Central files

GL-80-69

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
631 PARK AVENUE
KING OF PRUSSIA, PENNSYLVANIA 19406

July 24, 1980

Docket Nos. 50-03
50-247

Consolidated Edison Company of
New York, Inc.
ATTN: Mr. Peter Zarakas
Vice President
4 Irving Place
New York, New York 10003

Gentlemen:

The enclosed IE Bulletin No. 80-18, "Maintenance of Adequate Minimum Flow Thru Centrifugal Charging Pumps Following Secondary Side High Energy Line Rupture," is forwarded to you for action. A written response is required.

In order to assist the NRC in evaluating the value/impact of each Bulletin on licensees, it would be helpful if you would provide an estimate of the manpower expended in conduct of the review and preparation of the report(s) required by the Bulletin. Please estimate separately the manpower associated with corrective actions necessary following identification of problems through the Bulletin.

If you desire additional information regarding this matter, please contact this office.

Sincerely,

James M. Allan
for Boyce H. Grier
Director

Enclosures:
1. IE Bulletin No. 80-18 and Enclosure with 2 Attachments
2. List of Recently Issued IE Bulletins

CONTACT: E. G. Greenman
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Enclosure 1

SSINS No.: 6820
Accession No.:
8005050062

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

IE Bulletin No. 80-18
Date: July 24, 1980

MAINTENANCE OF ADEQUATE MINIMUM FLOW THRU CENTRIFUGAL CHARGING PUMPS FOLLOWING SECONDARY SIDE HIGH ENERGY LINE RUPTURE

Description of Circumstances:

Letters similar to the May 8, 1980 notification made pursuant to Title 10 CFR Part 21 (enclosure) were sent from Westinghouse to a number of operating plants and plants under construction (list, within enclosure) in early May, 1980.

The letters and the enclosed "Part 21" letter contain a complete description of the potential problem summarized below. The letters indicated that under certain conditions the centrifugal charging pumps (CCPs) could be damaged due to lack of minimum flow before presently applicable safety injection (SI) termination criteria are met. The particular circumstances that could result in damage vary somewhat from plant to plant, but involve unavailability of the pressurizer power operated relief valves (PORVs), with operation of one or more CCPs repressurizing the reactor during SI following a secondary system high energy line break. Since the SI signal automatically isolates the CCP mini-flow return line, the flow through the CCPs is determined by the individual pump characteristic head vs. flow curve, the pressurizer safety valve setpoint, and the flow resistances and pressure losses in the piping and in the reactor core. That minimum flow may not be adequate to insure pump cooling, and resulting pump damage could violate design criteria before current SI termination criteria are met.

Westinghouse recommends that plant specific calculations outlined in the letter (enclosure) be performed to determine if adequate minimum flow is assured under all conditions. If adequate minimum flow is not assured, Westinghouse recommends specific equipment and procedure modifications which will result in adequate minimum flow. The recommended modifications assure availability of the necessary minimum flow by assuring that the mini-flow bypass line will be open when needed, but will be closed at lower pressures when the extra flow resulting from bypass line closure might be necessary for core cooling.

Actions to be taken by PWR licensees listed in the enclosure as "operating plants," and those listed as "non-operating plants" which are nearing licensing* are listed below:

1. Perform the calculations, outlined in the enclosure, for your plant.

2. If availability of minimum cooling flow for the CCPs is not assured for all conditions by the calculations in 1:

   a. Make modifications to equipment and/or procedures, such as those suggested in the enclosure, to insure availability of adequate minimum flow under all conditions. If modifications are made as described in the attachment for interim modification II, verify that the Volume Control Tank Relief Valve is operable and will actuate at its design setpoint.

   b. Justify that any manual actions necessary to assure adequate minimum flow for any transient or accident requiring SI can and will be accomplished in the time necessary.

   c. Verify that any manipulations required (valve opening or closing, along with the instrumentation necessary to indicate need for the action or accomplishment of the action, etc.) can be accomplished without offsite power available.

   d. Justify that flow available from the CCPs with the modifications in place will be sufficient to justify continued applicability of any safety related analyses which take credit for flow from the CCPs (LOCA, HELB, etc.).

   e. Justify that all Technical Specifications based on the Item 2.d analyses remain valid.

