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October 30, 1995
C311-95-2451

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

Gentlemen:

Subject: Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Additional Information in Response to Generic Letter (GL) 95-03
"Circumferential Cracking of Steam Generator Tubes"

On April 28, 1995, the NRC issued GL 95-03 which requested addressees to evaluate recent operating experience related to circumferential cracking, justify continued operation until their next scheduled steam generator tube inspections, and to develop plans for their next steam generator tube inspections. GPU Nuclear submitted a response to the GL on June 20, 1995. Our letter committed to perform certain steam generator tube inservice inspection (ISI) examinations during the Cycle 11 Refueling (11R) Outage in September 1995.

In a letter dated August 29, 1995 the NRC issued a request for additional information to supplement the previous TMI-1 response. Our letter dated September 28, 1995 requested an extension beyond the initial 30 day response date. Attached is our response which incorporates the results from 11R examinations. Approximately 21% of the TMI-1 steam generator tubes were inspected during the 11R Outage and no defects attributable to circumferential cracks were found.

Sincerely,

J. Knubel
Vice President and Director, TMI

MRK
Attachments

cc: Administrator, Region I
TMI-1 Senior Project Manager
TMI Senior Resident Inspector

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GPU Nuclear Response to Generic Letter 95-03 Request for Additional Information

1. NRC Question:

Discuss the design differences between the TMI-1 steam generators and the generic design information provided in the B&W Owners Group response, if any.

GPU Nuclear Response:

The following design and manufacturing differences are noted between TMI-1 and the generic description given in the BWOG response to GL 95-03, dated June 16, 1995. Only those items determined to be potentially significant to the circumferential cracking issue and that are not addressed in that letter are included here.

The outer tube locations in the 15th tube support plate (TSP) at all units are drilled to a .637" minimum / .646" maximum diameter. Approximately 1621 locations are typically drilled. At TMI-1 1626 locations are drilled in the 15th TSP as shown on Figure 1. All remaining locations at this support plate, and all locations at the other support plates, are broached as described in the GL 95-03 response.

According to shop manufacturing records, the number of tubes presently in service that were re-expanded at the tubesheet after full bundle stress relief are as follows (although the records are not clear on the exact location for some of these tubes):

	OTSG "A"	OTSG "B"
Upper Tube Sheet (UTS)	0	0
Lower Tube Sheet (LTS)	11	0

The upper and lower tubesheets for the TMI-1 "A" OTSG were drilled prior to implementation of the open lane design. In order to accommodate the un-tubed lane, the UTS holes were plugged with welded tubesheet plugs. The LTS holes were plugged by installing a short thick-walled tube section that extends from the primary face to just beyond the secondary face of the tubesheet. The primary side of the tube was rolled to the tubesheet and seal welded using the same process used for normal tubes. The opposite end of the tube, protruding above the tubesheet, was sealed with a welded end cap. This affects 63 locations in row 76, from the periphery of the "Z" axis to the center of the bundle, for the "A" OTSG only.

As a result of a sulfur intrusion event in 1981, circumferential stress-assisted intergranular cracks, initiated from the inside diameter (ID), were found at the UTS region of both TMI-1 OTSGs, mainly at the original roll expansion transition. To repair the resulting defective tubes, GPU Nuclear applied a kinetic expansion technique. This method utilized an explosive process to form the tube against the tubesheet, closing the 5-mil (nominal) radial gap to produce an interference fit between the OD of the tube and the ID of the holes drilled through the tubesheet. Thus, a leak-tight load-carrying joint was achieved. This tube repair procedure required that all repaired tubes have a 2" defect-free unexpanded

section within the UTS above the secondary side tubesheet interface. The purpose of the unexpanded section is to prevent tube pullout in the event a tube were to be severed at the repair transition zone.

The NRC's Safety Evaluation Report (SER) related to the kinetic expansion repairs is documented in NUREG 1019, which was transmitted by letter dated August 25, 1983. All in-service (unplugged) tubes were repaired by kinetic expansion in 1982. Most of the resulting tubes have a kinetic expansion transition at 7" into the secondary face of the UTS and a 17" kinetic expansion length; several hundred tubes have kinetic expansion transitions at 2" above the secondary face of the UTS and a 22" kinetic expansion length. Following the kinetic expansion to repair sulfur-induced primary side circumferential cracks, the last 10 years of operation has demonstrated the success of the repair.

2. NRC Question:

Dented Regions including dented tube support plates

The Electric Power Research Institute (EPRI) report NP-6201 "PWR Steam Generator Examination Guidelines: Revision 3," dated November 1992, indicated that B&W plants have experienced denting at tube support plates and in the LTS. Circumferential indications have been observed at dented areas in recirculating steam generators. If denting has been observed at TMI-1 and it is a location susceptible to circumferential cracking, please submit the information requested in Generic Letter (GL) 95-03 per the guidance contained in the GL. If a voltage threshold is used for determining the threshold for examining dents, provide the calibration procedure used (e.g., 4.0 volts on 4-20% through-wall ASME holes at 550/130 mix).

