Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
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REGULATORY DOCKET FILE COPY

August 2, 1976

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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
Long Term Cooling Capability
NRC Dockets 50-237/249 and 50-254/265

Reference (a): D. L. Ziemann Letter to R. L. Bolger dated May 20, 1976

Dear Mr. Ziemann:

Reference (a) requested an analysis of potential run out conditions for the residual heat removal (RHR) and low pressure coolant injection pumps (LPCI) at Dresden Units 2 and 3 and Quad-Cities Units 1 and 2.

Analyses are enclosed for the following cases:

1. Three and four pump combinations injecting simultaneously into both recirculation loops with one broken loop.

2. Three and four pump combinations injecting into one broken loop. The break in this case is assumed at the injection point in the recirculation loop, and no credit is assumed for recirculation piping resistance.

3. Three and four pump combinations injecting into one intact loop with the discharge valve open.

The following assumptions were made in the calculations:

A. Torus water temperature is 130°F and is assumed to be the maximum to which the torus water termperature will increase.

B. No credit is taken for increase in torus level after the LOCA.

8010

C. Atmospheric pressure about the suppression pool and in the drywell is 14.7 psia.

D. Reactor pressure is 56 psig.

E. The containment cooling heat exchanger bypass valve is open.

F. LPCI and RHR design flow point is 5350 GPM.

G. Run out is interpreted as a point on the flow characteristic at which cavitation occurs because the net positive suction required exceeds the available NPSH.

H. The suction valve will isolate even if the discharge valve does not and thus prevent backflow through the pump.

A review of the data indicates only a few instances in which the required NPSH exceeds the available NPSH. The most extreme case is a three foot deficiency in one of the Dresden Case 2 three pump combinations. The presence of a two pound pressure in the drywell will offset this deficiency and two pounds in the drywell is one of the signals needed to initiate the emergency core cooling system. Although drywell pressure is taken as atmospheric, for the breaks assumed in the calculations, there will be an estimated 20 to 35 pounds in the drywell and suppression chamber. It is, therefore, concluded that a condition will not exist wherein the NPSH will not be sufficient to prevent cavitation.

During a LOCA, the operator's concern will be restoration of the vessel water level. The LPCI flow will be among the parameters closely monitored in the minutes immediately after the LOCA. The operator has several motor operated valves available to him in the control room to adjust flow rates or even isolate flow paths. It is, therefore, concluded that operator observation and response to flow conditions will be completed shortly after the LOCA.

Even in the event of cavitation, the vendors, Bingham Pump Company, has conducted cavitation tests at points between 4,000 and 6,000 GPM with no significant effect on the pump internals after an hour of such operation. See Enclosure (3) for details.

Because of falling head characteristics of these pumps, the brake horsepower (BHP) requirements are nearly constant from 4,000 to 6,000 GPM. It is thus concluded that no overload will occur for either the LPCI/RHR pumps or the emergency diesel generators powering them in the event of a loss of off-site power.

It is, therefore, concluded that for the conditions evaluated, no threat to the long term cooling capability exists and no modifications to the existing systems are required.

Please address any additional questions to this office.

One (1) signed original and 39 copies are provided for your use.

Very truly yours,

G. A. Abrell
Nuclear Licensing Administrator
Boiling Water Reactors

Enclosures(1): Commonwealth Edison Company's response to General Electric SIL 151.

(2): Commonwealth Edison Company's LPCI/RHR System Performance with Three Pumps in Operation.

(3): Bingham Pump Company's Cavitation Test Report 12 x 14 x 14½ CVDS Pump.

(4): Bingham Pump Company's Characteristic Curve Set.

Sargent & Lundy
Chicago, Illinois

NRC Dkts. 50-237/249
50-254/265

COMMONWEALTH EDISON COMPANY
RESPONSE TO GENERAL ELECTRIC SIL 151

Station	Unit(s)	Case No.	Pump (Pair) Flows, gpm AB PAIR	CD PAIR	RNPSH	ANPSH at 130°F
Dresden	2, 3	1	10860	11000	34.0	33.9
		2	10640	10770	33.0	34.3
		3	9560	9470	28	36.1
Quad Cities	1, 2	1	10910	10820	34.0	33.2
		2	10230	10190	30.0	34.4
		3	9160	9070	28	36.1

NOTES:
1a) Design flow, pump pair: 10700 gpm
b) Runout flow, pump pair: 12000 gpm
2) Net positive suction head calculated for greater pump flow in each case
3) Friction drop for NPSH calculation at flows other than design obtained by square of flows factor.
4) Torus water temperature from GE process diagram 730E775
5) Pressure above torus 14.7 psia (Ref. reg. guide 1.1)
6) Strainer nearest pump is plugged (Ref. G.E. 730E775)

