UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JAN 24 1986

Docket Nos.: STN 50-454
and STN 50-455

APPLICANT: COMMONWEALTH EDISON COMPANY

FACILITIES: BYRON STATION, UNITS 1 AND 2

SUBJECT: MEETING SUMMARY - REVIEW OF BYRON LCO RELAXATION PROGRAM

On December 3 and December 6, 1985, meetings were held in Bethesda, Maryland to discuss the review of the Byron LCO (Limiting Conditions for Operation) Relaxation Program. Members of the NRC, Brookhaven National Laboratory (BNL), Commonwealth Edison (CECO) and Westinghouse were present. Attendees at the meetings are listed in Enclosures 1 and 2.

CECO submitted its LCO Relaxation Program in May 1984 to justify extending the allowable outage times (AOT) for certain equipment from 72 hours to 7 days. The CECO submittal included a Probablistc Risk Assessment (PRA) done for Byron to evaluate the change in risk to the public with the increased AOT. NRC was assisted in its review of the PRA by BNL.

At the December 3 meeting, BNL presented the results of its review using the slides provided in Enclosure 3. The most significant result of the BNL review was that BNL estimated the core melt frequency for Byron 1 to be about 10^{-3}/year. For this estimate, BNL assumed one unit operation, loss of service water as an initiating event and the probability of a seal LOCA, given loss of service water, is 0.5. The main contribution to this estimate was the two-pump Essential Service Water (ESW) System on Byron 1. Loss of ESW results in a loss of reactor coolant pump seal cooling and loss of cooling to ECCS pumps. Thus, when considering the probability of the running ESW pump failing, the standby ESW pump failing to start, the subsequent induced seal LOCA (from loss of reactor coolant pump seal cooling) and the inability to mitigate the LOCA (from loss of cooling to ECCS pumps), BNL estimated the core melt frequency to be about 10^{-3}/year.

Most of the December 3 meeting was spent discussing ways to lower the estimated core melt frequency for Byron 1. The two major areas of discussion were the success criterion for the cooling tower fans and interim modes of operation until Byron 2 is licensed. When Byron 2 is licensed, its ESW pumps can be cross-tied to Byron 1 if needed. This ability to cross-tie ESW systems significantly reduces the core melt frequency.

CECO pointed out that the success criteria for the cooling tower fans assumed in its original submittal, and subsequently used in the BNL analysis, was too conservative. Westinghouse and BNL agreed to provide a new estimate of core melt frequency using a revised success criterion for the cooling tower fans.

In addition to the discussion on the core melt frequency, BNL also presented the results of its review concerning CECO's request to increase the AOTs on certain equipment. BNL indicated that the increase in core melt frequency when increasing the AOT from 72 hours to 7 days is negligible for the following systems: containment heat removal systems (containment spray pumps and fan coolers), ECCS (charging pumps, SI pumps and RHR pumps), and component cooling. For the auxiliary feedwater pumps, the effect of the increased AOT is slightly greater, and for the diesel generators and ESW pumps the effect is greater still. (See Enclosure 3 for additional details).

During a conference call on December 4, Westinghouse stated that results of recent tests conducted in France indicated that the assumptions used concerning the induced seal LOCA were conservative.

Thus, on December 6 another meeting was held to follow-up the discussions held on December 3 and 4. Slides used by CECO are included in Enclosure 4.

CECO began the meeting with a brief description of the ESW system for Byron and summary of PRA results determined by Westinghouse and BNL. In its discussion, CECO demonstrated that the original success criterion for cooling tower fans was, in fact, too conservative.

CECO then committed to have at least one of the Byron 2 ESW pumps "available" for cross-tie to Byron 1 before Byron 1 enters Mode 4; i.e, subcritical and reactor coolant temperature greater 200°F. Byron 1 had been shutdown since October 25, 1985 for reasons unrelated to this discussion.

BNL then presented its results considering the revised success criterion for cooling tower fans and having a Byron 2 ESW pump available. However, BNL also felt that the failure rate of the ESW pumps assumed in the Westinghouse analysis was not conservative enough. Thus, assuming the revised success criteria for the cooling tower fans and an increased value of for the failure rate of the ESW pumps, BNL estimated the core melt frequency to be still about 10^{-3}/year. However, having a Byron 2 ESW pump available reduces the core melt frequency by about a factor of ten, to about 10^{-4}/year.

A member of the NRC asked whether Byron met the single failure criteria. The NRC member postulated the loss of one ESW pump to be the transient and the single failure to be the failure of the other pump to start. This scenario, as previously discussed, could lead to core melt. Westinghouse responded by quoting from ANSI/ANS-58.9-1981, "Single Failure Criteria for Light Water Reactor Safety-Related Fluid System," which was written by a group comprised on industry and NRC representatives. Paragraph 4.5 of this document states, "Where the initiating event is the postulated failure of one or more redundant trains of a dual purpose safety-related fluid system, i.e., one required to operate during Condition I as well as to shut down the reactor and mitigate the consequences of the initiating event, a single failure in the remaining

train, or trains, of that system shall not be assumed, provided that the system is designed to Seismic Category I standards, is capable of being powered from both off-site and onsite sources, and is constructed, operated, and inspected to quality assurance, testing, and inservice inspection standards appropriate for safety classes 1, 2 or 3." This statement is reiterated in paragraph 3.2.1.d. of ANSI/ANSI-51.1-1983. Westinghouse concluded that the scenario postulated by the NRC member was not appropriate and that the Byron ESW system met the single failure criteria.

Finally, Westinghouse briefly discussed the results of recent testing in France. Westinghouse believes that the test results demonstrate that the assumption in the PRA study regarding the probability of a induced seal LOCA, given loss of seal cooling, is conservative. Westinghouse believes that the test results indicate that there may be sufficient time to take corrective action, such as repairing an ESW pump, before the induced seal LOCA leads to core melt.

