000 .000 .166 .135
28Z 77R1.0 .479 .462 .000 .000 .357 .309 .277
  .250 .225 .210 .000 .000 .150 .121
28Z 77R1.0 .437 .401 .385 .353 .306 .275 .247
  .222 .200 .180 .169 .151 .127 .107
28Z 77R1.0 .389 .347 .317 .289 .263 .238 .214
  .193 .173 .155 .139 .124 .108 .091
  28Z
```

APPENDIX B

Description of the 3D Flux Synthesis Method

PEG/CALVERT

Appendix B. Description of the 3D Flux Synthesis Method

A 3D (RθZ) flux distribution is synthesized using the following well established approximation:

$$\phi(R,\theta,Z) = \phi_{R\theta}(R,\theta)\frac{\phi_{RZ}(R,Z)}{\phi_R(R)} = \phi_{R\theta}\,A(R,Z) \qquad \text{B.1}$$

where $\phi_{R\theta}$ is the flux obtained from the Rθ DOT calculation; and

$A(R,Z) = \dfrac{\phi_{RZ}}{\phi_R}$ = axial distribution function obtained by representing the RZ flux (ϕ_{RZ}) distribution and dividing it by the integral over Z of the RZ flux, i.e.,

$$\phi_R = \int_Z \phi_{RZ}\,dZ.$$

In some previous studies the RZ flux distribution was represented by the results obtained from a DOT RZ calculation, while the radial flux ϕ_R was obtained from a one-dimensional calculation. However, it has been discovered that a simplier approximation gives similar results (within a few percent) as the results of these transport calculations for locations not outside of the RPV and near the reactor midplane. In this approach we represent

$$A(R,Z) = \frac{\phi_{RZ}\ (RZ)}{\phi_R} \approx \frac{P_{(Z)}}{\int_Z P(Z)dZ} \qquad \text{B.2}$$

where P(Z) is the average axial distribution of power in the core. The function P(Z) has been represented by discrete nodal values corresponding to the core-average axial power distribution at MOC, which was provided by Baltimore Gas and Electric. The relative axial power values were provided at 51 points for the 12 and 18 month cycles, and at 24 points for the 24 month

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where P(Z) is the average axial distribution of power in the core. The function P(Z) has been represented by discrete nodal values corresponding to the core-average axial power distribution at MOC, which was provided by Baltimore Gas and Electric for the peripheral assemblies. The relative axial power values were provided at 51 points for the 12 and 18 month cycles, and at 24 points for the 24 month cycle.

Therefore employing the expression eq. B.2 for axial point k, we find

$$A(R,Z) \approx A(Z) \rightarrow A_k = \frac{P_k}{\int P(Z)dZ} \text{ ; k=1, \# of axial points}$$

There are 51 points used for the 12 and 18 month cycles, in the axial dimension. The 51 points define 50 nodes (i.e., intervals). To calculate the integrated axial power we use the expression

$$\int_0^H P(Z)dZ \approx \sum_{k=1}^{50} \bar{P}_k \Delta Z_k \qquad \text{B.3}$$

where $\bar{P}_k$ is the average power (relative) in the kth axial node. This value is approximated by $\bar{P}_k = \frac{P_k + P_{k+1}}{2}$, where P_k and P_{k+1} are the point powers taken from the axial power data provided by BG&E.

Equation B.3 was used to approximate the denominator of eq. B.2, for the 12 and 18 month cycles.

The axial distribution provided by BG&E for the 24 month cycle only has 24 intervals instead of 51 as for the 12 and 18 month cycles. A similar development for this gives

$$\int_0^H P(Z)dZ \approx \sum_{k=1}^{24} \bar{P}_k \Delta Z_k \qquad \text{B.4}$$

Equation B.4 was used to approximate the denominator of eq. B.2 for the 24 month cycle.

The final axial synthesis factors for the 12 and 18 month cycles are given in Table B.1, and for the 24 month cycle in Table B.2.

In order to compute the 3D flux or activity at some axial location (corresponding to a height Z in Table B.1 and B.2), for some RΘ location one must

(a) find the flux or activity at the appropriate (R_I, Θ_J) location in the DOT run

(b) find the axial flux factor at the appropriate node K

(c) compute the 3D value using expression

$$\phi(R_I, \Theta_J, Z_K) = \phi_{R\Theta}(R_I, \Theta_J)*A_K.$$

(*) For example, in the 18 month cycle the peak power corresponds approximately to Z = 3.20 feet from the bottom of the core. From Table B.1 it can be seen that the axial flux factor for this location is equal to 3.17×10^{-3}. Therefore all activities and fluxes in the DOT RΘ output should be multiplied by this factor in order to obtain the corresponding peak values.

Table B.1 Calvert Cliffs Unit 2 Axial Distribution Factors for Flux Synthesis: 12 and 18 Month Cycles

Height (feet)	A_k, 12 Month	A_k, 18 Month
11.4300	1.84446E-03	1.74971E-03
11.2000	2.02698E-03	1.94625E-03
10.9700	2.19258E-03	2.12788E-03
10.7400	2.34726E-03	2.29373E-03
10.5100	2.48415E-03	2.44322E-03
10.2800	2.60497E-03	2.57607E-03
10.0500	2.70972E-03	2.69199E-03
9.8300	2.79898E-03	2.79155E-03
9.6800	2.87331E-03	2.87734E-03
9.3700	2.93329E-03	2.94277E-03
9.1400	2.97978E-03	2.99642E-03
8.9100	3.01393E-03	3.03659E-03
8.6800	3.03718E-03	3.06471E-03
8.4500	3.05095E-03	3.00221E-03
8.2300	3.05640E-03	3.09053E-03
8.0000	3.05554E-03	3.09139E-03
7.7700	3.04952E-03	3.08652E-03
7.5400	3.03976E-03	3.07734E-03
7.3100	3.02799E-03	3.06528E-03
7.0800	3.01565E-03	3.05208E-03
6.8500	3.00388E-03	3.03869E-03
6.6300	2.9935[illegible]E-03	3.02569E-03
6.4000	2.98500E-03	3.01737E-03
6.1700	2.98150E-03	3.01077E-03
5.9400	2.98093E-03	3.00761E-03
5.7100	2.98437E-03	3.00286E-03
5.4800	2.99097E-03	3.00388E-03
5.2600	3.00274E-03	3.03688E-03
5.0300	3.01823E-03	3.02856E-03
4.8000	3.03689E-03	3.04663E-03
4.5700	3.05784E-03	3.06959E-03
4.3400	3.07994E-03	3.08967E-03
4.1100	3.12499E-03	3.11234E-03
3.8800	3.12270E-03	3.13357E-03
3.6600	3.14049E-03	3.15194E-03
3.4300	3.15628E-03	3.16571E-03
3.2000	3.16144E-03	3.17317E-03
2.9700	3.16144E-03	3.17231E-03
2.7400	3.15226E-03	3.16169E-03
2.5100	3.13246E-03	3.13960E-03
2.2800	3.10031E-03	3.10431E-03
2.0600	3.05497E-03	3.05467E-03
1.8300	2.99499E-03	2.98925E-03
1.6000	2.91923E-03	2.90690E-03
1.3700	2.82739E-03	2.80733E-03
1.1400	2.71891E-03	2.68940E-03
0.9100	2.59321E-03	2.55369E-03

0.6900	2.45029E-03	2.39960E-03
0.4600	2.29072E-03	2.22773E-03
0.2300	2.11480E-03	2.06160E-03
0.0	1.92367E-03	1.83349E-03

Table B.2 Calvert Cliffs Unit 2 Axial Distribution Factors for Flux Synthesis: 24 Month Cycles

Height (feet)	A_k, 24 Month
11.2500	1.48084E-03
10.9600	2.02411E-03
10.6600	2.43010E-03
10.3700	2.68129E-03
10.0800	2.87990E-03
9.6200	3.02594E-03
8.9700	3.08728E-03
8.3100	3.10188E-03
7.8300	3.10188E-03
7.3500	3.10188E-03
6.6900	3.09896E-03
6.0300	3.10188E-03
5.5500	3.10773E-03
5.0700	3.11649E-03
4.4100	3.13109E-03
3.7600	3.14278E-03
3.2700	3.15446E-03
2.7900	3.15738E-03
2.1300	3.11941E-03
1.4800	3.01134E-03
1.0220	2.84485E-03
0.7300	2.61703E-03
0.4380	2.23149E-03
0.1460	1.69990E-03

APPENDIX C

Energy Group Structure and Dosimeter Activation Cross Sections Used in Transport Calculations

Energy Group Structure and Dosimeter Activation
Cross Sections Used in Transport Calculations
are presented in Tables C.1 and C.2.

Table C.1 SAILOR 47-Group Library Energy Structure

Group	Lower energy (MeV)	Group	Lower energy (MeV)
1	14.19*	25	0.183
2	12.21	26	0.111
3	10.00	27	0.0674
4	8.61	28	0.0409
5	7.41	29	0.0318
6	6.07	30	0.0261
7	4.97	31	0.0242
8	3.68	32	0.0219
9	3.01	33	0.0150
10	2.73	34	7.10×10^{-3}
11	2.47	35	3.36×10^{-3}
12	2.37	36	1.59×10^{-3}
13	2.35	37	4.54×10^{-4}
14	2.23	38	2.14×10^{-4}
15	1.92	39	1.01×10^{-4}
16	1.65	40	3.73×10^{-5}
17	1.35	41	1.07×10^{-5}
18	1.00	42	5.04×10^{-6}
19	0.821	43	1.86×10^{-6}
20	0.743	44	8.76×10^{-7}
21	0.608	45	4.14×10^{-7}
22	0.498	46	1.00×10^{-7}
23	0.369	47	1.00×10^{-11}
24	0.298		

*The upper energy of Group 1 is 17.33 MeV.

