Referance B

NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

August 25, 1975

Mr. A. Giambusso, Director
Division of Reactor Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Giambusso:

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket No. 50-282 License No. DPR-42
50-306 60

Submittal of Supplement No. 1 to Cooling Water System Test Report Dated October 7, 1974

Attached you will find 40 copies of a report entitled, "Supplement No. 1 to Cooling Water System Test Report dated October 7, 1974."

The original report was submitted prior to the startup of Unit 2 and full power cooling water requirements for two unit operation were conservatively estimated. Supplement No. 1 provides additional test data which was obtained following the commencement of full power operation of both units.

The additional data provided in this supplement confirms the findings of the October 7, 1974 report. Following loss of all offsite power and the subsequent trip of both units with only one diesel pump starting, the pressure in the cooling water supply header will be adequate to supply all essential equipment.

Yours very truly,

L. O. Mayer

L. O. Mayer, PE
Manager, Nuclear Support Services

cc: J. G. Keppler
G. Charnoff
MPCA
Attn: J. W. Ferman

attachment

NORTHERN STATES POWER COMPANY

Prairie Island Nuclear Generating Plant
Docket No. 50-282 License No. DPR-42
50-306 DPR-60

Supplement No. 1 to Cooling Water System Test Report dated October 7, 1974

Date: August 25, 1975

1.0 Introduction

On October 7, 1974 a report was submitted to the Directorate of Licensing, USAEC, which summarized the testing conducted at the Prairie Island Nuclear Generating Plant to demonstrate the ability of the Cooling Water System to supply the diesel generators in the event of a loss of all offsite power during two unit operation. This testing was required by Table TS.6.7-1 (item 8) of the Prairie Island Technical Specifications. It is described in Section 9.6 of the Final Safety Analysis Report and in Section 9.3.3 of the Prairie Island Island AEC Safety Evaluation Report.

In the event of loss of all offsite power and subsequent trip of both units, the emergency diesel cooling water pumps will start and supply all Cooling Water System loads. If one diesel cooling water pump fails to start, the remaining diesel cooling water pump must supply all cooling water demands. The purpose of the testing that was conducted was to demonstrate that the demands on a single pump will not reduce Cooling Water System header pressure below that needed to adequately cool the diesel generators at full load. The diesel generators are the only equipment required for safe plant shutdown following a loss of offsite power which require adequate cooling water to be automatically provided.

The October 7, 1974 report was required to be completed within three months of completion of the Unit No. 1 Startup Test Program. It was therefore submitted before the commencement of Unit No. 2 operation. Cooling water demand for two unit 100% power operation had to be inferred from data available during one unit operation.

In its "Safety Evaluation of Startup Test Results for Diesel Generators and Cooling Water Systems, Prairie Island Nuclear Generating Plant, Units 1 and 2," contained in a letter dated October 30, 1974 from Karl Kniel, Chief, LWR Branch 2-2, Directorate of Licensing, USAEC, to Mr. L. O. Mayer, NSP, the Regulatory Staff concluded that the testing performed provided a satisfactory demonstration that the Cooling Water System will provide adequate cooling water to the diesel generators following a loss of offsite power assuming a single failure. The October 30, 1974 safety evaluation further stated that following startup of Unit No. 2, additional data would be available to verify the analysis presented in the October 7, 1974 report.

2.0 Purpose

This report provides an analysis of data that has been obtained since the start of two unit full power operation at Prairie Island. This analysis confirms the findings of the October 7, 1974 report.

3.0 Additional Data Available To Verify October 7, 1974 Analysis

1. Two Unit 100% Power Cooling Water Demand

On July 18, 1975, with cooling water supply temperature at its upper limit of 85 - 90°F, total plant cooling water requirements were measured. The results of this measurement are presented in Table 1.

2. Determination of Minimum Acceptable Cooling Water Supply Pressure to Serve a Fully Loaded Diesel Generator

On July 17, 1975 the test described in Section 2.2.2 of the October 7, 1974 report was repeated with cooling water supply temperature and engine air inlet temperature near their upper limits. The original test was performed with 55 - 56°F cooling water supply temperature and 45°F air temperature. A correction factor was applied to account for the difference between worst case temperatures and the temperatures encountered during the test. Determination of this factor involved a certain amount of uncertainty.

The results of this test are presented in Table 2.

