Station Support Department

GL 94-03

PECO NUCLEAR
A UNIT OF PECO ENERGY

PECO Energy Company
Nuclear Group Headquarters
965 Chesterbrook Boulevard
Wayne, PA 19087-5691

March 18, 1996

Docket No. 50-352

License No. NPF-39

Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: Limerick Generating Station, Unit 1
Supplemental Response to Generic Letter 94-03
Summary of Core Shroud Inspection Results

Dear Sir:

On August 24, 1994, PECO Energy Company responded to Generic Letter (GL) 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors," dated July 25, 1994. Your letter dated March 7, 1995 provided a Safety Evaluation for Limerick Generating Station (LGS), Unit 1 concerning GL 94-03 and a reminder that, in accordance with Reporting Requirement 2 of the GL, an inspection plan of the core shroud be submitted to the U. S. Nuclear Regulatory Commission (USNRC) no later than 3 months prior to performing the inspections. In response to Reporting Requirement 2, the inspection plan was provided in our letter dated October 27, 1995. Additionally, Reporting Requirement 3 requested that a final summary report of the inspections be submitted within 30 days of the completion of the core shroud inspections. In response to Reporting Requirement 3, attached is the summary report.

In summary, the overall results of the inspection revealed no indications on welds H-4, H-5 and H-7, and revealed five short-length, shallow indications on weld H-3. The results of the inspections and evaluations conclude that the condition of the LGS, Unit 1 shroud, projected through a minimum of the next two operating cycles, will support the required safety margins specified in the ASME Code and reinforced by the Boiling Water Reactor Vessel and Internals Project (BWRVIP) recommendations.

If you have any questions, please contact us.

Very truly yours,

G. A. Hunger, Jr.

G. A. Hunger, Jr.
Director - Licensing

cc: T. T. Martin, Administrator, Region I, USNRC
N. S. Perry, USNRC Senior Resident Inspector, LGS

COMMONWEALTH OF PENNSYLVANIA :

: ss.

COUNTY OF CHESTER :

W. G. MacFarland, being first duly sworn, deposes and says:

That he is Vice President of PECO Energy Company; that he has read the enclosed additional response to Generic Letter 94-03, dated July 25, 1994, for the Limerick Operating License NPF-39, and knows the contents thereof; and that the statements and matters set forth therein are true and correct to the best of his knowledge, information and belief.

Walter G MacFarland

Vice President

Subscribed and sworn to
before me this 18th day
of March 1996

Mary Lou Skrocki

Notary Public

Notarial Seal
Mary Lou Skrocki, Notary Public
Tredyffrin Twp., Chester County
My Commission Expires May 17, 1998

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In February 1996, during the sixth refueling outage (1R06) of Limerick Generating Station (LGS), Unit 1, portions of the core shroud structure were inspected. These inspections were conducted to determine the condition of specific shroud welds, considered to be most susceptible to the potential for existence of Intergranular Stress Corrosion Cracking (IGSCC), based on industry experience. This effort is discussed in the PECO Energy response to NRC Generic Letter 94-03, dated August 24, 1994, the Safety Evaluation contained in NRC letter dated March 7, 1995, and the LGS, Unit 1 core shroud inspection plan, forwarded to the NRC in our letter dated October 27, 1995. The inspections were conducted in accordance with the guidance provided by the Boiling Water Reactor Vessel and Internals Project (BWRVIP), as presented in the "BWR Core Shroud Inspection and Flaw Evaluation Guidelines", GENE-523-113-0894, Rev. 1, dated March, 1995 (Reference 1).

The following describes the overall inspection effort and summarizes the results of this effort.

BACKGROUND:

The LGS, Unit 1 shroud was fabricated by Sun Shipbuilding and Drydock Co., Chester Pa. The product forms used for this fabrication included 2" thick SA240, Type 304L stainless steel plate (for shroud cylinders), and varying thicknesses of SA240, Type 304L stainless steel plate for the rings. Attachment 1 includes a drawing which depicts the shroud configuration, weld locations, and materials of fabrication. The plate materials have a low carbon content (.018% to .026%). The product forms where joined using the submerged arc welding process. The weld filler metal was SA371 Type ER308L. Welds H-1 through H-6 were welded from both surfaces, using a double bevel weld prep. Weld H-7 was welded from the inside surface of the shroud using a single bevel weld prep and a backing ring. The H-7 weld was made at the LGS site, and it connected the prefabricated shroud structure to the Reactor Pressure Vessel. This weld is a dissimilar metal weld (304 stainless to Alloy 600). The filler metal for this weld was ASME III, SFA 5.14, Class ERNiCr-3 (Alloy 82) for the root, and ASME III, SFA 5.11, Class ENiCrFe-3 (Alloy 182) for the remainder of the weld. The processes used for this joint was the Gas Tungsten Arc Welding and Shielded Metal Arc Welding.