EPRI report NP-6201 indicates that the 15th TSP contains both broached holes and drilled holes, the drilled holes being prone to denting. Please clarify whether all of the tube support plates are of the broached hole designs or whether a number of them contain drilled locations, if applicable, or if it has been observed at other support plate intersections (i.e., broached holes).

GPU Nuclear Response:

In general, tube diameter reductions are called "dings" in most other B&W plants to distinguish them from the more severe denting observed in recirculation steam generators and are most prevalent at the secondary faces of the upper and lower tubesheets. Although not as common, dings have also been detected at tube support plate locations as well; but in most cases the number is minor when compared to those at the tubesheet faces. In some cases OD volumetric degradation has been detected in dings, and is thought to be caused by corrosion or wear at the TSP or tubesheet interface.

At TMI-1, however, diameter reductions which occur at support structures are recorded as dents and reductions which occur in the freespan of the tube are recorded as dings. Voltage normalization for TMI-1 is performed by setting the 400 kHz differential response

from the four 20% ASME through wall holes to 10 volts and storing this response (normalizing) to all examination channels and mixes. A 400/200 kHz mix is used for evaluating indications at support structure transitions such as tubesheets and support plates. GPU Nuclear records tube diameter reductions greater than or equal to 10 volts. Currently, TMI-1 OTSG's recorded dents and dings equal to or greater than 10 volts in service are as follows:

OTSG "A"

1. LTS dents due to installation of adjacent plugs	67
2. LTS dents at the secondary face	66
3. 15th TSP dents	2
4. UTS dents at the secondary face	11
5. Dings	12

OTSG "B"

1. LTS dents due to installation of adjacent plugs	33
2. LTS dents at the secondary face	219
3. 15th TSP dents	0
4. UTS dents at the secondary face	0
5. Dings	6

The LTS dents due to adjacent plugs are generally midway between the primary and secondary faces of the LTS and are due to distortion of the tubesheet ligament resulting from installation of explosive plugs in adjacent tubes. These dents are small (generally 10 to 15 volts in amplitude) and have accumulated over a decade of service without significant growth or degradation. The LTS dents at the secondary face are generally located in the OTSG "kidney-shaped" area which is generally an area of light sludge buildup (2-3"). Both tubes with 15th TSP indications are located in tubes with drilled 15th TSP holes. The UTS dents are located in the TMI-1 Technical Specification (Tech Spec) defined inspection lane/wedge. The few recorded dings have no specific pattern or location on the tubesheet array or axial elevation.

Dents or dings above the LTS recorded during the 11R Outage (September 1995) were examined with a 3-coil motorized rotating pancake coil (MRPC) technique. LTS dents greater than or equal to 40 volts (in addition to a number of dents <40 volts which were also examined) recorded during 11R were examined with 3-coil or 2-coil MRPC techniques. One of the 15th TSP dent tubes has been sleeved and the other was examined with a 3-coil MRPC technique during 11R. The UTS dents have either been previously sleeved or were examined with a 3-coil MRPC technique during 11R. No evidence of defects or cracking was identified in any of these MRPC examinations.

As stated above in response to question #1, at TMI-1 all support plate holes are broached except for 1626 holes in the peripheral holes of the 15th TSP where the holes have been drilled only (See Figure 1).

3. NRC Question:

Expansion transition examinations

a. Discuss the extent of the kinetic expansions at TMI-1 (e.g., 1000 tubes expanded 10", 2000 tubes expanded 15", remaining tubes have 1" roll expansion, etc.). Provide the number of tubes currently in service that were rerolled after the furnace stress relief.

GPU Nuclear Response:

TMI-1 currently has either 17" or 22" nominal length UTS kinetic expansions on all tubes in service. OTSG "A" has 14,021 17" expansions and 241 22" UTS expansions in service. OTSG "B" has 14,903 17" and 250 22" UTS expansions in service.

TMI-1's LTSs were not damaged in 1981 and retain the original design 1" roll expansions near the primary face of the LTS (i.e., no kinetic expansions were done in LTSs).

According to shop manufacturing records, the number of tubes presently in service that were re-expanded at the tubesheet after full bundle stress relief are as follows (although the records are not clear on the exact location for some of these tubes):

	OTSG "A"	OTSG "B"
UTS	0	0
LTS	11	0

During the 11R Outage all in service locations where rerolls could be identified from shop records were examined using MRPC and bobbin coil profile techniques. One shop reroll was positively confirmed and no indications of cracking were identified in any of these examinations.

b. Clarify the inspections performed during the last outage at the expansion transition region. Address the probe used and the number of tubes inspected.

GPU Nuclear Response:

During the TMI-1 Cycle 10 Refueling (10R) Outage, 217 lane/wedge tubes in each OTSG were examined with the 8x1 pancake coil technique. This examination included the 15th TSP, UTS secondary face and kinetic expansion transition. During the most recent outage (11R), 589 tubes were examined with a 3-coil MRPC technique.

c. The TMI-1 response indicates that the kinetic expansion transitions for un-sleeved tubes in the lane region will be inspected (approximately 280 tubes per Once-Through Steam Generator (OTSG)). However, the report indicates that all OTSG plants have completed sleeving tubes in their defined lane/wedge region.

