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June 29, 1976

Director of Nuclear Reactor Regulation
Attn: Mr. D. L. Ziemann, Chief
Operating Reactors Branch 2
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden Station Unit 2
Feedwater Nozzle Temperature Transients
NRC Docket Nos. 50-237

Dear Mr. Ziemann:

At a meeting on May 6, 1976 in Bethesda between your staff and representatives of Commonwealth Edison Company, it was agreed that the staff would be provided with a report of the following:

1. Review previous operating history to determine if additional data could be gathered and analyzed during the next start up of Dresden Unit 2.

2. Review previous operating history and data gathered during the start up to identify changes in operating practices which could reduce the magnitude of thermal cycles on Feedwater nozzles.

3. A sketch showing location of the Feedwater nozzle thermocouples.

The enclosed report provides this information and identifies the cutting in of feedwater heaters on start up and flooding of the vessel during cooldown as the most severe feedwater nozzle temperature transients.

The final figure in the report did not reproduce clearly. The "saw tooth" traces are the nozzle temperatures during a flood up for vessel cooldown.

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Please contact this office for additional information on this matter.

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

Very truly yours,

G. A. Abrell
Nuclear Licensing Administrator

Enclosure: 40 copies Dresden Unit 2 Feedwater Nozzle Temperature Data Review and testing.

DRESDEN UNIT-2 FEEDWATER NOZZLE TEMPERATURE DATA REVIEW AND TESTING

At the request of the NRC, a study was made of the parameters which would affect the inlet feedwater temperature. This study had as its goal to determine the operational conditions which would cause a change of 100°F/hour or greater in the final feedwater temperature. It has been determined that the probably cause of cracks in the feedwater nozzle blend area is thermal cycling of the stainless steel cladding. Since the thermal expansion characteristics of the cladding and carbon steel base metal are different, high stresses may result during thermal transients. Eventually, these stresses initiate and further propagate cracks through the clad and into the ferritic base metal.

Feedwater temperature data for the last fuel cycle on Dresden Unit-2 was selected for review. The following data available from plant process monitors was reviewed.

1. Final Feedwater Temperature.
2. Feedwater Nozzle Outside Metal Temperature (see Figure 1).
3. Feedwater Flow.

The charts of final feedwater temperature showed that the largest temperature changes (those 100°F/hour or greater) occurred during plant startups and shutdowns.

1. Out of eighteen (18) startups during the fuel cycle, there were seventeen (17) startups that had recorded at least one $>$ 100°F/hour event. One startup (February 14, 1976) occurred during a recorder malfunction.
2. All of the eighteen (18) shutdowns (of which six (6) were scrams)

during the cycle had at least one instance of 100°F/hour change in final feedwater temperature.

Most of the events during a reactor startup or shutdown which caused a significant change in final feedwater temperature were tied to the cutting in and out of feedwater heaters.

Inboard feedwater nozzle temperature and feedwater flow charts did not prove to provide meaningful data relative to cyclic temperature changes in the feedwater system.

Feedwater nozzle temperature undergoes significant transients during a "flood-up" of the reactor vessel. During this operation, the water level is brought up rapidly to the main steam lines, then slowly the main steam lines are filled after which the level is raised rapidly up to the reactor vessel flange, the only limit being the shell to flange Δ T limitation. Since this operation is done through the startup regulating line and the valve cycles (open and closed) the feedwater nozzle is heated from reactor heat and then cooled from the colder feedwater. This transient operation causes approximately four (4) temperature swings, the average rate being 280°F/hour with an average temperature change of 94°. See Figure 4 for an actual recorder trace of a "flood-up". After evaluating the above data, it was concluded that the operations which have the greatest affect on final feedwater temperature are cutting in and out feedwater heaters and flooding the reactor vessel.

In order to investigate a possible method for limiting final feedwater temperature changes, a special operating procedure was prepared for cutting in feedwater heaters. This special procedure directed the operator to limit the final feedwater temperature increase to 100°F/hour. This rate of increase was controlled by slowly opening the extraction steam valves and monitoring final feedwater temperature. Data gathered during this startup was taken and reviewed (final feedwater temperature, nozzle temperature, 4B and 4C and startup regulating valve position). This review showed that by altering the heater startup procedure, the maximum rate of change of the final feedwater temperature was limited to 320°/hour during cutting in the first set of feedwater heaters and to an overall change of 80°F/hour over one and one-half (1½) hours. See Figure 2 for the actual recorder trace. Feedwater nozzle temperatures, data, startup Feedwater Regulator Position data, and Feedwater Flow data was reviewed and no other significant information was obtained. Feedwater nozzle temperature (thermocouple mounted on feedwater line - outboard of safe end) tracked the final feedwater temperature and it was verified that the startup feedwater regulating valve did not cycle during startup. During previous startups, it was found that head-up rates in the range of 400-500°/hour with 90° temperature changes were common. See Figure 3 for a typical recorder trace.