The LGS, Unit 1 shroud has been in service since February 1, 1986. During this first decade of operation, LGS, Unit 1 operated with relatively low, primary-water conductivity. Unit 1's mean conductivity has been maintained well below the EPRI recommended value of .20 μS/cm for a majority of this time period. The effects of early water chemistry history on the susceptibility of the shroud welds to IGSCC are addressed in Reference 1.

The above described factors place the LGS, Unit 1 shroud into Inspection Category B, as defined by Reference 1. This category has a lower potential for shroud cracking. Therefore, limited inspections of welds H-3, H-4, H-5 and H-7 are recommended.

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INSPECTIONS:

The scope of the LGS, Unit 1 core shroud inspections included all of the Category B circumferential welds (e.g. H-3, H-4, H-5 and H-7). The method used for inspection of these circumferential welds was Ultrasonic Testing (UT), performed from the outside surface of the shroud, using the General Electric Nuclear Energy (GENE) SMART 2000 data acquisition system and the GENE OD Tracker. This shroud inspection equipment was satisfactorily demonstrated at the EPRI NDE Center. The extent of the planned inspections included all portions of the circumferential welds which were accessible for the above described equipment. This scope and extent of planned inspections was identified in our second response to Generic Letter 94-03, dated October 27, 1995.

The UT scanning was accomplished using three transducers. These transducers included 45° shear wave, 60° longitudinal wave, and creeping wave units. The transducers scanned each Heat Affected Zone (HAZ) of the accessible lengths of each weld. The creeping wave transducer was used to enable better near-surface detection capabilities.

The purpose of the shroud inspections was to assess the condition of the shroud circumferential welds so that the integrity of the shroud structure could be quantitatively demonstrated. Additionally, the inspection results will be used to establish a baseline of this condition for comparison to future inspection results. This baseline data will also be used to develop schedules for future shroud inspections, evaluations, or repairs.

The original 1R06 scan plan included use of both the OD Tracker and the Suction Cup (Area) Scanners. This combination of UT delivery equipment was developed to maximize the weld scanning lengths, due to severe access restrictions inherent in the LGS, Unit 1 type vessel. These access restrictions are caused primarily by the four (4) Low Pressure Coolant Injection (LPCI) nozzle/couplings which pass radially through the vessel annulus, between the vessel wall and the shroud, just above the H-2 shroud weld. These nozzle/couplings not only interfere with circumferential scanning of all shroud welds below the H-1 weld, but also impact the access space needed for insertion of the Tracker tool into the vessel annulus. The LPCI nozzle/couplings are located at azimuth 45°, 135°, 225°, and 315°. Figure 1 provides a plan view of the LGS, Unit 1 vessel and shroud, and provides a breakdown of the shroud circumference into scanning zones, which were established to plan the implementation of the inspections; six zones identified are paired into 3 groups of corresponding access conditions. Zones 1 and 4 have essentially the same access restrictions. Likewise, zones 2 and 5 have the same access restrictions, as do zones 3 and 6. Zones 2 and 5 have the least restriction to insertion and scanning with the OD Tracker. These zones are representative of accessibility found during past industry shroud inspection experiences. Zones 3 and 6 do not provide access for insertion of the OD Tracker, due to interferences with the shroud lifting lugs, jet pumps and core spray downcomer piping. Zones 1 and 4 also have restricted clearances for insertion of the OD Tracker due to the Core Spray downcomer piping and the jet pumps. These zones (i.e. 1, 3, 4, and 6) were originally planned to be inspected using the Suction Cup Scanner. Use of the OD Tracker delivery device in these zones was not recommended by General Electric, due to the potential for damage to the inspection tool during the insertion and set-up process.

During implementation of the original scan plan, substantial problems were encountered with the use of the Suction Cup scanner. Several attempts to set the equipment on, and inspect both the H-3 and H-7 welds failed, without yielding any inspection data. Attempts at inspecting the H-4 and H-5 weld provided inspection data; however, the quality of the data was called into question, given the results of the attempted scans on weld H-3 and H-7. At this point, the decision was made to transition from the original scan plan to a modified plan. This modified plan included use of only the OD Tracker for the complete shroud inspection program. The modified scan plan included attempts at additional use of the tool in zones 1 and 4. Factors which contributed to the attempts in these zones included amount of inspection coverage in the other scan zones and the availability, on site, of replacement parts for the numerous parts of the tool which were subject to damage. Scanning in zones 1 and 4 was successful; however, several incidence of equipment damage did occur. Nevertheless, essentially 100% of the accessible length of the shroud welds was inspected in these zones.

The extent of shroud weld inspections performed during 1R06 include:

54.8% of the length of weld H-3,	356.45"
56.2% of the length of weld H-4,	365.74"
56.2% of the length of weld H-5,	365.74"
54.7% of the length of weld H-7,	344.91"
Subtotal	1432.84"
x 2 (HAZ per weld)	
Total	2,865.68"

The extent of these weld inspections is graphically depicted on the attached weld maps for welds H-3, H-4, H-5 and H-7 (Attachment 2).

