PECO ENERGY

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

November 3, 1995

Docket No. 50-278
License No. DPR-56

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

Subject: Peach Bottom Atomic Power Station, Unit 3
Supplemental Response to Generic Letter 94-03
Summary of Core Shroud Inspection Results

Dear Sir:

In our letters from G. A. Hunger, Jr. (PECO Energy Company) to U. S. Nuclear Regulatory Commission (USNRC), dated August 24, 1994 and June 16, 1995, PECO Energy Company provided inspection plans for the Peach Bottom Atomic Power Station (PBAPS), Unit 3 core shroud. These plans were submitted in accordance with Reporting Requirements 1 and 2 of Generic Letter (GL) 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors." By letter dated October 25, 1995, the USNRC indicated that the proposed scope of inspections was acceptable. The purpose of this letter is to provide the final summary report, as requested by Reporting Requirement 3, of the GL.

In summary, the overall results of the inspection revealed a moderate amount of indications. Less than 12% of the examined weld length was found to contain flaws. The evaluation of the results was performed following the approach outlined in the "BWR Core Shroud Inspection and Flaw Evaluation Guidelines," GENE-523-113-8094, Revision 1, dated March 1995. This evaluation, based on the examination data, concludes that there is a substantial margin for each of these welds under conservative, bounding conditions to allow for continued operation of PBAPS, Unit 3.

If you have any questions, please contact us.

Very truly yours,

M. C. Kray for

G. A. Hunger, Jr.,
Director - Licensing

Attachment, Affidavit

cc: T. T. Martin, Administrator, Region I, USNRC
W. L. Schmidt, USNRC Senior Resident Inspector, PBAPS

A018
/1

COMMONWEALTH OF PENNSYLVANIA :

: ss.

COUNTY OF CHESTER :

D. B. Fetters, being first duly sworn, deposes and says:

That he is Vice President of PECO Energy Company; that he has read the enclosed supplemental response to Generic Letter 94-03, for Peach Bottom Facility Operating License DPR-56 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.

[signature]

Vice President

Subscribed and sworn to

before me this 3rd day

of November 1995.

[signature]

Notary Public

Notarial Seal
Wayne H. Shych, Notary Public
Tredyffrin Twp., Chester County
My Commission Expires May 13, 1996
Member, Pennsylvania Association of Notaries

ATTACHMENT

PECO ENERGY COMPANY
PEACH BOTTOM ATOMIC POWER STATION
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In September and October of 1995, during the tenth refueling outage of Peach Bottom Atomic Power Station (PBAPS), Unit 3, the core shroud structure was comprehensively inspected. These inspections were conducted to determine the condition of the shroud welds, relative to the potential for existence of Intergranular Stress Corrosion Cracking (IGSCC). The effort satisfied the commitments made for PBAPS, Unit 3, in the PECO Energy response to NRC Generic Letter 94-03, dated August 24, 1994, and as discussed in our PBAPS, Unit 3 core shroud inspection plan, forwarded to the NRC in our letter dated June 16, 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 PBAPS, Unit 3 shroud was fabricated by Rotterdam Drydock Co. LTD., Rotterdam, Holland. The product forms used for this fabrication included 2" thick ASTM A240, Type 304 stainless steel plate (for shroud cylinders), and ASTM A182, Grade F304 seamless, stainless steel rolled forgings (rings). The plate materials contain relatively high carbon contents (.059% to .062%), while the ring forgings contain lower carbon contents (.030% to .035%). The product forms where joined using the submerged arc welding process. The weld filler metal used was ASTM A371 Type Er308, with low carbon content. 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 PBAPS site, and it attached the prefabricated shroud structure to the Reactor Pressure Vessel. This weld is a dissimilar metal weld (304 stainless to Alloy 600). The filler metal used for this weld was ASTM B 304, Type ERNiCr-3 (Alloy 82). The process used for this joint was the Shielded Metal Arc Welding process. Attachment 1 includes a drawing which depicts the shroud configuration, weld locations, and materials of fabrication.

The PBAPS, Unit 3 shroud has been in service since December 1974. During the first decade of hot operation, PBAPS, Unit 3 operated with relatively high primary water conductivity. Unit 3's arithmetic mean conductivity exceeded 1.0 μS/cm during the first few years of operation. Subsequently, conductivity values were steadily decreased to below current EPRI guidelines. 1992 and 1993 values were actually less than 0.1 μS/cm. The effects of such early water chemistry history on the susceptibility of the shroud welds to IGSCC are addressed in Reference 1.