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ENCLOSURE 1

REVIEW OF BYRON LEO RELAXATION PROGRAM

DECEMBER 3, 1985

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M. Oper
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D. Sharp

ENCLOSURE 2

REVIEW OF BYRON LCO RELAXATION PROGRAM

December 6, 1985

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BASIC CONSIDERATIONS

- CORE DAMAGE FREQUENCY FOR ONE UNIT OPERATION
- LOSS OF SERVICE WATER INITIATOR
- SEAL LOCA
  - PROBABILITY OF SEAL LOCA GIVEN LOSS OF SERVICE WATER; 0.5--0.0
  - NO RECOVERY FROM SEAL LOCA
- FAULT TREE LINKING APPROACH
- BOUNDING CALCULATIONS AND SENSITIVITY ANALYSIS ON AOT
- SYSTEM IMPORTANCE WITH RESPECT TO AOT

INITIATOR FREQUENCY FOR LOSS OF SERVICE WATER SYSTEM

- ESTIMATE EXPECTED NUMBER OF SYSTEM FAILURES DURING ONE YEAR INTERVAL
- USE THE FAULT TREE
- MODELING REPAIRS OF AN ALTERNATING SYSTEM REQUIRES RENEWAL THEORETIC CONSIDERATIONS
- FOR CUT SETS $I_A E_B + I_B E_A$

$$\frac{1}{2}\int_0^T \lambda_A Q_B \, DT + \frac{1}{2}\int_0^T \lambda_B Q_A \, DT$$

$$= \frac{1}{2}\lambda_A T \bar{Q}_B + \frac{1}{2}\lambda_B T \bar{Q}_A$$

WHERE T = 1 YEAR

- BNL RESULTS
  - CASE 1: 1.53×10^{-3}/RY
  - CASE 2: 1.14×10^{-2}/RY
- WCAP-10526 SUPPLEMENT RESULTS
  - 3 DAY LCO: 1.96×10^{-4}/RY
  - 7 DAY LCO: 3.39×10^{-4}/RY

Model 0 - Model in WCAP-10526 with modifications in Section 4.2 (except Event Tree 17) and data in Tables 4.1 and 4.2.

Model 1 - Model 0 plus Event Tree 17 (loss of service water).

Model 2 - Model 1 with $P_r(S_2\text{-QA}) = 0$ where S_2-QA is the seal LOCA event given loss of service water.

Model 3 - Model 1 with no maintenance unavailability contributions from CCWS and ESWS.

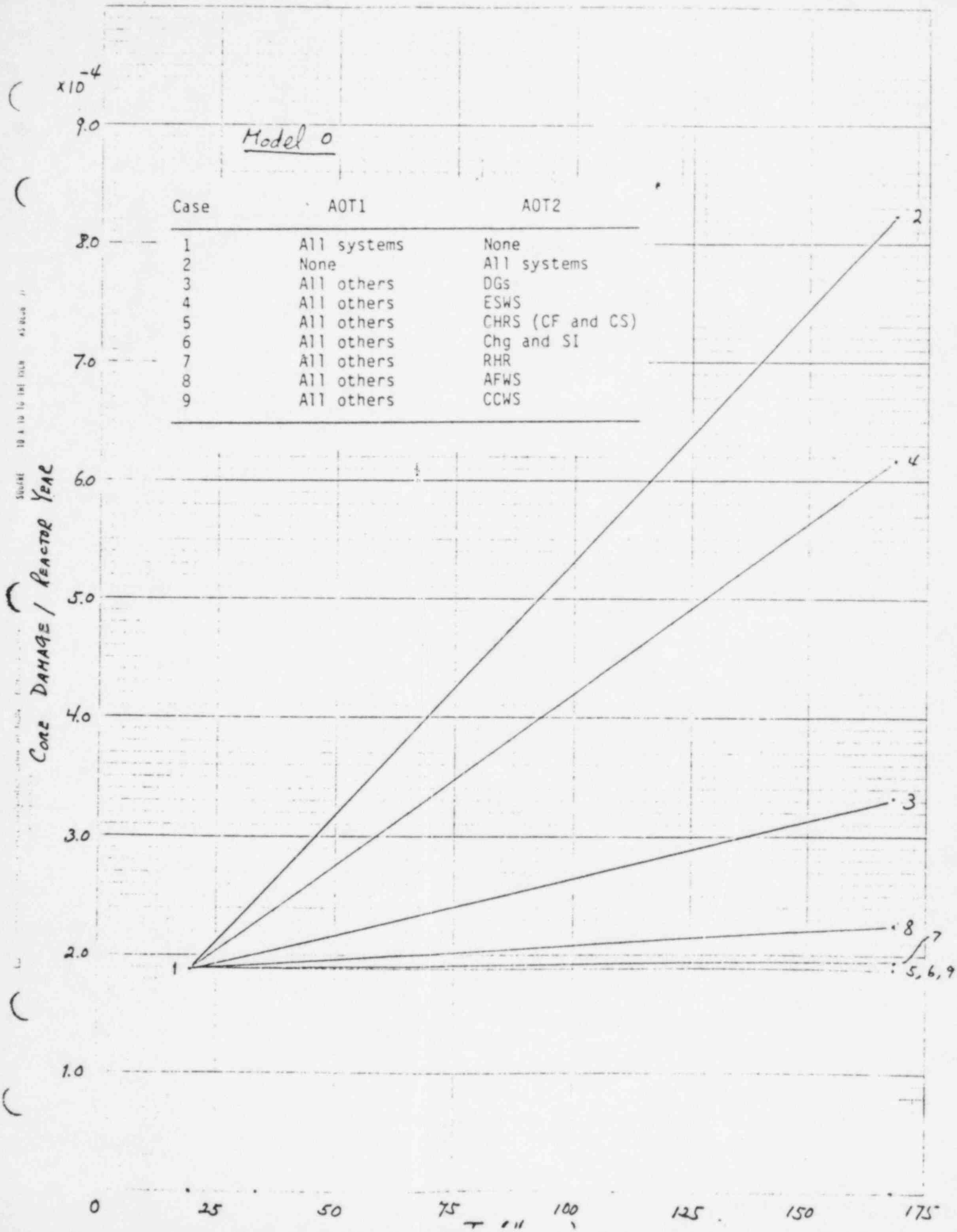
Case	AOT1	AOT2
1	All systems	None
2	None	All systems
3	All others	DGs
4	All others	ESWS
5	All others	CHRS (CF and CS)
6	All others	Chg and SI
7	All others	RHR
8	All others	AFWS
9	All others	CCWS

