REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

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SUBJECT: Forwards response to NRC 841130 request for addl info re reactor inventory tracking sys & subcooling margin monitor. Updated description of trackign sys also encl.

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WISCONSIN PUBLIC SERVICE CORPORATION
P.O. Box 1200, Green Bay, WI 54305

March 29, 1985

Director of Nuclear Reactor Regulation
Attention: Mr. S. A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
TAC #M45143
Proposed Inadequate Core Cooling Instrumentation (ICC)

References: 1) Letter from S. A. Varga to D. C. Hintz dated November 30, 1984
2) Letter from C. W. Giesler to D. G. Eisenhut dated March 9, 1983
3) Letter from S. A. Varga to C. W. Giesler dated May 18, 1984

Enclosure 2 of reference 1 requested additional information concerning Kewaunee Nuclear Power Plant's (KNPP's) Reactor Inventory Tracking System (RITS) and Subcooling Margin Monitor. The report enclosed with this letter provides the requested information. Also enclosed with this letter is an updated system description of the RITS.

Very truly yours,

Charles A. Schrock for

D. C. Hintz
Manager - Nuclear Power

TJW/js

Enc.

cc - Mr. Robert Nelson, US NRC

A002

Response to NRC Letter Docket No. 50-305

Request for Additional Information on Proposed Inadequate Core Cooling Monitor

The following responses address the items listed in Enclosure 2 of reference 1, "Request for Additional Information on the Wisconsin Public Service Corporation Proposed Inadequate Core Cooling Instrumentation for the Kewaunee Nuclear Power Station".

1. QUESTION: Provide an analysis of the expected errors in the reactor vessel level measurements. This analysis should include not only an overall estimate of the measurement uncertainty, but estimates of each contributing factor, i.e., temperature of the impulse lines, common mode pressure effects on the differential pressure transducer, and uncertainties associated with the transducer. Explain how the individual errors are combined to give an estimate of the overall error. Note: other applicants have encountered difficulty in achieving satisfactory accuracy with dp transmitters located inside containment in a LOCA environment.

   RESPONSE: See attached uncertainty analysis.

2. QUESTION: Discuss the ability of the transmitters to withstand a LOCA environment within the containment and be available for post-accident monitoring--consider the loss of the pressurizer transmitters in the TMI-2 accident in this discussion.

   RESPONSE: The full flow and reduced flow differential pressure transmitters (models N-E11DM and N-E13DH respectively) are Foxboro N-E10 series qualified to IEEE 323-1974. The ability of these transmitters to withstand a LOCA environment within containment and be available for post-accident monitoring is demonstrated in Foxboro Qualification Test Report QOAAC11. Furthermore, the transmitters will be environmentally qualified in accordance with Kewaunee's approved EQ program.

3. QUESTION: Provide an analysis of the error that would be expected both with and without the reference line temperature compensation.

RESPONSE: The KNPP RITS installation is provided with redundant channels of reference line temperature compensation. Loss of both channels is considered incredible and is outside the design criteria of the system. The reference line is divided into discrete temperature zones. These zones are monitored by redundant RTDs qualified to IEEE 323-1974. Each channel of RTDs is input to its dedicated ICC monitor to compute leg density compensation. The loss of one or more of these RTD inputs to an ICC Monitor will result in an invalid display signal to the operator. The display will have indication which will inform the operator that the readout is invalid. RITS will be able to be continuously monitored by observation of the redundant control room display.

4. QUESTION: Describe the qualification, upgrade and redundancy of the Subcooling Margin Monitoring System.

RESPONSE: The new ICC Monitoring System will calculate and display the subcooling margin in degrees Fahrenheit and psid. The ICC Monitoring System will be qualified to class 1E standards and will be totally redundant. The existing Subcooling Margin Monitor, as described to the NRC in reference 2 and accepted by the NRC in references 1 and 3, is qualified but not redundant. Therefore, system availability will be enhanced with the new system.

In addition, the existing system uses 5 core exit thermocouples to calculate margin. The new system will scan all core exit thermocouples, check all inputs for validity, and use the hottest valid thermocouple, on each respective train, for the margin calculation.

KEWAUNEE NUCLEAR POWER PLANT

REACTOR INVENTORY TRACKING SYSTEM

UNCERTAINTY ANALYSIS

Prepared by:

WISCONSIN PUBLIC SERVICE CORPORATION

March, 1985

This analysis provides a summary of expected system uncertainties in the Reactor Inventory Tracking System (RITS) at the Kewaunee Nuclear Power Plant (KNPP). Overall system uncertainty is expressed in terms of the standard deviation.

