THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP PRELIMINARY

(2)

To	G. A. MEYER
From	L. L. LOSH/J. F. BURROW
Cust.	TMI-2
Subj.	CRITERIA DURING ESTABLISHMENT OF NATURAL CIRCULATION

805 663-5

File No. or Ref.

Date 5:40 P.M. APRIL 10, 1979

This letter to cover one customer and one subject only.

THE TRANSITION FROM FORCED CORE COOLING USING ONE REACTOR COOLANT PUMP TO NATURAL CIRCULATION WILL BE ACCOMPLISHED OVER A PERIOD OF TIME. HEATUP OF THE CORE COOLANT WILL GENERATE A DENSITY GRADIENT AXIALLY IN THE CORE WHICH WILL PRODUCE THE DRIVING FORCE FOR THE CIRCULATION FLOW. THE TIME REQUIRED TO ESTABLISH NATURAL CIRCULATION IS THEN DIRECTLY RELATED TO THE HEATUP RATE OF THE CORE WHICH GENERATES THE DRIVING FORCE. TO ESTIMATE THIS HEATUP TIME THE FOLLOWING ANALYSIS WAS PERFORMED: (1) IT WAS ASSUMED THAT THERE WAS NO CORE FLOW, (2) THE ENTIRE CORE COOLANT INVENTORY WAS RAISED FROM T_{IN} TO T_{SAT}, (3) NO NET STEAM QUALITY WAS GENERATED, (4) CALCULATIONS WERE BASED ON GROSS CORE AVERAGE CONDITIONS.

FIGURE 1 DEPICTS THE CORE DECAY HEAT GENERATION AS A FUNCTION OF TIME. THE RESULTS OF THIS ANALYSIS ARE SHOWN IN FIGURE 2-4 FOR VARIOUS ASSUMPTIONS ON T_{IN}, SYSTEM PRESSURE AND CORE POWER (TIME AFTER SHUTDOWN). THESE CURVES WERE USED TO ESTABLISH A MAXIMUM TIME REQUIRED TO ESTABLISH NATURAL CIRCULATION.

NATURAL CIRCULATION RESPONDS TO HIGHER FLOW RESISTANCE BY GOING FURTHER INTO TWO-PHASE FLOW UNTIL THE VAPORIZED DENSITY CHANGE IS SUFFICIENT TO OVERCOME SYSTEM RESISTANCE. WITH DEBRIS BLOCKING A GRID, FLOW WILL PASS LATERALLY AROUND THE BLOCKAGE AND ADEQUATELY IMMERSE THE FUEL BEFORE AND AFTER THE BLOCKAGE. IF THE BLOCKAGE DEBRIS ALSO CONTAINS FUEL, THE MAXIMUM TEMPERATURE AT THE BLOCKAGE CENTER WILL BE CONDUCTION LIMITED AND RELATIVELY INSENSITIVE TO THE

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MODE OF SURFACE HEAT TRANSFER. THE FLOW PATTERNS IN NATURAL CIRCULATION ARE DIRECTLY RESPONSIVE TO RESTRICTIONS, AND MAY WELL SHOW LOCAL TWO-PHASE TRANSITIONS AND RELATIVELY HIGH VELOCITIES AT PARTIALLY-BLOCKED HOTTER REGIONS.

