Central Files

# INDIANA & MICHIGAN POWER COMPANY

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NEW YORK, N. Y. 10004

August 3, 1979
AEP:NRC:00221A

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74

Mr. J. G. Keppler, Regional Director
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Avenue
Glen Ellyn, Illinois 60137

Dear Mr. Keppler:

The attachment to this letter contains the first progress report on the feedwater line data collection program in Unit No. 2 of the Donald C. Cook Nuclear Power Plant. The data collection program was described in our AEP:NRC:00221 submittal dated June 15, 1979. This progress report is submitted in accordance with the commitment made in our AEP:NRC:00216 submittal dated June 15, 1979.

The AEPSC interprets 10 CFR 170.22 as requiring that no fee accompany this submittal.

Very truly yours,

John E. Dolan

John E. Dolan
Vice President

JED:em

cc: R. C. Callen
G. Charnoff
R. S. Hunter
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PROGRESS REPORT

## Feedwater Line Data Collection Program

### Introduction

A test program was recently initiated on two feedwater lines of D.C. Cook Unit 2. The purpose of this program was to collect data on steady state and transient conditions during normal plant operation from two steam generators and their associated feedwater piping. Data on pipe motions, strains, pressures and temperatures were collected from cold shutdown to full power and trip from full load. We and Westinghouse are collectively in the process of reducing and evaluating the data collected.

Preliminary review of the data has revealed a cyclic and steady state temperature phenomenon which was unforseen prior to data gathering. Samples of this phenomenon will be presented in this report. Herein, we will describe the instrumentation set-up, test procedure and outline our future plans for data reduction and evaluation.

### Test Instrumentation

Test instrumentation was installed on the auxiliary and main feedwater piping and steam generator feedwater nozzles for loops number one and three of Unit 2. These loops were instrumented identically with respect to type, quantity and location of test instrumentation. The loops were instrumented in this manner to insure redundancy of information. The following is a brief summary of the number and location of the various types of test instrumentation:

Strain Gages: Twelve (12) strain gage channels per loop were utilized to obtain data on: bending, torsional and axial stresses on the sixteen inch elbow, at a location adjacent to the elbow to nozzle weld and bending stresses on the steam generator nozzle. Three (3) strain gages were used to measure loadings on three seismic snubbers.

Accelerometers: Thirteen (13) accelerometers per loop were utilized to monitor possible oscillations of the steam generator and the associated main feedwater piping within the containment. Accelerometers were placed at each of the three feedwater line elbows inside the containment crane wall, midway along the vertical riser and on one of the seismic snubber bases.

Thermocouples: Twenty-three (23) thermocouples per loop were used to measure: circumferential temperature distribution on the nozzle, associated weld and pipe elbow, axial temperature distribution along the elbow and vertical riser and the auxiliary feedwater temperature. In addition, two (2) thermocouples per loop were placed inside the elbow, approximately six inches upstream from the elbow to nozzle weld, at the nine o'clock position looking into the steam generator.

These thermocouples were used to measure the inside metal and water temperatures.

Pressure Transducers: Five (5) pressure and four (4) differential pressure transducers were employed to monitor possible water pressure or flow oscillations within the elbow, and the main feedwater and auxiliary feedwater piping.

Displacement Transducers: Ten (10) Direct Current Differential Transformers (DCDT) per loop were used to measure main feedwater pipe displacement within the containment.

In addition to the data recorded on the above channels, control room readings of steam generator pressure, hot and cold leg temperature, main feedwater temperature and flow, feed pump speed, auxiliary feedwater flow and steam generator level for both loops one and three were recorded.

Test Procedure

The test program took place in two parts. The first test period began on June 28 when the reactor was at cold shutdown and continued until July 4 when the unit attained full load. During this phase of the test program data was collected during the following sequence of events:

a) Start-up of reactor coolant pumps.

b) Various intervals during RCS heatup.

c) Periods of time that coincided with intermittent injection of auxiliary feedwater flow into the steam generator while the unit was at hot-standby.

d) During unit start-up, including start-up of both the main feedpumps and main turbine.

e) At roughly every ten percent power level up to and including full load.

f) During a turbine stop valve test sequence.