RESULTS:

A sufficient length of each circumferential weld was inspected to demonstrate quantifiably the condition and, therefore, the structural integrity of these welds.

Some short indications were found on weld H-3. No indications were found on welds H-4, H-5, and H-7. The general location of the indications are depicted on the attached weld maps (Attachment 2). Shroud Weld Indication Data Sheets provide details of the as-found indications, and are included as Appendix 1 of Attachment 3.

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EVALUATIONS:

All as-found surface connected indications were conservatively assumed to be through wall cracks. Therefore, depth sizing of the indications was not utilized in the evaluations. Additionally, the weld lengths which were not inspected, due to inaccessibility, were assumed to have through wall cracks.

Inspection results were then utilized to perform a detailed evaluation for all inspected welds, to determine the margin of safety for each weld (see Tables 2-2 through 2-4 in Attachment 3).

The detailed evaluations were performed by GE Nuclear Energy. These evaluations used the guidance provided in the evaluation portion of Reference 1. The as-found indication lengths were adjusted for upper bound crack growth, NDE uncertainty and proximity factors. The resultant indication lengths (as-evaluated indications) were then used to calculate the amount of safety margin remaining in the subject weld, using the limit load methodology. Additionally, for welds H-3 and H-4, the Linear Elastic Fracture Mechanics (LEFM) technique was used, due to the extent of neutron exposure received at these weld locations. The safety factors were calculated against the most limiting, design-basis-loading conditions, derived from the GE Nuclear Energy "Determination of Inspection Lengths" document (Reference 2) and the LGS, Unit 1 UFSAR. The loadings also considered power rerate conditions.

Safety Factors were calculated considering 1, 2 and 5 operating cycles of expected crack growth. The normal operating cycle was considered to be twenty four months. A more detailed discussion of the evaluations, including factors utilized for crack growth and NDE uncertainties, is contained in the GENE Evaluation Report GE-NE-B13-01805-16 (Attachment 3).

CONCLUSIONS:

A 10CFR50.59 determination and safety evaluation has been developed and reviewed by the Plant Operations Review Committee (PORC). The conclusion of this evaluation indicates that no unreviewed safety questions exist as a result of the shroud inspection findings.

The results of the inspections and evaluations conclude that the condition of the LGS, Unit 1 shroud, projected through at least the next two operating cycles, will support the required safety margins, specified in the ASME Code and reinforced by the BWRVIP recommendations. Additionally, the results of these UT inspections substantiate the Safety Analysis developed in response to Generic Letter 94-03.

The extent of the shroud inspections provides a comprehensive baseline for comparison to future inspections. PECO Energy will continue to follow the developments of the BWRVIP guidance documents, and will evaluate their applicability to LGS. Reinspection of the shroud welds will be determined following resolution of the BWRVIP reinspection recommendations.

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REFERENCES:

1. BWR Core Shroud Inspection and Flaw Evaluation Guidelines, GENE-523-113-0894, Rev. 1, March, 1995.
2. Determination of Inspection Lengths for the Limerick Unit-1 Shroud, GENE-523-A037-0495, July, 1995.
3. Evaluation of the Limerick Unit-1 Core Shroud Inspections (Refuel Outage 6), GE-NE-B13-01805-16, February 1996.
4. BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard, dated November 21, 1994.
5. NRC Safety Evaluation of Referenced Documents 1 and 4, dated June 16, 1995.
6. BWR-VIP Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03), October 1995.