The above described factors place the PBAPS, Unit 3 shroud into Inspection Category C, as defined by Reference 1. This category has a high potential for some amount of shroud cracking, and, therefore, comprehensive inspections of welds H-1 through H-7 are recommended.

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INSPECTIONS:

The scope of the core shroud inspections included all of the shroud circumferential welds (e.g. H-1 through 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 PECO Energy's second response to Generic Letter 94-03, dated June 16, 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 and subsequent inspection results will also be used to develop schedules for future shroud inspections, evaluations, or repairs.

The extent of shroud weld inspections performed during 3R10 include:

84.5% of the length of Weld H-1,		584"
84.5% of the length of Weld H-2,		584"
89.5% of the length of Weld H-3,		582"
89.2% of the length of Weld H-4,		580"
90.8% of the length of Weld H-5,		591"
80.1% of the length of Weld H-6,		506"
89.6% of the length of Weld H-7.		566"
	Subtotal	3993"
	x 2 (HAZ per weld)	
	Total	7986"

The extent of these weld inspections is graphically depicted on the attached weld maps for welds H-1 through H-7, (Attachment 2).

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RESULTS:

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

Some indications were found on welds H-1, H-3, H-4, and H-5. No indications were found on welds H-2, H-6, 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.

EVALUATIONS:

All as-found indications were assumed to be through wall. Therefore, depth sizing of the indications was not utilized. Additionally, the weld lengths which were not inspected, due to inaccessibility, were also assumed to be through wall indications.

Inspection results were initially compared against a screening criteria, which had been developed prior to the inspections. Application of this very conservative screening criteria allowed for a rapid assessment of the acceptability of each weld, based on initial examination data. The screening was applied for both the Limit Load and Linear Elastic Fracture Mechanics Methodology. If the results of this screening indicated that sufficient unflawed material existed, the weld was considered acceptable. Ultimately, a detailed evaluation was performed for all welds, to determine the margin of safety for each weld (see Tables 2-3 through 2-6 in Attachment 3).

The detailed evaluations were performed by General Electric 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 (0.4" plus 0.5° each end), 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 General Electric Nuclear Energy Screening Criteria Document (Reference 2) and the PBAPS, Unit 3 UFSAR. The loadings also considered Power Rerate conditions and updated seismic loadings.

A more detailed discussion of the evaluations, including factors utilized for crack growth and NDE uncertainties, is contained in the GENE Evaluation Report GENE-523-A104-0995, (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 PBAPS, Unit 3 shroud, projected through 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 use-as-is disposition of NCR No. 93-00743, Rev. 1, developed during the PBAPS, Unit 3 Refueling Outage 9 (1993), as a result of shroud visual inspections findings, and the Safety Analysis developed in response to Generic Letter 94-03.

The extent of the shroud inspections provide 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 the PBAPS Site. Reinspection of the shroud welds will be determined following resolution of the BWRVIP reinspection recommendations.

REFERENCES:

1. BWR Core Shroud Inspection and Flaw Evaluation Guidelines, GENE-523-113-0894, Rev. 1, March, 1995.
2. Screening Criteria and Flaw Evaluation Methodology for the Peach Bottom Unit-3 Shroud, GENE-523-A076-0895, September, 1995.
3. Evaluation of the Peach Bottom Unit-3 Core Shroud Indications (Refuel 10), GENE-523-A104-0995, Revision 1, October 1995.
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.