The changes in feedwater nozzle temperatures experienced during a flood-up of the reactor vessel were reviewed to determine possible operational changes to minimize these transients. In light of the reactor vessel to flange differential temperature design limits specified the technical specifications, it appears that the current method of rapid flooding in steps is the only practical method. The reactor vessel is flooded only at the beginning of a refueling outage or on occasions when work in the upper areas of the drywell are planned.

Future Studies

After reviewing data from the previous operating cycle, it appears that additional testing and collection data may identify further methods for minimizing thermal cycles. During the data review, it became apparent that some of the data points being reviewed produced no additional or meaningful information concerning transient feedwater temperature conditions. Therefore, our future data collecting and analysis will be concentrated on final feedwater temperature and outboard feedwater nozzle temperature recordings. It may be useful to obtain additional outboard feedwater nozzle temperature indications.

Conclusion

The two (2) major feedwater temperature transients, feedwater heater startup and shutdown and reactor vessel "flood-up" can be minimized to some extent. The number of feedwater heater startups and shutdowns cannot be limited; however, procedures for minimizing the rate of temperature change are effective. The high rate of feedwater nozzle temperature change during reactor vessel "flood-up" is fixed; however, having recognized this as a significant factor, the number of "flood-ups" will be limited to the extent practicable.

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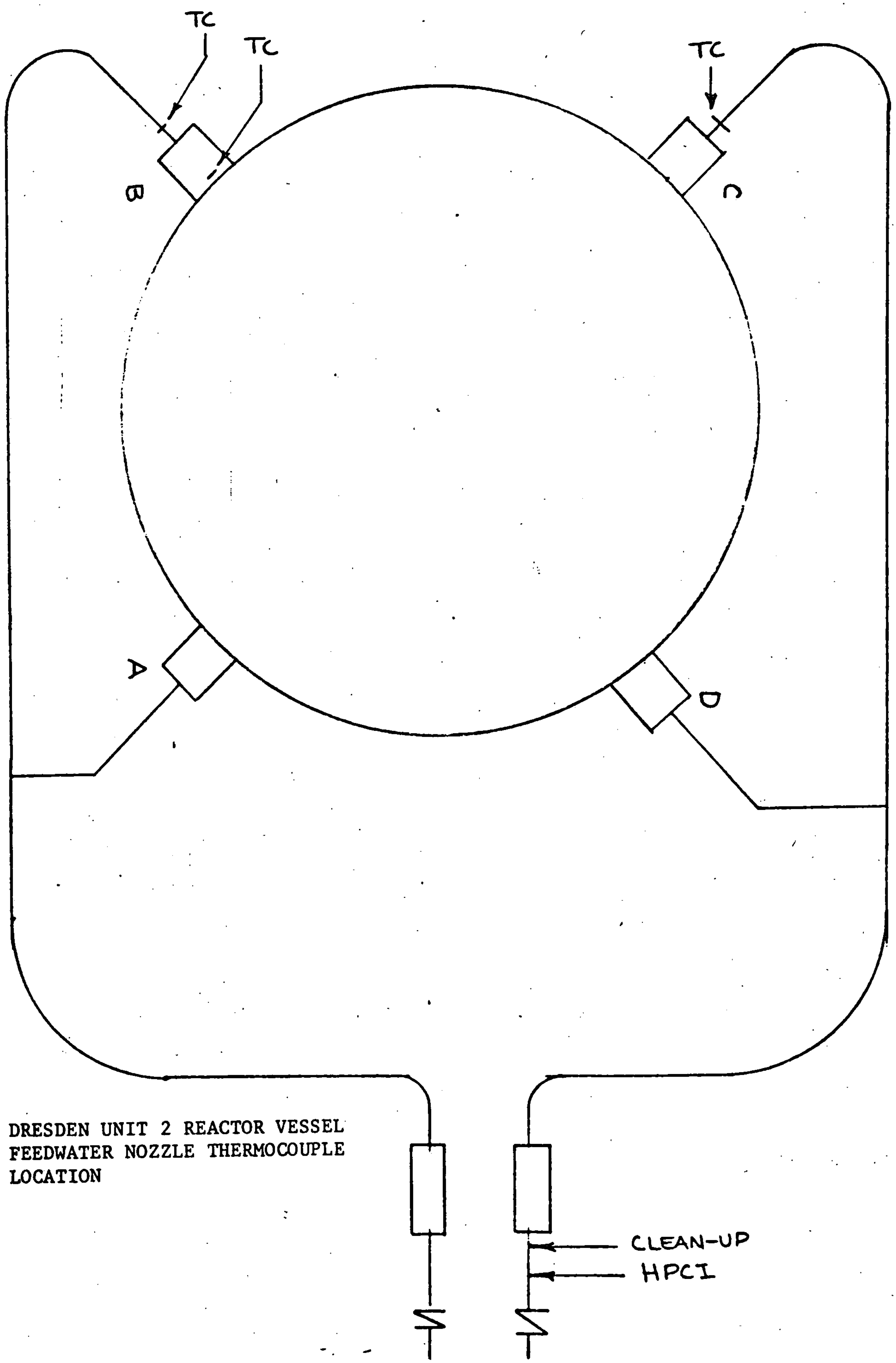
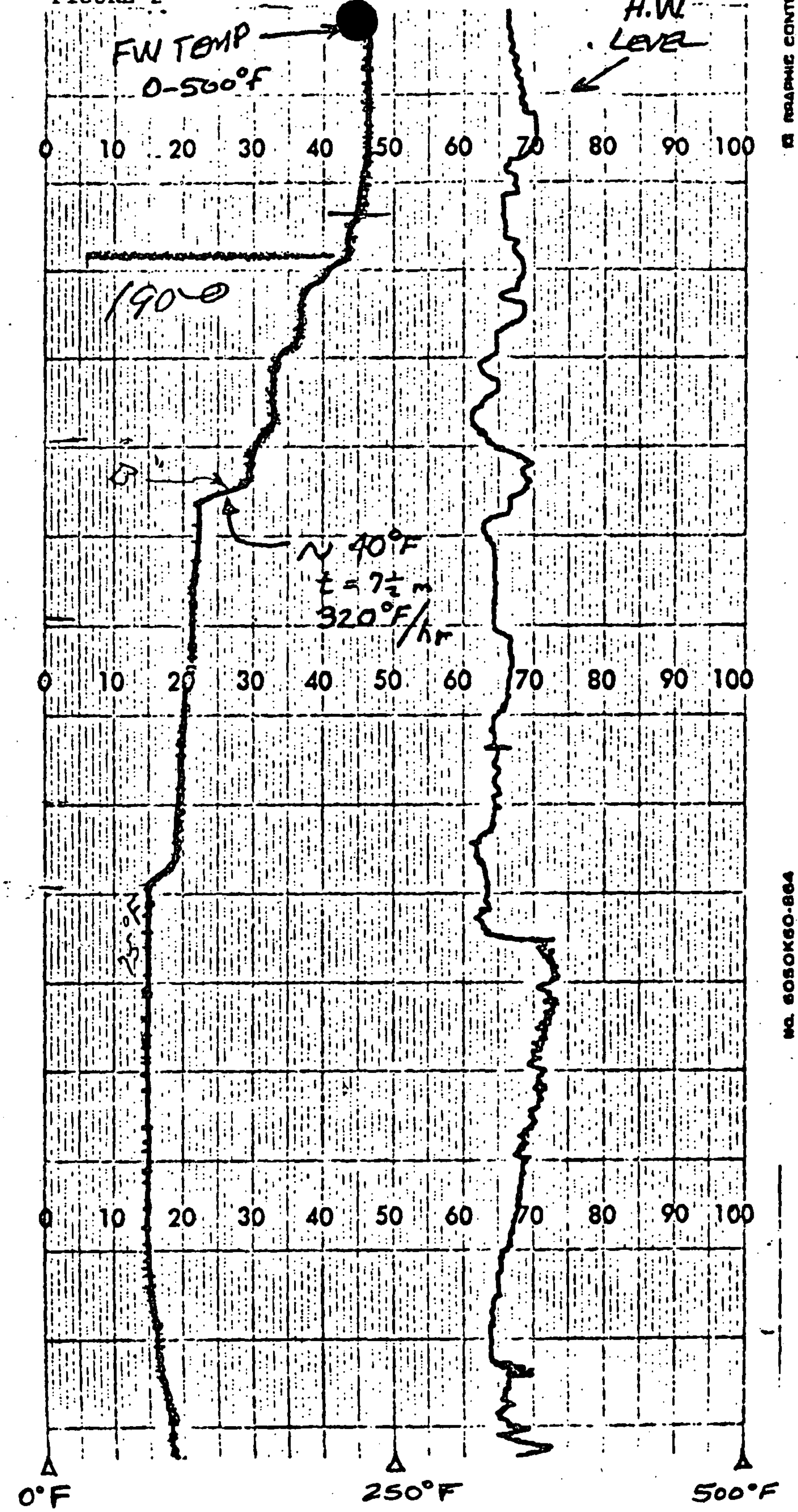


