ENCLOSURE 2

J.O.No. 14799.02

NORTH ANNA UNITS 1 AND 2
CORE POWER UPRATING
STONE & WEBSTER/BOP
LICENSING SUMMARY

STONE & WEBSTER ENGINEERING CORPORATION
JANUARY 1985

NORTH ANNA UNITS 1 AND 2
CORE POWER UPRATING

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1.0 OBJECTIVE

The objective of this report is to provide a technical basis for determining that the proposed core power uprating does not involve an unreviewed safety question in accordance with the requirements of 10CFR50.59. The review summarized here was limited to systems within Stone & Webster Engineering Corporation's original scope of work.

The evaluation used the following parameters, except where noted in the text, which bound the proposed uprated conditions:

Main Steam Pressure 100% Power	880 psia
Main Steam Temp. NoLoad	547°F
Main Steam Pressure NoLoad	1020 psia
RCS T_{avg}	586.8°F
Steam Flow 10^6 lb/hr Total	13.15
Reactor Power MWt	2898.
NSSS Power MWt	2910.

This review encompassed all systems and previous analyses potentially affected by a core uprating. Systems and analyses were reviewed to verify continued compliance to the licensing criteria and standards currently applicable to North Anna Power Station.

The review was performed to verify that plant systems continue, after the uprating, to meet the functional requirements specified in the UFSAR.

2.0 CONCLUSIONS

The proposed change in reactor core power has been reviewed and evaluated with respect to the following:

1. Accident Analyses
2. Environmental Qualification
3. Transient Analyses
4. BOP Systems Review
5. BOP Components Review
6. Structures
7. Radiation Protection
8. Review of Technical Specifications

The station will continue to meet the existing design and performance objectives and the system functional requirements.

Based on the results of this review, it has been concluded that the proposed core uprating does not represent an unreviewed safety question as defined in 10CFR50.59. These conclusions can be summarized as follows:

1. It has been determined that the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety and previously evaluated in the UFSAR has not been increased.

2. The possibility for an accident or malfunction of a different type than any evaluated previously in the UFSAR has not been created.

3. The margin of safety as defined in the basis for any Technical Specification has not been reduced.

3.0 ACCIDENT ANALYSES

3.1 Accidents From UFSAR

The UFSAR has been reviewed and accidents and analyses that were evaluated are listed with their UFSAR section below:

1. Containment Loss of Coolant Accident (LOCA), Section 6.2.1.3.1.1
2. Containment Main Steam Line Break (MSLB), Section 6.2.1.3.1.2
3. Containment Inadvertent CDA, Section 6.2.6.3
4. Volume Control Tank (VCT) Rupture, Section 15.3.6
5. Waste Gas Decay Tank (WGDT) Rupture, Section 15.3.5
6. LOCA Doses, Section 15.4.1.7
7. MSLB Doses, Section 15.4.2.1.3
8. Fuel-Handling Accident Outside Containment, Section 15.4.5
9. Steam Generator Tube Rupture, Section 15.4.3
10. Containment Subcompartment Pressure Analysis, Section 6.2.1.3.2

From the above listed analyses, only the containment LOCA is affected.

3.2 Revised Accident Analyses

3.2.1 Containment Loss of Coolant Accident (LOCA)

The current containment LOCA Analysis was performed for a NSSS power level of 2910 MWt. The containment LOCA Analysis was redone for an NSSS power level of 2910 MWt + 2 percent to account for uncertainty in core thermal power. Although Westinghouse has confirmed that the current initial RCS mass and energy release rates remain applicable for the 2 percent increase in power, the long term blowdown, as calculated by LOCTIC, takes into account a 2 percent increase in decay heat. The analysis was performed in accordance with the methods described in UFSAR 6.2.1.3.1.1. The results showed that the increased power level has a negligible effect on the peak calculated containment pressure for the accident. The depressurization time is lengthened somewhat at the

proposed power level but is still within the design basis of one hour. The subatmospheric peak pressure remains below zero at the proposed power level. These results are compared to the current license results in Table 3.2-1.

Reanalysis of available Net Positive Suction Head (NPSH) for the recirculation spray pumps and low head safety injection pumps shows that the available NPSH is unaffected by the proposed power uprate.

Additional containment analysis input data and calculation results are shown in Tables 3.2-3 through 3.2-7 and Figures 3.2-2 through 3.2-20.

3.2.2 Containment MSLB Analysis

Equipment qualification inside the containment is based on the Main Steam Line Break (MSLB) and LOCA and on the containment design pressure. The current Main Steam Line Break analysis and containment design pressure are unchanged for the uprate conditions.

The basis of the steam line break analysis is the full guillotine main steam line break at the no-load (hot shutdown) condition. The no-load Reactor Coolant System and Steam Generator temperature and pressure remain unchanged subsequent to the uprate. Although there are changes in energy releases at uprated power operating conditions, the no-load condition remains the limiting case. In addition, the current analysis assumes dry steam is released from the break. Therefore, the Main Steam Line Break post-accident conditions remain as previously analyzed.

3.2.3 Containment Inadvertent Containment Depressurization Actuation (CDA) Minimum Credible Pressure

There are no changes required for the CDA system due to the uprate and the results of the accident do not change. The limiting technical specification conditions remain unchanged. The spray system input parameters remain unchanged.

3.2.4 Volume Control Tank (VCT) Rupture

The accident doses currently reported in UFSAR Section 15.3.6 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7), which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.5 Waste Gas Decay Tank

The accident doses currently reported in UFSAR Section 15.3.5 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.6 LOCA Doses

The accident doses currently reported in UFSAR Section 15.4.1.7 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.7 MSLB Doses

The accident doses currently reported in UFSAR Section 15.4.2.1.3 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.8 Fuel Handling Accident

The accident doses currently reported in UFSAR Section 15.4.5 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.9 Steam Generator Tube Rupture

The accident doses currently reported in UFSAR Section 15.4.3 are for a core power of 2900 MWt, which bounds the proposed uprated core power of 2898 MWt. These accident doses are based on source terms (reference UFSAR Section 15.1.7) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

3.2.10 Containment Subcompartment Pressure Analysis

The subcompartment pressure analyses for the reactor cavity, steam generator compartment, and pressurizer cubicle are presented in the UFSAR. A review of these analyses indicates that they are applicable to the proposed core uprate as they were originally performed at the Engineered Safeguards Design Rating (ESDR) - 2900 MWt.

3.3 Accident Analyses Conclusions

The review encompassed all UFSAR analyses potentially affected by a core uprating.

Only the containment LOCA analyses were redone and the results were within the applicable licensing and design criteria.

TABLE 3.2-1

CONTAINMENT ANALYSIS RESULTS

Worst Case	2900 MWt Uprate	Design Limit
Containment Peak Pressure (psig)	40.94	45.0
Time of Peak Pressure (sec)	302	-
Containment Depressurization Time (sec)	3400	3600
Containment Subatmospheric Peak (psig)	-.01	0
Containment Atmosphere Peak Temperature	268	-

Notes:

1. Initial containment pressure and temperature are 12.2 psia and 105°F, respectively.
2. Peak containment pressure and peak containment temperature occur concurrently.

TABLE 3.2-2

ACCIDENT CHRONOLOGY

PUMP SUCTION DER WITH FAILURE OF A DIESEL GENERATOR
(LIMITING CASE FOR MAXIMUM POST-LOCA CONTAINMENT PRESSURE)

Time (sec)	Event
0.0	Accident occurs.
3.0	Containment depressurization actuation signal (10 psig).
15.5	First containment peak pressure occurs.
25.0	End of blowdown; core reflooding begins.
30.0	Safety injection pumps become effective.
37.6	Accumulators empty.
63.5	Quench spray subsystem and casing cooling become effective.
204.0	Core reflooding ends; post-reflood frothing begins.
302	Second peak containment pressure occurs; recirculation spray system becomes effective.
1283.	Post-reflood frothing ends.
3160.	Containment pressure becomes subatmospheric.
3580.	Safety injection pumps switch to recirculation mode.

TABLE 3.2-3

Mass and Energy Release to Containment Pump Section DER with Failure of a Diesel Generator Limiting Case for Max. Post-LOCA Cont. Press.

MASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

RATE DATA						INTEGRATED DATA				
TIME INTERVAL		BLOWDOWN		SPILLAGE		TIME	BLOWDOWN		SPILLAGE	
START (SEC)	END (SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	(SEC)	MASS (LBM)	ENERGY (BTU)	MASS (LBM)	ENERGY (BTU)
0.0	0.1	8.1212E+04	4.7044E+07	0.0	0.0	0.1	8.1212E+03	4.7044E+06	0.0	0.0
0.1	1.0	3.6015E+04	2.0839E+07	0.0	0.0	1.0	4.0535E+04	2.3459E+07	0.0	0.0
1.0	2.0	3.5027E+04	2.0505E+07	0.0	0.0	2.0	7.5561E+04	4.3964E+07	0.0	0.0
2.0	3.0	3.5101E+04	2.0741E+07	0.0	0.0	3.0	1.1066E+05	6.4705E+07	0.0	0.0
3.0	4.0	3.4840E+04	2.0723E+07	0.0	0.0	4.0	1.4550E+05	8.5429E+07	0.0	0.0
4.0	5.0	3.4359E+04	2.0517E+07	0.0	0.0	5.0	1.7986E+05	1.0595E+08	0.0	0.0
5.0	6.0	3.3690E+04	2.0175E+07	0.0	0.0	6.0	2.1355E+05	1.2612E+08	0.0	0.0
6.0	7.0	3.2687E+04	1.9617E+07	0.0	0.0	7.0	2.4624E+05	1.4574E+08	0.0	0.0
7.0	8.0	3.1479E+04	1.8847E+07	0.0	0.0	8.0	2.7772E+05	1.6458E+08	0.0	0.0
8.0	9.0	3.0439E+04	1.8140E+07	0.0	0.0	9.0	3.0815E+05	1.8272E+08	0.0	0.0
9.0	10.0	2.9505E+04	1.7456E+07	0.0	0.0	10.0	3.3766E+05	2.0018E+08	0.0	0.0
10.0	11.0	1.8334E+04	1.2562E+07	0.0	0.0	11.0	3.5599E+05	2.1274E+08	0.0	0.0
11.0	12.0	6.6535E+03	7.0558E+06	0.0	0.0	12.0	3.6265E+05	2.1980E+08	0.0	0.0
12.0	13.0	4.4809E+03	5.3652E+06	0.0	0.0	13.0	3.6713E+05	2.2516E+08	0.0	0.0
13.0	14.0	3.2936E+03	3.9679E+06	0.0	0.0	14.0	3.7042E+05	2.2913E+08	0.0	0.0
14.0	15.0	2.1517E+03	2.5987E+06	0.0	0.0	15.0	3.7257E+05	2.3173E+08	0.0	0.0
15.0	16.0	1.4118E+03	1.7026E+06	0.0	0.0	16.0	3.7399E+05	2.3343E+08	0.0	0.0
16.0	17.0	9.3356E+02	1.1250E+06	0.0	0.0	17.0	3.7492E+05	2.3456E+08	0.0	0.0
17.0	18.0	6.6201E+02	7.9800E+05	0.0	0.0	18.0	3.7558E+05	2.3536E+08	0.0	0.0
18.0	19.0	5.0837E+02	6.1189E+05	0.0	0.0	19.0	3.7609E+05	2.3597E+08	0.0	0.0
19.0	20.0	4.0362E+02	4.8600E+05	0.0	0.0	20.0	3.7649E+05	2.3645E+08	0.0	0.0
20.0	21.0	3.3400E+02	4.0230E+05	0.0	0.0	21.0	3.7683E+05	2.3685E+08	0.0	0.0
21.0	22.0	2.8455E+02	3.4325E+05	0.0	0.0	22.0	3.7711E+05	2.3720E+08	0.0	0.0
22.0	23.0	2.5500E.02	3.0085E+05	0.0	0.0	23.0	3.7737E+05	2.3750E+08	0.0	0.0
23.0	24.0	2.3187E+02	2.7331E+05	0.0	0.0	24.0	3.7760E+05	2.3777E+08	0.0	0.0
24.0	25.0	1.3044E+02	1.5379E+05	0.0	0.0	25.0	3.7773E+05	2.3793E+08	0.0	0.0
25.0	26.0	5.5456E+02	7.2182E+05	1.1010E+02	6.5880E+03	26.0	3.7828E+05	2.3865E+08	1.1010E+02	6.5880E+03
26.0	27.0	5.5531E+02	7.2450E+05	1.4677E+03	8.7014E+04	27.0	3.7884E+05	2.3937E+08	1.5778E+03	9.3602E+04
27.0	28.0	2.9994E+02	3.9221E+05	2.3704E+03	1.3937E+05	28.0	3.7914E+05	2.3977E+08	3.9482E+03	2.3297E+05
28.0	29.0	3.4244E+02	4.4771E+05	5.7636E+02	3.3635E+04	29.0	3.7948E+05	2.4021E+08	4.5245E+03	2.6660E+05
29.0	30.0	4.0600E+02	5.3062E+05	4.1353E+02	2.3704E+04	30.0	3.7969E+05	2.4074E+08	4.9381E+03	2.9031E+05
30.0	35.0	4.9017E+02	6.3082E+05	5.5351E+03	2.9967E+05	35.0	3.8234E+05	2.4394E+08	3.2614E+04	1.7086E+06
35.0	40.0	4.9842E+02	6.4704E+05	2.8388E+03	1.5333E+05	40.0	3.8403E+05	2.4717E+08	4.6007E+04	2.5553E+06
40.0	45.0	4.9556E+02	6.4237E+05	5.9609E 01	5.7000E+01	45.0	3.8731E+05	2.5030E+08	4.6010E+04	2.5556E+06
45.0	50.0	4.9344E+02	6.3070E+05	7.6441E+01	6.9992E+03	50.0	3.8970E+05	2.5336E+08	4.7193E+04	2.5906E+06

TABLE 3.2-3 (cont.)

HASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

RATE DATA						INTEGRATED DATA				
TIME INTERVAL		BLOWDOWN		SPILLAGE		TIME	BLOWDOWN		SPILLAGE	
START (SEC)	END (SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	(SEC)	MASS (LBM)	ENERGY (BTU)	MASS (LBM)	ENERGY (BTU)
50.0	55.0	4.8287E+02	6.2443E+05	1.3644E+02	1.1929E+04	55.0	3.9219E+05	2.5670E+08	4.7875E+04	2.6502E+06
55.0	60.0	4.7115E+02	6.0850E+05	1.5747E+02	1.3107E+04	60.0	3.9455E+05	2.5974E+08	4.8662E+04	2.7158E+06
60.0	72.5	4.4937E+02	5.7948E+05	1.4207E+02	1.1026E+04	72.5	4.0016E+05	2.6699E+08	5.0438E+04	2.8543E+06
72.5	85.0	4.2467E+02	5.4598E+05	1.3049E+02	9.8542E+03	85.0	4.0547E+05	2.7381E+08	5.2169E+04	2.9777E+06
85.0	105.0	4.0241E+02	5.1556E+05	1.1737E+02	7.7581E+03	105.0	4.1352E+05	2.0412E+08	5.4516E+04	3.1328E+06
105.0	140.0	3.7724E+02	4.8029E+05	1.0862E+02	6.4208E+03	140.0	4.2672E+05	3.0093E+08	5.8318E+04	3.3575E+06
140.0	190.0	3.4121E+02	4.3022E+05	1.7568E+02	9.1425E+03	190.0	4.4378E+05	3.2244E+08	6.7102E+04	3.8147E+06
190.0	240.0	2.3713E+02	2.9770E+05	3.7711E+02	5.1749E+04	240.0	4.5564E+05	3.3733E+08	8.5950E+04	6.4021E+06
240.0	290.0	2.0594E+02	2.5272E+05	4.3529E+02	6.7236E+04	290.0	4.6594E+05	3.4797E+08	1.0772E+05	9.7639E+06
290.0	340.0	2.0061E+02	2.4040E+05	4.4063E+02	6.6440E+04	340.0	4.7597E+05	3.6199E+08	1.2975E+05	1.3086E+07
340.0	390.0	1.6509E+02	1.9692E+05	4.7536E+02	7.5543E+04	390.0	4.8426E+05	3.7183E+08	1.5352E+05	1.6863E+07
390.0	500.0	1.0626E+02	1.2611E+05	5.3502E+02	9.1991E+04	500.0	4.9595E+05	3.8570E+08	2.1237E+05	2.6982E+07
500.0	650.0	9.8020E+01	1.1612E+05	5.4329E+02	9.2044E+04	650.0	5.1065E+05	4.0312E+08	2.9397E+05	4.0789E+07
650.0	900.0	9.0872E+01	1.0640E+05	5.5048E+02	9.0416E+04	900.0	5.3337E+05	4.2972E+08	4.3149E+05	6.3393E+07
900.0	1450.0	8.1540E+01	9.6101E+04	5.5986E+02	6.2222E+04	1450.0	5.7822E+05	4.8258E+08	7.3941E+05	9.7615E+07
1450.0	2200.0	6.6837E+01	7.7393E+04	5.7919E+02	1.1095E+04	2200.0	6.2835E+05	5.4062E+08	1.1738E+06	1.0594E+08
2200.0	2950.0	5.2158E+01	6.0107E+04	5.9693E+02	1.1432E+04	2950.0	6.6747E+05	5.8570E+08	1.6215E+06	1.1451E+08
2950.0	3730.0	4.4087E+01	5.0707E+04	5.7923E+02	2.1130E+04	3730.0	7.0185E+05	6.2525E+08	2.0733E+06	1.3099E+08
3730.0	5230.0	4.1077E+01	4.7217E+04	5.1126E+02	5.1366E+04	5230.0	7.6347E+05	6.9608E+08	2.8402E+06	2.0604E+08
5230.0	6730.0	3.6614E+01	4.2092E+04	5.1663E+02	4.8758E+04	6730.0	8.1039E+05	7.5922E+08	3.6151E+06	2.8118E+08
6730.0	8230.0	3.4379E+01	3.9527E+04	5.1919E+02	4.7795E+04	8230.0	8.6996E+05	8.1851E+08	4.3939E+06	3.5287E+08
8230.0	9730.0	3.2713E+01	3.7607E+04	5.2114E+02	4.6919E+04	9730.0	9.1903E+05	8.7492E+08	5.1756E+06	4.2325E+08
9730.0	11230.0	3.1573E+01	3.6291E+04	5.2253E+02	4.6006E+04	11230.0	9.6639E+05	9.2936E+08	5.9594E+06	4.9238E+08
11230.0	12730.0	3.0483E+01	3.5033E+04	5.2307E+02	4.5218E+04	12730.0	1.0121E+06	9.8190E+08	6.7452E+06	5.6021E+08

TABLE 3.2-4

ENERGY DISTRIBUTION
PUMP SUCTION DER WITH FAILURE OF DIESEL GENERATOR
(LIMITING CASE FOR MAXIMUM POST-LOCA CONTAINMENT PRESSURE
IN UNITS OF MILLIONS OF BTUs)

	Time (sec)[a]				
	0.0	25.0	204.0	1300.0	3610.0
Heat sources					
Primary coolant	216.06	35.15	13.09	-	-
Primary hot metal	24.71	24.01	23.41	-	-
Piping, pumps, valves reactor vessel, and internals	61.95	60.07	54.02	-	-
Pressurizer metal and lines	13.76	12.98	12.91	-	-
Steam generator metal	117.56	117.11	105.10	-	-
Steam generator secondary water	155.30	160.38	116.68	-	-
Pressurizer water	27.47	0.0	0.0	-	-
Core sensible heat	26.31	7.92	4.63	-	-
Accumulator contents	8.89	4.20	0.01	-	-
External water tanks (RWST and CCT)	87.81	87.81	84.90	77.58	61.18
Heat sinks					
Containment atmosphere water	6.27	175.7	188.36	72.27	9.86

[a]The significance of the chosen times is as follows:

0.0 - Accident occurs
25.0 - End of blowdown
204.0 - End of core reflooding
1300.0 - End of post-reflood frothing (approximate)
3610.0 - One hour after accident (approximate) - containment has depressurized and is subatmospheric

TABLE 3.2-4 (Cont'd)

ENERGY DISTRIBUTION
PUMP SUCTION DER WITH FAILURE OF DIESEL GENERATOR
(LIMITING CASE FOR MAXIMUM POST-LOCA CONTAINMENT PRESSURE
IN UNITS OF MILLIONS OF BTUs)

	Time (sec)[a]				
	0.0	25.0	204.0	1300.0	3610.0
Heat sinks (Cont'd)					
Containment atmosphere air	1.22	3.82	4.04	2.96	1.56
Containment floor water[b]	0.0	41.64	87.33	306.75	430.96
Concrete sinks	0.0	6.00	25.50	69.80	75.31
Liner and metal sinks	0.0	18.10	56.72	57.30	35.75
Heat inputs[c]					
Delayed fissions	0.0	3.50	3.50	-	-
Decay heat	0.0	4.25	26.18	-	-
Pump heat	0.0	0.0	0.15	0.69	1.93
Input blowdown	-	-	0.0	141.10	291.42
Input spillage	-	-	0.0	92.02	120.63
Heat outputs					
Safety injection sump suction	-	-	0.0	0.0	3.47
Recirculation coolers	0.0	0.0	0.0	93.84	242.57

[a]The significance of the chosen times is as follows:

0.0 - Accident occurs
25.0 - End of blowdown
204.0 - End of core reflooding
1300.0 - End of post-reflood frothing (approximate)
3610.0 - One hour after accident (approximate) - containment has depressurized and is subatmospheric

[b]The energy store in the water on the containment floor is calculated as a function of time after an accident by the LOCTIC computer program. The water on the containment floor is treated as a separate node, apart from the containment atmosphere and apart from the concrete floor of the containment structure. The mass and energy inventories are determined by performing mass and energy balances on the node for each time step of the calculation.

TABLE 3.2-4 (Cont'd)

ENERGY DISTRIBUTION
PUMP SUCTION DER WITH FAILURE OF DIESEL GENERATOR
(LIMITING CASE FOR MAXIMUM POST-LOCA CONTAINMENT PRESSURE
IN UNITS OF MILLIONS OF BTUs)

[c]After the end of core reflooding, Westinghouse froth data are used for mass and energy release calculations. Heat sources and inputs associated with the primary coolant system are not individually accounted for after this time in the LOCTIC calculation. Energy removed from these sources after the end of core reflooding is included in "Input Blowdown" and "Input Spillage."

TABLE 3.2-5

RECIRCULATION SPRAY AND LOW HEAD SAFETY INJECTION PUMPS NPSHA

Worst Case	Break	ESF	Initial Water Temp of RWST	Initial Water Temp of Service	Minimum NPSHA, ft (at time, sec) IRS	ORS	LHSI	NPSHR*
IRS ORS	HLDER	Norm	50	35	11.6 (550)	17.0 (630)	25.3 (1910)	9.4 11.0
LHSI	PSDER	Min.	50	95	13.9 (1810)	21.5 (1990)	15.9 (2980)	13.4

*At design flow

Mass and Energy Release Pump Suction DER-Min-ESF Limiting Case for LHSI pump NPSH.

MASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

RATE DATA						INTEGRATED DATA				
TIME INTERVAL		BLOWDOWN		SPILLAGE		TIME	BLOWDOWN		SPILLAGE	
START (SEC)	END (SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	(SEC)	MASS (LBM)	ENERGY (BTU)	MASS (LBM)	ENERGY (BTU)
0.0	0.1	8.1212E+04	4.7044E+07	0.0	0.0	0.1	8.1212E+03	4.7044E+06	0.0	0.0
0.1	1.0	3.6015E+04	2.0839E+07	0.0	0.0	1.0	4.0535E+04	2.3459E+07	0.0	0.0
1.0	2.0	3.5027E+04	2.0505E+07	0.0	0.0	2.0	7.5551E+04	4.3964E+07	0.0	0.0
2.0	3.0	3.5101E+04	2.0741E+07	0.0	0.0	3.0	1.1066E+05	6.4705E+07	0.0	0.0
3.0	4.0	3.4840E+04	2.0723E+07	0.0	0.0	4.0	1.4550E+05	8.5429E+07	0.0	0.0
4.0	5.0	3.4359E+04	2.0517E+07	0.0	0.0	5.0	1.7986E+05	1.0595E+08	0.0	0.0
5.0	6.0	3.3690E+04	2.0175E+07	0.0	0.0	6.0	2.1355E+05	1.2612E+08	0.0	0.0
6.0	7.0	3.2687E+04	1.9617E+07	0.0	0.0	7.0	2.4624E+05	1.4574E+08	0.0	0.0
7.0	8.0	3.1479E+04	1.8847E+07	0.0	0.0	8.0	2.7772E+05	1.6459E+08	0.0	0.0
8.0	9.0	3.0439E+04	1.8140E+07	0.0	0.0	9.0	3.0815E+05	1.8272E+08	0.0	0.0
9.0	10.0	2.9505E+04	1.7456E+07	0.0	0.0	10.0	3.3766E+05	2.0018E+08	0.0	0.0
10.0	11.0	1.8334E+04	1.2562E+07	0.0	0.0	11.0	3.5599E+05	2.1274E+08	0.0	0.0
11.0	12.0	6.6535E+03	7.0552E+06	0.0	0.0	12.0	3.6265E+05	2.1980E+08	0.0	0.0
12.0	13.0	4.4818E+03	5.3637E+06	0.0	0.0	13.0	3.6713E+05	2.2516E+08	0.0	0.0
13.0	14.0	3.2956E+03	3.9651E+06	0.0	0.0	14.0	3.7043E+05	2.2913E+08	0.0	0.0
14.0	15.0	2.1552E+03	2.5962E+06	0.0	0.0	15.0	3.7258E+05	2.3172E+08	0.0	0.0
15.0	16.0	1.4148E+03	1.7024E+06	0.0	0.0	16.0	3.7400E+05	2.3342E+08	0.0	0.0
16.0	17.0	9.3637E+02	1.1238E+06	0.0	0.0	17.0	3.7493E+05	2.3455E+08	0.0	0.0
17.0	18.0	6.6462E+02	7.9507E+05	0.0	0.0	18.0	3.7560E+05	2.3534E+08	0.0	0.0
18.0	19.0	5.1012E+02	6.0819E+05	0.0	0.0	19.0	3.7611E+05	2.3595E+08	0.0	0.0
19.0	20.0	4.0525E+02	4.8154E+05	0.0	0.0	20.0	3.7651E+05	2.3643E+08	0.0	0.0
20.0	21.0	3.3537E+02	3.9738E+05	0.0	0.0	21.0	3.7685E+05	2.3683E+08	0.0	0.0
21.0	22.0	2.8581E+02	3.3794E+05	0.0	0.0	22.0	3.7713E+05	2.3717E+08	0.0	0.0
22.0	23.0	2.5612E+02	3.0221E+05	0.0	0.0	23.0	3.7739E+05	2.3747E+08	0.0	0.0
23.0	24.0	2.3294E+02	2.7438E+05	0.0	0.0	24.0	3.7762E+05	2.3774E+08	0.0	0.0
24.0	25.0	2.1325E+02	2.5094E+05	0.0	0.0	25.0	3.7783E+05	2.3800E+08	0.0	0.0
25.0	26.0	1.2392E+03	4.0906E+05	0.0	0.0	26.0	3.7907E+05	2.3840E+08	0.0	0.0
26.0	27.0	4.8611E+03	1.3919E+06	0.0	0.0	27.0	3.8394E+05	2.3980E+08	0.0	0.0
27.0	28.0	1.3634E+03	9.8426E+05	0.0	0.0	28.0	3.8530E+05	2.4078E+08	0.0	0.0
28.0	29.0	2.4612E+03	5.7275E+05	0.0	0.0	29.0	3.8776E+05	2.4135E+08	0.0	0.0
29.0	30.0	1.5533E+03	4.9896E+05	0.0	0.0	30.0	3.8931E+05	2.4185E+08	0.0	0.0
30.0	35.0	4.3495E+03	8.1108E+05	0.0	0.0	35.0	4.1106E+05	2.4591E+08	0.0	0.0
35.0	40.0	3.1493E+03	7.8393E+05	0.0	0.0	40.0	4.2681E+05	2.4983E+08	0.0	0.0
40.0	45.0	4.9302E+02	6.3952E+05	0.0	0.0	45.0	4.2927E+05	2.5303E+08	0.0	0.0
45.0	50.0	5.3849E+02	6.4792E+05	0.0	0.0	50.0	4.3197E+05	2.5627E+08	0.0	0.0

TABLE 3.2-6

TABLE 3.2-6 (cont.)

MASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

RATE DATA						INTEGRATED DATA				
TIME INTERVAL		BLOWDOWN		SPILLAGE		TIME	BLOWDOWN		SPILLAGE	
START (SEC)	END (SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	(SEC)	MASS (LBM)	ENERGY (BTU)	MASS (LBM)	ENERGY (BTU)
50.0	55.0	6.1695E+02	6.4179E+05	0.0	0.0	55.0	4.3505E+05	2.5947E+08	0.0	0.0
55.0	60.0	6.2607E+02	6.2764E+05	0.0	0.0	60.0	4.3818E+05	2.6261E+08	0.0	0.0
60.0	72.5	6.0008E+02	5.9672E+05	0.0	0.0	72.5	4.4568E+05	2.7007E+08	0.0	0.0
72.5	85.0	5.6235E+02	5.6033E+05	0.0	0.0	85.0	4.5271E+05	2.7708E+08	0.0	0.0
85.0	105.0	5.2342E+02	5.2641E+05	0.0	0.0	105.0	4.6318E+05	2.8760E+08	0.0	0.0
105.0	140.0	4.8825E+02	4.8892E+05	0.0	0.0	140.0	4.8027E+05	3.0472E+08	0.0	0.0
140.0	190.0	5.1530E+02	4.4164E+05	0.0	0.0	190.0	5.0603E+05	3.2680E+08	0.0	0.0
190.0	240.0	6.0381E+02	3.5401E+05	0.0	0.0	240.0	5.3622E+05	3.4450E+08	0.0	0.0
240.0	290.0	6.4131E+02	3.1995E+05	0.0	0.0	290.0	5.6029E+05	3.6050E+08	0.0	0.0
290.0	340.0	6.4131E+02	3.0684E+05	0.0	0.0	340.0	6.0036E+05	3.7504E+08	0.0	0.0
340.0	390.0	6.4131E+02	2.9959E+05	0.0	0.0	390.0	6.3242E+05	3.9082E+08	0.0	0.0
390.0	500.0	6.4135E+02	2.2856E+05	0.0	0.0	500.0	7.0297E+05	4.1596E+08	0.0	0.0
500.0	650.0	6.4138E+02	2.0776E+05	0.0	0.0	650.0	7.9918E+05	4.4713E+08	0.0	0.0
650.0	900.0	6.4143E+02	1.9593E+05	0.0	0.0	900.0	9.5953E+05	4.9611E+08	0.0	0.0
900.0	1450.0	6.4885E+02	1.7056E+05	0.0	0.0	1450.0	1.3164E+06	5.8992E+08	0.0	0.0
1450.0	2200.0	6.6094E+02	8.9719E+04	0.0	0.0	2200.0	1.8121E+06	6.5721E+08	0.0	0.0
2200.0	2950.0	6.5993E+02	6.5849E+04	0.0	0.0	2950.0	2.3071E+06	7.0560E+08	0.0	0.0
2950.0	3730.0	5.4734E+02	1.1792E+05	0.0	0.0	3730.0	2.7340E+06	7.9857E+08	0.0	0.0
3730.0	5230.0	5.4855E+02	1.1057E+05	0.0	0.0	5230.0	3.5568E+06	9.6443E+08	0.0	0.0
5230.0	6730.0	5.49[illegible]9E+02	1.0287E+05	0.0	0.0	6730.0	4.3815E+06	1.1187E+09	0.0	0.0
6730.0	8230.0	5.5032E+02	9.8[illegible]3E+04	0.0	0.0	8230.0	5.2070E+06	1.2665E+09	0.0	0.0
8230.0	9730.0	5.5024E+02	9.7[illegible]4E+04	0.0	0.0	9730.0	6.0323E+06	1.4123E+09	0.0	0.0
9730.0	11230.0	5.5019E+02	9.6166E+04	0.0	0.0	11230.0	6.8576E+06	1.5566E+09	0.0	0.0
11230.0	12730.0	5.5020E+02	9.5101E+04	0.0	0.0	12730.0	7.6829E+06	1.6992E+09	0.0	0.0

TABLE 3.2-7

Mass and Energy Release Hot Leg DER Normal ESF Limiting Case RS Pump NPSH.

MASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

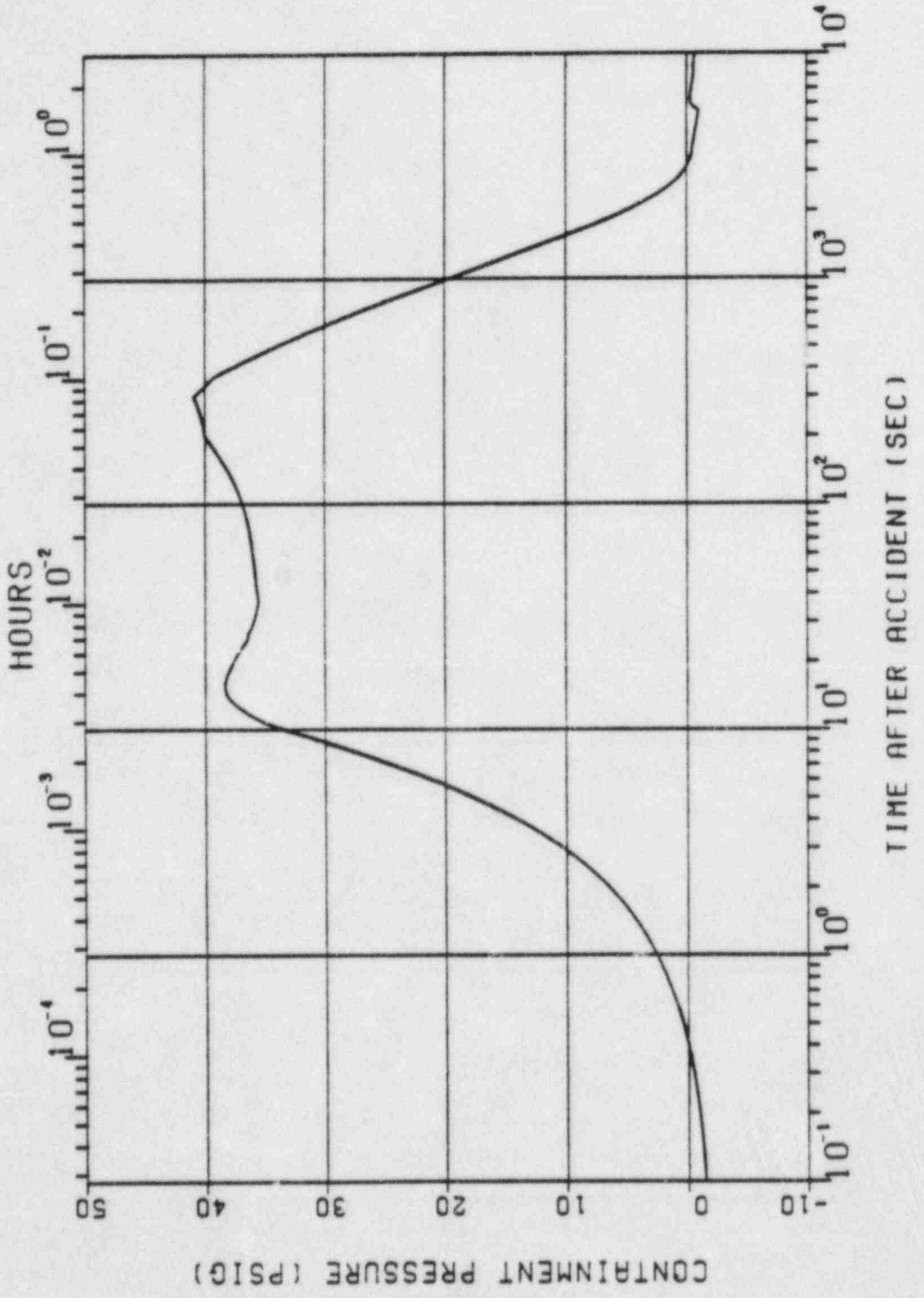
RATE DATA: TIME INTERVAL START (SEC)	RATE DATA: TIME INTERVAL END (SEC)	RATE DATA: BLOWDOWN MASS (LBM/SEC)	RATE DATA: BLOWDOWN ENERGY (BTU/SEC)	RATE DATA: SPILLAGE MASS (LBM/SEC)	RATE DATA: SPILLAGE ENERGY (BTU/SEC)	INTEGRATED DATA: TIME (SEC)	INTEGRATED DATA: BLOWDOWN MASS (LBM)	INTEGRATED DATA: BLOWDOWN ENERGY (BTU)	INTEGRATED DATA: SPILLAGE MASS (LBM)	INTEGRATED DATA: SPILLAGE ENERGY (BTU)
0.0	0.1	1.1260E+05	6.5227E+07	0.0	0.0	0.1	1.1260E+04	6.5227E+06	0.0	0.0
0.1	1.0	4.9362E+04	2.8557E+07	0.0	0.0	1.0	5.5686E+04	3.2224E+07	0.0	0.0
1.0	2.0	4.7985E+04	2.8079E+07	0.0	0.0	2.0	1.0367E+05	6.0303E+07	0.0	0.0
2.0	3.0	4.7132E+04	2.7825E+07	0.0	0.0	3.0	1.5000E+05	8.0126E+07	0.0	0.0
3.0	4.0	4.6020E+04	2.7315E+07	0.0	0.0	4.0	1.9682E+05	1.1544E+08	0.0	0.0
4.0	5.0	4.4710E+04	2.6576E+07	0.0	0.0	5.0	2.4153E+05	1.4202E+08	0.0	0.0
5.0	6.0	4.3226E+04	2.5685E+07	0.0	0.0	6.0	2.8476E+05	1.6770E+08	0.0	0.0
6.0	7.0	4.1332E+04	2.4556E+07	0.0	0.0	7.0	3.2609E+05	1.9226E+08	0.0	0.0
7.0	8.0	2.9967E+04	1.9793E+07	0.0	0.0	8.0	3.5606E+05	2.1205E+08	0.0	0.0
8.0	9.0	1.0079E+04	1.0618E+07	0.0	0.0	9.0	3.6614E+05	2.2267E+08	0.0	0.0
9.0	10.0	5.8515E+03	6.8304E+06	0.0	0.0	10.0	3.7199E+05	2.2950E+08	0.0	0.0
10.0	11.0	3.2797E+03	3.9489E+06	0.0	0.0	11.0	3.7527E+05	2.3345E+08	0.0	0.0
11.0	12.0	1.9432E+03	2.3316E+06	0.0	0.0	12.0	3.7721E+05	2.3578E+08	0.0	0.0
12.0	13.0	1.2605E+03	1.5055E+06	0.0	0.0	13.0	3.7847E+05	2.3729E+08	0.0	0.0
13.0	14.0	8.8800E+02	1.0557E+06	0.0	0.0	14.0	3.7936E+05	2.3834E+08	0.0	0.0
14.0	15.0	6.7431E+02	7.9838E+05	0.0	0.0	15.0	3.8003E+05	2.3914E+08	0.0	0.0
15.0	16.0	5.4269E+02	6.4010E+05	0.0	0.0	16.0	3.8058E+05	2.3978E+08	0.0	0.0
16.0	17.0	3.8356E+02	4.5131E+05	0.0	0.0	17.0	3.8096E+05	2.4023E+08	0.0	0.0
17.0	18.0	7.4375E+01	8.7440E+04	0.0	0.0	18.0	3.8103E+05	2.4032E+08	0.0	0.0
18.0	19.0	0.0	0.0	0.0	0.0	19.0	3.8103E+05	2.4032E+09	0.0	0.0
19.0	20.0	0.0	0.0	0.0	0.0	20.0	3.8103E+05	2.4032E+08	0.0	0.0
20.0	21.0	0.0	0.0	0.0	0.0	21.0	3.8103E+05	2.4032E+08	0.0	0.0
21.0	22.0	4.0921E+03	1.1278E+06	0.0	0.0	22.0	3.8593E+05	2.4145E+08	0.0	0.0
22.0	23.0	7.7651E+03	1.7609E+06	0.0	0.0	23.0	3.9359E+05	2.4321E+08	0.0	0.0
23.0	24.0	7.5962E+03	1.6877E+06	0.0	0.0	24.0	4.0129E+05	2.4490E+08	0.0	0.0
24.0	25.0	7.4389E+03	1.6194E+06	0.0	0.0	25.0	4.0873E+05	2.4652E+08	0.0	0.0
25.0	26.0	7.2930E+03	1.5550E+06	0.0	0.0	26.0	4.1702E+05	2.4807E+08	0.0	0.0
26.0	27.0	7.1564E+03	1.4965E+06	0.0	0.0	27.0	4.2318E+05	2.4957E+08	0.0	0.0
27.0	28.0	7.0289E+03	1.4412E+06	0.0	0.0	28.0	4.3020E+05	2.5101E+08	0.0	0.0
28.0	29.0	6.9091E+03	1.3695E+06	0.0	0.0	29.0	4.3711E+05	2.5240E+08	0.0	0.0
29.0	30.0	6.8793E+03	1.3574E+06	0.0	0.0	30.0	4.4399E+05	2.5376E+08	0.0	0.0
30.0	35.0	3.8974E+03	7.3812E+05	0.0	0.0	35.0	4.6343E+05	2.5745E+08	0.0	0.0
35.0	40.0	8.2336E+02	1.5959E+05	0.0	0.0	40.0	4.6755E+05	2.5824E+08	0.0	0.0
40.0	45.0	8.2425E+02	1.6370E+05	0.0	0.0	45.0	4.7167E+05	2.5906E+08	0.0	0.0
45.0	50.0	8.2512E+02	1.6678E+05	0.0	0.0	50.0	4.7579E+05	2.5990E+08	0.0	0.0

TABLE 3.2-7 (cont.)

MASS AND ENERGY RELEASE RATES, SPILLAGE RATES, AND INTEGRATED RELEASES AND SPILLAGE

NOTE: RATE DATA IS CONSTANT OVER THE TIME INTERVAL AND IS EQUAL TO THE CHANGE IN THE INTEGRATED DATA OVER THE TIME INTERVAL DIVIDED BY THE DURATION OF THE INTERVAL

RATE DATA						INTEGRATED DATA				
TIME INTERVAL		BLOWDOWN		SPILLAGE		TIME	BLOWDOWN		SPILLAGE	
START (SEC)	END (SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	MASS (LBM/SEC)	ENERGY (BTU/SEC)	(SEC)	MASS (LBM)	ENERGY (BTU)	MASS (LBM)	ENERGY (BTU)
50.0	55.0	8.2651E+02	1.6928E+05	0.0	0.0	55.0	4.7993E+05	2.6074E+08	0.0	0.0
55.0	60.0	8.2812E+02	1.7143E+05	0.0	0.0	60.0	4.8407E+05	2.6160E+08	0.0	0.0
60.0	72.5	8.2893E+02	1.7416E+05	0.0	0.0	72.5	4.9443E+05	2.6370E+08	0.0	0.0
72.5	85.0	8.3077E+02	1.7720E+05	0.0	0.0	85.0	5.0481E+05	2.6599E+08	0.0	0.0
85.0	105.0	8.3345E+02	1.7995E+05	0.0	0.0	105.0	5.2148E+05	2.6957E+08	0.0	0.0
105.0	140.0	8.3635E+02	1.8212E+05	0.0	0.0	140.0	5.5075E+05	2.7597E+08	0.0	0.0
140.0	190.0	8.3949E+02	1.8201E+05	0.0	0.0	190.0	5.9273E+05	2.8507E+08	0.0	0.0
190.0	240.0	8.4205E+02	1.7900E+05	0.0	0.0	240.0	6.3487E+05	2.9402E+08	0.0	0.0
240.0	290.0	8.4532E+02	1.7456E+05	0.0	0.0	290.0	6.7714E+05	3.0274E+08	0.0	0.0
290.0	340.0	8.4240E+02	1.6855E+05	0.0	0.0	340.0	7.1926E+05	3.1117E+08	0.0	0.0
340.0	390.0	8.4584E+02	1.6352E+05	0.0	0.0	390.0	7.6155E+05	3.1935E+08	0.0	0.0
390.0	500.0	8.5680E+02	1.5602E+05	0.0	0.0	500.0	8.5580E+05	3.3651E+08	0.0	0.0
500.0	650.0	8.7011E+02	1.4500E+05	0.0	0.0	650.0	9.8751E+05	3.5838E+08	0.0	0.0
650.0	900.0	8.8571E+02	1.3099E+05	0.0	0.0	900.0	1.2069E+06	3.9110E+08	0.0	0.0
900.0	1150.0	8.7590E+02	1.1656E+05	0.0	0.0	1150.0	1.4279E+06	4.2024E+08	0.0	0.0
1150.0	1400.0	8.6791E+02	1.0617E+05	0.0	0.0	1400.0	1.6449E+06	4.4679E+08	0.0	0.0
1400.0	1650.0	8.6278E+02	9.7656E+04	0.0	0.0	1650.0	1.8606E+06	4.7121E+08	0.0	0.0
1650.0	1900.0	8.5812E+02	9.1275E+04	0.0	0.0	1900.0	2.0751E+06	4.9403E+08	0.0	0.0
1900.0	2150.0	7.9737E+02	9.7399E+04	0.0	0.0	2150.0	2.2745E+06	5.1839E+08	0.0	0.0
2150.0	2400.0	7.9430E+02	1.0774E+05	0.0	0.0	2400.0	2.4731E+06	5.4531E+08	0.0	0.0
2400.0	2650.0	7.9478E+02	1.0815E+05	0.0	0.0	2650.0	2.6718E+06	5.7235E+08	0.0	0.0
2650.0	2900.0	7.9511E+02	1.0606E+05	0.0	0.0	2900.0	2.8705E+06	5.9885E+08	0.0	0.0
2900.0	3150.0	7.9539E+02	1.0332E+05	0.0	0.0	3150.0	3.0694E+06	6.2470E+08	0.0	0.0
3150.0	3400.0	7.9562E+02	1.0043E+05	0.0	0.0	3400.0	3.2683E+06	6.4930E+08	0.0	0.0
3400.0	3650.0	7.9535E+02	9.7554E+04	0.0	0.0	3650.0	3.4673E+06	6.7419E+08	0.0	0.0



