Duke Power.
A Duke Energy Company

Duke Power Company
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February 26, 1998

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Site
Docket Nos. 50-269, -270, -287
Response to NRC Bulletin 88-08, Supplement 1

In a letter dated March 10, 1989, Duke Energy Corporation (Duke) submitted the original response to NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to the Reactor Coolant System". That submittal did not address the, then unknown, issue of thermal stratification in the high pressure injection (HPI) system normal makeup lines. On April 21, 1997, Oconee Unit 2 was shut down due to a leak in the 2A1 HPI normal makeup line. As a followup action stemming from the investigation of this leak, Duke committed in a letter to the NRC dated July 28, 1997 to update its response to NRC Bulletin 88-08 by March 1, 1998. Supplement 1 to that bulletin is attached and contains the following commitments:

1. A computational fluid dynamics (CFD) analysis of the HPI and normal makeup nozzles on the RCS will be performed by Framatome Technologies. This CFD analysis is scheduled for completion by May 15, 1998.

2. Thermal monitoring of the HPI normal makeup and emergency injection lines will continue until 1EOC18 (Spring 1999), 2EOC17 (Fall 1999) and 3EOC18 (Spring 2000).

IE16

3. A final supplement to NRC Bulletin 88-08 will be provided after completion of the monitoring effort and related activities. The proposed date of this submittal is July 1, 2000.

If there are any questions regarding this submittal, please contact Ed Burchfield at (864) 885-3292.

Very truly yours,

W. R. McCollum, Jr.
Site Vice President
Oconee Nuclear Site

edp

cc: L. A. Reyes, Regional Administrator
Region II

M. A. Scott, Senior Resident Inspector
Oconee Nuclear Site

D. E. LaBarge, Project Manager
NRR

Oconee Nuclear Station

Response to NRC Bulletin 88-08
Supplement 1

Duke Energy Corporation

Response to NRCB 88-08, Supplement 1

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1.0 Introduction

Oconee Nuclear Station's original response to NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to the Reactor Coolant System" is contained in Reference 1. The original submittal did not include the thermal stratification discovered in the High Pressure Injection/Normal Makeup (HPI/NMU) Lines. The back flow/thermal stratification in these lines was discovered during the investigations into the April 1997 Unit 2 HPI/NMU failure of the piping to safe end weld adjacent to the Reactor Coolant System (RCS) injection nozzle. As a result of the failure and in a letter to the staff dated July 28, 1997, Oconee committed to submit supplemental information regarding the HPI/NMU lines related to NRC Bulletin 88-08 by March 1, 1998.

Oconee has a six part plan that addresses the back flow/thermal stratification issue for the HPI/NMU lines. This plan includes an assessment of the effect of back flow/thermal stratification on the fatigue analysis of the HPI systems, implementation of design changes and operating procedure changes to minimize future back flow/thermal stratification events, and continued thermal monitoring to assess the effectiveness of the changes to minimize the phenomena. Oconee believes that this plan will assure that the structural integrity of the HPI system is not compromised. This plan is as follows:

- Limited cycle short term fatigue evaluation of stratification using 1989 -1990 recorded thermocouple data.
- Replacement of the combination HPI Emergency Injection (HPI/EI) and HPI/NMU stop check valves with separate gate and lift check valves to prevent back leakage through the valves. These modifications have been implemented on all three Oconee units.
- Operating procedure changes to maximize warming (minimum flow) line flow to the HPI/RCS nozzles during heat-ups and cool-downs to minimize the possibility of back flow/thermal stratification
- Continual monitoring of thermocouple temperature data for verification that changes made minimize or eliminate the back flow/thermal stratification phenomena.
- Stress analysis to Class 1 rules of the HPI/EI and HPI/NMU lines. These analyses will include effects due to the back flow/thermal stratification phenomena.

- Computational Fluid Dynamic work to assess sensitivity of phenomena to varying flows in the HPI/NMU lines.

This document provides an update on Oconee's activities related to the investigation of thermal stratification and other thermal phenomena discovered on the HPI/NMU lines. Monitoring of the subject lines via thermocouples is continuing to provide more detail to the thermal phenomena. The monitoring effort is slated to continue until refueling outages 1EOC18, 2EOC17, and 3EOC18. Duke proposes to provide a final supplement to Bulletin 88-08 after conclusion of the monitoring effort.

Oconee is not aware of additional systems that may be potentially affected by the thermal phenomena identified by Bulletin 88-08.

2.0 Previous Submittal

The following paragraphs provide a synopsis of specific actions requested by the original issue of the Bulletin 88-08 and supplements 1-3, and Duke's response to those requests (Reference 1).

2.1 Action 1

Action 1 requested that licensees review the systems connected to the RCS to determine whether unisolable sections of piping connected to the RCS can be subjected to unanalyzed and unacceptable thermal stresses resulting from valve leakage past valves isolating high pressure systems.

The completed review identified portions of the High Pressure Injection/Emergency Injection (HPI/EI) lines as the only unisolable piping potentially susceptible to unacceptable thermal stresses resulting from the type of event described in Bulletin 88-08.

2.2 Action 2

Action 2 requested that licensees inspect any unisolable sections of piping connected to the RCS that may have been subjected to excessive thermal stresses to provide assurance that there are no existing flaws.

The applicable portions of the HPI/EI lines for all three Oconee Units were reviewed. Certain piping welds were identified for augmented inspections. Each identified weld received a full volumetric ultrasonic examination and the examination extended one inch into the base metal. Six welds on Unit 1, eight on Unit 2, and seven on Unit 3 were identified for inspection. No reportable indications were found.

2.3 Action 3

Action 3 requested that licensees plan and implement a program to provide continuing assurance that the piping identified in Action 1 is not subjected to unacceptable thermal stresses.

As defined in Reference 1, the Oconee program had four components:

- Perform a preliminary bounding analysis using the Farley data presented in Bulletin 88-08 and Information Notice 88-01.
- Instrument both Unit 1 HPI/EI lines to detect stratified temperature conditions.
- Collect and evaluate data from the Unit 1 instrumented HPI/EI piping.
- Determine and implement the most effective means of providing long term assurance of piping integrity for all Oconee units.

These tasks were dispositioned as follows (Reference 1):

- A preliminary bounding analysis using the Farley data did not show complete code compliance for a 40 year fatigue life. Inspection results coupled with the preliminary analysis formed a justification for continued operation.
- The Unit 1 HPI/EI were instrumented to detect stratified temperature conditions. A total of seventeen thermocouples were installed during 1989.
- The Ref. 2 calculation was completed to review the temperature data collected from the Unit 1 HPI/EI lines and to reduce the data into a representative thermal load on the piping.
- Using the conclusions of Ref. 2, Ref. 3 contains the analyses for all of the Oconee units to confirm the integrity of the HPI/EI lines for forty year plant life using the methodology of ASME Sec. III, Paragraph NB-3653, 1986 Edition with 1987 Addenda.

2.4 Response to NRC Supplement 3

Reference 4 provides a review of the possibility of intermittent valve leakage across the seat of a limit set gate valve through the packing gland leak-off line. The review determined that this scenario was not possible at Oconee due to the fact that Oconee valves are set on torque rather than limit. Setting on torque assures good seating. In addition, the packing gland leak-off taps are plugged at Oconee.

3.0 New Informa ion

Due to the failure of the weld between the Unit 2 A1 HPI/NMU pipe and the nozzle safe end, a detailed review was begun to explore the possibility of stratification in the HPI/NMU lines. 1990 monitoring data from thermocouples installed on one of the Unit 1 HPI/NMU was reviewed. In addition new monitoring equipment (thermocouples) were installed on both the HPI/NMU & HPI/EI lines in Units 1 & 2, and on the HPI/NMU lines in Unit 3 during the summer and spring of 1997.

3.1 1990 Monitoring Effort

In the spring of 1990, a decision was made to add thermal monitoring instrumentation on one of the Unit 1 HPI/NMU lines. Attachment 1 shows the arrangement of the thermocouples installed during 1990 on the Unit 1 HPI/NMU lines. Data was collected in late May and early June, 1990, during restart after a refueling outage. Attachment 2 (Sheets 1-3) depicts monitoring data recorded on June 4, 1990. Review of the data indicated a maximum stratification of 327 degrees F. Reference 5 provides an overview of the data and concludes that the cause of the stratification is back flow through a leaking check valve while the unit is in start-up mode with one Reactor Coolant Pump (RCP) off in that loop.

3.2 Analysis of High Pressure Injection Lines

Both the HPI/NMU & HPI/EI lines were included in the scope of work required for the Reactor Coolant System (RCS) Auxiliary Piping Fatigue Analysis Project. In a letter dated July 10, 1995 (Ref. 6), the staff agreed with the project completion date of August 31, 1999. Oconee awarded the project to Structural Integrity Associates (SIA) of San Jose, Ca. in the spring of 1996. Oconee was in the process of locating and supplying the 1990 thermocouple data to SIA for inclusion into the fatigue analysis of both the HPI/NMU & HPI/EI lines at the time of the April 21, 1997 failure of the Unit 2 pipe to safe end weld on the 2A1 HPI/NMU line. As a result of the failure, Duke committed in a letter to the staff dated July 28, 1998, to accelerate the completion of the HPI analysis to December 31, 1997. Later, due to difficulties in analyzing the vast amount of thermocouple data, the completion date was changed (Ref. 7) to February 28, 1998. Oconee received the final HPI analyses from SIA on February 24, 1998. Oconee is verifying that correct inputs were used in the SIA analyses and reviewing results for potential changes to Oconee's plan to minimize or eliminate the phenomena. Oconee will complete the review by May 1, 1998.

Based on the 1990 thermocouple data supplied to SIA, a total of twenty-two stratification events were conservatively identified for each time the unit was in the hot shutdown mode for both the HPI/NMU and the HPI/EI lines. These events bounded the 1990 data and conservatively added a set of cycles assuming opposite loop reactor coolant pump cycling (on/off). It was postulated for the analysis that the system would return to hot shutdown conditions after each stratification event. The analysis included the following effects from stratification:

- Thermal expansion based on the average measured temperature in the Class 1 and Class 2 portions of the lines.
- Global bending moment effect for the stratification assumed in the Class 1 and Class 2 portions based upon a stratification level at the center of the pipe.
- Local stress effects at the stratified Class 1 section considering the most adverse stratification level, coincident with the above.