COMPARISON OF MEAN CORE DAMAGE FREQUENCIES FROM ONE UNIT OPERATION

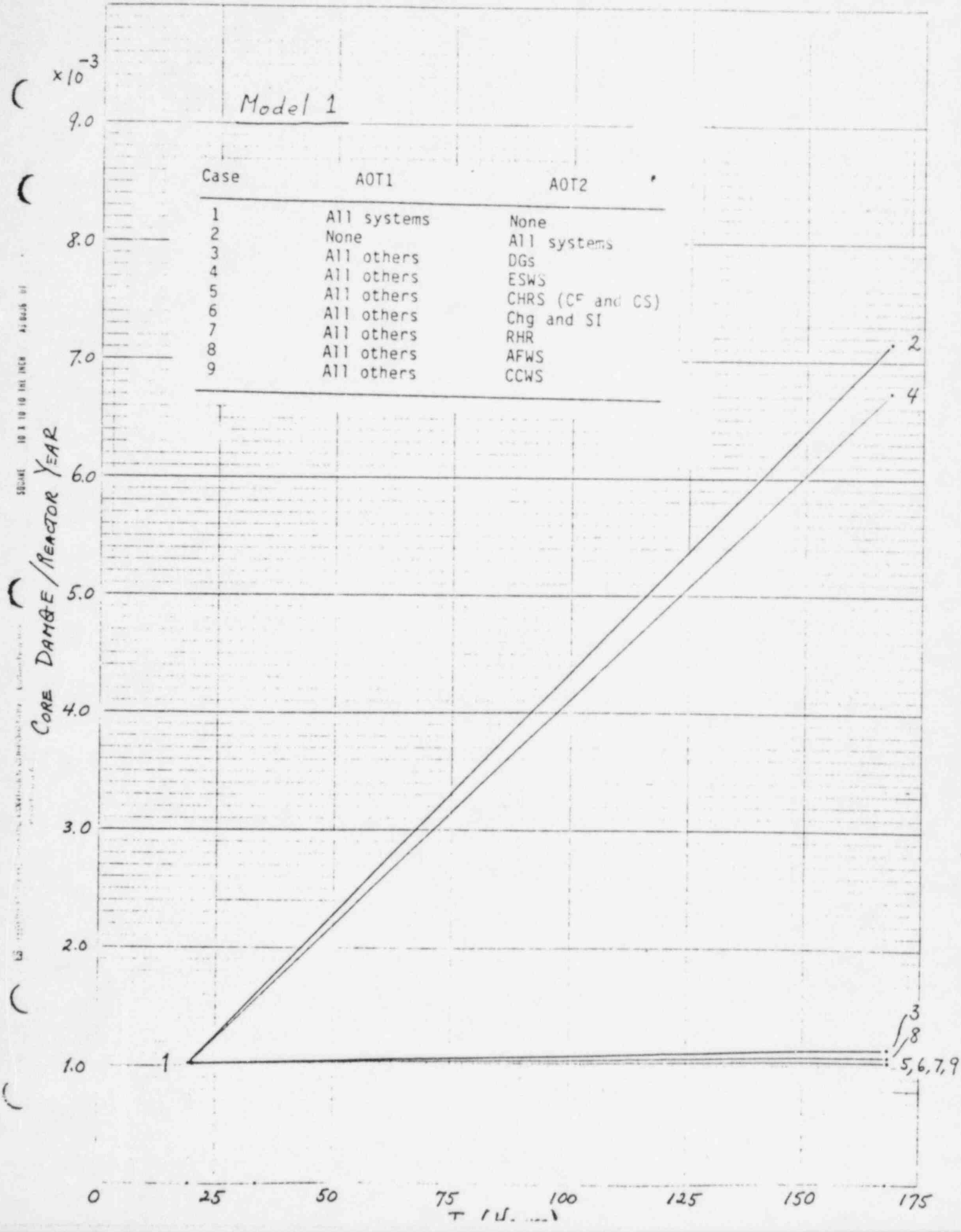
CASE	WCAP-10526	MODEL 0	MODEL 1	MODEL 2	MODEL 3
1	1.41(-4)	1.88(-4)	1.01(-3)	1.07(-4)	2.77(-4)
2	--	8.24(-4)	7.15(-3)	7.72(-4)	4.73(-4)
3	--	3.32(-4)	1.15(-3)	1.18(-4)	4.21(-4)
4	--	6.18(-4)	6.73(-3)	4.85(-4)	NA**
5	--	1.88(-4)	1.01(-3)	1.07(-4)	2.80(-4)
6	--	1.88(-4)	1.01(-3)	1.07(-4)	2.77(-4)
7	--	1.94(-4)	1.01(-3)	1.13(-4)	2.84(-4)
8	--	2.26(-4)	1.07(-3)	1.73(-4)	3.18(-4)
9	--	1.88(-4)	1.01(-3)	1.07(-4)	NA**
10*	1.67(-4)	2.52(-4)	1.63(-3)	1.74(-4)	2.97(-4)

*T_R = 34 HOURS FOR ALL SYSTEMS.