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COMMONWEALTH EDISON COMPANY

LPCI/RHR SYSTEM PERFORMANCE WITH THREE PUMPS IN OPERATION
FOR CASES OUTLINED IN GENERAL ELECTRIC SIL 151

CASE No.	STATION	PUMP FLOWS, GPM		RNPSH		ANPSH, @ 130°F	
		A and/or B	C and/or D	A and/or B	C and/or D	A and/or B	C and/or D
1	Dresden	11,220	5,920	35	39	34	41
	2 & 3	5,750	11,620	37	37	41	34
2		11,490	5,920	37	39	34	41
		5,880	11,620	39	37	41	34
3		10,370	5,300	30	32	36	41
		5,300	10,320	32	30	41	36
1	QUAD CITIES	11,360	5,810	36	37	34	41
	1 & 2	5,770	11,220	37	35	41	34
2		11,180	5,750	35	37	34	41
		5,750	11,180	37	35	41	34
3		10,060	5,180	29	31	36	42
		5,180	10,050	31	29	42	36

CASE NO. 1 - Three pumps injecting into two recirculation loops with one loop broken.

CASE NO. 2 - Three pumps injecting into one broken loop.

CASE NO. 3 - Three pumps injecting into one intact loop.

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BINGHAM PUMP COMPANY

Engineers and Manufacturers of

HORIZONTAL & VERTICAL CENTRIFUGAL • TURBINE • AXIAL FLOW • WET PIT PUMPS

2800 N.W. FRONT AVENUE •• PORTLAND, OREGON 97210

REF: S.O. 280685
(Pumps Nos. 270419/26)

CAVITATION TEST REPORT

12x14x14-1/2 CVDS Pump

GENERAL ELECTRIC APED
QUAD CITIES I & II
RESIDUAL HEAT REMOVAL PUMPS

ATTACHED IS THE REPORT OF THE CAVITATION TEST RUN ON PUMP NO. 270425 ON MAY 15 & 16, 1969.

SUBJECT: CAVITATION TEST
12x14x14-1/2 CVDS Pumps

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50-254 50-265

For this test, Pump No. 270425 was set up in a closed loop on the large suppression tank. All set ups, instrumentation and testing procedures were in strict accordance with the standards of Hydraulic Institute and ASME Ptc 8.2. Upon completion of witness and NPSH testing, pump was disassembled for inspection. This inspection revealed the following:

Shaft Sleeve: Excellent condition - only minor scratches from small particles which passed through separator.

Bearing: Excellent condition - only minor scratches as on sleeve.

Impeller: Excellent condition, except wear surfaces showed some evidence of wear from larger particles in water and lower wear surface showed one groove.

Seal: Excellent condition.

Wear Rings - Case: Excellent - slight wear only.

Shaft: Total runout less than 0.0005".

No damage was evident from this test.

Pictures were taken by G.E. personnel and pump was reassembled for cavitation test. This test consisted of setting the desired capacity and then reducing the suction pressure to various NPSH values until the impeller was cavitating. This was run at capacities of 4000, 5350, and 6000 GPM. Data taken at each point was suction and discharge pressure, capacity, power input, vibration, and water temperature. See curve No. 26992 and pages 1 & 2 of test data for results.

At completion of testing, impeller was removed and inspected by G.E. and Bingham personnel. There was no evidence of any damage to the impeller from cavitating. There was an indication of slight rubbing on bottom impeller wear surfaces. Nothing was evident on case ring.

Pictures of impeller were taken by G.E. and pump was reassembled for run-out cavitation test at 6000 GPM. For this test capacity was set at 6000 GPM. Suction pressure was then reduced until an NPSH value was reached that was below the cavitating point attained on the previous test. However, the discharge valve was opened to maintain 6000 GPM capacity, rather than let the capacity fall back 3', as this was a more severe test of the pump. This condition was maintained for one hour. See attached data sheet, page 3, for test results.

At conclusion of test, impeller was removed and inspected by G.E. and Bingham personnel. Again there was no sign of any cavitating damage to impeller. The only indication of wear appeared on bottom wear ring, which seemed to be slightly "duller" in color, which indicated possibly more rubbing. Bingham Inspection miked the diameter of this area of impeller and it was within drawing tolerance - 8.6070". G.E. personnel photographed impeller.