DRESDEN UNIT 2 REACTOR VESSEL FEEDWATER NOZZLE THERMOCOUPLE LOCATION

- FIGURE 2 -



DRESDEN UNIT 2 FINAL
FEEDWATER TEMPERATURE
DURING STARTUP WITH SPECIAL
OPERATING PROCEDURE

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- FIGURE 3 -

DRESDEN UNIT 2 FINAL FEEDWATER TEMPERATURE DURING ROUTINE STARTUP

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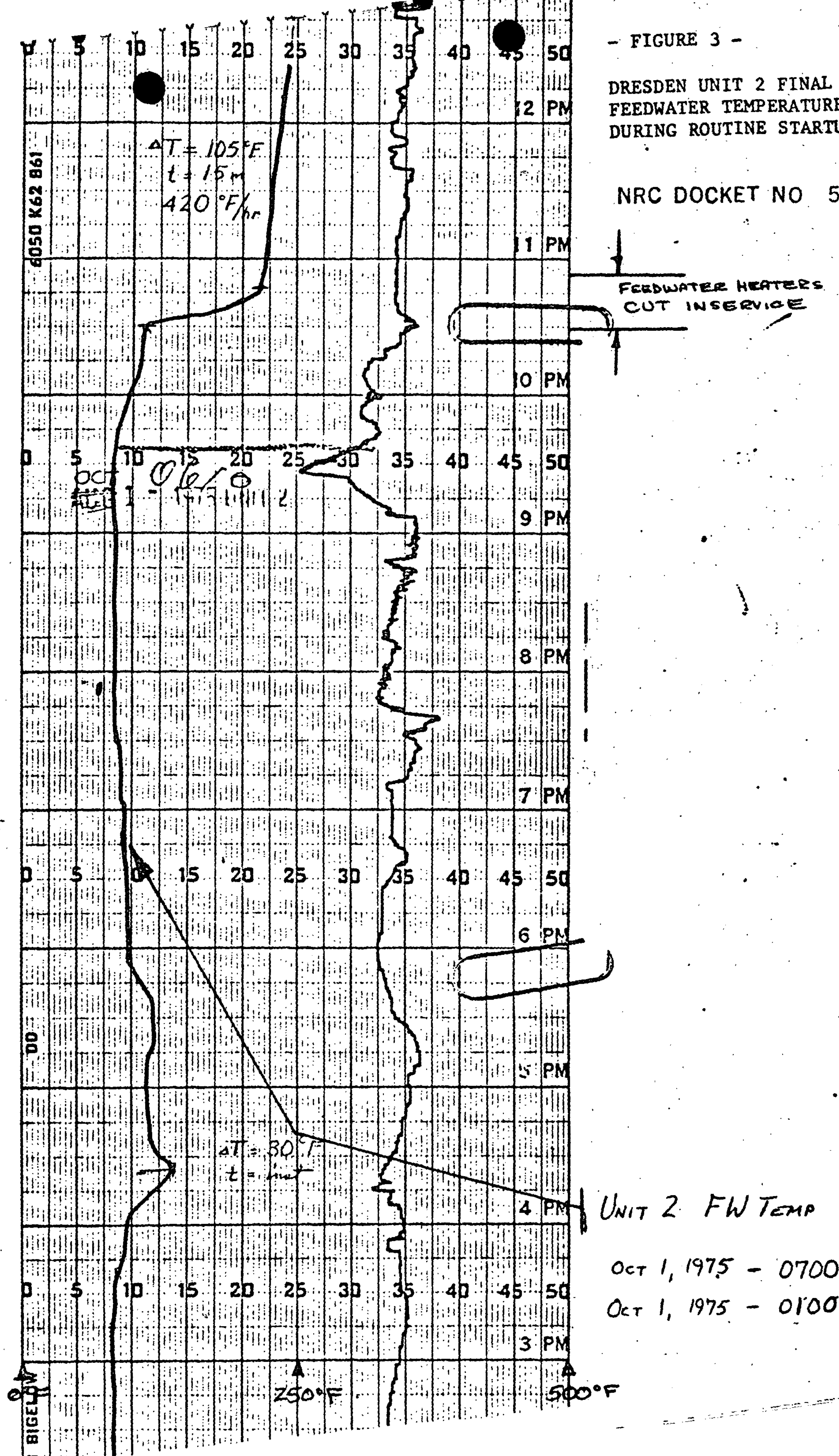
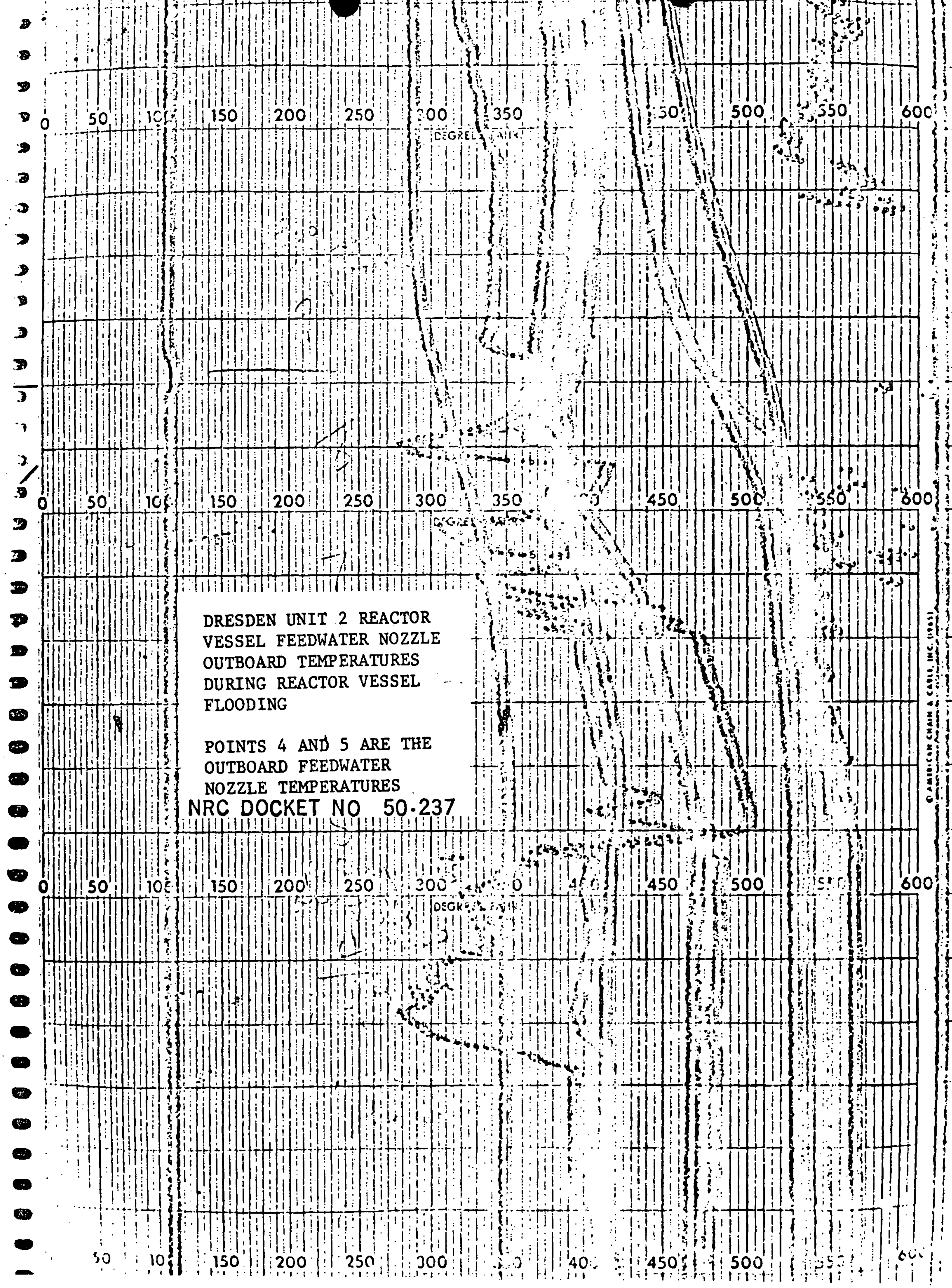


- FIGURE 4 -



DRESDEN UNIT 2 REACTOR VESSEL FEEDWATER NOZZLE OUTBOARD TEMPERATURES DURING REACTOR VESSEL FLOODING

POINTS 4 AND 5 ARE THE OUTBOARD FEEDWATER NOZZLE TEMPERATURES

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