3. Pressure Drop Calculations for the Diesel Supply Piping

Since the October 7, 1974 was submitted, the diesel cooling water supply piping has been modeled and the relationship between cooling water supply header pressure and diesel cooler flow has been determined. The results of this analysis are in good agreement with observed characteristics of the system.

Figure 1 is the model which was used for the cooling water piping to the diesel generators. Figure 2 is the calculated relationship between header pressure and diesel generator cooler flow. Figure 3 is the calculated relationship between diesel cooler supply pressure and cooler flow.

4.0 Analysis of Additional Data

1. Two Unit 100% Power Cooling Water System Characteristic

Using the data available from Table 1 and the method outlined in Section 2.3 of the October 7, 1974 report, the two unit 100% power cooling water system characteristic can be approximated as follows:

Total Flow at Test Conditions	24575 gpm @ 87 psig
Correction to 100% Rated Generator KVA at pump elevation	$24575 + 2300\left[\left(\frac{659}{536}\right)^2 + \left(\frac{659}{539}\right)^2 - 2\right]$
	= 26890 gpm @ 87 + 11.5 = 98.5 psig

The system characteristic immediately before and after a two unit trip remains unchanged. Therefore following the trip:

$$H(ft) = 26.5 + 2.78 \times 10^{-7} Q(gpm)^2$$

This is plotted along with the pump curve (Figure 4) for the diesel-driven pump in Figure 5. The system operating point immediately after the two unit trip is 18900 gpm at 124 Ft. The corresponding supply header pressure is 42.3 psig. Using Figures 2 and 3, the flow rate to the diesel coolers will be 1250 gpm and the pressure available at the cooler inlet will be 35 psig.

As the hydrogen cooler control valves on each generator close down over a period of approximately ten minutes, the header pressure and flow to the diesel coolers will gradually increase as discussed in the October 7, 1974 report.

2. Determination of Minimum Acceptable Cooler Inlet Pressure by Test

By throttling cooling water flow to a fully loaded diesel, the minimum acceptable cooler inlet pressure can be determined. As shown in Table 2, with cooling water inlet pressure near the top of it allowed band, cooling water supply pressure was reduced to as low as 15 psig without reaching a limiting condition.

This test confirms the calculations which where performed to determine Figures 2 and 3, which show that inlet pressure can be reduced to 18 psig before cooler flow is reduced to 900 gpm (rated cooling water flow at 95°F).

4.0 Conclusions

This additional data and analyses confirms the conclusions of the October 7, 1974 report. These conclusions can be summarized as follows:

	t=0 header pres	t=0 pres at cooler inlet	Minimum Required cooler inlet pres
October 7, ~~1975~~ 1974 Reported Value	33.1	24.3	≤13.3
Value Based on Actual Two Unit Data and Additional Analyses	42.3	35	≤15

TABLE 1 MEASURED COOLING WATER REQUIREMENTS
FOR 2 UNIT OPERATION AT 100%

Parameter	Value
Date	7/18/75
Time	1330
Load (KVA)	Unit 1 - 523.42 MW, 130 MVAR Del. Unit 2 - 527.69 MW, 90 MVAR Del.
Total Loop A Flow (GPM)	12,250
Loop A Flow to Aux Bldg (GPM)	6,900 - 7,000
Loop A Pressure (PSIG) (Aux Bldg)	87
Loop A Temperature (°F)*	86
Total Loop B Flow (GPM)	12,325
Loop B Flow to Aux Bldg (GPM)	Not in Service
Loop B Pressure (PSIG) (Aux Bldg)	88
Loop B Temperature (°F)*	84
Outdoor dry bulb	91°F

Notes:

Data taken with 3 cooling towers and 980 cfs blowdown.