CONTAINMENT PRESSURE VS TIME
WORST CASE PEAK PRESSURE
MIN ESF PSDER
NORTH ANNA POWER STATION UNITS 1&2

FIGURE
3.[illegible]-1

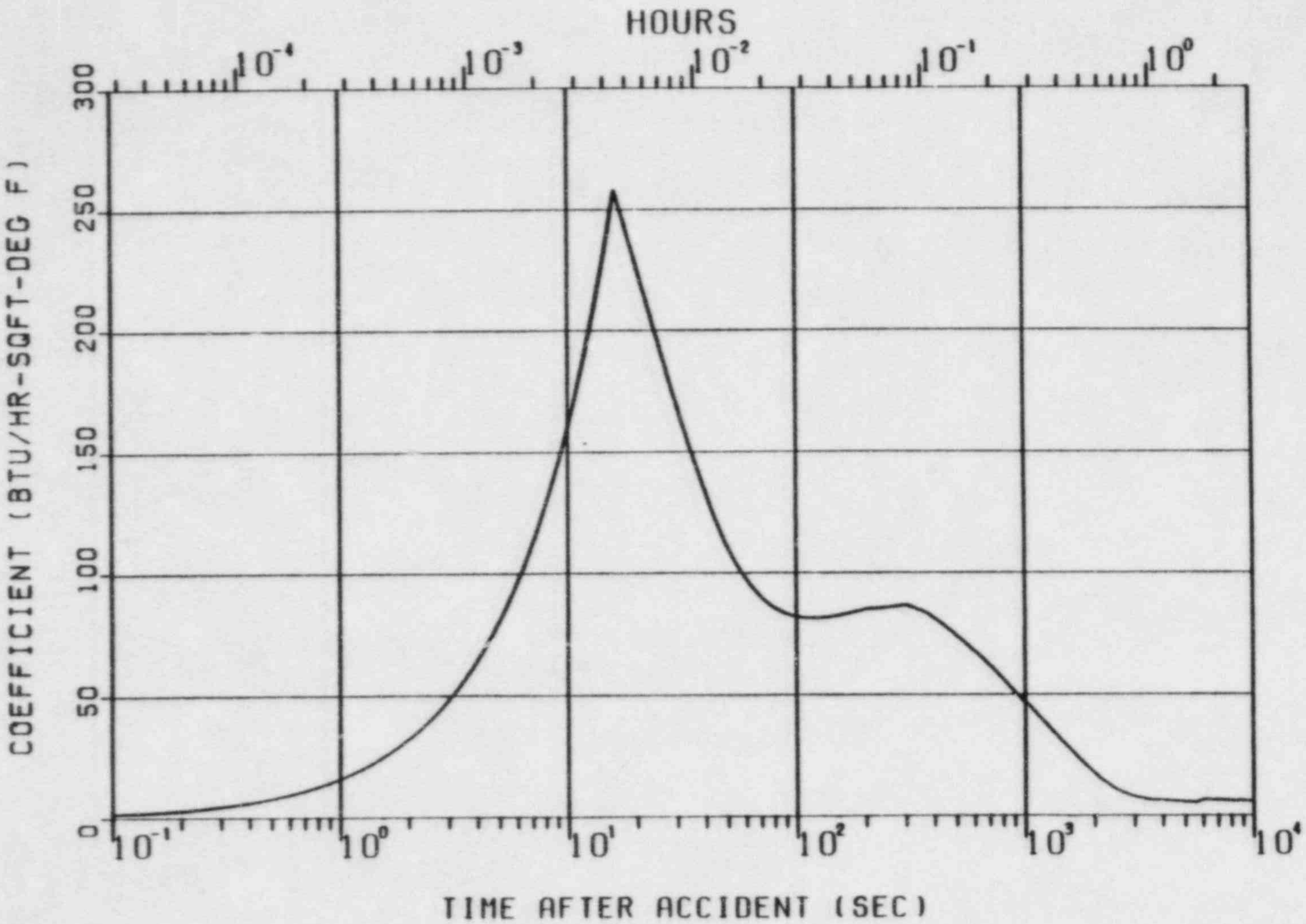


FIGURE
3.2-2

STEAM CONDENSINO COEFFICIENT VS TIME
MIN ESF PSDER
NORTH ANNA POWER STATION UNITS 1&2
MAXIMUM PRESSURE CASE

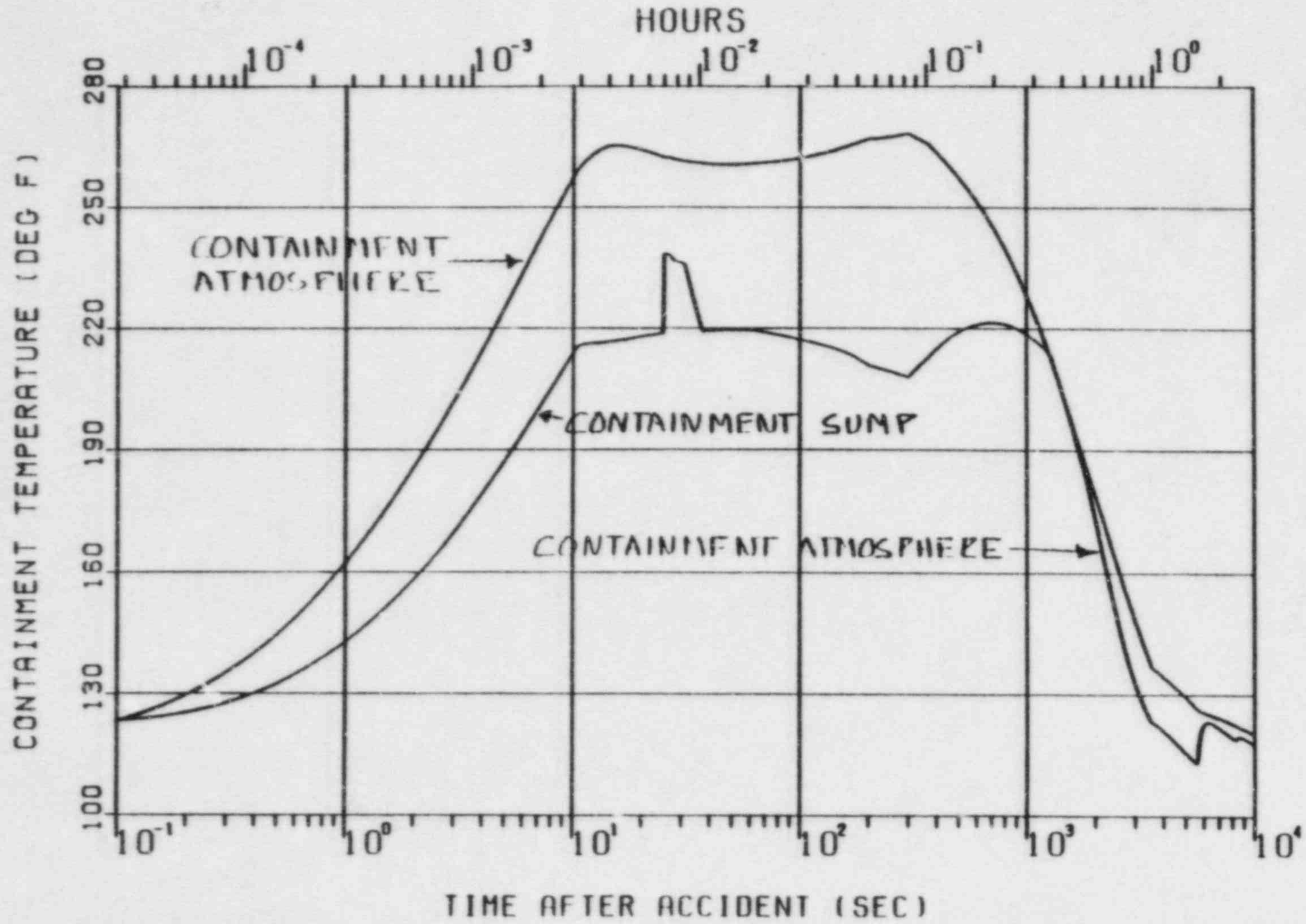


FIGURE 3.2-3

CONTAINMENT TEMPERATURE VS TIME
MIN ESF PSDER
NORTH ANNA POWER STATION UNITS 1&2
MAXIMUM PRESSURE CASE

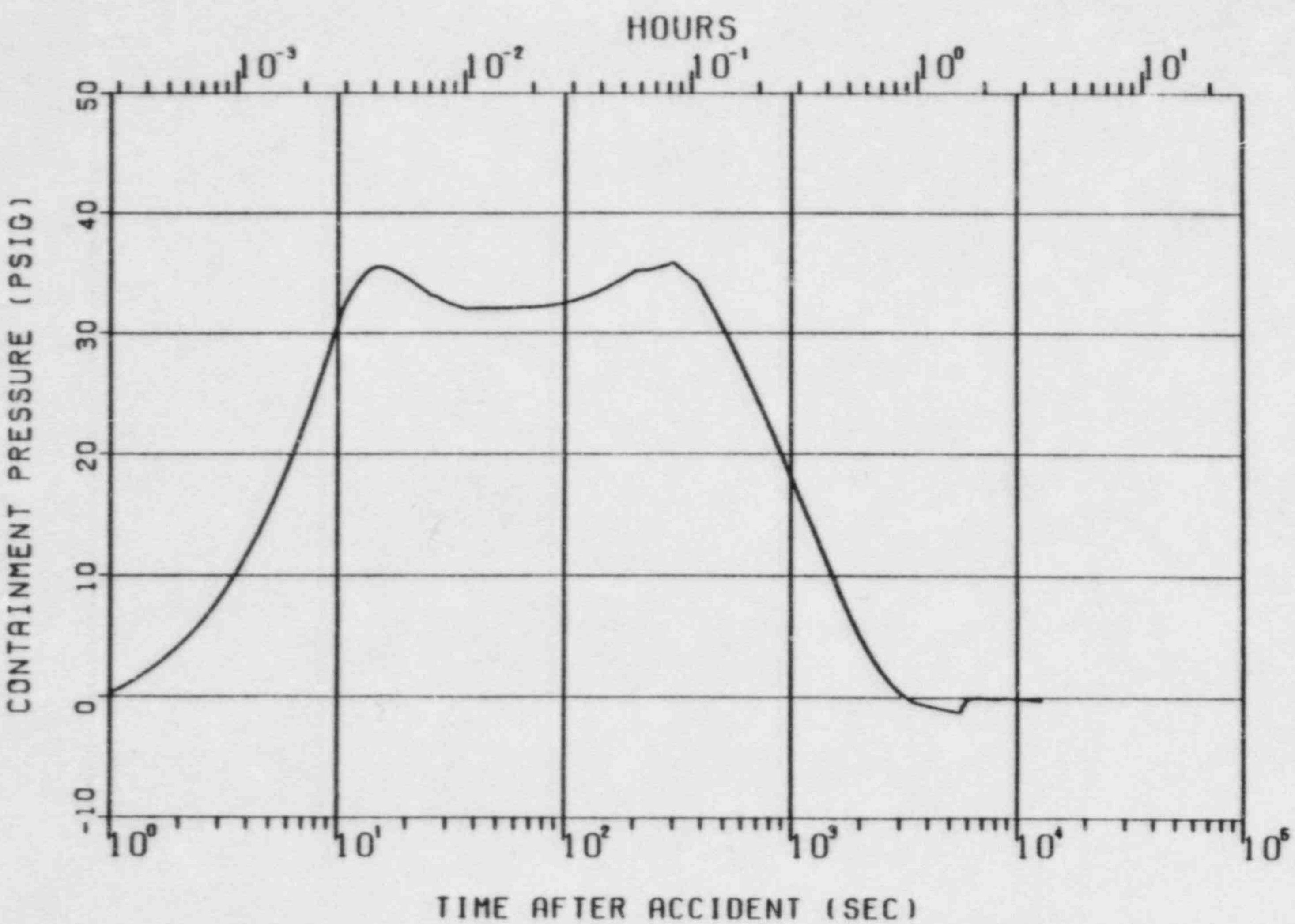
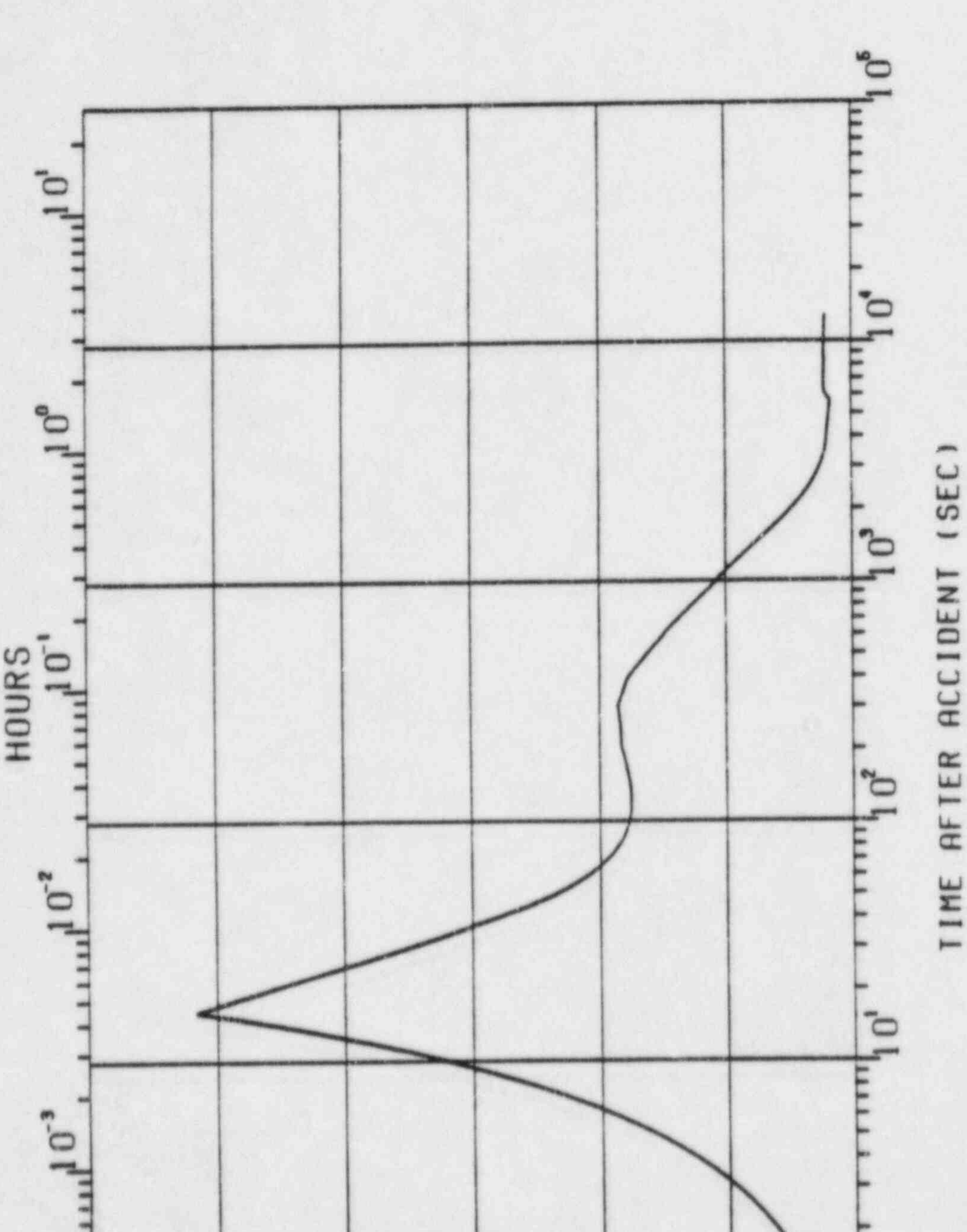


FIGURE
3.2-4

PRESSURE TRANSIENT
HORST CASE DEPRESSURIZATION
MIN ESF PODER 40F RWST 95F TX
NORTH ANNA POWER STATION UNITS 1&2



STEAM CONDENSING COEFFICIENT
WORST CASE DEPRESSURIZATION
MIN ESF PSDER 40F RWST 96F TX
NORTH ANNA POWER STATION UNITS 1&2

FIGURE
3.2-5

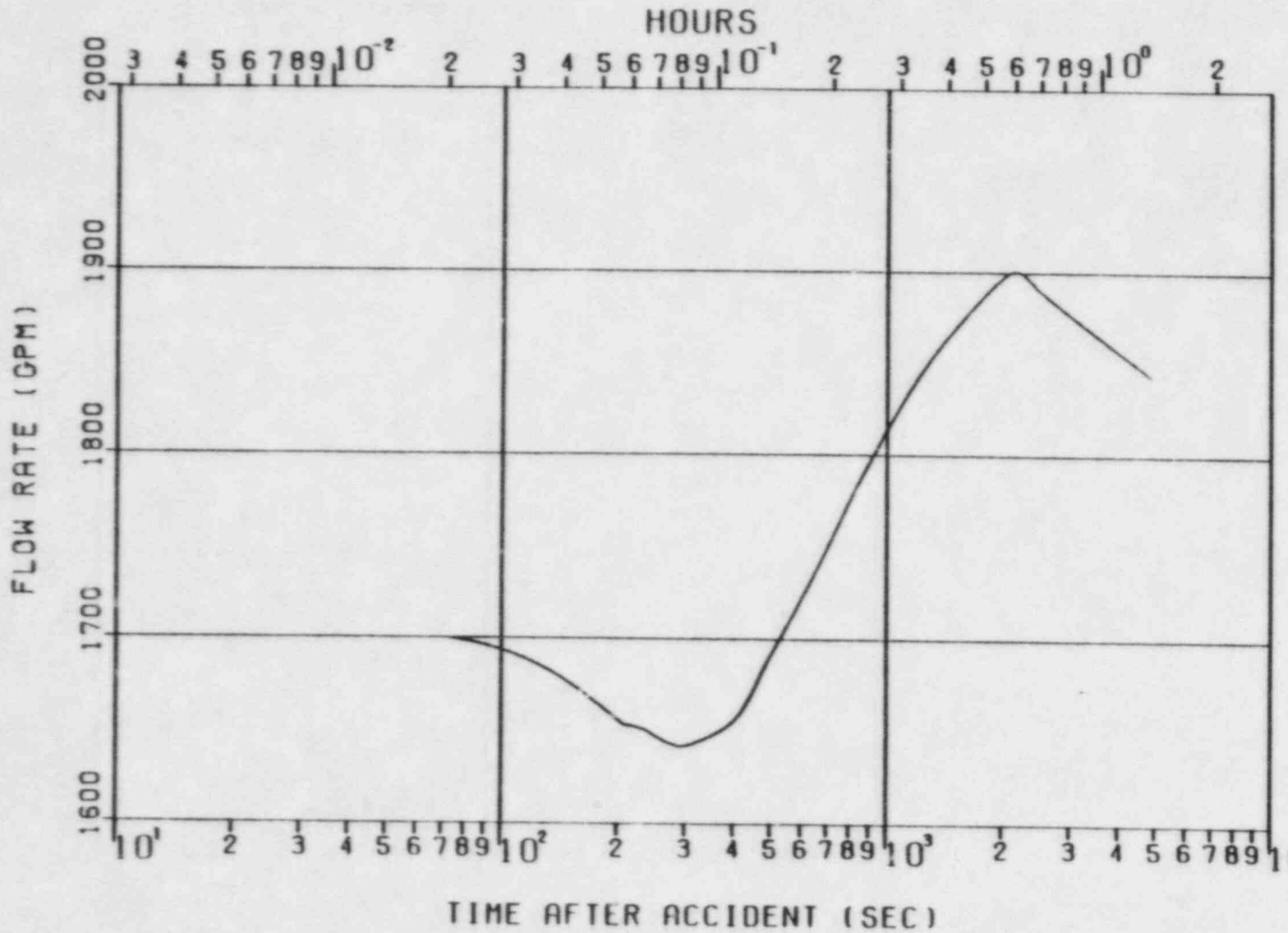
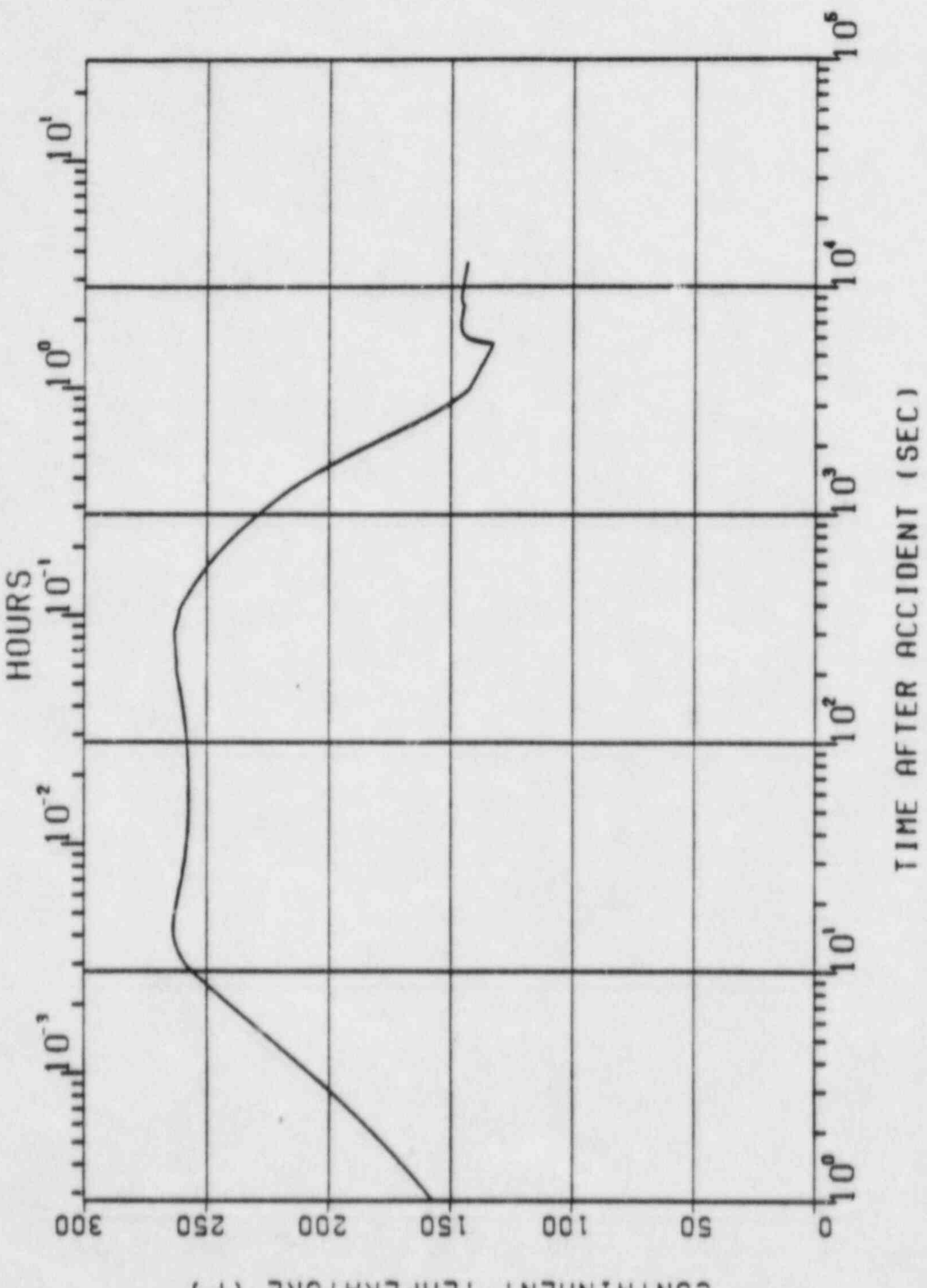