REDISTRIBUTION OF CORE DEBRIS IS ANTICIPATED WHEN THE PUMPED FLOW IS TERMINATED. CHANGES IN THERMOCOUPLE INCORE TEMPERATURE DISTRIBUTIONS SHOULD BE EXPECTED. NOT ALL THERMOCOUPLE READINGS CAN BE EXPLAINED BY HYDRAULIC PHENOMENA. SOME THERMOCOUPLES, PARTICULARLY NEAR THE CENTER, ARE CURRENTLY INDICATING LOCALIZED HEATING EFFECTS AND ARE NOT MEASURING BULK FLUID TEMPERATURES. SINCE THE PRIMARY CONCERNS DURING THE TRANSITION FROM PUMPED FLOW TO NATURAL CIRCULATION ARE ADEQUATE COVERAGE OF THE CORE AND BULK COOLANT TEMPERATURES BELOW SATURATION TEMPERATURE, IT IS REQUIRED THAT AT LEAST 10 (TEN) INCORE THERMOCOUPLES HAVE READINGS BELOW SATURATION TEMPERATURE FOR THE SYSTEM PRESSURE (FIGURE 5). ADDITIONALLY, NO TWO INCORE THERMOCOUPLES SHOULD EXCEED 800°F. ANTICIPATED CORE TRANSIENTS ARE VERY SLOW. FIGURE 4 SHOWS THAT IT WILL REQUIRE AT LEAST 45 MINUTES TO ONE HOUR TO RAISE THE WATER TEMPERATURE IN THE CORE FROM 200°F TO SATURATION TEMPERATURE FOR DATES BETWEEN 4/10/79 AND 4/17/79. ADDITIONALLY, THE CORE ADIABATIC HEATUP FROM 200°F TO 1000°F EXCEEDS ONE HOUR FOR DATES AFTER 4/12/79. HENCE, NO CORE COOLING PROBLEMS EXIST FOR AT LEAST THE FIRST HOUR OF TRANSITION TO NATURAL CIRCULATION.

THE "HOT LEG" THERMOCOUPLE SHOULD SHOW A TEMPERATURE INCREASE AS NATURAL CIRCULATION IS ESTABLISHED. TEMPERATURE INCREASES IN THE T_H RESISTANCE TEMPERATURE DETECTOR (RTD) SHOULD BE OBSERVED WITHIN THE BOUNDS OF THE TIME TO SATURATE THE CORE AS SHOWN IN FIGURE 4 (I.E., 45 MINUTES ON 4/10/79; 2.5 HOURS ON 6/6/79).

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ADDITIONALLY, THE MAXIMUM TEMPERATURE OF THE HOT LEG RTD SHOULD NOT EXCEED 250°F FOR PRESSURES ABOVE 500 PSIA AND 180°F FOR PRESSURES NEAR ATMOSPHERIC. THE CORE ΔT SHOULD BE LIMITED TO 150°F.

SUMMARY:

REQUIREMENTS FOR TRANSITION TO NATURAL CIRCULATION:

1) INCORE THERMOCOUPLES — AT LEAST 10 (TEN) THERMOCOUPLES MUST READ BELOW THE SATURATION TEMPERATURE CORRESPONDING TO SYSTEM PRESSURE (FIGURE 5). NO TWO INCORE THERMOCOUPLES MAY EXCEED 800°F.

2) HOT LEG RTD'S — THE HOT LEG RTD'S MUST INDICATE A TEMPERATURE RISE WITHIN THE TIME REQUIRED TO SATURATE THE CORE (FIGURE 4) AND THE MAXIMUM TEMPERATURE SHOULD NOT EXCEED 250°F FOR SYSTEM PRESSURES ABOVE 500 PSIA AND 180°F FOR PRESSURES NEAR ATMOSPHERIC. THE CORE ΔT SHOULD BE LIMITED TO 150°F.

LLL:JFB:nw

cc: J. S. TULENKO
FUEL ENG. UNIT MANAGERS
CORE HOT SPOT TASK FORCE

ATTACHMENTS (5 FIGURES)

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FIGURE 1
TMI-2 CORE DECAY HEAT VS. TIME