Table C.2 Reaction Cross Sections (Barns) Used in Calculations for Calvert Cliffs Unit 2

Group	Energy (MeV)	U-238 (n,f)	Np-237 (n,f)	Fe-54 (n,p)	Ni-58 (n,p)	Cu-63 (n,α)
1	1.733E+01	1.275E+00	2.535E+00	2.686E+01	2.962E-01	3.682E-02
2	1.419E+01	1.086E+00	2.320E+00	4.137E-01	4.416E-01	4.540E-02
3	1.221E+01	9.844E-01	2.334E+00	5.276E-01	6.103E-01	5.357E-02
4	1.000E+01	9.864E-01	2.329E+00	5.781E-01	6.588E-01	3.811E-02
5	8.607E+00	9.891E-01	2.248E+00	5.888E-01	6.553E-01	1.906E-02
6	7.408E+00	8.574E-01	1.965E+00	5.590E-01	6.285E-01	9.277E-03
7	6.065E+00	5.849E-01	1.520E+00	4.697E-01	5.365E-01	2.915E-03
8	4.966E+00	5.615E-01	1.538E+00	3.199E-01	3.917E-01	4.437E-04
9	3.679E+00	5.475E-01	1.638E+00	1.762E-01	2.287E-01	3.568E-05
10	3.012E+00	5.463E-01	1.680E+00	1.155E-01	1.658E-01	5.831E-06
11	2.725E+00	5.527E-01	1.697E+00	7.755E-02	1.131E-01	1.707E-06
12	2.466E+00	5.521E-01	1.695E+00	5.111E-02	9.308E-02	6.834E-07
13	2.365E+00	5.512E-01	1.694E+00	4.756E-02	9.232E-02	4.637E-07
14	2.346E+00	5.504E-01	1.693E+00	4.484E-02	8.614E-02	3.430E-07
15	2.231E+00	5.390E-01	1.677E+00	2.008E-02	4.661E-02	1.150E-07
16	1.920E+00	4.685E-01	1.645E+00	4.771E-03	2.660E-03	1.536E-08
17	1.653E+00	2.706E-01	1.604E+00	6.335E-04	1.337E-02	0
18	1.353E+00	4.502E-02	1.543E+00	1.311E-05	4.438E-03	0
19	1.003E+00	1.102E-02	1.389E+00	0	5.023E-04	0
20	8.208E-01	2.881E-03	1.205E+00	0	1.729E-04	0
21	7.427E-01	1.397E-03	9.845E-01	0	4.914E-05	0
22	6.081E-01	5.378E-04	6.437E-01	0	7.673E-06	0
23	4.979E-01	1.502E-04	2.642E-01	0	8.903E-07	0
24	3.688E-01	8.333E-05	8.800E-02	0	4.070E-08	0
25	2.972E-01	6.168E-05	3.552E-02	0	1.832E-15	0
26	1.832E-01	4.668E-05	2.043E-02	0	0	0
27	1.111E-01	4.015E-05	1.542E-02	0	0	0
28	6.738E-02	4.000E-05	1.228E-02	0	0	0
29	4.087E-02	6.176E-05	1.088E-02	0	0	0
30	3.183E-02	8.610E-05	1.023E-02	0	0	0
31	2.606E-02	8.700E-05	1.002E-02	0	0	0
32	2.418E-02	8.700E-05	9.906E-03	0	0	0
33	2.188E-02	8.700E-05	9.723E-03	0	0	0
34	1.503E-02	5.650E-05	1.004E-02	0	0	0
35	7.102E-03	4.860E-11	6.506E-03	0	0	0
36	3.355E-03	7.439E-10	8.716E-03	0	0	0
37	1.585E-03	4.199E-04	2.303E-02	0	0	0
38	4.540E-04	1.464E-08	3.701E-02	0	0	0
39	2.144E-04	1.044E-08	6.129E-02	0	0	0
40	1.013E-04	1.243E-08	9.027E-02	0	0	0
41	3.727E-05	1.955E-08	2.296E-02	0	0	0
42	1.068E-05	3.086E-08	1.014E-02	0	0	0
43	5.043E-06	4.770E-08	4.011E-03	0	0	0
44	1.855E-06	7.171E-08	9.350E-03	0	0	0
45	8.764E-07	5.067E-08	1.407E-02	0	0	0
46	4.140E-07	1.881E-08	4.328E-03	0	0	0
47	1.000E-07	1.182E-09	8.332E-02	0	0	0

APPENDIX D

Definition of "Measured Saturated Activity" Used in Calvert Cliffs-2 Capsule Analysis

Appendix D. Definition of "Measured Saturated Acitivity" Used in Calvert Cliffs-2 Capsule Analysis"

The term "measured saturated activity" is a somewhat ambiguous term which is extensively used, but often misunderstood. In this appendix we will discuss the definition of saturated activity and derive the expressions used in the present analysis.

In the Calvert Cliffs-2 263° capsule analysis following cycle 4, most dosimeters did not remain in the core long enough to reach "saturation conditions" (i.e., the activity at which the rate of decay is equal to the rate of production). This is often the case for dosimeters removed relatively early in the life of a plant. Thus the "time-of-removal" activity (A_{TOR}) which is physically measured does not actually correspond to a saturated activity. However it is common to define a "measured saturated activity" (A_{SAT}) by the relation:

(1) $A_{TOR} = h \, A_{SAT}$,

(2) $A_{SAT} = A_{TOR/h}$

where h is the non-saturation factor given by

(3) $$h = \sum_j P_j \, (1-e^{-\lambda T_j}) \, e^{-\lambda(T-t_j)}$$

In reality the saturated activity is not measured at all --- only the TOR activity is measured, and a "measured saturated activity" is then calculated using eq.(1).

As shown in reference (1), eq. (1)-(3) are rigorous only if the core power distribution does not change with time. If the distribution is time-dependent, then the idea of a saturated activity is ambiguous, since the different power distributions may cause the dosimeters to saturate at different activities. We encounter this difficulty in analyzing the surveillance capsule from Unit 2, which was exposed to cycles 1-3 having a power distribution representative of a 12 month cycle, and to cycle 4 having an 18 month cycle distribution. Which cycle type should be used in defining the saturated activity? Obviously the simplistic expression in eq.(1) breaks down whenever several different power distributions are involved; and it is no longer clear how to define a "measured saturated activity" in terms of A_{TOR}. In the following development we derive an alternate expression to eq.(2) for defining a "measured saturated activity" in terms of A_{TOR} for the Calvert Cliffs-2 analysis. [This derivation is easily generalized.]

We assume that a single power distribution can be used to represent all 12 month cycles; and another to represent 18 month cycles. If the dosimeter were exposed to either of these distributions for a long enough period of time, it would obtain a saturated activity equal to A^{12}_{SAT} and A^{18}_{SAT}, respectively. Note that in general

$$A^{12}_{SAT} \neq A^{18}_{SAT} ;$$

and that the A_{TOR} value should represent some combined effect of the two power distributions.

The value for A_{TOR} at the end of cycle 4 will be given by

$$(4)\quad A_{TOR} = h_{1\to 3}\, A_{SAT}^{12}\, e^{-\lambda T_{3\to 4}} + h_4\, A_{SAT}^{18}$$

where $h_{1\to 3}$ = non-saturation factor from beginning of cycle 1 to end of cycle 3.

h_4 = non-saturation factor from beginning of cycle 4 to end of cycle 4.

$T_{3\to 4}$ = time from the end of cycle 3 to the end of cycle 4.

A_{SAT}^{12} and A_{SAT}^{18} = saturated activity associated with the power distribution for the 12 and 18 month cycles, respectively.

λ = dosimeter decay

Equation (4) can be written as

$$(5)\quad A_{TOR} = \left[\, h_{1\to 3}\, e^{-\lambda T_{3\to 4}} + h_4 \left(\frac{A_{SAT}^{18}}{A_{SAT}^{12}}\right) \right] \cdot A_{SAT}^{12}$$

From this relation we define the "measured saturated activity" for the 12 month cycle to be

$$(6)\quad (A_{SAT}^{12})_{meas.} = \frac{A_{(TOR)meas.}}{\left[\, h_{1\to 3} e^{-\lambda T_{3\to 4}} + h_4 \left(\frac{A_{SAT}^{18}}{A_{SAT}^{12}}\right)_{CALC.} \right]}$$

Note that eq.(6) allows us to obtain a "measured" saturated activity by utilizing the A_{TOR} measurements; however it also requires knowing the ratio

$\frac{A_{SAT}^{18}}{A_{SAT}^{12}}$ which must be obtained from the transport calculations.

In a similar way we obtain the measured saturated activity for the 18 month cycle:

$$(7)\quad (A_{SAT}^{18})_{meas.} = \frac{(A_{TOR})_{meas.}}{\left[h_4 + h_{1\to3}e^{-\lambda T_{3\to4}}\left(\frac{A_{SAT}^{12}}{A_{SAT}^{18}}\right)_{CALC}\right]}$$

The results called measured saturated activities in Tables 6a and 6b were obtained using eqs.(6) and (7) respectively.

REFERENCES

R. E. Maerker, M. L. Williams, B. L. Broadhead, "Accounting for Changing Source Distributions in Light Water Reactor Surveillance Dosimetry Analysis," *Nucl. Science Engr. 94*, 291-308 (1986).

