DUQUESNE LIGHT COMPANY

SHIPPINGPORT ATOMIC POWER STATION

TEST EVALUATION

DLCS 3330201

1A HEAT EXCHANGER LEAK TEST

CORE I SEED 2

Section 2 of 2 Sections

First Issue, July 24, 1961

DISCLAIMER

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DLCS 3330201

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Purpose

To determine which tubes of the 1A loop heat exchanger are leaking, thereby verifying the chemical sampling which initially indicated leakage was occurring.

Conclusions

The air pressurization test, periscope test, and the probolog tests were inconclusive in determining which tubes of the 1A heat exchanger were leaking or if leakage was occurring.

Description of Test Equipment and Test Procedure

The following are descriptions of tests performed:

A. The air pressurization test was the basic method by which the heat exchanger tubes were tested for leakage of reactor coolant water into the secondary system. With the loop hydraulic stop valves closed and the water drained from both sides of the heat exchanger, air pressure of 75 psig was applied to the secondary (shell) side. The upper five (5) rows of tubes of the 1A heat exchanger were plugged with solid rubber stoppers on the inlet side, and rubber stoppers with plastic hoses attached were inserted into the corresponding tubes on the outlet side. The plastic hoses from the rubber stoppers were placed in a container of water and observed for air bubbles for a period of 10 minutes.

   All rubber stoppers were then removed and the entire tube sheet was covered with a soap solution on both the inlet and outlet sides of the heat exchanger. The secondary side was pressurized to 75 psig and the tubes were observed for bubble formations for a period of 30 minutes.

   With all foreign material (stoppers, plastic hoses etc.) removed, the heat exchanger was filled with water up to and including Row F (sixth row from the top). The tube sheets on both the inlet and outlet side were observed for leakage (bubbles) for a period of three (3) hours.

   This procedure was repeated with the secondary side pressurized to 150 psig with nitrogen.

B. The periscope was used to test the upper five (5) rows of tubes of the heat exchanger. With the special adapters installed on the four (4) handholes of the heat exchanger, the primary side was filled until all tubes were covered with water. The secondary side was pressurized to 150 psig with nitrogen.

The five (5) rows of tubes were divided into sections (approximately 20 tubes per section) and each section was observed for bubbles for a period of thirty (30) minutes using a site fabricated periscope. This step was performed on both the inlet and outlet ends of the heat exchanger.

C. A probolog test was performed to determine if any tube irregularities, cracks, or deformities existed in the heat exchanger. The probolog is an instrument used to detect irregularities such as cracking, corrosion, etc. in non-magnetic metal tubing. It is, in principle, a recording inductance bridge wherein the two coil legs of the bridge are mounted coaxially on a core and act as the sensing probe that passes through the metal tube being tested. The alternating current magnetic field of the two coils penetrates the metal tubing surrounding the probe, the metal tubing acting as a shorted turn of variable conductance. Variation in conductance may be due to changes in tube wall thickness, pits or cracks due to corrosion, magnetic metal in or on the tubes, and differences in the annealing of the metal. The probolog (Model E) was supplied by Bettis.

Results

DLCS 3330201, 1A Heat Exchanger Leak Test, was performed at various periods from December 10, 1960, to January 13, 1961.

During Station start-up on November 6, 1960, it was determined that primary to secondary leakage had developed in the 1A heat exchanger. Although Iodine activity had been previously observed in this heat exchanger, the presence of Iodine-133 had not been established. Boiler leak detection is based on the activity of 20.8 hour half life Iodine-133 in the boiler water. Based upon chemical sampling the leakage observed in the heat exchanger on the following dates was:

11/21/60	0.57 ml/min.
11/22/60	0.65 ml/min.
11/23/60	0.60 ml/min.
11/24/60	0.45 ml/min.
11/25/60	0.82 ml/min.

Probolog testing of 203 heat exchanger tubes (Figure 1) from the inlet end was performed, and 67 tubes gave indications of irregularities. Interpretations of the severity of the indications has been hampered by the unusual character of the pen deflections and the presence of magnetic crud on the outer surface of the tubes. The evaluation of Probolog results is continuing at Bettis. Preliminary examination of the data suggested more gross irregularities in the following tubes:

J-8	K-23
J-15	M-9
J-16	M-11
K-20	M-22
K-21	B-17

The approximate location in the tube of these observed irregularities, and the amount of deflection of the probolog meter for each tested tube are listed in

Table I. The terminology "bay" used in Table I has reference to spaces between tube supports in the heat exchanger. A further investigation of the 10 suspected leakers, using the air pressurization test, revealed no discernible leaks. Since the probolog is affected to such a great extent by the tube surface conditions, the results are inconclusive. The probolog test is a good method of checking the conditions of the inside of the heat exchanger tubes, so far as checking the leakage, the test requires refinement of technique to provide reliable results.