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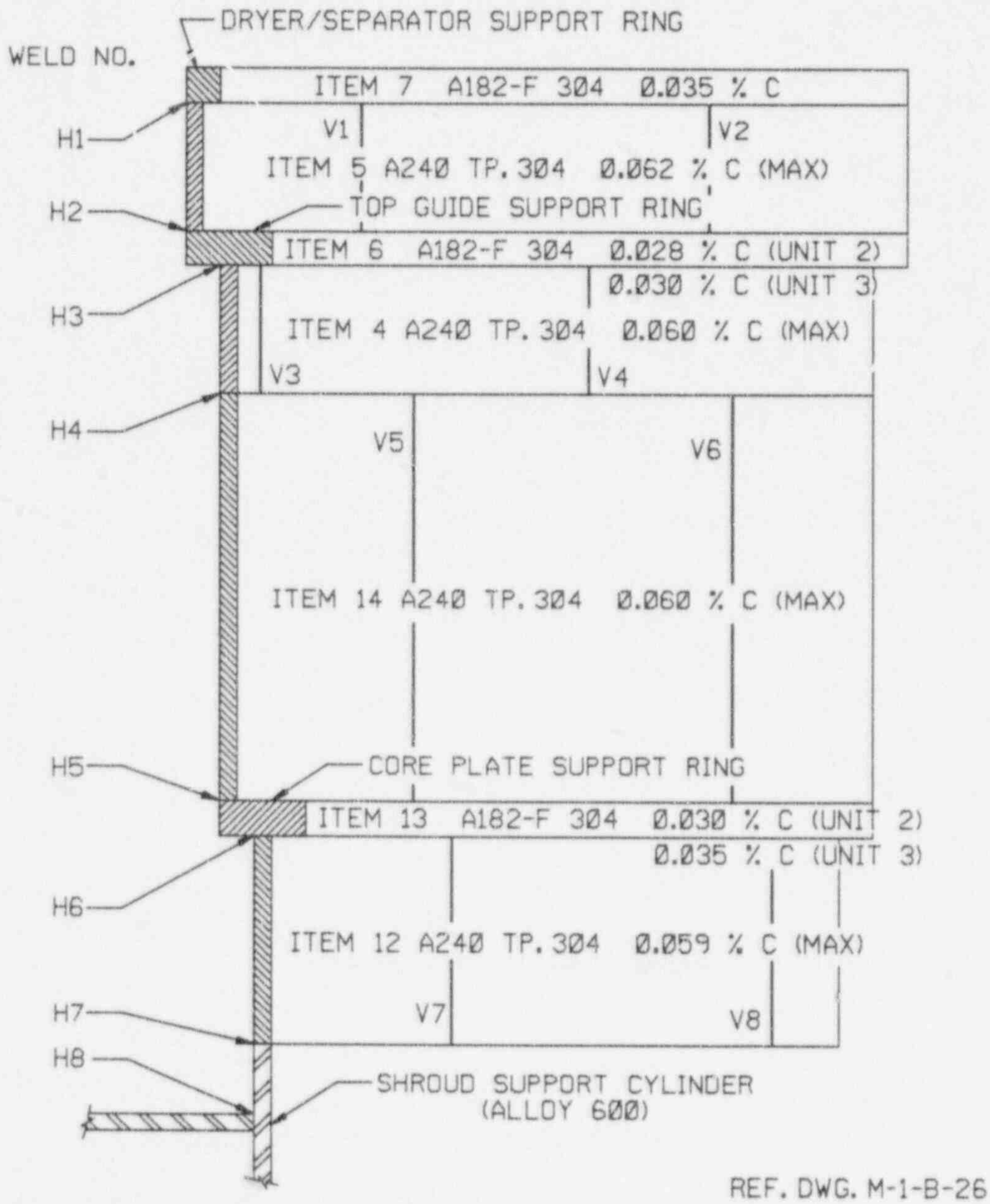
ATTACHMENT 1