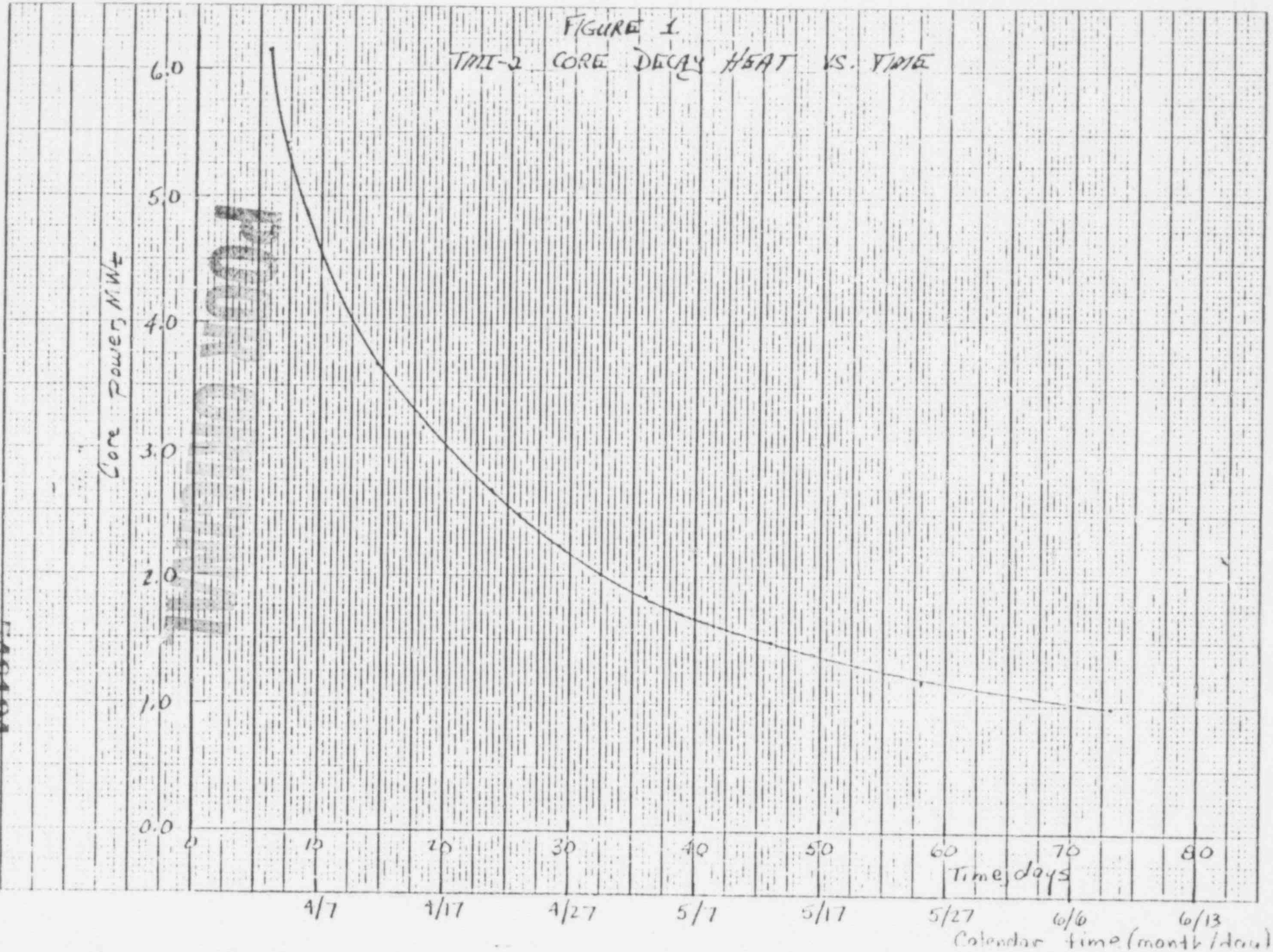

FIGURE 2

