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Final Report on Delay Tank Leak at the UIUC Nuclear Reactor Laboratory

Description of Event

On Tuesday, January 4, 1994, the delay tanks were accidentally submitted to a compressive stress that resulted in a leak developing in the larger of the two delay tanks. The manner in which this stress was initiated was as follows:

> The reactor operator was doing the pump check portion of the daily checklist and had gotten to the part where the primary pump was started. The pump is started with the isolation valves closed so that the pump starts at a dead head. This reduces starting torque on the motor and verifies that the isolation valves can in fact isolate the reactor tank by confirming that no flow occurs. The isolation valves indicated closed and the operator started the pump. The operator immediately noticed that the pressures were abnormally low, 15 psig discharge pressure and 20 - 25" Hg suction pressure (normal is 2 psig suction and 33 psig discharge with the isolation valves closed). At this point the reactor operator heard the sound of water from the bay and immediately turned off the primary pump. Total elapsed time was 5-10 seconds. The tunnel was opened up and it was found that the roll pin in the operator for the pump outlet valve/reactor tank inlet valve had dislodged and that the valve was slightly open even though it indicated closed. This problem was immediately corrected. The water heard by the operator was due to the pump trying to discharge water into the tank without taking a suction on the tank, thus causing a surge in the water level.
>
> The stress caused by this situation apparently caused a fracture in one of the circumferential weld seams in the large delay tank [see Fig. IV - 6]. The 3 gpm makeup valve operated sporadically during Tuesday afternoon, but that was attributed to the fact that the controller got wet when the tank overflowed. The next day the reactor and primary system were operated and it was noticed that the 3 gpm makeup valve was operating fairly frequently and the operator decided to shutdown the reactor. It was found that there was a vault sump alarm and the vault was opened. Approximately 1400 gallons of water were found in the vault and the leak was immediately evident as it was relatively close to the manway. A physical inspection was

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performed on both delay tanks and no other leaks were found. The leak is approximately 4 inches in length along a circumferential weld on the 3000 gallon tank slightly above the tank centerline.

Comments on Event: The operator actions taken during the event were excellent and fully in accordance with their training and procedures. Three items are noted as being deficient:

1. The delay tanks were not checked immediately for problems after the primary pump was operated with only the suction valve shut. The Reactor Supervisor takes responsibility for this in that he did not expect that a problem would occur from reduced suction pressure on the delay tanks.

2. The vault sump alarm occurred overnight and was not noticed. The vault sump alarm is input to the control console warning window. When the operator came in in the morning to perform the daily checklist the status window of the high resolution screen showed "Source Interlock" since this occurs fairly frequently when the reactor is shutdown. The vault sump alarm had been superseded in the status window and the operator did not see it. The operator then performed the prestart checks on the console which floods the system with scram signals. The operator acknowledged these signals after the prestart checks were done and did not notice the vault sump alarm. This situation is currently being reviewed as to whether or not the daily checklist should identify/record any alarm/warning condition that occurs overnight. It should also be recognized that this inaction by the operator had a minimal effect on the overall situation.

3. The operator performing the daily checklist noticed the excessive primary makeup that had occurred since the previous day, but confused it with the secondary makeup that had occurred due to evaporative losses during cooling tower operation. He also had the expectation of their being more makeup than usual due to the tank overflow the previous day. The operator has since been corrected in his thinking and recognizes his mistake.

Safety Significance of Event

This event did not violate the facility Technical Specifications or the Code of Federal Regulations as near as can be determined. **NO radioactive water was released to the environment and no Technical Specification was violated.** Section 3.5, Reactor Safety Systems, of the Technical Specifications requires a scram and initiation of core spray relative to the reactor tank level. These functions were never compromised. The failure of the roll pin did not affect the ability of the Reactor Safety Systems to perform their required functions. Failure of the roll pin is discussed in the abstract in the 'NOTE' in Section 6.7.2 (1)(c)(iii) of ANSI/ANS - 15.1 - 1990 [see attached] as being an item *"provided in addition to those required by the technical specifications"*. It should be noted that the makeup system performed exactly as designed and maintained the tank level even though there was a slow leak.

The breach of the primary system was not a violation. Whether or not this should be defined as an abnormal occurrence is a subject for discussion and will be followed up on.