REACTOR PRESSURE VESSEL - SHROUD
PEACH BOTTOM ATOMIC POWER STATION
UNIT 2 & 3



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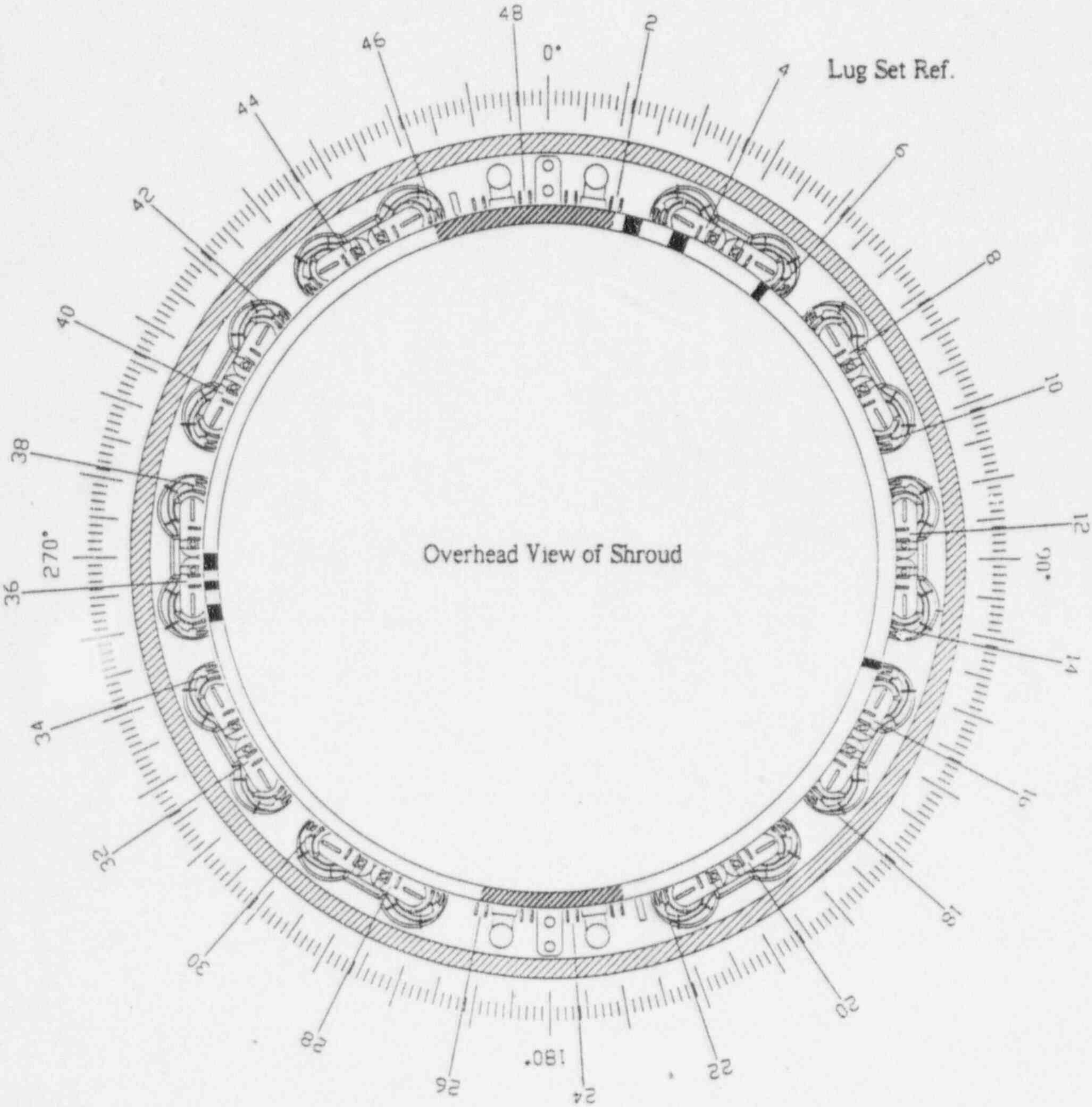
ATTACHMENT 2

Shroud Weld H1

