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SUPPLEMENT 1

DRESDEN UNIT 3 REVISED MPLHGR ANALYSIS USING THE ENC EXEM EVALUATION MODEL

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DRESDEN UNIT 3 LOCA ANALYSIS USING THE ENC EXEM EVALUATION MODEL - MAPLHGR RESULTS

Revised MAPLHGR Analysis for
Cycle 9 Core Configuration

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1.0 INTRODUCTION AND SUMMARY

This document presents the revised Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) results for Cycle 9 of the Dresden Unit 3 reactor based on ECCS analysis. MAPLHGR results derived from LOCA analysis for Dresden Unit 3 were previously reported in XN-NF-81-75(P).[1] The LOCA analysis has been performed again in order to more accurately model the hydraulic performance of the core in its Cycle 9 configuration and to allow the use of certain revised computer codes.

The limiting break for a jet pump BWR/3 was determined and reported in XN-NF-81-71(P)[2] to be a double-ended guillotine (DEG) configuration with a discharge coefficient of 1.0 in the recirculation piping on the suction side of the pump (PS). This limiting break forms the basis of the MAPLHGR analyses reported herein.

Heatup analyses were performed for ENC fuel with a range of fuel exposures using blowdown boundary conditions from the limiting 1.0 DEG/PS break. The heatup analysis results are shown in Table 1.1 and Figure 1.1. The calculations were performed according to Appendix K of 10 CFR 50. The MAPLHGR limits defined in Table 1.1 satisfy requirements specified by 10 CFR 50.46.[3]

The MAPLHGR results confirm that the limits established previously continue to apply for Dresden 3 Cycle 9 with the revised core configuration and updated evaluation model codes. A MAPLHGR of 13 kW/ft applies to an assembly burnup of 15 GWD/MTM. For higher assembly burnups, the allowed MAPLHGR decreases as shown in Figure 1.1 to a value of 10.45 kW/ft at 35 GWD/MTM assembly burnup.

Table 1.1 Dresden Unit 3 MAPLHGR Summary for ENC 8x8 Reload Fuel

(Types XN-1 and XN-2)

Assembly Average Burnup (GWD/MTM)	Cycle 9 MAPLHGR Limits (kW/ft)
0.	13.0
10.	13.0
15.	13.0
18.	12.85
20.	12.6
25.	11.95
30.	11.2
35.	10.45

NOTE: MAPLHGR limits calculated for Cycle 9 core configurations are equal to those calculated by earlier methods for Cycle 8.