System Description

The Reactor Inventory Tracking System (RITS) at KNPP is a differential pressure based system. Foxboro differential pressure transmitters, located in Containment, provide a 4-20 mA signal to a microprocessor based inadequate core cooling (ICC) monitor. The ICC monitor compensates this signal for density of the RCS system as a function of temperature. This compensation is achieved by incorporation of other inputs such as tubing leg temperature, average core exit thermocouple temperature, average cold leg temperature, and reactor coolant pump status. This resultant reactor vessel level is output in the Control Room on an analog display of the reactor vessel. This display is expressed in units of percent, where 100% = a full vessel and 0% = level at the elevation of the pressure transmitters. The elevation of the top of the reactor core is approximately 15%. (See figure 4)

Analysis Method

The total system uncertainty presented in Figures 1-3 included individual component errors and errors introduced by the calculation of vessel level in the ICC monitor. The supplier's published maximum errors for each component were used as standard deviation figures in the analysis with the exception of the differential pressure transmitter LOCA uncertainty. For the LOCA uncertainty, actual data from the Foxboro qualification test reports were used to calculate a standard deviation.

The combined error of a component was determined through use of the root-sum-squares (RSS) method. Table 1 lists all uncertainties considered along with the combined error for each component.

The accumulation of error in the ICC system calculations was determined using the relationship

$$Sy = (S_a^2 + S_b^2 + S_c^2 + \ldots + S_n^2)^{\frac{1}{2}}$$

for a sum or difference, and the relationship

$$Sy/Y = \left[(S_a/a)^2 + (S_b/b)^2 + (S_c/c)^2 + \ldots + (S_n/n)^2\right]^{\frac{1}{2}}$$

for multiplication and division where Sy is the standard deviation of the calculated result, Y is the calculated result, and S_n is the absolute standard deviation of the term n in the equation.

<u>Assumptions</u>

To perform the analysis, the suppliers' published maximum error limits were used as standard deviations.

For the LOCA case, it was assumed that the event occurred on the last day of the operating cycle and the transmitters had received full radiation exposure of 5 X 10^7 RADS prior to the LOCA temperature peak. In addition, the test data used from the Foxboro test reports were for 320°F peak (KNPP peak = 293°F) and 180°F post accident (KNPP post accident = 120°F).

All of the above assumptions tend to increase the uncertainty values shown in figures 1-3.

Summary

During normal operating conditions, the total system uncertainty for the Reactor Vessel Level System is ±15". During the most severe LOCA conditions, the total system uncertainty is ±26" for vessel level approaching core un-covery. See Figures 1-3 for additional detail.

TABLE 1

COMPONENT ERRORS

1. Differential Pressure Transmitters - output shift in percent of calibrated span:

	Full Flow Transmitter	Reduced Flow Transmitter
a. Accuracy	±0.50	±0.75
b. Repeatability	±0.10	±0.10
c. Hysteresis	±0.10	±0.10
d. Deadband	±0.05	±0.05
e. Reproducibility	±0.15	±0.15
f. Power Supply	±0.50	±0.50
g. Drift/Year	±0.25	±0.25
h. LOCA		
1. 320°F	±6.00	±1.35
2. 240°F	±4.11	±0.17
3. 180°F	±1.43	±0.32
i. Radiation	±2.57	±2.25
j. Thermal Aging	±0.67	±0.26

COMBINED ERROR:

1. 320°F	±6.61 (±11.90")	±2.81 (18.43")
2. 240°F	±4.96 (±8.93")	±2.47 (±7.41")
3. 180°F	±3.12 (±5.60)	±2.48 (±7.44")
4. Normal operating	±1.27 (±2.28")	±0.99 (±2.97")

TABLE 1 - cont'd

2. Reference Leg RTDs - output shift in percent of measured temperature:

a. Accuracy	±0.50
b. Thermal Gradient on reference leg	±6.00
COMBINED ERROR:	±6.02

3. Core Exit Thermocouples - output shift in percent of measured temperature:

a. Accuracy	±0.375
b. Reference junction compensation	±0.50
COMBINED ERROR:	±0.625

4. ICC Monitoring System - output shift in percent:

a. A/D Converter	
1. Linearity	±0.03
2. Temperature	±0.06
3. Calibration	±0.03
COMBINED ERROR:	±0.07
b. RTD Converter	
1. Repeatability	±0.50
2. Linearity	±0.25
3. Power Supply	±0.25
4. Temperature	±2.00
COMBINED ERROR:	±2.09
c. System Calculator	±0.01