Th. fatigue usage due to the "self-cycling" of the stratification will be added to the fatigue usage resulting from the other design transients.

4.0 Current Monitoring Effort

In a effort to more fully understand the thermal phenomena that caused the Unit 2 weld failure, Duke decided to implement temporary monitoring on both the HPI/NMU & HPI/EI lines in Units 1 & 2, and on the HPI/NMU lines in Unit 3. Forty-two (42) thermocouples were installed on the Unit 1 HPI/NMU & HPI/EI lines. Seventy-eight (78) thermocouples were installed on the Unit 2 HPI/NMU & HPI/EI lines. Due to the similarities between Units 2 and 3, only sixteen (16) thermocouples were installed on the Unit 3 HPI/NMU lines. The data for each unit's thermocouples are collected and recorded on stand alone personal computers located in the respective units' cable spread room. Units 1 & 3 have a Fluke Netdaq data collection system, while Unit 2 has a Helios data collection system. The location of the thermocouples on the Oconee Units HPI/NMU & HPI/EI lines are shown in Attachment 3 of this document. The thermocouples are located to allow recognition of turbulent penetration or leakage of RCS fluid back into the piping and nozzles and to allow recognition of top to bottom thermal stratification.

4.1 Units 1 & 3 Data Collection System

The Units 1 and 3 Fluke Netdaq data acquisition systems record thermocouple data at the user specified rate. During power operations, the scan rate for Unit 1 & 3 is normally set for every 20 seconds. During hot shutdown conditions, the scan rate is accelerated. The data from each day is copied to a uniquely named file. Data files are down loaded frequently for analysis and trending purposes. The Fluke Netdaq software allows instantaneous graphing of temperature versus time for any individual thermocouple or any group of thermocouples. The software also has the capability to provide statistics for any temperature vs. time continuum. For example, it can provide the maximum temperature, the minimum temperature, the median temperature, and the standard deviation for each data stream (for a given time interval).

4.2 Unit 2 Data Collection System

The Unit 2 data acquisition system is a Helios system. The Helios system works similarly to the Fluke Netdaq system except that the Helios system does not have on line graphing and statistical functions. These functions are attained by down loading the Helios data files to EXCEL and using custom macros to analyze and graph the data. The frequency of data analysis and trending is similar to Units 1 & 3.

4.3 Trending Thermal Monitoring Data vs. Plant Operating Data

Plant operating data from the Operator Aid Computer (OAC) can be accessed via OILS-PI (plant parameter data acquisition program) using EXCEL. Accessing OILS-PI allows comparison of the thermocouple data versus plant operating parameters. Usually plant parameters such as RCP operation (digital point, i.e. ON or OFF), HPI flow, HPI warming line flow, Pressurizer Level, HPI Letdown flow, and Unit power are of interest. The plant operating parameter data can be merged with thermocouple data for analysis, graphing, and trending. The frequency of the plant parameter data can be retrieved at an identical scan rate as the thermocouple data was recorded. This allows a one to one correspondence between the thermocouple temperatures and the plant parameters. Correlation of the thermocouple data with the plant parameter data allows a cause and affect analysis to be determined (i.e which change in plant parameter caused the change in the thermocouple data).

4.4 Acceptance Limits

The acceptance limits for the currently recorded thermocouple data is based on a limited cycle Class 1 fatigue analysis of the Unit 1 HPI/NMU nozzles provided by SIA in late May of 1997 (Reference 8 & 9). The intent of the limited cycle calculation was to qualify the HPI/NMU lines until the combination stop check valves were replaced.

Thermocouple data from 1990 was used in the computation of the stratification used in the analysis. The results of the analysis indicated a cumulative fatigue usage of .028 for all postulated transients that could occur during a fuel cycle. Due to the similarities between the HPI systems of the Oconee units, this analysis was adopted for the other Oconee units as well. Margin was conservatively applied to the stratification input used in those calculations to establish the acceptance limits. The acceptance limits will be adjusted as necessary pending Oconee's review of the final SIA analyses.

4.5 Current Thermal Monitoring Results

Since the replacement of the Oconee Units 1, 2, & 3 HPI/NMU & HPI/EI combination isolation stop and check valves with a new lift check and a new stop valve, no severe thermal stratification events have been recorded via the thermocouples for any of the Oconee units. Several minor stratification events have been recorded, however, the bottom to top delta temperatures were well within acceptance limits. The success in preventing the back flow/stratification is attributed to the replacement of the above noted valves, and operating procedure changes which maximize HPI warming (minimum circulation) flow to the HPI nozzles to the RCS.

4.6 Future Activities

As noted previously, Oconee intends to continue thermal monitoring of the HPI/NMU & HPI/EI lines until refueling outages 1EOC18 (Spring 1999), 2EOC17 (Fall 1999), and 3EOC18 (Spring 2000). Continued analysis and trending of the thermal data will provide verification that the replacement valves and operational procedure changes minimize the back flow/thermal stratification phenomena.

In concert with above, Oconee has contracted with Framatome Technologies Inc. (FTI) to complete a computational fluid dynamics (CFD) analysis of the HPI/NMU nozzle on the RCS. This work will determine the interface zone between the hot RCS fluid and the relatively cold HPI fluid for differing levels of HPI/NMU flow and HPI warming flow. In addition, the analysis will provide an assessment of back leakage through an assumed gap between the thermal sleeve and the nozzle safe end. A stress analysis of the nozzle safe end for the applied thermal gradients resulting from the back flow/stratification will accompany the CFD analysis. These results will be merged with the previously mentioned Class 1 fatigue analysis by SIA. Acceptance limits for stratification will be amended accordingly. Completion of the CFD analysis is currently scheduled for May 15, 1998.

5.0 Conclusions

As noted in Duke's internal investigation of the Unit 2 weld failure, the combination of the following events are believed to cause the back flow/stratification:

- Cross flow between loops with one RCP on in a loop, while the other RCP is off in a loop.
- Widely Varying HPI Normal Makeup flow.
- Erratic HPI Warming flow.
- Back leaking system boundary check valves.

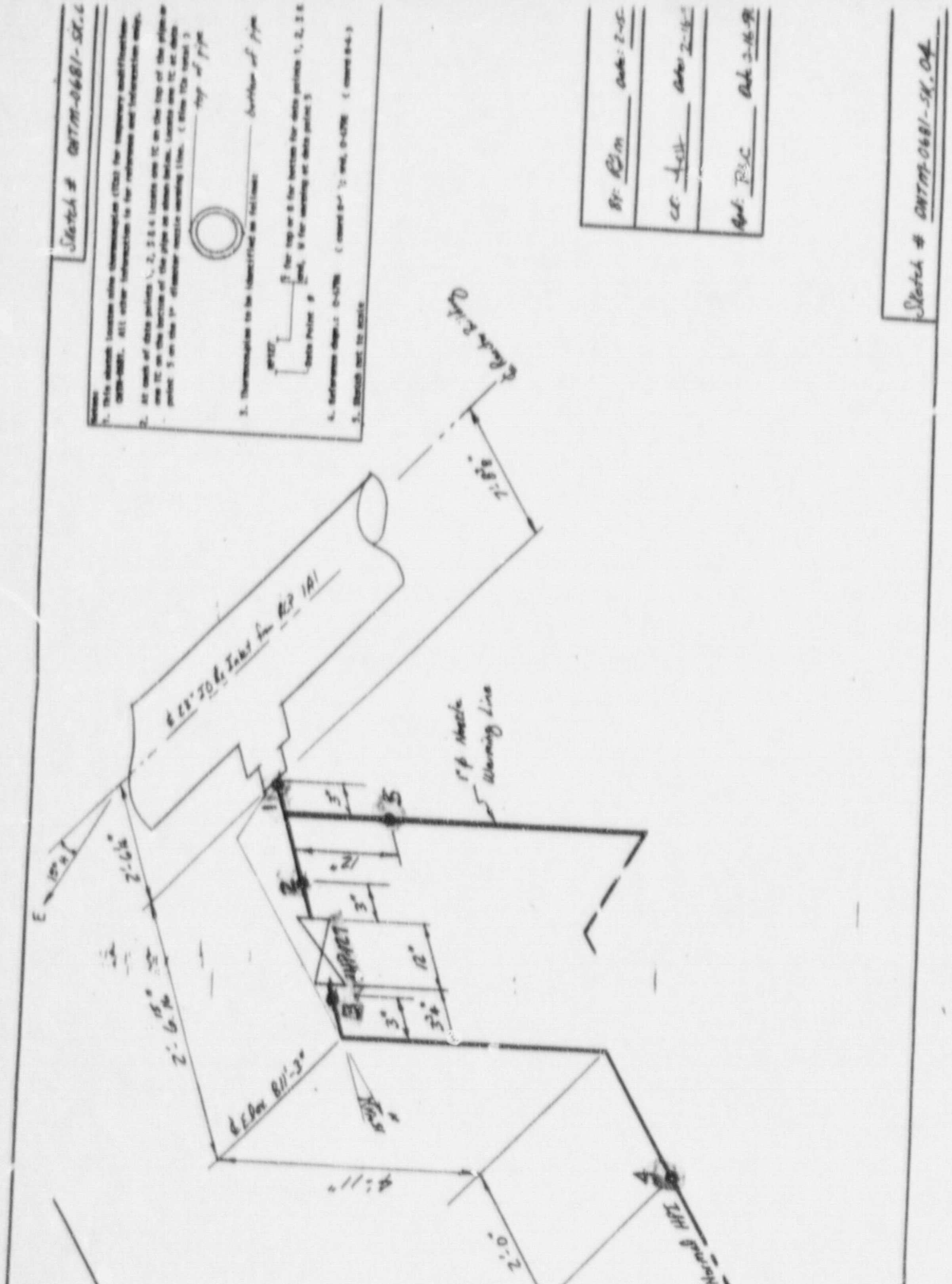
Oconee believes that the solution to the back flow/stratification problem is rooted in solving the HPI flow perturbations noted during plant Heat ups and Cool downs. As noted herein, Oconee has implemented a six part program to manage the back flow thermal stratification phenomena detected on the HPI/NMU lines:

- A limited cycle thermal f-·'gue analysis has been completed and indicates insignificant fatigue usage due to back flow/thermal stratification.
- The combination stop check valves have been replaced by separate gate and lift check valves for all of the Oconee units.
- Operating procedures have been completed to maximize warming line flow to the HPI/NMU nozzles during heat-ups and cool-downs.
- Thermocouples have been installed on the Units 1 & 2 HPI/NMU & HPI/EI lines and on the Unit 3 HPI/NMU lines. Monitoring will continue until 1EOC18, 2EOC17, and 3EOC18 respectively.
- Stress analysis to Class 1 rules for design transients, including the effects from back flow/thermal stratification, has been completed. Oconee's review of the inputs and results is in progress and is currently scheduled for completion by May 1, 1998.
- Computational fluid dynamics work is in progress to determine the sensitivity of back flow/thermal stratification to varying HPI/NMU flows.