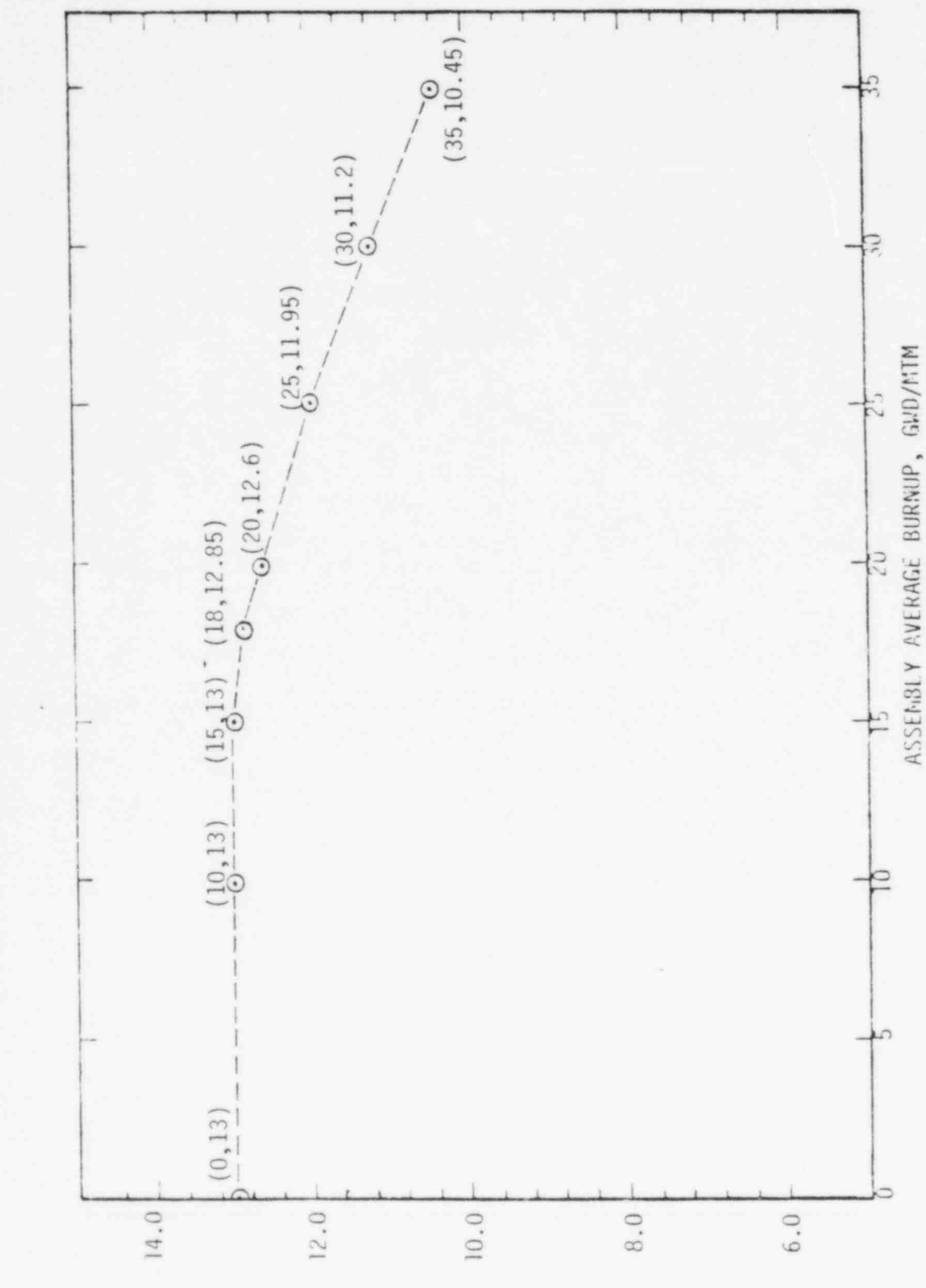

Figure 1.1 Dresden Unit 3 MAPLHGR vs. Assembly Average Burnup

(Types XN-1 and XN-2)

2.0 JET PUMP BWR ECCS EVALUATION MODEL

2.1 EXEM MODIFICATION

The evaluation model used for the Dresden Unit 3 LOCA analysis is the ENC EXEM(4) code package for jet pump BWR plants. EXEM is made up of the RODEX2(5), RELAX(6), FLEX(7), and HUXY/BULGEX(8,9) codes. The original LOCA analysis was performed using a preliminary version of the RODEX2 code as the fuel behavior model. The RODEX2 code has since been modified to include changes required by the NRC and described in XN-NF-81-58(P).(5) The revised RODEX2 code was used in the MAPLHGR analyses described herein.

There have also been three minor changes to the FLEX code. These changes will have no effect on the FLEX results for Dresden Unit 3. The HUXY/BULGEX code differs from the previous version by the use of the NUREG-0630 rupture and blockage data.

2.2 EXEM APPLICATION TO DRESDEN 3

The initial stored energy and fission gas release calculations for the fuel at various exposures are performed with the RODEX2 code. The FLEX code performs the reactor system refill/reflood calculation from the time of rated core spray until liquid is entrained at the core midplane during the core reflood process. The HUXY/BULGEX code performs the hot assembly heatup, clad swelling and rupture calculations.