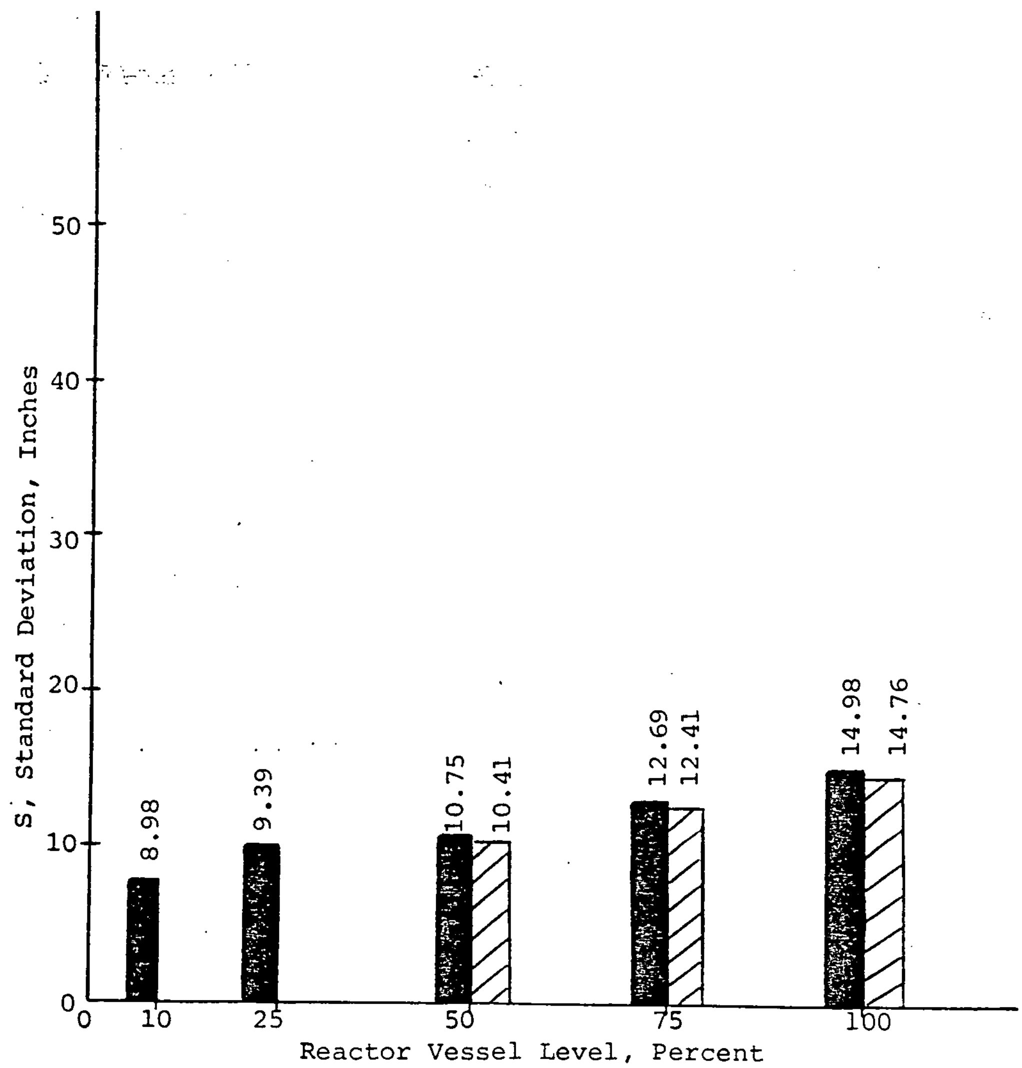
TABLE 1 - cont'd

d.	D/A converter	
	1. Linearity	±0.03
	2. Temperature	±0.06
	3. Calibration	±0.03
	COMBINED ERROR:	±0.07
e.	Display	
	1. Repeatability	±1.00
	2. Temperature	±0.66
	COMBINED ERROR:	±1.20

FIGURE 1

TOTAL SYSTEM UNCERTAINTY

Case: Normal Operating Conditions, T=120°F



Total System Error Using Full Flow Transmitter

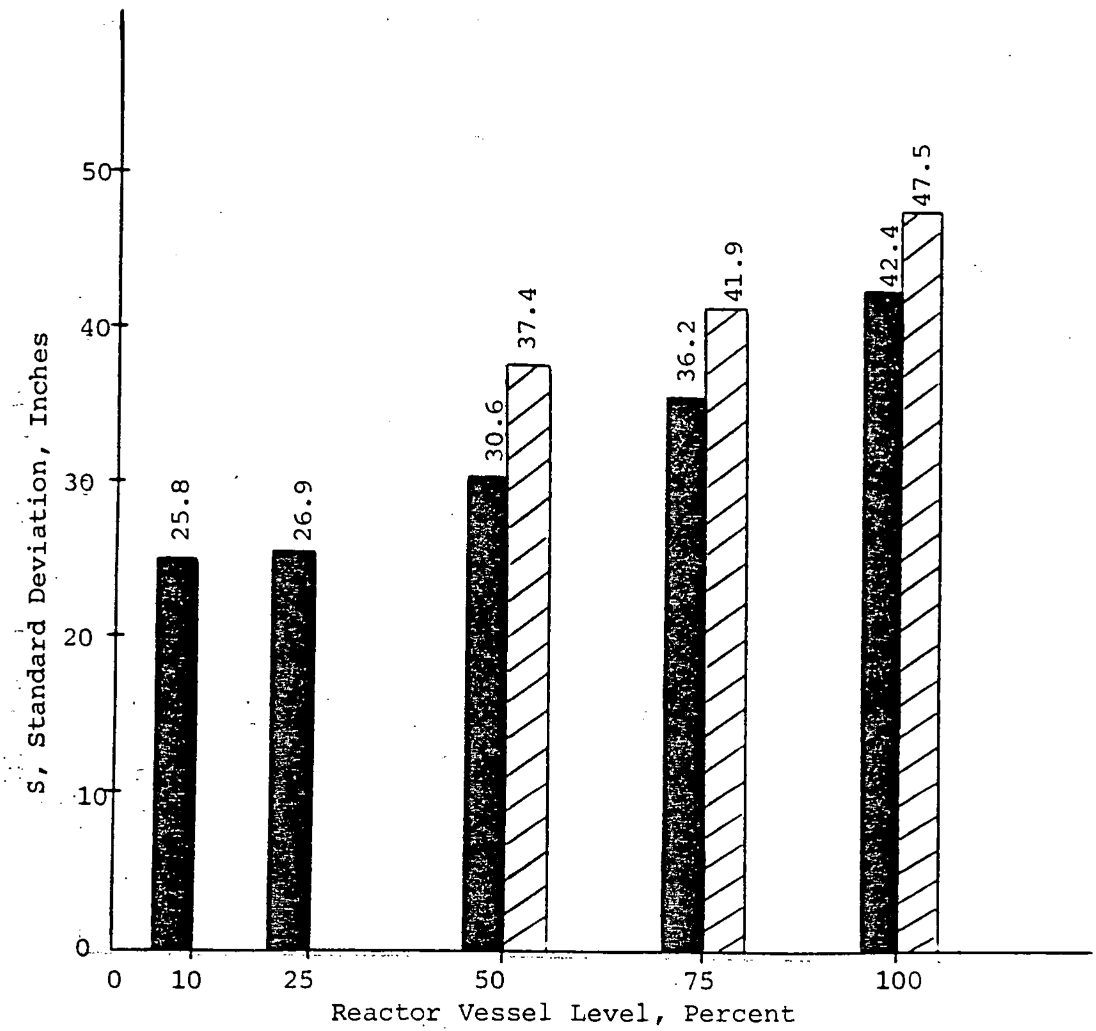
Total System Error Using Reduced Flow Transmitter

