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January 28, 1986

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Mr. George W. Knighton, Director
PWR Project Directorate No. 7
Division of PWR Licensing - B
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
ICC Monitoring System
Installation - NUREG-0737 Item II.F.2

Dear Mr. Knighton:

In our letter of April 30, 1985 (2CANØ485Ø7) we committed to providing a summary of the results of the tests and analyses performed to determine the level detection capability of the installed ANO-2 Inadequate Core Cooling (ICC) instrumentation. The purpose of this letter is to provide the summary of the tests and analyses results.

The as-installed system design (see Figure 1) was modeled in the Oak Ridge Laboratories air/water test facility in order to determine its level detection capability. The tests and analyses results indicated that the installed configuration will not provide an adequate measure of collapsed liquid level in the upper plenum and dome regions of the pressure vessel.

The reasons for the inadequate performance of the installed system are: (1) the inability to cut the desired port geometries in the guide tube in the axial domain above the fuel alignment plate and around the upper guide structure support plate during the fourth refueling outage of ANO-2 (2R4), and (2) the reduction in hydraulic isolator outer diameter from 0.480 inches to 0.420 inches.

As discussed in our April 30, 1985 letter, the cuts in the incore instrument guide tubes were to be made using a technique referred to as mechanical disintegration of metal (MDM). However, the inability to obtain the required air/water flow down the incore instrument guide tube to flush away the metal particles removed by the MDM process rendered the cutter

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ineffective. AP&L evaluated other techniques to cut the tubes but none were feasible considering ALARA constraints and available time. Based on our inability to correct the problem during the outage, the decision was made to modify the probe to take advantage of existing slots and gaps in the incore instrument guide tube and proceed with the remaining hardware installation. The lack of porting in the upper guide structure support plate region does not allow the purging of voids swept into the lower portion of the manometer during RCP operation. Thus, voids which enter this lower region are carried up the length of the manometer thereby causing a misrepresentation of collapsed liquid level above the fuel alignment plate during RCP operation.

Prior to installing the Radcal probes, a decision was made to reduce the hydraulic isolators outer diameters from 0.480 to 0.420 inches to allow sufficient clearance for insertion (not to exceed a maximum installation force) into the guide tubes. This decision was based on analyses which indicated that smaller diameter hydraulic isolators would provide a reasonable certainty of proper Radcal probe insertion while not degrading the performance of the upper plenum and dome manometers to measure collapsed liquid level. Hydraulic isolator efficiency calculations indicated the 0.420-inch outer diameter hydraulic isolators would provide a hydraulic isolator efficiency of 80 percent while providing a relatively low probability of binding in the guide tubes during insertion. However, the tests indicated that the 0.420-inch outer diameter hydraulic isolators do not adequately decouple the manometers in order for each manometer to independently measure collapsed liquid level.

After determining that the as-installed design would not provide an adequate measure of collapsed liquid level, AP&L initiated additional tests at the air/water test facility. The objectives of these tests were to: (1) provide basic design data on the performance of the as-installed and to be modified ANO-2 ICC system installation configurations, (2) demonstrate the ability of each of these installation configurations to measure collapsed liquid level in the upper plenum and dome regions of the pressure vessel under a variety of air/water mixtures, and (3) examine for each of the installation configurations the dome and upper plenum manometer drain time delays relative to main channel uncovery.

An extensive set of ambient temperature and pressure air/water hydraulic tests was performed utilizing a full-scale simulator of the ANO-2 upper plenum and dome regions as shown schematically in Figure 2. The system was modeled using the installed porting in the fuel alignment plate region and the originally designed porting in the upper guide structure support plate region. Hydraulic isolators were modeled as being positioned just above the vertical (exit) ports of each manometer. Three parameters (manometer efficiency, hydraulic isolator efficiency and drain time delay) were investigated as a function of void fraction and hydraulic isolator outer diameter.

Manometer efficiency calculations were performed as a function of void fraction for both the upper plenum and dome manometers. Tables 1 and 2 show void fraction dependent information on the absolute manometer efficiencies for the upper plenum and dome manometers, respectively.