The RELAX blowdown calculation determines the reactor system behavior during the initial portion of the reactor system depressurization transient. The latest calculation differs from the original RELAX calculation for Dresden 3 in the phase separation model used in the guide tubes,

which allows improved predictions of liquid inventory distribution and core thermal hydraulics during and after flashing. This has a small impact on time of rated spray which changed from 59.3 s. to 56.8 s. A separate RELAX/HOT CHANNEL calculation is used to calculate for the maximum power fuel assembly the cladding to coolant heat transfer coefficients, and coolant thermodynamic properties using time-dependent boundary conditions from the RELAX blowdown analysis. This blowdown calculation also supplies reactor system conditions at the time of rated low pressure core spray flow to initialize the system refill/reflood transient calculation.

The FLEX system refill/reflood analysis predicts the latter segment of the reactor depressurization, lower plenum refill, core reflood, and the time at which the reflooding liquid is entrained to the maximum power plane in the core (time of hot node reflood). The time of hot node reflood is an input parameter for the heatup calculation. The latest FLEX calculation differs from the original in that the hydraulic configuration at the bypass inlet (leakage paths) corresponds to that of Cycle 9, which will include more ENC fuel assemblies than are in Cycle 8. This change resulted in the time of hot node reflood dropping from 182 s. to 169 s.

The HUXY/BULGEX heatup calculation uses calculated parameters from RODEX2 (fuel stored energy and fission gas release), RELAX (time of rated spray, decay power, heat transfer coefficients and coolant temperatures) and FLEX (time of hot node reflood) to determine the peak clad temperature (PCT) and the percent oxidation of cladding. A symmetric center peaked axial power profile was used. Through a series of heatup calculations at different burnups, the plant MAPLHGR limits are determined.

Except for the leakage holes and paths in the FLEX calculation, this LOCA analysis was performed for an entire core of ENC 8x8 reload fuel. ENC reload fuel has hydraulic and neutronic compatibility with the NSSS vendor fuel.[10] Dresden 3 reactor system data appropriate for this analysis are given in Table 2.1.

Table 2.1 Dresden Unit 3 Reactor System Data

Primary Heat Output, MW	2577.5*
Total Reactor System Volume, ft^3	20160.
Total Reactor Flow Rate, lb/hr.	98.0×10^6
Active Core Flow Rate, lb/hr.	87.27×10^6
Nominal Reactor System Pressure, (upper plenum) psia	1,017.
Reactor Inlet Enthalpy, Btu/lb.	525.3
Recirculation Loop Flow Rate, lb/hr.	17.11×10^6
Steam Flow Rate, lb/hr.	9.95×10^6*
Feedwater Flow Rate, lb/hr.	9.95×10^6*
Rated Recirculation Pump Head, ft.	570.
Rated Recirculation Pump Speed, rpm	1,670.
Moment of Inertia, lbm-ft^2/rad	10,950.
Recirculation Suction Pipe I.D., in.	25.78
Recirculation Discharge Pipe I.D., in.	25.46
Fuel Assembly Rod Diameter, in.**	0.484
Fuel Assembly Rod Pitch, in.**	0.641
Active Core Height, in.**	145.24

* 102% of rated power
** ENC fuel parameters

3.0 RESULTS

The MAPLHGR results for the Dresden 3 reactor have been calculated using the break shown to be limiting in the generic BWR/3 break spectrum analyses(10): a double-ended guillotine break (DEG) with a discharge coefficient of 1.0 in the recirculation suction piping. The revised blowdown and refill/reflood calculations resulted in a slight improvement of time of rated spray and a larger improvement of time of hot node reflood.

This analysis uses the bounding hot channel calculation as performed for the original MAPLHGR analysis and described in the previous report XN-NF-81-75(P). The maximum fuel stored energy occurred at an assembly average burnup of 20 GWD/MTM. This bounding hot channel calculation provides heat transfer coefficients, fluid temperature and fluid quality at the plane of interest for the HUXY/BULGEX calculations.

The HUXY/BULGEX calculated results and corresponding MAPLHGR limits for ENC 8x8 reload fuel are shown in Table 3.1 and Figures 1.1 and 3.1. These results conform to the NRC requirements specified by 10 CFR 50.46. Table 3.1 shows the average burnup of the hot assembly (not planar burnup), MAPLHGR, peak local metal-wate reaction, and peak clad temperature. Figure 3.1 is a heatup vs. time plot calculated by the HUXY/BULGEX code at an assembly average burnup of 18 GWD/MTM.