FIGURE
3.2-6

QUENCH SPRAY FLOW RATE
WORST CASE DEPRESSURIZATION
MIN ESF POWER 40F RWST 85F 1X
NORTH ANNA POWER STATION UNITS 1&2



TEMPERATURE TRANSIENT
WORST CASE DEPRESSURIZATION
MIN ESF POWER 40F RWST
NORTH ANNA POWER STATION UNITS 1&2

FIGURE 3.2-7

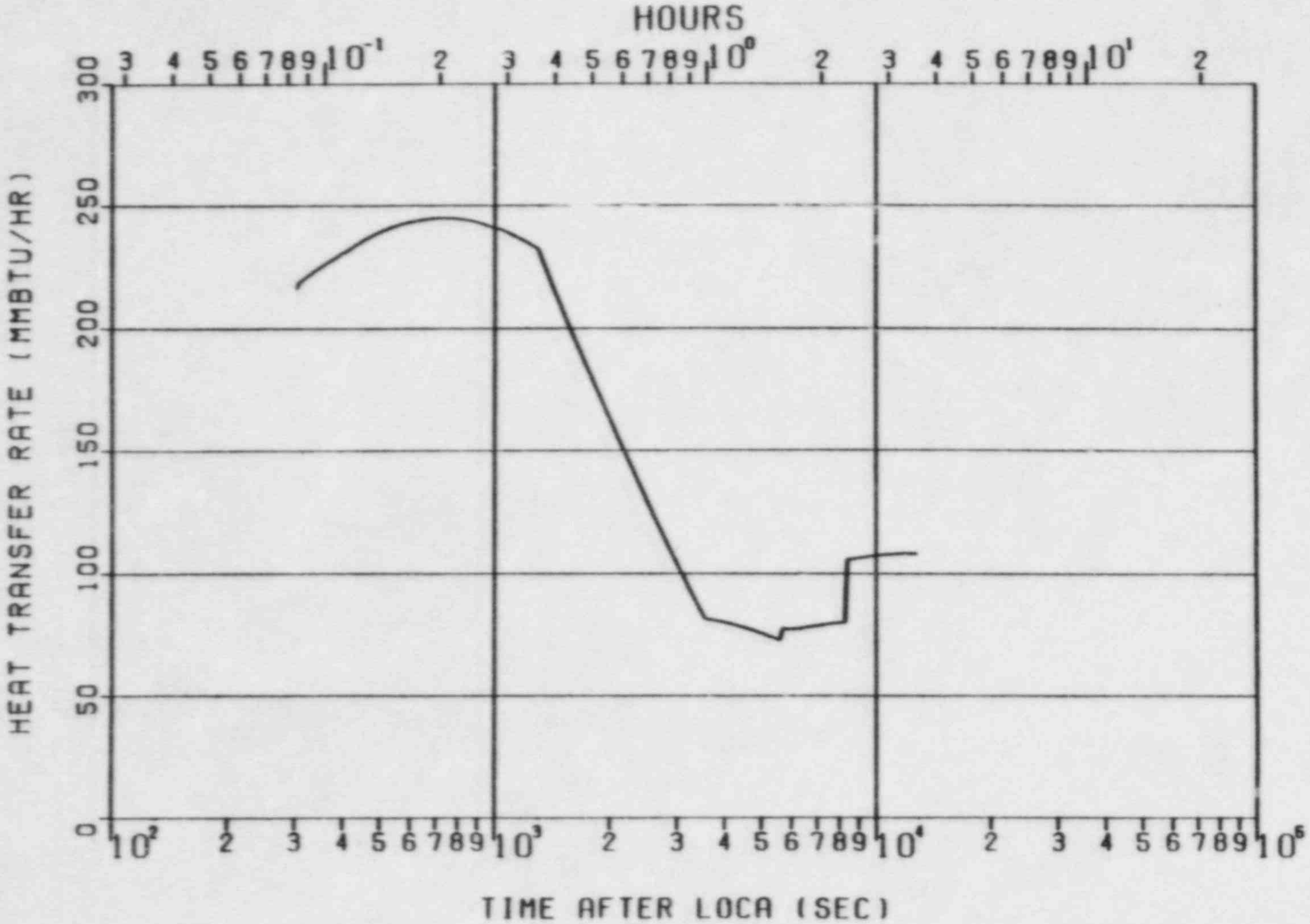
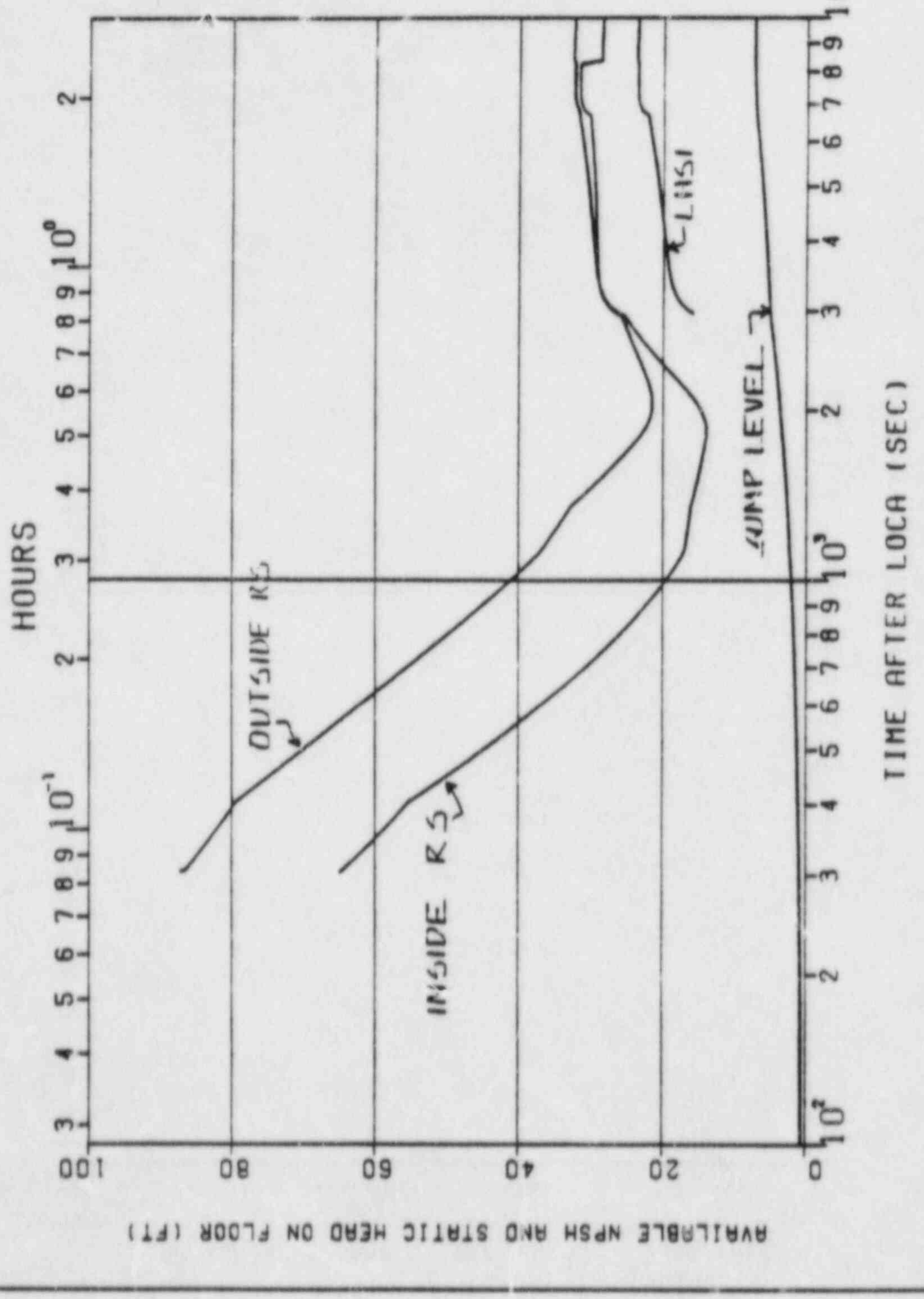


FIGURE
3.2-8

RECIRC SPRAY COOLER DUTY
WORST CASE DEPRESSURIZATION
MIN ESF POWER 40F RWST 85F SW
NORTH ANNA POWER STATION UNITS 1&2



NPSHA TRANSIENTS
WORST CASE LHSI PUMP NPSH
MIN ESF POWER
NORTH ANNA POWER STATION UNITS 1&2

FIGURE 3.2-9

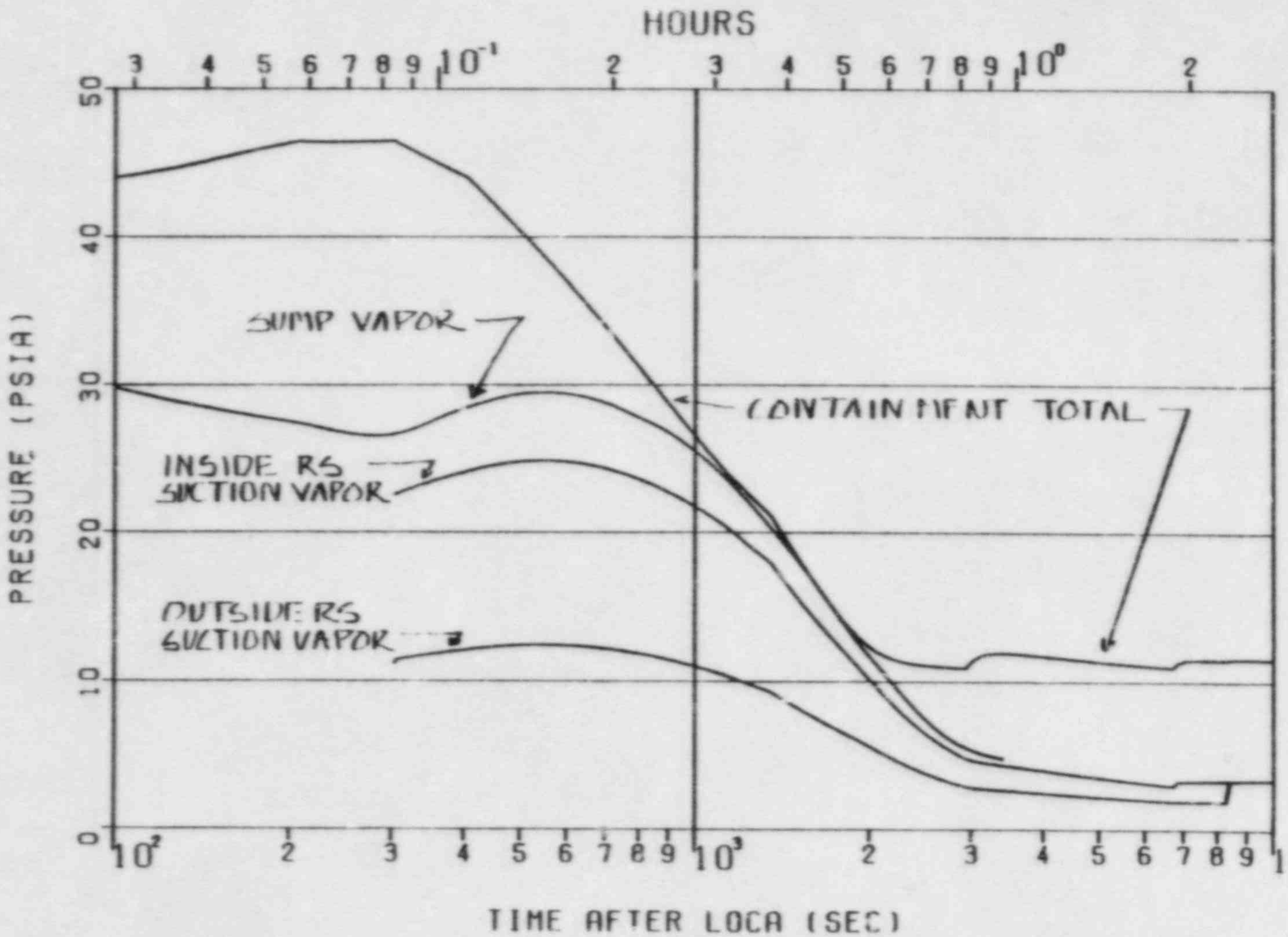


FIGURE 3.2-10

PRESSURE TRANSIENTS
WORST CASE LHSI PUMP NPSH
MIN TSF PSDER
NORTH ANNA POWER STATION UNITS 1&2

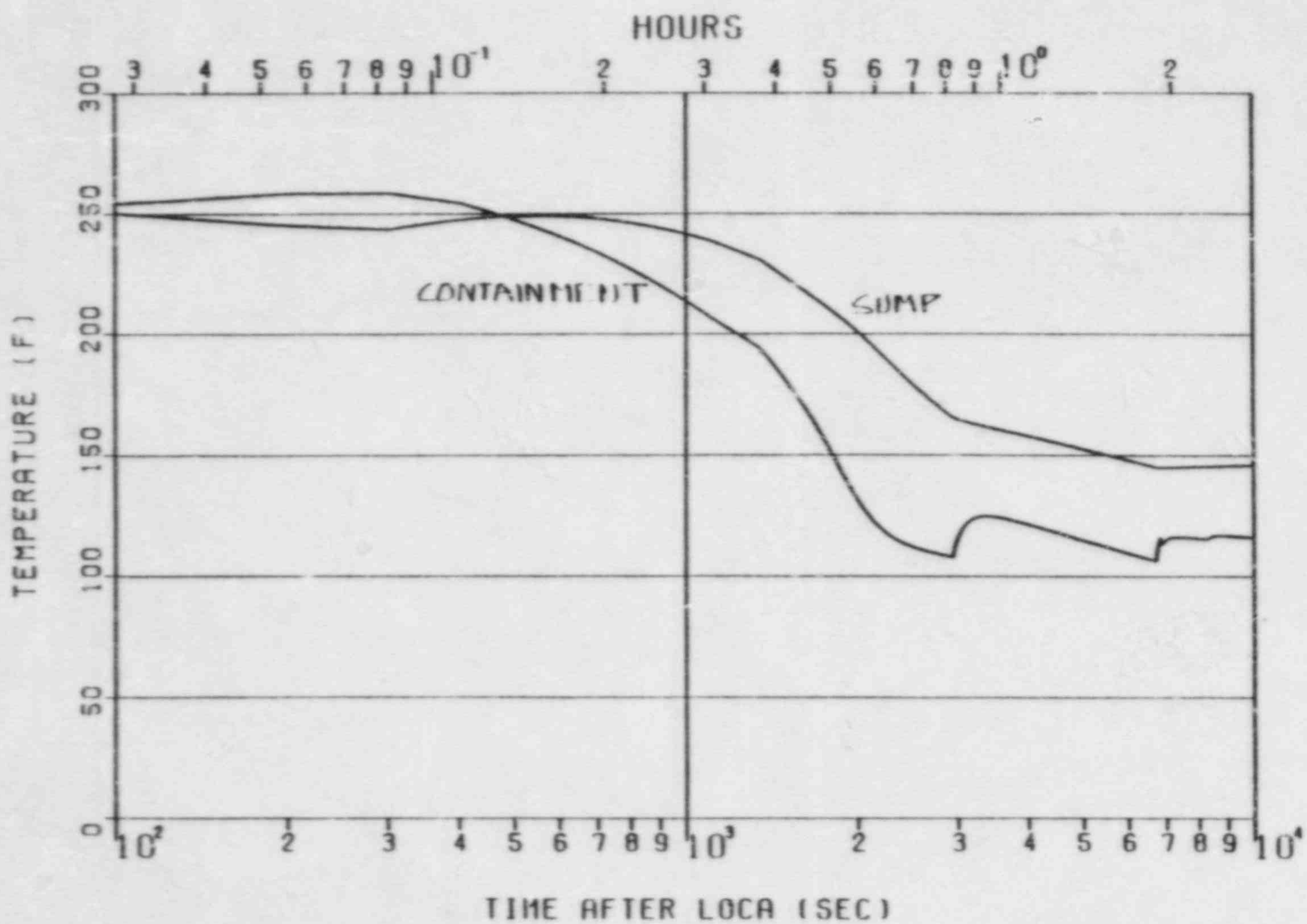
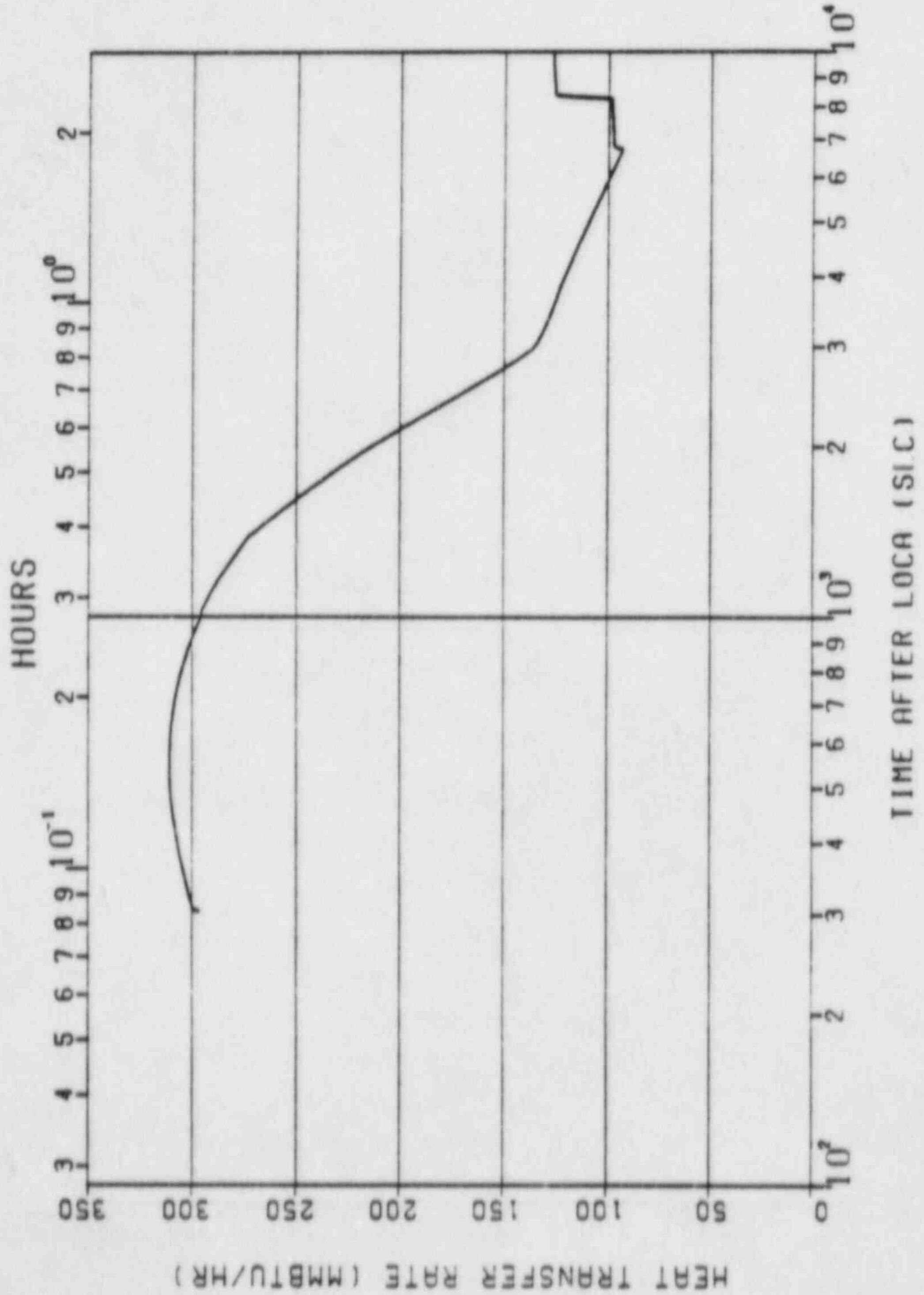