The tube sheet soap test revealed no discernible leaks, however, the accuracy of the test is questionable due to the fact that the soap solution did not readily adhere to the tube sheet itself. A large number of tubes could not be tested because small quantities of water continued to drain from the tubes causing the soap film to break. Since both tube sheets were not covered sufficiently with the soap solution, it is conceivable that air might have escaped from a tube without detection. However, since no bubbles were seen when all tubes were later submerged in water and checked for leakage, this possibility is extremely remote.

With the primary side of the heat exchanger filled with water the periscope was used to view the upper five (5) rows of tubes which were obscured from direct vision. The periscope test indicated no leaks present. The principle of the periscope worked satisfactorily, however, the major difficulty encountered was with the visual distortion which occurred mostly in the upper row of tubes. Also, the upper row of tubes gave a reflection from the top of the water. The remaining tubes below the fifth row observed for leakage, with the primary side filled with water to a level of the heat exchanger handholes, revealed no leaks. The periscope was used for these observations. Seepage entered the periscope at the bottom and it was difficult to hold due to its smooth surface.

The air pressure test revealed no leaks present in the upper five (5) rows or the ten (10) tubes selected from the Probolog test preliminary data.

On January 13, 1960, a film badge survey was made of the tube sheet and the hemispherical head area of the 1A heat exchanger. These radiation levels were taken at various distances from the tube sheet at the inlet side of the steam generator. Different types of films and shielding were used in performing the radiation survey. The results of this survey will be issued under DLCS 34102.

Based on the chemistry samples indicating that a leak was present, the leak test method was inadequate. This may be attributed to a number of reasons. The activity of Iodine corresponds to a leak of 0.60 ml/min., which is considered to be minute leakage. The boiler lay-up period (3 days) prior to the tests could have permitted the secondary residue to plug any existing holes. The temperature of the tube metal during operation is considerably higher than it was at the time of the test, resulting in the expansion of the holes when it is hot, and contraction when it is cold. For this test, the pressure was applied from the secondary side, where as during actual operation the leak was from the primary side to secondary, and the test pressure was considerably less than that at which the boiler is operated.

With no discernible leaks revealed, the 1A heat exchanger and loop were hydrostatically tested and were returned to service on February 19, 1960. Chemistry samples taken subsequent to the test indicate a leak rate of 2.7 ml/min. (May 23). This rate is estimated to be $\pm$ 40%.