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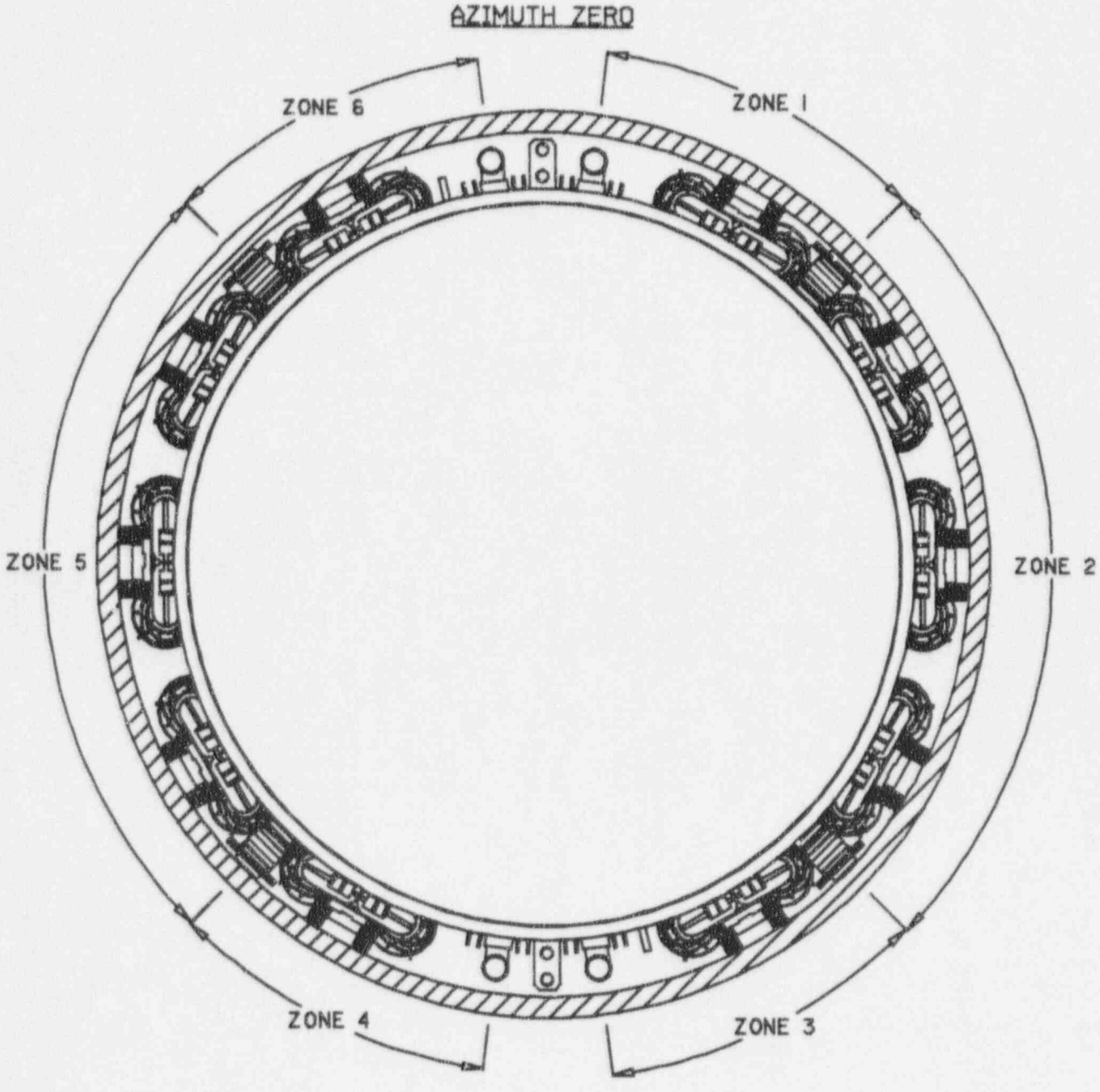
FIGURE 1



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ATTACHMENT 1

REACTOR PRESSURE VESSEL - SHROUD
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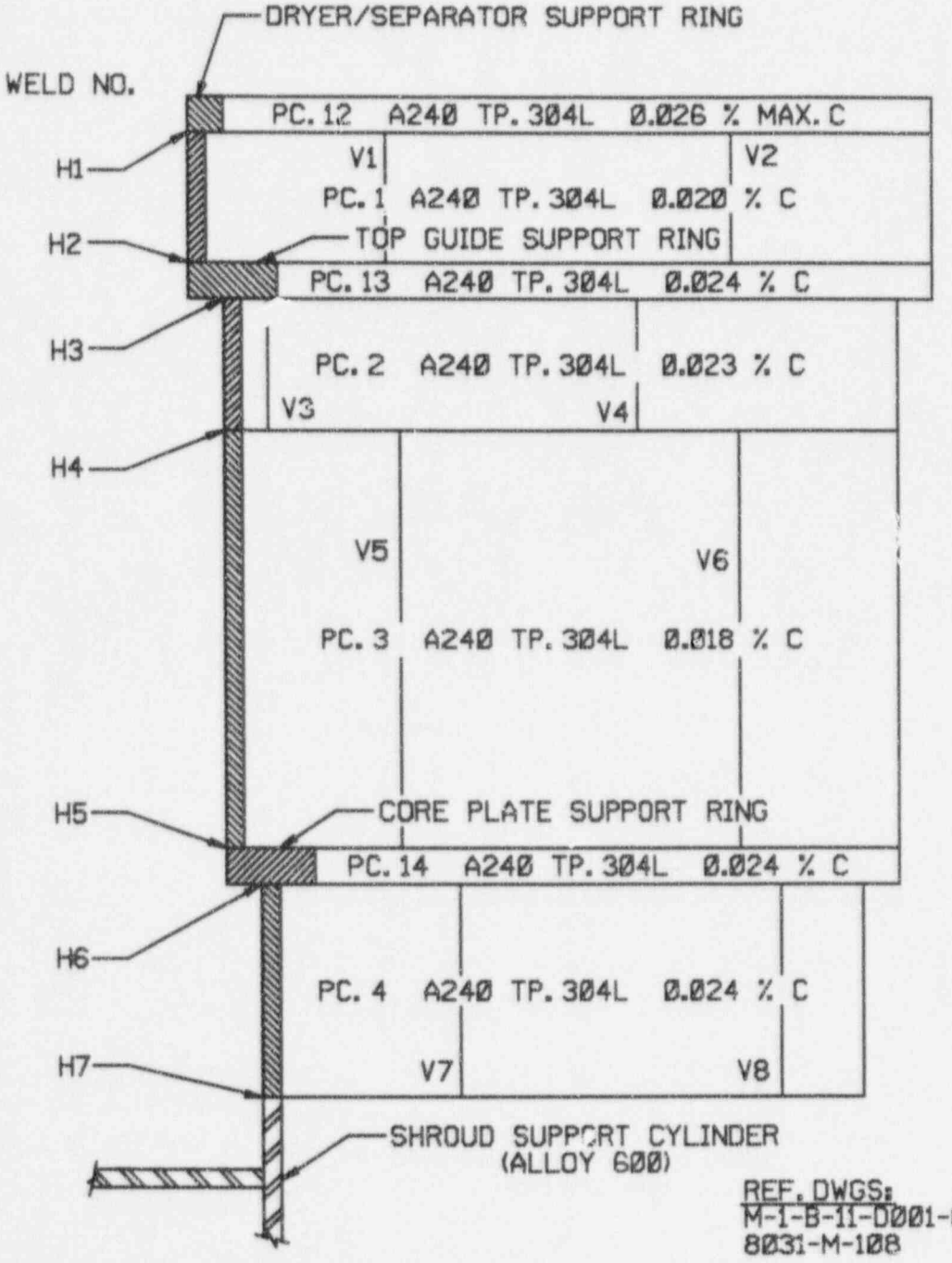