FIGURE 3.2-11

TEMPERATURE TRANSIENTS
WORST CASE LHSI PUMP NPSH
MIN ESF POWER
NORTH ANNA POWER STATION UNITS 1&2



RECIRC SPRAY COOLER DUTY
WORST CASE LHSI PUMP NPSH
MIN ESF POWER
NORTH ANNA POWER STATION UNITS 1&2

FIGURE
3.2-12

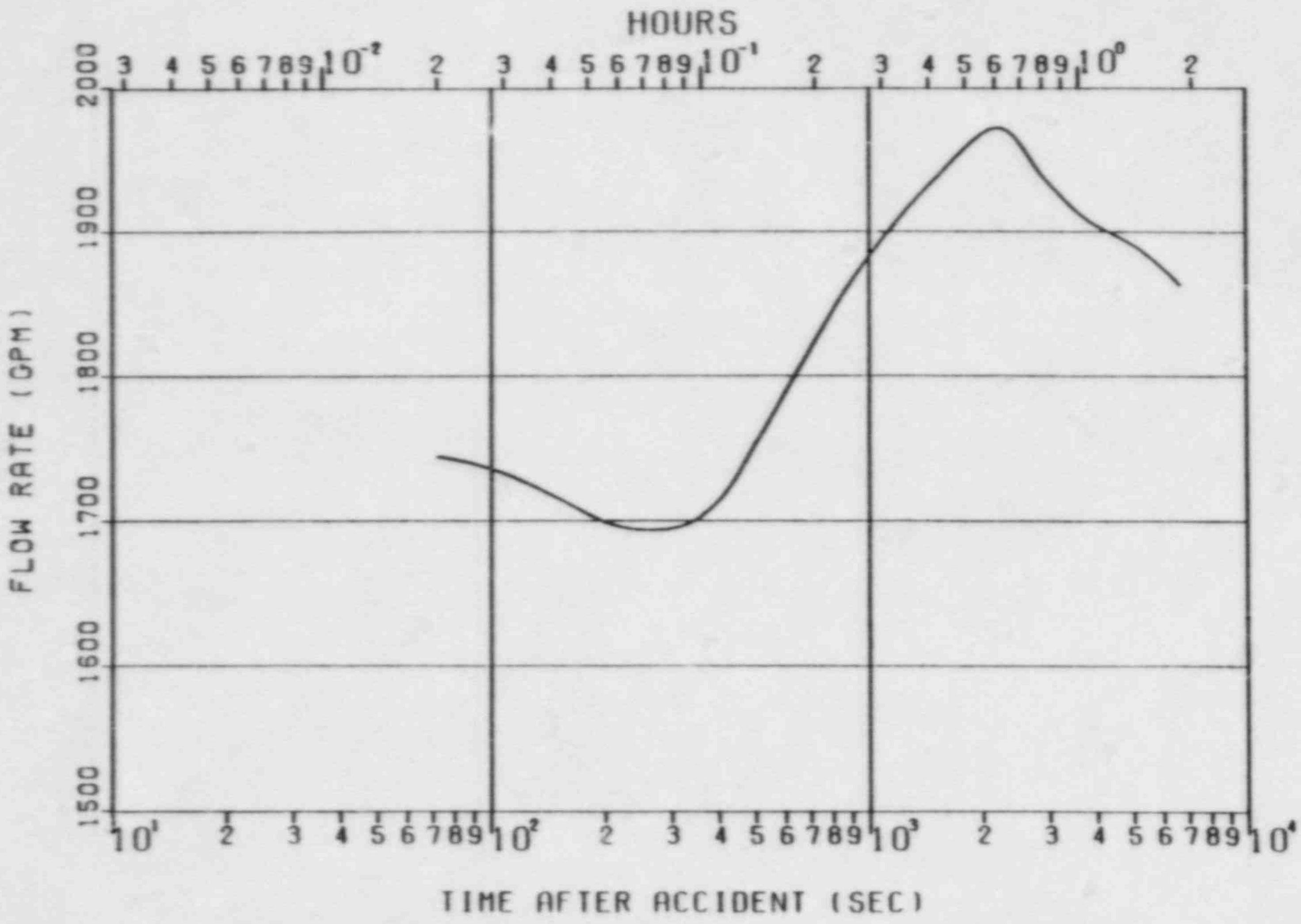


FIGURE 3.2-13

QUENCH SPRAY FLOW RATE
WORST CASE LHSI PUMP NPSH
MIN ESF POWER
NORTH ANNA POWER STATION UNITS 1&2

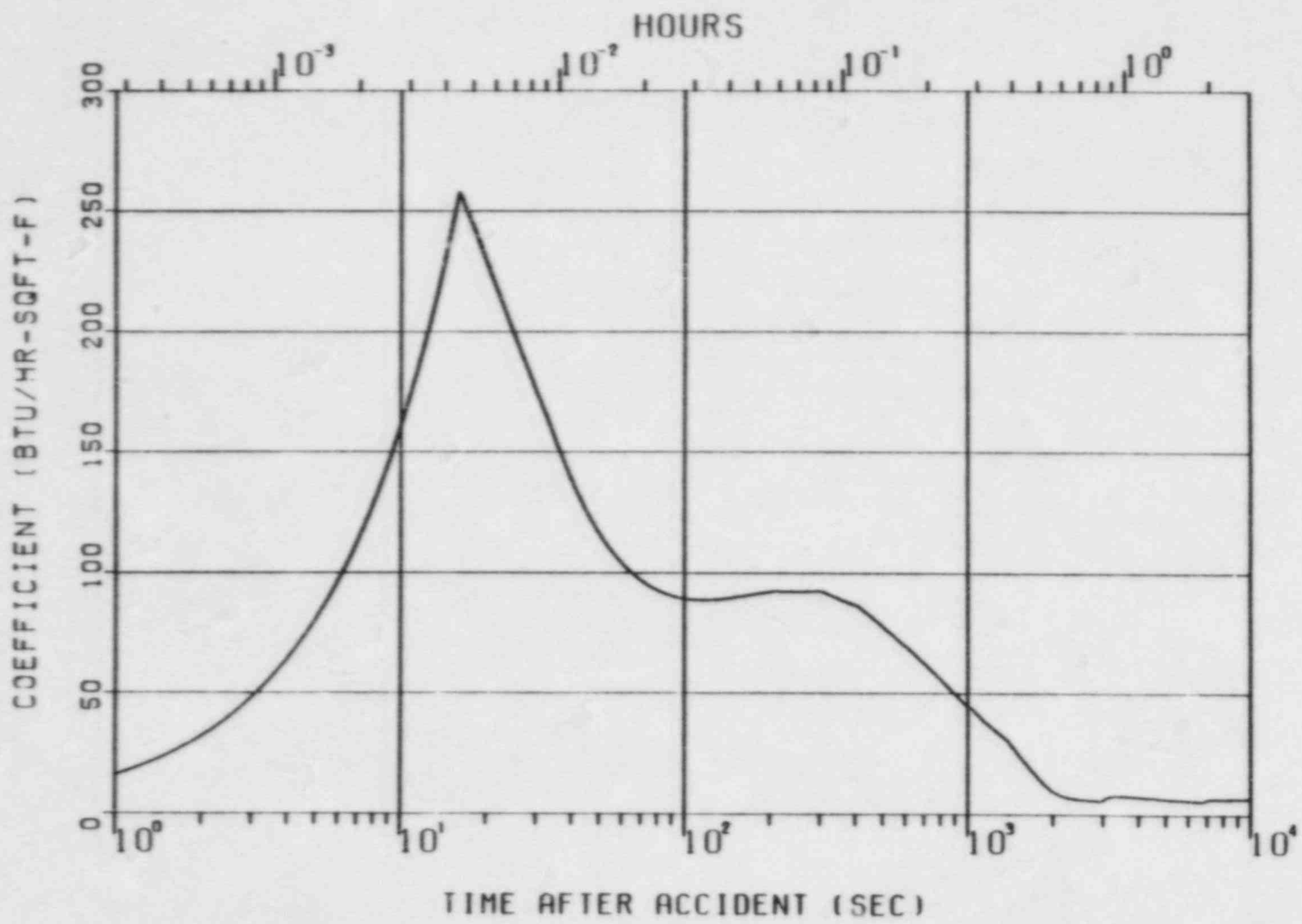


FIGURE
3.2-14

STEAM CONDENSING COEFFICIENT
WORST CASE LHSI PUMP NPSH
MIN ESF POWER
NORTH ANNA POWER STATION UNITS 1&2

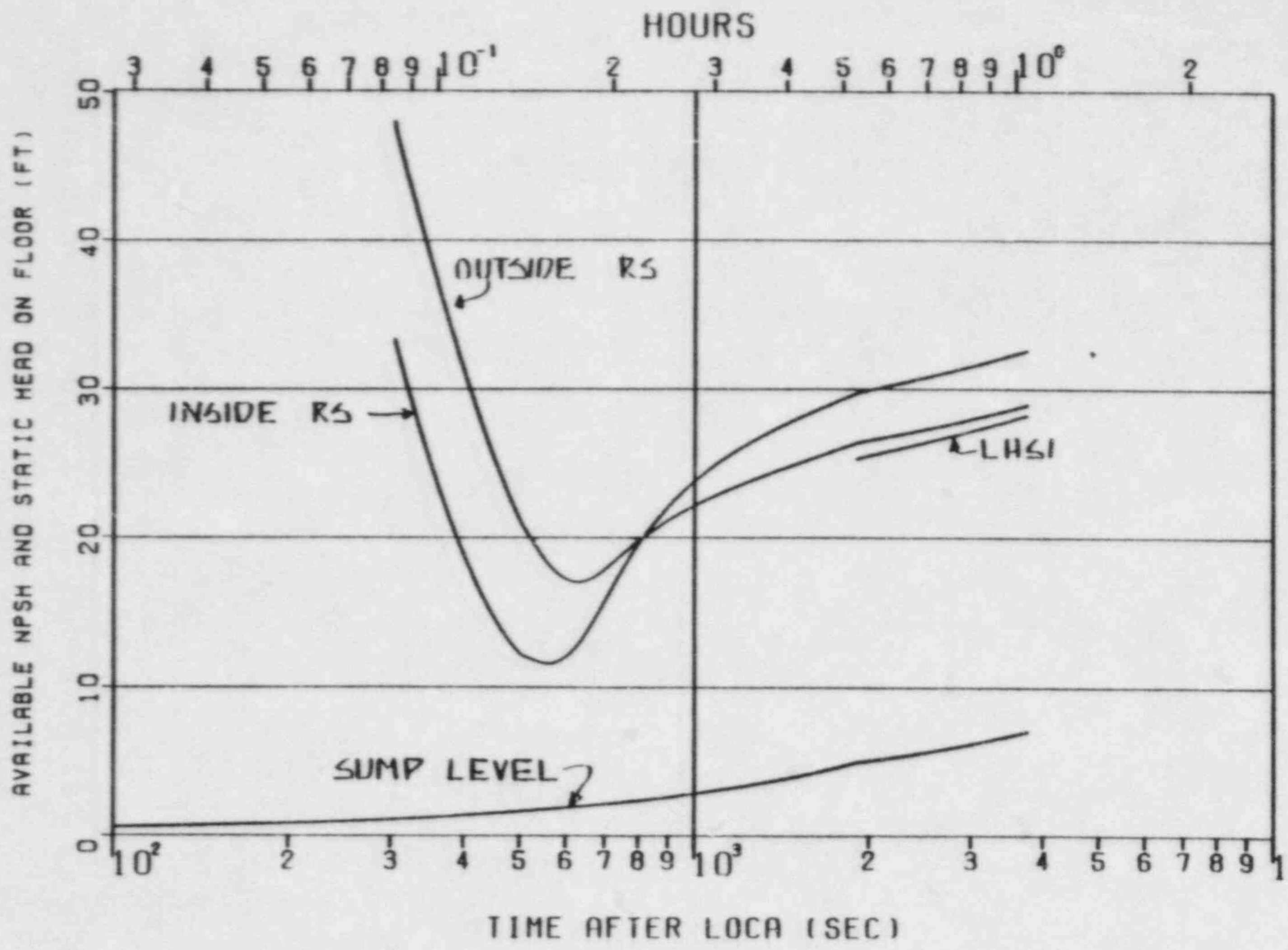


FIGURE
3.2-15

NPSHA TRANSIENTS
WORST CASE RS PUMP NPSH
NORM ESF HLDER
NORTH ANNA POWER STATION UNITS 1&2

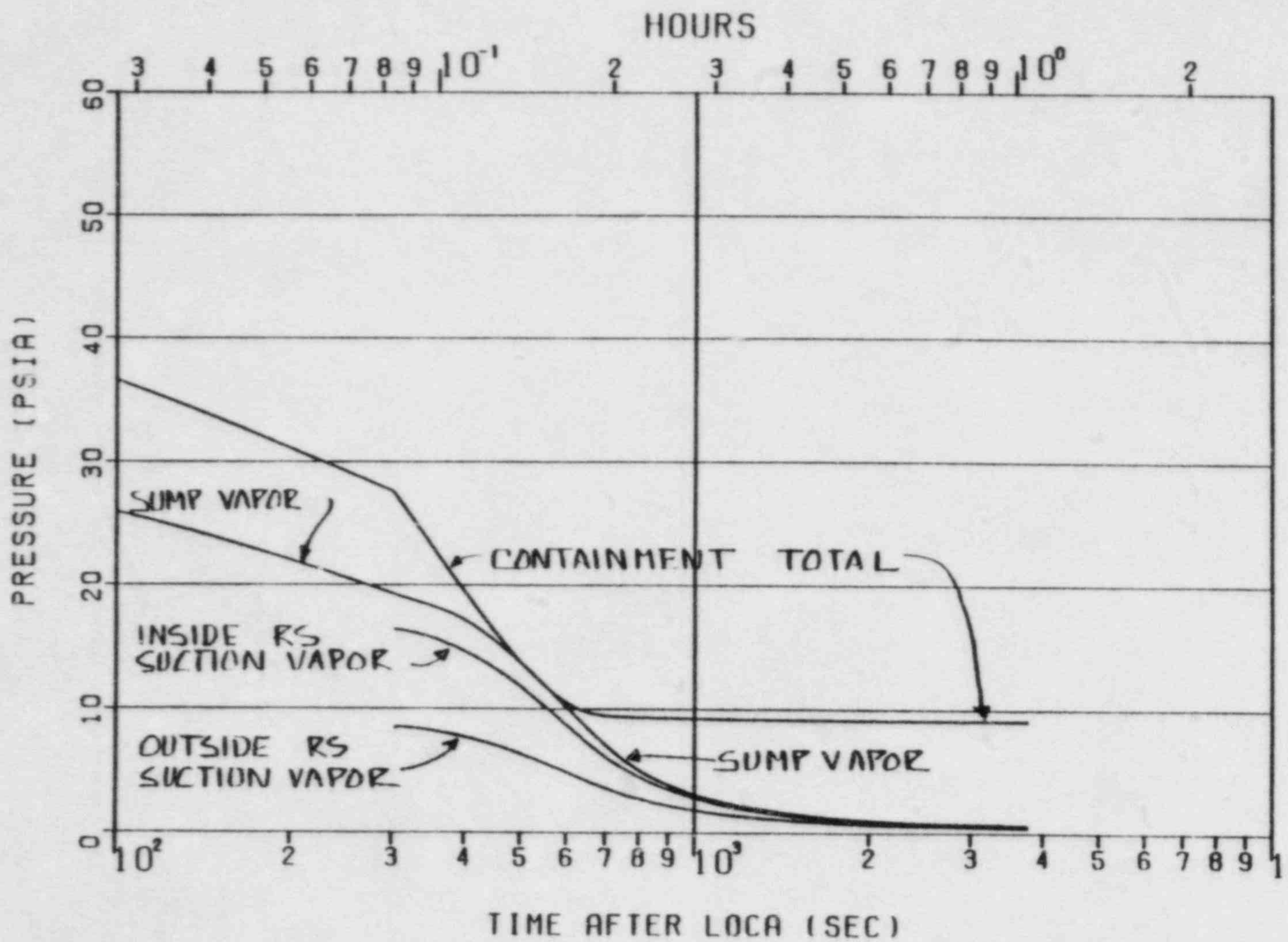


FIGURE 3.2-16

PRESSURE TRANSIENTS
WORST CASE RS PUMP NPSH
NORM ESF MLDER
NORTH ANNA POWER STATION UNITS 1&2

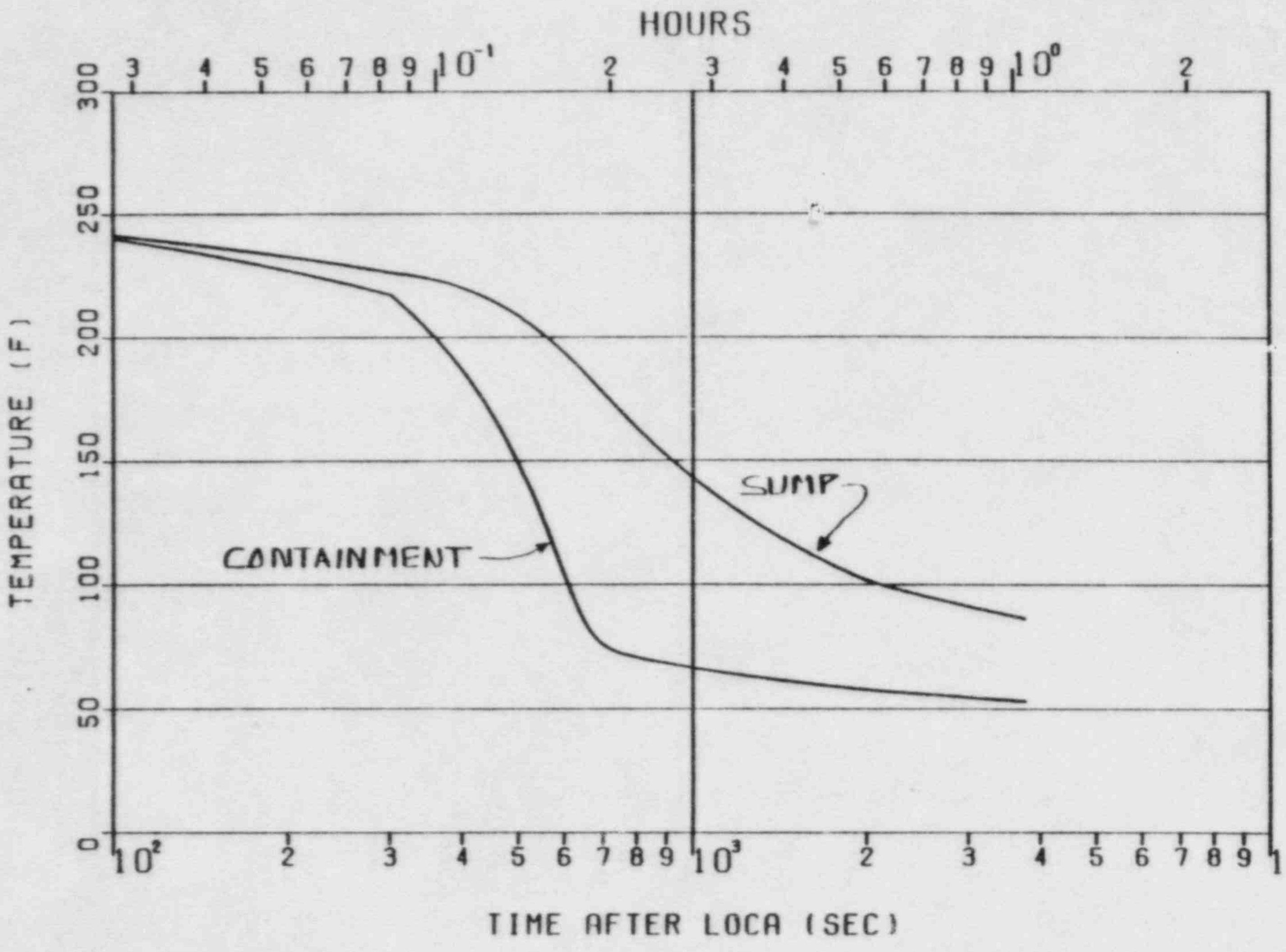
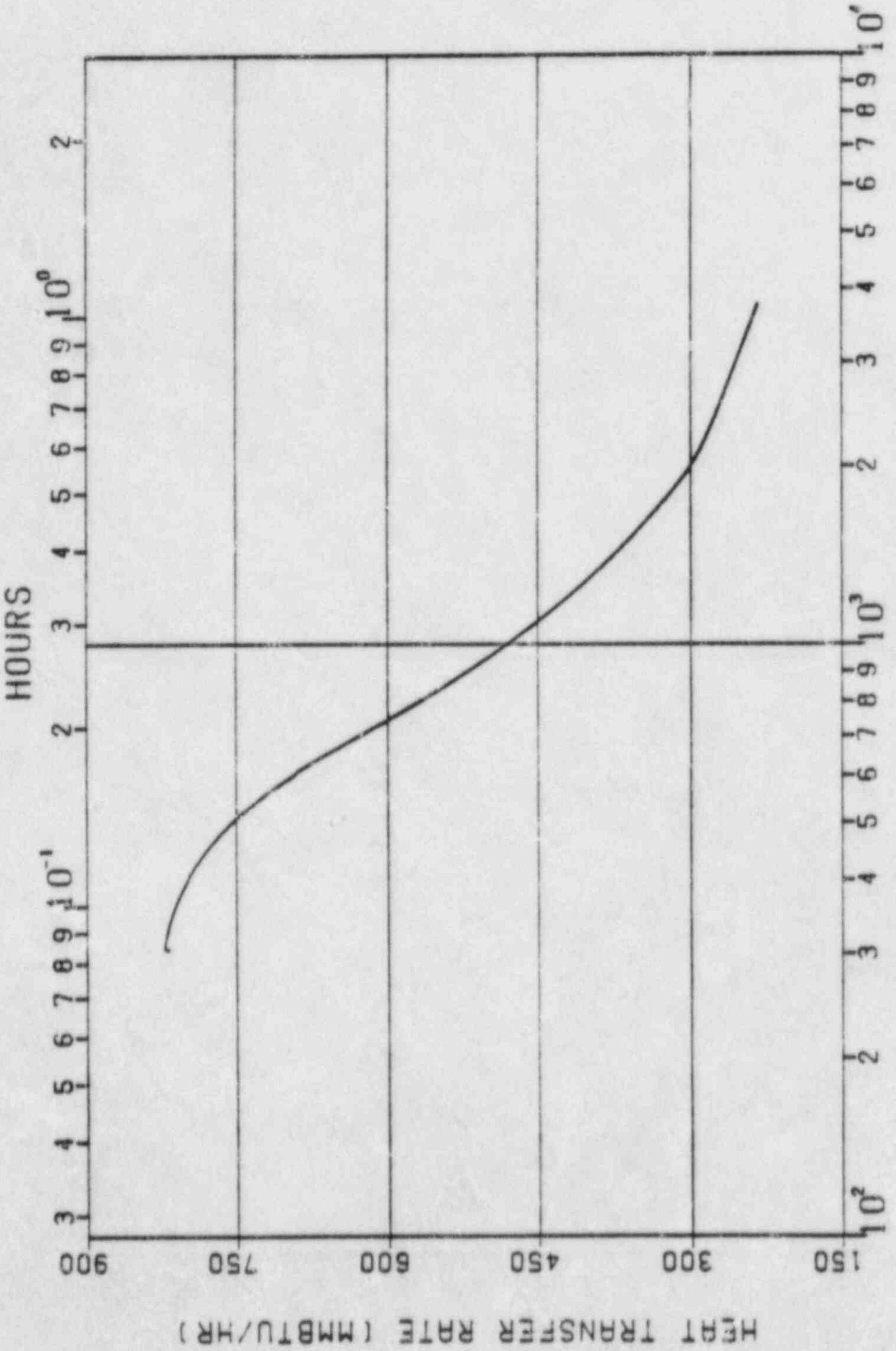