Chronology of Corrective Action

- Upon discovery of the leak in the delay tank a visual inspection was performed on the remainder of the welds on the delay tanks and primary piping. No other leaks were found. The Nuclear Regulatory Commission was notified of the problem and kept up to date as progress was made.

- The pneumatic and manual isolation valves for the primary piping were closed to isolate the delay tanks and the delay tanks were pumped down below the level of the leak to the facility retention tank for disposal. No radioactivity above allowable limits was released.

- A welder, qualified in aluminum welding, and employed by the University of Illinois repaired the weld in the delay tank on Monday morning, January 10, 1994. *[It was later determined that the welder was not 'certified' for welding on an ASME qualified tank. This situation developed due to miscommunication on the part of the Reactor Supervisor and the Operations and Maintenance Division of the University of Illinois. The Reactor Supervisor did not specify correctly to O & M what was required.]* It was noted that the crack was very evidently due to the stress placed on the weld and not due to corrosive forces. It was also noted that the area of the original weld where the crack occurred had been ground down. This presents the possibility that a stress zone may have been introduced at that time that failed during the transient. The vast majority of the weldment on the tanks still retained the weld cap material, i.e., no grinding had taken place.

- DNV Industries, Inc. of Des Plaines, IL was engaged to perform an NDE inspection of the weld repair and all other accessible weldment. DNV is certified to inspect aluminum tank welds. Dye penetrant and ultrasonic testing of the weld repair and all other accessible weld material on the delay tanks and the sections of the primary piping were tested. No further cracking was evident on any of the weld seams.

- The University of Illinois welder was later certified on aluminum welding to the satisfaction of the Superintendent, Division of Boiler and Pressure Vessel Safety, Office of the State Fire Marshal. However, when the tank was filled with water weepage was found at both the top and the bottom of the repair weld where the new weld material fused with the original weld material. The tank was drained again and a certified welder from Independent Mechanical Industries, Inc. was brought in to repair these weepage points successfully.

- The Nuclear Reactor Committee met several times to discuss progress on repairs and on March 3, 1994, voted to place the tank back on service upon a satisfactory inspection by the IMI inspector, State of Illinois Pressure Vessel inspector and completion of the R1 form.

- The State of Illinois Pressure Vessel inspector and an inspector from IMI inspected the tank and completed an R1 form for the weld repair (see "Further Comments" at end) on March 9, 1994. The delay tanks were put back on service and normal operation was resumed.

- The possibility of a change in procedure to starting the primary pump with the isolation valves open to prevent a reoccurrence of the trigger event was suggested. The Safety Analysis Report (p. VI-18) for the facility discusses the fact that the pump is started with the isolation valves closed as a way of verifying that the isolation valves will indeed isolate the reactor tank by showing that no primary flow occurs with the pump running and isolation valves closed.

Permanent Changes Made in Response to the Episode

- The installation of a locking device on the roll pin in the primary isolation valve to prevent a reoccurrence of this type of event is being installed. A simple lockwire will be installed in both isolation valve operators. A 50.59 has been reviewed by the Reactor Committee.

- An annual surveillance was created that will change out the roll pin in both valve operators as well as the tie rod between the two valves and the pneumatic operator.

- A water tight cover will be manufactured for the water level controller.

- Consideration will be given to changing the daily checklist to record alarm/warning conditions.

- Consideration is being given to installation of permanent LEDs that will light and remain lit when a specific warning condition exists for significant warning conditions.

- Consideration will be given to re engineering the way in which the micro switches activate for primary isolation valve position such that perhaps it can be designed in such a way the actuator rod goes through the roll pin (or by use of a longer roll pin) to actuate the switches. Currently the micro switches are operated by movement of the valve operator which is seated on the valve stem.

Further Comments

The weld and subsequent repair were performed in accordance with the ASME codes, however this does not restore the ASME class U rating to the tank. The repair form (R1 form) documents that this repair has met the ASME codes. There are several reasons why the class U stamp cannot be reinstated:

1. In 1974 a similar event occurred where a vacuum was drawn on the tank and a leak was caused. The leak was repaired by a welder from the University of Illinois Physical Services. This was reported to the NRC (received by NRC on September 20, 1974) and subsequently reviewed during an inspection that occurred on February 25 - 27, 1975. The inspection report indicates that the leak and actions taken were reviewed and no items of noncompliance were noted. There is no documentation that the welder was ASME certified, what type of weld material was used for the repair, that a repair certificate was generated in response to the repair or what type of testing might have been done after the repair. It is reasonable to assume that the welder was not certified and that a repair certificate was not generated. At this point in time the tank was no longer an ASME class U tank.

