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September 27, 1976

REGULATORY DOCKET FILE COPY

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USNRC
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U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. Dennis L. Ziemann, Chief
Operating Reactors - Branch 2
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden Station Units 2 and 3
Quad-Cities Station Units 1 and 2
NRC Docket Nos. 50-237, 50-249,
50-254, and 50-265

Dear Mr. Ziemann:

The following is in response to your August 23, 1976 letter requesting additional information in regard to long term cooling capability relative to Dresden Station Units 2 and 3 and Quad-Cities Station Units 1 and 2.

The additional information you requested is contained in the attachment.

One (1) signed original and 39 copies are submitted for your review.

Very truly yours,

G. J. Pliml
Nuclear Licensing Administrator

Attachment

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QUESTION 1
Calculation Method Description

The method used for calculations pertaining to the LPCI line break is described as follows.

The system in question is comprised of two-two pump systems. Due to the fact that the two systems have different system losses, and yet are interconnected systems, the two systems will have different operating points. In order to find the operating points it was necessary to solve three head loss versus flow equations written for different branches of the system. Incorporated into these equations was an equation that approximates the pumps head-capacity curve. Then an iteration process was used to solve the equations producing the systems operating points.

Piping and components equivalent lengths (L/D) were calculated using Sargent & Lundy Standard ME-2.16. A piping roughness coefficient, from Sargent & Lundy Standard 2.10, of .00015 feet (commercial steel or wrought iron) was assumed. The friction factors used were obtained from the Moody Diagram, Sargent & Lundy Standard 2.10, using the Reynolds number and roughness coefficient for the particular piping segment in question.

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Chicago, Illinois

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Mechanical Analytical Division
Prepared by DA Brosseau Date 9-3-76
Reviewed by Date [illegible]-76
Approved by R E Henry Date 9-3-76
Sheet 1 of 8

Commonwealth Edison Company
Dresden Station Units 2&3

Low Pressure Core Injection System
Piping Segment Summary

PIPING SEGMENT SUMMARY

Segment A - 12 Inch I.D.	5810 GPM		
Component	K	L/D	Friction Loss (Ft.)
1 - 90° Standard Radius Elbow	-	30	1.65
1 - Check Valve	-	135	7.42
1 - Gate Valve	-	13	0.71
1 - Tee (Flow through branch)	-	30	1.65
Straight Piping - 3 feet	-	3	0.16
Totals	0	211	11.6

Segment B - 17.124 Inch I.D.	11620 GPM		
Component	K	L/D	Friction Loss (Ft.)
1 - 90° Standard Radius Elbow	-	30	1.59
3 - 90° Long Radius Elbows	-	60	3.18
1 - Tee (Flow through run)	-	20	1.06
1 - Gate Valve	-	13	0.69
1 - 45° Long Radius Elbow	-	12	0.64
1 - Tee (Flow through branch)	-	60	3.18
Straight Piping - 33 feet	-	23.1	1.22
Totals	0	218.1	11.55

Segment C - 17.124 Inch I.D.	17370 GPM		
Component	K	L/D	Friction Loss (Ft.)
2 - 90° Long Radius Elbows	-	40	4.65
1 - 90 Standard Radius Elobw	-	30	3.49
1 - Tee (Flow through branch)	-	60	6.98
2 - 45° Long Radius Elbows	-	24	2.79
1 - Angle Valve	-	145	16.86
1 - Tee (Flow through run)	-	15.8	1.84
Straight Piping - 89.5 feet	-	62.7	7.29
Totals	0	377.5	43.90

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Sheet 2 of 8

Commonwealth Edison Company
Dresden Station Units 2&3

Low Pressure Core Injection System
Piping Segment Summary

PIPING SEGMENT SUMMARY

Segment D - 15.25 Inch I.D. 17370 GPM

Component	K	L/D	Friction Loss (Ft.)
1 - Reducer (17.124 x 15.25)	0.05	-	0.72
2 - Gate Valves	-	26	4.81
1 - Tee (Flow through run)	-	17.4	3.22
1 - 45° Long Radius Elbow	-	12	2.22
1 - Check Valve	-	145	26.83
3 - 90° Long Radius Elbows	-	60	11.1
1 - Tee (Flow through branch)	-	35.6	6.59
Exit Loss	1.0	-	14.44
Straight Piping - 22.5 feet	-	17.7	3.27
Totals	1.05	313.7	73.2

