NRC FORM 195 (2-76)

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TO: Mr. George Lear

FROM: Iowa Electric Light & Power Co.
Cedar Rapids, Iowa
Lee Liu

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(1-P)

PLANT NAME:

Duane Arnold

ENCLOSURE

Furnishing Response To Request For Additional Information Related to Potential RHR Pump Runout Conditions.

(16-P)

ACKNOWLEDGED

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NRC FORM 195 (2-76)

IOWA ELECTRIC LIGHT AND POWER COMPANY

General Office
CEDAR RAPIDS, IOWA
September 24, 1976
IE-76-1445

LEE LIU
VICE PRESIDENT – ENGINEERING

50-331

Mr. George Lear, Chief
Operating Reactors Branch 3
Division of Operating Reactors
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Lear:

The enclosed is submitted in response to your letter requesting additional information concerning potential RHR (LPCI) pump runout conditions following a postulated LOCA.

These additional responses do not change our conclusion as stated in my June 18, 1976 letter. The Duane Arnold Energy Center will not experience RHR pump cavitation or pump runout resulting in damaging motor overloading following a postulated LOCA.

Three signed originals and thirty-seven copies of this letter and attachment are transmitted herewith. This letter and its attachment are true and accurate to the best of my knowledge and belief.

Iowa Electric Light and Power Company

By Larry D. Root
Lee Liu *for*
Vice President-Engineering

LL/D
Attachment
cc: K. Meyer
D. Arnold
J. Newman
J. Shea (NRC)
L. Root
File: A-107
A-225
E-17

Subscribed and sworn to before me on this *24th* day of September, 1976.

Wendy A. Rodenhizer
Notary Public in and for the State of Iowa.

NOTARIAL SEAL IOWA
Wendy Rodenhizer
My Commission Expires
September 30, 1979

9751

REQUEST FOR ADDITIONAL INFORMATION RELATED TO POTENTIAL RHR PUMP RUNOUT CONDITIONS

Question

1) What break location was assumed when evaluating the maximum flow possible from a LPCI pump or pumps pumping directly to a break? Describe how the system losses were calculated, including a sketch of the system assumed and a tabulation of the head loss in feet for each component in the system (valves, orifices, heat exchangers, etc.).

Response

1) In condition (1) and (2), as listed in Reference (2), the recirculation line break was assumed to be located at the point where the RHR injection line intersects the reactor recirculation line to minimize flow resistance. In condition (3) listed in Reference (2) the LPCI pumps were directed to this intact reactor recirculation line. The break location in this case was assumed to be between the reactor vessel and the reactor recirculation pump to maximize the effects of a postulated Loss-Of-Coolant-Accident.

   The assumptions used in calculating RHR system losses maximized system resistance in the LPCI pump suction lines and components and minimized system resistance in the LPCI pump injection lines. This maximized the potential for LPCI pump runout and minimized the Net Positive Suction Head (NPSH) available to the LPCI pumps.

   The system configuration for the above three conditions are shown in Figures 1 and 2. The RHR system losses, in equivalent feet of head, for each component are tabulated in Table 1. The flow paths in the RHR system were selected to minimize system resistance in the LPCI pump injection lines and minimize NPSH available to the pumps. In calculating system resistance no credit was taken for static head in reactor vessel during reflooding following a postulated LOCA.

Question

2) Describe the NPSH available to the LPCI pump for the worst pump configuration (single failure resulting in highest pump flow) 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.

Response

2) Iowa Electric has not calculated NPSH available to the LPCI pumps, as a function of time, for the worst pump configuration in the event of a postulated loss-of-coolant accident. Suppression pool temperatures have not been calculated as a function of time.

The NPSH available to the LPCI pumps for the above three conditions are listed in page 3 of the attachment to our previous response (reference 2). The figures for condition (2) represent the worst pump configuration (single failure resulting in the highest pump flow) for both short-term and long-term cooling conditions.

The suppression pool temperature used in calculating available NPSH was conservatively taken as the highest anticipated temperature during any postulated LOCA.