Oconee believes that these actions continue to substantiate the structural integrity of the HPI systems. Oconee proposes to provide a final supplement to NRCB 88-08 after completion of the monitoring effort and the related activities. The proposed date for the submittal of the final supplement is July 1, 2000.

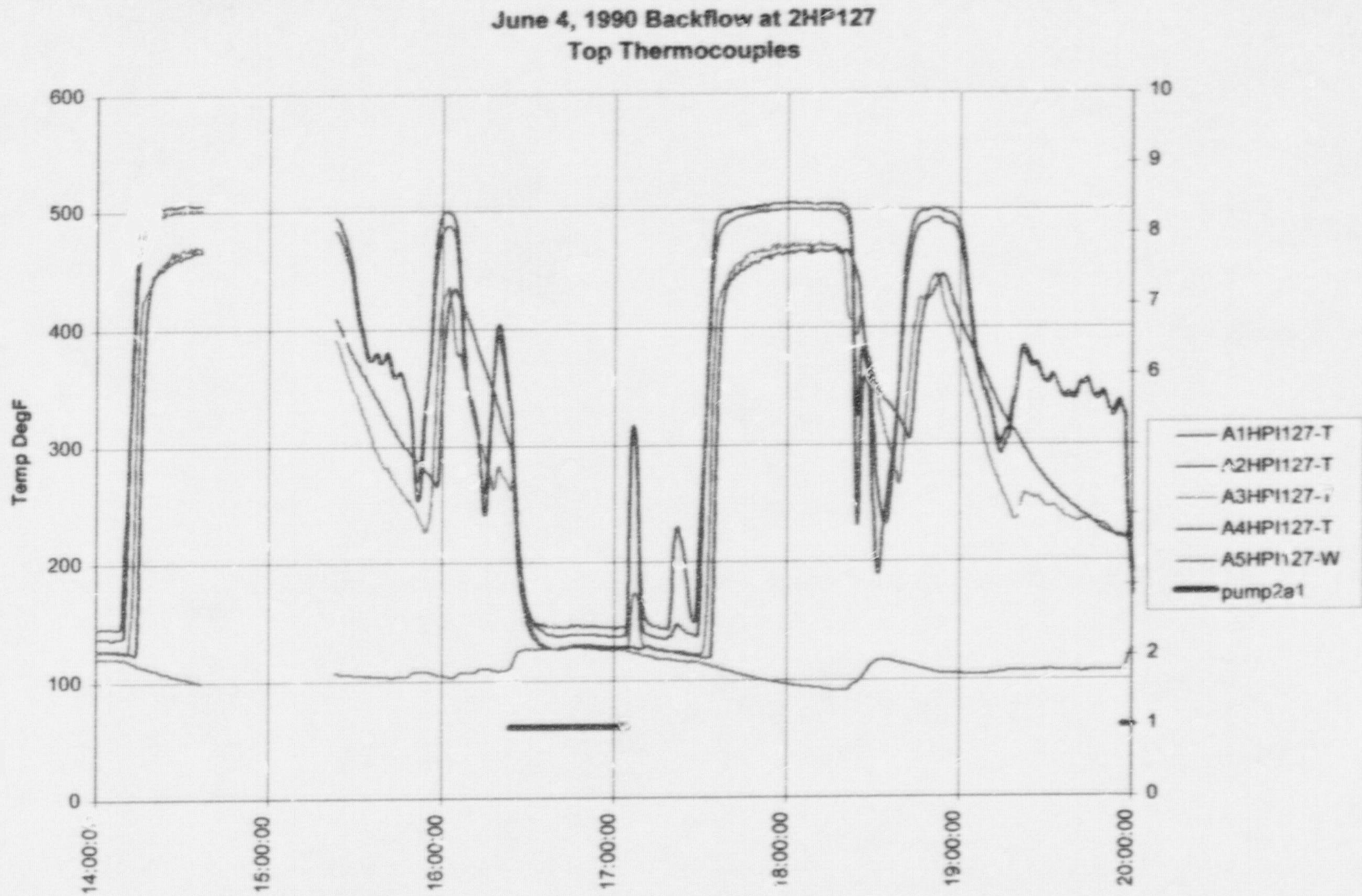
6.0 References

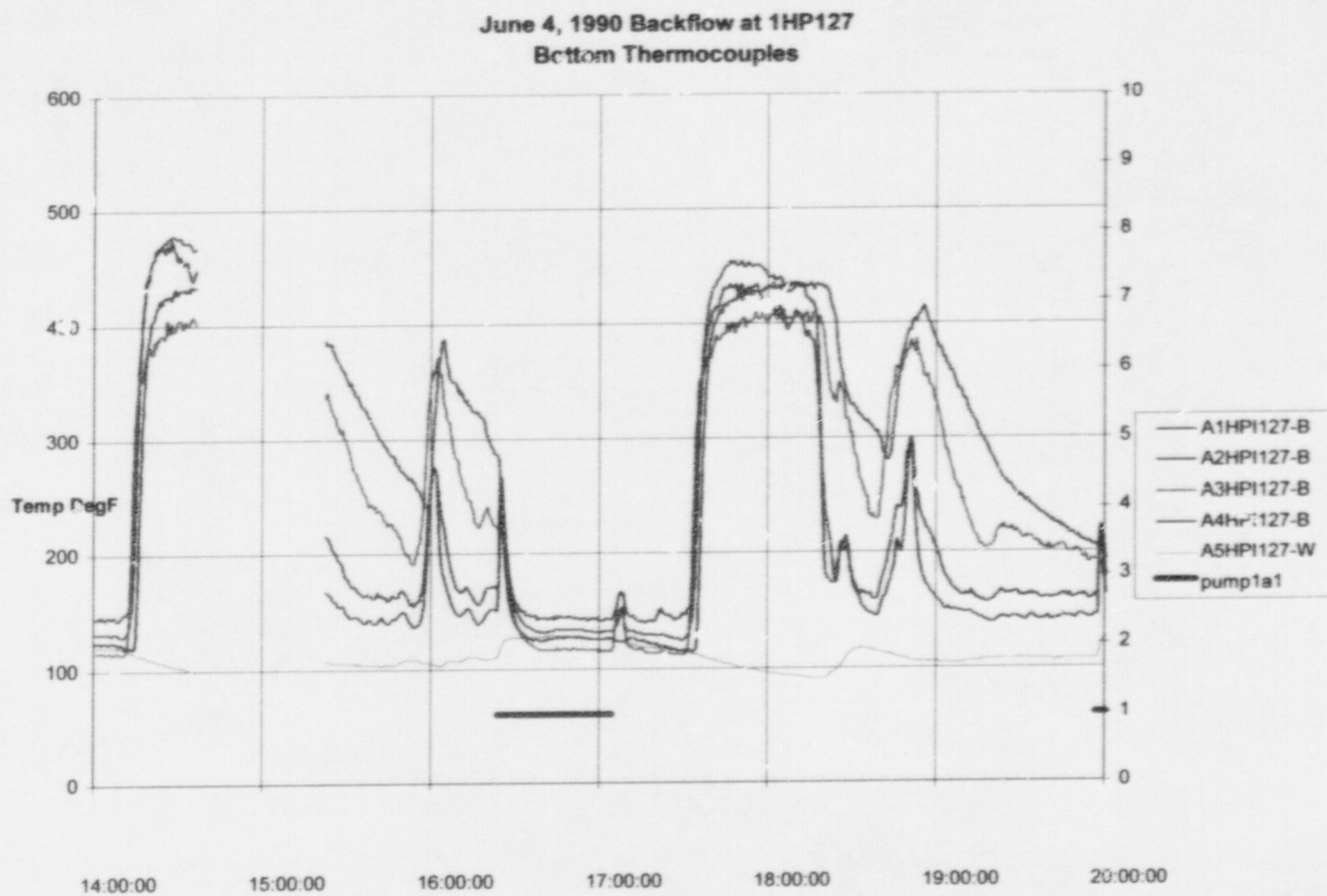
1. H.B. Tucker's (Duke) 3/10/89 letter to Document Control Desk of USNRC (Oconee's original response to Bulletin 88-08)
2. Reduction and Review of HPI Temperature Data Collected for NRC Bulletin 88-08, Oconee calculation OSC-3681.
3. HPI piping reanalyses for Bulletin 88-08: OSC-1304-06 (Unit 1), OSC-1323-06 (Unit 2), OSC-1342-06 (Unit 3)
4. T.L. Edwards (Duke) 11/16/89 letter MOEE-89-482, Design Engineering File OS-20-E (Engineering review of Supplement 3 to Bulletin 88-08)
5. BWNS Document 51-1212842-00, "An Overview of Thermal Stratification Data From Oconee Unit 1 During the BOC-13 Heat-up of June 1990"
6. L.A. Wiens, (NRR) 7/10/95 letter to J.W. Hampton (Duke) "Reactor Coolant System (RCS) Auxiliary Piping Fatigue



Attachment 1
(Sheet 1 of 1)