1) Please clarify if all tubes in the lane/wedge region have been sleeved at TMI-1.

GPU Nuclear Response:

Tubes along the inspection lane, including an area that fans out at the periphery, are referred to as the lane/wedge region. TMI-1 Tech Spec §4.19.2.a.4(1) defines a group of tubes in the lane/wedge region as "Group A-1," which, along with another group of tubes, may be excluded from the first random sample if all tubes in that group in both steam generators are inspected. Group A-1 is sometimes referred to as the "Tech Spec defined lane/wedge." Un-sleeved tubes in the TMI-1 Tech Spec defined lane/wedge areas of OTSG "A" and "B" are shown in red on Figures 2A and 2B respectively.

The "TMI-1 defined repair lane/wedge" is a region where engineering analysis and OTSG history review has determined that high cycle fatigue cracking is most likely to occur. All in service tubes in the "TMI-1 defined repair lane/wedge" have been sleeved. These tubes are shown in green on Figures 2A and 2B respectively.

2) Please describe the basis for limiting the inspection to the lane region.

GPU Nuclear Response:

Figures 3A and 3B show the 589 tubes where 3-coil MRPC examination of the kinetic expansion was performed during 11R. These tubes were chosen because they should be the first to exhibit high cycle fatigue cracking based on highest main steam cross flows and proximity to the previous historical OTSG high cycle fatigue failure locations.

3) Please discuss the expansion criteria to be used if indications are detected at the kinetic expansions.

GPU Nuclear Response:

During previous outages no crack indications were detected at the examined kinetic expansions and thus no increases in examination scope were necessary. If eddy current indications are recorded at expansion transitions in future outages, GPU Nuclear would perform an engineering evaluation. Tubes to be examined in an expanded inspection scope (up to an additional 20%) would be selected under that engineering evaluation. The engineering evaluation would consider the plant's Tech Specs and various aspects including location of the eddy current indication within the tube, tube operating and repair history, tube location within the tube bundle, and the results of supplemental inspections such as those from video, penetrant, and other eddy current inspections.

d. Clarify what is meant by no "confirmed" service-induced tube cracks have been found in the TMI-1 kinetic expansions. It is stated that leak tests since 1985 have consistently found that there were no leaking kinetic expansion transitions. Describe how these tests are performed (e.g., test pressure, how leakage is monitored, etc.).

GPU Nuclear Response:

Review of examinations since plant restart reveal that tube B-98-84 is the only tube removed from service for indications in the kinetic expansion transition. This non-leaking tube had a two coil 8x1 indication identified during the TMI-1 Cycle 5 Maintenance (5M) Outage which was the first examination performed after kinetic expansion repairs and plant restart following the TMI-2 accident. The expansion indication was unlikely to have been service induced because of its short period of service (less than six months service following expansion) and was most likely due to the sulfur intrusion which occurred during the TMI-1 extended shutdown (and likely due to grain dropout following kinetic expansion repairs).

GPUN has frequently performed leak tests of the kinetic expansions by bubble test. In this test the secondary (shell) side water level is lowered to a level below the UTS and a nitrogen pressure of approximately 150 psig is applied to the secondary side. The primary (tube) side water level is set to cover the UTS to approximately 2" to 4" above the primary face. The primary tubesheet is then observed from the upper primary side to note any nitrogen bubbles. The location of any bubbles identifies which, if any, tubes are leaking near the kinetic expansion.

e. Provide the criteria to be used for determining whether expansion of the inspections for expansion transition indications is necessary.

GPU Nuclear Response:

See response to previous question 3, subpart c.3.

4. NRC Question:

Lane/Wedge Region

a. Clarify the inspection scope in the lane/wedge region during the last steam generator tube inspections (including the probe type and number (and/or percentage) of tubes inspected).

GPU Nuclear Response:

Figures 3A and 3B show the lane/wedge tubes which were examined with the 3-coil MRPC technique during 11R. The 3-coil head contained 0.115" pancake, axial and circumferentially wound coils.

b. Provide the criteria to be used for determining whether the expanded inspection scope around any identified indications adjacent to the sleeved lane/wedge region is bounded.

GPU Nuclear Response:

During 11R no cracks (or other defects) were detected in these tubes. If cracks were detected in this region the sample would have been expanded to bound the degraded region. Selection of the specific additional tubes to be inspected would be based on an engineering evaluation of the location of the degraded tube and the thermal/hydraulic conditions believed to be responsible for the fatigue failures. For example, detection of cracking in a tube near the periphery in the wedge region would be addressed by expanding the inspection in the wedge region on both sides of the lane. Detection of a crack along the lane further toward the center of the bundle would be addressed by extending the inspection toward the bundle center, and/or inspecting an additional row on either side of the lane.