(Note: Full flow transmitter case not applicable for levels below the hot legs.)

FIGURE 2

TOTAL SYSTEM UNCERTAINTY

Case: Peak LOCA Conditions, T=293°F



Total System Error Using Full Flow Transmitter

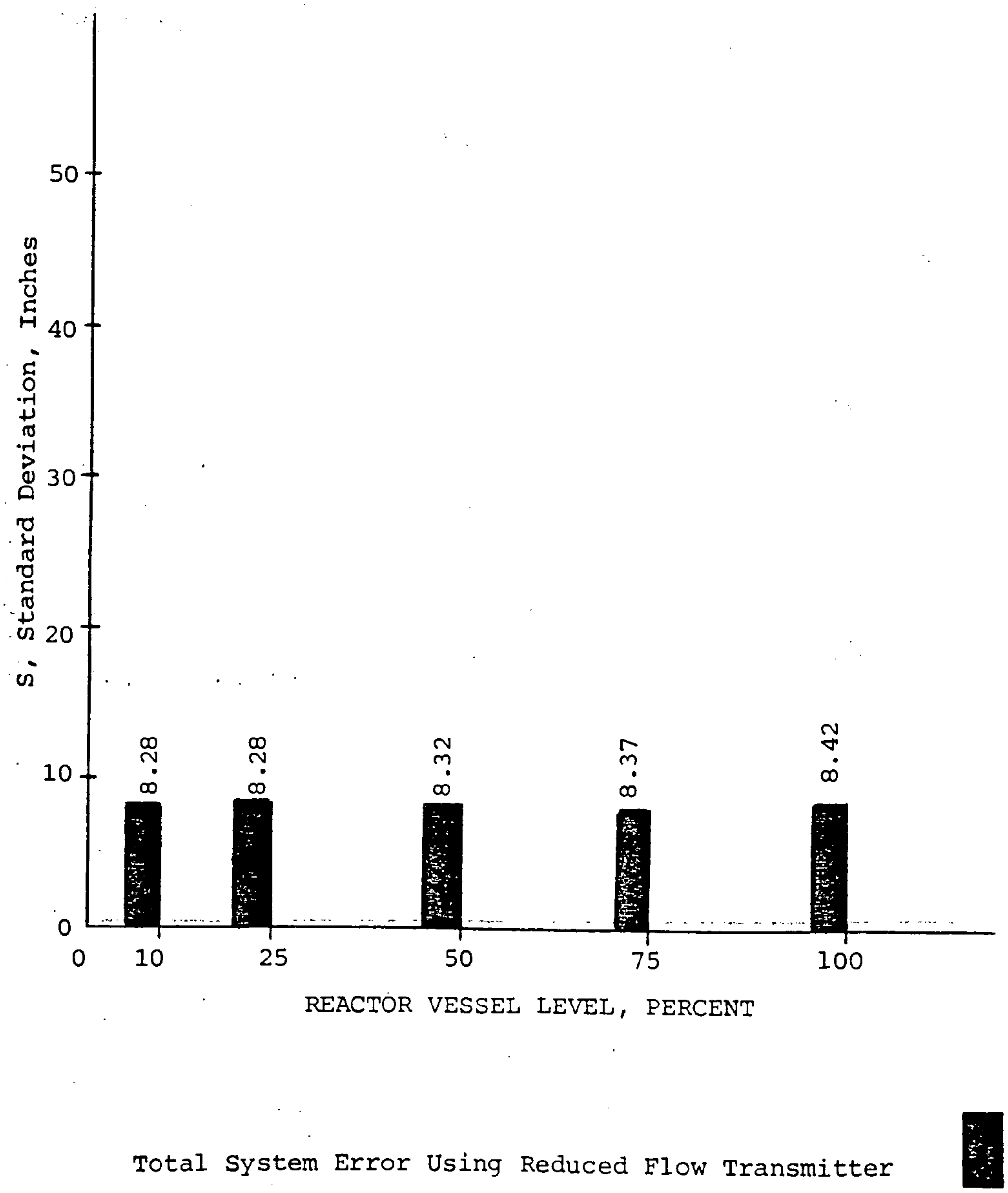
Total System Error Using Reduced Flow Transmitter