REF. DWGS:
M-1-B-11-D001-C-24-2
8031-M-108

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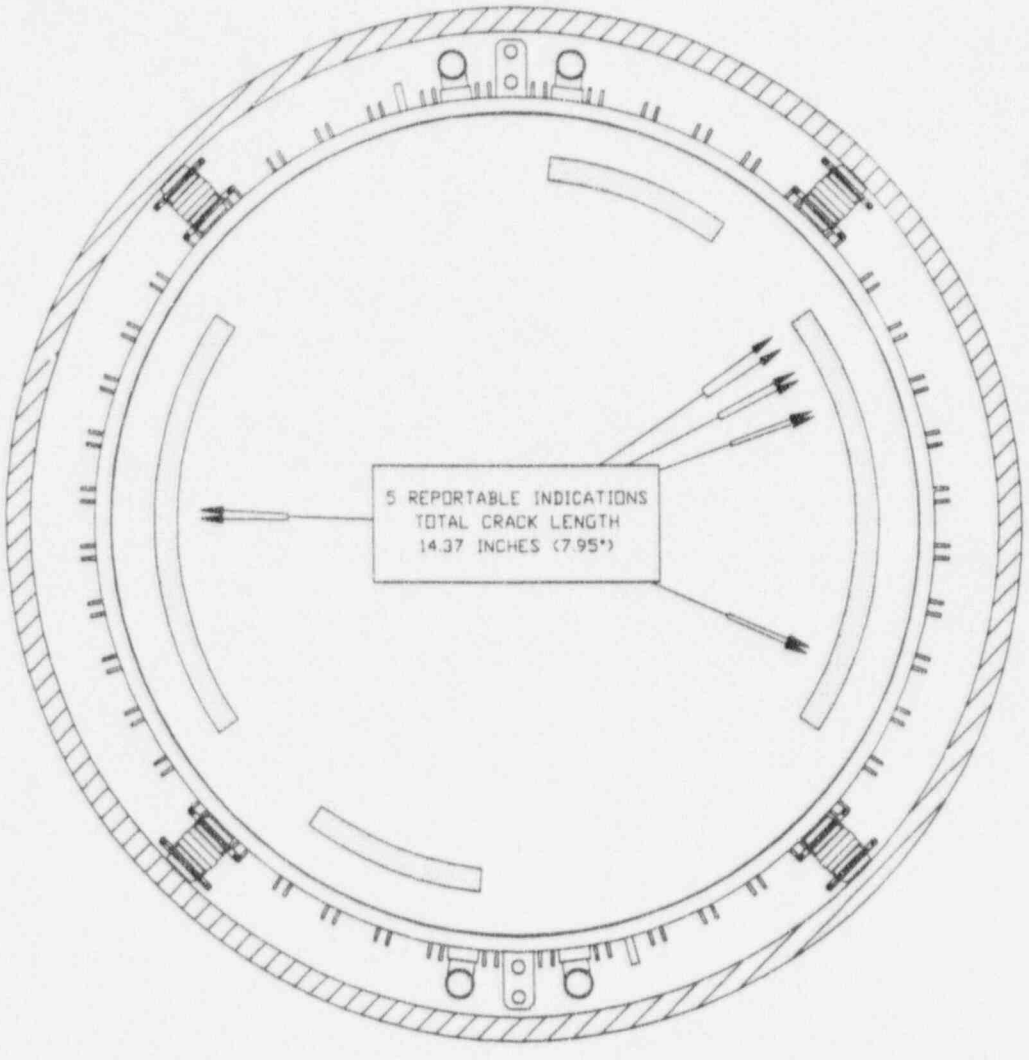
ATTACHMENT 2
(4 Pages)