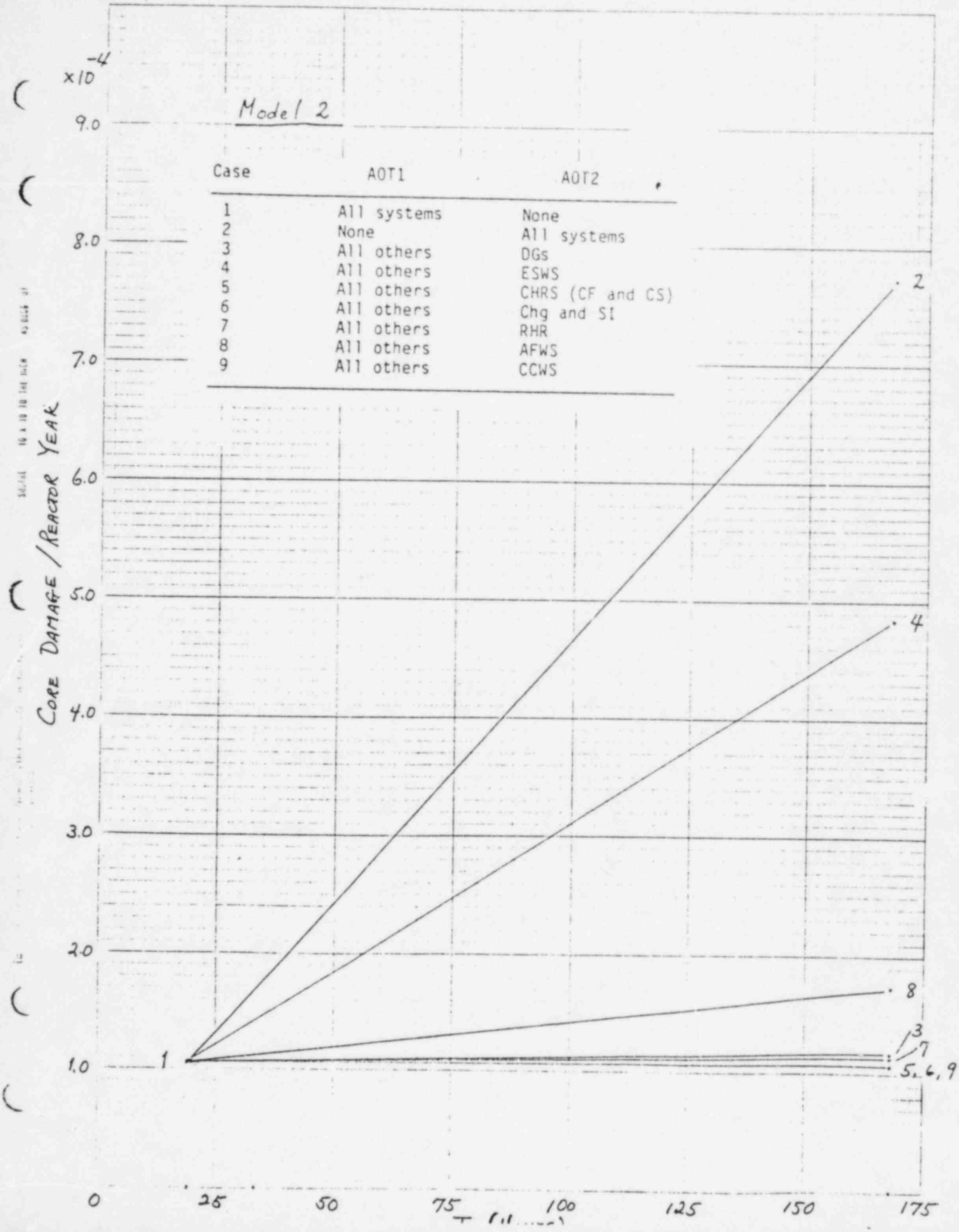
**NOT APPLICABLE.

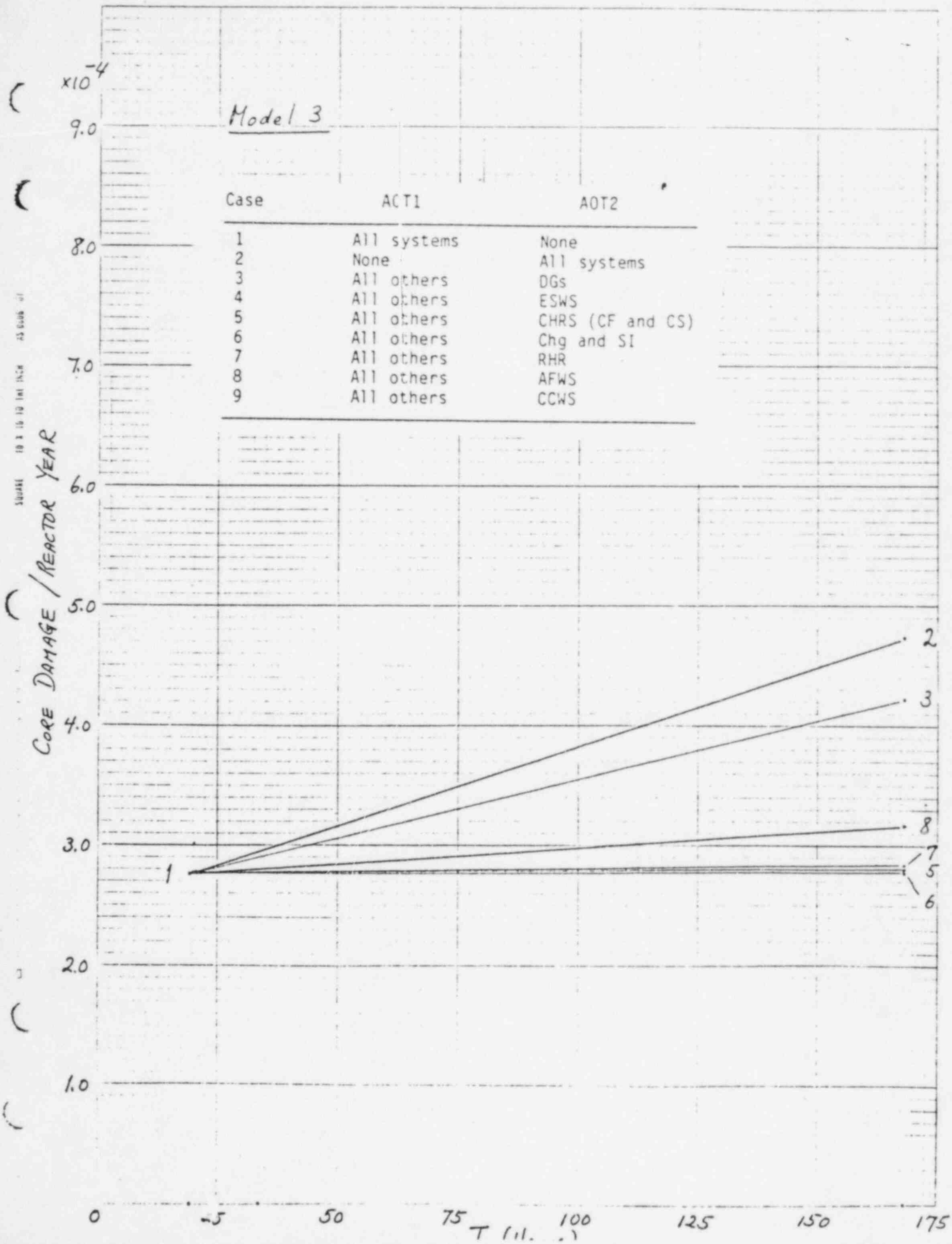


Case	AOT1	AOT2
1	All systems	None
2	None	All systems
3	All others	DGs
4	All others	ESWS
5	All others	CHRS (CF and CS)
6	All others	Chg and SI
7	All others	RHR
8	All others	AFWS
9	All others	CCWS