The minimum allowable water level was assumed for the suppression pool. No credit was taken for the pressure in the suppression chamber resulting from the LOCA. The LPCI pump suction strainers were assumed to be 50% plugged. No credit was taken for velocity head in the available NPSH calculations. The calculations for NPSH were performed in accordance with NRC Regulatory Guide 1.1.

Question

3) Provide a complete description of any tests performed by you or the pump manufacturer to demonstrate that the RHR pumps can operate at less than recommended design NPSH conditions without sustaining damage. The description should include the test procedures, the test points, and data taken at each point, i.e. pump flow, pump suction pressure, pump discharge pressure, vibration, water temperature, etc. Give operating times (estimated if not recorded) over which the pumps operated at less than design NPSH. Include observations concerning pump vibration, noise, and cavitation during the tests.

Response

3) As concluded in Reference (2) the analysis has shown that the Duane Arnold Energy Center will not experience less than recommended design NPSH conditions or pump runout following a postulated LOCA. Therefore no tests have been conducted by the licensee to demonstrate the operability of the LPCI pumps at less than recommended design NPSH conditions. The licensee is unaware of any tests which may have been conducted by the manufacturer.

Question

4) Provide the required NPSH vs time for a postulated LOCA with the worst pump configuration (single failure resulting in highest pump flow) for both short and long-term cooling.

Response

4) Iowa Electric has not calculated NPSH vs time. The maximum required NPSH for each LPCI pump for each of the above three conditions following a postulated LOCA have been tabulated on page (3) of the attachment to Reference (2). The figures for condition (2) reflect the highest NPSH required (as taken from the pump performance curves) for the worst pump configuration (single failure resulting in highest pump flow) for both short-term and long-term conditions.

Question

5) Following a LOCA, what indication of RHR pump flows would the operator have in the control room? What indications would the operator have to know that the RHR pumps were cavitating? What action could be taken to alleviate such operation, and how long would such action take?

Response

5) Following a postulated LOCA an operator would have LPCI pump flow indication in the control room on control panel 1C-04, flow indicators FI-1971 A&B. The licensee is not aware of any instrumentation available which would readily give indication of NPSH. No direct indication of NPSH is available in the control room.

As concluded in Reference (2) the analysis has shown that the LPCI pumps at the Duane Arnold Energy Center will not experience pump cavitation or pump runout following a postulated LOCA. However, flow in the RHR system can be throttled from the control room.

In accordance with the licensee's Final Safety Analysis Report, Docket No. 50-331, an operator may take action as necessary after the first 10 minutes following a postulated LOCA.

Question

6) Assuming the most limiting single failure, what is the minimum number of LPCI pumps that may be pumping directly to the break? Be sure to consider diesel failure and valve failures. For this most limiting condition, show that the pump(s) will not sustain significant damage while pumping directly to the break.

Response

6) The most limiting single failure which would cause the minimum number of LPCI pumps to be pumping directly to the break is outlined in item II.A.3 of the attachment to Reference (1). Under these conditions three (3) LPCI pumps would be pumping directly to the break in the recirc loop. As concluded in the attachment to Reference (2), the LPCI pump(s) will not sustain damage due to lack of NPSH or runout in the short-term or long-term for this condition.

Question

7) Define the term "runout" as used in your response.

Response

7) The term "runout" is defined as the flow in GPM of one pump (from parallel operation) running alone, at the point at which the pump Head-Capacity curve intersects the system curve.

Question

8) For the DBA-LOCA assuming the single failure which results in maximum LPCI pump flow, provide a plot or table of the pump motor current requirements and horsepower vs time, and compare these to the motor's recommended limits which you should also supply. Also, calculate the diesel generator load for the generator supplying this current, and compare with the generator's recommended limits. This detail is needed to evaluate the acceptability of your response C, in your June 18, 1976 letter.

Response

8) Condition (2) as listed in the attachment to Reference (2) results in maximum LPCI pump flow. The break location assumed for the reactor recirculation line in condition (2) minimizes system resistance.

The following LPCI pump current requirements are tabulated for condition (2).