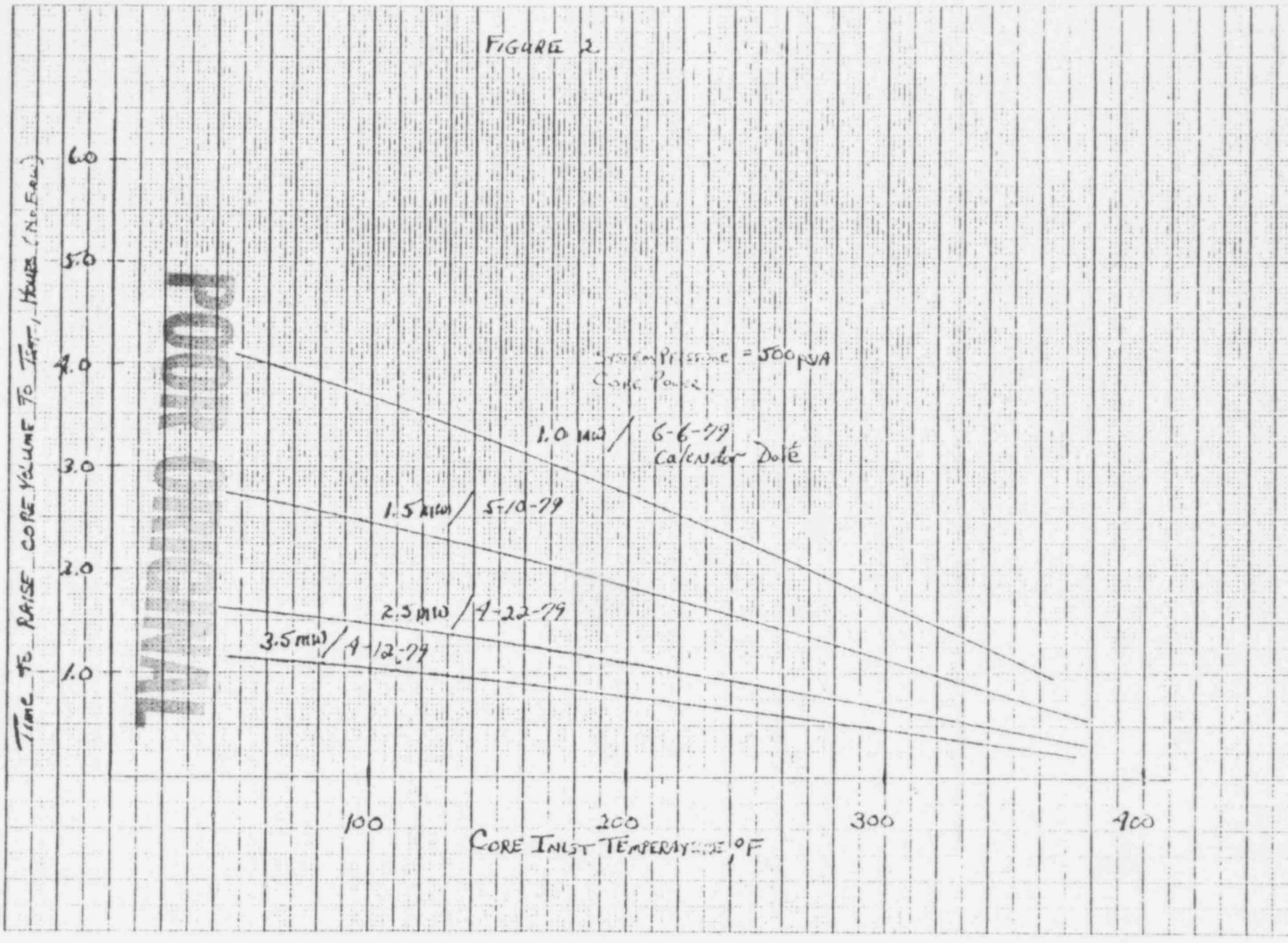