Areas Not Examined

Azimuths Areas with Indications



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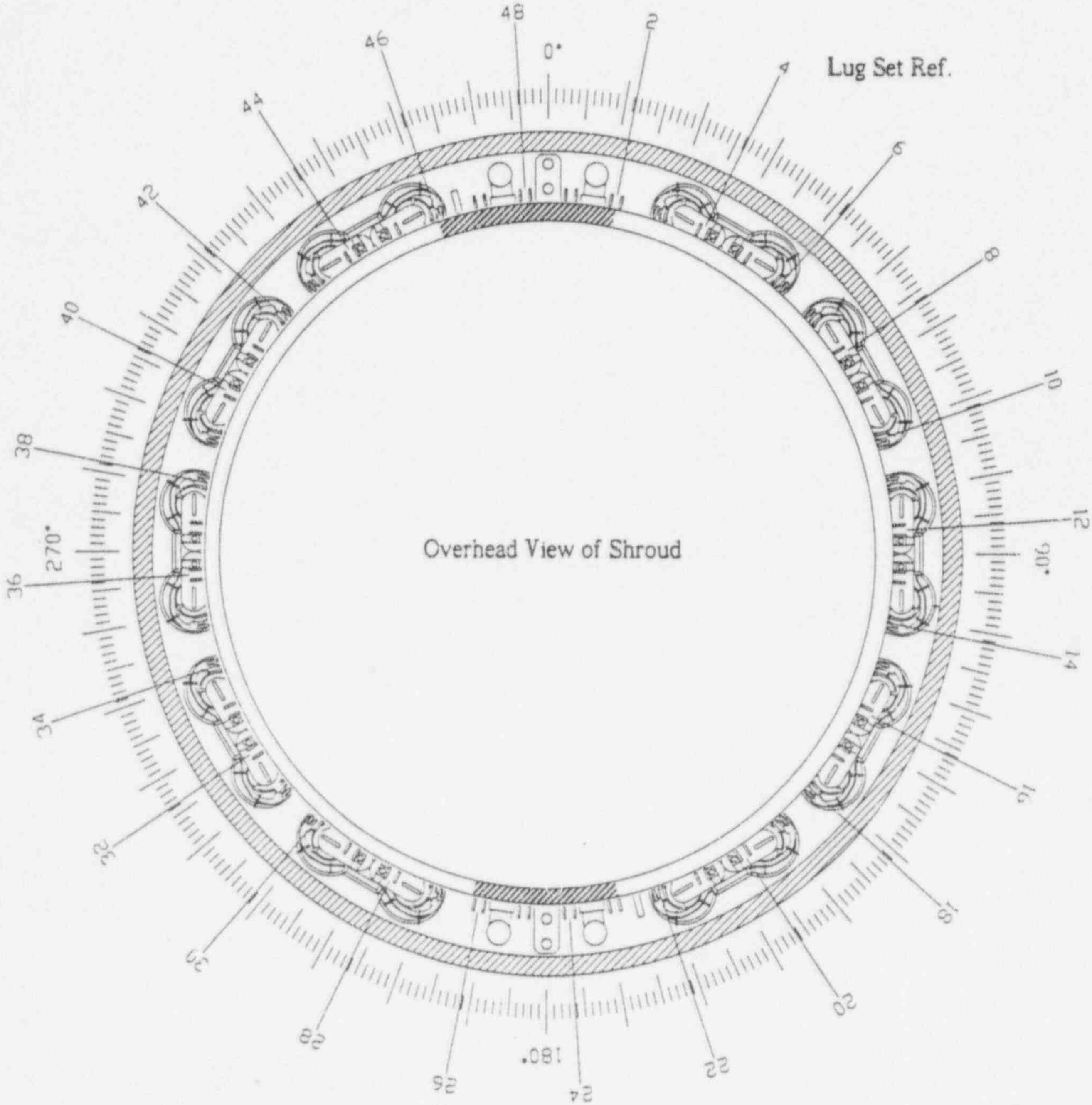
Peach Bottom 3R10 Shroud UT Project 1CK5C September 1995