3. Provide the results of calculations performed under Item 1, and describe any modifications made as a result of Item 2 (include the justifications requested).

Actions to be taken by PWR licensees not listed in the enclosure are listed below:

1. In a quantitative manner similar to 1 above, determine whether or not minimum cooling is provided to centrifugal pumps used for high pressure injection, for all conditions requiring SI, prior to satisfying SI

*Those listed in the enclosure considered to be "nearing licensing" are: North Anna 2, Diablo Canyon 1, McGuire 1, Salem 2, and Sequoyah. These plants must respond in writing within the specified time. Other non-licensed plants whether or not listed in the enclosure, are not required to submit a written response at this time.

termination criteria. If a "minimum flow bypass" line is present which remains open during high pressure injection, and if that line guarantees that minimum cooling flow will be provided to the pumps under such conditions, then no further calculations are required if all safety related analyses (Item 2.d above) assumed presence of the open line.

2. Same as 2 above.

3. Same as 3 above.

Licensees of all operating PWR power reactor facilities and those nearing licensing* shall submit the information requested within 60 days of the date of this letter. Include in your response to this Bulletin, (a) your schedule for any changes proposed, (b) if reactor operation is to continue prior to completion of the proposed changes, include your justification for continued operation.

Reports shall be submitted to the Director of the appropriate NRC Regional Office and a copy forwarded to the Director, NRC Office of Inspection and Enforcement, Division of Reactor Operations Inspection, Washington, D. C. 20555.

Approved by GAO, B280225 (R0072); clearance expires 7-31-80. Approval was given under a blanket clearance specifically for identified generic problems.

Enclosure:
Ltr from T. M. Anderson, W
to V. Stello, IE dtd 5/8/80
and Enclosure with 2 Attachments

*Those considered to be "nearing licensing" are: North Anna 2, Diablo Canyon 1, McGuire, Salem 2, and Sequoyah.

Enclosure to IE Bulletin 80-18

Westinghouse Electric Corporation

Water Reactor Divisions

Nuclear Technology Division

Box 355
Pittsburgh Pennsylvania 15230

May 8, 1980

NS-TMA-2245

80-219-000

Mr. V. Stello, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
1717 H Street
Washington, D. C. 20555

Subject: Centrifugal Charging Pump Operation Following Secondary Side High Energy Line Rupture

Dear Mr. Stello:

This letter is to confirm the telephone conversation of May 8, 1980 between Westinghouse and Mr. Ed Blackwood of Division of Reactor Operations Inspection, Office of Inspection and Enforcement, regarding notification made pursuant to Title 10 CFR Part 21.

A review of the Westinghouse Safety Injection (SI) Termination Criteria following a secondary side high energy line rupture (feedline or steamline rupture at high initial power levels) has revealed a potential for consequential damage of one or more centrifugal charging pumps (CCPs) before the SI termination criteria are satisfied and CCP operation terminated. Such consequential damage may adversely impact long-term recovery operations for the initiating event and is not permitted by design criteria. This concern exists for plants which utilize the CCPs as Emergency Core Cooling System (ECCS) pumps, where the CCPs are automatically started, and where the CCP miniflow isolation valves are automatically isolated upon safety injection initiation. Attachment A identifies plants potentially subject to this concern. A summary of the concern and recommendations follow.