APPENDIX E

Pressure-Temperature Limit Tables For Calvert Cliffs Unit 2

E-1 Heat-Up Conditions

Rates: 40°F/hr
50°F/hr
60°F/hr
70°F/hr

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16. 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 40.0 (DEGF/HR)

TEMP	12 EFPY PRESS	16 EFPY PRESS	20 EFPY PRESS	24 EFPY PRESS	28 EFPY PRESS	32 EFPY PRESS	36 EFPY PRESS	40 EFPY PRESS
70.0	461.0	441.1	427.3	416.3	407.7	400.7	395.2	391.1
75.0	464.7	441.1	427.3	416.3	407.7	400.7	395.2	391.1
80.0	468.8	441.1	427.3	416.3	407.7	400.7	395.2	391.1
85.0	473.2	441.1	427.3	416.3	407.7	400.7	395.2	391.1
90.0	472.9	441.1	427.3	416.3	407.7	400.7	395.2	391.1
95.0	466.1	441.1	427.3	416.3	407.7	400.7	395.2	391.1
100.0	462.5	441.1	427.3	416.3	407.7	400.7	395.2	391.1
105.0	461.6	441.1	427.3	416.3	407.7	400.7	395.2	391.1
110.0	463.0	441.3	427.3	416.3	407.7	400.7	395.2	391.1
115.0	466.5	443.4	428.6	416.9	407.8	400.7	395.2	391.1
120.0	471.8	447.3	431.5	419.1	409.3	401.7	395.9	391.5
125.0	478.7	452.6	435.8	422.6	412.2	404.1	397.8	393.2
130.0	487.2	459.4	441.4	427.3	416.2	407.5	400.8	395.9
135.0	497.2	467.5	448.2	433.1	421.2	412.0	404.9	399.5
140.0	508.7	476.8	456.2	440.0	427.3	417.4	409.8	404.1
145.0	521.5	487.3	465.3	448.0	434.4	423.7	415.6	409.4
150.0	535.7	499.1	475.5	457.0	442.4	431.0	422.2	415.6
155.0	551.4	512.1	486.8	466.9	451.3	439.1	429.6	422.6
160.0	568.5	526.4	499.2	477.9	461.1	448.0	437.9	430.3
165.0	587.2	542.0	512.8	489.9	471.9	457.9	447.0	438.9
170.0	607.5	558.9	527.6	503.0	483.7	468.6	457.0	448.3
175.0	629.4	577.3	543.7	517.3	496.5	480.3	467.9	458.5
180.0	653.1	597.1	561.0	532.7	510.4	493.0	479.7	469.6
185.0	676.6	618.6	579.8	549.4	525.5	506.8	492.4	481.6
190.0	696.6	641.7	600.1	567.4	541.7	521.6	506.2	494.6
195.0	718.0	666.7	622.0	586.8	559.2	537.7	521.1	508.7
200.0	741.0	688.4	645.6	607.8	578.1	555.0	537.2	523.8
205.0	765.8	709.2	669.0	630.4	598.5	573.6	554.5	540.2
210.0	792.3	731.6	688.4	654.7	620.4	593.7	573.2	557.7
215.0	820.9	755.6	709.2	680.5	644.0	615.3	593.3	576.7
220.0	851.6	781.5	731.6	700.7	669.4	638.6	614.9	597.1
225.0	884.6	809.2	755.6	722.5	696.6	663.6	638.1	619.0
230.0	920.0	839.1	781.5	748.8	718.0	690.5	662.2	642.6
235.0	958.1	871.1	809.2	770.9	741.0	718.0	690.1	668.0
240.0	999.0	905.5	839.1	797.9	765.8	741.0	718.0	695.3
245.0	1042.9	942.5	871.1	826.9	792.3	765.8	741.0	722.5
250.0	1090.0	982.3	905.5	858.0	820.9	792.3	765.8	748.8
255.0	1140.6	1024.9	942.5	891.5	851.6	820.9	792.3	770.9
260.0	1195.0	1070.7	982.3	927.4	884.6	851.6	820.9	797.9
265.0	1253.3	1120.0	1024.9	966.0	920.0	884.6	851.6	826.9
270.0	1316.0	1172.8	1070.7	1007.5	958.1	920.0	884.6	858.0
275.0	1383.2	1229.5	1120.0	1052.0	999.0	958.1	920.0	891.5
280.0	1455.2	1290.4	1172.8	1099.9	1042.9	999.0	958.1	927.4
285.0	1532.5	1355.7	1229.5	1151.2	1090.0	1042.9	999.0	966.0
290.0	1615.4	1425.8	1290.4	1206.3	1140.6	1090.0	1042.9	1007.5
295.0	1704.2	1501.0	1355.7	1265.5	1195.0	1140.6	1090.0	1052.0
300.0	1799.4	1581.6	1425.8	1329.0	1253.3	1195.0	1140.6	1099.9
305.0	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
310.0	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
315.0	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.5

CALVERT CLIFFS HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 40.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
320.0	2251.5	1965.8	1760.5	1632.7	1532.5	1455.2	1363.2	1329.0
325.0	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.2
330.0	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1548.6
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
435.0	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
480.0	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
525.0	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
545.0	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 50.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
70.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
75.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
80.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
85.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
90.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
95.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
100.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
105.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
110.0	443.1	421.3	407.1	395.4	386.2	378.7	372.9	368.5
115.0	443.2	421.3	407.1	395.4	386.2	378.7	372.9	368.5
120.0	445.3	422.1	407.1	395.4	386.2	378.7	372.9	368.5
125.0	449.2	424.5	408.7	396.2	386.4	378.7	372.9	368.5
130.0	454.7	428.5	411.6	398.3	387.9	379.8	373.6	368.9
135.0	461.9	433.9	415.9	401.8	390.7	382.0	375.3	370.4
140.0	470.5	440.7	421.5	406.4	394.5	385.3	378.2	372.9
145.0	480.6	448.8	428.3	412.1	399.5	389.6	382.0	376.3
150.0	492.1	458.2	436.2	419.0	405.4	394.9	386.7	380.7
155.0	505.2	468.8	445.4	426.9	412.4	401.1	392.4	385.9
160.0	519.7	480.8	455.7	435.9	420.4	408.3	398.9	392.0
165.0	535.7	494.0	467.1	446.0	429.3	416.3	406.4	398.9
170.0	553.3	508.6	479.8	457.1	439.3	425.4	414.7	406.6
175.0	572.6	524.6	493.7	469.4	450.3	435.4	423.9	415.3
180.0	593.5	542.1	508.9	482.9	462.4	446.4	434.1	424.8
185.0	616.3	561.1	525.5	497.5	475.6	458.4	445.2	435.3
190.0	640.9	581.6	543.5	513.4	489.9	471.5	457.3	446.7
195.0	667.5	603.9	562.9	530.7	505.4	485.7	470.5	459.1
200.0	696.3	628.0	584.0	549.4	522.3	501.1	484.8	472.6
205.0	727.3	654.0	606.8	569.7	540.9	517.7	500.2	487.1
210.0	760.8	682.1	631.4	591.5	560.2	535.7	516.9	502.8
215.0	796.8	712.3	657.9	615.0	581.4	555.2	535.0	519.8
220.0	835.6	744.9	686.4	640.4	604.3	576.1	554.4	538.1
225.0	877.3	779.9	717.1	667.7	629.0	598.7	575.4	557.9
230.0	920.0	817.6	750.2	697.2	655.8	623.0	598.0	579.2
235.0	958.1	858.1	785.8	728.8	684.1	649.2	622.3	602.1
240.0	999.0	901.7	824.0	762.9	714.9	677.4	648.5	626.8
245.0	1042.9	942.5	865.2	799.5	747.9	707.7	676.7	653.4
250.0	1090.0	982.3	905.5	838.9	783.5	740.2	706.9	682.0
255.0	1140.6	1024.9	942.5	881.2	821.7	775.3	739.5	712.7
260.0	1195.0	1070.7	982.3	926.6	862.8	812.9	774.5	745.7
265.0	1253.3	1120.0	1024.9	966.0	906.9	853.4	812.2	781.3
270.0	1316.0	1172.8	1070.7	1007.5	954.3	896.9	852.6	819.4
275.0	1383.2	1229.5	1120.0	1052.0	999.0	943.5	896.0	860.4
280.0	1455.2	1290.4	1172.8	1099.9	1042.9	993.7	942.7	904.4
285.0	1532.5	1355.7	1229.5	1151.2	1090.0	1042.9	992.8	951.7
290.0	1615.4	1428.8	1290.4	1206.3	1140.6	1090.0	1042.9	1002.5
295.0	1704.2	1501.0	1355.7	1265.5	1195.0	1140.6	1090.0	1052.0
300.0	1799.4	1581.6	1428.8	1329.0	1253.3	1195.0	1140.6	1099.9
305.0	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
310.0	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
315.0	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.5

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 50.0 (DEGF/HR)

TEMP	12 EFPY PRESS	16 EFPY PRESS	20 EFPY PRESS	24 EFPY PRESS	28 EFPY PRESS	32 EFPY PRESS	36 EFPY PRESS	40 EFP PRESS
320.0	2251.5	1965.8	1760.5	1632.7	1532.5	1455.2	1383.2	1329.0
325.0	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.2
330.0	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1548.6
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
435.0	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
480.0	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
525.0	33998.1	28629.7	24816.8	22480.1	20618.4	19202.9	17886.3	16899.6
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
545.0	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22480.1
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 60.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
70.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
75.0	424.5	402.0	386.6	374.7	364.8	357.1	350.8	346.1
80.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
85.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
90.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
95.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
100.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
105.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
110.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
115.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
120.0	424.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
125.0	425.5	402.0	386.8	374.7	364.8	357.1	350.8	346.1
130.0	428.2	403.3	387.3	374.7	364.8	357.1	350.8	346.1
135.0	432.5	406.1	389.1	375.8	365.3	357.1	350.8	346.1
140.0	438.4	410.3	392.3	378.1	366.9	358.2	351.5	346.5
145.0	445.8	415.9	396.7	381.6	369.7	360.4	353.3	348.0
150.0	454.8	422.9	402.3	386.2	373.6	363.7	356.1	350.4
155.0	465.2	431.1	409.2	392.0	378.5	368.0	359.9	353.8
160.0	477.0	440.7	417.3	398.9	384.4	373.2	364.5	358.0
165.0	490.4	451.6	426.6	406.9	391.4	379.4	370.1	363.2
170.0	505.3	463.8	437.0	416.0	399.5	386.6	376.7	369.2
175.0	521.8	477.4	448.8	426.2	408.5	394.7	384.1	376.1
180.0	539.9	492.4	461.8	437.6	418.7	403.9	392.5	384.0
185.0	559.8	508.9	476.1	450.2	429.9	414.1	401.9	392.7
190.0	581.5	526.9	491.7	464.1	442.3	425.3	412.2	402.4
195.0	605.1	546.5	508.8	479.2	455.9	437.6	423.6	413.1
200.0	630.6	567.9	527.4	495.6	470.7	451.1	436.1	424.8
205.0	658.3	591.0	547.6	513.5	486.7	465.8	449.7	437.6
210.0	688.3	616.1	569.5	532.9	504.2	481.8	464.5	451.5
215.0	720.7	643.2	593.2	553.9	523.1	499.0	480.5	466.6
220.0	755.6	672.4	618.8	576.7	543.5	517.7	497.8	482.9
225.0	793.2	704.0	646.5	601.2	565.7	537.9	516.6	500.6
230.0	833.7	738.0	676.2	627.7	589.5	559.7	536.8	519.6
235.0	877.4	774.6	708.4	656.2	615.3	583.3	558.7	540.3
240.0	924.3	814.0	742.9	687.0	643.0	608.7	582.3	562.5
245.0	974.8	856.5	780.1	720.1	678.9	636.0	607.7	586.4
250.0	1029.1	902.1	820.2	755.7	705.0	665.5	635.0	612.2
255.0	1087.4	951.2	863.2	794.0	739.6	697.2	664.5	640.0
260.0	1150.0	1004.9	909.5	836.2	776.8	731.3	696.2	669.9
265.0	1217.3	1060.5	959.2	879.5	816.9	768.0	730.3	702.0
270.0	1289.4	1121.3	1012.7	927.1	859.9	807.4	766.9	736.6
275.0	1366.8	1186.6	1070.0	978.2	906.1	849.7	806.3	773.8
280.0	1449.9	1256.6	1131.7	1033.2	955.8	895.3	848.7	813.8
285.0	1532.5	1331.7	1197.8	1092.1	1009.1	944.2	894.2	856.7
290.0	1615.4	1412.4	1268.8	1155.5	1066.4	996.7	943.1	902.8
295.0	1704.2	1498.8	1344.9	1223.4	1127.8	1053.1	995.6	952.4
300.0	1799.4	1581.6	1425.8	1296.3	1193.8	1113.7	1051.9	1005.6
305.0	1901.3	1668.0	1504.0	1374.5	1264.6	1178.7	1112.4	1062.7
310.0	2010.3	1760.5	1581.6	1458.3	1340.5	1248.3	1177.3	1124.0
315.0	2126.9	1859.7	1668.0	1548.1	1421.9	1323.1	1246.9	1189.8

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 60.0 (DEGF/HR)

TEMP	12 EFPY PRESS	16 EFPY PRESS	20 EFPY PRESS	24 EFPY PRESS	28 EFPY PRESS	32 EFPY PRESS	36 EFPY PRESS	40 EFF PRESS
320.0	2251.5	1965.8	1760.5	1632.7	1509.1	1403.3	1321.6	1260.3
325.0	2384.5	2079.3	1859.7	1722.7	1602.5	1489.2	1401.7	1335.9
330.0	2526.3	2200.6	1965.8	1819.2	1702.6	1581.2	1487.5	1417.1
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1679.8	1579.5	1504.0
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1785.4	1678.0	1597.2
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1898.3	1783.3	1696.9
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1896.1	1803.7
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1917.9
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
435.0	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
480.0	17886.3	15089.9	13103.7	11879.1	10916.7	10179.4	9493.6	8979.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11879.1
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
525.0	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
545.0	45305.8	38132.3	33037.3	29888.6	27427.3	25535.8	23776.5	22458.1
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 70.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EF
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRES
70.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
75.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
80.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
85.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
90.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
95.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
100.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
105.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
110.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
115.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
120.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
125.0	406.3	382.6	366.8	354.1	343.7	335.4	328.9	323.