Duke Energy Corp.
Response to NRCB 88-08 Supplement 1
Attachment 2

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Bottom Thermocouples
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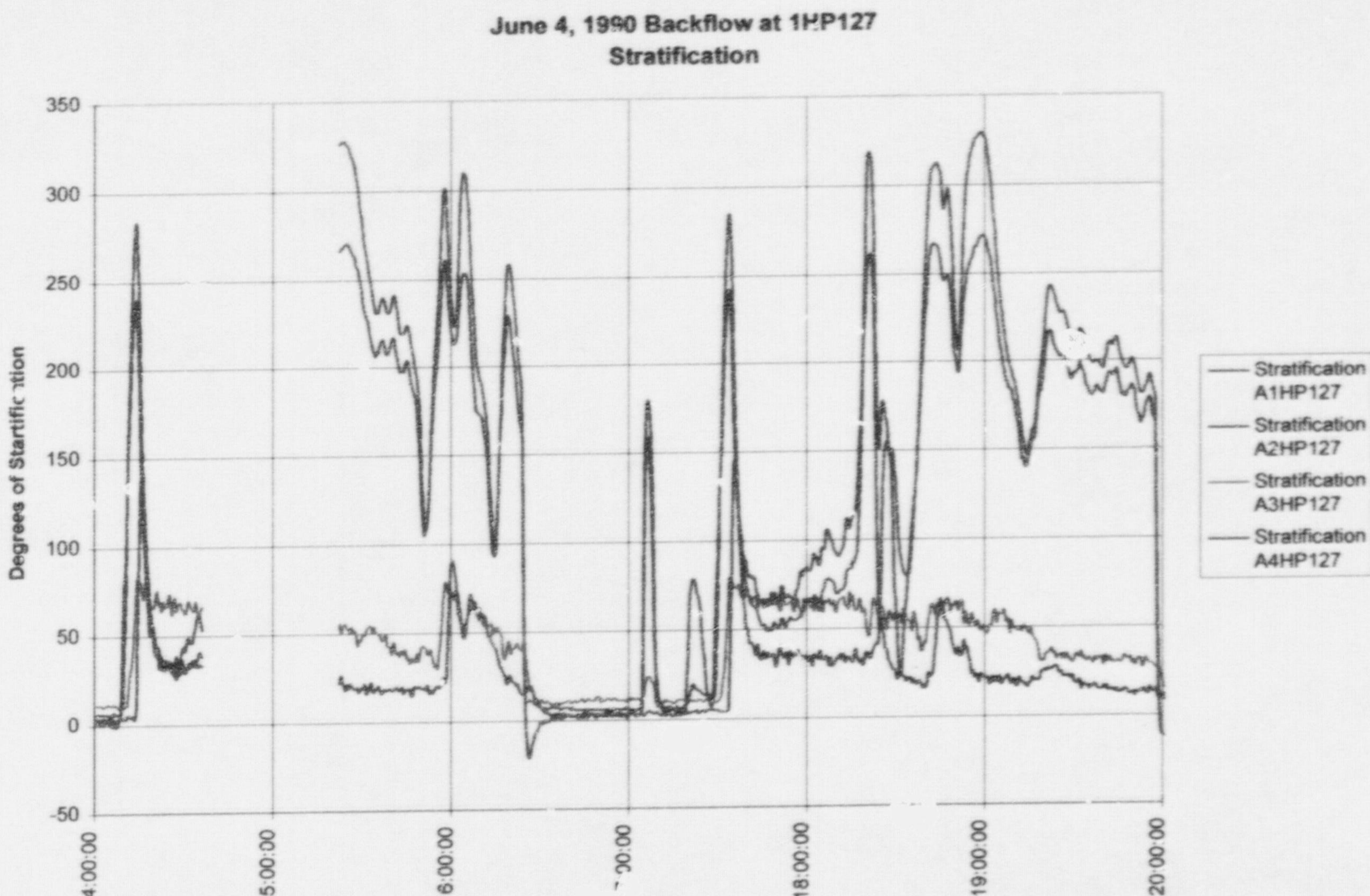
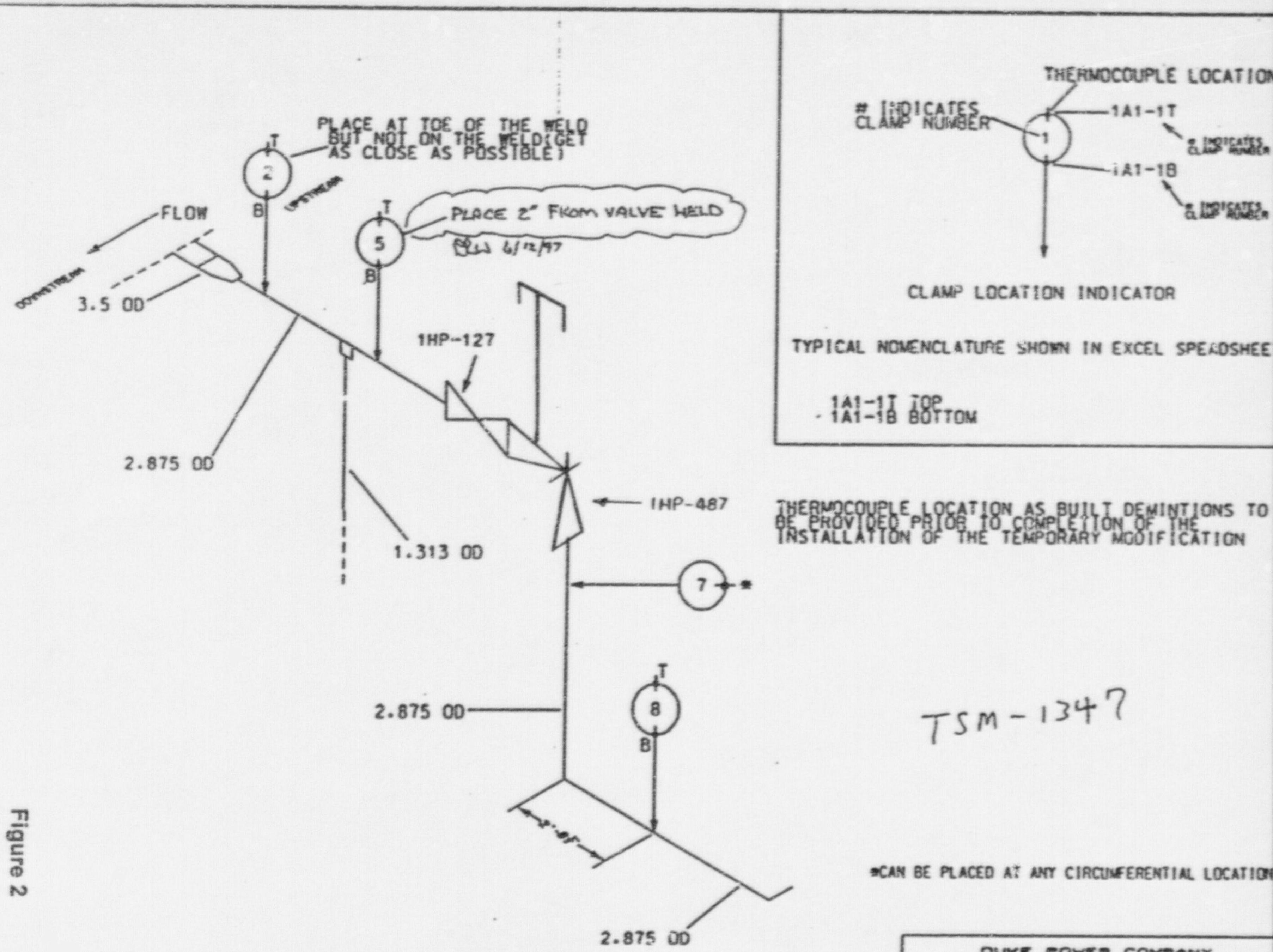
500
400
300
200
100
0
10
9
8
7
6
5
4
3
2
1
0
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
A1HPI127-B
A2HPI127-B
A3HPI127-B
A4HPI127-B
A5HPI127-W
pump1a1

Duke Energy Corp.
Response to NRCB 88-08 Supplement 1
Attachment 2



Attachment 3
(Sheet 1 of 10)

Figure 2



RECORD AS-INSTALLED LOCATIONS OF EACH THERMOCOUPLE

DUKE POWER COMPANY
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TO PUMP 1A1