Table 3.1 Dresden Unit 3 LOCA Analysis Results for ENC 8x8 Reload Fuel

Assembly Average Burnup (GWD/MTM)	MAPLHGR (kW/ft)	Local MWR (%)	PCT (^oF)
0.	13.0	.8	1879
10.	13.0	1.0	1942
15.	13.0	1.7	2123
18.	12.85	1.9	2159
20.	12.6	1.5	2074
25.	11.95	1.2	2011
30.	11.2	1.9	1895
35.	10.45	1.4	1808

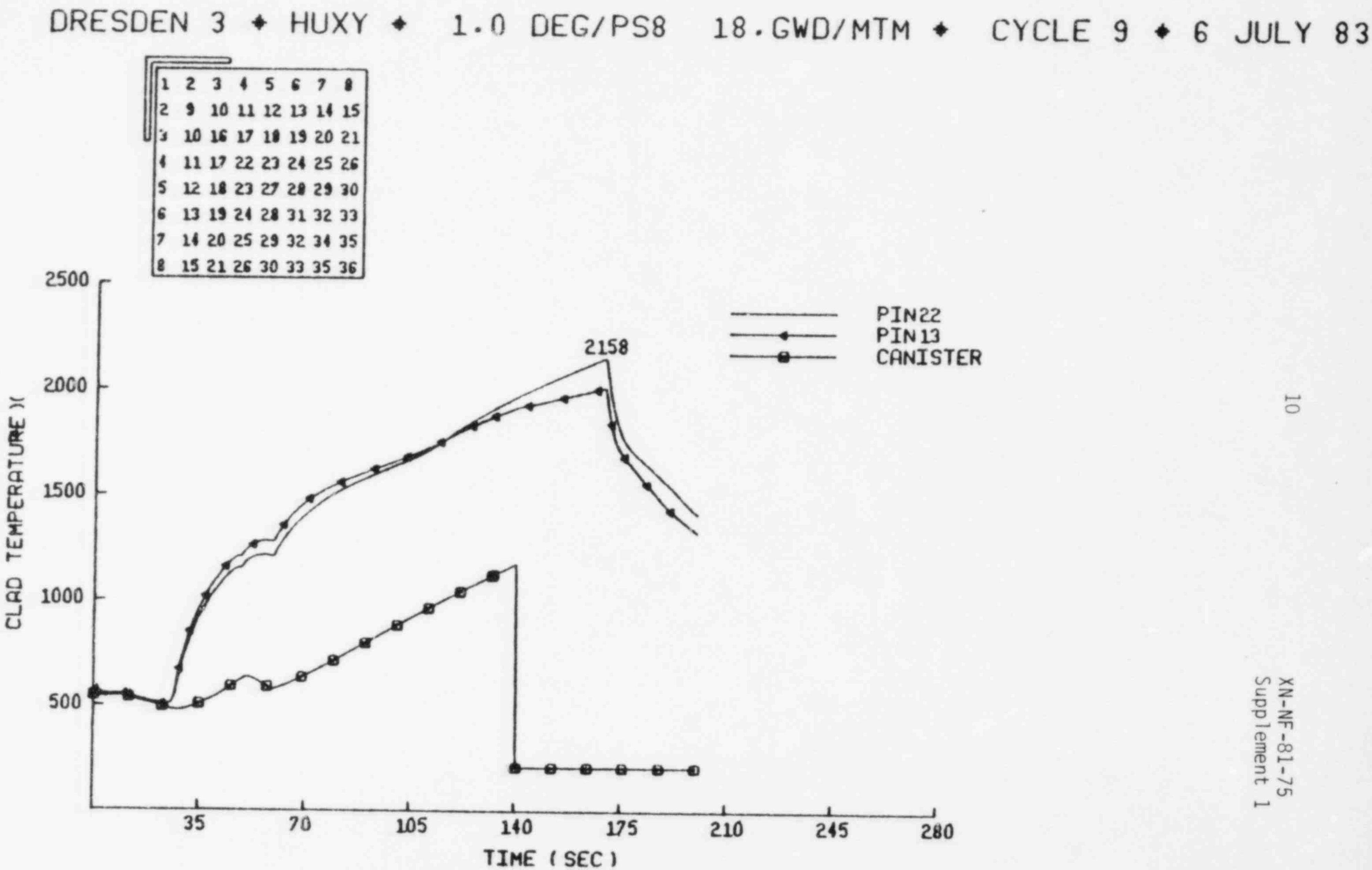

Figure 3.1 Hot Assembly Heatup Results, 1.0 DEG/PS Break

4.0 CONCLUSIONS

A LOCA-ECCS analysis has been performed for the Dresden Unit 3 reactor using the EXEM ECCS Evaluation Model in conformance with Appendix K of 10 CFR 50. The limiting break was identified as the 1.0 DEG break in the recirculation suction piping.(2) The limiting Maximum Average Planar Linear Heat Generation Rates (MAPLHGR) based on this break were developed for ENC fuel for the exposures given in Tables 1.1 and 3.1, and Figure 1.1. These limits apply for ENC 8x8 reload fuel.

Operation of the Dresden 3 reactor with ENC fuel within the limits defined by Table 1.1 assures that the Dresden 3 Emergency Core Cooling System will meet the acceptance criteria as required in 10 CFR 50.46. That is:

1. The calculated peak fuel element clad temperature does not exceed the 2200°F limit.
2. The amount of fuel element cladding that reacts chemically with water or steam does not exceed 1% of the total amount of zircaloy in the reactor.
3. The cladding temperature transient is terminated at a time when the core geometry is still amenable to cooling. The hot fuel rod cladding oxidation limit of 17% is not exceeded during or after quenching.
4. The system long term cooling capabilities provided for previous cores remains applicable to ENC fuel.

5.0 REFERENCES