Segment E - 17.124 Inch I.D. 5750 GPM

Component	K	L/D	Friction Loss (Ft.)
3 - 90° Long Radius Elbows	-	60	0.80
1 - Tee (Flow through run)	-	20	0.27
2 - Gate Valves	-	26	0.35
2 - 90° Standard Radius Elbows	-	60	0.80
2 - 45° Long Radius Elbows	-	24	0.32
Straight Piping - 82.5 feet	-	57.8	0.77
Totals	0	247.8	3.3

Segment F - 12.0 Inch I.D. 5750 GPM

Component	K	L/D	Friction Loss (Ft.)
1 - 90° Standard Radius Elbow	-	30	1.62
1 - Check Valve	-	135	7.29
1 - Gate Valve	-	13	0.70
1 - Tee (Flow through branch)	-	30	1.62
Straight Piping - 3 feet	-	3	0.16
Totals	0	211	11.4

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Sheet 3 of 8

Commonwealth Edison Company
Dredsen Station Units 2&3

Low Pressure Core Injection System
Piping Segment Summary

PIPING SEGMENT SUMMARY

Segment G - 17.124 Inch I.D. 5750 GPM

Component	K	L/D	Friction Loss (Ft.)
2 - 90° Standard Radius Elbows	-	60	0.80
4 - 90° Long Radius Elbows	-	80	1.06
1 - Tee (Flow through run)	-	20	0.27
1 - Gate Valve	-	13	0.17
2 - Tees (Flow through branch)	-	120	1.60
Straight Piping - 34.5 feet	-	24.2	0.32
Totals	0	317.2	4.22

Segment H - 32.25 Inch I.D. See Note 1

Component	K	L/D	Friction Loss (Ft.)
1 - Tee (Branch Flow)	-	38.2	
7 - 22° Single Miter Bends	-	35	
1 - Tee (Flow through run)	-	15.2	See Note 1
1 - Tee (Flow through run)	-	16.4	
1 - Tee (Flow through branch)	-	30	
Entrance and Strainer loss	-	-	1.0
Straight Piping - 183.8 feet	-	94.9	
Totals	0	229.7	See Note 1

Segment I - 23.25 Inch I.D. 11620 GPM

Component	K	L/D	Friction Loss (Ft.)
1 - 90° Long Radius Elbow	-	20	0.32
1 - 45° Long Radius Elbow	-	12	0.19
1 - Gate Valve	-	13	0.21
1 - Tee (Flow through branch)	-	5.7	0.09
Straight Piping - 13 feet	-	6.7	0.11
Totals	0	57.4	0.91

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Commonwealth Edison Company
Dresden Station Units 2&3

Low Pressure Core Injection System
Piping Segment Summary

PIPING SEGMENT SUMMARY

Segment J - 13.25 Inch I.D.	5810 GPM		
Component	**K**	**L/D**	**Friction Loss (Ft.)**
1 - Reducer (23.25 x 13.25)	0.05	-	0.14
2 - 90° Standard Radius Elbows	-	60	2.24
1 - Gate Valve	-	13	0.49
1 - Tee (Flow through run)	-	20	0.75
1 - 45° Long Radius Elbow	-	13	0.49
Strainer	-	-	1
Straight Piping - 4.5 feet	-	4.1	0.15
Totals	0.05	110.1	5.25

Segment K - 23.25 Inch I.D.	5750 GPM		
Component	**K**	**L/D**	**Friction Loss (Ft.)**
1 - 90° Long Radius Elbows	-	20	0.08
1 - 45° Long Radius Elbow	-	12	0.05
1 - Gate Valve	-	13	0.05
1 - Tee (Flow through branch)	-	5.7	0.02
Straight Piping - 13 feet	-	6.7	0.03
Totals	0	57.4	0.23