Shroud Weld H2

Areas Not Examined



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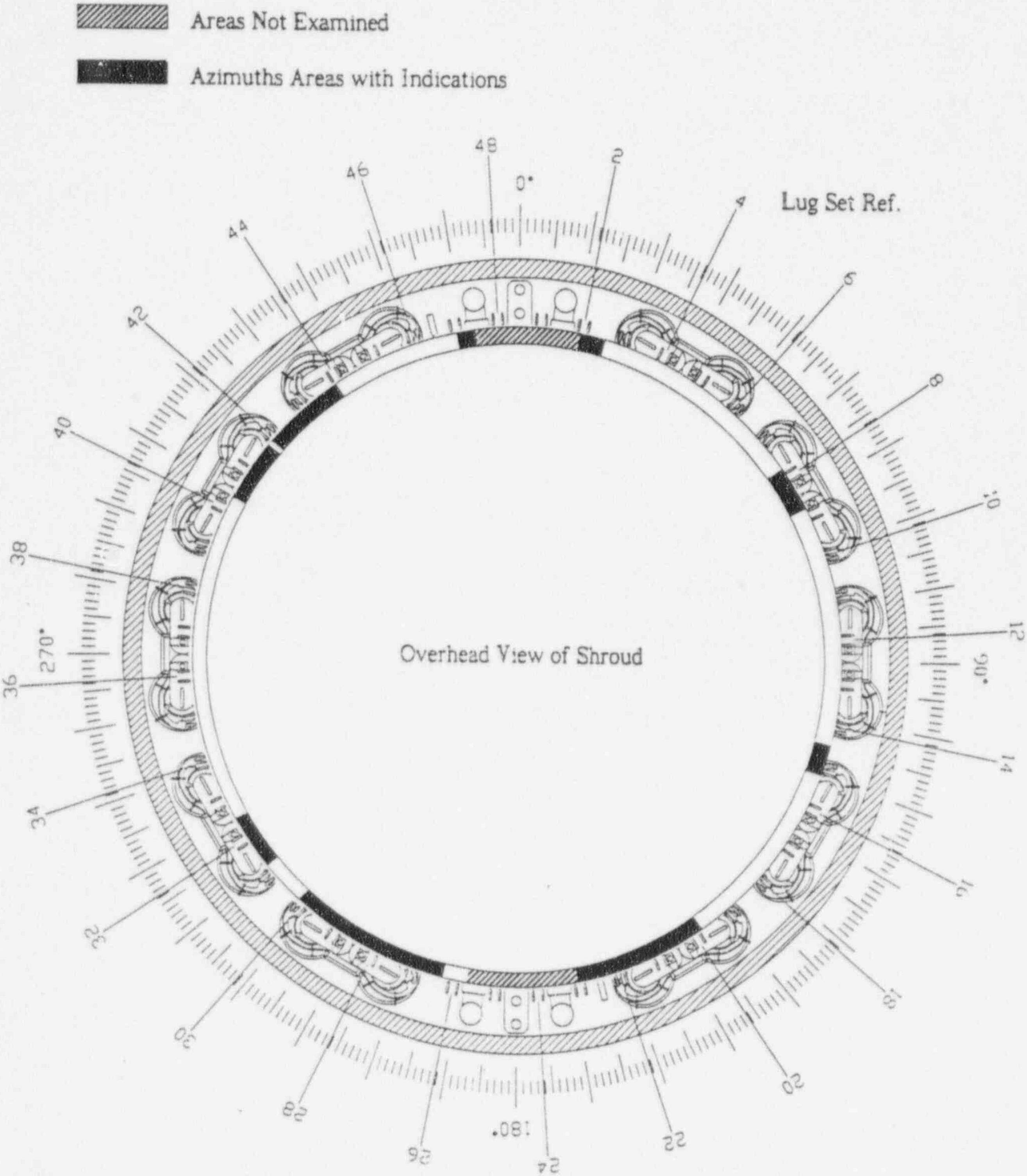
Shroud Weld H3