Following a secondary side high energy line rupture and associated reactor trip, Reactor Coolant System (RCS) pressure and temperature initially decrease. Safety injection is actuated and the CCPs start to increase RCS inventory. Reactor Coolant System pressure and temperature subsequently increase due to the loss of secondary inventory, steamline and feedline isolation, RCS inventory addition and reactor core decay heat generation. The accident scenario may vary with rupture size and specific plant design, but it will develop into a RCS heatup transient with accompanying increase in RCS pressure. As RCS pressure increases, the pressurizer power-operated relief valves (PORVs) are designed to limit RCS pressure to 2350 psia. Although these valves are normally available, they are not designed as safety-related equipment. It can be postulated that, due to either loss of offsite power, adverse environment inside containment, the pressurizer PORV in manual mode, or the PORV block valve in a closed position, due to PORV leakage, the pressurizer PORVs may not be operable. As a result of the RCS heatup and inventory increase, the RCS pressure could rise to the pressurizer safety valve setpoint of 2500 psia within approximately 200 seconds and remain at that pressure until transient "turnaround." Transient "turnaround" can occur between 1800 and 4200 seconds depending on operator action and available equipment. During the initial portion of this transient, the SI termination criteria may not be satisfied. Consequently, the RCS pressure can reach the pressurizer safety valve relief pressure before CCP operation is terminated. During this period, the minimum flow required for CCP operation must be satisfied by flow to the RCS since the CCP miniflow isolation valves are automatically closed on safety injection initiation. This requires that the CCPs be able to deliver their minimum required flow to the RCS at the safety valve setpoint pressure.

To evaluate this concern, Westinghouse has developed a calculational method and has reviewed typical CCP head versus flow performance curves and other representative plant parameters. The calculational method considers the effects of safety valve relief setpoint accuracy, RCS piping resistance, ECCS piping resistance, number of CCPs operating, technical specification allowable CCP head degradation, and uncertainties associated with in-plant verification testing. The analyses for two CCP operation, the best estimate condition, is similar to the analysis for one CCP operation except that the flowrate used to determine ECCS piping line loss must ensure the minimum flow through each pump. For example, at a specific required head, the pump with the higher developed head may be required to deliver greater than the minimum flow in order to permit the lower head pump to meet the minimum flow requirement. This generic evaluation indicates that sufficient flow to satisfy CCP minimum flow requirements to avoid pump degradation may not be ensured for a secondary system high energy line rupture under the conditions described above.

Based on the generic evaluation, Westinghouse recommends that operating plants perform a plant specific evaluation to assess this concern. Attachment B provides the Westinghouse calculational method and a sample calculation which can be used in this evaluation. Based on Westinghouse generic review, satisfactory results may not be obtained. Should a plant specific concern be identified, the following recommendations have been developed and can be tailored to specific plant applications for the interim until necessary design modifications can be implemented. The interim modifications consist of system alignment and operating procedure changes to provide backup to the pressurizer PORVs in ensuring that CCP minimum flow requirements are satisfied. In conjunction with the interim modifications, it is recommended that plants, (a) review the pressurizer PORV operations to maximize the availability of these valves to limit challenges to the pressurizer safety valves, and (b) review the maintenance operations and technical specifications for the backup (i.e., third) charging pump to maximize its availability for long-term recovery from a secondary side rupture. These recommendations, in combination with the interim modifications described below, are considered sufficient to address this concern in the interim until necessary design modifications can be implemented.

Interim Modification I

This interim modification is preferred and requires that component cooling water be supplied to the seal water heat exchanger following safety injection initiation in order to provide cooling for CCP miniflow.

1. Verify that CCP miniflow return is aligned directly to the CCP suction during normal operation with the alternate return path to the volume control tank isolated (lock closed).

2. Remove the safety injection initiation automatic closure signal from the CCP miniflow isolation valves.

3. Modify plant emergency operating procedures to instruct the operator to:

   a. Close the CCP miniflow isolation valves when the actual RCS pressure drops to the calculated pressure for manual reactor coolant pump trip.

   b. Reopen the CCP miniflow isolation valves should the wide range RCS pressure subsequently rise to greater than 2000 psig.

Interim Modification II

This modification is an alternative for plants in which component cooling water is not supplied to the seal water heat exchanger following safety injection initiation. Since miniflow cooling is not provided, this alternative directs miniflow to the volume control tank to permit the CCP minimum flow requirements to be satisfied with cool uncirculated water. The volume control tank acts as a surge tank to collect miniflow following safety injection initiation with excess flow directed to a holdup tank via the volume control tank relief valve.