With respect to hydraulic isolator efficiency, a qualitative evaluation of the dynamic performance of various outer diameter hydraulic isolators was undertaken. The theoretical behavioral trends (greater fractions of transversely directed bubbles for increasing hydraulic isolator outer diameter) were verified using both visual observations and experimental data obtained from the tests.

The drain time delay tests were performed with an average test section level fall rate of 0.21 feet/second. The level in the annulus surrounding the probe closely tracked this value for all outer diameter hydraulic isolators. Thus, for both the upper plenum and dome monitors, no significant time delays were recorded for this magnitude of level fall rate. Drain time delay does not adversely contribute to the ability of the ICC system to measure level.

As a result the tests and analyses of the as-installed system, AP&L has determined that modifications are necessary in order to meet the intent of the December 10, 1982, "Order for Modification of License." An evaluation of the most appropriate modifications is currently underway.

Specific progress has been made to correct the deficiencies of the ICC system which rendered the system ineffective. A vendor has been chosen as the contractor to perform the guide tube cutting during the ANO-2 fifth refueling outage (2R5) which is currently scheduled for June 13, 1986 - August 6, 1986. A full-scale mock-up of the cutting effort is planned for March 1986. Additionally, design and fabrication efforts have begun on expandable hydraulic isolators. These isolators will provide ease of probe insertion and proper isolation during operation. AP&L has reviewed four proposed designs and is proceeding with further analysis of two of these designs. AP&L will continue working on the implementation of hardware modifications in an attempt to have the present ICC system modified during 2R5.