(Note: Full flow transmitter case not applicable for levels below the hot legs.)

FIGURE 3

TOTAL SYSTEM UNCERTAINTY

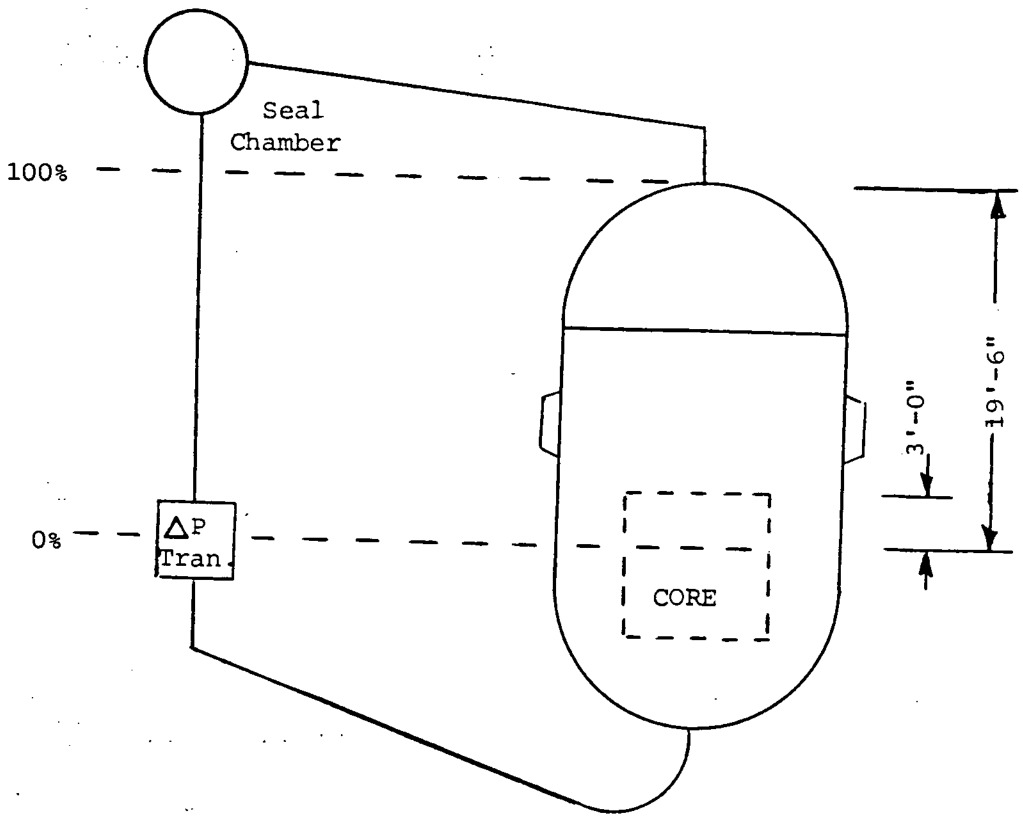
Case: Post LOCA, T-120°F



(Note: Full flow transmitter case not applicable for post LOCA conditions)

FIGURE 4

REACTOR VESSEL LEVEL SYSTEM MEASURED RANGE



REACTOR VESSEL

System Description

Reactor Inventory Tracking System
(RITS)

REACTOR INVENTORY TRACKING SYSTEM

SUMMARY

The Reactor Inventory Tracking System was designed to provide a direct unambiguous indication in the control room of the water level in the reactor vessel. Indication will be continuous from the top of the vessel head to the top of the core. The level system was designed to meet the requirements of NUREG-0578, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations", and NUREG-0737, "Clarification of TMI Action Plan Requirements".

The Reactor Inventory Tracking System is based on the measurement of the differential pressure between the top of the reactor vessel and the top of the core. It contains a top fluid connection to a plutonium recycle port on the reactor vessel head and a bottom fluid connection to a coupling in an incore detector thimble guide tube. The top and bottom fluid connections are connected via 3/8 inch diameter tubing to four differential pressure transmitters. Two of the transmitters are full flow and intended for use primarily when both reactor coolant pumps are running. However, they will also provide indication with the pumps off. Two of the transmitters are reduced flow and intended for use when one or zero pumps are operating. A reference chamber is located at the high point of the system to Keep the fluid line to the transmitters full of water. Each pair of full flow and reduced flow transmitters is independently powered by Class 1E instrumentation power.