5. NRC Question:

Recently, several tubes have been pulled from B&W once through steam generators (OTSGs). Discuss any analyses performed on these pulled tubes for monitoring the development of circumferential cracking. For example, discuss the destructive and non-destructive examinations performed on these pulled tubes in the laboratory at the expansion transition area.

GPU Nuclear Response:

During the late 1970's and early 1980's, tubes were pulled from Oconee plants to investigate the cause for tube leaks observed at locations near the un-tubed lane. Laboratory results from these pulls confirmed that the leaks were due to circumferential cracks caused by corrosion assisted high-cycle fatigue, due to the unique secondary side flow characteristics existing in this part of the steam generator. These failures have been addressed by sleeving the susceptible area, as discussed in BWOG generic response to GL 95-03.

Portions of three tubes were pulled from TMI-1's "A" OTSG in 1986. However, the kinetic expansion area was not of interest for the post removal metallurgical evaluations. These tubes were pulled to follow up on the sulfur-induced ID cracking mentioned above.

Recent tube pulls from Crystal River-3 (1992 and 1994) and Oconee-3 (1994) have been performed to determine the cause of eddy current indications that were observed in areas of the steam generator where the damage mechanisms are not well understood. These included both freespan indications and TSP indications, primarily in the boiling region of the OTSG. The tubesheet expansion region was not an area of interest due to the lack of observed degradation in this area, and was drilled out during the removal process to ease the removal of the rest of the tube. The tubesheet expansion area was therefore not available for laboratory examination.

6. NRC Question:

Clarify whether the inspection method to be used at TMI-1 is qualified for the detection of circumferential cracks per Appendix H of EPRI report NP-6201 or whether a site specific qualification program will be used. If using site specific qualification procedures, state the differences and provide the justification for these criteria including a discussion of pulled tube data to support the detectability of circumferential cracks in the field.

GPU Nuclear Response:

The MRPC (0.115 inch diameter pancake) probe utilized at TMI-1 is qualified per Appendix H of the EPRI guidelines for detection of circumferential cracks.

7. NRC Question:

a. Discuss the number and types of sleeves used at TMI-1 along with their installation dates (i.e., month/year).

GPU Nuclear Response:

TMI-1 currently has installed 502 B&W Mechanical Rolled Sleeves, 80" in length. All sleeves are manufactured of Inconel 690 material. 250 sleeves were installed during September of 1991 and the remaining sleeves were installed during September of 1993. One sleeved tube was removed from service during the 11R outage for a parent tube indication unrelated to the sleeve, that is, an indication below the sleeve in a tube with previous ISI history of an indication.

b. Discuss the inspections performed on the sleeved portions of these tubes during the last outage.

GPU Nuclear Response:

All the sleeves were examined with a combination stationary crosswound and bobbin coil probe during September 1993. No degradation was recorded at that time. During the 11R Outage the unexpanded portion of the sleeve in 232 tubes was examined with a 0.400" bobbin coil probe. The lower sleeve end and all roll expansions in 251 tubes were examined with a motorized rotating plus point coil. No degradation or cracking in the sleeve or parent tube (in the installed sleeve area) was recorded during the 11R Outage examinations.

ATTACHMENT 2
C311-95-2451

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY
PENNSYLVANIA ELECTRIC COMPANY
GENERAL PUBLIC UTILITIES NUCLEAR CORPORATION