×10^-3
Model 1
Case AOT1 AOT2
1 All systems None
2 None All systems
3 All others DGs
4 All others ESWS
5 All others CHRS (CF and CS)
6 All others Chg and SI
7 All others RHR
8 All others AFWS
9 All others CCWS
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Core Damage/Reactor Year
1
2
4
3
8
5,6,7,9
0
25
50
75
100
125
150
175


Model 2
Case AOT1 AOT2
1 All systems None
2 None All systems
3 All others DGs
4 All others ESWS
5 All others CHRS (CF and CS)
6 All others Chg and SI
7 All others RHR
8 All others AFWS
9 All others CCWS
x10^-4
CORE DAMAGE / REACTOR YEAR
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
25
50
75
100
125
150
175
1
2
4
8
3
7
5, 6, 9



Case	ACT1	AOT2
1	All systems	None
2	None	All systems
3	All others	DGs
4	All others	ESWS
5	All others	CHRS (CF and CS)
6	All others	Chg and SI
7	All others	RHR
8	All others	AFWS
9	All others	CCWS

BYRON ESSENTIAL SERVICE WATER SYSTEM

PRA EVALUATIONS

	WESTINGHOUSE	BROOKHAVEN NATIONAL LAB
CORE DAMAGE FREQUENCY FROM BYRON PRA (ASSUMES 2 UNIT OPERATION WITH SYSTEM CROSS-TIES)	2 x 10-5	
CORE DAMAGE FREQUENCY FROM BYRON LCORP (ASSUMES SINGLE UNIT OPERATION LOSS OF ESW NOT AN INITIATOR)	1.4 x 10-4	1.9×10^{-4}
- LOSS OF ESW PROBABILITY	1.9×10^{-4}	1.6×10^{-3}
- PROBABILITY OF RCP SEAL LOCA	.5	.5
CORE DAMAGE FREQUENCY WITH LOSS OF ESW INITIATOR	1×10^{-4}	8×10^{-4}
OVERALL CORE DAMAGE FREQUENCY - ALL INITIATORS ONE UNIT OPERATION NO CROSS-TIES	2.4×10^{-4}	1×10^{-3}

ENCLOSURE 4

EFFECT ON ESW FAILURE PROBABILITY FROM DIFFERENT TOWER FAN CRITERIA	1 MAGNITUDE
EFFECT ON ESW FAILURE PROBABILITY FROM CROSS-CONNECTED PUMPS	1-2 MAGNITUDES