FIGURE
3.2-17

TEMPERATURE TRANSIENTS
WORST CASE RS PUMP NPSH
NORM ESF HLDER
NORTH ANNA POWER STATION UNITS 1&2



RECIRC SPRAY COOLER DUTY
WORST CASE RS PUMP NPSH
NORM ESF MLDER
NORTH ANNA POWER STATION UNITS 1&2

FIGURE 3.2-18

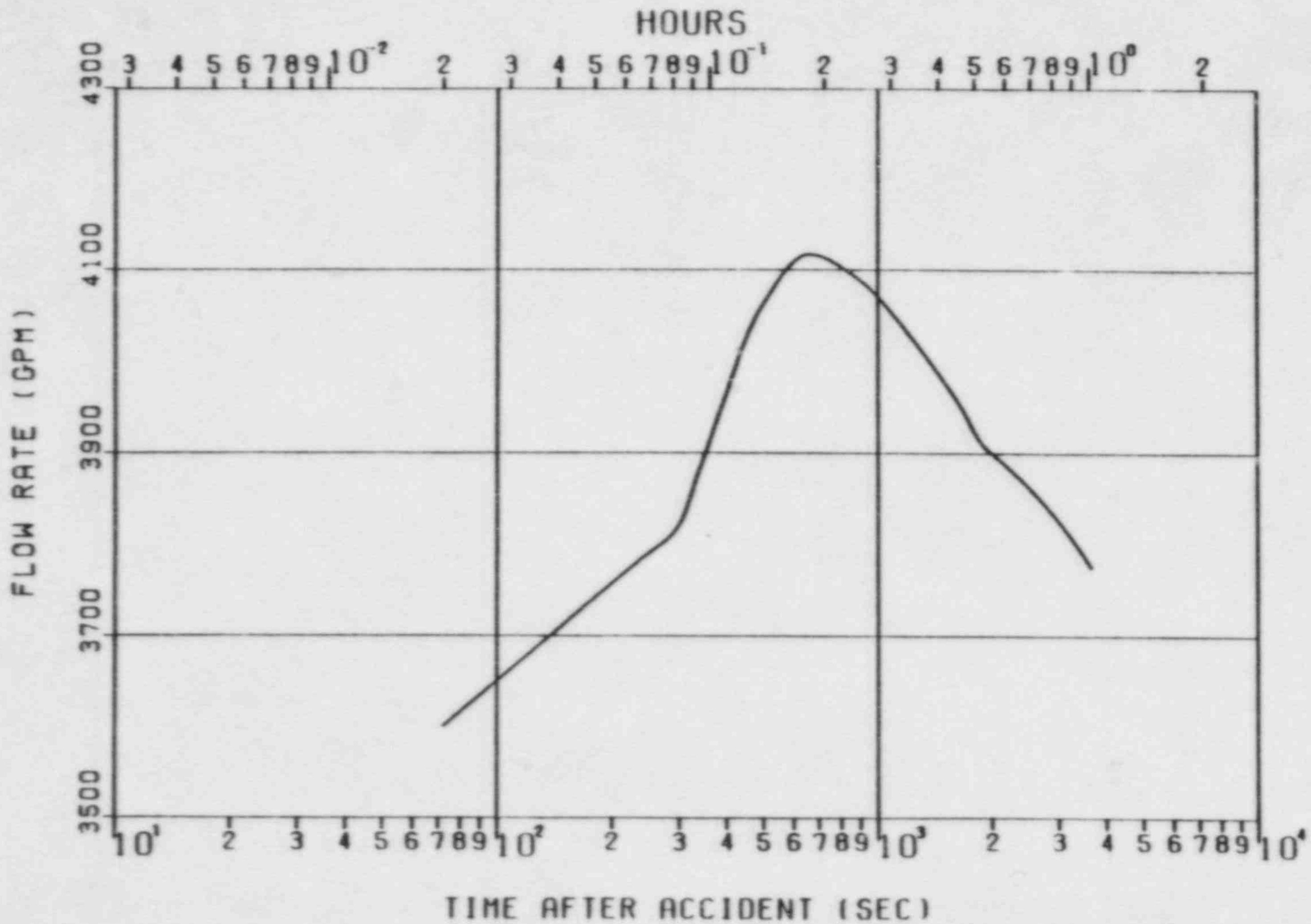


FIGURE
3.2-19

QUENCH SPRAY FLOW RATE
WORST CASE RS PUMP NPSH
WORN ESF MLOER
NORTH ANNA POWER STATION UNITS 1&2

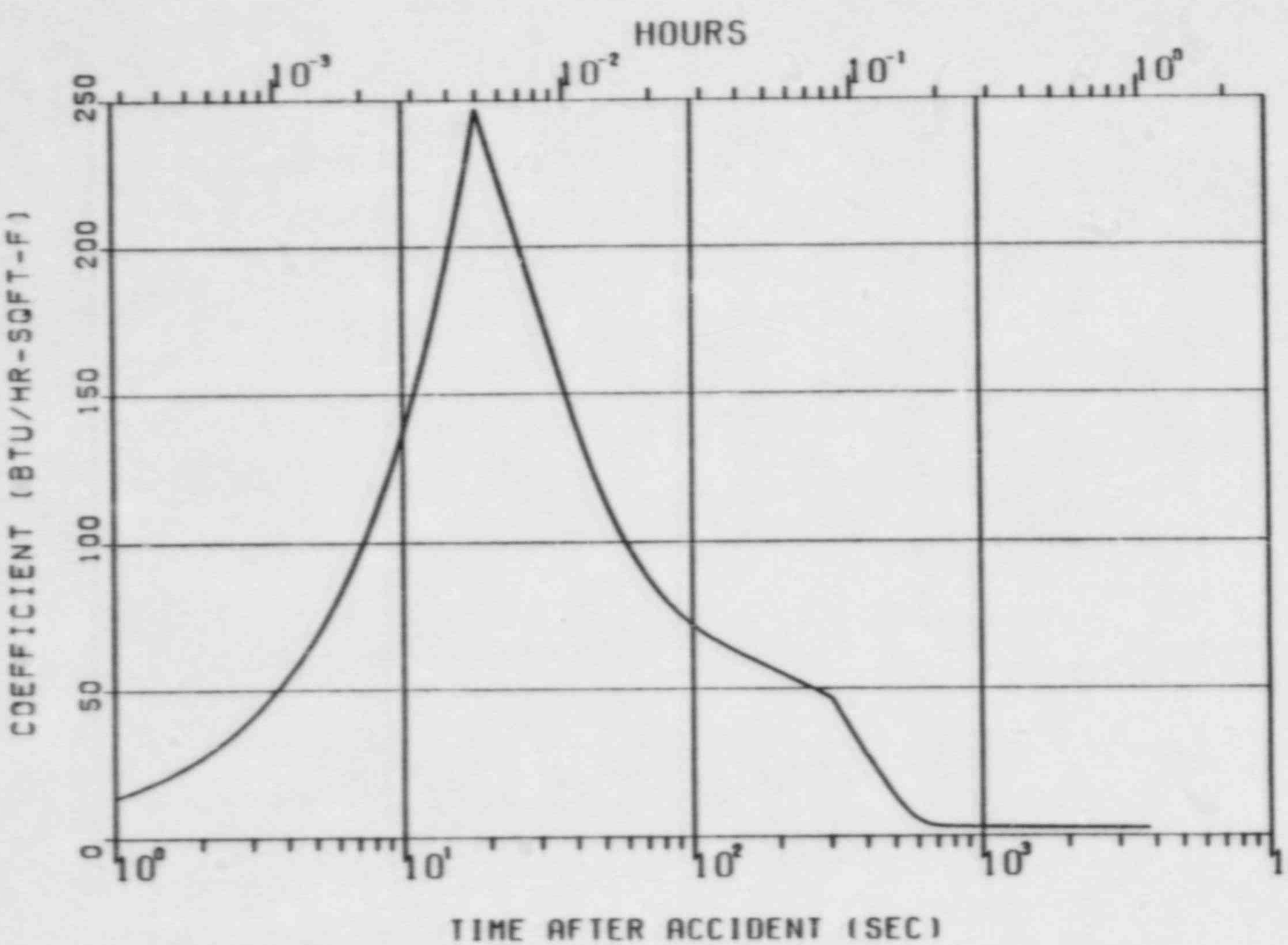


FIGURE
3.2-20

STEAM CONDENSING COEFFICIENT
WORST CASE RS PUMP NPSH
NORTH ANNA POWER STATION UNITS 1&2

4.0 ENVIRONMENTAL QUALIFICATION (EQ)

4.1 General

The EQ limits for North Anna are presented in the Station Environmental Zone Descriptions (EZD) for the following environments: High Energy Line Break (HELB), normal, LOCA and MSLB. A review has been performed to assess the impact on the EZD and associated EQ limits for the core uprating.

4.2 EQ Review

4.2.1 LOCA & MSLB Environments

The limiting equipment qualification conditions inside the containment are based on the Main Steam Line Break, the LOCA and the containment design pressure. The current Main Steam Line Break analysis and containment design pressure are unchanged for the uprate conditions.

The containment LOCA analyses were redone, but did not effect the envelope in the EZD.

The basis of the steam line break analysis is the full guillotine main steam line break at the no-load (hot shutdown) condition. The no-load Reactor Coolant System and Steam Generator temperature and pressure remain unchanged subsequent to the uprate. Although mass and energy releases change at power operating conditions due to decreased (uprated) Steam Generator pressure and temperature, and increased core power, the no-load condition remains the limiting case. Therefore, the Main Steam Line Break post-accident conditions remain as previously analyzed.

As stated in Section 9.0, LOCA & MSLB radiation limits have already been based on a bounding core power of 2900 MW. Therefore, the radiation EQ limits are unaffected by the core uprate.

Chemical spray environments within the containment are based on the volumes and concentrations of boron and NAOH in the reactor coolant system, refueling water storage tank, boron injection tank, accumulators, chemical addition tank, casing cooling tank, etc. These volumes and concentrations remain unchanged for the core uprate confirming that the existing chemical spray EQ limits remain valid.

4.2.2 Normal Environments

Normal environments both inside and outside the containment remain unaffected by the uprate. Technical Specifications for containment pressure and temperature will not change for the uprate. As discussed in Section 9.0, radiation limits both inside and outside the containment have already been based on a bounding core power of 2900 MWt, and temperatures of systems outside the containment have not changed significantly, therefore, the temperature and pressure limits outside the containment will also remain valid.

4.2.3 HELB Environments

Post-accident environments outside containment which are used to generate equipment qualification envelopes are based on the following high energy line breaks.

4.2.3.1 Primary System Branch Line Break

The Letdown Line Break forms part of the basis for the environmental qualification in the charging pump cubicle in the auxiliary building. For the uprate, the letdown line temperature

from the regenerative heat exchanger is bounded by the current analysis.

4.2.3.2 Secondary System Break

The Main Steam Line Break affects the Main Steam Valve House, the Service Water Valve Pit and the Turbine Building. The Main Steam Valve House environmental envelope is based on no-load power condition which is unaffected by the uprate. Equipment qualification temperature and pressure in the Service Water Valve Pit and Turbine Building is limited by the Turbine Building siding pressure-retaining capability. Any changes to break effluent due to the uprate has no effect on this pressure or temperature, and therefore, on equipment qualification.

4.2.3.3 Auxiliary Steam Line Break

This break affects the Auxiliary Building and the Service Water Valve Pit. The releases are based on the Auxiliary Steam Line relief valve pressure setting which is unchanged by the uprate. Additionally, the Auxiliary Steam System pressure is controlled by a pressure reduction valve tied into the Main Steam header. The decreased Main Steam operating pressure will not affect the operation of this valve, and therefore, the Auxiliary Steam System pressure will remain unchanged.

4.2.3.4 Steam Generator Blowdown Line Break

This affects the Pipe Tunnel and the Auxiliary Building. The releases are based on the bounding condition of no-load steam generator pressure which is unchanged by the uprate.

4.3 EQ Conclusions

The EQ limits as presented in the station EZD remain bounding for the core uprating.

5.0 TRANSIENT ANALYSES

Transient analyses have been performed for the uprated condition and have verified the following UFSAR performance objectives:

1) On 50 percent load rejection, there will be no reactor trip or atmospheric dump through the main steam safety valves.

2) On turbine trip with a reactor trip, there will be no atmospheric dump through the main steam safety valves.

These analyses were completed using a NSSS power of 2968 MWt.

6.0 BOP SYSTEMS REVIEW

6.1 General

The objectives of the review of Balance of Plant (BOP) systems were to determine the effect of the core uprating on system normal and accident operations. Also, compliance with the design basis and performance criteria were reviewed.

The BOP system interfaces were reviewed to determine the effect the uprated conditions have on system operation, flow, pressure, temperature, and heat load. The existing system component capacities were used to determine the effect on the system operation, pressure, and temperature.

The following systems have been reviewed:

1. Main Steam System
2. Auxiliary Feedwater System
3. Extraction Steam System, Feedwater Heaters
4. Condensate and Feedwater Systems
5. Low Pressure and High Pressure Heater Drain System
6. Steam Generator Blowdown System
7. Condensate Polishing System
8. Component Cooling System
9. Spent Fuel Pool Cooling System
10. Containment Air Recirculation System
11. Control Systems and Instrumentation
12. Electrical Systems
13. Service Water System

14. Radioactive Waste Systems
15. Boron Recovery System
16. Circulating Water System
17. Bearing Cooling System
18. Quench Spray Subsystem
19. Recirculation Spray Subsystem
20. Auxiliary Steam System

6.2 Results of BOP Systems Review

6.2.1 Main Steam System

The Main Steam System piping is designed for 560°F and 1100 psia. These conditions bound the uprated Main Steam conditions of 547°F/ 1020 psia at no-load and 530°F/880 psia at 100 percent power.

The Main Steam Safety Valves (MSSV) were designed for an NSSS rating of 2910 MWt and the capability is in accordance with applicable codes.

The MSSV's have a total relieving capacity of 12,826,260 lb/hr. Based on Heat Balance Figure 6.2-3, the total Main Steam flow rate will be 12,766,627 lb/hr at 2905 MWt.

The Main Steam Trip and Non-Return Valves were evaluated for rapid closure impact loads applied subsequent to Main Steam System Pipe rupture at uprated conditions. The results of computer runs that modeled the transient's effect on the valves showed that they would close as required during a Main Steam Pipe break without jeopardizing the integrity of the pressure boundary.

6.2.2 Auxiliary Feedwater System

The Auxiliary Feedwater pumps are designed to deliver rated flow to the Steam Generator at a static discharge head equivalent to the set pressure of the lowest set Main Steam Safety Valve, 1085 psig. Because this set point will not change at the uprated conditions, it is concluded that the resistance parameters associated with the Auxiliary Feedwater System are unchanged. Therefore, since the flow requirements are unchanged at the uprated conditions, the system is considered adequate.

Westinghouse supplied the Auxiliary Feedwater flow requirements (based on 2910 MWt core power plus 2 percent) for North Anna as follows:

	Transient	AFWS Actuation Signal Time Delay For AFWS	Flow Rate
1)	Loss of Feedwater (Station Blackout)	60 Seconds	680 gpm total to 2 of 3 S/G's.
2)	Main Feedline Break	60 Seconds	340 gpm to one intact S/G. 680 gpm to 2 intact S/G after 30 minutes.

The conclusion is that the existing Auxiliary Feedwater System is adequate at the uprated conditions as the flow requirements and system resistance parameters are unchanged as a result of the uprating.

6.2.3 Extraction Steam System, Feedwater Heaters and Flash Evaporator

A heat balance was developed that bounds the proposed Core Uprate conditions. From the bounding Heat Balance (Figure 6.2-2), the values were taken for the temperatures and pressures of the Extraction Steam lines.

It was observed that the uprated operating temperatures of the first, second, and fifth point extraction lines and pressure of the fifth point extraction line on both units were above the design values. The third point extraction temperature is above design for the Core Uprate (347°F), but was previously evaluated at a bounding temperature (356°F) for operation at the existing plants parameters. The maximum thermal stress in these extraction lines were reviewed and found to be below the code allowable stress, confirming that all Extraction Steam lines are adequate to operate at the uprated conditions.

It has also been verified that the uprated extraction pressures are within the shell side design pressures for all of the Feedwater Heaters and the Flash Evaporator. It was conservatively assumed that the pressure at the turbine extraction nozzle was equivalent to the operating pressure at the Feedwater Heater shell without considering pressure drop in the extraction lines.

Refer to Table 6.2-1 for a summary of design conditions and the proposed operating conditions corresponding to the bounding Core Uprate conditions for the Units 1 and 2 Extraction Steam lines. Table 6.2.-2 lists a comparison of the Feedwater Heater shell design pressures and the uprated operating pressures. In both tables, absolute pressures were taken from the heat balance and converted to gage pressures.

6.2.4 Condensate and Feedwater Systems

To determine if the Condensate and Feedwater System piping would be adequate at the uprated conditions, a comparison was made between the current North Anna heat balance (Figure 6.2-1) and the bounding uprated heat balance (Figure 6.2-2). It was shown that the entire Condensate/Feedwater piping train uprated temperature did not increase significantly from the current conditions.

Discharge pressure at the Condensate pump discharge decreases from 486.58 psia to 461.36 psia. Discharge pressure at the Feedwater pump discharge decreased from 1180.3 psia to 1109.93 psia. The decrease in pressure is due to pump/head characterstic at increased flow rates.

It has been shown that there is an insignificant change in Condensate and Feedwater System temperature and pressure parameters due to the uprating and these small changes are within the capability of the current system.

The total Condensate and Feedwater System resistance was evaluated for the new flow rates and Steam Generator pressure pertaining to the Core Uprate. It has been determined from reviewing the existing Condensate/Feedwater System calculation that the existing pumps have sufficient head to overcome the total system resistance with two Condensate and two Steam Generator Feed Pumps in operation at the uprated condition.

The NPSHA at the suction of the Condensate and Feedwater pumps was evaluated at the uprated conditions. It was determined that sufficient NPSHA exists to allow acceptable operation at the uprated flow.

The main feedwater regulating valves have been reviewed for the uprated conditions and it has been determined that the Unit 1 valves are acceptable for the core uprating. A valve trim change is required for the Unit 2 valves to provide operational flexibility at the uprated condition.

6.2.5 Low Pressure and High Pressure Heater Drain System

As with the Condensate and Feedwater systems, the uprated temperature and pressure conditions associated with the Low and High Pressure Heater Drain Systems did not change significantly from the current conditions.

The Low and High Pressure Heater Drain Pumps have been shown to be adequate at the uprated flow conditions. Uprated NPSHA has been evaluated at the pump suctions and has been determined to be acceptable for pump operation.

6.2.6 Steam Generator Blowdown System

A review of the Steam Generator Blowdown System has indicated that the core uprating will not affect the present safety aspects or operability of the system. Under Core Uprate conditions, the steam generator pressure at both no-load and 100 percent power remains equivalent to the current operation pressure. Therefore, the uprate does not affect any piping design pressure limitations.

The design of the excess flow high energy line break isolation valves was for an inlet pressure of 1100 psig which is higher than the lowest Main Steam Safety Valve setpoints and is therefore acceptable with regard to the uprate.

All remaining portions of the Steam Generator Blowdown System including flow control valves, safety valves, tanks and pressure control valves were reviewed for any expected temperature and pressure changes and are unaffected by the uprate.

Additionally, the system is protected from the consequences of excess blowdown flow rates (greater than 100 gpm) and blowdown tank high pressure (greater than 125 psig) by instrumentation that terminates blowdown as required under these conditions. These setpoints will not be changed as part of the Core Uprate program.

6.2.7 Condensate Polishing System

The design conditions for the Condensate Polishing System were evaluated to determine the ability of the polishers to operate at the uprated conditions. The proposed temperature and pressure of the condensate at the polisher inlet (445 psig and 104°F) remain below the polishing system design conditions of 700 psig and 180°F.

From the bounding heat balance (Figure 6.2-2), the condensate flow rate is given as 8,644,000 lb/hr or 2.90 gpm per sq ft of Condensate Polishing System filtering surface area. This flow rate is less than the vendors guaranteed filtering capacity of 4.0 gpm per sq ft of surface area at design pressure drop. Therefore, it has been determined that the condensate polishing system is adequate to operate at the Core Uprate conditions. Although, at increased flow rates, filter differential pressure will increase at a faster rate and the backwash frequency will be slightly higher.

6.2.8 Component Cooling System

The decreased RCS cold leg temperature decreases the heat loadings on the Component Cooling Water System due to the Chemical and Volume Control System heat exchangers which are designed to remove heat from the letdown flow stream. The letdown line is tied into one RCS cold leg.

The Westinghouse supplied heat loads to the Non-Regenerative, Excess Letdown, and Seal Water Return heat exchangers at the current normal operating condition and associated Stone & Webster Engineering Corporation Design values are shown in Table 6.2-3 as Design Heat Loads. Because the heat loads resulting from the existing plant parameters (555.5°F cold leg temperature) are greater than those as a result of the Core Uprate program (552.3°F cold leg temperature), the current heat load is bounding for the the Core Uprating.

Table 6.2-1

Design Conditions, Extraction Steam

Unit 1

Extraction Line	*Design Conditions T(F)	*Design Conditions P(PSIG)	Core Uprate Conditions T(F)	Core Uprate Conditions P(PSIG)
1st point	450	460	455	428
2nd point	395	260	402	237
3rd point	324	110	347	80
4th point	293	75	292	44
5th point	230	6	233	7
6th point	188	−5.9	187	−8

Unit 2

Extraction Line	*Design Conditions T(F)	*Design Conditions P(PSIG)	Core Uprate Conditions T(F)	Core Uprate Conditions P(PSIG)
1st point	450	460	455	428
2nd point	395	260	402	237
3rd point	324	110	347	80
4th point	293	75	292	44
5th point	230	6	233	7
6th point	188	−5.9	187	−8

*Maximum Operating Conditions used for pipe stress analysis.

Table 6.2-2

Design Conditions, Feedwater Heaters

Units 1 and 2

Heater	Shell Design Pressure (Psig)	Core Uprated System Pressure (Psig)
1st point	475	428
2nd point	250	237
3rd point	100	80
4th point	50	44
5th point	50	7
6th point	50	-8
Flash Evaporator	15	-8

Table 6.2-3

Component Cooling System Heat Loads

Heat Exchanger	Current Heat Load* (BTU/HR)	Design Heat Load (BTU/HR)
Non-Regenerative	16.1×10^6	15.72×10^6
Excess Letdown	3.26×10^6	3.23×10^6
Seal Water Return	1.02×10^6	1.45×10^6
Total	20.38×10^6	20.40×10^6

*Based on a bounding condition associated with the current plant parameters.

6.2.9 Spent Fuel Pool Cooling System

There is no impact on the Spent Fuel Pit Heat Loads as a result of the uprating as core power and associated decay levels were based on a core power of 2910 MWt.

6.2.10 Containment Air Recirculation System

The heat input into the containment will not increase because of the power uprating and the heat loads for the existing plant conditions are bounding. Since Technical Specifications limit the ambient temperature inside the containment to 105°F, no changes in the operating procedures are necessary.

6.2.11 Control Systems and Instrumentation

The bounding Core Uprate heat balance diagram (Figure 6.2-2) was reviewed to determine the effect of the uprate on Balance of Plant (BOP) instrumentation and control valves in the Feedwater, Condensate, Main Steam, and Heater Drain systems. It was determined that all equipment has sufficient margin to be adequate for use at the uprated conditions. No setpoint changes are required as a result of this uprating other than those already specified by Westinghouse.

6.2.12 Electrical Systems

An uprated generator output of 1,007,726 KW from the bounding Heat Balance (Figure 6.2-2) at .9 PF yields 29,363 amps to the Isophase Bus Duct. The existing bus duct is rated at 30,500 amps continuous and is adequate for the uprated conditions.

A review was performed to evaluate the increased loading on the Feedwater, Condensate, and Heater Drain Pump motors resulting from increases in fluid flow rate. As a result of this review, it was determined that the motors and their associated power feeds are adequate for the uprated conditions.