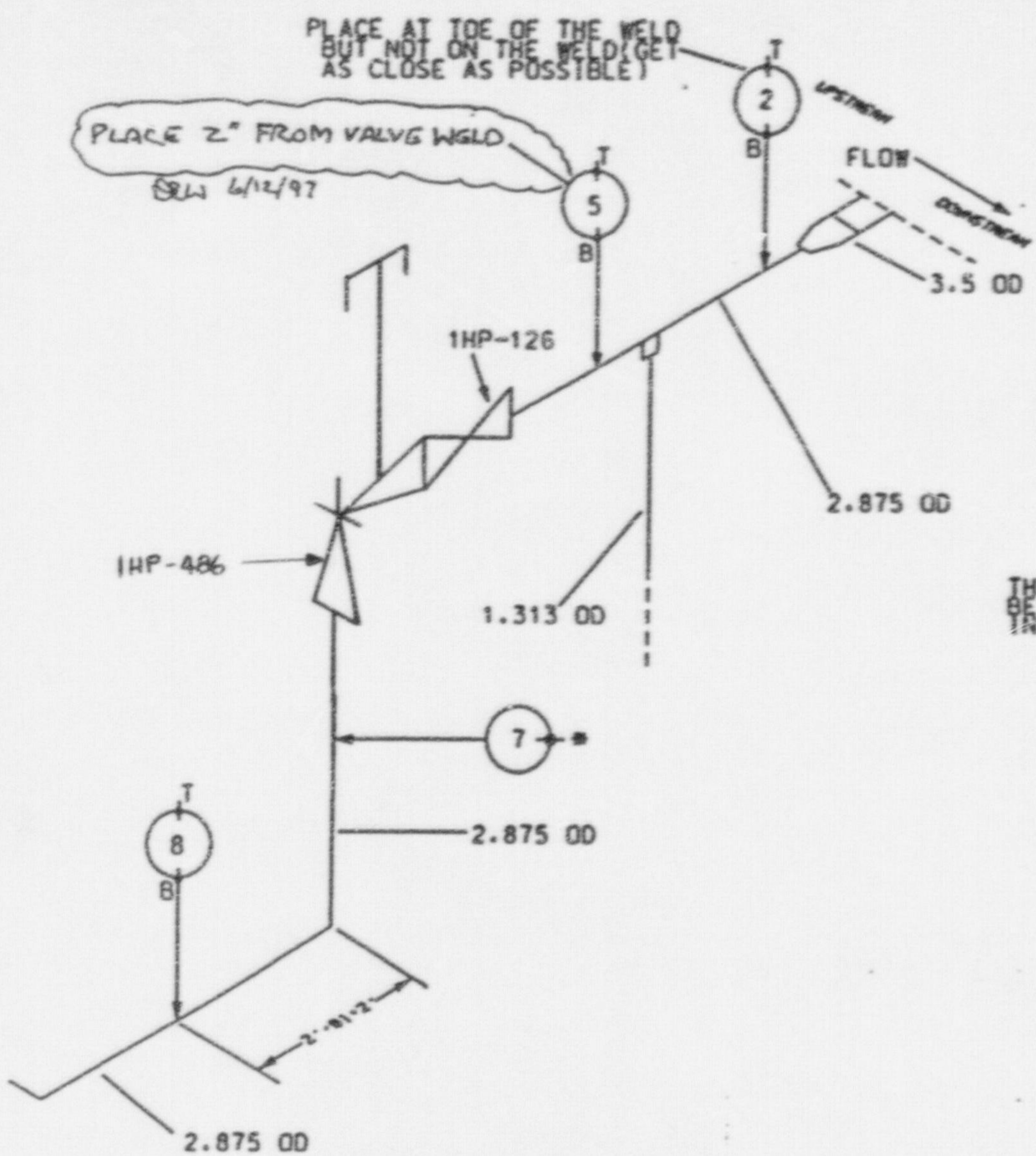
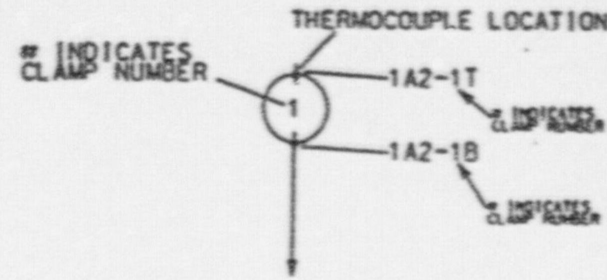


Figure 3



CLAMP LOCATION INDICATOR

TYPICAL NOMENCLATURE SHOWN IN EXCEL SPEADSHEET

1A2-1T TOP
1A2-1B BOTTOM

THERMOCOUPLE LOCATION AS BUILT DEMINTIONS TO BE PROVIDED PRIOR TO COMPLETION OF THE INSTALLATION OF THE TEMPORARY MODIFICATION

TSM-1347

*CAN BE PLACED AT ANY CIRCUMFERENTIAL LOCATION

RECORD AS-INSTALLED LOCATIONS OF EACH THERMOCOUPLE

DUKE POWER COMPANY
OCONEE NUCLEAR STATION UNIT 1
TITLE: REACTOR COOLANT SYSTEM FROM HP INJECTION NORMAL MAKE-UPTO THE REACTOR VESSEL
TO PUMP 1A2

June 9, 1997

63-5000/53-00

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Attachment 3
(Sheet 3 of 10)

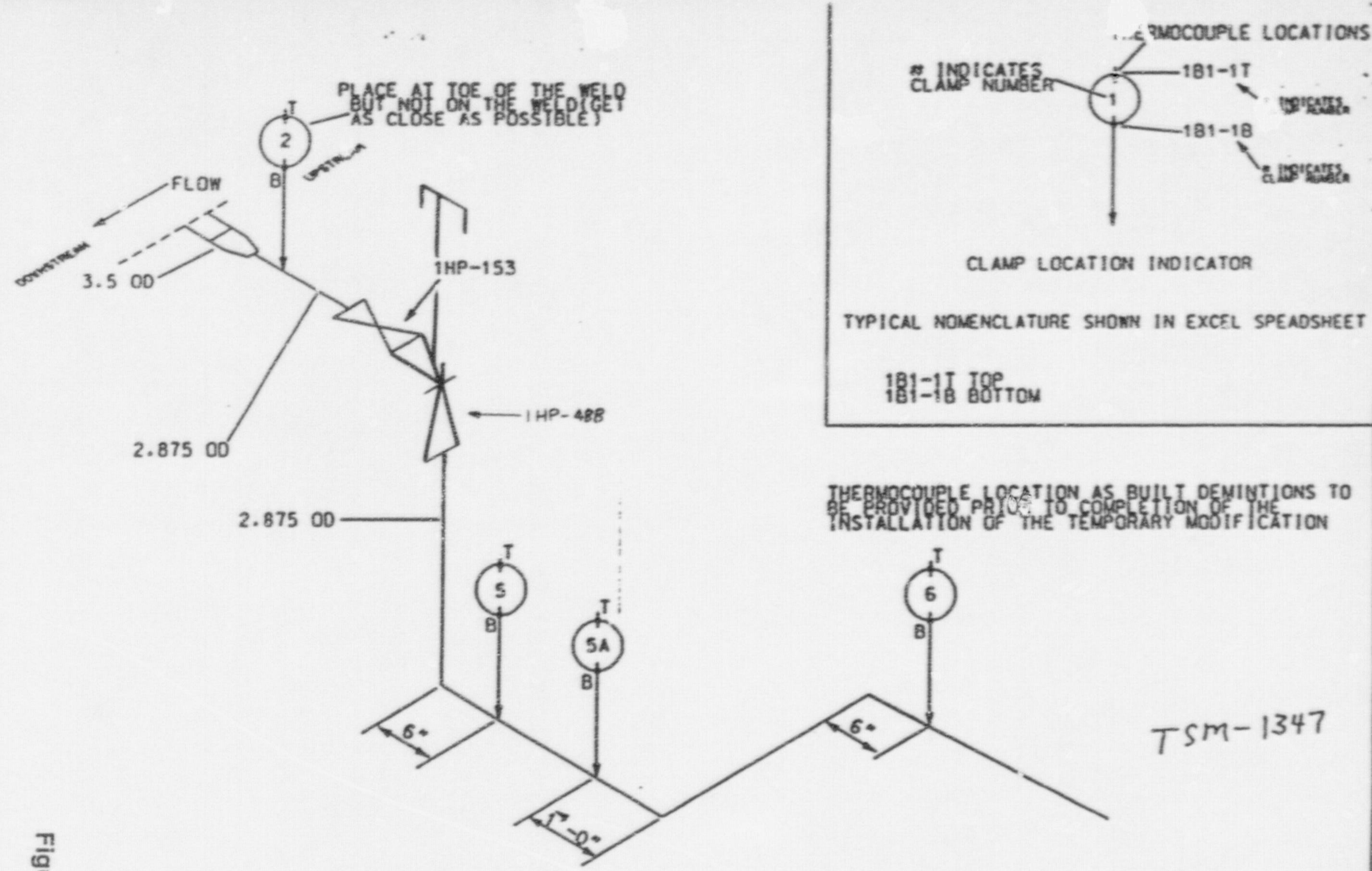

Figure 4

RECORD AS-INSTALLED LOCATIONS OF EACH THERMOCOUPLE

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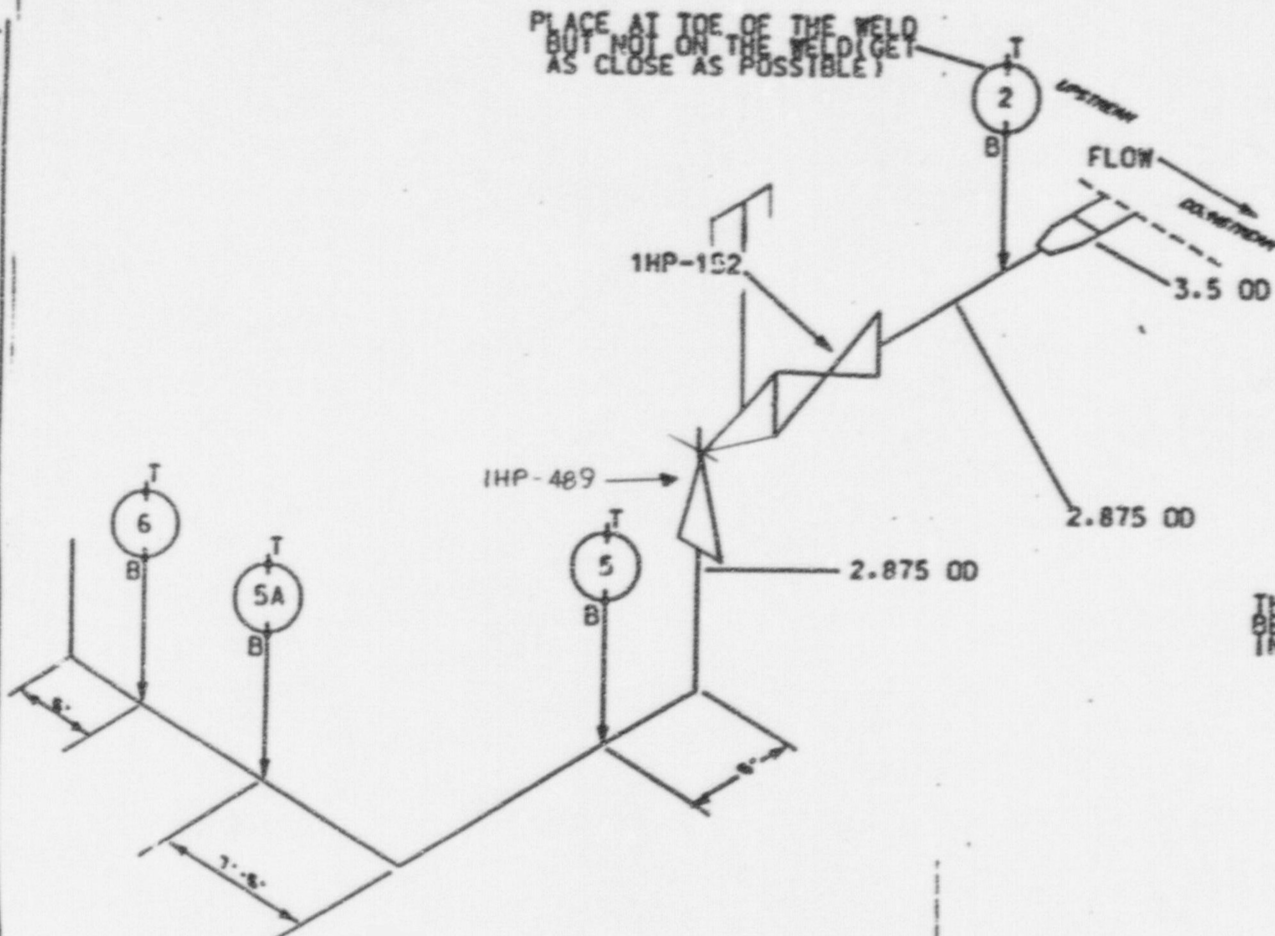
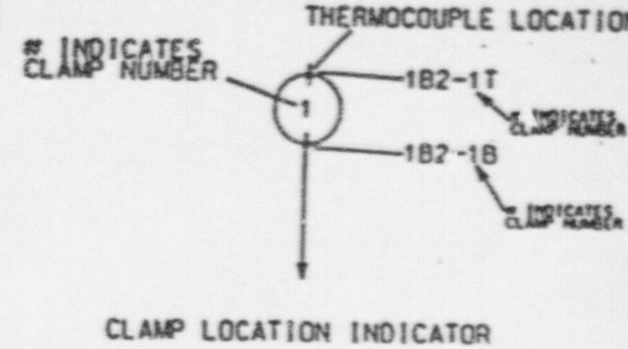
TITLE: REACTOR COOLANT SYSTEM FROM HP INJECTION EMERGENCY MAKE-UPTO THE REACTOR VESSEL
TO PUMP 1B1