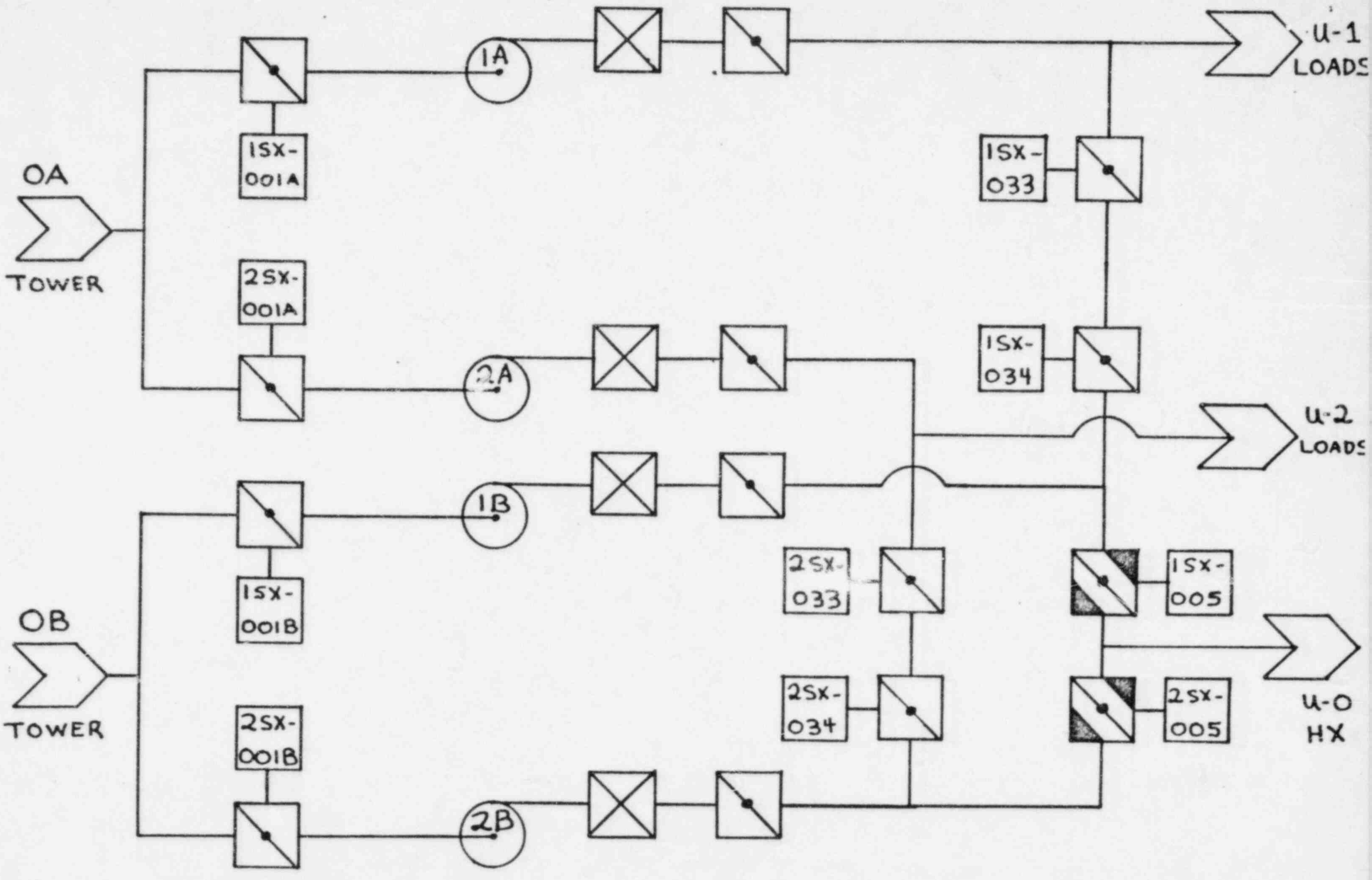
SX COOLING TOWER

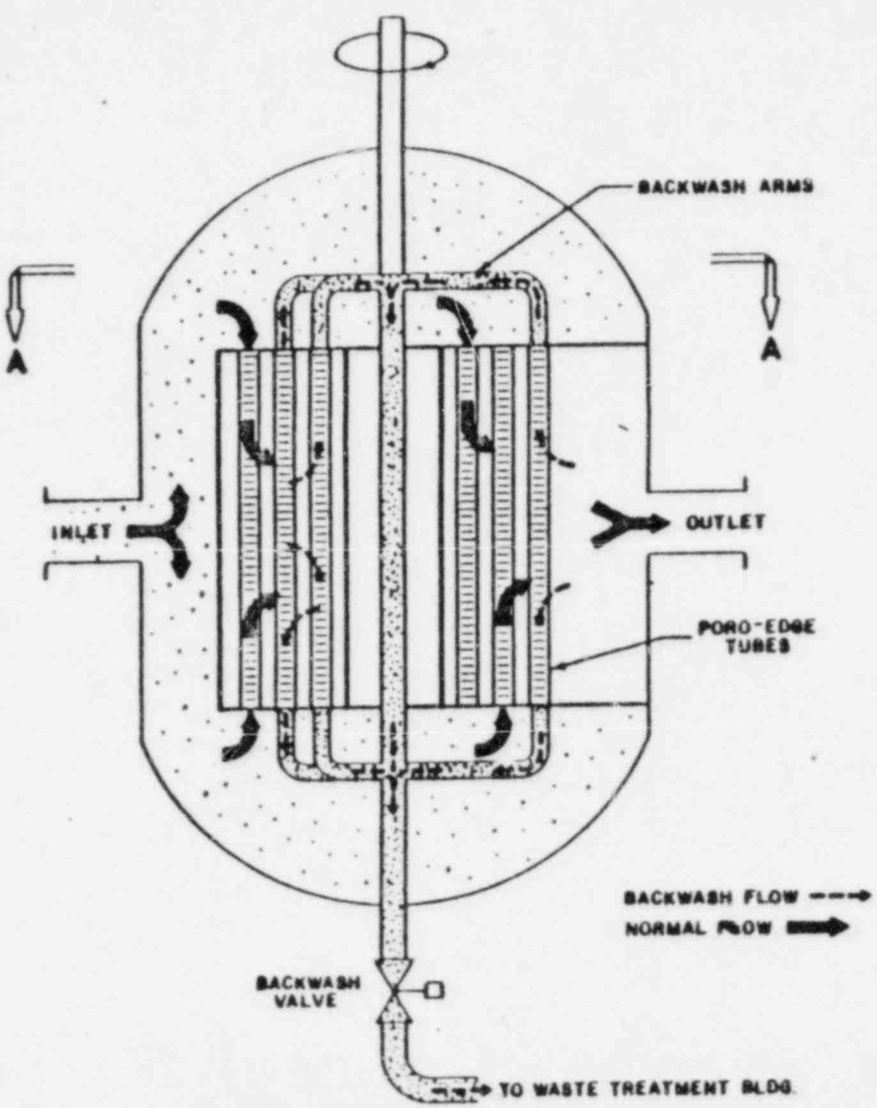
DESIGN DATA

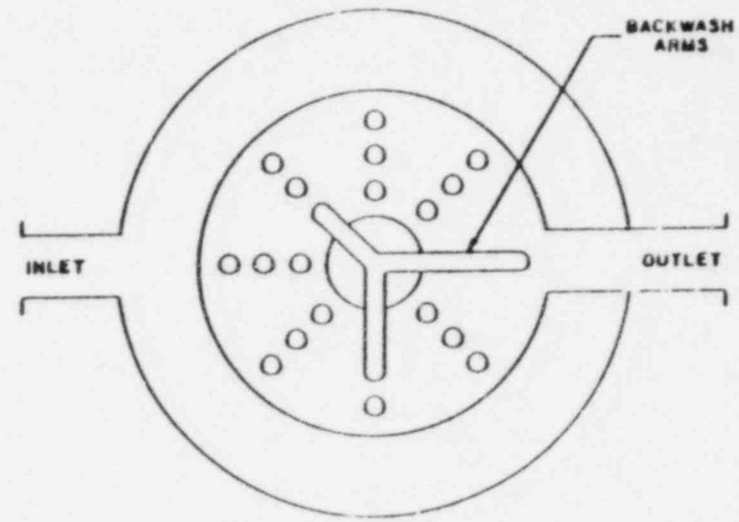
WET BULB	78 °F
WATER TERMPERATURE (LV TOWER)	98 °F
SX WATER TEMP (SYSTEM DESIGN)	100 °F

PERFORMANCE

	LOCA	NON-LOCA
HEAT LOAD	1.4×10^9 BTU/HR	7.5×10^7 BTU/HR
FANS REQUIRED	3 (DESIGN)	o (ANALYSIS) (Q10.39)
DOMINENT HEAT LOADS	RHR RCFC	RHR


OA
TOWER
OB
TOWER
1SX-001A
2SX-001A
1SX-001B
2SX-001B
1A
2A
1B
2B
1SX-033
1SX-034
2SX-033
2SX-034
1SX-005
2SX-005
U-1 LOADS
U-2 LOADS
U-0 HX





SECTION "A-A"

SX STRAINER	
DRAWN 6-2-84	REVISED
COMMONWEALTH EDISON CO.	