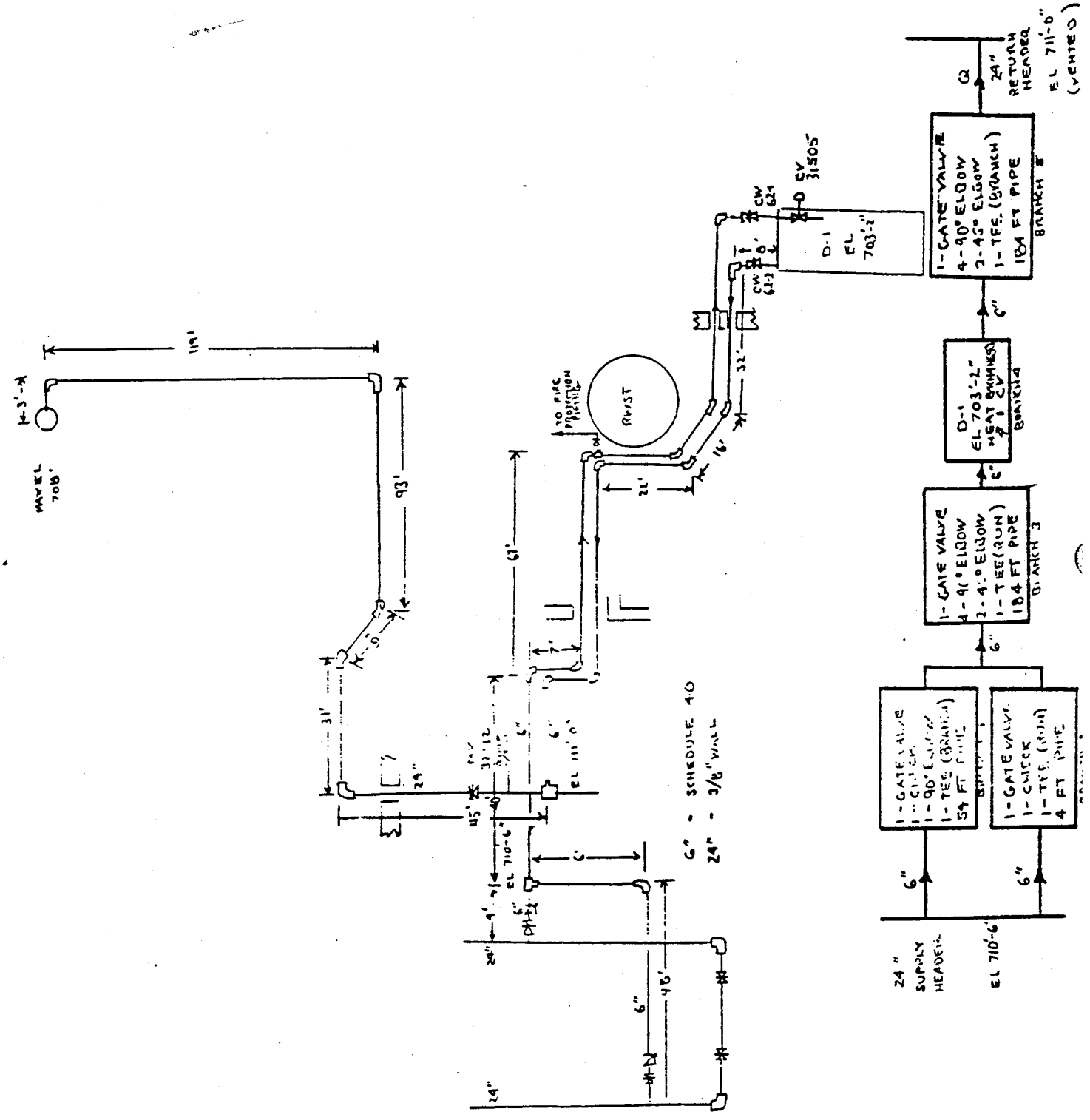

Figure 1. Model of Cooling Water Supply to Diesel Coolers

TABLE 2

DATA FROM DIESEL GENERATOR OPERABILITY WITH REDUCED COOLING WATER FLOW TEST - Conducted 7/17/75

Parameter	Units	1	2	3	4	5	6	7	8
Cooling Water Pressure	PSIG	59	50	40.5	30	24.2	19.8	15	59
Lube Oil Temp fm Engine (Note 2)	°F	204	203	203.5	204	204	204+	205	203
Lube Oil Temp to Engine (Note 2)	°F	184	184	184	185	184	185	184	183
Jacket Coolant fm Engine (Note 3)	°F	170	170	171	171	171	172	172	170
Jacket Coolant to Engine (Note 3)	°F	164	164	164	164	164	164	164	163
Air Coolant Temp (Note 4)	°F	107	107	107	108	109	110	112	107
Exhaust Stack Temp (Note 4)	°F	790	800	800	800	800	800	800	790
Cooling Water Temp In*	°F	84	84.4	84.4	85	85	85	85	85
Cooling Water Temp Out	°F	94	94	94	99.5	102	105	110	94
Cooling Water Header Pressure	PSIG	84	86	86	86	87	87	87	89
Air to Engine Temp **	°F	107	107	107	107	108	108	108	108

Notes:

1. Data point No. 1 taken after 1-hour running time at 2750 KW and 1925 KVAR with CW-62-1 fully open. Other data points taken 10-15 min. following pressure change of approximately 10 PSIG.