Very truly yours,

J. Ted Enos

J. Ted Enos
Manager, Licensing

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Attachments

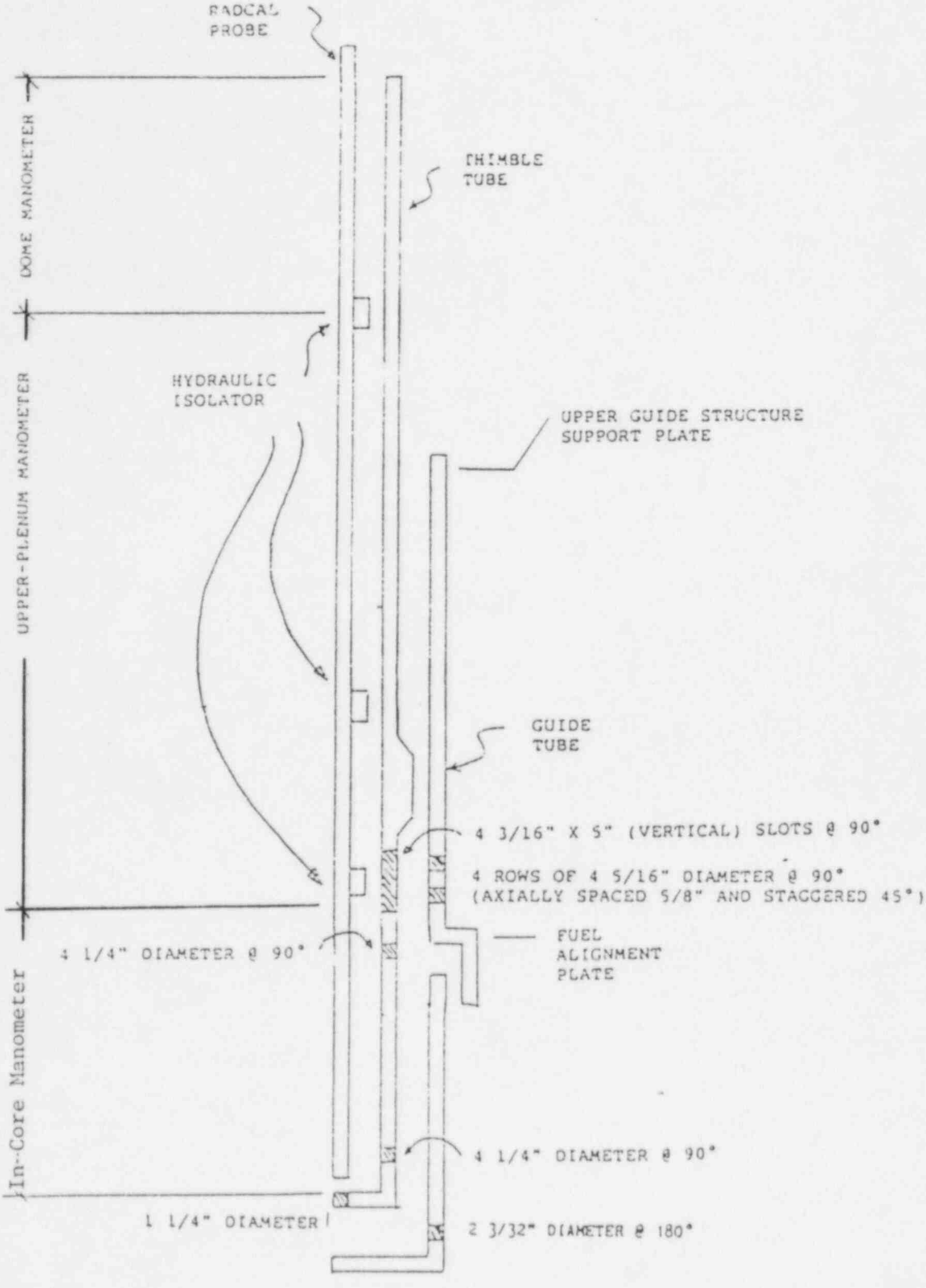

Figure 1 Schematic of the as-installed ANO-2 ICC system showing the axial locations of pertinent components.