130.0	406.4	382.6	366.8	354.1	343.7	335.4	328.9	323.
135.0	408.2	383.0	366.8	354.1	343.7	335.4	328.9	323.
140.0	411.5	384.9	367.7	354.2	343.7	335.4	328.9	323.
145.0	416.4	388.1	369.9	355.6	344.4	335.6	328.9	323.
150.0	422.7	392.7	373.3	358.1	346.2	336.9	329.7	324.4
155.0	430.5	398.6	378.0	361.8	349.1	339.2	331.6	325.9
160.0	439.9	405.8	383.9	366.6	353.1	342.5	334.4	328.3
165.0	450.7	414.3	390.9	372.6	358.1	346.9	338.2	331.7
170.0	463.0	424.2	399.2	379.6	364.2	352.2	342.9	336.
175.0	476.9	435.5	408.8	387.8	371.3	358.5	348.6	341.5
180.0	492.3	448.1	419.5	397.1	379.5	365.8	355.2	347.3
185.0	509.4	462.2	431.6	407.6	388.8	374.1	362.8	354.3
190.0	528.2	477.7	445.0	419.3	399.2	383.4	371.3	362.3
195.0	548.8	494.7	459.8	432.3	410.7	393.9	380.9	371.2
200.0	571.4	513.4	476.0	446.6	423.5	405.4	391.5	381.1
205.0	595.9	533.8	493.7	462.3	437.5	418.1	403.2	392.1
210.0	622.5	555.9	513.0	479.3	452.8	432.0	416.1	404.1
215.0	651.4	580.0	534.0	497.9	469.5	447.2	430.1	417.3
220.0	682.6	606.1	556.8	518.0	487.6	463.8	445.4	431.7
225.0	716.4	634.3	581.4	539.8	507.2	481.7	462.1	447.3
230.0	752.8	664.9	608.1	563.5	528.5	501.1	480.1	464.3
235.0	792.2	697.8	636.9	589.1	551.5	522.2	499.6	482.7
240.0	834.5	733.3	668.0	616.7	576.4	544.9	520.7	502.5
245.0	880.2	771.6	701.6	646.5	603.2	569.4	543.4	524.0
250.0	929.3	812.8	737.7	678.6	632.2	595.9	568.0	547.1
255.0	982.1	857.2	776.6	713.2	663.4	624.5	594.6	572.1
260.0	1038.9	905.0	818.5	750.8	697.0	655.3	623.1	599.0
265.0	1100.0	956.3	863.5	790.5	733.2	688.4	653.9	628.0
270.0	1165.5	1011.5	912.0	833.7	772.1	724.0	687.0	659.3
275.0	1236.9	1070.8	964.1	880.0	814.0	762.4	722.7	692.9
280.0	1311.5	1134.4	1020.0	929.9	859.0	803.7	761.1	729.1
285.0	1392.6	1202.8	1080.1	983.4	907.4	848.0	802.3	768.0
290.0	1479.5	1276.1	1144.6	1040.9	959.4	895.7	846.6	809.8
295.0	1572.7	1354.8	1213.8	1102.7	1015.2	946.9	894.2	854.7
300.0	1672.5	1439.2	1288.1	1168.9	1075.2	1001.9	945.4	903.0
305.0	1779.5	1529.7	1367.8	1240.1	1139.5	1060.9	1000.3	954.9
310.0	1893.9	1626.6	1453.2	1316.4	1208.6	1124.3	1059.3	1010.6
315.0	2016.2	1730.4	1544.8	1398.2	1282.7	1192.3	1122.6	1070.4

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CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
HEATUP ANALYSIS - HEAT RISE RATE = 70.0 (DEGF/HR)

              12 EFPY     16 EFPY     20 EFPY     24 EFPY     28 EFPY     32 EFPY     36 EFPY     40 EF
    TEMP       PRESS       PRESS       PRESS       PRESS       PRESS       PRESS       PRESS       PREE
   320.0      2147.0      1841.5      1642.9      1485.9      1362.1      1265.3      1190.6      1134.
   325.0      2286.5      1960.3      1747.9      1579.8      1447.3      1343.5      1263.5      1203.
   330.0      2435.3      2087.3      1860.3      1680.5      1538.5      1427.4      1341.6      1277.
   335.0      2593.9      2222.9      1980.4      1788.1      1636.2      1517.2      1425.4      1356.
   340.0      2762.5      2367.6      2108.8      1903.3      1740.9      1613.5      1515.1      1441.
   345.0      2943.4      2521.8      2245.9      2026.5      1852.9      1716.6      1611.3      1532.
   350.0      3134.5      2685.8      2392.1      2158.0      1972.5      1826.8      1714.2      1629.
   355.0      3337.2      2861.5      2547.9      2298.5      2100.5      1944.8      1824.3      1733.
   360.0      3551.9      3047.6      2713.7      2448.1      2237.0      2070.8      1942.1      1845.
   365.0      3777.5      3245.1      2891.2      2607.5      2382.7      2205.4      2067.9      1964.
   370.0      4016.0      3454.4      3079.1      2777.0      2537.8      2348.9      2202.3      2091.
   375.0      4266.6      3675.7      3278.5      2958.8      2702.9      2502.7      2345.7      2227.
   380.0      4526.8      3907.6      3489.6      3150.8      2879.7      2664.7      2499.0      2372.
   385.0      4789.5      4152.7      3712.9      3354.4      3066.8      2838.9      2661.0      2527.
   390.0      5103.2      4409.8      3943.2      3569.9      3265.4      3023.5      2834.9      2691.
   395.0      5467.4      4678.6      4177.7      3796.3      3475.7      3219.4      3019.3      2867.
   400.0      5858.5      4960.6      4423.6      4035.5      3698.1      3427.0      3214.9      3054.
   405.0      6276.0      5300.2      4682.0      4286.8      3931.0      3646.6      3422.2      3251.
   410.0      6720.0      5678.6      4985.9      4549.9      4177.0      3876.8      3641.4      3461.
   415.0      7197.4      6084.9      5333.0      4825.1      4434.9      4120.0      3871.3      3682.
   420.0      7710.6      6520.9      5706.1      5129.6      4706.2      4375.2      4114.2      3914.
   425.0      8262.4      6988.9      6107.3      5495.2      4987.6      4642.1      4369.1      4159.
   430.0      8855.7      7491.1      6538.6      5867.6      5333.9      4921.9      4635.7      4416.
   435.0      9493.6      8030.1      7002.3      6308.7      5714.2      5250.6      4915.0      4686.
   440.0     10179.4      8608.5      7500.9      6760.6      6122.6      5624.9      5241.9      4966.
   445.0     10916.7      9229.2      8036.9      7245.6      6560.7      6026.4      5615.4      5307.
   450.0     11709.5      9895.3      8613.2      7766.1      7030.8      6457.4      6016.1      5688.
   455.0     12561.8     10609.9      9232.9      8324.5      7535.3      6919.7      6446.1      6091.
   460.0     13478.2     11376.8      9899.1      8923.7      8076.7      7416.0      6907.6      6526.
   465.0     14463.5     12199.6     10615.4      9566.7      8657.5      7948.4      7402.7      6993.
   470.0     15522.8     13082.3     11385.5     10256.4      9280.6      8519.5      7933.9      7495.
   475.0     16661.8     14029.3     12213.5     10996.5      9949.2      9132.4      8503.9      8032.
   480.0     17876.5     15045.2     13103.7     11790.4     10666.4      9789.8      9115.3      8609.
   485.0     19173.6     16135.1     14060.8     12642.1     11435.9     10495.1      9771.2      9228.
   490.0     20564.8     17304.2     15089.9     13555.6     12261.3     11251.6     10474.8      9892.
   495.0     22057.4     18558.4     16196.3     14535.8     13146.8     12063.3     11229.7     10606.
   500.0     23658.6     19903.8     17385.8     15587.2     14096.6     12934.0     12039.5     11369.
   505.0     25375.9     21346.8     18664.8     16714.9     15115.5     13867.9     12908.1     12188.
   510.0     27217.5     22894.3     20029.8     17924.3     16208.1     14869.5     13839.5     13067.
   515.0     29192.7     24554.0     21518.3     19221.4     17380.0     15943.7     14838.6     14010.
   520.0     31311.3     26334.3     23107.8     20612.7     18636.9     17095.9     15910.2     15021.
   525.0     33583.0     28243.2     24808.6     22104.5     19984.8     18331.4     17089.3     16108.
   530.0     36019.1     30290.3     26602.3     23704.4     21430.3     19656.4     18291.6     17268.
   535.0     38631.1     32485.2     28520.6     25419.8     22980.0     21077.1     19612.9     18518.
   540.0     41432.0     34838.8     30594.3     27289.2     24641.9     22600.5     21029.7     19855.