Segment L - 13.25 Inch I.D.	5750 GPM		
Component	**K**	**L/D**	**Friction Loss (Ft.)**
1 - Reducer (23.25 x 13.25)	0.05	-	0.14
2 - 90° Standard Radius Elbows	-	60	2.21
1 - Gate Valve	-	13	0.48
1 - Tee (Flow through run)	-	20	0.74
1 - 45° Long Radius Elbow	-	13	0.48
Strainer	-	-	1
Straight Piping 4.5 feet	-	4.1	0.15
Totals	0.05	110.1	5.19

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Sheet 5 of 8

Commonwealth Edison Company
Dresden Station Units 2&3

Low Pressure Core Injection System
Piping Segment Summary

Notes:

1. Total L/D for the torus ring header was divided equally to each suction loop. With 11620 gpm to the loop with two operating pumps and 5750 gpm to the loop with one operating pump, separate friction losses were calculated. An entrance and strainer loss of 1 foot was assumed for the two-pump loop and 0.25 feet for the loop with one operating pump. Total friction loss to the two-pump loop is 2.47 feet; total friction loss to the one-pump loop is 0.8 feet.

2. With pump centerline as reference, torus water level is 15.0 feet, Segment E is 20.0 feet, location of pipe line break is 50.0 feet and injection header is at elevation 67.0 feet.

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COMMONWEALTH EDISON COMPANY
DRESDEN STATION - UNITS 2&3

LOW PRESSURE CORE INJECTION SYSTEM

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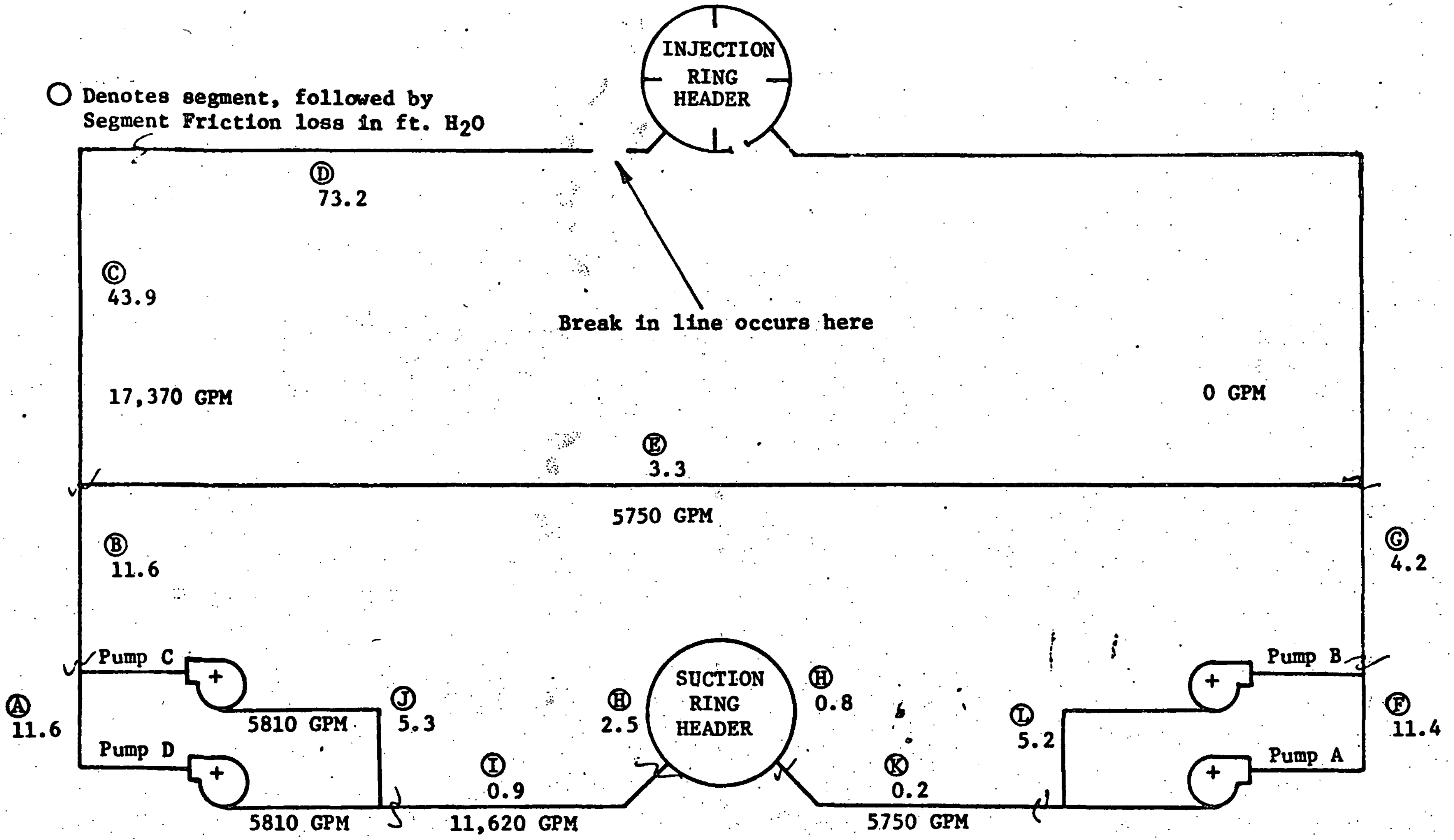
Approved by ______ Date 9-3-76
Sheet 6 of 8