During this phase of the test program, data was also collected during an unplanned trip from 19% thermal power. The final phase of the test program took place on July 21 and consisted of data collection during a planned trip from full load. Data was recorded beginning with the trip and continued until the unit was returned on line.

## Preliminary Results

Preliminary analysis of the data reveals that when the unit is at hot-standby and during startup, the elbows adjacent to the steam generator nozzles and the nozzles exhibited large circumferential temperature gradients which indicates temperature stratification in the water. This condition occurs during low auxiliary feedwater flow rates, and manifests as the lower portion of the nozzle and adjacent elbow being significantly cooler than the upper portion. When the water flow rate is increased, in order to maintain steam generator level, the upper portion of both the nozzle and elbow cool. This results in a cyclic circumferential temperature gradient when the water flow rate is later reduced and the temperatures return to their previous state of stratification.

This is shown graphically for two different runs in Figures 1-4. The variation in auxiliary feedwater flow rate is indicated on the figures. The thermocouple locations are shown on Figure 5. Both runs were preceeded by steady low auxiliary feedwater flow through the feedwater lines, though this flow differed for both runs. This accounts for the different initial stratification. Since this data is still preliminary a few channels whose calibrations are uncertain during either run were omitted for the time in question.

As can be seen at minimum flow the elbow and nozzle see the most severe stratification. As the flow rate is increased the temperatures at the top of the nozzle and elbow decay. The higher the flow rate the more rapid the decay in stratification. As flow is reduced thereafter, the temperatures immediately return to a stratified condition.

The observed cyclic circumferential temperature gradient was accompanied by cyclic readings from the strain gages. The strain gage readings followed the cyclic circumferential temperature gradients.

The nonuniformity in circumferential temperature during low auxiliary water flow is apparently due to thermal stratification within the horizontal portion of the elbow and nozzle. Data taken during two ascensions from zero to 20% power showed similar temperature fluctuations due to the frequent variations in auxiliary feedwater flow rates. Once the feedwater lines were on main feedwater, variation in temperature were no longer observed.

Review of the accelerometer data did not reveal significant pipe motion. On-line spectral analysis to selected channels during the test made it possible to identify the modal frequencies of pipe motion but the displacements were insignificant. There was no evidence of the pipe being excited by any outside source. Finally, examination of the piping at both cold and hot steam generator conditions did not show any interference or unexpected movements.

Conclusions

Further analysis requires the translation of the data recorded on magnetic tapes. However, the preliminary review of the data, including the full load trip, substantiates the conclusion that there is a thermal related problem that occurs when the system is at hot-standby and continues through start-up, until the system is transferred to main feedwater. This generally occurs somewhere between 4% and 20% thermal power.

Westinghouse is presently in the process of digitizing and reducing the data recorded on magnetic tapes. In addition, because our strain measurements give us only the change of strain, rather than the absolute strain value, Westinghouse is developing a three-dimensional stress analysis model. Using our measured temperatures as an input the three-dimensional model will yield absolute stress. This will enable us to develop the absolute stresses caused by the differential temperature pattern and correlate the strain changes as indicated by the strain gages.

Our schedule presently calls for completion of the data reduction by early to mid September. At that time we expect to have initial results from the three-dimensional stress model which will yield the absolute magnitude of the induced stresses and their fluctuation. The final results of the thermal stress analysis is scheduled for mid October with the completion of the evaluation report due by the end of October.