2. No documentation would appear to exist to document the original construction of the tank, testing performed on the tank or on the original welds.

3. No Material Safety Data Report would appear to exist for the tank.

A 50.59 review will be performed for the deviation from the facility Safety Analysis Report (SAR), since in 1974 the class U rating on the tank was lost and at that point the tank deviated from the description as stated in the SAR.

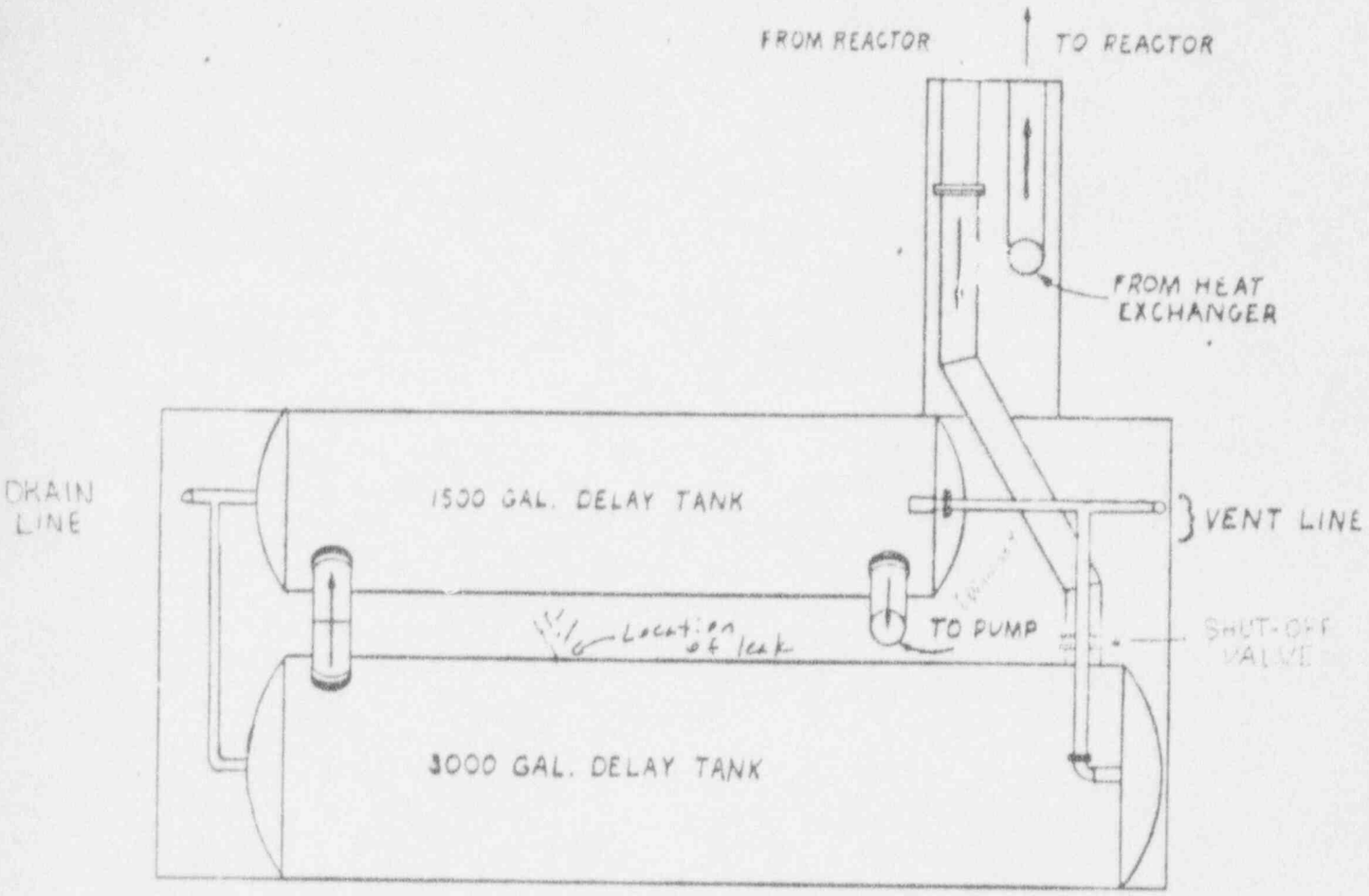
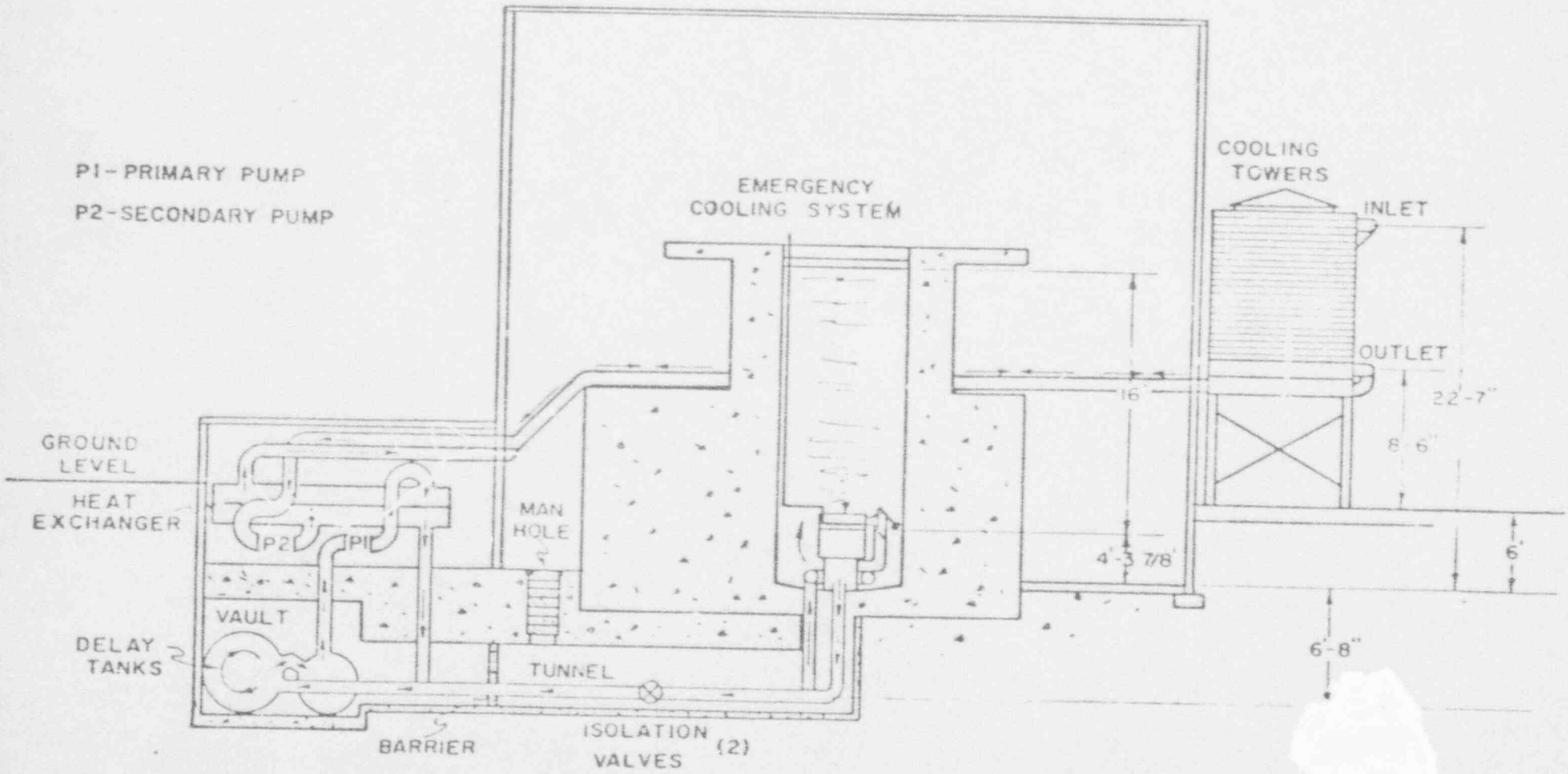