Because the increased loadings on the above-mentioned pumps does not exceed the rated horsepower for the respective motors, there is no impact on the Station Service Transformers, Normal Buses, or connecting cables due to the uprate.

The Emergency Buses are not affected because the uprating causes none of the emergency loads to increase.

The GDC-17 Confirmatory Analysis Studies have been evaluated with respect to the uprating and it has been determined that the GDC-17 confirmatory analyses bound the core uprating conditions.

6.2.13 Service Water System

The service water flow rate and design heat loads of each component serviced is not changed due to the core uprate, therefore, the system design capacity and design pressure and temperature remain unaffected for the core uprate. Existing system para-meters were used in the accident analysis.

6.2.14 Radioactive Waste Systems

The liquid, solid, and gaseous waste systems have a design based on 2900 MWt. The proposed core uprate conditions are bounded by the design of the current system. The design of the systems are based on source terms (reference UFSAR Section 11.1) which Vepco has determined to be applicable for the core uprating up to a batch average fuel burn-up of 45,000 MWD/MTU.

6.2.15 Boron Recovery Systems

The flow rate, temperature, and pressure of the Boron Recovery System are not affected by the core uprating and are bounded by the current design.

6.2.16 Circulating Water System

The heat balance performed for the core uprate conditions utilized existing flow rates and inlet temperatures. The outlet temperature increased slightly, but is within the current system design.

6.2.17 Bearing Cooling System

Operating heat loads at the turbine may increase due to the core uprate, however, the bearing cooling water flow, temperatures, and pressure are based on the turbine generator design which is bounding for the core uprating. The other bearing cooling water requirements are unaffected by the core uprate.

6.2.18 Quench Spray Subsystem

The quench spray subsystem flow rates and fluid temperature are unaffected by the core uprating. Since the containment analysis reported herein gives acceptable results, the current quench spray subsystem design is adequate.

6.2.19 Recirculation Spray Subsystem

Since the containment analyses reported herein give acceptable results, the current recirculation spray system design is adequate.

6.2.20 Auxiliary Steam System

The Auxiliary Steam Pressure Control Valve (PCV), PCV-AS-105, has been reviewed for the uprated pressure conditions. The valve is designed for a maximum inlet pressure of 1200 psig. This design pressure is higher than the maximum possible upstream pressure of 1020 psia at no-load conditions. It is, therefore, concluded that the Auxiliary Steam PCV is adequate for the Core Uprate conditions and will reduce uprated Main Steam pressure to 150 psig as originally designed.

6.2.21 Heat Balance Calculations

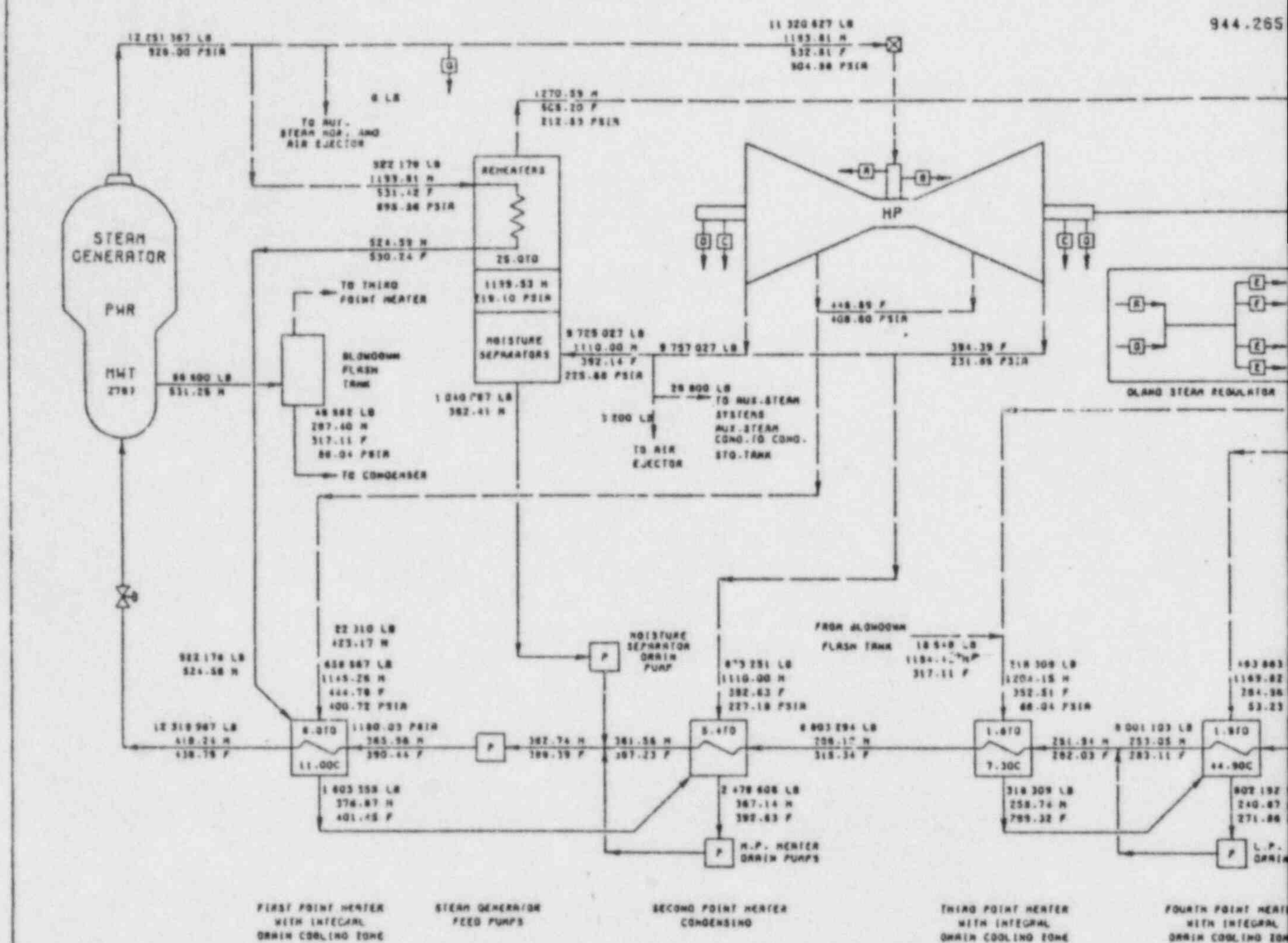
Heat balance diagram Figure 6.2-2 was developed and represents the Core Uprate program at 2968 MWt (2898 MWt core power x 1.02 plus 12 MWt pump heat) and 880 psia steam pressure. This heat balance was developed for analytical use.

Heat balance Figure 6.2-3 was also developed and represents the Core Uprate program at 2905 MWt (2893 MWt core power plus 12 MWt pump heat) and 850 psia steam pressure. This heat balance reflects the normal operating condition expected at the uprated condition.

6.3 BOP Systems Review Conclusions

In conclusion, all BOP systems reviewed are adequate for the uprated conditions.

944.265



CIRCULATING WATER TEMPERATURE F	CONDENSER PRESSURE IN HG	TURBINE BACK PRESSURE IN HG	TURBINE EXHAUST FLOW LB/HR
35.00	0.82	1.47	5 309 639
75.00	1.99	1.99	6 530 [illegible]
95.00	3.47	3.47	6 683 961

BASIS OF HEAT BALANCE CALCULATIONS

BASIS OF HEAT BALANCE CALCULATIONS
ELEVATION - APPROXIMATELY 271 FEET ABOVE SEA LEVEL.

STEAM GENERATOR BLOWDOWN = 180 GPM BASED ON OPERATING DATA.

PRESSURE DROPS - PRESSURE DROPS FOR THE STEAM GENERATORS, REHEATERS, MOISTURE SEPARATORS, MAIN STEAM, H.P. EXHAUST, REHEAT, AND EXTRACTION PIPING WERE CALCULATED AT ALL LOADS. THE CONDENSATE SYSTEM PRESSURE DROP REFLECTS THE ADDITION OF A CONDENSATE POLISHER.

PRESSURES - TURBINE FLANGE PRESSURES ARE SHOWN ON EXTRACTION LINES ADJACENT TO THE TURBINE. HEATER INLET PRESSURES ARE SHOWN ADJACENT TO THE HEATERS.

TABULATED CONDITIONS - ALL VALUES SHOWN IN THE TABLES WERE DEVELOPED BY CALCULATING COMPLETE HEAT BALANCES AT A FIXED THROTTLE FLOW AND VARYING THE CIRCULATING WATER TEMPERATURE. CIRCULATING WATER FLOW IS 540,300 GPM AND CLEANLINESS FACTOR IS 0.8 FOR ALL BALANCES.

AUXILIARY POWER REQUIREMENTS ARE CALCULATED FOR ALL EQUIPMENT. THE REQUIREMENTS OF THE FOLLOWING MAJOR EQUIPMENT VARY WITH LOAD.

3 CONDENSATE PUMPS	2 OPERATING
2 H. P. HEATER DRAIN PUMPS	2 OPERATING
2 L. P. HEATER DRAIN PUMPS	2 OPERATING
3 STEAM GENERATOR FEED PUMPS	2 OPERATING
1 MOISTURE SEP. DRAIN PUMP	1 OPERATING

THE FOLLOWING ARE IMPORTANT AUXILIARY POWER ITEMS WHICH ARE CONSIDERED NOT TO VARY WITH LOAD. AUXILIARY POWER FOR THESE AND LESSER EQUIPMENT HAS BEEN CALCULATED FOR AVERAGE DAILY REQUIREMENTS.

CIRCULATING WATER PUMPS
REACTOR COOLANT PUMPS
BEARING COOLING WATER PUMPS
COMPONENT COOLING WATER PUMPS
SERVICE WATER PUMPS

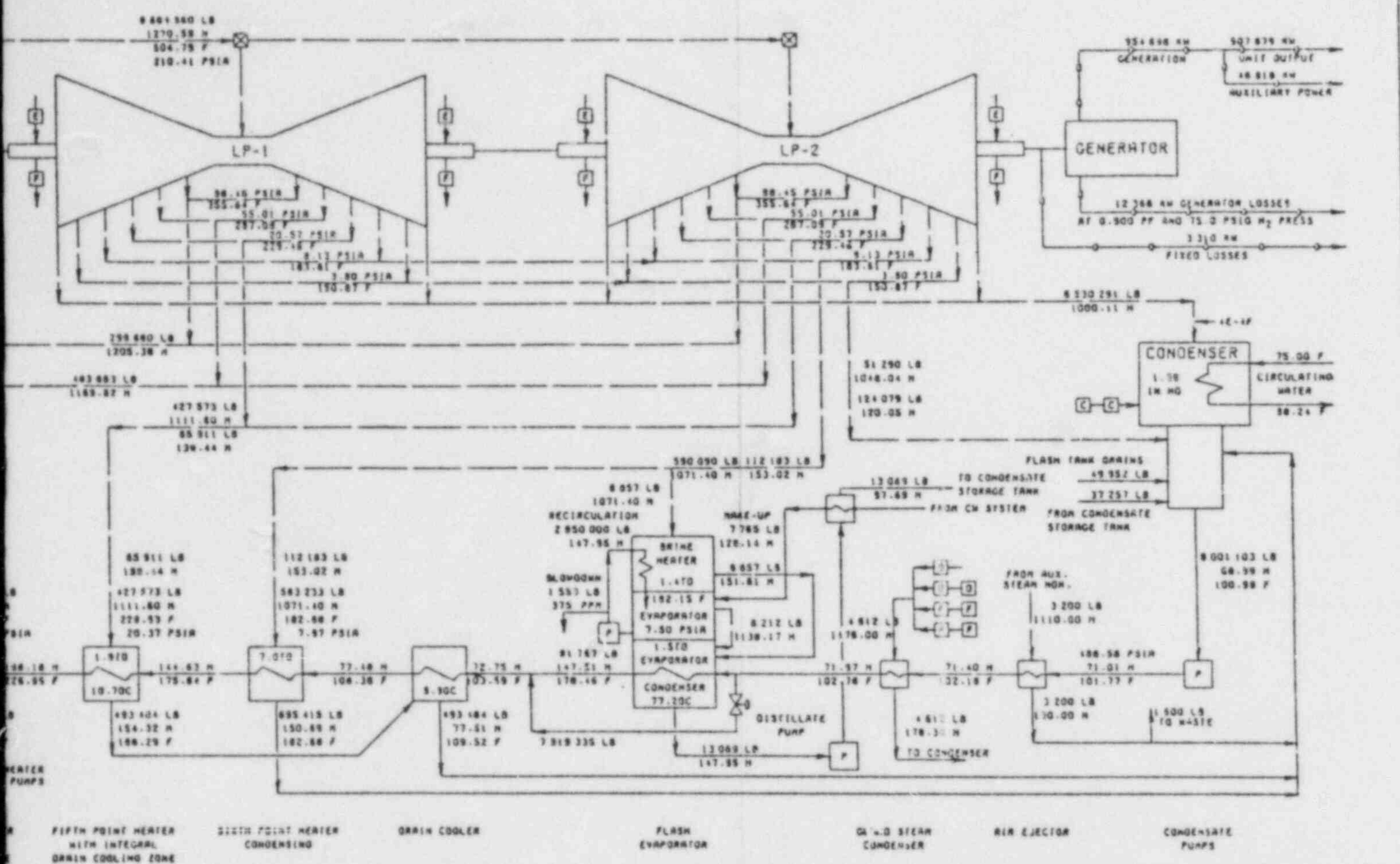
CALCULATIONS ARE BASED ON 1967 ASME STEAM TABLES

GROSS TURBINE HEAT RATE =

NET TURBINE HEAT RATE =

UNIT HEAT RATE = STEAM GENERATOR … / UNIT OUT…

KW TURBINE GENERATOR - TC4F-44" LSB



...PANSION LINE ...D POINT ...TU/LB	EXHAUST ENTHALPY BTU/LB	GENERATION KW	UNIT OUTPUT KW	GROSS TURBINE HEAT RATE BTU/KW-HR	NET TURBINE HEAT RATE BTU/KW-HR	UNIT HEAT RATE BTU/KW-HR
...68.57	549.40	952 864	906 128	9979.69	10106.C?	10494.70
...81.00	1006.11	954 698	907 879	9960.80	10087.50	10474.47
...05.38	1011.70	935 758	838 997	10161.87	10293.87	10696.35

LEAKAGES

	FLOW	ENTHALPY
A	938	1193.81
B	311	1193.81
C	3 472	1110.00
D	450	1110.00
E	2 375	1193.81
F	830	1193.81
G	8 562	1193.81

LEGEND

— — —	STEAM
———	WATER
—o—	POWER
LB	FLOW, POUNDS PER HOUR
H	ENTHALPY, BTU PER POUND
F	TEMPERATURE, DEGREES F
TD	TERMINAL DIFFERENCE, DEGREES F
DC	DRAIN COOLER APPROACH, DEGREES F
KW	POWER, KILOWATTS
IN HG	PRESSURE, IN OF MERCURY, ABS.
PSIA	PRESSURE, LB PER SQUARE IN. ABS.
⊠	THROTTLE OR INTERCEPT VALVE
⋈	CONTROL VALVE

TI APERTURE CARD

...N GENERATOR DUTY / GENERATION = 9 509 553 901 / 954 698 = 9960.80 BTU/KWHR

...EAM GENERATOR DUTY / ...TION - FEED PUMP POWER = 9 509 553 901 / 954 698 - 11 991 = 10087.50 BTU/KWHR

...OR DUTY / ...PUT = 9 509 553 901 / 907 879 = 10474.47 BTU/KWHR

Also Available On Aperture Card

THIS HEAT BALANCE DIAGRAM WAS PRODUCED FROM
RUN 92/07/01 09:17:18 BALANCE NO. 198

HEAT BALANCE DIAGRAM
2787 MW THERMAL

NORTH ANNA POWER STATION UNIT 1

VIRGINIA ELECTRIC AND POWER COMPANY

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

FIGURE 6.2-1

ORIGINAL ISSUE	CORR	APPR	DATE

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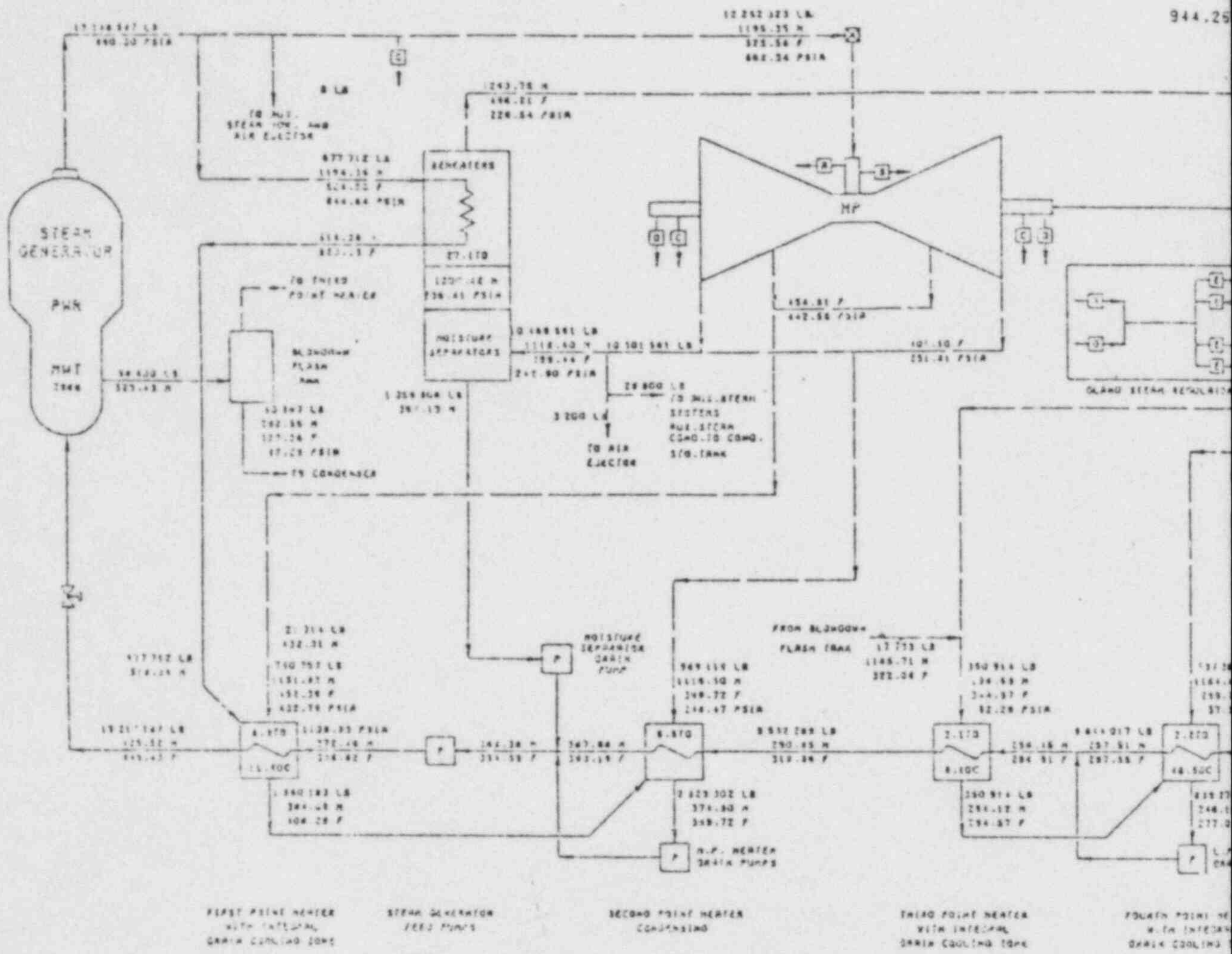


BASIS OF HEAT BALANCE CALCULATIONS

BASIS OF HEAT BALANCE CALCULATIONS
ELEVATION – APPROXIMATELY [illegible] FEET ABOVE SEA LEVEL.

STEAM GENERATOR BLOWDOWN – [illegible] GPM BASED ON OPERATING DATA.

PRESSURE DROPS – [illegible] DROPS FOR THE STEAM GENERATORS, REHEATERS, MOISTURE SEPARATORS, MAIN STEAM, H.P. EXHAUST, REHEAT, AND EXTRACTION PIPING WERE CALCULATED AT ALL LOADS. THE CONDENSATE SYSTEM PRESSURE DROP REFLECTS THE ADDITION OF A CONDENSATE POLISHER.

PRESSURES – TURBINE FLANGE PRESSURES ARE SHOWN ON EXTRACTION LINES ADJACENT TO THE TURBINE. HEATER INLET PRESSURES ARE SHOWN ADJACENT TO THE HEATERS.

TABULATED CONDITIONS – ALL VALUES SHOWN IN THE TABLES WERE DEVELOPED BY [illegible] COMPLETE HEAT BALANCES AT A FIXED [illegible] AND VARYING THE CIRCULATING WATER TEMPERATURE. CIRCULATING WATER FLOW IS 540,300 GPM. THE CLEANLINESS FACTOR IS 0.9 FOR ALL BALANCES.

AUXILIARY POWER REQUIREMENTS ARE CALCULATED FOR ALL EQUIPMENT. THE REQUIREMENTS OF THE FOLLOWING MAJOR EQUIPMENT VARY WITH LOAD.

3 CONDENSATE PUMPS	2 OPERATING
2 H. P. HEATER DRAIN PUMPS	2 OPERATING
2 L. P. HEATER DRAIN PUMPS	2 OPERATING
3 STEAM GENERATOR FEED PUMPS	2 OPERATING
1 MOISTURE SEP. DRAIN PUMP	1 OPERATING

THE FOLLOWING ARE IMPORTANT AUXILIARY POWER ITEMS WHICH ARE CONSIDERED NOT TO VARY WITH LOAD. AUXILIARY POWER FOR THESE AND LESSER EQUIPMENT HAS BEEN CALCULATED FOR AVERAGE DAILY REQUIREMENTS.