LIMERICK-1 SHROUD UT INSPECTION

AZIMUTH ZERO (NORTH)



H3 EXAMINATION AREA

REVIEWED PECO Energy Co.
NDE SUPPORT GROUP FEB 20 '96

SKETCH RELEASE RECORD							
REV	DATE	PREPARED	REVIEWED	INIT.	APPROVED	INIT.	PURPOSE
0	10-06-95	D. OCAMPO	J. COLLINS		N. RAMSOUR		SHROUD INSPECTABILITY STUDY
1	2/19/96	J. COLLINS	S. TRAVES		M. KRUEGER		SHROUD H3 INSPECTION COVERAGE & INDICATIONS

SKETCH NO. LK1-001

TITLE SHROUD TOP VIEW

PROJECT LIMERICK, UNIT 1

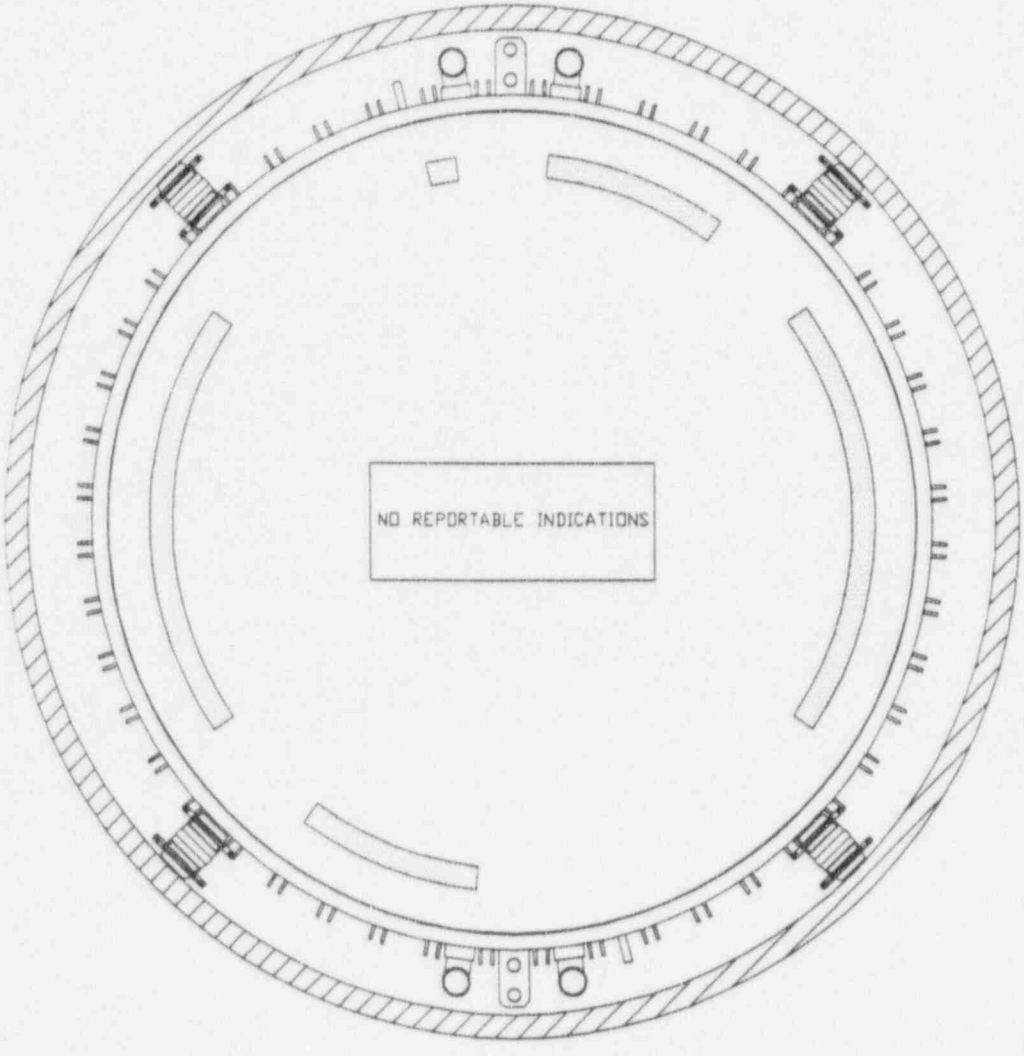
GE DWG NO 811-00677

NOTE: THIS SKETCH IS FOR ISI PROGRAM USE ONLY AND SHALL NOT BE USED FOR FABRICATION/INSTALLATION.