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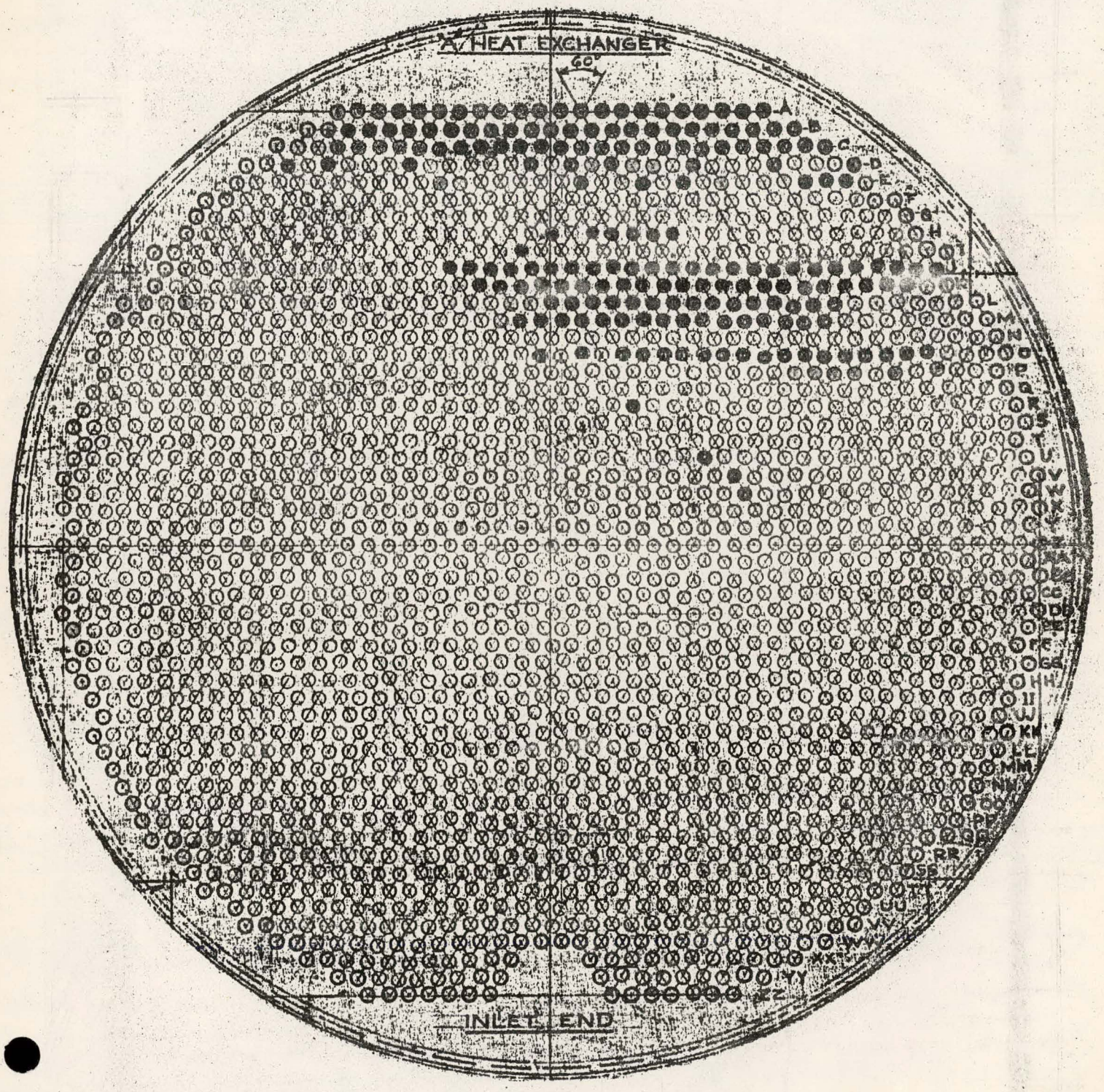

FIGURE 1

Tubes probologed, counted right to left.

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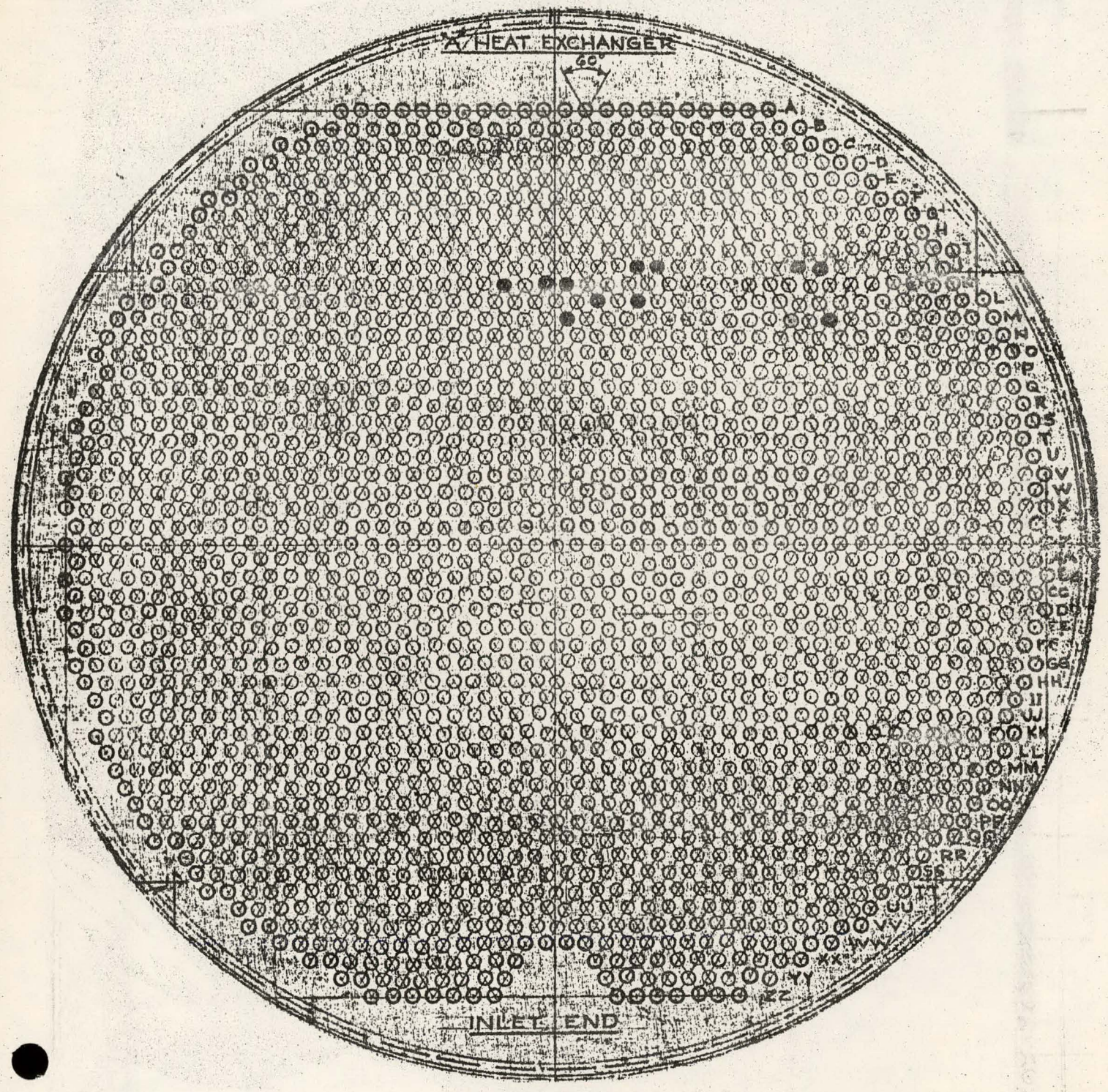