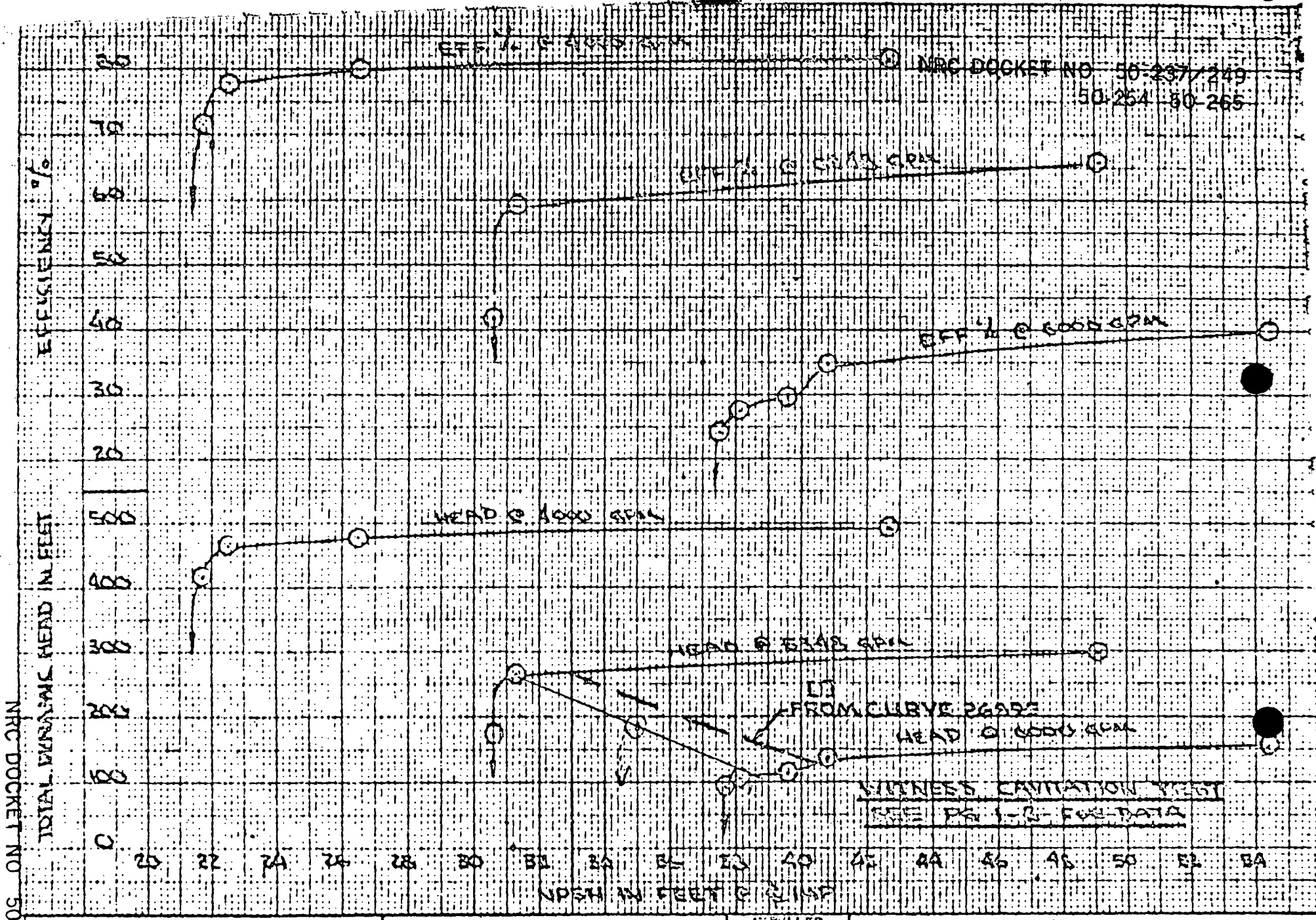
Pump was reassembled for second run-out cavitation test at 6000 GPM and suction pressure reduced to an NPSH value slightly below the guaranteed value (about 40.2 ft.). The suction pressure was then further lowered until the pump capacity fell off to 5700 GPM. This cavitating condition was maintained for one hour. At this time, the suction pressure was lowered again until the pump capacity dropped to 5400 GPM. The pump was run in this manner for 30 minutes. See attached data sheet, page 4, for test results.

Pump was disassembled for inspection. Condition of impeller was not changed - bottom impeller wear surface still miked 8.6070". Shaft sleeve and bearing in excellent condition, except for a few minor scratches.

Cavitation test was considered complete and pump was released for shipment.

All cavitation testing and inspection witnessed by A. Spivak. Other G.E. personnel present included Tom Day, Norm Petersen and Elden Bingham.