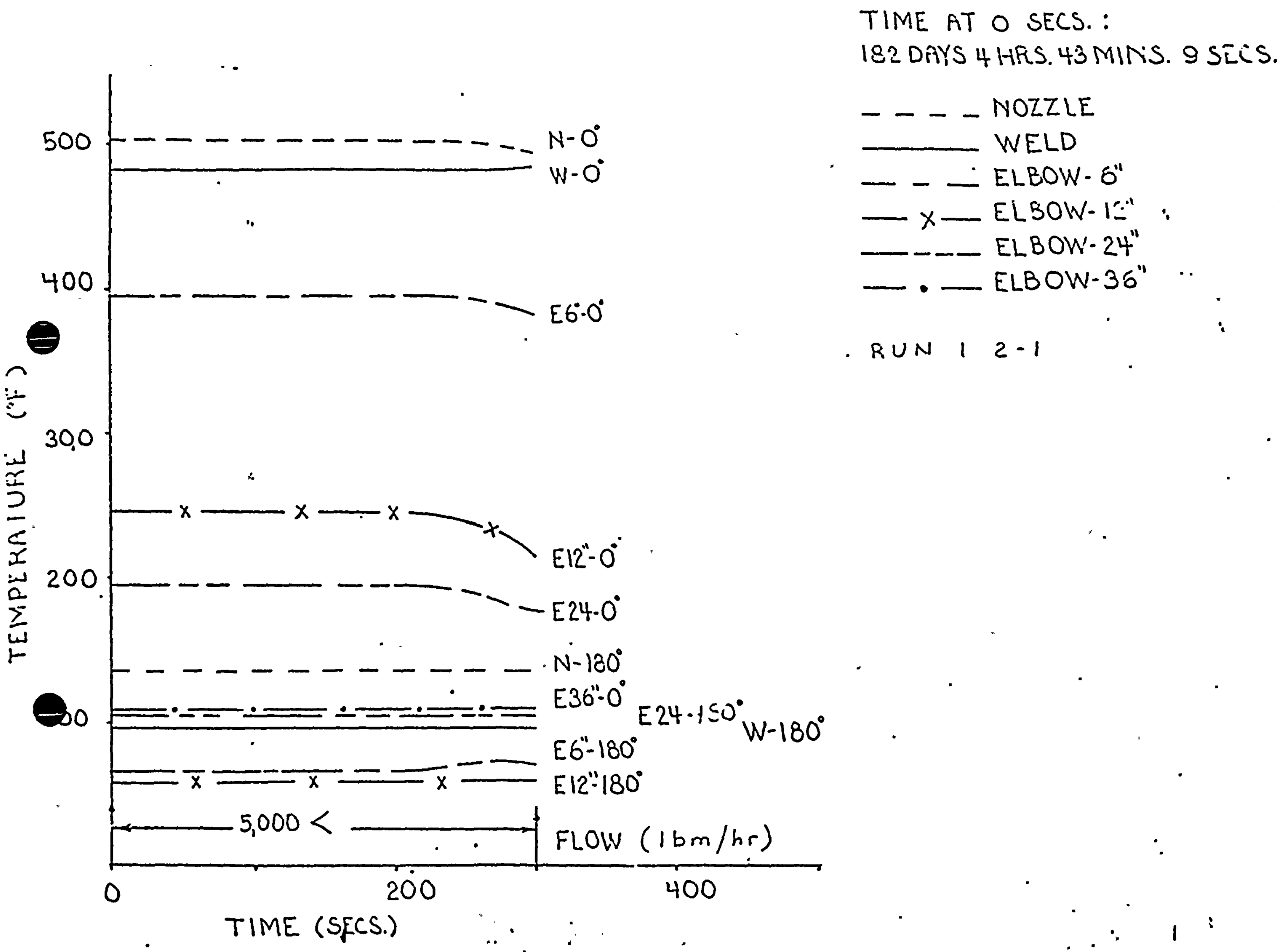


FIGURE 1: OUTSIDE TEMPERATURES ON STEAM GENERATOR NOZZLE 2-1 AND NEARBY ELBOW AT LOW AUXILIARY FLOW RATE