2. Temperature controller maintains oil leaving engine between 195-215°F.

3. Temperature controller maintains coolant leaving engine between 170-185°F.

4. Temperature controller begins to open port to heat exchanger at 100°F.

5. Temperature in area of intake. Outdoor dry bulb temperature 93.5 at start and 94°F at end of test.

FIG: 2. DIESEL COOLING WATER FLOW RATE VS. AUX BLDG COOLING WATER HEADER PRESSURE.

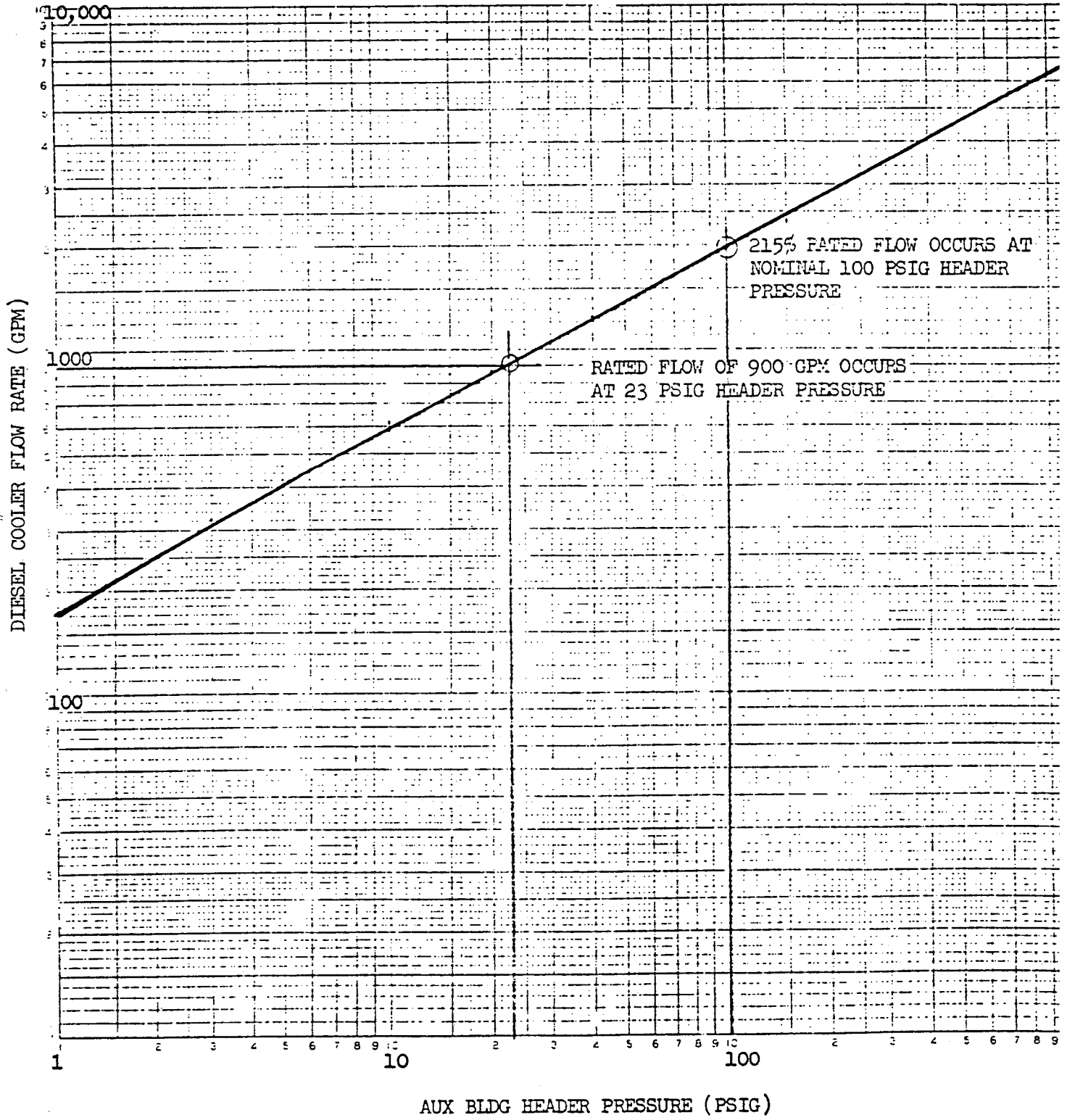

FIG. 3. DIESEL COOLING WATER FLOW RATE VS. DIESEL INLET PRESSURE

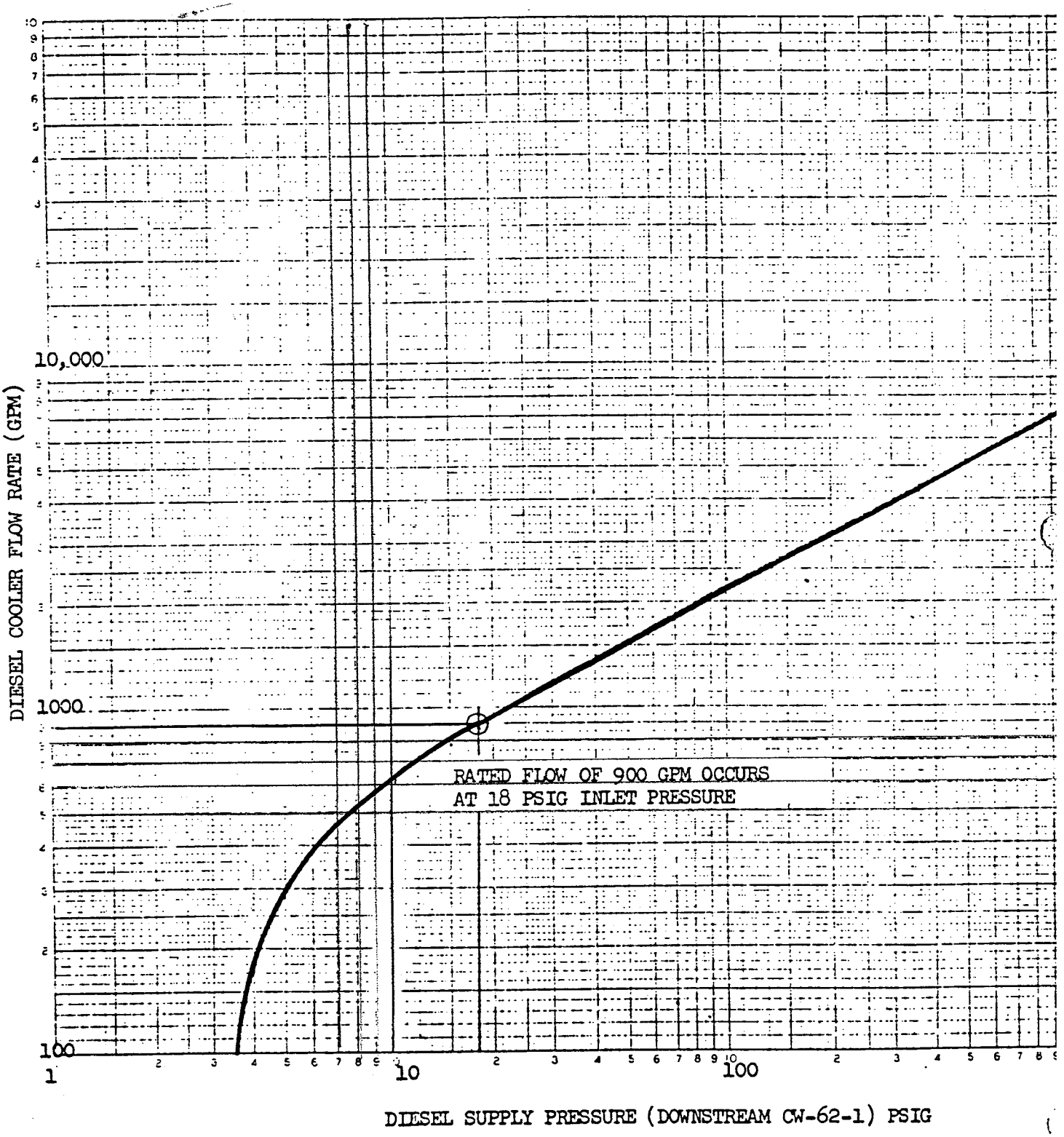

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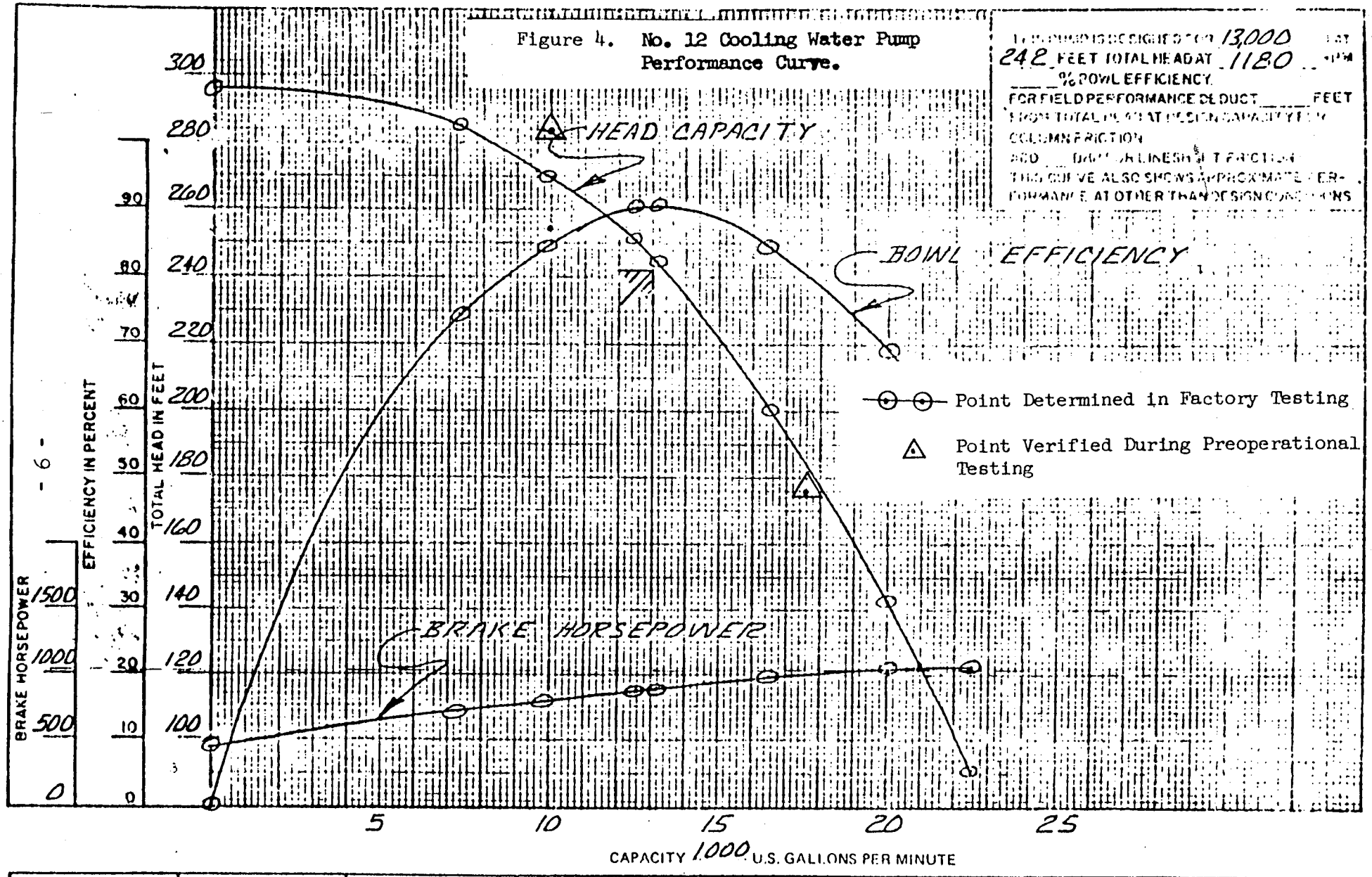
Figure 4. **No. 12 Cooling Water Pump Performance Curve.**



AMPCO-18 IMP. MAT'L.	DUCTILE IRON BOWL MAT'L.	20QL-26 PUMP	WORTHINGTON PUMP INTERNATIONAL VERTICAL PUMP OPERATIONS DENVER, COLORADO, U.S.A.	8-11-72 DATE	VTP-30533 SERIAL NO.
24 V8" IMP. DIA.	150 H.P. TEST DRIVER	1 NO. OF STAGES	WORTHINGTON	CUST. NO.	DTP-35106 ORDER NO.
3476	1180	L.A.L.			

Figure 5. System Operating Point Immediately Following Two Unit Trip With Failure of One Diesel Pump