Leo Garrow
Chief Test Engineer
Bingham Pump Company
May 22, 1969



GENERAL ELECTRIC CO APED
COMMONWEALTH EDISON CO
QUAD CITIES, RES HT REMOVAL
ITEM 1002 PUMP NO. 270625

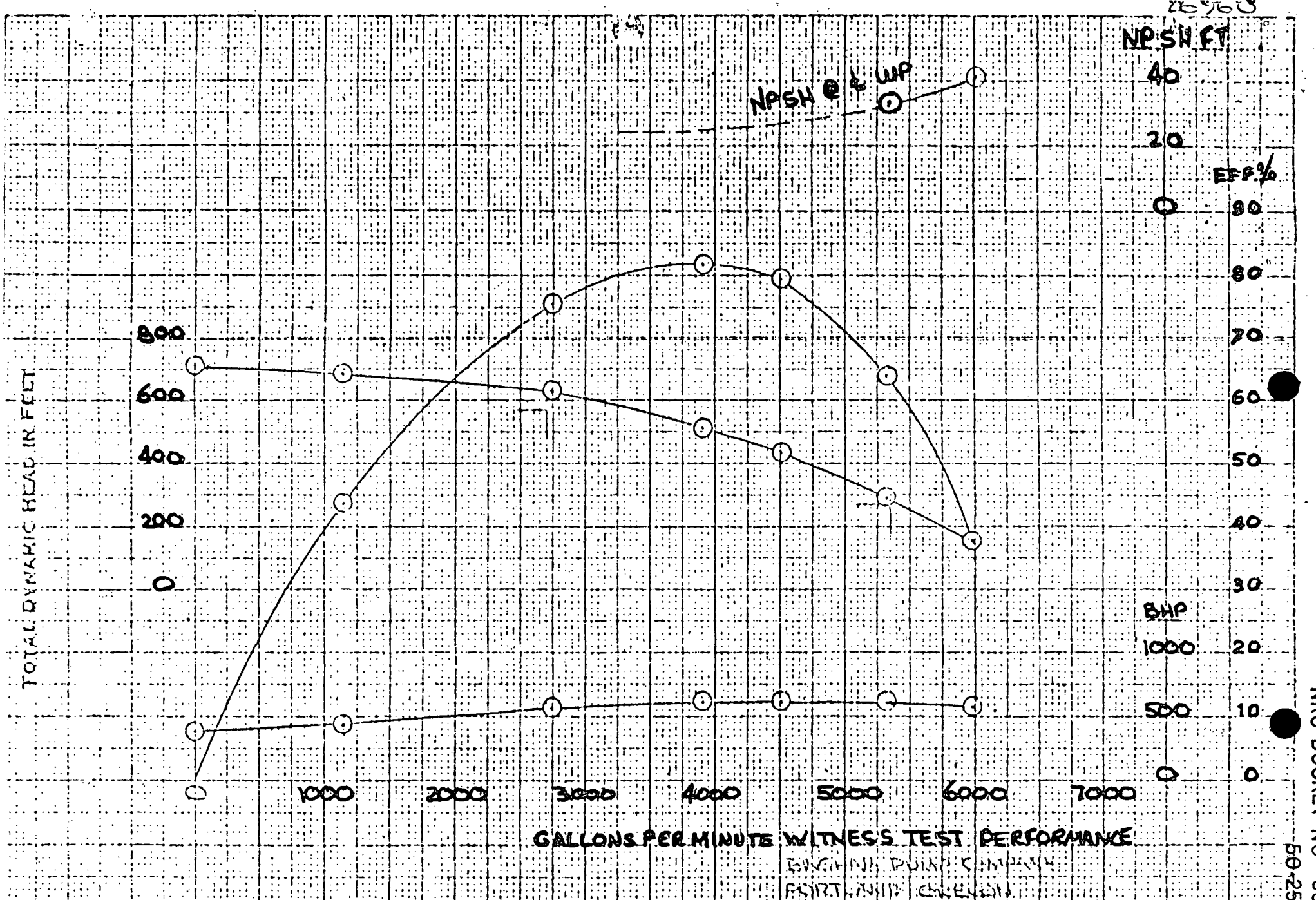
CHARACTERISTIC CURVE SHEET

BINGHAM PUMP CO.

2000 N. W. FRONT AVE.
PORTLAND OREGON 97209

IMPELLER MAX. DIA. 14½	12 x 14 x 14½ CVDS PUMP		
MIN. DIA.	DIA. IMPELLER 12 11/16	IMPELLER PATT. 1212CVDS-1	3576 R.P.M.
EYE 80 AREA 72.2 IN.	N.P.S.H. REQUIRED	REFERENCE	CURVE NO 26992

REVISED 6-13-76



CHARACTERISTIC CURVE SHEET	IMPELLER MAX DIA 14½	12 × 14 - 14½ CVDS	PUMP	
BINGHAM PUMP CO.	MIN DIA	DIA IMPELLER 12⅞	IMPELLER PART 1213CVDS-1	3560 R.P.M.
PORTLAND OREGON	EYE AREA 72.2 SQ IN	N.P.S.H. REQUIRED	REFERENCE	CURVE NO. 26960

GENERAL ELECTRIC CO./MED
COMMONWEALTH EDISON CO.
QUAD CITIES, RES. HEAT REMOVAL
ITEM NO. 2 PUMP NO. 2-70X-74

NRC DOCKET NO 50-237/249
50-254 50-265