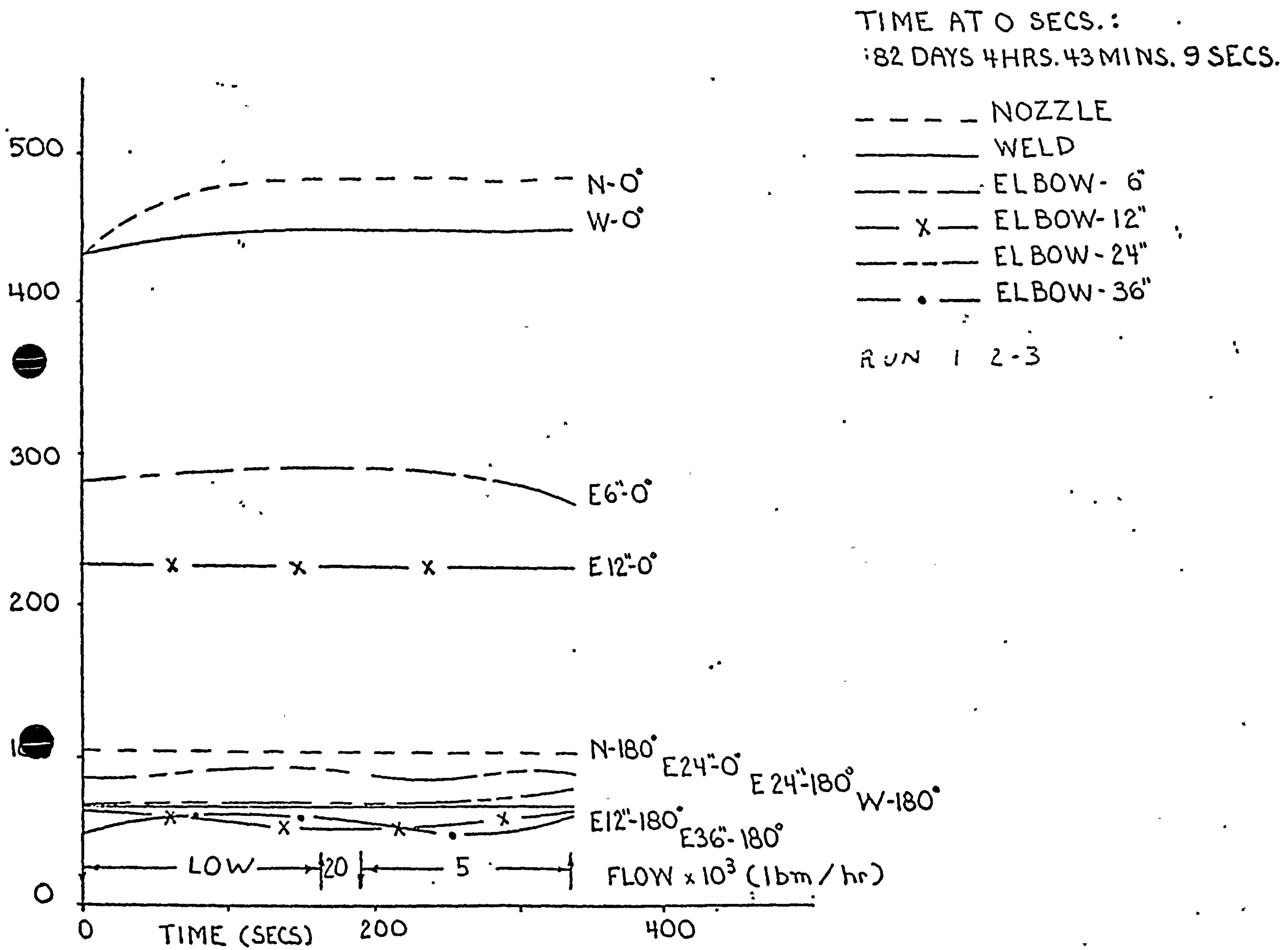


FIGURE 2: OUTSIDE TEMPERATURES ON STEAM GENERATOR NOZZLE 2-3 AND NEARBY ELBOW AT LOW AUXILIARY FEEDWATER FLOW RATE