   545.0     44435.1     37362.4     32809.2     29231.6     26423.9     24233.9     22549.0     21286.
   550.0     47655.4     40068.5     35184.2     31346.4     28334.7     25985.5     24178.0     22823.
   555.0     51107.2     42969.1     37730.0     33613.4     30382.8     27863.0     25924.2     24471.
   560.0     54808.1     46079.1     40459.6     36044.1     32578.9     29876.1     27796.5     26238.
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E-1 Cool-Down Conditions

Rates: 20°F/hr
50°F/hr
100°F/hr

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE = 20.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
545.0	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
525.0	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
480.0	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
435.0	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1548.6
330.0	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
325.0	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.8
320.0	2251.5	1965.8	1760.5	1632.7	1532.5	1455.2	1383.2	1329.0
315.0	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.5

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE = 20.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
310.0	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
305.0	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
300.0	1799.4	1581.6	1425.8	1329.0	1253.3	1195.0	1140.6	1097.8
295.0	1704.2	1501.0	1355.7	1265.5	1195.0	1140.6	1087.1	1045.5
290.0	1615.4	1425.8	1290.4	1206.3	1140.6	1087.2	1035.5	996.8
285.0	1532.5	1355.7	1229.5	1151.2	1087.3	1035.6	987.5	951.4
280.0	1455.2	1290.4	1172.8	1098.1	1035.7	987.6	942.9	909.3
275.0	1383.2	1229.5	1120.0	1045.9	987.8	943.0	901.3	870.0
270.0	1316.0	1172.8	1066.5	997.2	943.1	901.4	862.6	833.5
265.0	1253.3	1120.0	1016.4	951.9	901.5	862.7	826.6	799.5
260.0	1195.0	1066.7	969.8	909.8	862.9	826.7	793.1	767.9
255.0	1140.6	1016.6	926.4	870.5	826.9	793.3	762.0	738.5
250.0	1088.0	970.0	886.0	834.0	793.4	762.1	733.0	711.1
245.0	1036.5	926.7	848.5	800.0	762.2	733.1	706.0	685.7
240.0	988.5	886.3	813.5	768.4	733.2	706.1	680.9	662.0
235.0	943.9	848.7	781.0	739.0	706.3	681.1	657.6	640.0
230.0	902.4	813.8	750.7	711.7	681.2	657.8	635.9	619.6
225.0	863.7	781.2	722.6	686.2	657.9	636.1	615.7	600.5
220.0	827.8	751.0	696.4	662.6	636.2	615.9	597.0	582.8
215.0	794.3	722.9	672.1	640.6	616.1	597.2	579.6	566.4
210.0	763.2	696.7	649.4	620.2	597.3	579.8	563.4	551.1
205.0	734.2	672.4	628.4	601.1	579.9	563.5	548.3	536.9
200.0	707.3	649.7	608.8	583.5	563.7	548.5	534.3	523.7
195.0	682.2	628.6	590.6	567.0	548.6	534.4	521.3	511.4
190.0	658.9	609.1	573.7	551.7	534.6	521.4	509.2	500.0
185.0	637.3	590.9	557.9	537.5	521.6	509.3	497.9	489.4
180.0	617.1	573.9	543.3	524.3	509.5	498.1	487.5	479.5
175.0	598.4	558.2	529.7	512.0	498.2	487.6	477.8	470.4
170.0	580.9	543.6	517.0	500.6	487.8	477.9	468.7	461.9
165.0	564.7	530.0	505.3	490.0	478.1	468.9	460.4	454.0
160.0	549.6	517.3	494.3	480.1	469.0	460.5	452.6	446.6
155.0	535.6	505.6	484.2	471.0	460.6	452.7	445.3	439.8
150.0	522.6	494.6	474.8	462.5	452.9	445.5	438.6	433.4
145.0	510.5	484.5	466.0	454.6	445.6	438.8	432.3	427.5
140.0	499.3	475.1	457.9	447.2	438.9	432.5	426.5	422.1
135.0	488.8	466.3	450.3	440.4	432.6	426.7	421.1	417.0
130.0	479.1	458.1	443.3	434.0	426.8	421.3	416.1	412.8
125.0	470.1	450.6	436.7	428.1	421.4	416.2	411.4	407.8
120.0	461.7	443.6	430.6	422.6	416.4	411.6	407.1	403.8
115.0	453.9	437.0	425.0	417.5	411.7	407.3	403.1	400.0
110.0	446.7	430.9	419.7	412.8	407.4	403.3	399.4	396.5
105.0	439.9	425.3	414.9	408.4	403.4	399.5	395.9	393.2
100.0	433.7	420.0	410.3	404.3	399.7	396.1	392.7	390.2
95.0	427.8	415.2	406.2	400.6	396.2	392.9	389.8	387.4
90.0	422.4	410.6	402.2	397.1	393.0	389.9	387.0	384.8
85.0	417.4	406.4	398.6	393.8	390.1	387.2	384.5	382.9
80.0	412.8	402.5	395.3	390.8	387.3	384.6	382.1	380.2
75.0	408.4	398.9	392.2	388.0	384.8	382.3	379.9	378.2
70.0	404.4	395.6	389.3	385.4	382.4	380.1	377.9	376.3

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE = 50.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFF
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
545.0	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
525.0	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
480.0	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
435.0	9453.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1548.6
330.0	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
325.0	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.2
320.0	2251.5	1965.8	1760.5	1632.7	1532.5	1455.2	1383.2	1329.0
315.0	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE = 50.0 (DEGF/HR)

TEMP	12 EFPY PRESS	16 EFPY PRESS	20 EFPY PRESS	24 EFPY PRESS	28 EFPY PRESS	32 EFPY PRESS	36 EFPY PRESS	40 EFPY PRESS
310.0	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
305.0	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
300.0	1799.4	1581.6	1425.8	1329.0	1253.3	1195.0	1140.6	1099.9
295.0	1704.2	1501.0	1355.7	1265.5	1195.0	1140.6	1090.0	1046.1
290.0	1615.4	1425.8	1290.4	1206.3	1140.6	1090.0	1034.8	990.3
285.0	1532.5	1355.7	1229.5	1151.2	1090.0	1035.0	979.8	938.4
280.0	1455.2	1290.4	1172.8	1099.9	1035.2	980.1	928.7	890.1
275.0	1383.2	1229.5	1120.0	1047.0	980.3	928.9	881.1	845.2
270.0	1316.0	1172.8	1070.7	991.3	929.2	881.4	836.9	803.5
265.0	1253.3	1120.0	1013.4	939.5	881.7	837.2	795.7	764.6
260.0	1195.0	1070.7	960.1	891.3	837.5	796.0	757.5	728.5
255.0	1140.6	1014.0	910.5	846.4	796.4	757.8	721.9	695.0
250.0	1090.0	960.7	864.4	804.7	758.1	722.2	688.8	663.8
245.0	1037.0	911.1	821.5	765.9	722.6	689.2	658.1	634.8
240.0	982.2	865.0	781.6	729.9	689.5	658.5	629.5	607.9
235.0	931.2	822.1	744.5	696.4	658.8	629.9	603.0	582.8
230.0	883.8	782.2	710.0	665.2	630.3	603.4	578.3	559.6
225.0	839.7	745.1	677.9	636.2	603.7	578.7	555.4	538.0
220.0	798.6	710.7	648.1	609.3	579.1	555.8	534.1	517.9
215.0	760.5	678.6	620.4	584.3	556.2	534.5	514.4	499.2
210.0	725.0	648.8	594.6	561.1	534.9	514.8	496.0	482.0
205.0	692.0	621.1	570.7	539.5	515.1	496.4	479.0	465.9
200.0	661.3	595.4	548.5	519.4	496.8	479.3	463.1	450.9
195.0	632.8	571.4	527.8	500.8	479.7	463.5	448.4	437.1
190.0	606.3	549.2	508.6	483.5	463.9	448.8	434.7	424.2
185.0	581.7	528.6	490.8	467.4	449.2	435.1	422.0	412.2
180.0	558.8	509.4	474.3	452.5	435.5	422.4	410.2	401.1
175.0	537.6	491.6	458.9	438.7	422.6	410.6	399.3	390.8
170.0	517.8	475.0	444.6	425.8	411.0	399.7	389.1	381.2
165.0	499.5	459.7	431.4	413.8	400.1	389.5	379.7	372.4
160.0	482.4	445.4	419.0	402.7	389.9	380.1	371.0	364.2
155.0	466.6	432.1	407.6	392.4	380.5	371.4	362.9	356.5
150.0	451.9	419.8	396.9	382.8	371.8	363.3	355.4	349.5
145.0	438.3	408.4	387.1	373.9	363.7	355.8	348.4	342.9
140.0	425.6	397.7	378.0	365.7	356.2	348.8	342.0	336.9
135.0	413.8	387.9	369.5	358.1	349.2	342.4	336.1	331.3
130.0	402.8	378.7	361.6	351.0	342.8	336.4	330.5	326.1
125.0	392.7	370.3	354.4	344.5	336.8	330.9	325.4	321.3
120.0	383.3	362.4	347.6	338.5	331.3	325.8	320.7	316.9
115.0	374.5	355.1	341.4	332.8	326.2	321.1	316.3	312.8
110.0	366.4	348.4	335.6	327.7	321.5	316.7	312.3	309.0
105.0	358.9	342.1	330.2	322.9	317.1	312.7	308.6	305.5
100.0	352.0	336.4	325.3	318.4	313.1	309.0	305.1	302.3
95.0	345.5	331.0	320.7	314.3	309.3	305.5	301.9	299.3
90.0	339.6	326.1	316.5	310.5	305.9	302.3	299.0	296.5
85.0	334.1	321.5	312.6	307.0	302.7	299.4	296.3	294.0
80.0	329.0	317.3	308.9	303.8	299.8	296.7	293.8	291.7
75.0	324.2	313.3	305.6	300.8	297.1	294.2	291.6	289.6
70.0	319.9	309.7	302.6	298.1	294.6	292.0	289.5	287.6

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE = 100.0 (DEGF/HR)

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
560.0	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3
555.0	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
550.0	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
545.0	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
540.0	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
535.0	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
530.0	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
525.0	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
520.0	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
515.0	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
510.0	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
505.0	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
500.0	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