SYSTEM CONDITIONS:
1) Three pumps (A, C and D) injecting into two recirculation loops with one loop broken,
2) Atmospheric pressure above the suppression pool and in the drywell,
3) Torus water temperature of 130°F, 4) Vessel pressure of 56 psig,
5) Suction ring header has one entrance strainer plugged, and
6) Core spray pumps are drawing suction from suction ring header also.

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Sheet 7 of 8

COMMONWEALTH EDISON COMPANY
DRESDEN STATION - UNITS 2&3

LOW PRESSURE CORE INJECTION SYSTEM

The following is for the case with the pumps (A, C and D) injecting into two recirculation loops, with one loop broken.

		Pump A	Pumps C and D
I. Pump Capacity	GPM/Pump	5750	5810
II. Calculated Total Dynamic Head			
1. Total Dynamic Discharge Head			
a) Piping, valves, and components losses	Ft. H_2O	136.0	140.3
b) Static Discharge head	Ft. H_2O	50.0	50.0
c) Total Dynamic Discharge Head	Ft. H_2O	186.0	190.3
2. Total Dynamic Suction Head			
a) Velocity head	Ft. H_2O	- 2.8	- 2.8
b) Piping, Valves and Components losses	Ft. H_2O	- 6.2	- 8.7
c) Static Suction Head	Ft. H_2O	15.0	15.0
d) Total Dynamic Suction Head	Ft. H_2O	6.0	3.5
3. Total Dynamic Head	Ft. H_2O	180.0	186.8

Based on the above flows and Bingham Pump Curve No. 26946,
Pump A Total Dynamic Head = 185 Ft. H_2O and Pumps C and D Total Dynamic Head = 180 Ft. H_2O

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Sheet 8 of 8

COMMONWEALTH EDISON COMPANY
DRESDEN STATION - UNITS 2&3

LOW PRESSURE CORE INJECTION SYSTEM

The following is for the case with three pumps (A, C and D) injecting into two recirculation loops, with one loop broken.

The worst NPSH case is for pumps C and D - operating at 5810 GPM each.

Available Net Positive Suction Head - Pumps C and D

1.	Pressure over water in suppression pool	Ft. H_2O	33.3
2.	Friction loss in suction piping and components	Ft. H_2O	8.7
3.	Vapor pressure, 130°F	Ft. H_2O	5.2
4.	Static suction head	Ft. H_2O	15.0
5.	ANPSH = (Item 1 + 4) - (Item 2 + 3)	Ft. H_2O	34.4 - Call 34 Ft. H_2O

Required NPSH (from Bingham Pump Curve No. 26946) = 37 Ft. H_2O

Response to NRC Questions Concerning LPCI/RHR Pump Runout Situations

Question 2: For the case resulting in largest RNPSH minus ANPSH, describe the NPSH available as a function of time, both short-term and long-term, in the event of a postulated loss-of-coolant accident. Suppression pool temperatures versus time should be indicated, and the effect of pool temperature should be included in the calculation.