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FIGURE 3

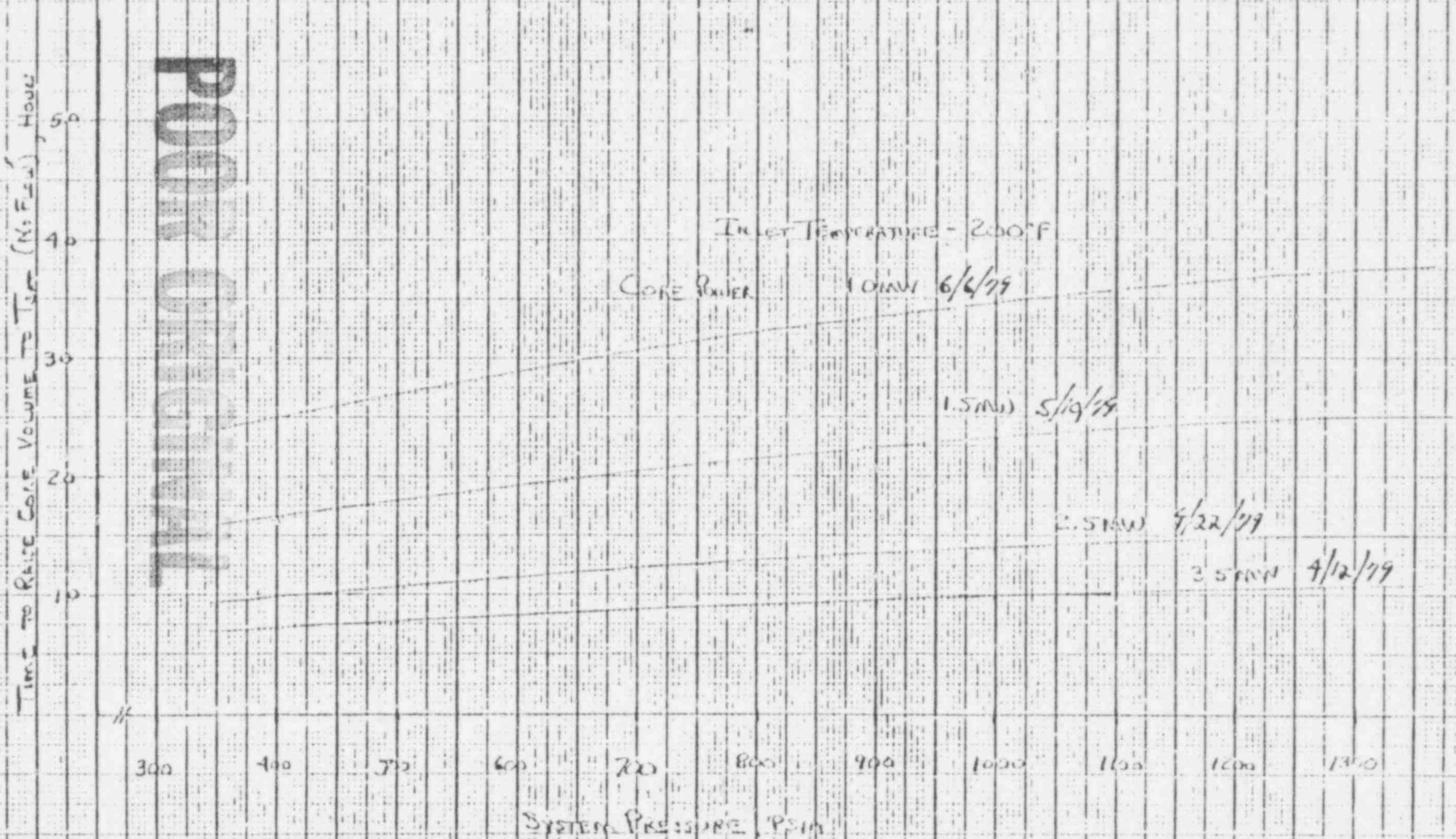