495.0	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
490.0	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
485.0	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
480.0	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
475.0	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
470.0	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
465.0	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
460.0	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
455.0	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
450.0	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
445.0	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
440.0	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
435.0	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
430.0	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
425.0	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
420.0	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
415.0	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
410.0	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
405.0	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
400.0	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
395.0	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
390.0	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
385.0	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
380.0	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
375.0	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
370.0	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
365.0	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
360.0	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
355.0	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
350.0	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
345.0	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
340.0	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
335.0	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1548.6
330.0	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
325.0	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.2
320.0	2251.5	1965.8	1760.5	1632.7	1532.5	1455.2	1383.2	1329.0
315.0	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.5

CALVERT CLIFF HEATUP AND COOLDOWN CURVES --- 12, 16, 20, 24, 28, 32, 36 AND 40 EFPY
COOLDOWN ANALYSIS - HEAT DROP RATE • 100.0 (DEGF/HR)

TEMP	12 EFPY PRESS	16 EFPY PRESS	20 EFPY PRESS	24 EFPY PRESS	28 EFPY PRESS	32 EFPY PRESS	36 EFPY PRESS	40 EFPY PRESS
310.0	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
305.0	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
300.0	1799.4	1581.6	1425.8	1329.0	1253.3	1195.0	1140.6	1099.9
295.0	1704.2	1501.0	1355.7	1265.5	1195.0	1140.6	1090.0	1052.0
290.0	1615.4	1425.8	1290.4	1206.3	1140.6	1090.0	1042.9	1007.5
285.0	1532.5	1355.7	1229.5	1151.2	1090.0	1042.9	996.1	944.1
280.0	1455.2	1290.4	1172.8	1099.9	1042.9	996.5	932.0	883.5
275.0	1383.2	1229.5	1120.0	1052.0	996.9	932.4	872.3	827.1
270.0	1316.0	1172.8	1070.7	1007.5	932.8	872.7	816.7	774.7
265.0	1253.3	1120.0	1024.9	945.8	873.1	817.2	765.1	726.0
260.0	1195.0	1070.7	971.8	885.3	817.7	765.6	717.1	680.7
255.0	1140.6	1024.9	909.6	829.1	766.1	717.6	672.5	638.7
250.0	1090.0	972.7	851.8	776.8	718.2	673.1	631.1	599.6
245.0	1042.9	910.6	798.0	728.2	673.7	631.7	592.6	563.3
240.0	999.0	852.8	748.0	683.0	632.3	593.2	556.9	529.6
235.0	936.1	799.1	701.5	641.0	593.8	557.5	523.6	498.3
230.0	876.7	749.1	658.3	602.1	558.1	524.3	492.8	469.2
225.0	821.5	702.7	618.2	565.8	525.0	493.5	464.2	442.3
220.0	770.1	659.6	580.9	532.2	494.2	464.9	437.7	417.2
215.0	722.4	619.5	546.3	501.0	465.7	438.4	413.0	393.9
210.0	678.0	582.3	514.2	472.1	439.2	413.7	390.1	372.4
205.0	636.8	547.7	484.4	445.2	414.5	390.8	368.8	352.4
200.0	598.5	515.6	456.7	420.2	391.6	369.6	349.2	333.8
195.0	563.0	485.9	431.0	396.9	370.4	349.9	330.9	316.7
190.0	529.9	458.2	407.1	375.4	350.7	331.7	314.0	300.7
185.0	499.3	432.5	384.9	355.5	332.5	314.8	298.4	286.0
180.0	470.8	408.6	364.3	336.9	315.6	299.1	283.8	272.4
175.0	444.4	386.5	345.3	319.8	300.0	284.7	270.4	259.8
170.0	419.8	365.9	327.6	303.9	285.5	271.2	258.0	248.1
165.0	397.0	346.9	311.3	289.2	272.1	258.8	246.5	237.3
160.0	375.9	329.3	296.1	275.7	259.7	247.4	235.9	227.4
155.0	356.3	312.9	282.1	263.0	248.2	236.7	226.1	218.1
150.0	338.1	297.8	269.1	251.4	237.6	226.9	217.0	209.6
145.0	321.3	283.7	257.1	240.6	227.8	217.9	208.7	201.8
140.0	305.7	270.8	246.0	230.7	218.7	209.5	200.9	194.5
135.0	291.2	258.8	235.7	221.5	210.3	201.8	193.8	187.9
130.0	277.8	247.7	226.2	212.9	202.6	194.6	187.2	181.7
125.0	265.5	237.4	217.5	205.1	195.5	188.1	181.2	176.0
120.0	254.0	227.9	209.3	197.9	188.9	182.0	175.6	170.8
115.0	243.5	219.2	201.9	191.2	182.9	176.5	170.5	166.0
110.0	233.7	211.1	195.0	185.1	177.3	171.4	165.8	161.7
105.0	224.6	203.6	188.7	179.4	172.2	166.7	161.5	157.6
100.0	216.3	196.7	182.8	174.2	167.5	162.3	157.5	153.9
95.0	208.6	190.4	177.4	169.4	163.2	158.4	153.9	150.6
90.0	201.5	184.6	172.5	165.1	159.3	154.8	150.6	147.5
85.0	195.0	179.2	168.0	161.1	155.7	151.5	147.6	144.7
80.0	188.9	174.3	163.9	157.4	152.4	148.5	144.9	142.2
75.0	183.4	169.7	160.0	154.0	149.4	145.8	142.4	139.9
70.0	178.3	165.6	156.6	151.0	146.7	143.3	140.2	137.9

APPENDIX F

Pressure-Temperature Limit Table For Varying Cooldown Rates For Calvert Cliffs Unit 2 (12 EFPY)

Rates: 550°F to 250°F = 100°F/hr
<250°F Rates 50°F/hr
40°F/hr
20°F/hr

CALVERT CLIFF UNIT 2 VARIABLE COOLDOWN RATE
COOLDOWN - HEAT DROP RATE=VARIABLE (DEGF/HR)

TEMP	H(RATE)	12 EFPY PRESS
560.0	100.0	56218.1
555.0	100.0	52314.1
550.0	100.0	48683.1
545.0	100.0	45305.8
540.0	100.0	42164.6
535.0	100.0	39242.9
530.0	100.0	36525.5
525.0	100.0	33998.1
520.0	100.0	31647.3
515.0	100.0	29460.9
510.0	100.0	27427.3
505.0	100.0	25535.8
500.0	100.0	23776.5
495.0	100.0	22140.3
490.0	100.0	20618.4
485.0	100.0	19202.9
480.0	100.0	17886.3
475.0	100.0	16661.8
470.0	100.0	15522.8
465.0	100.0	14463.5
460.0	100.0	13478.2
455.0	100.0	12561.8
450.0	100.0	11709.5
445.0	100.0	10916.7
440.0	100.0	10179.4
435.0	100.0	9493.6
430.0	100.0	8855.7
425.0	100.0	8262.4
420.0	100.0	7710.6
415.0	100.0	7197.4
410.0	100.0	6720.0
405.0	100.0	6276.0
400.0	100.0	5863.1
395.0	100.0	5479.0
390.0	100.0	5121.8
385.0	100.0	4789.5
380.0	100.0	4526.8
375.0	100.0	4274.7
370.0	100.0	4039.6
365.0	100.0	3808.0
360.0	100.0	3591.9
355.0	100.0	3388.0
350.0	100.0	3194.3
345.0	100.0	3011.8
340.0	100.0	2839.9
335.0	100.0	2678.4
330.0	100.0	2526.3
325.0	100.0	2384.5
320.0	100.0	2251.5
315.0	100.0	2126.9
310.0	100.0	2010.3
305.0	100.0	1901.3
300.0	100.0	1799.4
295.0	100.0	1704.2
290.0	100.0	1615.4
285.0	100.0	1532.5
280.0	100.0	1455.2
275.0	100.0	1383.2
270.0	100.0	1316.0
265.0	100.0	1253.3
260.0	50.0	1195.0
255.0	50.0	1140.6
250.0	50.0	1090.0
245.0	50.0	1032.3
240.0	50.0	972.9
235.0	50.0	919.3
230.0	50.0	870.7
225.0	50.0	826.3
220.0	50.0	785.6
215.0	50.0	748.2
210.0	50.0	713.6
205.0	50.0	681.7
200.0	50.0	652.1
195.0	50.0	624.6
190.0	50.0	599.1
185.0	50.0	575.3
180.0	50.0	553.3
175.0	50.0	532.7
170.0	50.0	513.7
165.0	50.0	495.9
160.0	50.0	479.4
155.0	50.0	464.0
150.0	50.0	449.7
145.0	50.0	436.4
140.0	50.0	423.9
135.0	50.0	412.4
130.0	50.0	401.7
125.0	50.0	391.7
120.0	50.0	382.4
115.0	50.0	373.8
110.0	50.0	365.8
105.0	50.0	358.4
100.0	50.0	351.6
95.0	50.0	345.2
90.0	50.0	339.3
85.0	50.0	333.8
80.0	50.0	328.7
75.0	50.0	324.0
70.0	50.0	319.7

CALVERT CLIFF UNIT 2 VARIABLE COOLDOWN RATE
COOLDOWN - HEAT DROP RATE=VARIABLE (DEGF/HR)

TEMP	H(RATE)	12 EFPY PRESS
560.0	100.0	56218.1
555.0	100.0	52314.1
550.0	100.0	48683.1
545.0	100.0	45305.8
540.0	100.0	42164.6
535.0	100.0	39242.9
530.0	100.0	36525.5
525.0	100.0	33998.1
520.0	100.0	31647.3
515.0	100.0	29460.9
510.0	100.0	27427.3
505.0	100.0	25535.8
500.0	100.0	23776.5
495.0	100.0	22140.3
490.0	100.0	20618.4
485.0	100.0	19202.9
480.0	100.0	17886.3
475.0	100.0	16661.8
470.0	100.0	15522.8
465.0	100.0	14463.5
460.0	100.0	13478.2
455.0	100.0	12561.8
450.0	100.0	11709.5
445.0	100.0	10916.7
440.0	100.0	10179.4
435.0	100.0	9493.6
430.0	100.0	8855.7
425.0	100.0	8262.4
420.0	100.0	7710.6
415.0	100.0	7197.4
410.0	100.0	6720.0
405.0	100.0	6276.0
400.0	100.0	5863.1
395.0	100.0	5479.0
390.0	100.0	5121.8
385.0	100.0	4789.5
380.0	100.0	4526.8
375.0	100.0	4274.7
370.0	100.0	4035.6
365.0	100.0	3808.0
360.0	100.0	3591.9
355.0	100.0	3388.0
350.0	100.0	3194.3
345.0	100.0	3011.8
340.0	100.0	2839.9
335.0	100.0	2678.4
330.0	100.0	2526.3