	0-25 Minutes		After 25 Minutes	
LPCI PUMP	Max.Motor Current	Max.Allowable Current	Max.Motor Current	Max.Allowable Current
A	1.15 of	1.20 of	*1.17 of	1.15 of
B	Rated	Rated	Rated	Rated
C	"	"	"	"
D	"	"	"	"

*Note: An alarm would sound in approximately two minutes if this condition exists. The operator can read out RHR current and RHR flow in the control room. Actions available to the operator are throttling of RHR flow, closing the valve to the broken loop, closing the cross-tie valve, etc. As stated below, by 25 minutes the operator has secured a LPCI pump in each loop and commenced long-term cooling. In addition, as loads have been conservatively calculated the actual current for these conditions would be less.

Response 8) continued

The following diesel generator load requirements are tabulated for condition (2).

Diesel Generator Load Configuration Per Unit	Required Load Per Unit	Recommended Load Limits Per Unit
1) 0-10 Minutes All Emergency Core Cooling System requirements with an additional LPCI motor load of 100 KW per motor	2396 KW	3250 KW
2a) 10 Minutes-300 Hours All essential loads, with an additional LPCI motor load of 100 KW per motor. One LPCI pump taken out of service by procedure.	2782 KW	3250 KW
2b) 10 Minutes-300 Hours All essential loads, both LPCI pumps in service with an additional LPCI motor load of 100 KW per motor	*3405 KW	3250 KW
3) 300 Hours-Continuous All essential loads, with additional LPCI motor load of 100 KW	2782 KW	2850 KW

*Note: As indicated, both LPCI pumps including an additional LPCI motor load of 100 KW per motor, cannot be run with all the other essential long-term loads on each diesel. However, following a postulated LOCA and reflooding of the reactor vessel, the operator is assumed to take one of the two LPCI pumps loaded on each diesel generator out of service prior to adding additional essential long-term cooling loads. If additional LPCI pumps are desired during long-term cooling (any two LPCI are capable of providing long-term cooling) the operator can take action to avoid overloading the diesel generators. Procedures specifically caution the operator to take one LPCI pump out of service prior to starting long-term cooling loads when the diesels are carrying the load. Therefore, the long-term cooling capability would not be diminished.

Question

9) Specify the number of pumps assumed to be available in your ECCS Appendix K Long-Term Cooling analysis.

Response

9) One pump is assumed to be available in our ECCS Appendix K Long-Term Cooling analysis for containment cooling.

References:

1) NRC Letter, George Lear to Duane Arnold, Docket No. 50-331.

2) IE Letter, Lee Liu to George Lear, IE-76-937, dated June 18, 1976

LPCI SYSTEM LOSSES

Component	Equivalent Length in Feet of 18" Sch.40 Carbon Steel Pipe
Item 1 Suction Strainer	1 (50% plugged)
Item 2 Suction Valve	5.0
Item 3 Suction Strainer	1 (50% plugged)
Item 4 Suction Valve	5.0
Item 5 Cross Tie Valve	16.7
Item 6 Injection Valve	177
Item 7 Injection Valve	177
Item 8 Flow Element	Mode 1) 874.2 Mode 2) 877.0 Mode 3) 875.0
Item 9 Flow Element	Mode 1) 870.2 Mode 2) 876.8 Mode 3) 876.8
Item 10 Jet Pumps	2564.7
Item 11 Jet Pumps	2564.7
Back Flow Through Reactor Recirculation Pump A or B	1768.8
Piping, Misc. Valves & Fittings Point 1 to Point 12	71
Piping, Misc. Valves & Fittings Point 3 to Point 13	45
Piping & Fittings Point 12 to LPCI Pump A	862
Piping & Fittings Point 12 to LPCI Pump C	986
Piping & Fittings Point 13 to LPCI Pump B	622.4
Piping & Fittings Point 13 to LPCI Pump D	896
Piping, Misc. Valves & Fittings LPCI Pump A to Point 14	1637
Piping, Misc. Valves & Fittings LPCI Pump C to Point 14	1368
Piping, Misc. Valves & Fittings LPCI Pump B to Point 15	1613
Piping, Misc. Valves & Fittings LPCI Pump D to Point 15	1362
Piping & Fittings Point 14 to Point 16	991.5
Piping & Fittings Point 15 to Point 17	919
Piping & Fittings Point 16 to Point 17	258