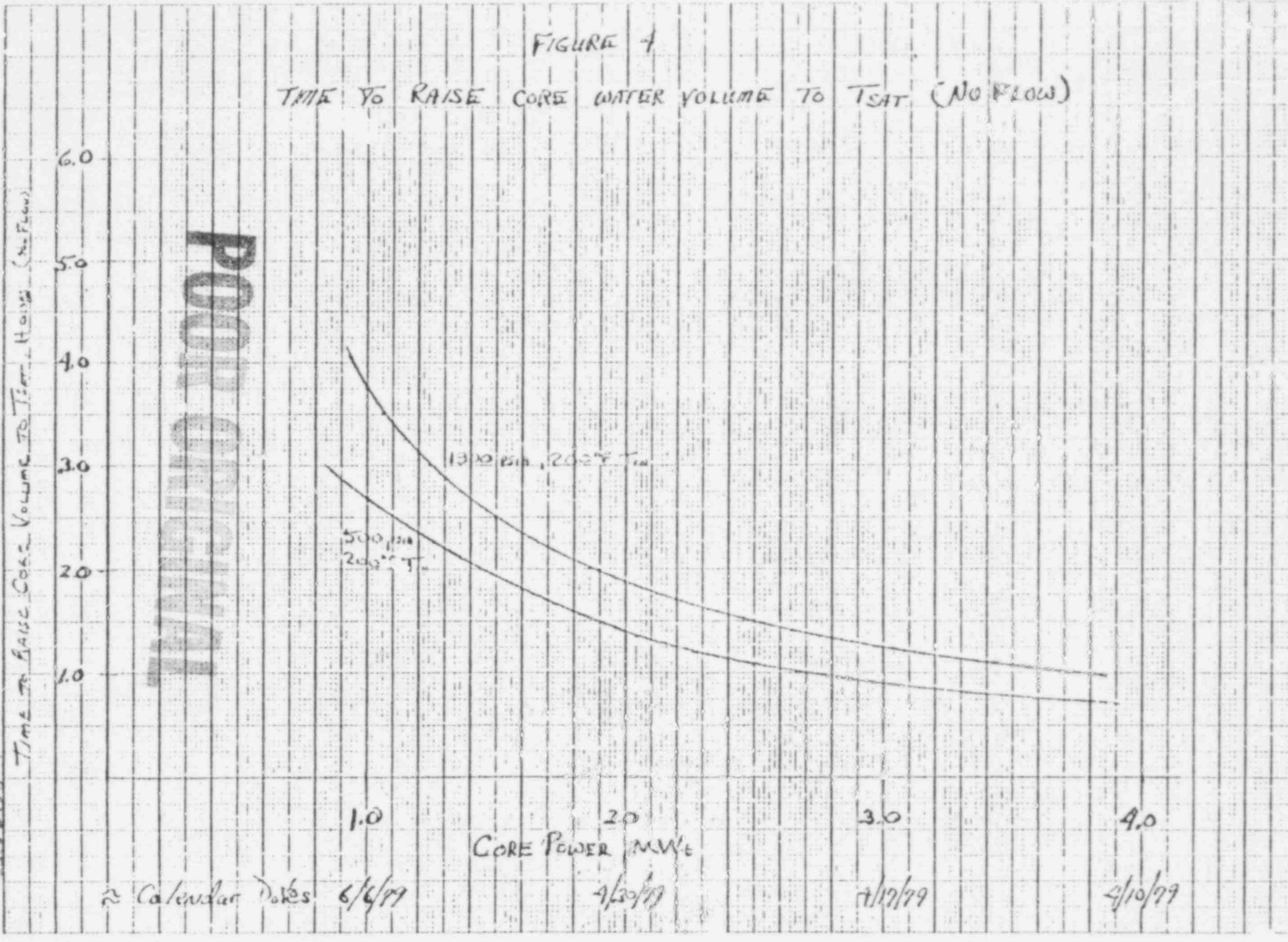