1. Align the CCP miniflow to the volume control tank during normal operation with the miniflow return path direct to the CCP suction isolated (lock closed). Verify that the volume control tank relief valve and discharge line capacity exceeds the miniflow requirements of all CCPs plus the reactor coolant pump seal return flow.

2. Same as Interim Modification I, Item 2.

3. Same as Interim Modification I, Item 3.

Based on the generic evaluation, Westinghouse has initiated efforts to perform additional plant specific analyses for non-operating plants and to develop design modifications to resolve any identified concerns. The modifications will be designed to safety-related standards and will be compatible with Westinghouse SI termination criteria and standardized technical specifications.

If you require further information, please call Ray Sero (412-373-4189) of my staff.

Very truly yours,

T. M. Anderson, Manager
Nuclear Safety Department

TMA/jaw

Attachments

ATTACHMENT A

OPERATING PLANTS

3-Loop

Beaver Valley 1
Farley 1
Surry 1 & 2
North Anna 1 & 2

4-Loop

Cook 1 & 2
Salem 1 & 2
Trojan
Zion 1 & 2
Sequoyah 1

NON-OPERATING PLANTS

Beaver Valley 2
Farley 2
Shearon Harris 1, 2, 3 & 4
Virgil Summer

Braidwood 1 & 2
Byron 1 & 2
Calloway 1 & 2
Catawba 1 & 2
Comanche Peak 1 & 2
Diablo Canyon 1 & 2
Jamesport 1 & 2
Haven
Marble Hill 1 & 2
McGuire 1 & 2
Millstone 3
Seabrook 1 & 2
Sequoyah 2
Sterling
Vogtle 1 & 2
Watts Bar 1 & 2
Tyrone
Wolf Creek

MINIMUM CENTRIFUGAL CHARGING PUMP FLOW DURING TWO PUMP PARALLEL SAFETY INJECTION OPERATION

In order to ensure that minimum pump flow is maintained during parallel safety injection operation of two centrifugal charging pumps (CCPs), Westinghouse provides below a sample calculation utilizing actual plant data and determines what actual CCP developed head at the miniflow flowrate must be available.

Step 1: Individually determine the developed head of each CCP at the miniflow flowrate of 60 gpm from field test data. (two pumps for 4-loop plants and three pumps for 3-loop plants)

Sample: Maximum developed head pump
2571.4 psid = 5940 ft. @ 60 gpm

Minimum developed head pump
2554.1 psid = 5900 ft. @ 60 gpm

Step 2: Correct the pump head for testing error. Add the appropriate error in determining the above measured developed head, i.e., instrument error plus reading error, to the maximum developed head and subtract this error from the minimum developed head.

Sample: Pressure instrument accuracy of ± 0.5 percent x span of measuring instrument of 3000 psig = 15 psi (35 ft. of head), plus 10 psi (23 ft.) reading accuracy = 58 ft.

The resultant CCP developed heads at miniflow which can be supported are a maximum developed head of 5998 ft. for the maximum head pump, and a minimum developed head of 5842 ft. for the minimum head pump.

Step 3: Determine total CCP flow. Construct a pump curve for the maximum head pump that is parallel to the actual "as-built" vendor pump curve and passes through the above determined developed head at the miniflow flowrate which is the measured developed head plus the determined measurement accuracy. (See attachment Figure 1.)

Use this head versus flow curve to determine the flow delivered by the maximum head pump (strong pump) at the developed head of the minimum head pump (weak pump) at the miniflow flowrate (i.e., 5842 ft. as determined in Step 1).

Sample: As illustrated in Figure 1, the delivered flow of the strong pump at 5842 ft. is 150 gpm. Therefore, the total flow from both CCPs which guarantees that the weak CCP will be delivering at least 60 gpm is 210 gpm (150 gpm + 60 gpm).