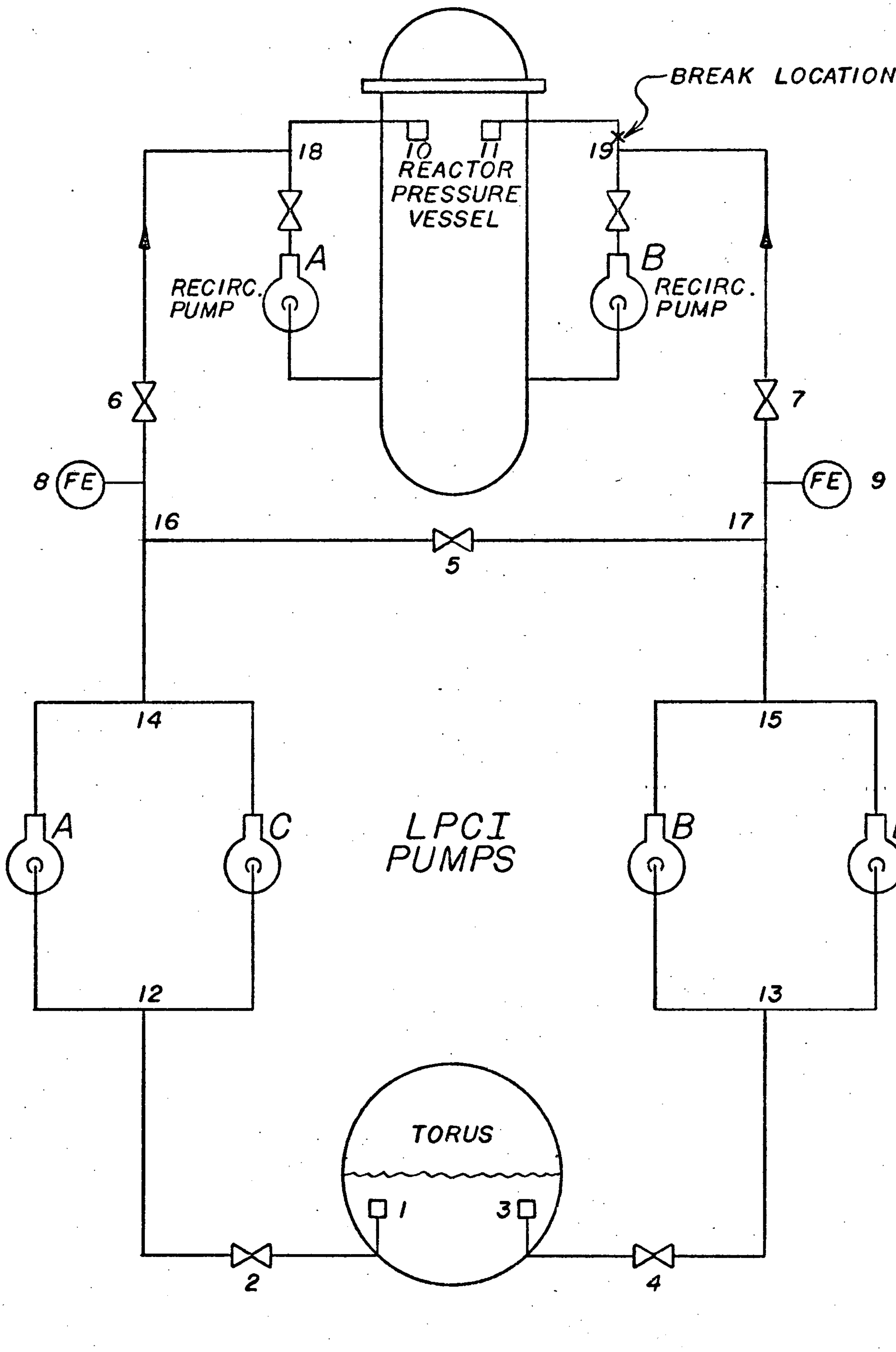
TABLE 1

Component	Equivalent Length in Feet of 18" Sch.40 Carbon Steel Pipe
Piping, Misc. Valves & Fittings Point 16 to Point 18	375
Piping, Misc. Valves & Fittings Point 17 to Point 19	365

All piping, valves and fittings in the A and B reactor recirculation loops were conservatively neglected in all system head loss caluclations.