Answer: The worst NPSH case analyzed in our letter of August 2, 1976 (from G.A. Abrell to D.L. Ziemann) involved three LPCI pumps injecting into a broken loop at Dresden Station. For this case, the difference between RNPSH and ANPSH was, at worst, 3 feet of head deficient.

Although the details of suppression pool temperature as a function of time are not immediately available for Dresden Station, this information is included in the Quad Cities FSAR. The assumption is made herein that the Dresden plant is similar enough to Quad Cities that the Quad Cities analysis is approximately applicable to Dresden also.

The suppression pool temperature versus time for a postulated LOCA is illustrated by the attached figure 5.2.17 from the Quad Cities FSAR. Also attached is the corresponding containment pressure plot. These figures show that, while torus temperature reaches 130°F within about 2 minutes, containment pressure in a similar time period approaches 25 psig. The suppression pool temperature increase from 95°F causes mild decrease in available NPSH for suction on the torus due to the increased vapor pressure of the pool water. However, the associated pressure increase easily compensates for the temperature induced deficiency. Incorporating both the temperature and pressure effects in the NPSH calculations (this should not be in violation of appropriate Regulatory Guides, since credit for the pressure increase is not required to provide adequate cooling flow.) yields an available NPSH at equilibrium of about 91ft for the worst case (RNPSH for this case is 40ft). Consequently, adequate NPSH is available in even the worst case analyzed to insure that no danger to the pumps will occur.

Question 3: Provide the required NPSH vs time for a postulated LOCA with the worst pump configuration (pump configuration resulting in the largest RNPSH minus ANPSH) for both short and long-term cooling.

Answer: For the worst cases analyzed (Dresden 3 LPCI pumps-injecting into a broken loop, and 3 LPCI pumps injecting into two loops, with one loop broken), the required NPSH for each pump is shown in the tables attached to our letter of August 2, 1976, previously referenced. The RNPSH is a constant as long as flow requirements do not change.