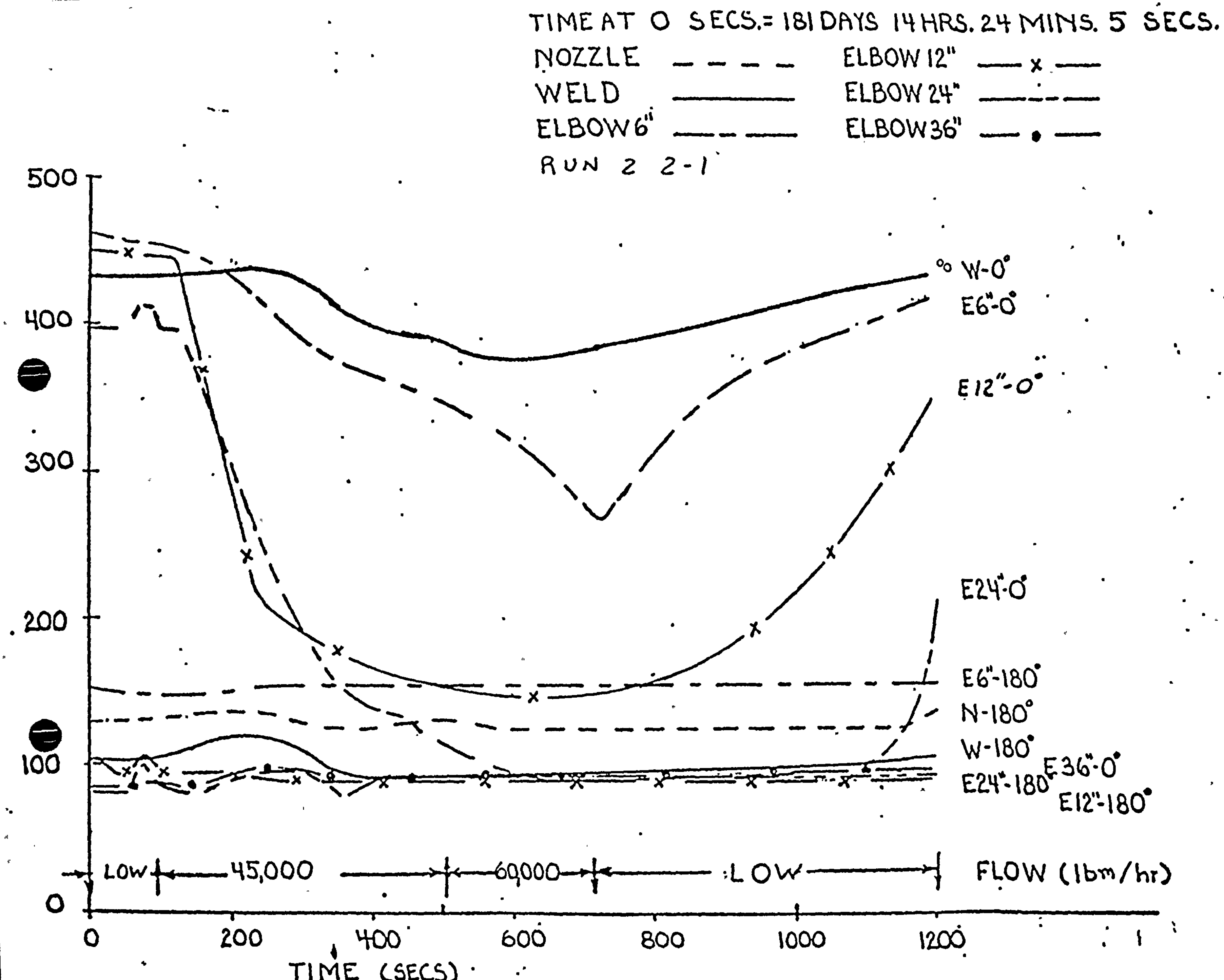


FIGURE 3: OUTSIDE TEMPERATURES ON STEAM GENERATOR NOZZLE 2-1 AND NEARBY ELBOW ~~AT~~ HIGH AUXILIARY FLOW RATE