Attachment 3
(Sheet 4 of 10)





THERMOCOUPLE LOCATION AS BUILT DEMINTIONS TO BE PROVIDED PRIOR TO COMPLETION OF THE INSTALLATION OF THE TEMPORARY MODIFICATION

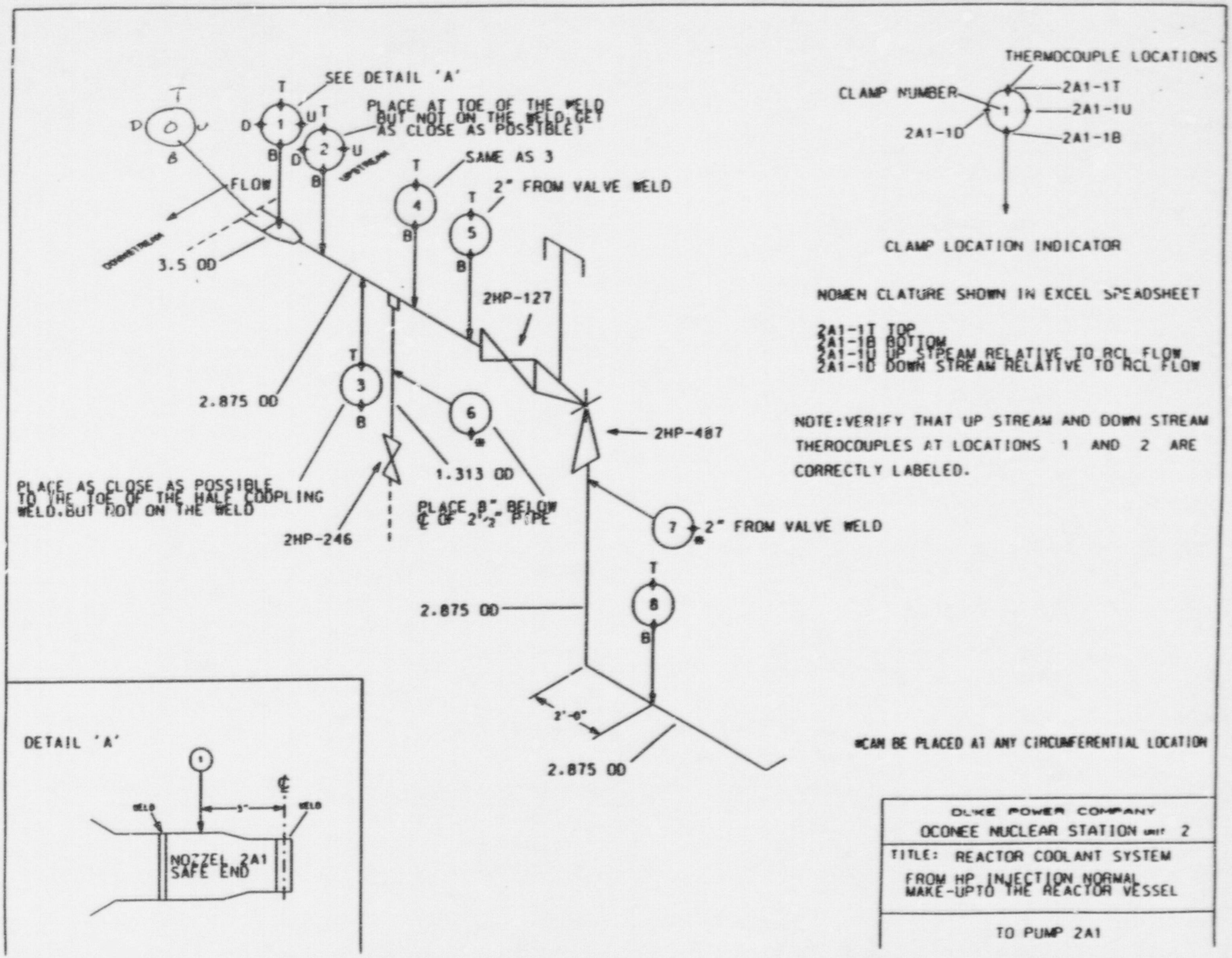
TSM-1347

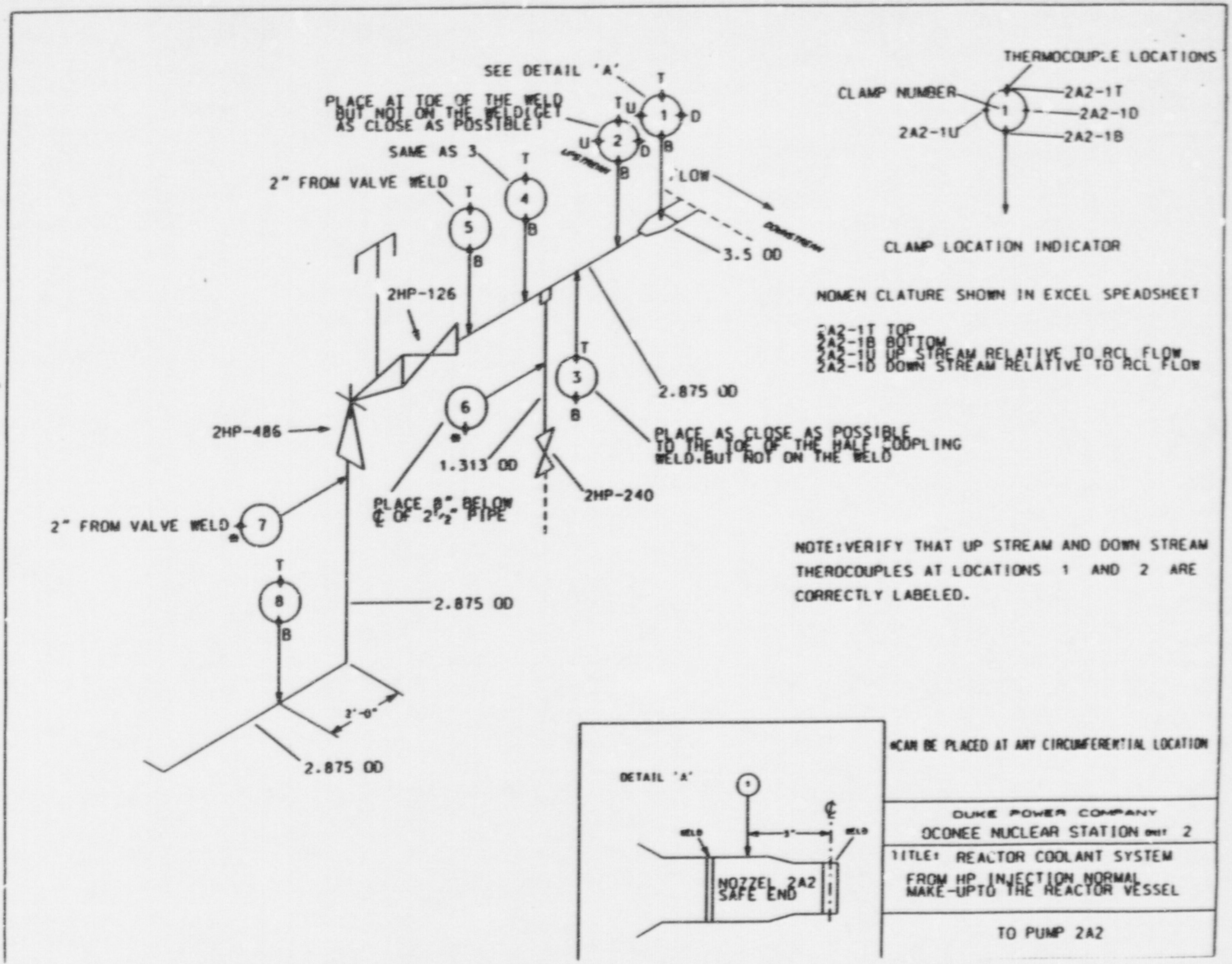
Figure 5

RECORD AS-INSTALLED LOCATIONS OF EACH THERMOCOUPLE

DUKE POWER COMPANY
OCONEE NUCLEAR STATION UNIT 1
TITLE: REACTOR COOLANT SYSTEM
FROM HP INJECTION EMERGENCY MAKE-UPTO THE REACTOR VESSEL
0 PUMP 1B2