REVIEWED FROM ... T.L. Andel OCT 07 '95

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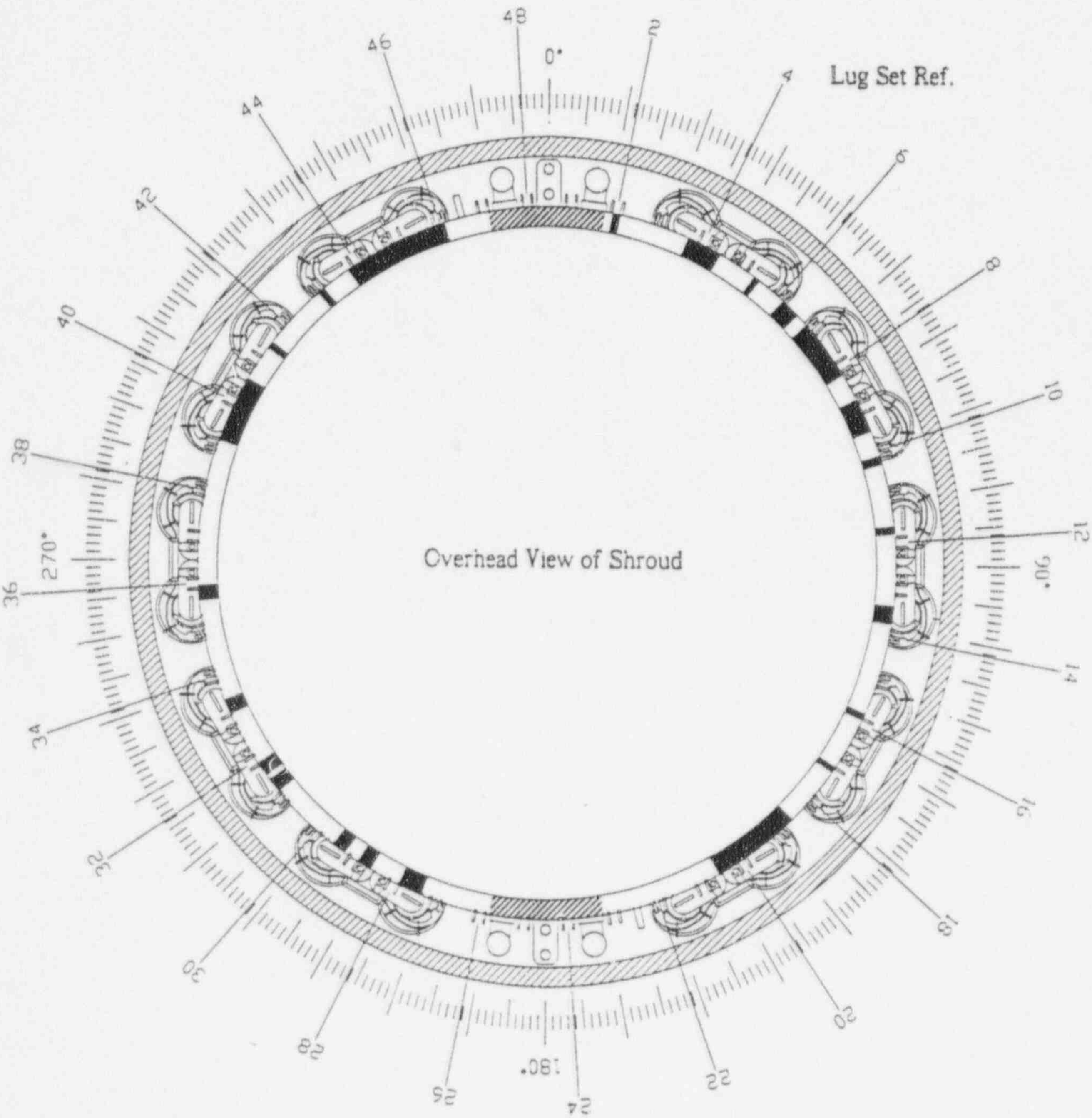
Peach Bottom 3R10 Shroud UT Project 1CK5C September 1995