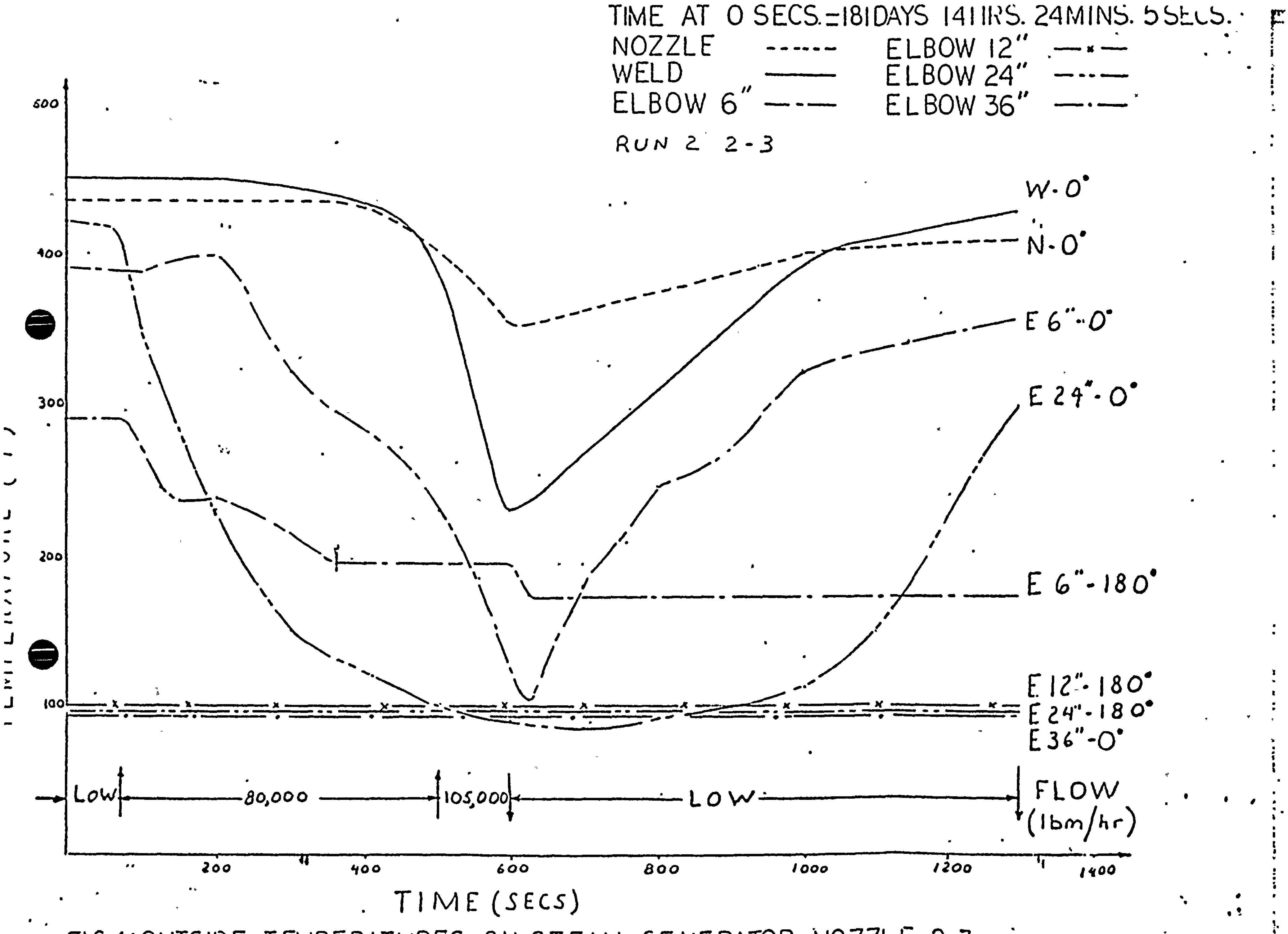


FIG.4: OUTSIDE TEMPERATURES ON STEAM GENERATOR NOZZLE 2-3 AND NEARBY ELBOW AT HIGH AUXILIARY FEEDWATER FLOW RATE