Step 4: Determine Injection Piping Head Loss. The head loss due to friction in the safety injection/RCP seal injection piping is determined as follows:

The Δh_f is equal to the strong CCP developed head at runout flow. This resistance is established during the CCP flow balance testing which limits CCP flow to the runout limit. The injection piping resistance (k) is equal to the developed head of the strong CCP at its runout flow divided by the (runout flowrate)^2.

e.g. $$k = \frac{\text{developed head}}{(\text{runout flowrate})^2} = \frac{\Delta h}{Q^2} = \frac{1500\text{ ft.}}{(550\text{ gpm})^2}$$

$$k = 4.96 \times 10^{-3}\text{ ft./gpm}^2$$

The resistance of the injection piping (Δh_f), at the total CCP flow required to maintain 60 gpm through the weak CCP is:

$$\Delta h_f = kQ^2 \text{ or } \Delta h_f = (4.96 \times 10^{-3} \frac{ft.}{gpm^2}) (210 \text{ gpm})^2 = 219 \text{ ft.}$$

<u>Step 5:</u> Determine head loss through the Reactor Coolant System. Consider that the reactor coolant pumps are operating, therefore, the pressure drop from the CCP cold leg injection nozzles through the reactor vessel to the pressurizer surge line off the hot leg at full RCS flow are to be included. This pressure drop is approximately 50 psid (116 ft.) for 4-loop plants and 48 psid (111 ft.) for 3-loop plants. This pressure drop must be overcome by the CCPs in order to deliver flow to the RCS at the hot leg/pressurizer pressure.

<u>Step 6:</u> Determine the elevational head between the RWST and the pressurizer safety valves.

e.g.	RWST elevation	- 160 ft.
	CCP suction elevation	- 100 ft.
	RCS cold leg injection nozzle elevation	- 126 ft.
	Pressurizer safety valve elevation	- 187 ft.
	RWST to CCP suction	- 60 ft.
	minus CCP suction to RCS	- (-26 ft.)
	minus RCS to pressurizer safety valves (61 ft. assuming a full pressurizer) corrected for density difference	- <u>(-44 ft.)</u>
		-10 ft.

Thus, in this example the CCPs must provide an additional 10 ft. of elevational head.

Step 7: Calculate the pressurizer safety valve relief pressure.

e.g. relief pressure = safety valve nominal relief pressure + 1% setting tolerance

relief pressure = 2485 psig + 25 psig = 2510 psig (5798 ft.)