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289

Additional Information in Response to NRC Generic Letter 95-03

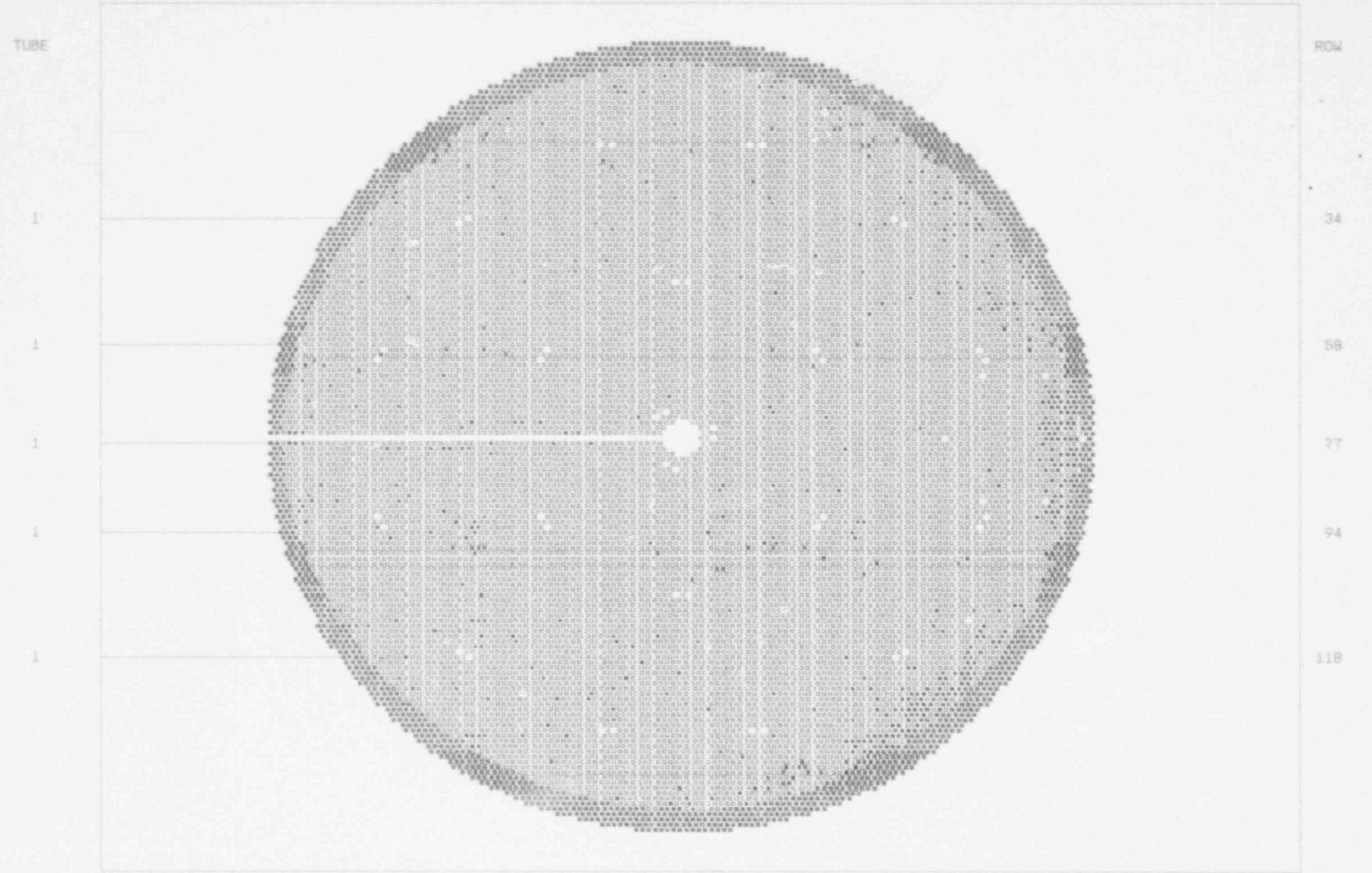
This letter is submitted in response to the NRC request for additional information regarding Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes." All statements contained in this response have been reviewed, and all such statements made and matter set forth therein are true and correct to the best of my knowledge.

J. Knubel
Vice President and Director, TMI

Signed and sworn before me this

30th day of October, 1995.

Notary Public



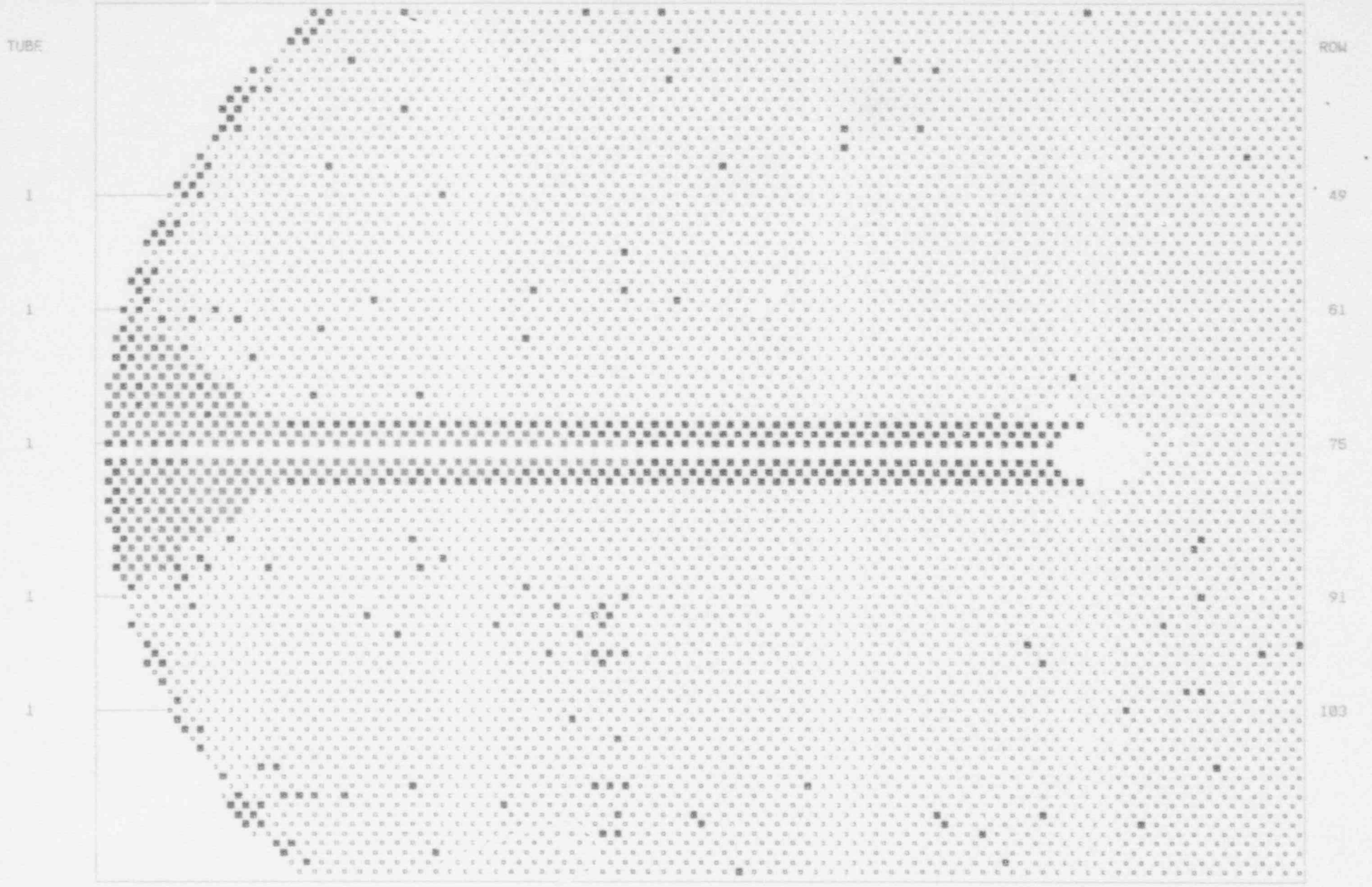
1826: locations where 15th tsp is drilled