Attachment 3
(Sheet 5 of 10)





Attachment 3
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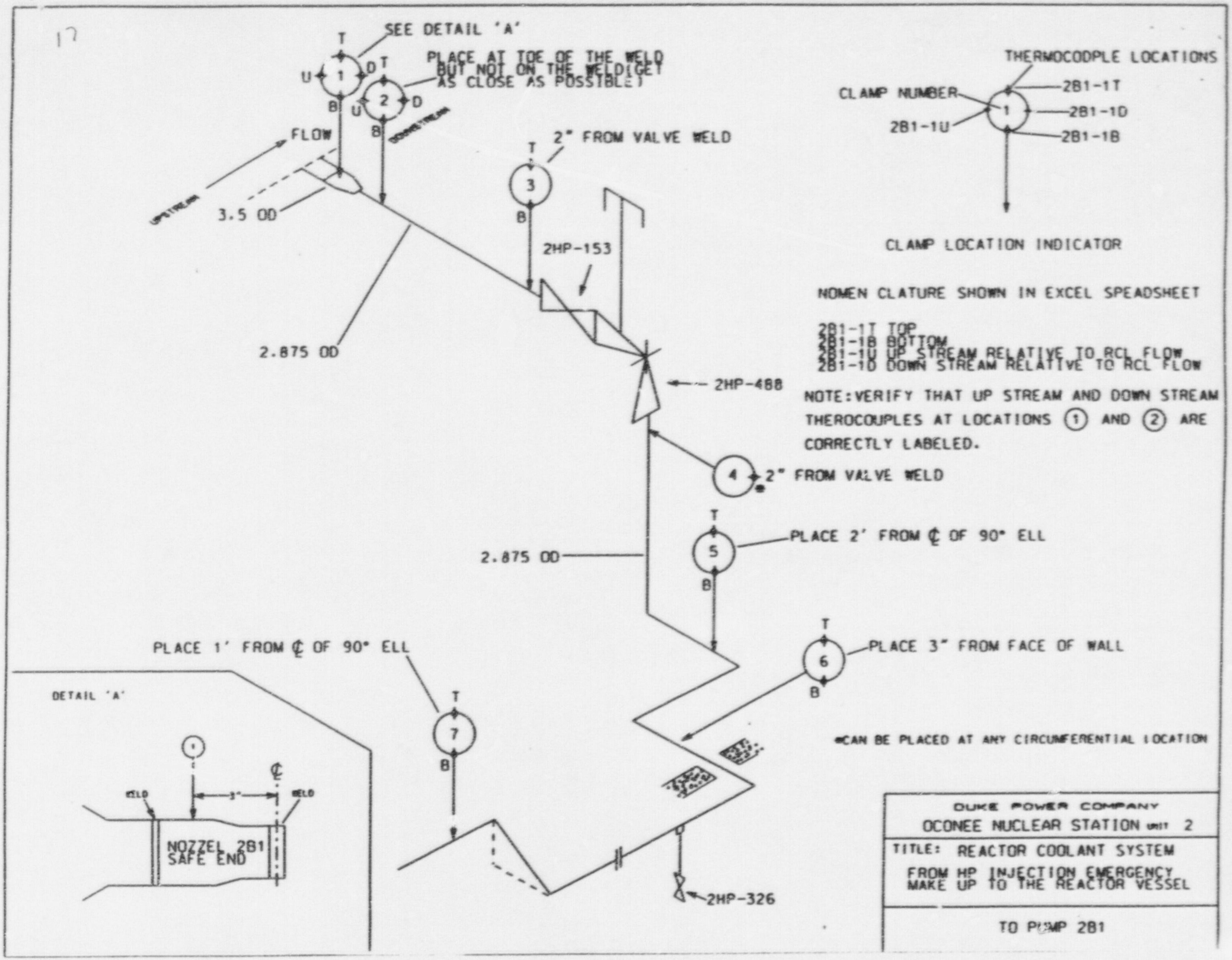
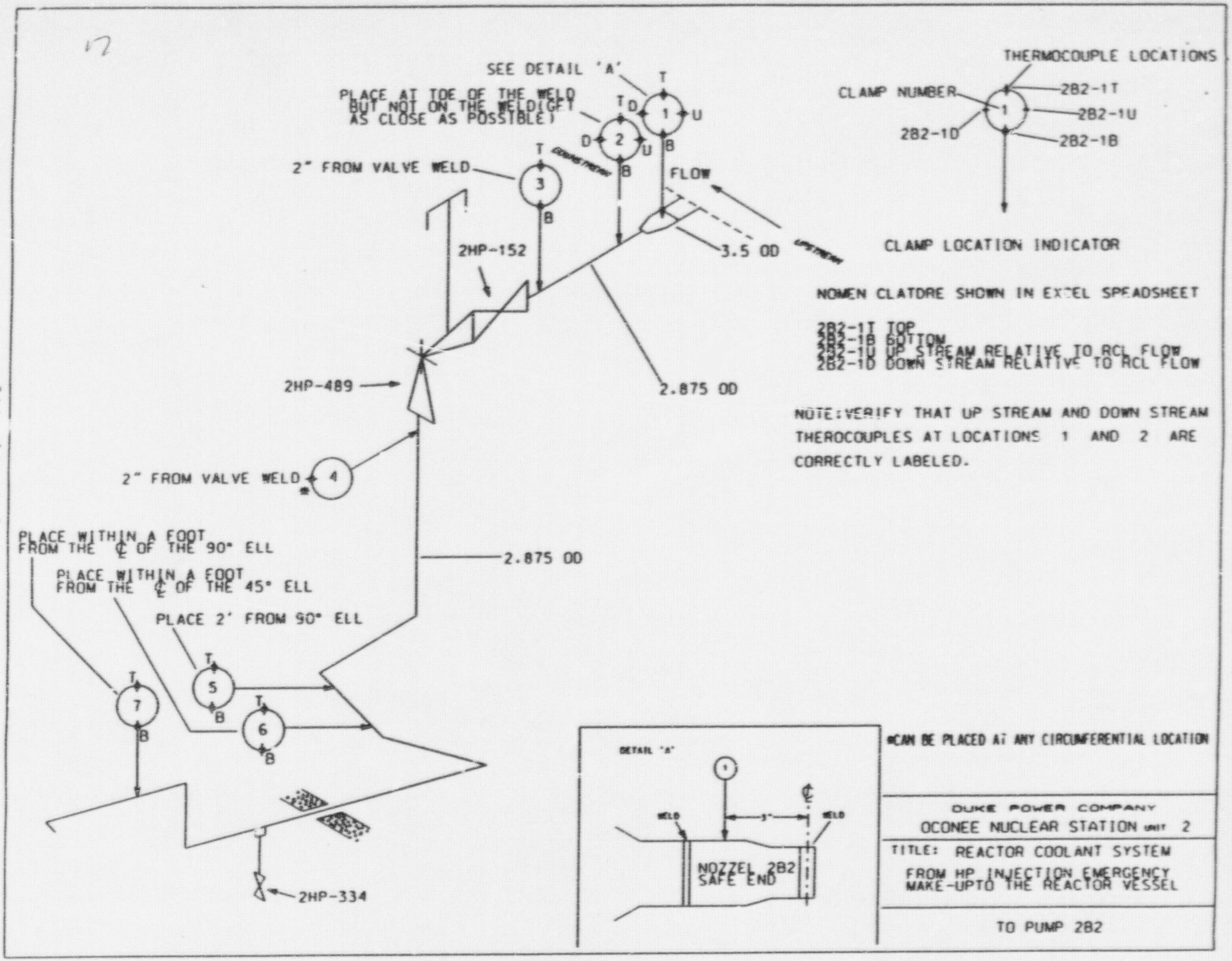
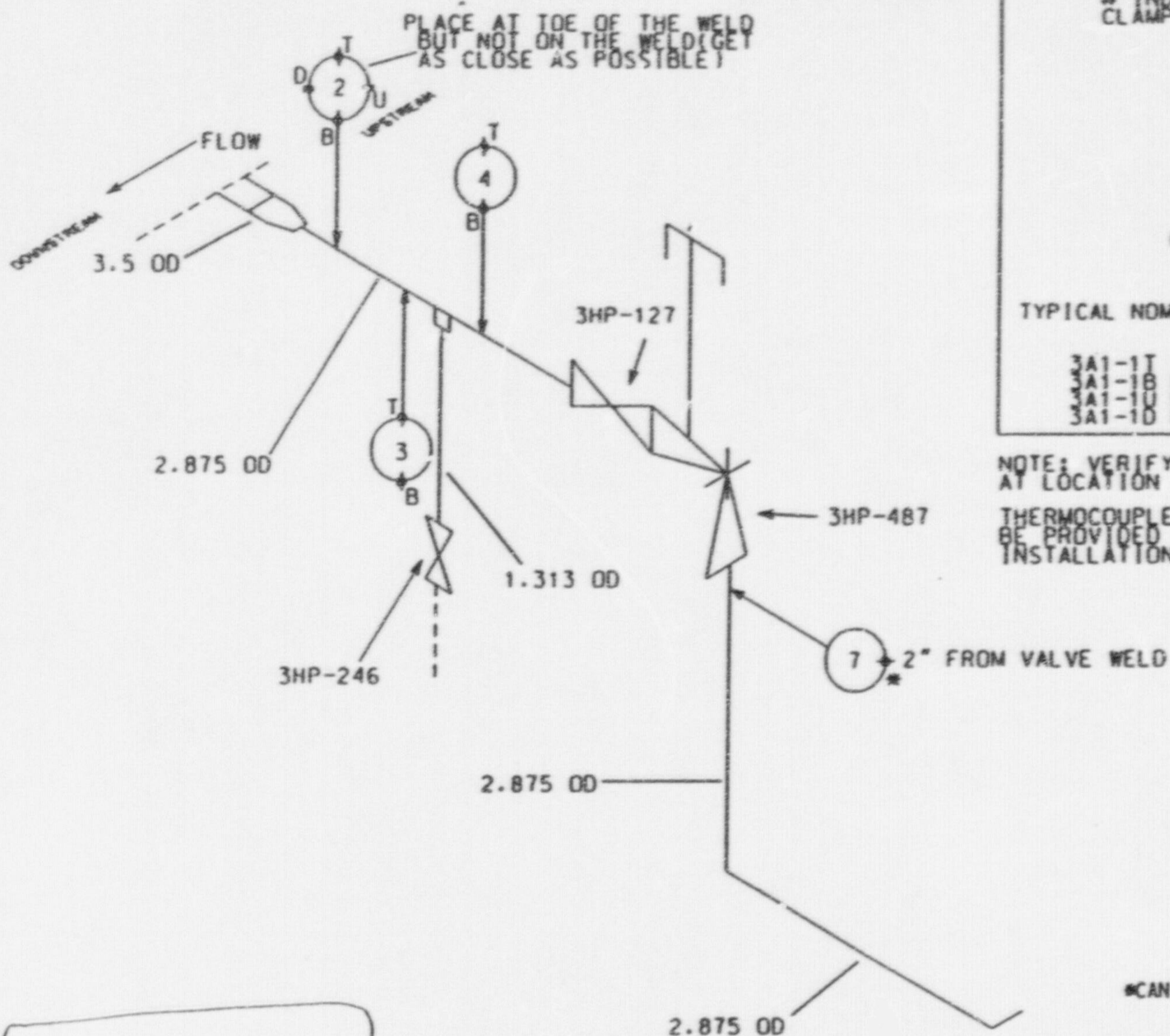
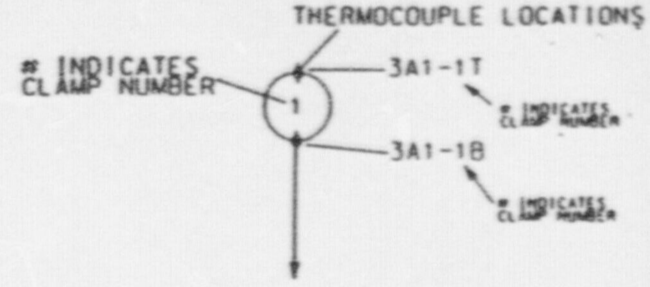
Attachment 3
(Sheet 7 of 10)