325.0	100.0	2384.5
320.0	100.0	2251.5
315.0	100.0	2126.9
310.0	100.0	2010.3
305.0	100.0	1901.3
300.0	100.0	1799.4
295.0	100.0	1704.2
290.0	100.0	1615.4
285.0	100.0	1532.5
280.0	100.0	1455.2
275.0	100.0	1383.2
270.0	100.0	1316.0
265.0	100.0	1253.3
260.0	40.0	1195.0
255.0	40.0	1140.6
250.0	40.0	1090.0
245.0	40.0	1027.3
240.0	40.0	971.5
235.0	40.0	921.4
230.0	40.0	876.0
225.0	40.0	834.4
220.0	40.0	796.3
215.0	40.0	760.9
210.0	40.0	728.2
205.0	40.0	697.8
200.0	40.0	669.6
195.0	40.0	643.2
190.0	40.0	618.7
185.0	40.0	595.9
180.0	40.0	574.6
175.0	40.0	554.8
170.0	40.0	536.3
165.0	40.0	519.1
160.0	40.0	503.1
155.0	40.0	488.2
150.0	40.0	474.3
145.0	40.0	461.4
140.0	40.0	449.3
135.0	40.0	438.2
130.0	40.0	427.7
125.0	40.0	418.0
120.0	40.0	409.0
115.0	40.0	400.7
110.0	40.0	392.9
105.0	40.0	385.7
100.0	40.0	379.0
95.0	40.0	372.8
90.0	40.0	367.1
85.0	40.0	361.7
80.0	40.0	356.8
75.0	40.0	352.2
70.0	40.0	348.0

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CALVERT CLIFF UNIT 2 VARIABLE COOLDOWN RATE
COOLDOWN - HEAT DROP RATE=VARIABLE (DEGF/HR)

                         12 EFPY                                   12 EFPY
  TEMP      H(RATE)        PRESS        TEMP      H(RATE)            PRESS
 560.0        100.0      56218.1       310.0        100.0           2010.3
 555.0        100.0      52314.1       305.0        100.0           1901.3
 550.0        100.0      48683.1       300.0        100.0           1799.4
 545.0        100.0      45305.8       295.0        100.0           1704.2
 540.0        100.0      42164.6       290.0        100.0           1615.4
 535.0        100.0      39242.9       285.0        100.0           1532.5
 530.0        100.0      36525.5       280.0        100.0           1455.2
 525.0        100.0      33998.1       275.0        100.0           1383.2
 520.0        100.0      31647.3       270.0        100.0           1316.0
 515.0        100.0      29460.9       265.0        100.0           1233.3
 510.0        100.0      27427.3       260.0         20.0           1195.0
 505.0        100.0      25535.8       255.0         20.0           1140.6
 500.0        100.0      23776.5       250.0         20.0           1079.8
 495.0        100.0      22140.3       245.0         20.0           1027.6
 490.0        100.0      20618.4       240.0         20.0            980.9
 485.0        100.0      19202.9       235.0         20.0            937.9
 480.0        100.0      17886.3       230.0         20.0            897.9
 475.0        100.0      16661.8       225.0         20.0            860.5
 470.0        100.0      15522.8       220.0         20.0            825.5
 465.0        100.0      14463.5       215.0         20.0            792.7
 460.0        100.0      13478.2       210.0         20.0            762.1
 455.0        100.0      12561.8       205.0         20.0            733.5
 450.0        100.0      11709.5       200.0         20.0            706.8
 445.0        100.0      10916.7       195.0         20.0            681.9
 440.0        100.0      10179.4       190.0         20.0            658.7
 435.0        100.0       9493.6       185.0         20.0            637.1
 430.0        100.0       8855.7       180.0         20.0            617.0
 425.0        100.0       8262.4       175.0         20.0            598.3
 420.0        100.0       7710.6       170.0         20.0            580.9
 415.0        100.0       7197.4       165.0         20.0            564.7
 410.0        100.0       6720.0       160.0         20.0            549.6
 405.0        100.0       6276.0       155.0         20.0            535.6
 400.0        100.0       5863.1       150.0         20.0            522.6
 395.0        100.0       5479.0       145.0         20.0            510.5
 390.0        100.0       5121.8       140.0         20.0            499.3
 385.0        100.0       4789.5       135.0         20.0            488.8
 380.0        100.0       4526.8       130.0         20.0            479.1
 375.0        100.0       4274.7       125.0         20.0            470.1
 370.0        100.0       4035.6       120.0         20.0            461.7
 365.0        100.0       3808.0       115.0         20.0            453.9
 360.0        100.0       3591.9       110.0         20.0            446.7
 355.0        100.0       3388.0       105.0         20.0            439.9
 350.0        100.0       3194.3       100.0         20.0            433.7
 345.0        100.0       3011.8        95.0         20.0            427.8
 340.0        100.0       2839.9        90.0         20.0            422.4
 335.0        100.0       2678.4        85.0         20.0            417.4
 330.0        100.0       2526.3        80.0         20.0            412.8
 325.0        100.0       2384.5        75.0         20.0            408.4
 320.0        100.0       2251.5        70.0         20.0            404.4
 315.0        100.0       2126.9
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APPENDIX G

Pressure-Temperature Limit Tables for Isothermal Conditions for Calvert Cliffs Unit-2

CALVERT CLIFF UNIT 2 HEAT UP TABLES -- HEAT UP RATE= STEADY STATE

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
70	461.0	452.9	447.2	443.7	440.9	438.8	436.8	435.4
75	464.7	456.1	450.0	446.2	443.2	440.9	438.8	437.2
80	468.8	459.5	452.9	448.8	445.7	443.2	440.9	439.2
85	473.2	463.2	456.1	451.7	448.3	445.7	443.2	441.4
90	477.9	467.1	459.5	454.8	451.1	448.3	445.7	443.7
95	482.9	471.4	463.2	458.1	454.2	451.1	448.3	446.2
100	488.3	475.9	467.1	461.7	457.4	454.2	451.1	448.8
105	494.2	480.9	471.4	465.5	461.0	457.4	454.2	451.7
110	500.5	486.1	475.9	469.6	464.7	461.0	457.4	454.8
115	507.2	491.8	480.9	474.1	468.8	464.7	461.0	458.1
120	514.5	497.9	486.1	478.8	473.2	468.8	464.7	461.7
125	522.3	504.5	491.8	484.0	477.9	473.2	468.8	465.5
130	530.6	511.5	497.9	489.5	482.9	477.9	473.2	469.6
135	539.7	519.1	504.5	495.4	488.3	482.9	477.9	474.1
140	549.3	527.2	511.5	501.8	494.2	488.3	482.9	478.8
145	559.8	536.0	519.1	508.6	500.5	494.2	488.3	484.0
150	570.9	545.4	527.2	516.0	507.2	500.5	494.2	489.5
155	583.0	555.5	536.0	523.9	514.5	507.2	500.5	495.4
160	595.9	566.4	545.4	532.4	522.3	514.5	507.2	501.8
165	609.8	578.1	555.5	541.5	530.6	522.3	514.5	508.6
170	624.7	590.6	566.4	551.4	539.7	530.6	522.3	516.0
175	640.8	604.1	578.1	561.9	549.3	539.7	530.6	523.9
180	658.1	618.6	590.6	573.3	559.8	549.3	539.7	532.4
185	676.6	634.2	604.1	585.5	570.9	559.8	549.3	541.5
190	696.6	651.0	618.6	598.6	583.0	570.9	559.8	551.4
195	718.0	669.0	634.2	612.7	595.9	583.0	570.9	561.9
200	741.0	688.4	651.0	627.9	609.8	595.9	583.0	573.3
205	765.8	709.2	669.0	644.2	624.7	609.8	595.9	585.5
210	792.3	731.6	688.4	661.7	640.8	624.7	609.8	598.6
215	820.9	755.6	709.2	680.5	658.1	640.8	624.7	612.7
220	851.6	781.5	731.6	700.7	676.6	658.1	640.8	627.9
225	884.6	809.2	755.6	722.5	696.6	676.6	658.1	644.2
230	920.0	839.1	781.5	745.8	718.0	696.6	676.6	661.7
235	958.1	871.1	809.2	770.9	741.0	718.0	696.6	680.5
240	999.0	905.5	839.1	797.9	765.8	741.0	718.0	700.7
245	1042.9	942.5	871.1	826.9	792.3	765.8	741.0	722.5
250	1090.0	982.3	905.5	858.0	820.9	792.3	765.8	745.8
255	1140.6	1024.9	942.5	891.5	851.6	820.9	792.3	770.9
260	1195.0	1070.7	982.3	927.4	884.6	851.6	820.9	797.9
265	1253.3	1120.0	1024.9	966.0	920.0	884.6	851.6	826.9
270	1316.0	1172.8	1070.7	1007.5	958.1	920.0	884.6	858.0
275	1383.2	1229.5	1120.0	1052.0	999.0	958.1	920.0	891.5
280	1455.2	1290.4	1172.8	1099.9	1042.9	999.0	958.1	927.4
285	1532.5	1355.7	1229.5	1151.2	1090.0	1042.9	999.0	966.0
290	1615.4	1425.8	1290.4	1206.3	1140.6	1090.0	1042.9	1007.5
295	1704.2	1501.0	1355.7	1265.5	1195.0	1140.0	1090.0	1052.0
300	1799.4	1581.6	1425.8	1329.0	1253.3	1195.0	1140.6	1099.9
305	1901.3	1668.0	1501.0	1397.2	1316.0	1253.3	1195.0	1151.2
310	2010.3	1760.5	1581.6	1470.3	1383.2	1316.0	1253.3	1206.3
315	2126.9	1859.7	1668.0	1548.6	1455.2	1383.2	1316.0	1265.5
320	2251.5	1965.8	1760.5	1632.7	1532.2	1455.2	1383.2	1329.0
325	2384.5	2079.3	1859.7	1722.7	1615.4	1532.5	1455.2	1397.2

330	2526.3	2200.6	1965.8	1819.2	1704.2	1615.4	1532.5	1470.3
335	2678.4	2330.2	2079.3	1922.5	1799.4	1704.2	1615.4	1543.6
340	2839.9	2468.5	2200.6	2033.0	1901.3	1799.4	1704.2	1632.7
345	3011.8	2615.8	2330.2	2151.1	2010.3	1901.3	1799.4	1722.7
350	3194.3	2774.1	2468.5	2277.4	2126.9	2010.3	1901.3	1819.2
355	3388.0	2941.8	2615.8	2412.1	2251.5	2126.9	2010.3	1922.5