HSB 2/22/96
ANII

LIMERICK-1 SHROUD UT INSPECTION

AZIMUTH ZERO (NORTH)



H4 EXAMINATION AREA

REVIEWED PECO Energy Co.
NDE SUPPORT GROUP Thomas L. Anderson FEB 20 '96

SKETCH RELEASE RECORD							
REV	DATE	PREPARED	REVIEWED	INIT.	APPROVED	INIT.	PURPOSE
0	10-06-95	D. OCAMPO	J. COLLINS		N. RAMSOUR		SHROUD INSPECTABILITY STUDY
1	2/19/96	J. COLLINS	S. TRAVES		M. KRUEGER		SHROUD H4 INSPECTION COVERAGE & INDICATIONS

SKETCH NO: LK1-001

TITLE: SHROUD TOP VIEW

PROJECT: LIMERICK, UNIT 1

GE DWG NO: B11-00677

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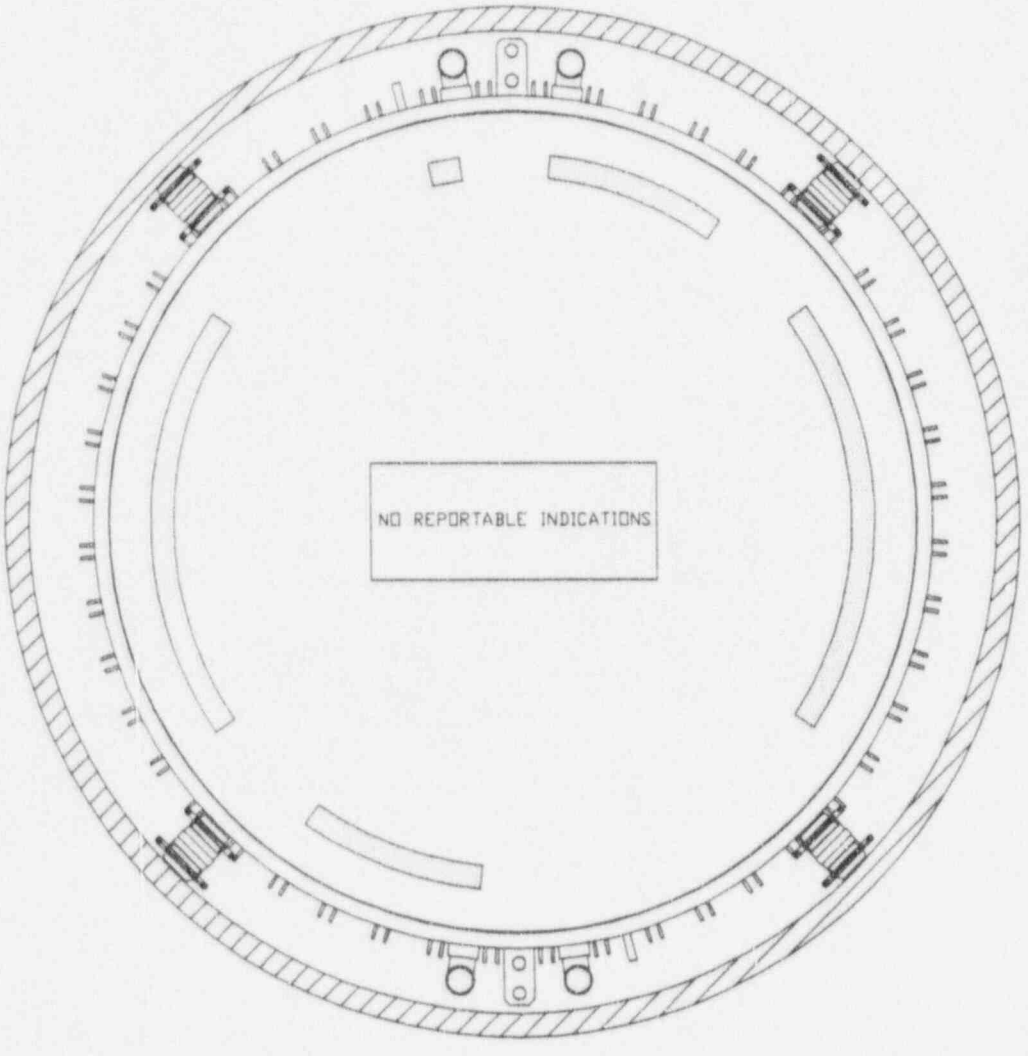
ANII

LIMERICK-1 SHROUD UT INSPECTION

AZIMUTH ZERO (NORTH)