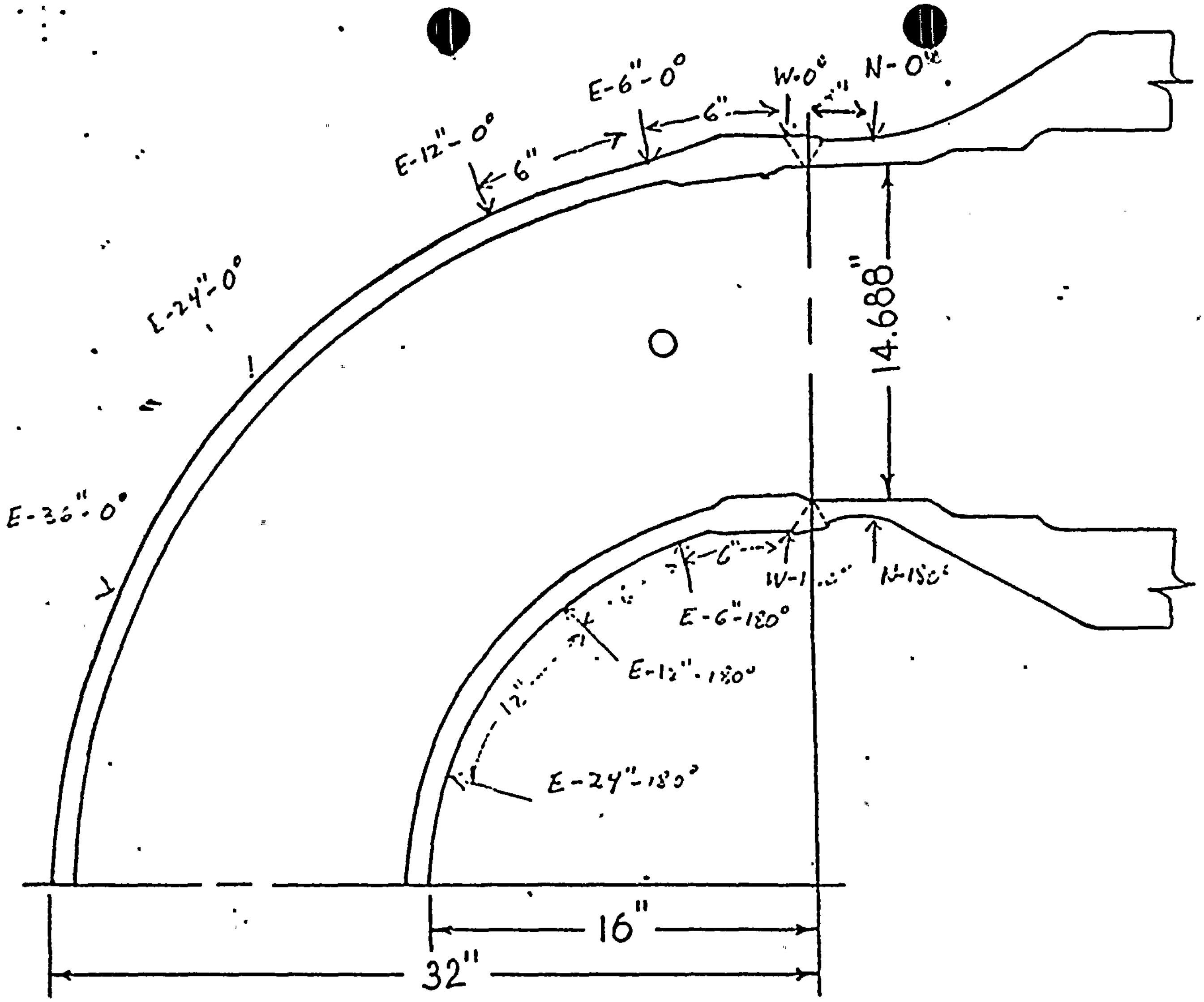


Figure 5. Location of Thermocouple on the Nozzle, Weld and Elbow at 0° and 180° Positions.