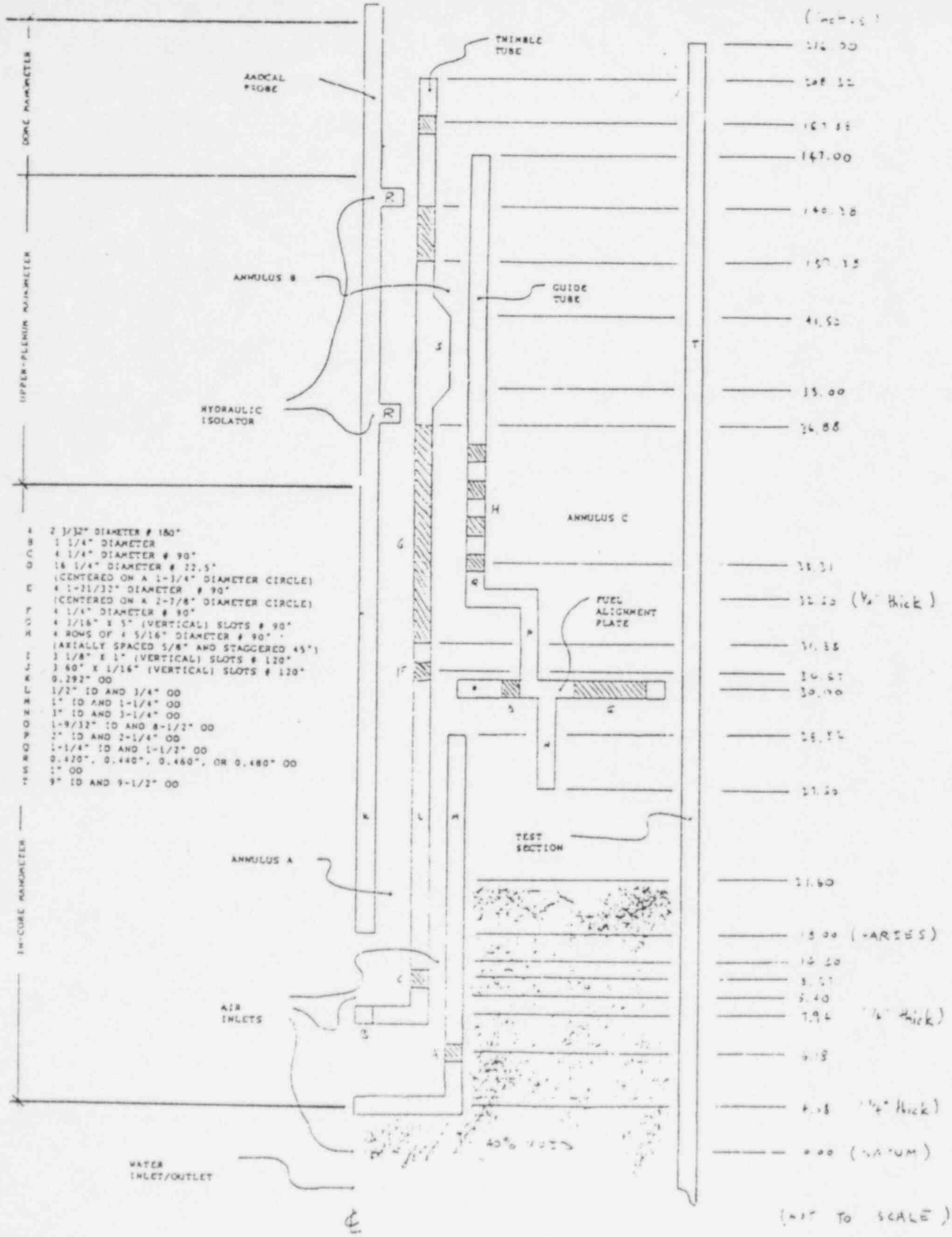

Figure 2 Schematic of the air/water test facility showing details of the assembly configuration.

Table 1

PERCENT EFFICIENCIES OF THE UPPER PLENUM MANOMETER GEOMETRIES
(WITH STANDARD DEVIATIONS)

Hydraulic Isolator OD (Inches)	Void Fraction (%)				
	5.0	10.0	15.0	20.0	30.0
NONE	0.0 (N.A.)	0.0 (N.A.)	0.0 (N.A.)	0.0 (N.A.)	0.0 (N.A.)
0.420	N.A. (N.A.)	24.5 (±15.1)	N.A. (N.A.)	24.4 (±12.1)	25.3 (±37.2)
0.440	32.2 (±10.0)	N.A. (N.A.)	36.6 (±16.6)	53.6 (±11.4)	N.A. (N.A.)
0.460	65.0 (±7.9)	60.4 (±14.4)	N.A. (N.A.)	84.7 (±10.7)	82.7 (±35.3)
0.480	93.4 (±7.6)	93.1 (±11.6)	92.8 (±10.2)	89.9 (±9.3)	94.1 (±23.6)

NOTE: Information is valid only for a 0.500-inch ID tube.

Table 2

PERCENT EFFICIENCES OF THE DOME MANOMETER GEOMETRIES
(WITH STANDARD DEVIATIONS)

Hydraulic Isolator OD (Inches)	Void Fraction (%) 5.0	10.0	15.0	20.0	30.0
NONE	71.3 (±10.4)	61.3 (±9.2)	41.4 (±8.4)	45.7 (±8.1)	N.A. (N.A.)
0.420	100.0 (±14.4)	41.7 (±14.2)	40.5 (±9.4)	27.6 (±9.3)	N.A. (N.A.)
0.440	100.0 (±14.9)	61.0 (±12.0)	48.5 (±9.7)	42.9 (±9.0)	N.A. (N.A.)
0.460	100.0 (±13.9)	100.0 (±11.4)	90.0 (±9.1)	80.4 (±8.4)	N.A. (N.A.)
0.480	100.0 (±15.3)	100.0 (±12.8)	94.2 (±10.5)	100.0 (±8.6)	N.A. (N.A.)

NOTE: Information is valid only for a 0.500-inch ID tube.