GPU NUCLEAR CORP, TMI - UNIT 1
ONCE THROUGH STEAM GENERATOR: A
10/23/95

FIGURE 1

1269 Plugged Tubes

ACRI ISIS Tubes



218: unsleeved inspection lane/wedge

248: sleeved tubes inservice

220: currently plugged tubes

GPU NUCLEAR CORP. TMI - UNIT 1

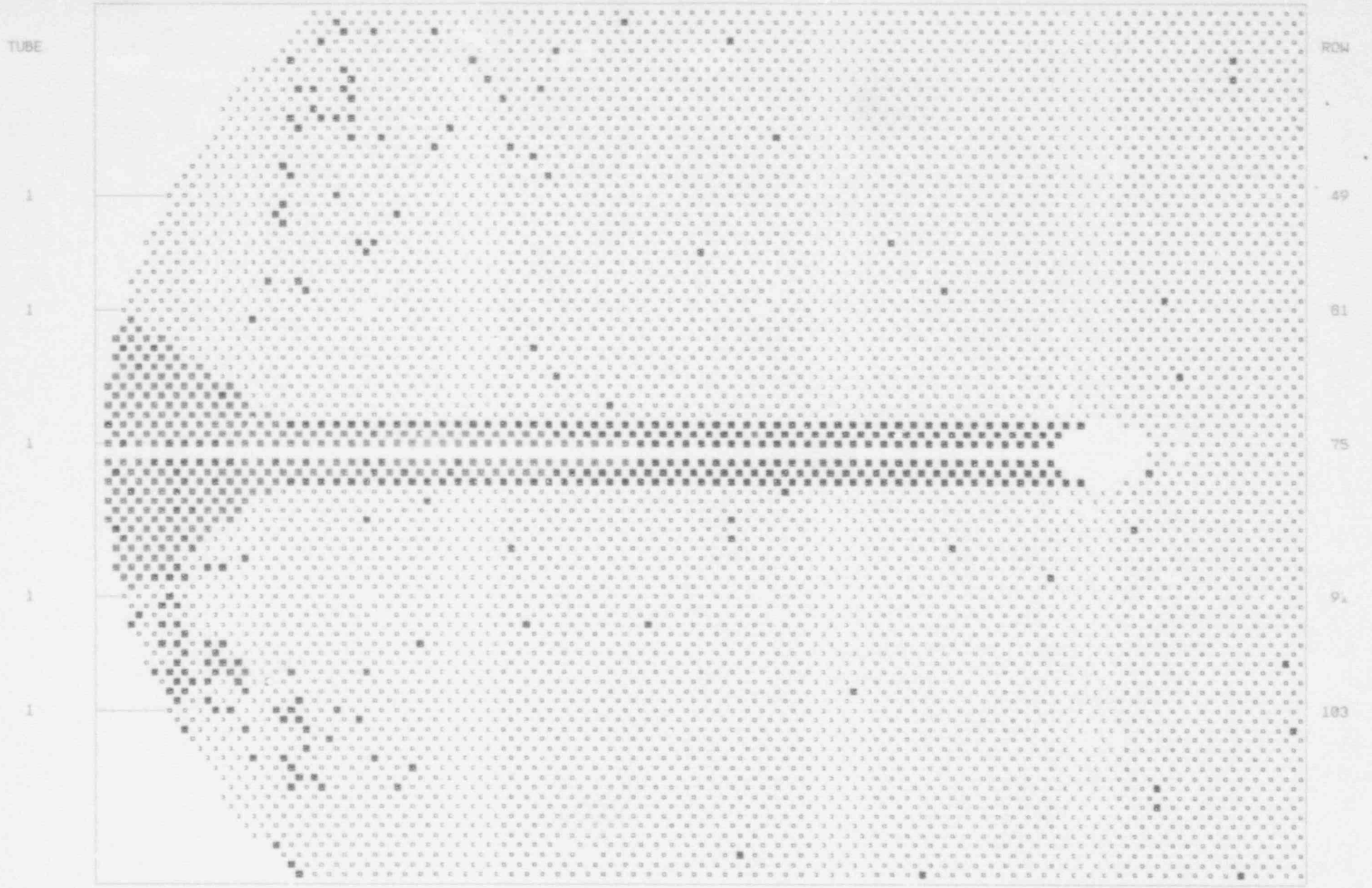
ONCE THROUGH STEAM GENERATOR: A

10/17/95

FIGURE 2A

220 Plugged Tubes

ACRI ISIS Tubes