H5 EXAMINATION AREA

REVIEWED PECO Energy Co. NDE SUPPORT GROUP Thomas L. Adams FEB 20 '96

SKETCH NO LK1-001

TITLE SHROUD TOP VIEW

PROJECT LIMERICK, UNIT 1

GE DRW NO B11-00677

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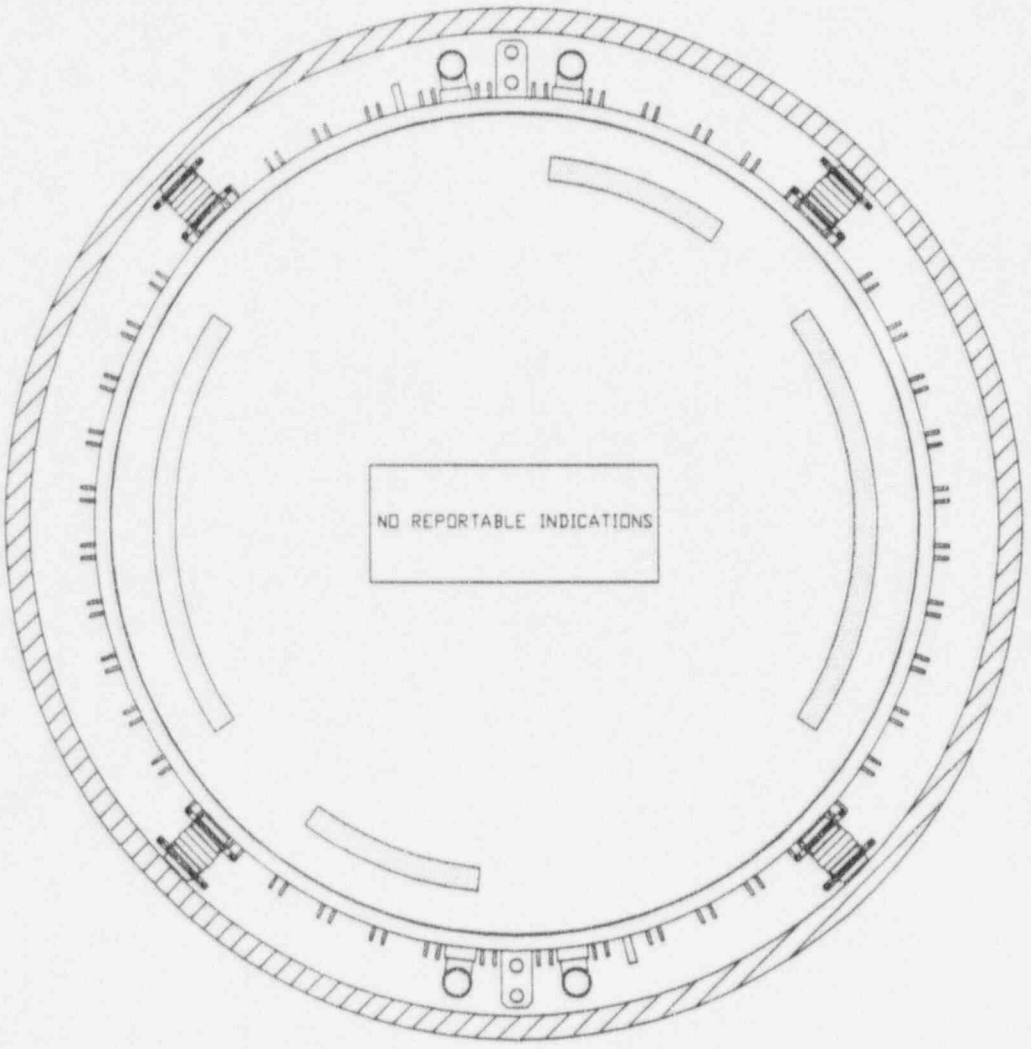
SKETCH RELEASE RECORD

REV	DATE	PREPARED	REVIEWED	INIT.	APPROVED	INIT.	PURPOSE
0	10-06-95	D. OCAMPO	J. COLLINS		N. RAMSOUR		SHROUD INSPECTABILITY STUDY
1	2/19/96	J. COLLINS	S. TRAVES		M. KRUEGER		SHROUD H5 INSPECTION COVERAGE & INDICATIONS

ASME ANII 2/22/96

LIMERICK-1 SHROUD UT INSPECTION

AZIMUTH ZERO (NORTH)



H7 EXAMINATION AREA

REVIEWED PECO Energy Co. NDE SUPPORT GROUP FEB 20 '96

SKETCH RELEASE RECORD							
REV	DATE	PREPARED	REVIEWED	INIT.	APPROVED	INIT.	PURPOSE
0	10-06-95	D. OCAMPO	J. COLLINS		N. RAMSOUR		SHROUD INSPECTABILITY STUDY
1	2/19/96	J. COLLINS	S. TRAVES		M. KRUEGER		SHROUD H7 INSPECTION COVERAGE & INDICATIONS

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GE DWG NO: B11-00677

PROJECT: LIMERICK, UNIT 1

TITLE: SHROUD TOP VIEW

SKETCH NO: LK1-001

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ATTACHMENT 3
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