FIG. IV-6 PRIMARY FLOW COMPONENTS IN THE VAULT



COOLING SYSTEM ELEVATION

Figure IV - 2

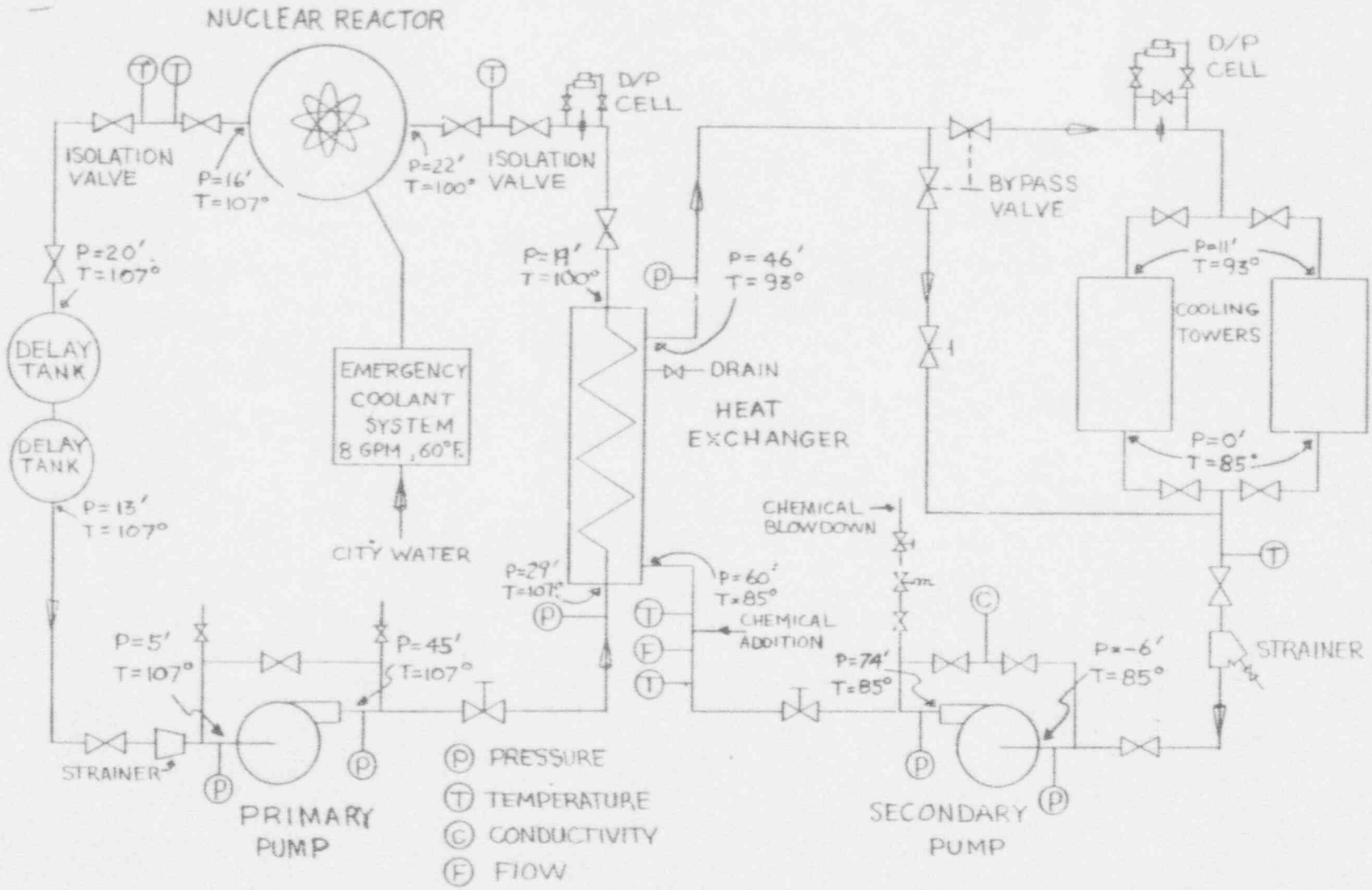


FIG. IV-1 FLOW DIAGRAM OF THE REACTOR COOLANT SYSTEM