Two microprocessors will be used to process the outputs of the differential pressure transmitters to compute the equivalent water level. The output signals provided by the microprocessors are Class 1E to the control room and non-class 1E to the Honeywell 4500 Computer. These microprocessors are also being used to process the signals from the resistance temperature detectors (RTDs) mounted on vertical sections of the tubing and the reactor vessel incore thermocouples.

A conceptual drawing of the system is shown in Figure 1. Individual parts of the system are described in the following paragraphs.

TOP FLUID CONNECTION

The top fluid connection (top tap) will be made to a plutonium recycle port on the head of the reactor vessel. This is penetration number 2 in the head. The design of the top tap will be performed by Fluor Engineering, Inc. The fabrication and installation will be performed by WPS or contractor personnel. The Design includes a one-half inch diameter pipe welded to the head adapter plug of a spare instrumentation port. A 3/8 inch diameter hole is drilled through the adapter plug to provide the fluid connection. The one-half inch pipe will then be routed to a 1" manual isolation valve mounted on the Control Rod Drive Mechanism cooling shroud. The 3/8" tubing will be routed from the outlet of this valve.

BOTTOM FLUID CONNECTION

The bottom fluid connection (bottom tap) will be made to a coupling of an incore detector thimble guide tube. The guide tube selected leads to position G-2 in the reactor core. The connection will be made in the containment keyway to the bottom of the coupling which is located in the horizontal portion of the guide tube run.

The bottom tap and the procedures for installation of the bottom tap were developed by NUS Corporation. The bottom tap consists of a half inch coupling welded to the guide tube coupling with 3/8 inch diameter tubing connecting the half inch coupling to an isolation valve mounted on the wall of the keyway. A 1/4 inch diameter hole is drilled in the guide tube coupling to provide the fluid connection. The isolation valve is a 1 inch manual globe valve. A one inch to a 3/8 inch adapters will be welded between the valve and tubing.

REFERENCE CHAMBER

At the high point of the system, a reference chamber will be installed to ensure that the upper fluid line to the differential pressure transmitters remains full of water. The reference chamber is a water reservoir only. It will be sized such that it contains enough water to refill the fluid line to the transmitters once. The reference chamber will be mounted on the outside of the refueling cavity wall.

Preliminary design of the reference chamber has determined that a four inch diameter stainless steel pipe approximately eight inches long with end caps will meet the refill requirements. The axis of the reference chamber will be mounted horizontally parallel with the wall. There will be three penetrations in the reference chamber, one at the top for connection to a vent valve, one at the bottom connected to the fluid line of the transmitters, and one at the centerline on one end connected to the fluid line of the reactor vessel. The centerline of the reference chamber will be at approximately the 631'-11" elevation in containment.

REMOVABLE SECTION OF FLUID LINE

A removable section of 3/8 inch stainless steel tubing will be installed between the reactor vessel top tap and the reference chamber. This tubing will slope upward from the top tap to the reference chamber. The tubing will contain Swagelock fittings at each end to permit removal during refueling.

SUPPORT FOR REMOVABLE SECTION OF FLUID LINE

A removable support for the removable section of 3/8 inch tubing between the reactor vessel top tap and the reference chamber will be installed. This support will be attached to the refueling cavity wall. This structure will extend approximately 3-1/2 feet and will provide a seismic support for the 3/8 inch tubing.

DIFFERENTIAL PRESSURE TRANSMITTERS

Differential pressure transmitters will be used to measure the differential pressure signals. Four transmitters will be installed; two full flow, and two reduced flow. One full flow and one reduced flow transmitter will receive power from the Safeguard 5 instrumentation racks and the other pair will receive power from the Safeguard 6 racks. Thus, there will be two pair of independently powered transmitters.

The transmitters will be mounted inside containment at an elevation of 611'-0". This elevation places them below the top of the vessel core and above the LOCA flood level.

The reduced flow transmitters will be calibrated for approximately 300 inches of water adjusted for temperature. This span is the difference between a full vessel and the transmitter's elevation (approx. 3 ft. below top of core). Reactor vessel elevations are shown in Figure 2. The zero of the transmitter will be set so that the transmitter's output is approximately twenty milliamps with the system full and approximately four milliamps with the water level at the level of the transmitters. During normal operation, with the reactor coolant pumps on, the reduced flow transmitter's output will be invalid.

The full flow transmitters will be calibrated to a span of approximately 150 inches. The transmitter will be set so that during normal operation with the reactor coolant pumps on, the output will be approximately 4 milliamps with the vessel full. With the reactor coolant pumps on and the water level at the transmitter elevation, the output will be approximately 20 milliamps. With one or zero reactor coolant pumps running, the full flow transmitter's output will be invalid.