Inlet Temperature - 200°F
Core Power
1.0MW 6/6/79
1.5MW 5/19/79
2.5MW 4/22/79
3.5MW 4/12/79
50
40
30
20
10
300
400
500
600
700
800
900
1000
1100
1200
1300
System Pressure, Psia
Time to Raise Core Volume to Tsat (No Flow), Hours

FIGURE 4

TIME TO RAISE CORE WATER VOLUME TO TSAT (NO FLOW)



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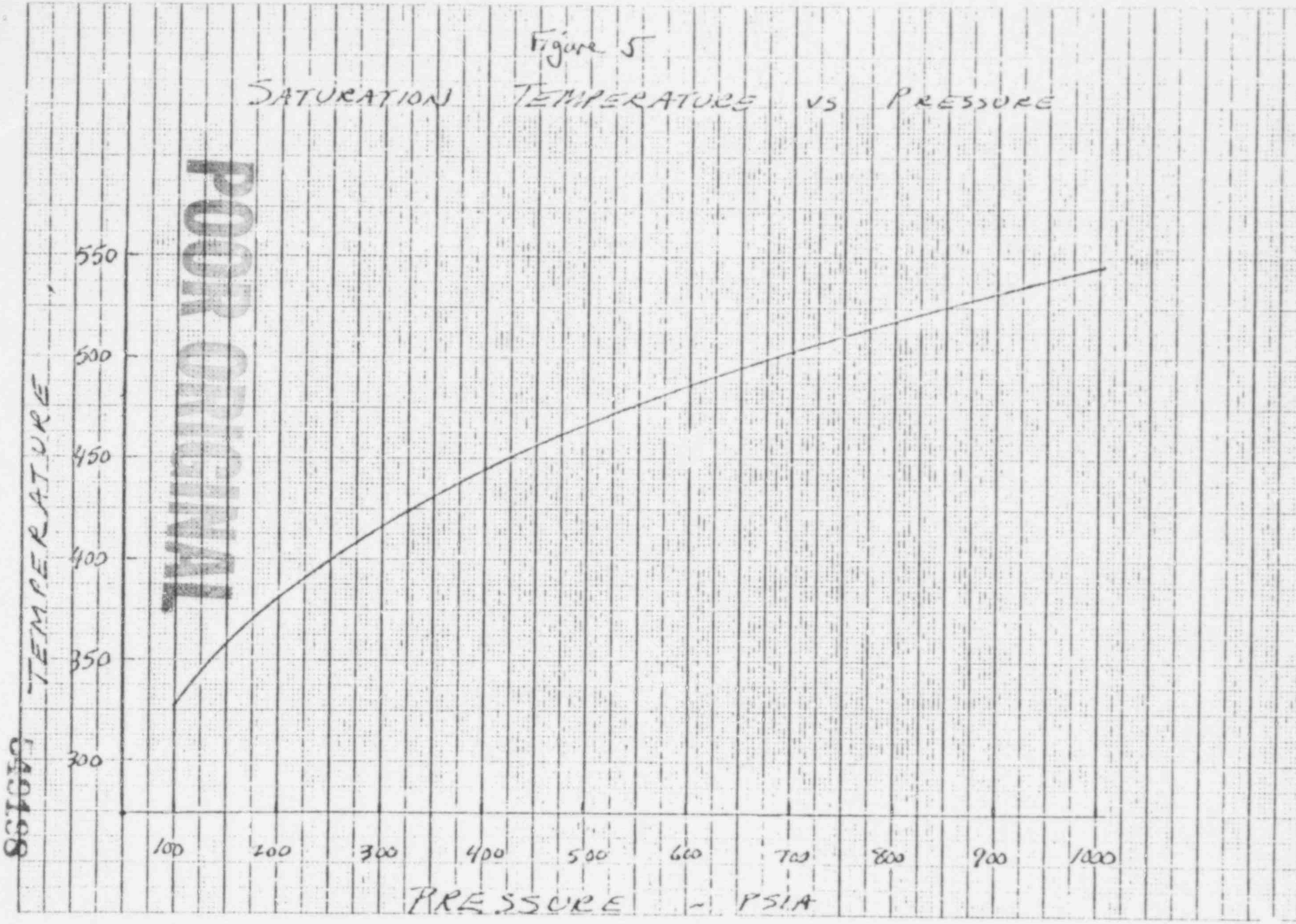

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