FIGURE 2

51-100% deflection of probolog needle.

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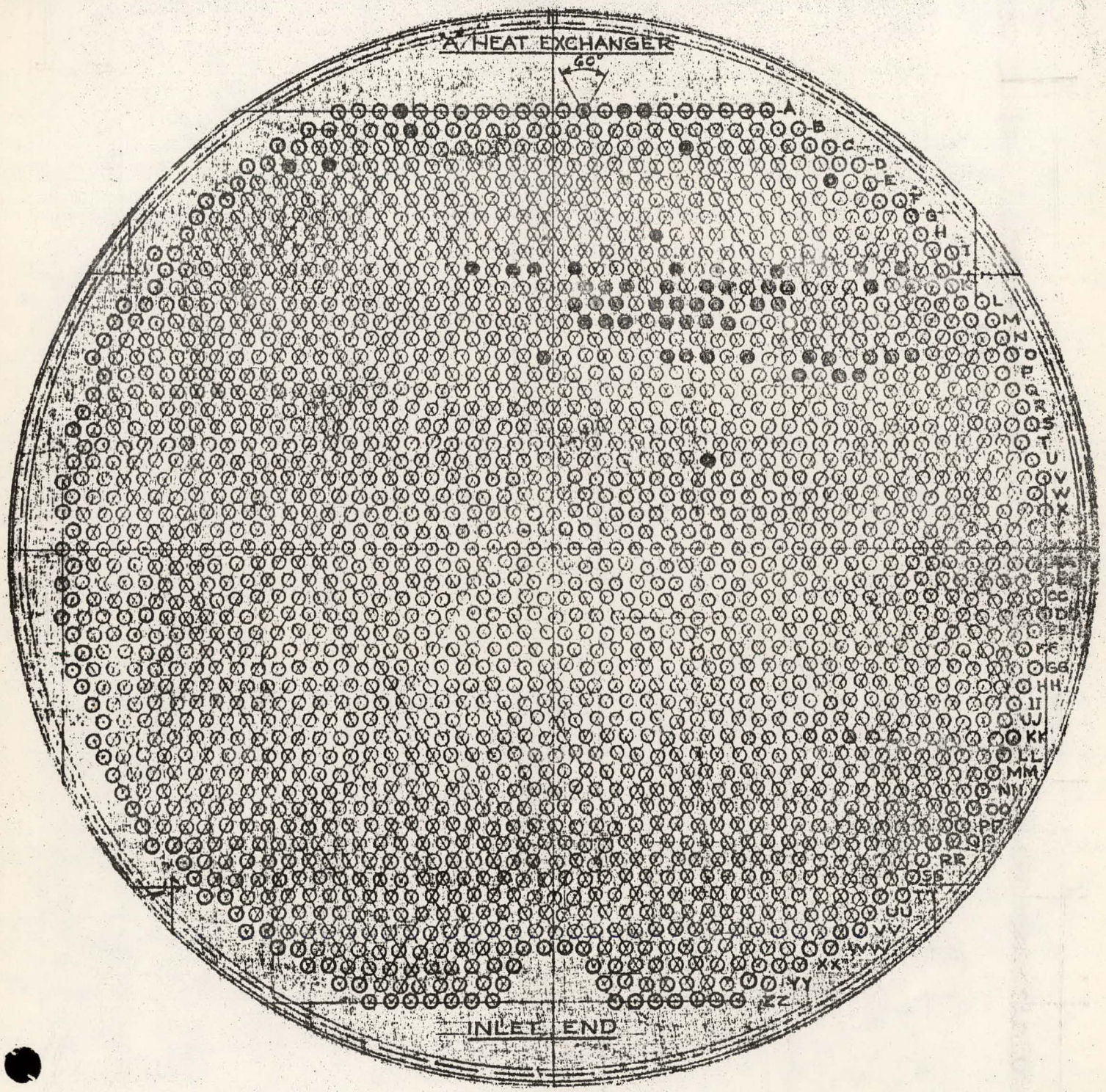