MICROPROCESSORS

Safeguard 5 and Safeguard 6 power sources will be used to power the differential pressure transmitters. Resistance Temperature Detectors will be used to measure the temperature of the vertical portions of the fluid lines to the differential pressure transmitters. Microprocessors will monitor the RTDs and compute the average temperature. The outputs of the transmitters and the RTDs will be processed to compute the reactor vessel water level.

These microprocessors will be located in the relay room. Two separate independently powered microprocessors are used. Each one processes one full flow and one reduced flow channel. The microprocessors will also monitor all thirty-nine incore thermocouples. They will output the average, the hottest, or a selected temperature signal.

The outputs of the microprocessors will be Class 1E input signals for analog control room indication and non-class 1E signals to the Honeywell 4500 Computer. Reactor vessel water level will be available for computer generated displays.

CONTROL ROOM INDICATION

Redundant Class 1E indication will be provided to the control room from the microprocessors (See Figure 1). Non Class 1E indication will be provided to the control room and the Technical Support Center from the Honeywell 4500 Computer. Reactor Vessel Level indication will be placed in near proximity to the displays of the incore thermocouples.

An analog display will be dedicated to reactor vessel level. It will graphically correlate percent level to reactor vessel level. The analog meter is a mimic of the reactor vessel which shows the reactor core and the reactor water level.

These displays will be provided independently for Train A and Train B vessel level.

RESISTANCE TEMPERATURE DETECTORS (RTDs)

RTDs will be installed along the vertical sections of tubing from the reactor vessel taps to the differential pressure transmitters. The signals from the RTDs are routed to the microprocessors in the relay room. The average temperatures is computed by the microprocessors. Five (5) RTDs will monitor leg temperatures on each train for a total of ten (10) RTDs.