360	3591.9	3120.0	2774.1	2555.8	2384.5	2251.5	2126.9	2033.0
365	3808.0	3309.2	2941.8	2709.9	2526.3	2384.5	2251.5	2151.1
370	4035.6	3509.7	3120.0	2873.4	2678.4	2526.3	2384.5	2277.4
375	4274.7	3720.2	3309.2	3047.4	2839.9	2678.4	2526.3	2412.1
380	4526.8	3943.2	3509.7	3232.2	3011.8	2839.9	2678.4	2555.8
385	4789.5	4177.7	3720.2	3428.1	3194.3	3011.8	2839.9	2709.9
390	5121.8	4423.6	3943.2	3634.2	3388.0	3194.3	3011.8	2873.4
395	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
400	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
405	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
410	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
415	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
420	7710.6	6538.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
425	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
430	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
435	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
440	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
445	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
450	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
455	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
460	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
465	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
470	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
475	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
480	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
485	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
490	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
495	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
500	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
505	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
510	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
515	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
520	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
525	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
530	36525.1	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
535	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
540	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
545	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
550	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
555	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
560	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3

CALVERT CLIFF UNIT 2 HEAT DROP TABLES -- HEAT DROP RATE- STEADY STATE

	12 EFPY	16 EFPY	20 EFPY	24 EFPY	28 EFPY	32 EFPY	36 EFPY	40 EFPY
TEMP	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS	PRESS
560	56218.1	47302.7	40970.4	37053.4	33998.1	31647.3	29460.9	27822.3
555	52314.1	44021.9	38132.3	34489.0	31647.3	29460.9	27427.3	25903.2
550	48683.1	40970.4	35492.5	32103.9	29460.9	27427.3	25535.8	24118.3
545	45305.8	38132.3	33037.3	29885.6	27427.3	25535.8	23776.5	22458.1
540	42164.6	35492.5	30753.7	27822.3	25535.8	23776.5	22140.3	20914.0
535	39242.9	33037.3	28629.7	25903.2	23776.5	22140.3	20618.4	19477.8
530	36525.5	30753.7	26654.2	24118.3	22140.3	20618.4	19202.9	18142.0
525	33998.1	28629.7	24816.8	22458.1	20618.4	19202.9	17886.3	16899.6
520	31647.3	26654.2	23107.8	20914.0	19202.9	17886.3	16661.8	15744.1
515	29460.9	24816.8	21518.3	19477.8	17886.3	16661.8	15522.8	14669.3
510	27427.3	23107.8	20039.8	18142.0	16661.8	15522.8	14463.5	13669.6
505	25535.8	21518.3	18664.8	16899.6	15522.8	14463.5	13478.2	12739.8
500	23776.5	20039.8	17385.8	15744.1	14463.5	13478.2	12561.8	11875.1
495	22140.3	18664.8	16196.3	14669.3	13478.2	12561.8	11709.5	11070.7
490	20618.4	17385.8	15089.9	13669.6	12561.8	11709.5	10916.7	10322.6
485	19202.9	16196.3	14060.8	12739.8	11709.5	10916.7	10179.4	9626.8
480	17886.3	15089.9	13103.7	11875.1	10916.7	10179.4	9493.6	8979.6
475	16661.8	14060.8	12213.5	11070.7	10179.4	9493.6	8855.7	8377.7
470	15522.8	13103.7	11385.5	10322.6	9493.6	8855.7	8262.4	7817.8
465	14463.5	12213.5	10615.4	9626.8	8855.7	8262.4	7710.6	7297.1
460	13478.2	11385.5	9899.1	8979.6	8262.4	7710.6	7197.4	6812.8
455	12561.8	10615.4	9232.9	8377.7	7710.6	7197.4	6720.0	6362.3
450	11709.5	9899.1	8613.2	7817.8	7197.4	6720.0	6276.0	5943.3
445	10916.7	9232.9	8036.9	7297.1	6720.0	6276.0	5863.1	5553.6
440	10179.4	8613.2	7500.9	6812.8	6276.0	5863.1	5479.0	5191.1
435	9493.6	8036.9	7002.3	6362.3	5863.1	5479.0	5121.8	4854.0
430	8855.7	7500.9	6538.6	5943.3	5479.0	5121.8	4789.5	4577.0
425	8262.4	7002.3	6107.3	5553.6	5121.8	4789.5	4526.8	4323.9
420	7710.6	6533.6	5706.1	5191.1	4789.5	4526.8	4274.7	4082.5
415	7197.4	6107.3	5333.0	4854.0	4526.8	4274.7	4035.6	3852.6
410	6720.0	5706.1	4985.9	4577.0	4274.7	4035.6	3808.0	3634.2
405	6276.0	5333.0	4682.0	4323.9	4035.6	3808.0	3591.9	3428.1
400	5863.1	4985.9	4423.6	4082.5	3808.0	3591.9	3388.0	3232.2
395	5479.0	4682.0	4177.7	3852.6	3591.9	3388.0	3194.3	3047.4
390	5121.8	4423.6	3943.2	3634.2	3591.9	3194.3	3011.8	2873.4
385	4789.5	4177.7	3720.2	3428.1	3388.0	3011.8	2839.9	2709.9
380	4526.8	3943.2	3509.7	3232.2	3194.3	2839.9	2678.4	2555.8
375	4274.7	3720.2	3309.2	3047.4	3011.8	2678.4	2526.3	2412.1
370	4035.6	3509.7	3120.0	2873.4	2839.9	2526.3	2384.5	2277.4
365	3808.0	3309.2	2941.8	2709.9	2678.4	2384.5	2251.5	2151.1
360	3591.9	3120.0	2774.1	2555.8	2526.3	2251.5	2126.9	2033.0
355	3388.0	2941.8	2615.8	2412.1	2384.5	2126.9	2010.3	1922.5
350	3194.3	2774.1	2468.5	2277.4	2251.5	2010.3	1901.3	1819.2
345	3011.8	2615.8	2330.2	2151.1	2126.9	1901.3	1799.4	1722.7
340	2839.9	2468.5	2200.6	2033.0	2010.3	1799.4	1704.2	1632.7
335	2678.4	2330.2	2079.3	1922.5	1901.3	1704.2	1615.4	1548.6
330	2526.3	2200.6	1965.8	1819.2	1799.4	1615.4	1532.5	1470.3
325	2384.5	2079.3	1859.7	1722.7	1704.2	1532.5	1455.2	1397.2
320	2251.5	1965.8	1760.5	1632.7	1615.4	1455.2	1383.2	1329.0
315	2126.9	1859.7	1668.0	1548.6	1532.5	1383.2	1316.0	1265.5
310	2010.3	1760.5	1581.6	1470.3	1455.2	1316.0	1253.3	1206.3
305	1901.3	1668.0	1501.0	1397.2	1383.2	1253.3	1195.0	1151.2

300	1799.4	1581.6	1425.8	1329.0	1316.0	1195.0	1140.6	1099.9
295	1704.2	1501.0	1355.7	1265.5	1253.3	1140.6	1090.0	1052.0
290	1615.4	1425.8	1290.4	1206.3	1195.0	1090.0	1042.9	1007.5
285	1532.5	1355.7	1229.5	1151.2	1140.6	1042.9	999.0	966.0
280	1455.2	1290.4	1172.8	1099.9	1090.0	999.0	958.1	927.4
275	1383.2	1229.5	1120.0	1052.0	1042.9	958.1	920.0	891.5
270	1316.0	1172.8	1070.7	1007.5	999.0	920.0	884.6	858.0
265	1253.3	1120.0	1024.9	966.0	958.1	884.6	851.6	826.9
260	1195.0	1070.7	982.3	927.4	920.0	851.6	820.9	797.9
255	1140.6	1024.9	942.5	891.5	884.6	820.9	792.3	770.9
250	1090.0	982.3	905.5	858.0	851.6	792.3	765.8	745.8
245	1042.9	942.5	871.1	826.9	820.9	765.8	741.0	722.5
240	999.0	905.5	839.1	797.9	792.3	741.0	718.0	700.7
235	958.1	871.1	809.2	770.9	765.8	718.0	696.6	680.5
230	920.0	839.1	781.5	745.8	741.0	696.6	676.6	661.7
225	884.6	809.2	755.6	722.5	718.0	676.6	658.1	644.2
220	851.6	781.5	731.6	700.7	696.6	658.1	640.8	627.9
215	820.9	755.6	709.2	680.5	676.6	640.8	624.7	612.7
210	792.3	731.6	688.4	661.7	658.1	624.7	609.8	598.6
205	765.8	709.2	669.0	644.2	640.8	609.8	595.9	585.5
200	741.0	688.4	651.0	627.9	624.7	595.9	583.0	573.3
195	718.0	669.0	634.2	612.7	609.8	583.0	570.9	561.9
190	696.6	651.0	618.6	598.6	595.9	570.9	559.8	551.4
185	676.6	634.2	604.1	585.5	583.0	559.8	549.3	541.5
180	658.1	618.6	590.6	573.3	570.9	549.3	539.7	532.4
175	640.8	604.1	578.1	561.9	559.8	539.7	530.6	523.9
170	624.7	590.6	566.4	551.4	549.3	530.6	522.3	516.0
165	609.8	578.1	555.5	541.5	539.7	522.3	514.5	508.6
160	595.9	566.4	545.4	532.4	530.6	514.5	507.2	501.8
155	583.0	555.5	536.0	523.9	522.3	507.2	500.5	495.4
150	570.9	545.4	527.2	516.0	514.5	500.5	494.2	489.5
145	559.8	536.0	519.1	508.6	507.2	494.2	488.3	484.0
140	549.3	527.2	511.5	501.8	494.2	488.3	482.9	478.8
135	539.7	519.1	504.5	495.4	488.3	482.9	477.9	474.1
130	530.6	511.5	497.9	489.5	482.9	477.9	473.2	469.6
125	522.3	504.5	491.8	484.0	477.9	473.2	468.8	465.5
120	514.5	497.9	486.1	478.8	473.2	468.8	464.7	461.7
115	507.2	491.8	480.9	474.1	468.8	464.7	461.0	458.1
110	500.5	486.1	475.9	469.6	464.7	461.0	457.4	454.8
105	494.2	480.9	471.4	465.5	461.0	457.4	454.2	451.7
100	488.3	475.9	467.1	461.7	457.4	454.2	451.1	448.8
95	482.9	471.4	463.2	458.1	454.2	451.1	448.3	446.2
90	477.9	467.1	459.5	454.8	451.1	448.3	445.7	443.7
85	473.2	463.2	456.1	451.7	448.3	445.7	443.2	441.4
80	468.8	459.5	452.9	448.8	445.7	443.2	440.9	439.2
75	464.7	456.1	450.0	446.2	443.2	440.9	438.8	437.2
70	461.0	452.9	447.2	443.7	440.9	438.8	436.8	435.4