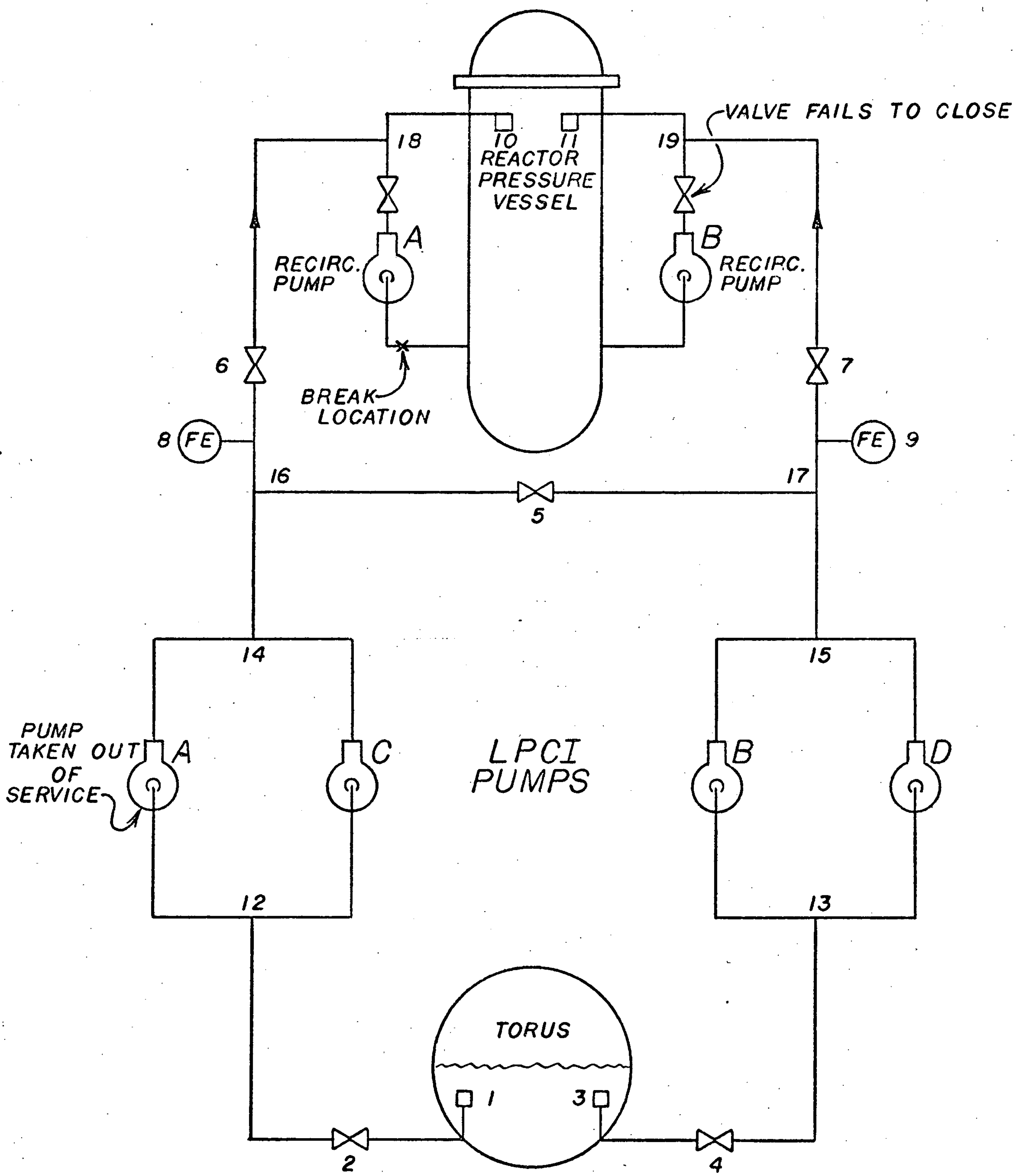
TABLE 1 (Continued)

CONDITIONS 1 & 2



(FIGURE-1)

CONDITION 3



(FIGURE-2)