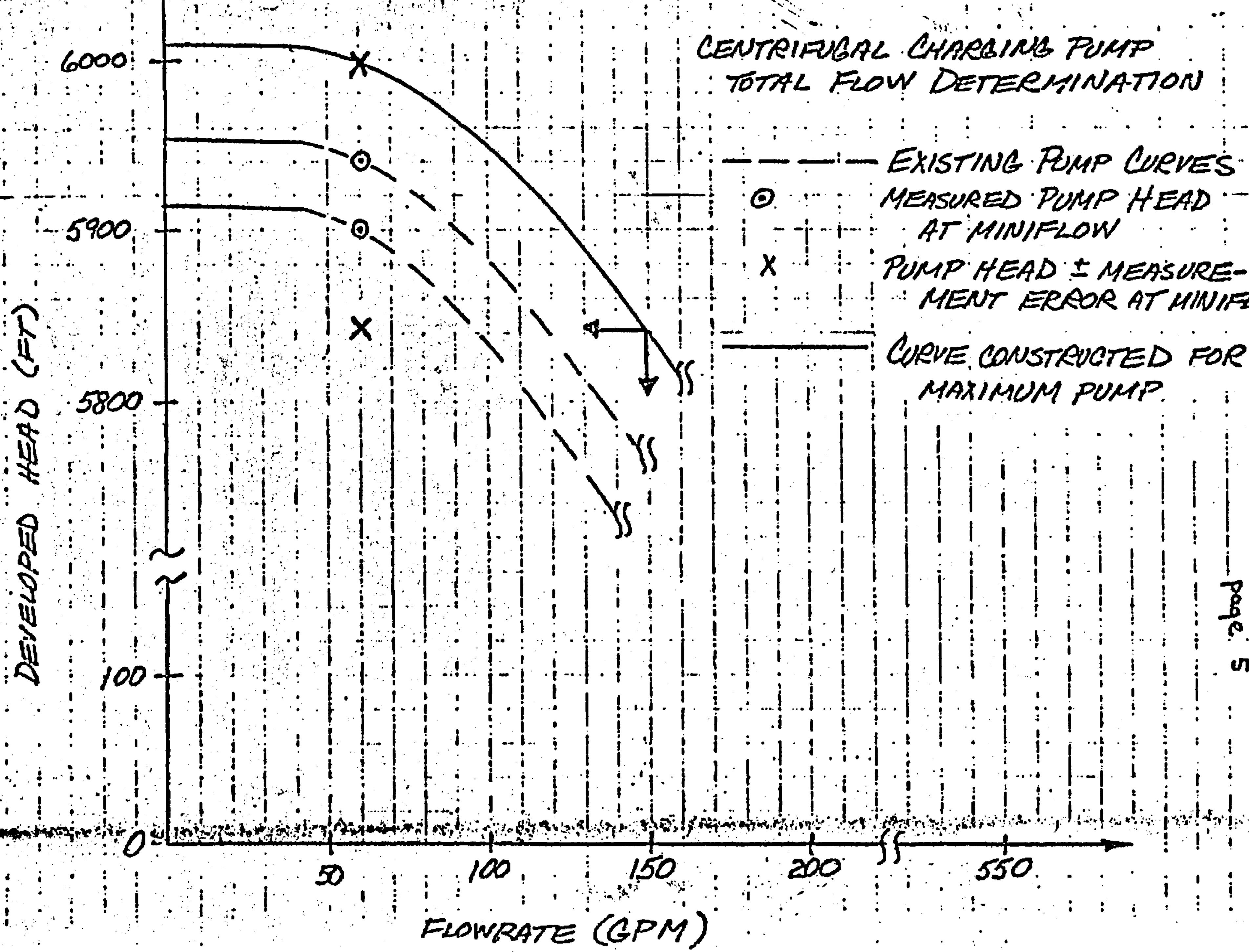
Step 8: Determine the maximum RCS pressurizer pressure at which 60 gpm minimum flow is maintained through the weak CCP.

Maximum RCS pressure = (CCP developed head at total CCP flowrate) - (injection piping head loss) - (head loss through RCS) - (elevation head loss)

Maximum RCS pressure = 5842 ft. - 219 ft. - 116 ft. - 10 ft. = 5497 ft. = 2380 psig

Comparing this pressure to the pressurizer safety valve relief pressure (Step 7) of 2510 psig, it is evident that the 60 gpm flow required for the weak CCP will not be maintained.

FIGURE 1



ATTACHMENT B
Page 5

IE Bulletin No. 80-18
July 24, 1980

Enclosure 2

RECENTLY ISSUED
IE BULLETINS

Bulletin No.	Subject	Date Issued	Issued To
Supplement 2 to 80-17	Failures Revealed by Testing Subsequent to Failure of Control Rods to Insert During a Scram at a BWR	7/22/80	All holders of BWR power reactor OLs
Supplement 1 to 80-17	Failure of Control Rods to Insert During a Scram at a BWR	7/18/80	All holders of a BWR OL or CP
80-17	Failure of Control Rods to Insert During a Scram at a BWR	7/3/80	All holders of a BWR OL or CP
80-16	Potential Misapplication of Rosemount Inc., Models 1151 and 1152 Pressure Transmitters with Either "A" or "D" Output Codes	6/27/80	All holders of a power reactor OL or CP
80-15	Possible Loss Of Hotline With Loss Of Off-Site Power	6/18/80	All holders of a power reactor OL and fuel cycle licensees connected to the Emergency Notification System
80-14	Degradation of Scram Discharge Volume Capability	6/12/80	All holders of a BWR OL
80-13	Cracking In Core Spray Spargers	5/12/80	All holders of a BWR OL
80-12	Decay Heat Removal System Operability	5/9/80	All holders of a PWR OL
80-11	Masonry Wall Design	5/8/80	All holders of a power reactor OL, except Trojan
80-10	Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release to Environment	5/6/80	All holders of a power reactor OL or CP