FIGURE 3

25-50% deflection of probolog needle.

TABLE I

PROBOLOG DATA

Row	Tube	Bay	Amplitude-%	Row	Tube	Bay	Amplitude-%
A	7	2	25-50	*K	21	3	100
A	8	1	25-50	*K	23	3	50-100
A	10	3	25-50	L	11	3	25-50
A	14	2	Disturbance	L	12	4	25
A	16	3	25-50	L	14	3	25-50
A	19	3	25	L	15	3	25-50
*B	17	3	50-100				
B	20	3	50	L	16	3	25-50
C	8	3	25-50	L	17	3	25-50
D	27	3	25-50	L	18	3	50-100
D	29	2	25-50	L	19	3	50
E	3	3	25-50	L	20	2	25-50
H	14	2	25-50	L	20	3	50-100
J	3	2	50	L	21	3	25-50
J	5	3	25-50	*M	9	3	50-100
J	7	3	50-100	M	10	3	10
*J	8	3	100	M	14	3	25-50
*J	15	1	100	M	15	3	25-50
*J	16	1	50-100	M	16	2 & 3	25-50
J	19	3	25-50	M	17	2 & 3	25-50
J	21	3	25-50	M	19	2	25-50
J	22	4	25-50	M	20	3	25-50
J	24	3	25	M	21	2	25-50
J	9	3	25-50	*M	22	3	50-100
J	12	2	25-50				
J	14	3	25	*M	11	3	50-100
K	5	3	25	0	6	1	25-50
K	9	3	25	0	7	3	50
K	9	4	25	0	8	3	25-50
				0	10	3	25-50
K	10	3	25	0	11	3	25-50
K	12	3	25	0	14	1 & 3	25-50
K	13	3	25-50	0	16	3	25-50
K	15	3	25-50	0	17	3	25-50
K	17	3	25-50	0	18	3	25-50
K	18	1	25-50	0	24	1	25-50
K	18	2	25-50	P	8	3	25-50
K	19	2	25-50	P	9	1,2 & 3	25-50
*K	20	2	50-100	P	11	3	25-50
*K	20	3	50-100	U	17	2	25

* Suspected leaking tubes, tubes counted right to left on inlet side.

TEST RESULTS DLCS 3330201
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Log of Events

December 10 and 11, 1960	With the primary and secondary side drained, and secondary side pressurized with 75 psig of service air, the upper five (5) rows (approximately 138 tubes) were leak tested; the inlet and outlet tube sheets covered with a soap solution and checked for leaks. Upon completion of the tests above, the primary side was filled with water up to Row F and checked for leaks.
December 14, 1960, to December 20, 1960	Selected tubes of the 1A Heat Exchanger were subjected to probolog tests.
December 21, 1960, to December 31, 1960	The secondary side pressurized with 150 psig of nitrogen, the same procedure was performed as was done with the secondary system pressurized at 75 psig with service air.
January 10, 1961, to January 13, 1961	The 1A Heat Exchanger filled completely, and with the secondary side pressurized with 150 psig of nitrogen, the upper five (5) rows of tubes were checked for leaks on both inlet and outlet sides using a periscope.

TEST RESULTS BLCS 3330201
1A HEAT EXCHANGER LEAK TEST

Results Prepared By Joseph Spicola

Results Reviewed By L W Noble

Approved (Duquesne Light Company) George A Santel Date 7-24-61