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3

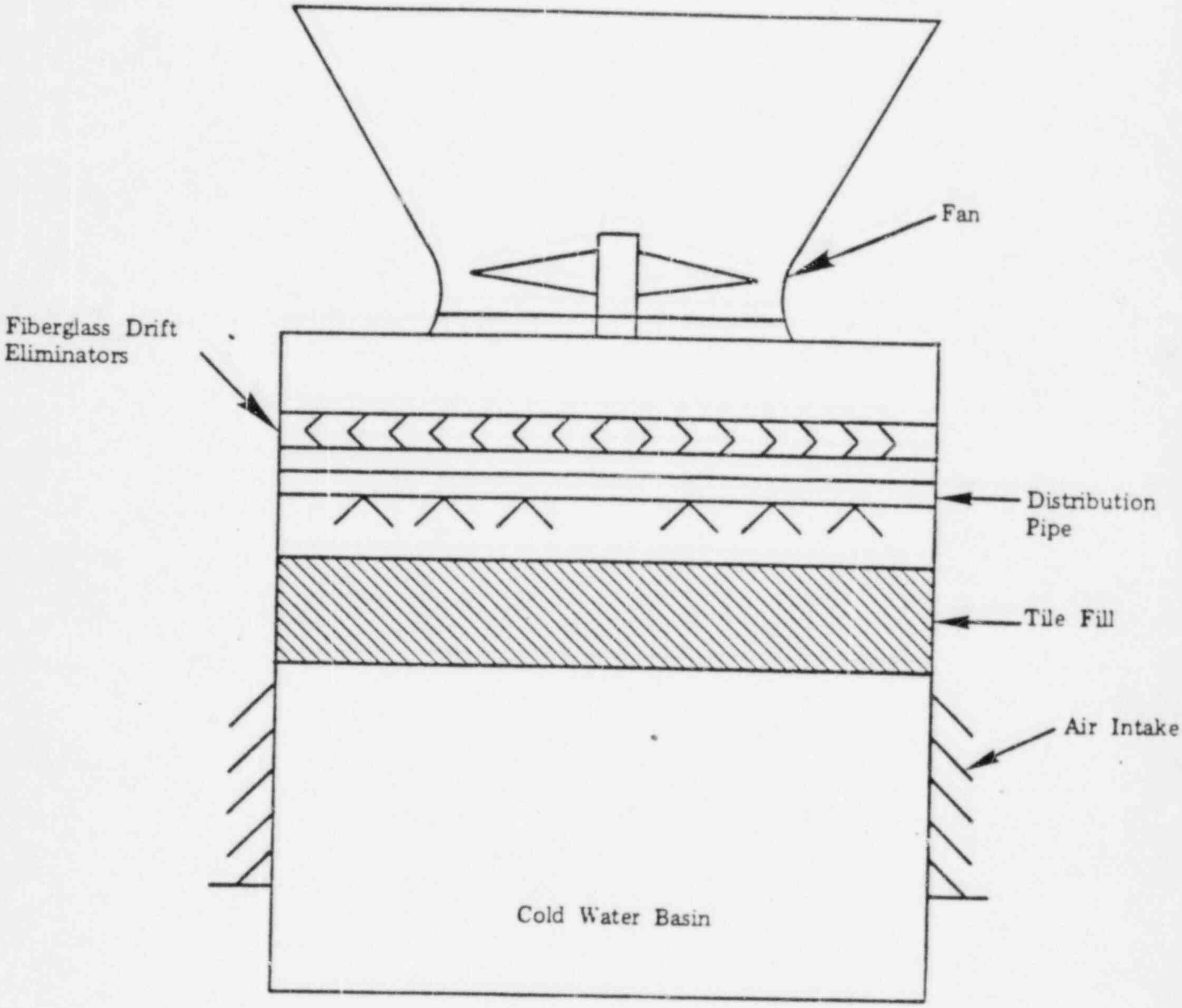
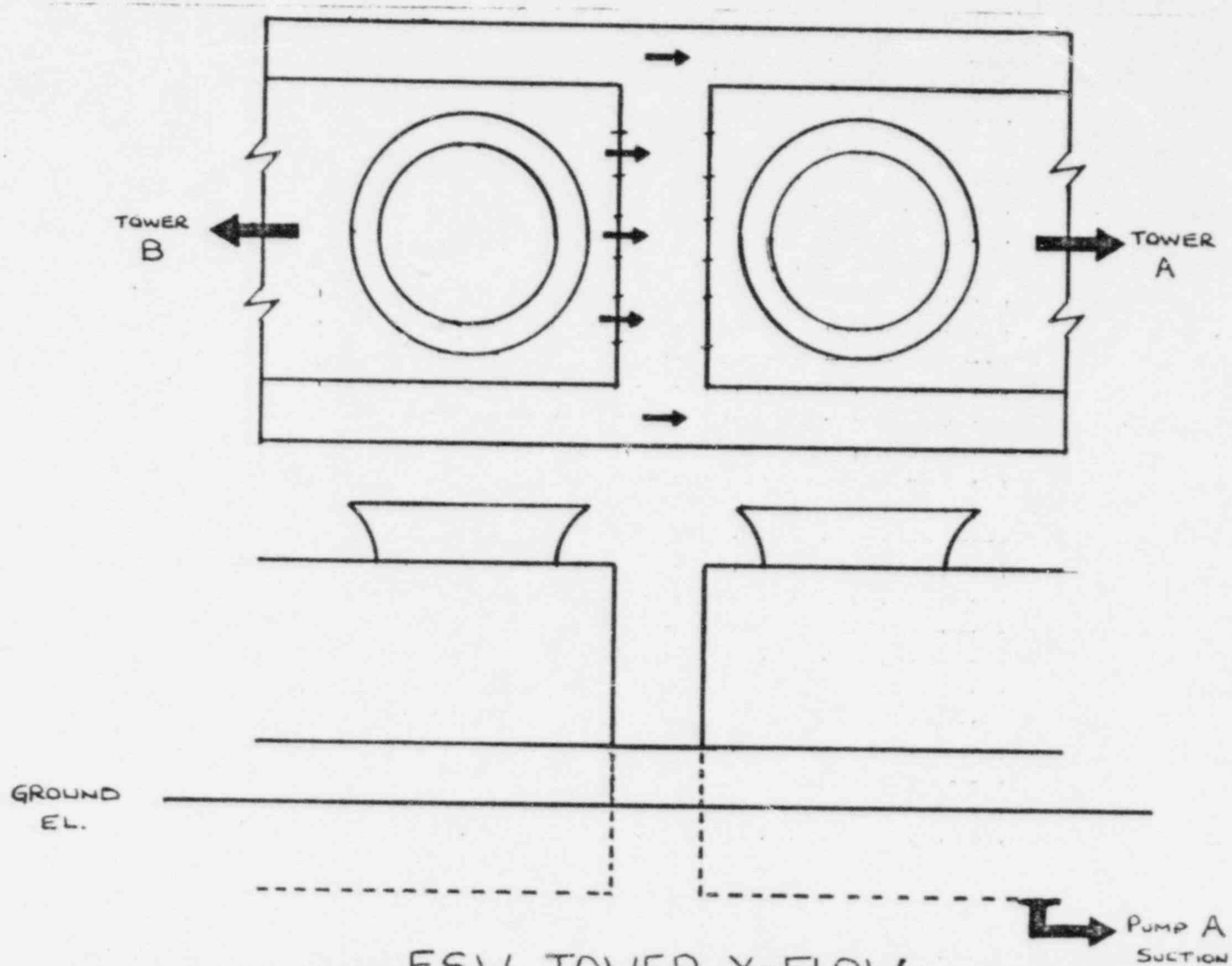
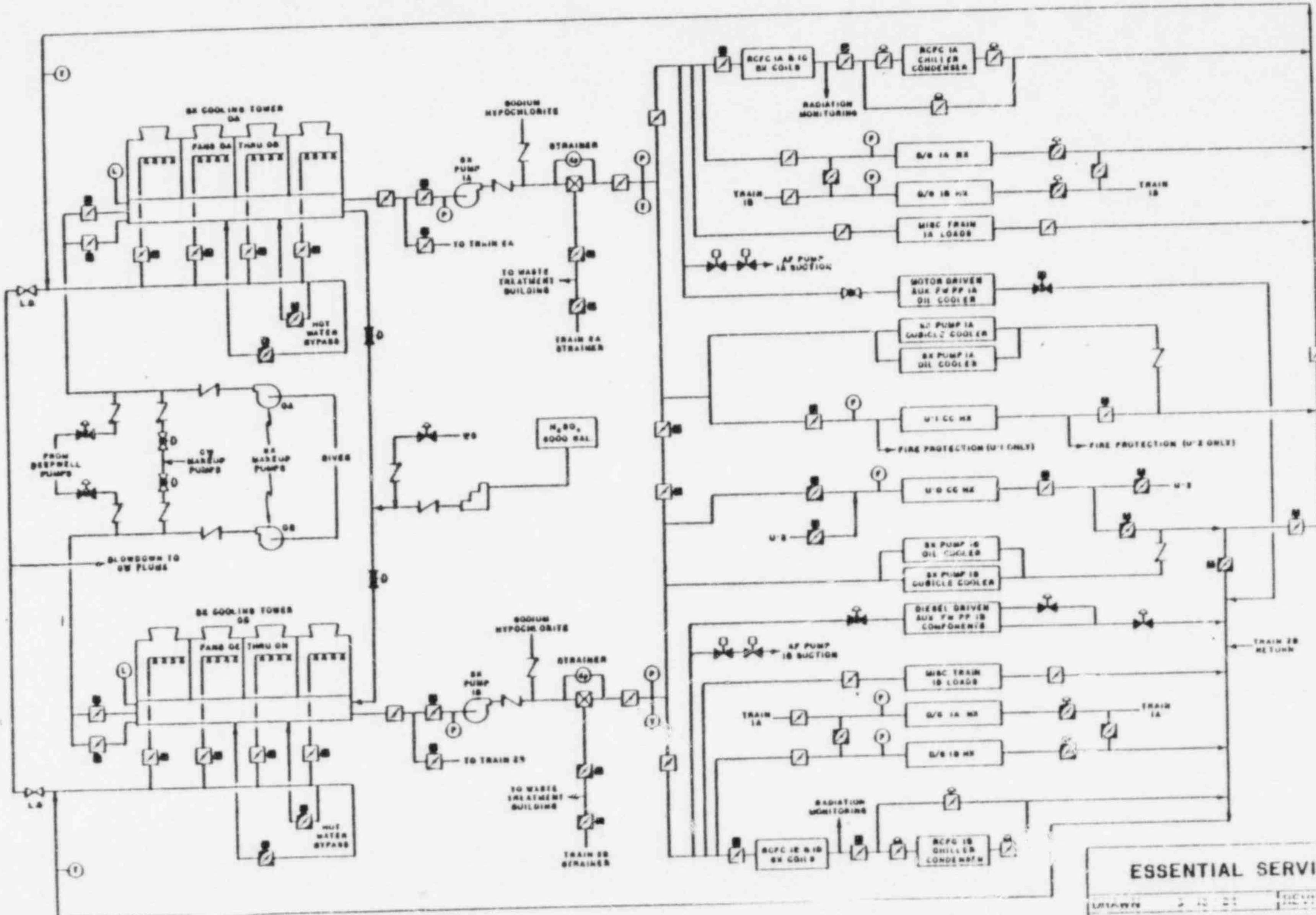


Figure 15-I-D2
Cross-Section of a Mechanical Draft Cooling Tower



ESW TOWER X-FLOW



ESSENTIAL SERVICE WATER

DRAWN 3-18-81 REVISED

COMMONWEALTH EDISON CO.

JDJ

1

3 - PUMP, 1 - UNIT OPERATION

THE TOTAL COREMELT FREQUENCY IS ESTIMATED TO BE IN THE RANGE OF

$$Q_3 = 6 \times 10^{-5} \quad - \quad 8 \times 10^{-5}/\text{YEAR}$$

train, or trains, of that system shall not be assumed, provided that the system is designed to Seismic Category I standards, is capable of being powered from both off-site and onsite sources, and is constructed, operated, and inspected to quality assurance, testing, and inservice inspection standards appropriate for safety classes 1, 2 or 3." This statement is reiterated in paragraph 3.2.1.d. of ANSI/ANSI-51.1-1983. Westinghouse concluded that the scenario postulated by the NRC member was not appropriate and that the Byron ESW system met the single failure criteria.

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