217: unsleeved inspection lane/wedge tubes

253: sleeved tubes in service

197: currently plugged tubes

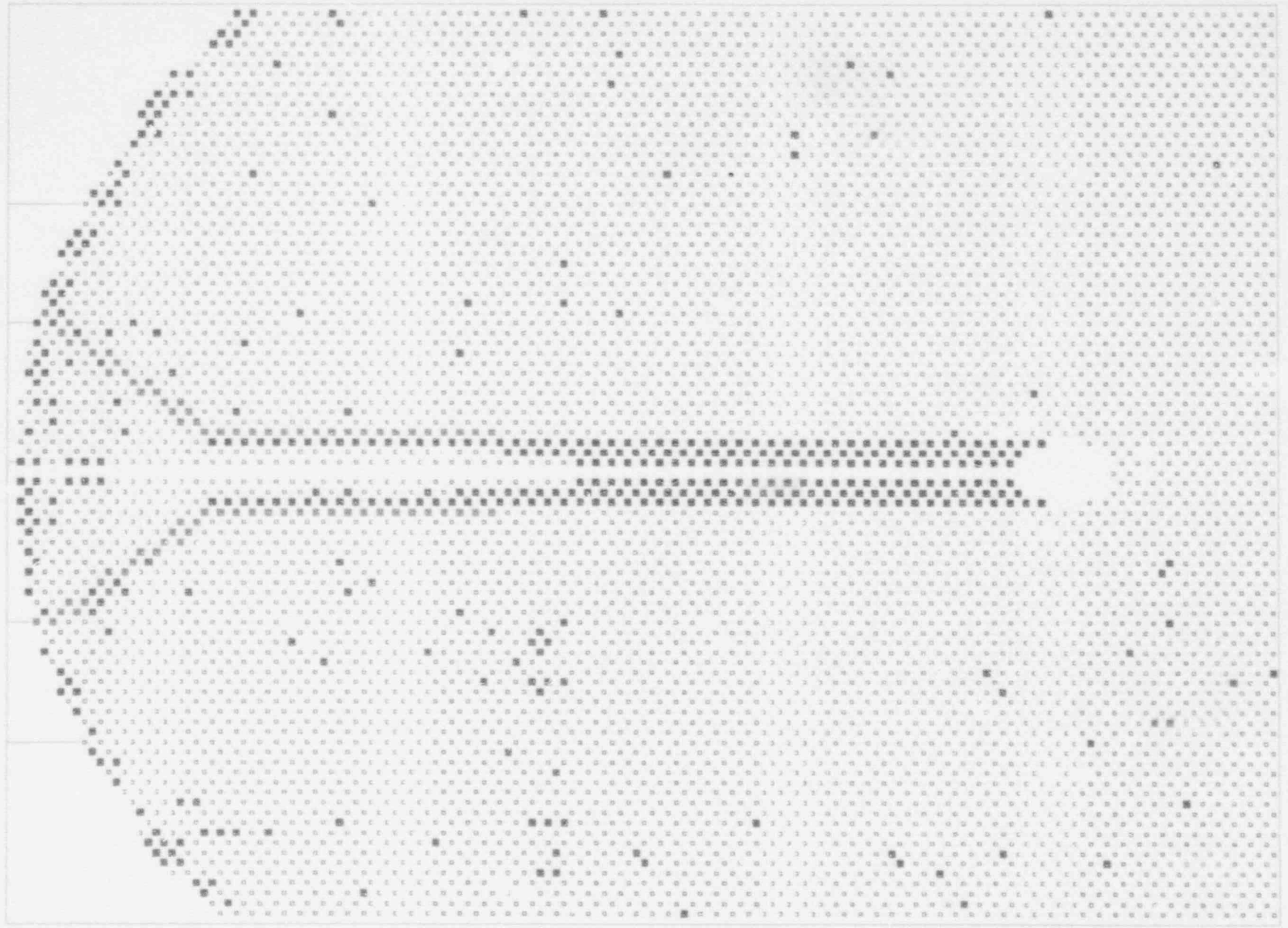
GPU NUCLEAR CORP. TMI - UNIT 1

ONCE THROUGH STEAM GENERATOR: B

10/17/95

ACRI ISIS Tubes

FIGURE 2B



216: lane/wedge tubes examined with mrpc

77: sleeve border tubes examined with mrpc

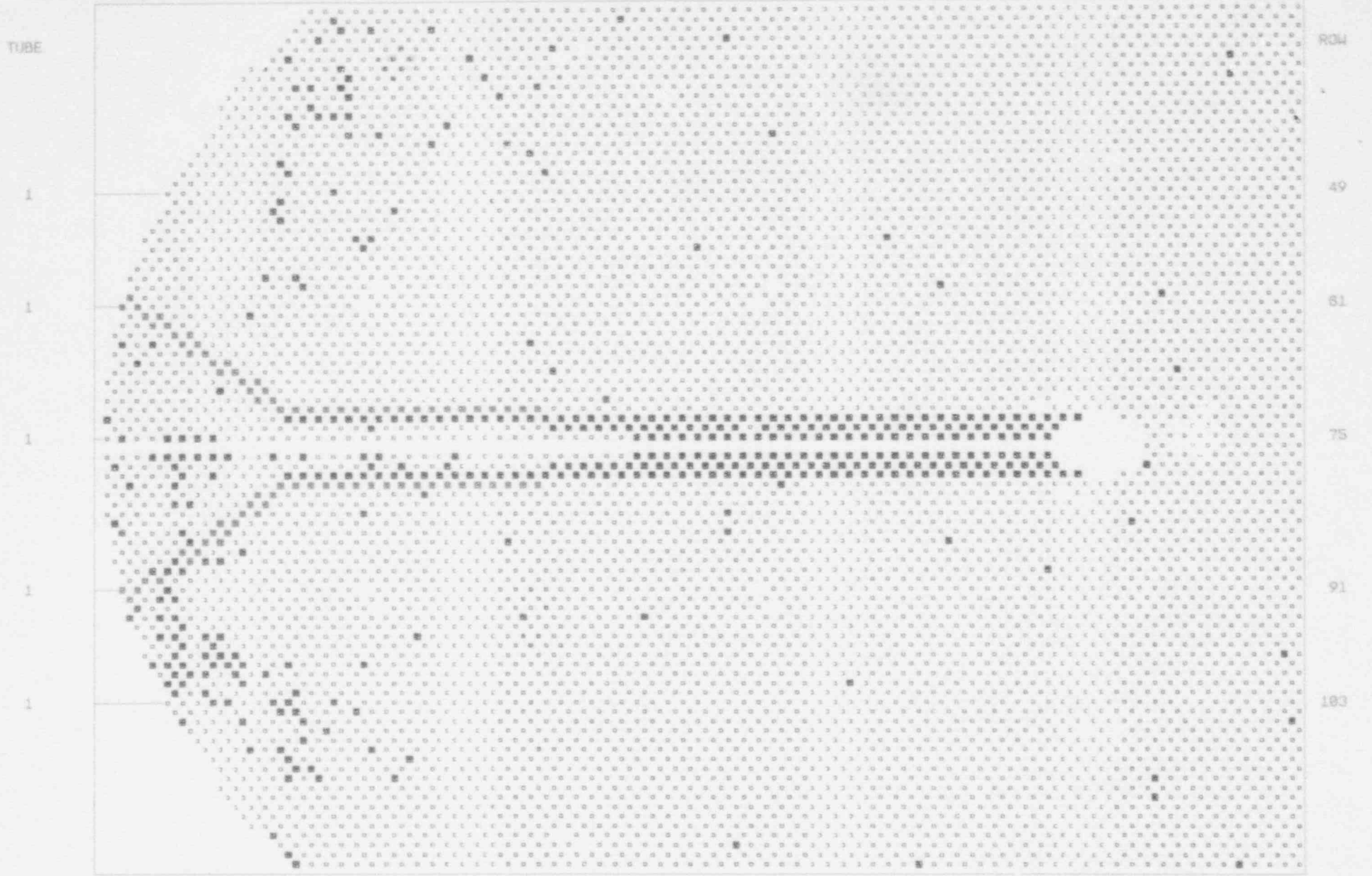
220: currently plugged tubes

GPU NUCLEAR CORP. TMI - UNIT 1
ONCE THROUGH STEAM GENERATOR: A
10/17/95

FIGURE 3A

220 Plugged Tubes

ACRI ISIS Tubes



217: lane/wedge tubes examined with mrpc

79: sleeve border tubes examined with mrpc

197: currently plugged tubes

FIGURE 3B

GPU NUCLEAR CORP. TMI - UNIT 1
ONCE THROUGH STEAM GENERATOR: B
10/17/95

ACRI ISIS Tubes