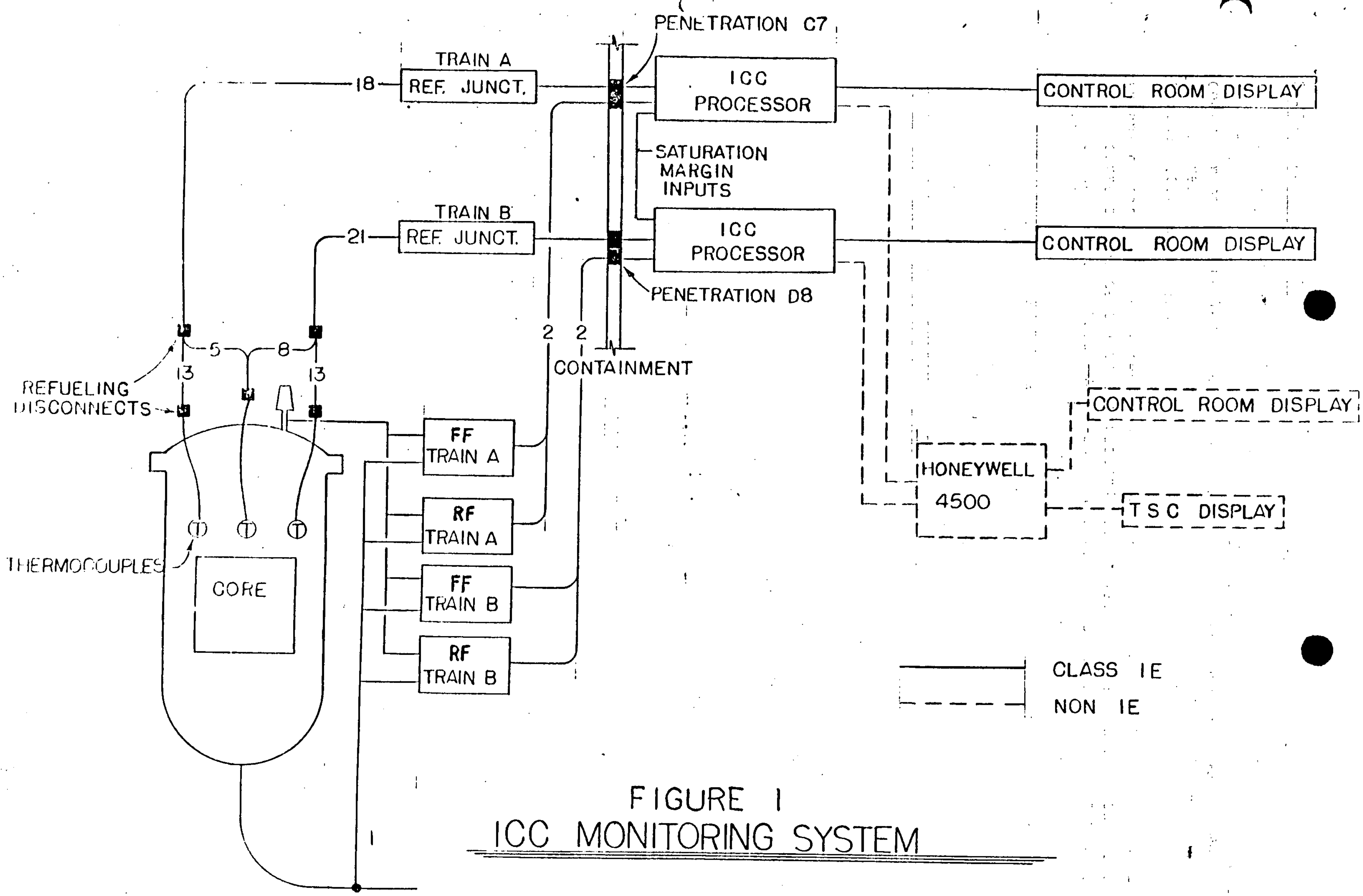
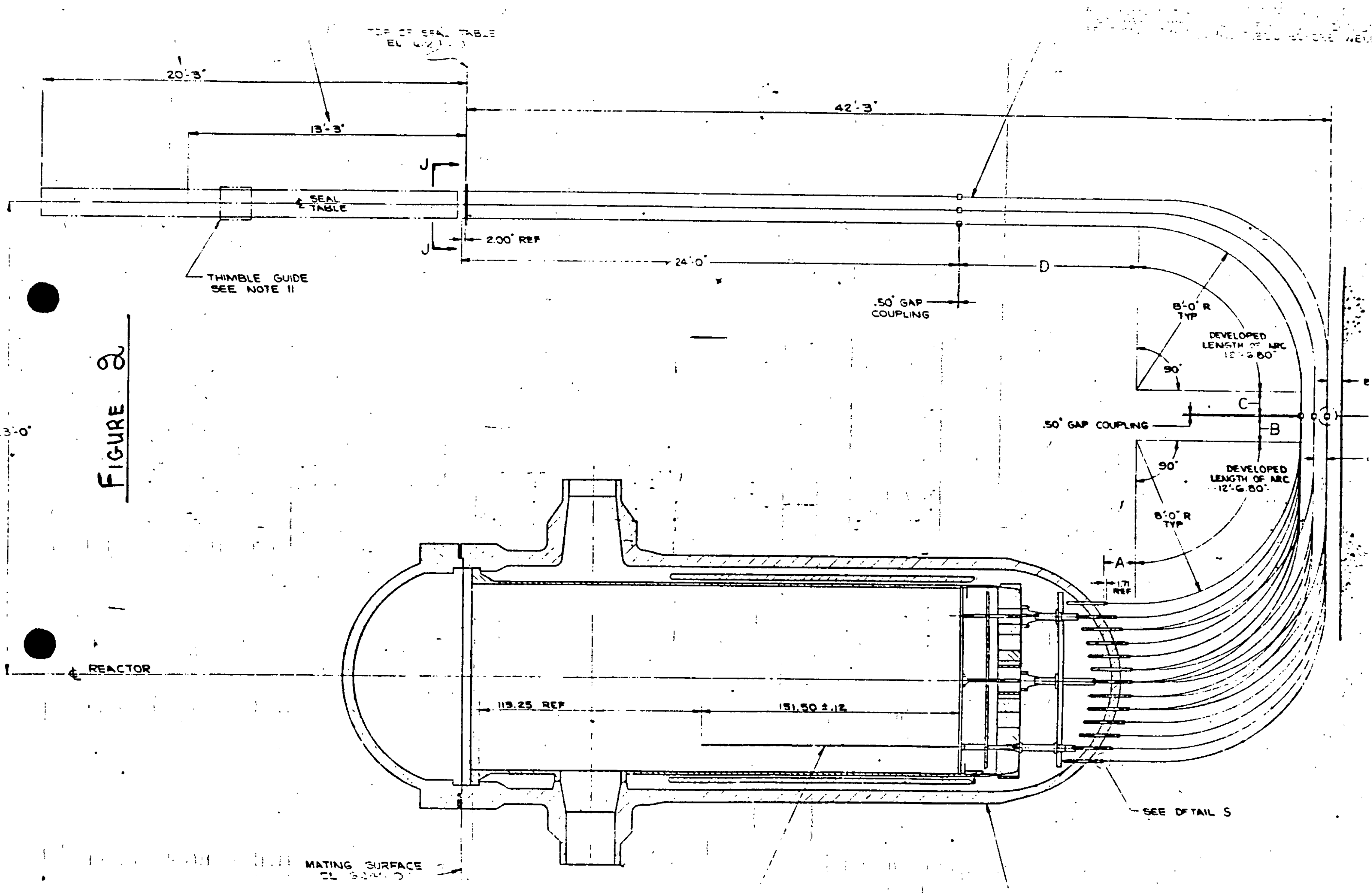


FIGURE I

ICC MONITORING SYSTEM



TOP OF SEAL TABLE
20'-3"
13'-3"
42'-3"
J
℄ SEAL TABLE
2.00" REF
24'-0"
D
THIMBLE GUIDE
SEE NOTE 11
.50" GAP
COUPLING
8'-0" R
TYP
DEVELOPED
LENGTH OF ARC
12'-6.80"
90°
C
.50" GAP COUPLING
B
A
1.71
REF
℄ REACTOR
119.25 REF
151.50 ± .12
SEE DETAIL S
MATING SURFACE
3'-0"

FIGURE 2