17
SEE DETAIL 'A'
PLACE AT TOE OF THE WELD BUT NOT ON THE WELD(GET AS CLOSE AS POSSIBLE)
2" FROM VALVE WELD
FLOW
3.5 OD
2HP-152
2HP-489
2.875 OD
2" FROM VALVE WELD
2.875 OD
PLACE WITHIN A FOOT FROM THE ℄ OF THE 90° ELL
PLACE WITHIN A FOOT FROM THE ℄ OF THE 45° ELL
PLACE 2' FROM 90° ELL
2HP-334
THERMOCOUPLE LOCATIONS
CLAMP NUMBER
2B2-1T
2B2-1U
2B2-1D
2B2-1B
CLAMP LOCATION INDICATOR
NOMEN CLATURE SHOWN IN EXCEL SPREADSHEET
2B2-1T TOP
2B2-1B BOTTOM
2B2-1U UP STREAM RELATIVE TO RCL FLOW
2B2-1D DOWN STREAM RELATIVE TO RCL FLOW
NOTE: VERIFY THAT UP STREAM AND DOWN STREAM THEROCOUPLES AT LOCATIONS 1 AND 2 ARE CORRECTLY LABELED.
*CAN BE PLACED AT ANY CIRCUMFERENTIAL LOCATION
DETAIL 'A'
WELD
3"
WELD
NOZZEL 2B2 SAFE END
DUKE POWER COMPANY
OCONEE NUCLEAR STATION UNIT 2
TITLE: REACTOR COOLANT SYSTEM
FROM HP INJECTION EMERGENCY MAKE-UPTO THE REACTOR VESSEL
TO PUMP 2B2





CLAMP LOCATION INDICATOR

TYPICAL NOMENCLATURE SHOWN IN EXCEL SPEADSHEET

3A1-1T TOP
3A1-1B BOTTOM
3A1-1U UPSTREAM RELATIVE TO RCL FLOW
3A1-1D DOWNSTREAM RELATIVE TO RCL FLOW

NOTE: VERIFY THAT UPSTREAM AND DOWNSTREAM T/C AT LOCATION 2 IS CORRECTLY LABLED.

THERMOCOUPLE LOCATION AS BUILT DEMINTIONS TO BE PROVIDED PRIOR TO COMPLETION OF THE INSTALLATION OF THE TEMPORARY MODIFICATION

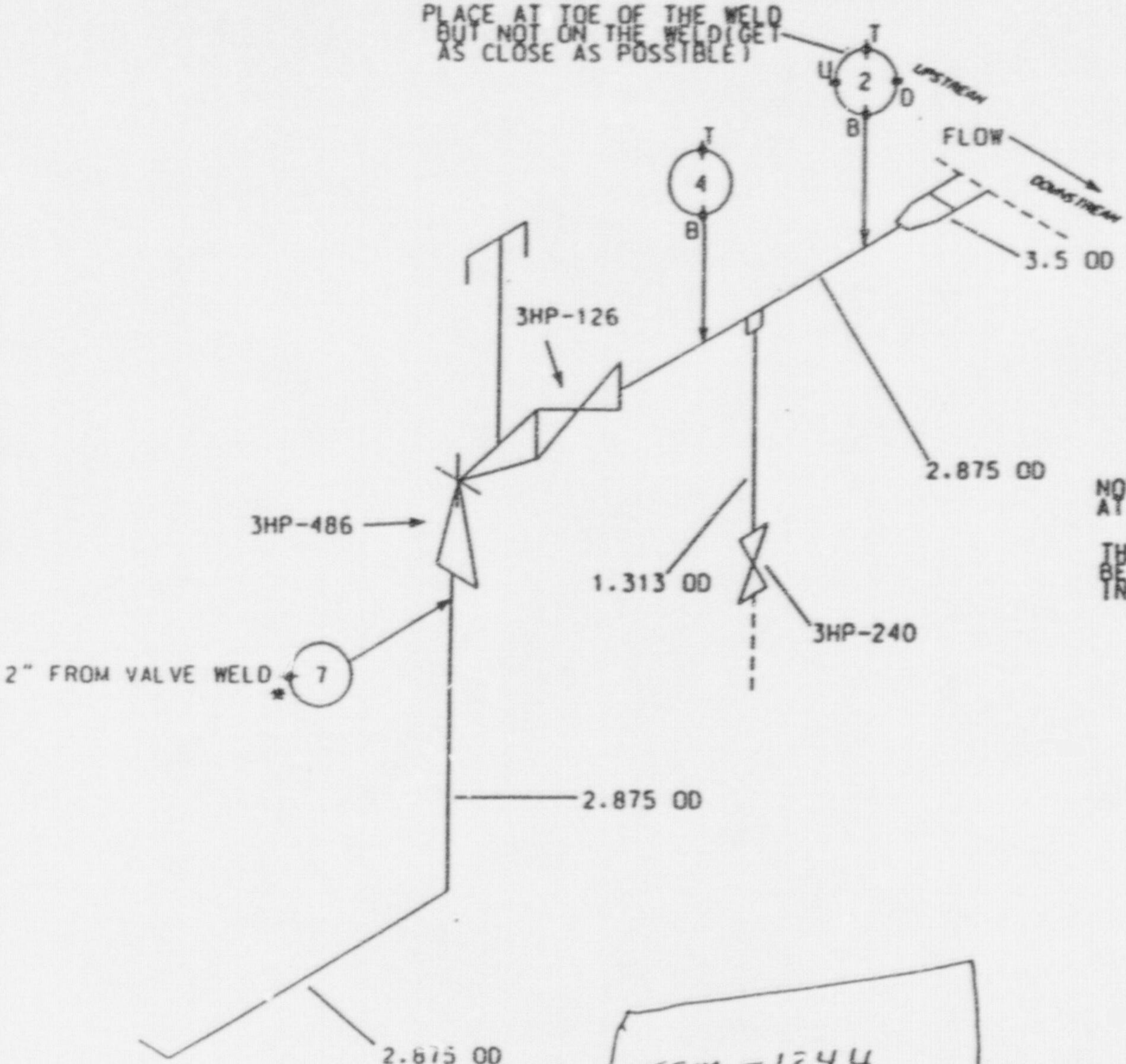
*CAN BE PLACED AT ANY CIRCUMFERENTIAL LOCATION

DRAFT COPY

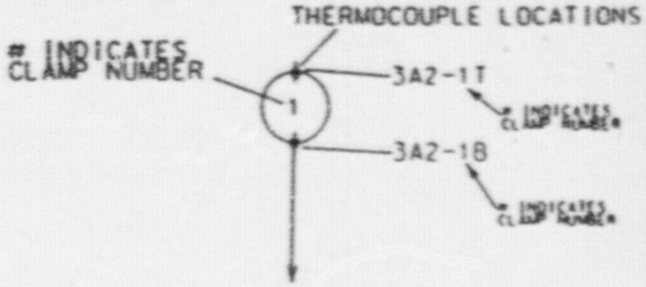
TSM - 1344
3A1 sketch

RECORD AS-INSTALLED LOCATIONS OF EACH THERMOCOUPLE

DUKE POWER COMPANY OCONEE NUCLEAR STATION UNIT 3
TITLE: REACTOR COOLANT SYSTEM FROM HP INJECTION NORMAL MAKE-UPTO THE REACTOR VESSEL
TO PUMP 3A1



TSM-1344
3A2 Sketch



CLAMP LOCATION INDICATOR

TYPICAL NOMENCLATURE SHOWN IN EXCEL SPEADSHEET

3A2-1T TOP
3A2-1B BOTTOM
3A2-1U UPSTREAM RELATIVE TO RCL FLOW
3A2-1D DOWNSTREAM RELATIVE TO RCL FLOW

NOTE: VERIFY THAT UPSTREAM AND DOWNSTREAM T/C AT LOCATION 2 IS CORRECTLY LABLED.

THERMOCOUPLE LOCATION AS BUILT DEMINTIONS TO BE PROVIDED PRIOR TO COMPLETION OF THE INSTALLATION OF THE TEMPORARY MODIFICATION

*CAN BE PLACED AT ANY CIRCUMFERENTIAL LOCATION

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