(1) XN-NF-81-75(P), "Dresden Unit 3 LOCA Analysis Using the ENC EXEM Evaluation Model MAPLHGR Results," Exxon Nuclear Company, dated November 1981.

(2) XN-NF-81-71(P), "Generic Jet Pump BWR 3 LOCA Analysis Using the ENC EXEM Evaluation Model," Exxon Nuclear Company, dated October 1981.

(3) 10 CFR 50.46 and Appendix K of 10 CFR 50, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Cooled Nuclear Power Reactors," Federal Register, Volume 39, Number 3, dated January 4, 1974.

(4) XN-NF-80-19(P), Revision 1, Volume 2, "Exxon Nuclear Methodology for Boiling Water Reactors, Volume 2, EXEM: ECCS Evaluation Model Summary Description," Exxon Nuclear Company, dated June 1981.

(5) XN-NF-81-58(P), Revision 2, "Fuel Rod Thermal-Mechanical Response Evaluation Model," Exxon Nuclear Company, dated February 1983.

(6) XN-NF-80-19(P), Volume 2A, Revision 1, "RELAX: A RELAP4-Based Computer Code for Calculating Blowdown Phenomena," Exxon Nuclear Company, dated June 1981.

(7) XN-NF-80-19(P), Volume 2B, Revision 1, "FLEX: A Computer Code for the Refill and Reflood Period of a LOCA," Exxon Nuclear Company, dated June 1981.

(8) XN-CC-33(A), Revision 1, "HUXY: A Generalized Multirod Heatup Code with 10 CFR 50 Appendix K Heatup Option - User's Manual," Exxon Nuclear Company, dated November 1, 1975.

(9) XN-74-21, Rev. 2, and XN-74-27, Rev. 2, "BULGEX: A Computer Code to Determine the Deformation and the Onset of Bulging of Zircaloy Fuel Rod Cladding," Exxon Nuclear Company, dated December 31, 1974.

(10) XN-NF-81-76, "Dresden Unit 3 Cycle 8 Reload Analysis," Exxon Nuclear Company, dated November 1981.

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