CIRCULATING WATER PUMPS
REACTOR COOLANT PUMPS
BEARING COOLING WATER PUMPS
COMPONENT COOLING WATER PUMPS
SERVICE WATER PUMPS

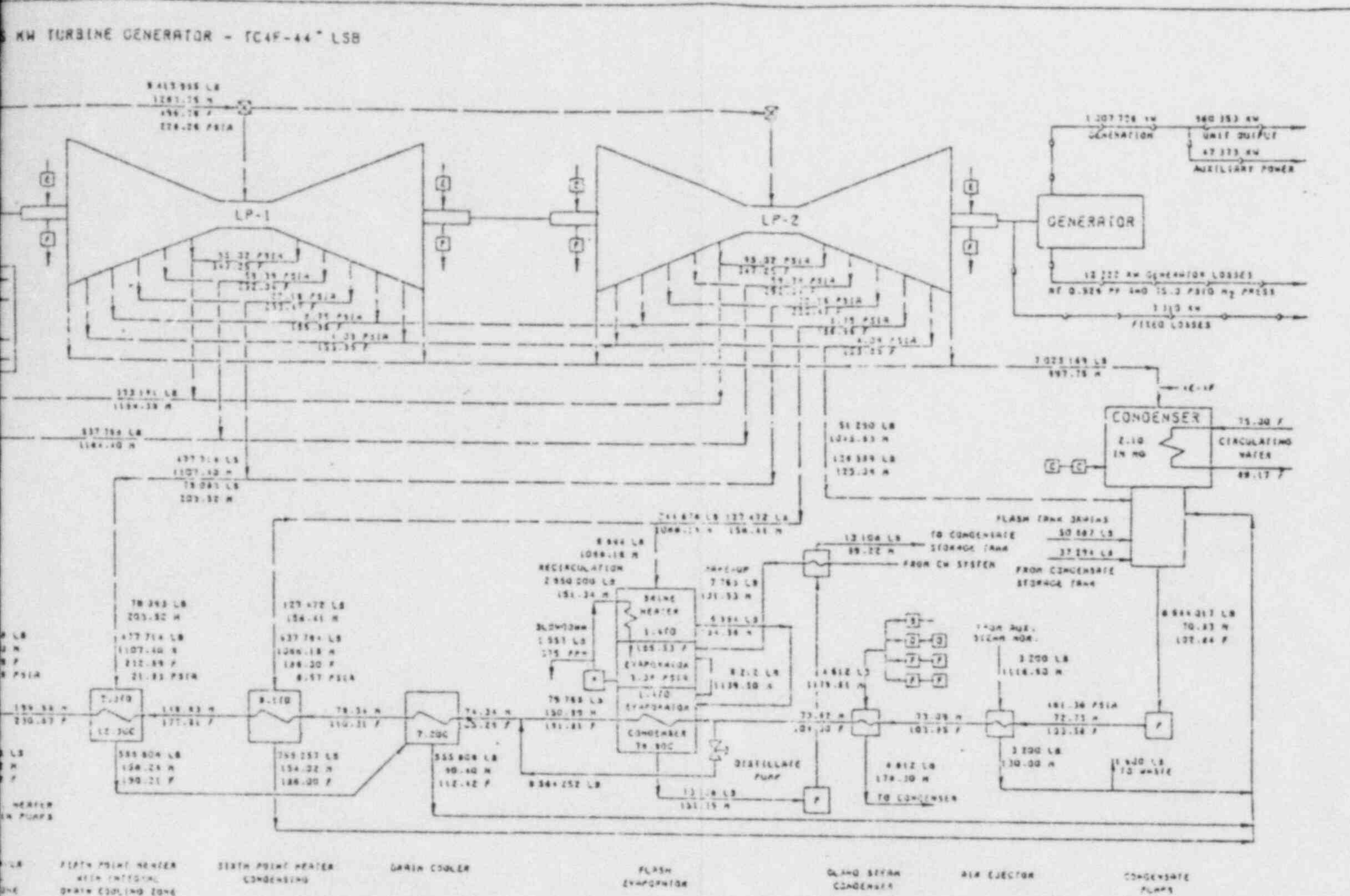
CALCULATIONS ARE BASED ON 1967 ASME STEAM TABLES

CIRCULATING WATER TEMPERATURE F	CONDENSER PRESSURE IN HG	TURBINE BACK PRESSURE IN HG	TURBINE EXHAUST FLOW LB/HR
55.20	0.96	1.28	[illegible]
75.20	2.13	2.10	7 225 [illegible]
86.00	3.44	3.44	7 133 [illegible]

GROSS TURBINE HEAT RATE = [illegible]

NET TURBINE HEAT RATE = [illegible]

UNIT HEAT RATE = STEAM GENE[RATOR] [illegible] / UNIT [illegible]



EXPANSION LINE END POINT BTU/LB	EXHAUST ENTHALPY BTU/LB	GENERATION KW	UNIT OUTPUT KW	GROSS TURBINE HEAT RATE BTU/KW-HR	NET TURBINE HEAT RATE BTU/KW-HR	UNIT HEAT RATE BTU/KW-HR
944.41	[illegible]	1 005 734	958 143	10071.37	10197.34	10549.11
937.60	947.75	1 007 726	962 353	10051.71	10174.34	10547.02
1001.87	1224.51	564 443	541 394	10247.23	10379.20	10797.87

LEAKAGES

	FLOW	ENTHALPY
A	518	1155.25
B	711	1195.35
C	2 472	1116.85
D	490	1114.90
E	2 375	1195.11
F	810	1155.35
G	6 557	1195.11

LEGEND

— —	STEAM
——	WATER
—→—	POWER
LB	FLOW, POUNDS PER HOUR
H	ENTHALPY, BTU PER POUND
F	TEMPERATURE, DEGREES F
TD	TERMINAL DIFFERENCE, DEGREES F
DC	DRAIN COOLER APPROACH, DEGREES F
KW	POWER, KILOWATTS
IN HG	PRESSURE, IN OF MERCURY, ABS.
PSIA	PRESSURE, LB PER SQUARE IN. ABS.
⊠	THROTTLE OR INTERCEPT VALVE
⋈	CONTROL VALVE

TI APERTURE CARD

... STEAM GENERATOR DUTY / GENERATION = 10 128 867 517 / 1 007 726 = 10051.71 BTU/KWHR

STEAM GENERATOR DUTY / GENERATION - FEED PUMP POWER = 10 128 867 517 / 1 007 726 - 12 455 = 10176.34 BTU/KWHR

... GENERATOR DUTY / OUTPUT = 10 128 867 517 / 960 353 = 10547.02 BTU/KWHR

Also Available On Aperture Card

THIS HEAT BALANCE DIAGRAM WAS PRODUCED FROM RUN 82/08/10 08:28:30 BALANCE NO. 219

HEAT BALANCE DIAGRAM
2568 MW THERMAL

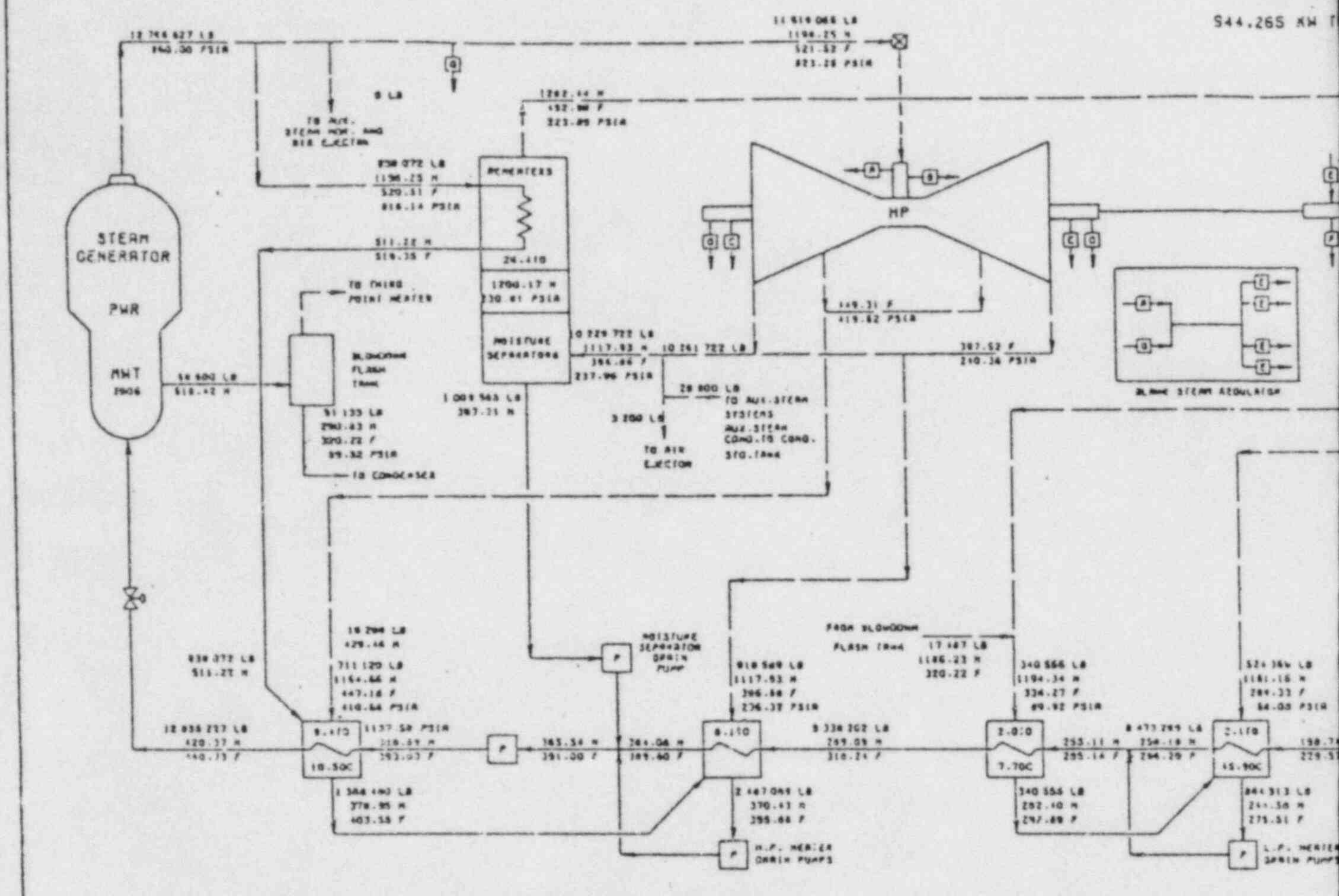
NORTH ANNA POWER STATION UNIT 1
VIRGINIA ELECTRIC AND POWER COMPANY
STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

ORIGINAL ISSUE

FIGURE 6.2-2

8505070381-02

544.265 KW T



FIRST POINT HEATER WITH INTEGRAL DRAIN COOLING ZONE

STEAM GENERATOR FEED PUMPS

SECOND POINT HEATER CONDENSING

THIRD POINT HEATER WITH INTEGRAL DRAIN COOLING ZONE

FOURTH POINT HEATER WITH INTEGRAL DRAIN COOLING ZONE

CIRCULATING WATER TEMPERATURE F	CONDENSER PRESSURE IN HG	TURBINE BACK PRESSURE IN HG	TURBINE EXHAUST FLOW LB/HR	EXPANSI[illegible] LINE END POI[illegible] BTU/L[illegible]
38.00	0.87	2.04	5 584 537	375.[illegible]
76.00	2.07	2.10	6 802 736	376 9[illegible]
98.00	3.50	3.50	7 064 917	1001.2[illegible]

BASIS OF HEAT BALANCE CALCULATIONS

BASIS OF HEAT BALANCE CALCULATIONS
ELEVATION - APPROXIMATELY 271 FEET ABOVE SEA LEVEL.

STEAM GENERATOR BLOWDOWN = 180 GPM BASED ON OPERATING DATA.

PRESSURE DROPS - PRESSURE DROPS FOR THE STEAM GENERATORS, REHEATERS, MOISTURE SEPARATORS, MAIN STEAM, H.P. EXHAUST, REHEAT, AND EXTRACTION PIPING WERE CALCULATED AT ALL LOADS. THE CONDENSATE SYSTEM PRESSURE DROP REFLECTS THE ADDITION OF A CONDENSATE POLISHER.

PRESSURES - TURBINE FLANGE PRESSURES ARE SHOWN ON EXTRACTION LINES ADJACENT TO THE TURBINE. HEATER INLET PRESSURES ARE SHOWN ADJACENT TO THE HEATERS.

TABULATED CONDITIONS - ALL VALUES SHOWN IN THE TABLES WERE DEVELOPED BY CALCULATING COMPLETE HEAT BALANCES AT A FIXED THROTTLE FLOW AND VARYING THE CIRCULATING WATER TEMPERATURE. CIRCULATING WATER FLOW IS 540,300 GPM AND CLEANLINESS FACTOR IS 0.9 FOR ALL BALANCES.

AUXILIARY POWER REQUIREMENTS ARE CALCULATED FOR ALL EQUIPMENT. THE REQUIREMENTS OF THE FOLLOWING MAJOR EQUIPMENT VARY WITH LOAD.

3 CONDENSATE PUMPS	2 OPERATING
2 H. P. HEATER DRAIN PUMPS	2 OPERATING
2 L. P. HEATER DRAIN PUMPS	2 OPERATING
3 STEAM GENERATOR FEED PUMPS	2 OPERATING
1 MOISTURE SEP. DRAIN PUMP	1 OPERATING

THE FOLLOWING ARE IMPORTANT AUXILIARY POWER ITEMS WHICH ARE CONSIDERED NOT TO VARY WITH LOAD. AUXILIARY POWER FOR THESE AND LESSER EQUIPMENT HAS BEEN CALCULATED FOR AVERAGE DAILY REQUIREMENTS.

CIRCULATING WATER PUMPS
REACTOR COOLANT PUMPS
BEARING COOLING WATER PUMPS
COMPONENT COOLING WATER PUMPS
SERVICE WATER PUMPS

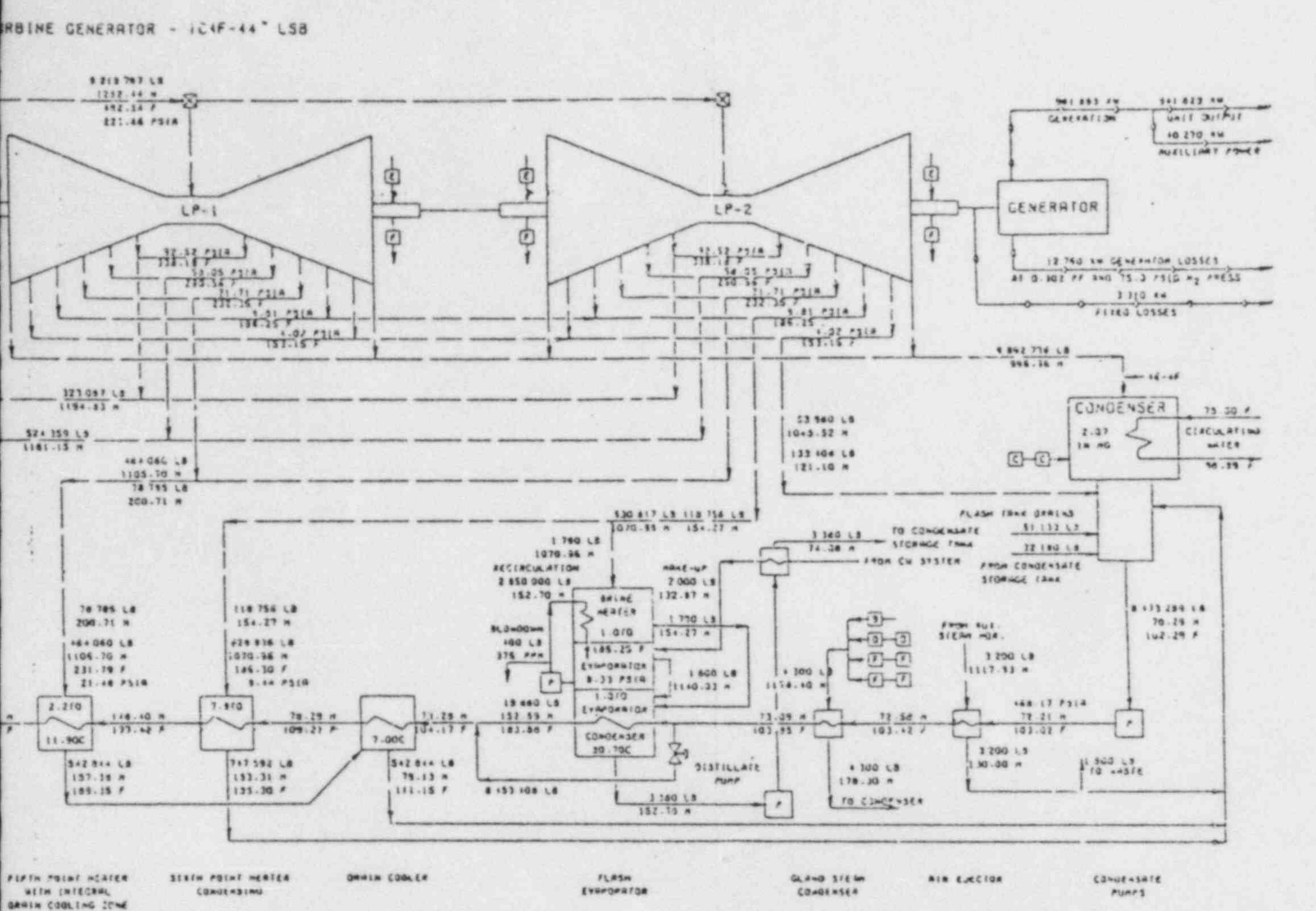
CALCULATIONS ARE BASED ON 1967 ASME STEAM TABLES

GROSS TURBINE HEAT RATE = STEAM GEN[illegible] / GENE[illegible]

NET TURBINE HEAT RATE = STEAM [illegible] / GENERATION [illegible]

UNIT HEAT RATE = STEAM GENERATOR OU[illegible] / UNIT OUTPUT [illegible]

RBINE GENERATOR - TC4F-44" LSB



	EXHAUST ENTHALPY BTU/LB	GENERATION KW	UNIT OUTPUT KW	GROSS TURBINE HEAT RATE BTU/KW-HR	NET TURBINE HEAT RATE BTU/KW-HR	UNIT HEAT RATE BTU/KW-HR
	994.37	975 438	939 148	10120.17	10120.17	10554.33
	995.95	981 893	941 823	10094.87	10094.87	10529.59
	1007.39	961 961	921 909	10305.10	10305.10	10755.19

LEAKAGES

	FLOW	ENTHALPY
A	0	-
B	0	-
C	3 878	1117.93
D	490	1117.93
E	2 375	1196.25
F	830	1196.25
G	9 500	1196.25

LEGEND

— — —	STEAM
———	WATER
—o—	POWER
LB	FLOW, POUNDS PER HOUR
H	ENTHALPY, BTU PER POUND
F	TEMPERATURE, DEGREES F
TD	TERMINAL DIFFERENCE, DEGREES F
DC	DRAIN COOLER APPROACH, DEGREES F
KW	POWER, KILOWATTS
IN HG	PRESSURE, IN OF MERCURY, ABS.
PSIA	PRESSURE, LB PER SQUARE IN. ABS
⊠	THROTTLE OR INTERCEPT VALVE
⋈	CONTROL VALVE

TI
APERTURE
CARD

...ERATOR OUTPUT / ...ATION = 9 912 079 615 / 981 893 = 10094.87 BTU/KWHR

...ENERATOR OUTPUT - FEED PUMP POWER = 9 912 079 615 / 981 893 - 0 = 10094.87 BTU/KWHR

...T = 9 912 079 615 / 941 823 = 10526.59 BTU/KWHR

Also Available On Aperture Card

THIS HEAT BALANCE DIAGRAM WAS PRODUCED FROM
RLK 83/12/02 12:22:51 BALANCE NO. 566

ORIGINAL ISSUE

HEAT BALANCE DIAGRAM
2905.00 MW THERMAL

NORTH ANNA POWER STATION UNIT 1

VIRGINIA ELECTRIC AND POWER COMPANY

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

FIGURE 6.2-3

8505070381-03

7.0 BOP COMPONENTS REVIEW

7.1 General

The objectives of the review for BOP Components were to determine the effect of the core uprating for normal and accident conditions on stress levels and fatigue analysis of all systems within the scope of the uprating program. Also, the design calculations were reviewed for major equipment supports, seismic tanks, vessels, pipe rupture restraints and shields and miscellaneous mecahnical equipment. The components of the following systems were evaluated for the uprated conditions:

System	Safety Class
Main Steam	2
Feedwater	2
Reactor Coolant	1
RC Loop Letdown	1
RC Loop Excess Letdown	1
Pressurizer Spray	1
Residual Heat Removal	1,2
Low Head Safety Injection	1
High Head Safety Injection	1
CVCS Seal Water Inlet	1
CVCS Seal Water Outlet	1
RC Loop Fill	1
Resistance Temperature Detection	1
RC Loop Drain	1
RC Loop Charging	1
Steam Generator Blowdown	2
Steam Generator Wet Layup	2
Component Cooling to RC Pumps	2
Reactor Vessel Level Indication System	2

7.2 Results of BOP Components Review

7.2.1 Pipe Stress and Supports

For all systems within the scope of the uprating program the appropriate maximum stress levels and fatigue analyses results have been reviewed for the plant uprate conditions. The review indicated that in all cases the associated piping stress and fatigue allowables would not be exceeded as a result of the uprate. It is concluded that all existing pipe support and equipment nozzle design loads remain valid.

7.2.2 Major Equipment Supports and Pipe Rupture Restraints

No-load and 100 percent power conditions were considered in the review of design calculations for major equipment supports, seismic tanks, vessels, pipe rupture restraints and shield and miscellaneous mechanical equipment. With the exception of the Main Steam and Feedwater flow rates, the parameters associated with the existing plant parameters bound the respective Core Uprate values. See Sections 6.2.1 and 6.2.4 for evaluation of Main Steam and Feedwater flow rates.

The data used to assess the effect of LOCA loadings on major equipment supports remain applicable for the uprated conditions. The amplitudes and time history of the LOCA loads data previously supplied by Westinghouse were verified as being applicable.

7.3 BOP Components Review Conclusions

In conclusion, and because the existing plant parameters represent a bounding condition, all existing pipe stress and support analyses within the scope of this evaluation have been determined to remain valid under the conditions of the Core Uprate.

8.0 STRUCTURES

The only structural loads subject to change as a result of the uprate were those resulting from system parameter changes such as pressure, temperature, and flow and subsequent postulated pipe breaks as developed in the review in Section 7.0. The new post LOCA peak containment pressure remained essentially the same, and is still less than the original containment design pressure. Subcompartment pressures are expected to decrease from the UFSAR values. There is no effect on the structural integrity of the Reactor Containment or other safety-related structures (Auxiliary Building, Main Steam Valve House, Fuel Building, Safeguards Building) due to the uprate.

9.0 RADIATION PROTECTION

9.1 Operational Releases

All operational releases reported in the UFSAR are based on a core power level of 2900 MWt. These releases are based on source terms (reference UFSAR Section 11.1) which Virginia Power has determined to be applicable for the core uprating up to a batch average fuel burnup of 45,000 MWD/MTU.

9.2 Accident Doses

All UFSAR accident doses are bounding for the core uprate. See Section 3.2.4 through 3.2.9.

9.3 Radiation Levels In EZD

The doses calculated for the North Anna Environmental Zone Description are calculated based on a core power level of 2910 MWt. This being greater than the proposed core uprate power level of 2898 MWt precludes having to revise these doses.

10.0 REVIEW OF THE TECHNICAL SPECIFICATIONS

The Technical Specifications have been reviewed to determine if any sections could be affected by the proposed increase in power from 2775 MWt to 2893 MWt. With the exception of the Technical Specification revisions recommended by Westinghouse Electric Corporation, no additional sections require NRC approval.

The Bases section, 3/4.7 Plant Systems, will need revision to reflect the uprated total secondary steam flow.