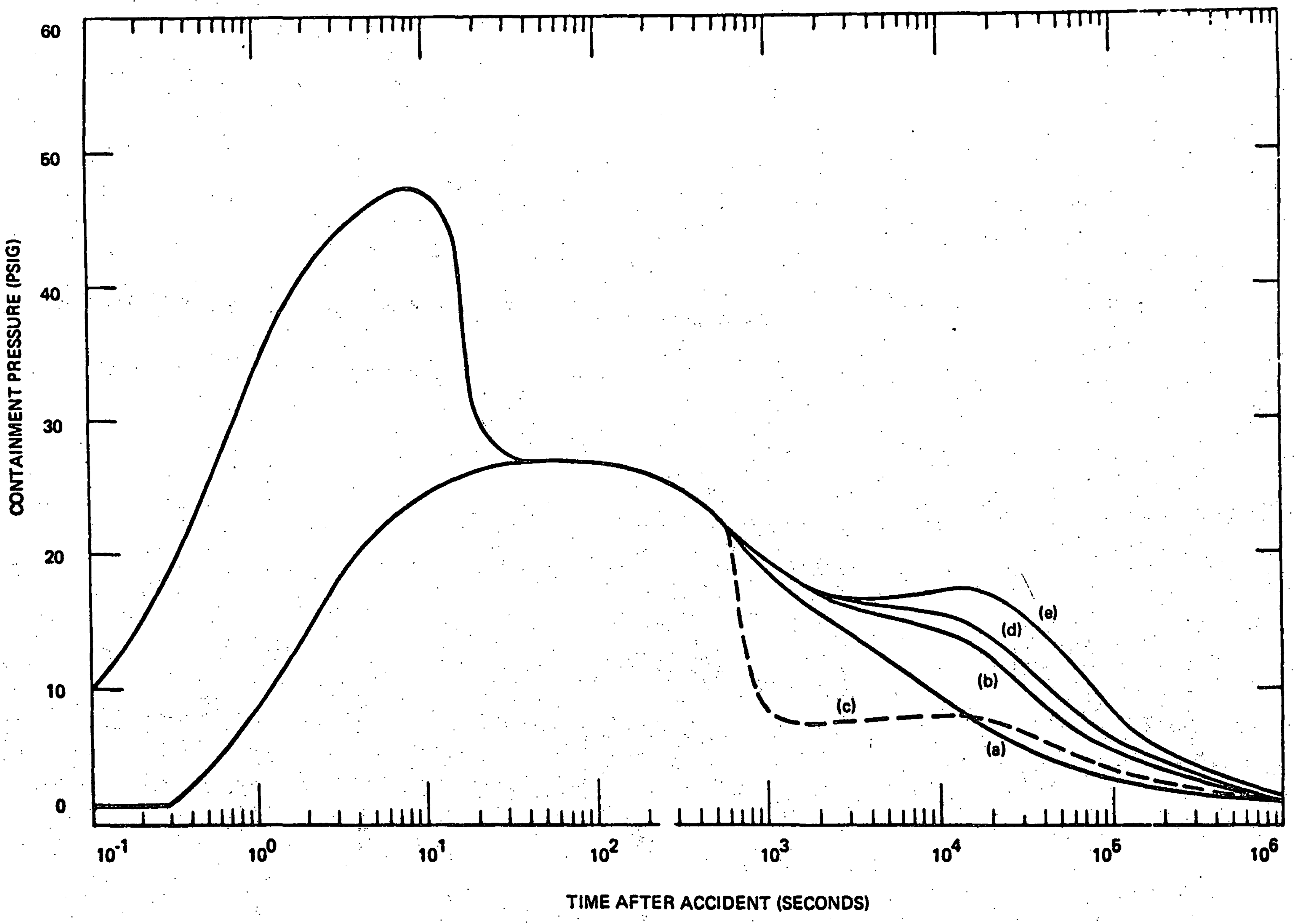

FIGURE 5.2.15. CONTAINMENT PRESSURE RESPONSE FOLLOWING DESIGN BASIS LOSS OF COOLANT ACCIDENT

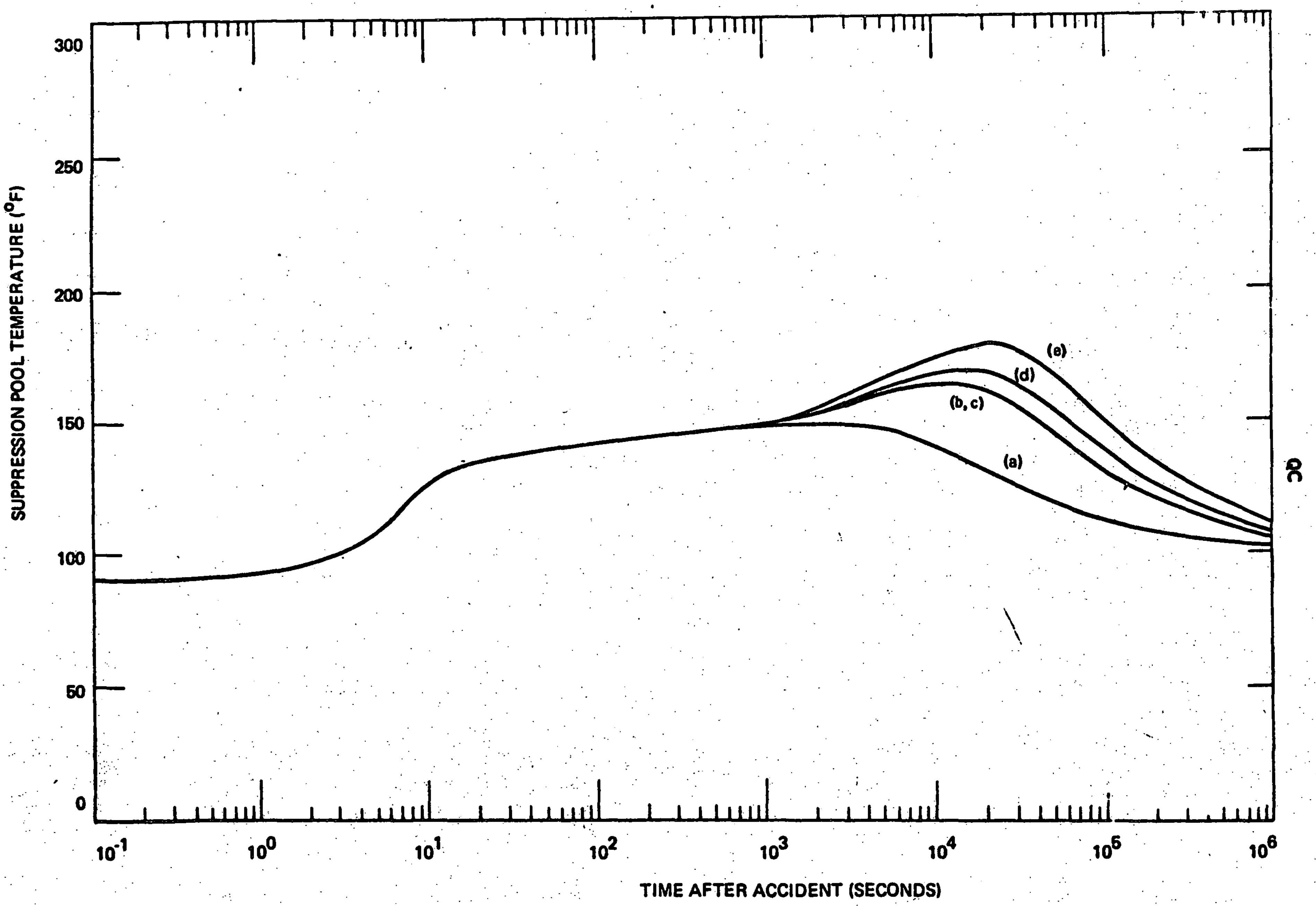

FIGURE 5.2.17. SUPPRESSION POOL TEMPERATURE RESPONSE FOLLOWING DESIGN BASIS LOSS OF COOLANT ACCIDENT

Commonwealth Edison

Response to NRC Questions of August 23, 1976
Concerning LPCI Pump Run Out

Question 4A: "Following a LOCA, what indication of RHR pump flows would the operator have in the control room?"

Answer: There are two flow elements in each injection path. One flow element provides input to an indicator and the other to a flow recorder. The flow recorders and flow indicators are located in the control room at the LPCI/RHR control panels.

Question 4B: "What indications would the operator have to know that the RHR pumps were cavitating?"

Answer: Potential cavitation would be revealed by indications of high flow. Severe cavitation could be indicated by instability of flow indications.

Question 4C: "What action could be taken to alleviate such operation, and how long would such action take?"

Answer: Cavitation could be alleviated by throttling the motor operated angle globe valves 1501-21A/B (Dresden) or motor operated globe valves 1001-28A/B (Quad-Cities). One throttle valve is located in each injection loop. These valves are controlled from the LPCI/RHR control panels in the control room. Action to throttle the pump discharge could be taken as soon as necessary from the control room. Because restoration of the reactor vessel level is of primary concern to the operator in this case, adjustments would be expected within minutes of the LOCA. In fact, all configurations for which a small deficit in required NPSH exists involve postulated failures or breaks which prevent the reflooding of the vessel by the LPCI system.

Question 5: "Assuming the most limiting single failure affecting long term cooling capability, justify your assumption that three pumps is the minimum number of LPCI pumps that may be pumping directly to the break..."

Answer: Only one type of single failure (to our knowledge) results in the possibility of any LPCI pumps injecting into a broken loop; this is a failure of the loop selection logic system (LSLS). If LSLS is operational, no pumps will pump to the break regardless of diesel failure, etc.

Assuming a failure of the LSLS, we have analyzed situations with four pumps injecting into the broken loop, three pumps similarly injecting, and three pumps injecting into two loops with one loop broken and the crosstie valves open (this last case assumes that the pre-selected "B" loop is the broken loop and that LSLS selected the "A" loop without deselecting the "B" loop). The last case results in fewer than three pumps effectively injecting into a broken loop. We did not assume that three pumps was the minimum number of LPCI pumps that could be injecting directly to the break.

Question 6: "Specify the number of pumps assumed to be available in your ECCS Appendix K long term cooling analysis."

Answer: In the Appendix K analysis, four LPCI pumps are assumed available upon initiation. One LPCI pump may be out of service for up to seven days, if all backup systems are tested daily. For long term cooling (i.e., maintaining reactor vessel level following recovery from a LOCA) only one LPCI pump is necessary.