Shroud Weld H4

Areas Not Examined

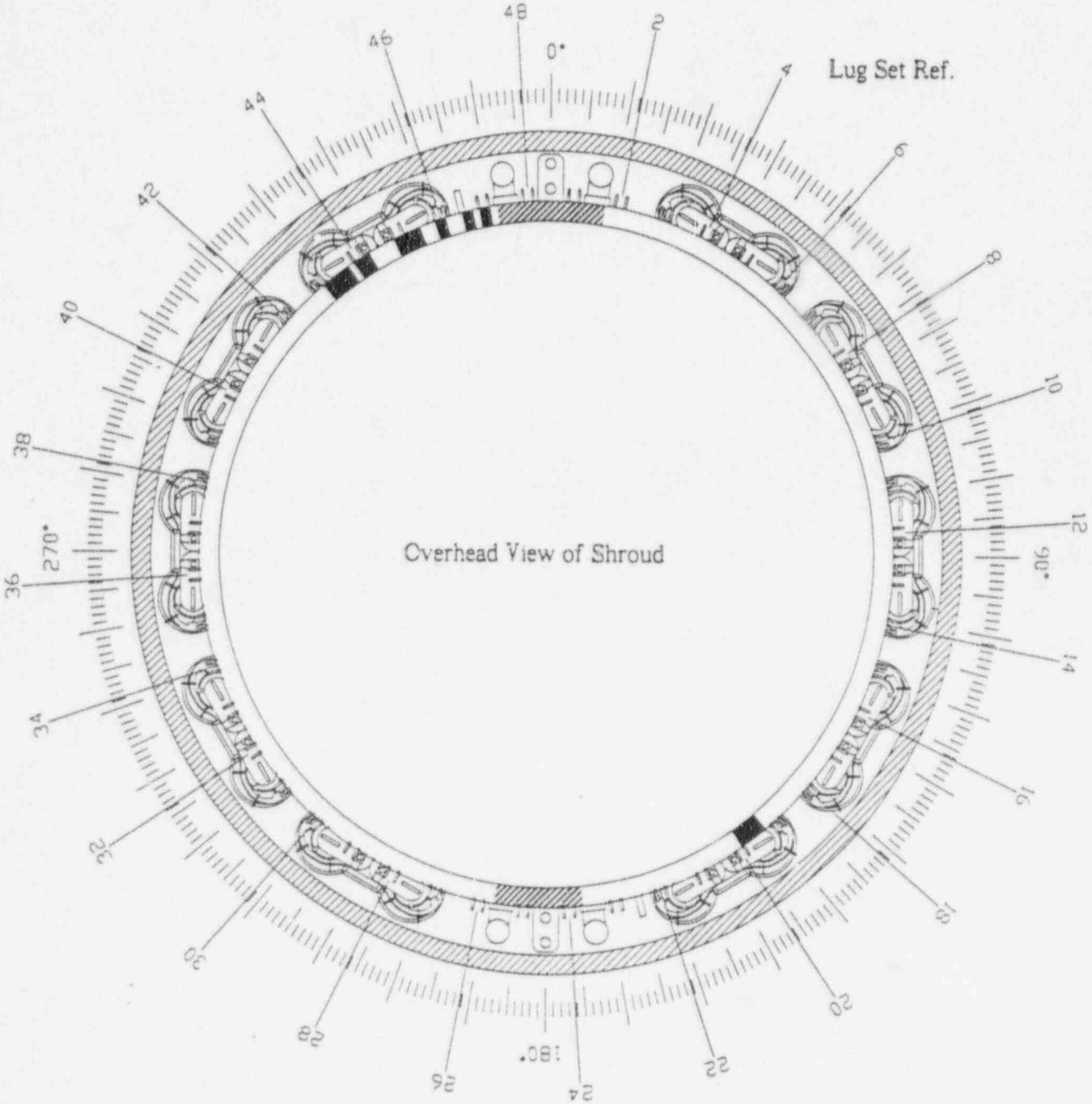
Azimuths Areas with Indications



Shroud Weld H5

Areas Not Examined

Azimuths Areas with Indications



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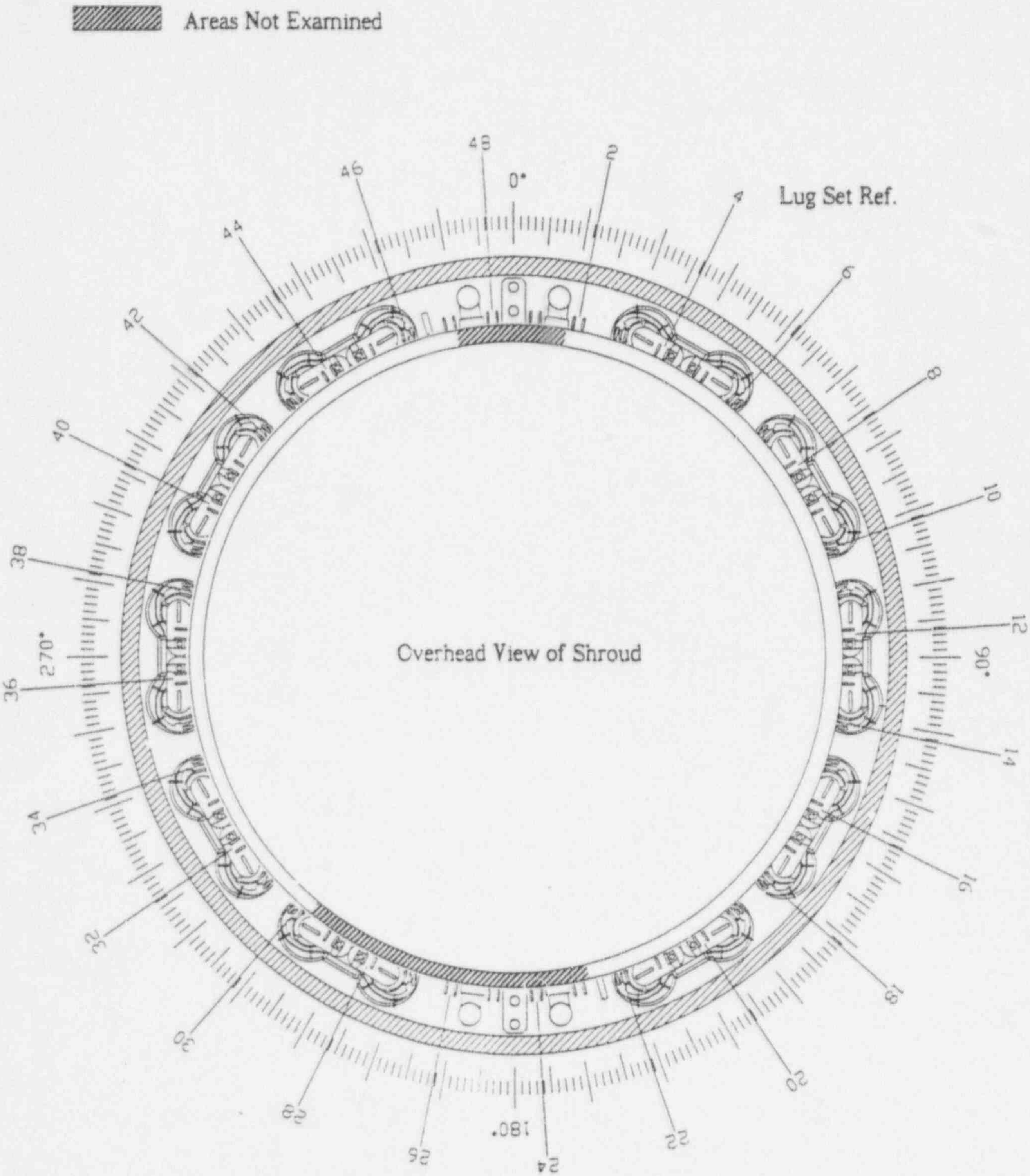
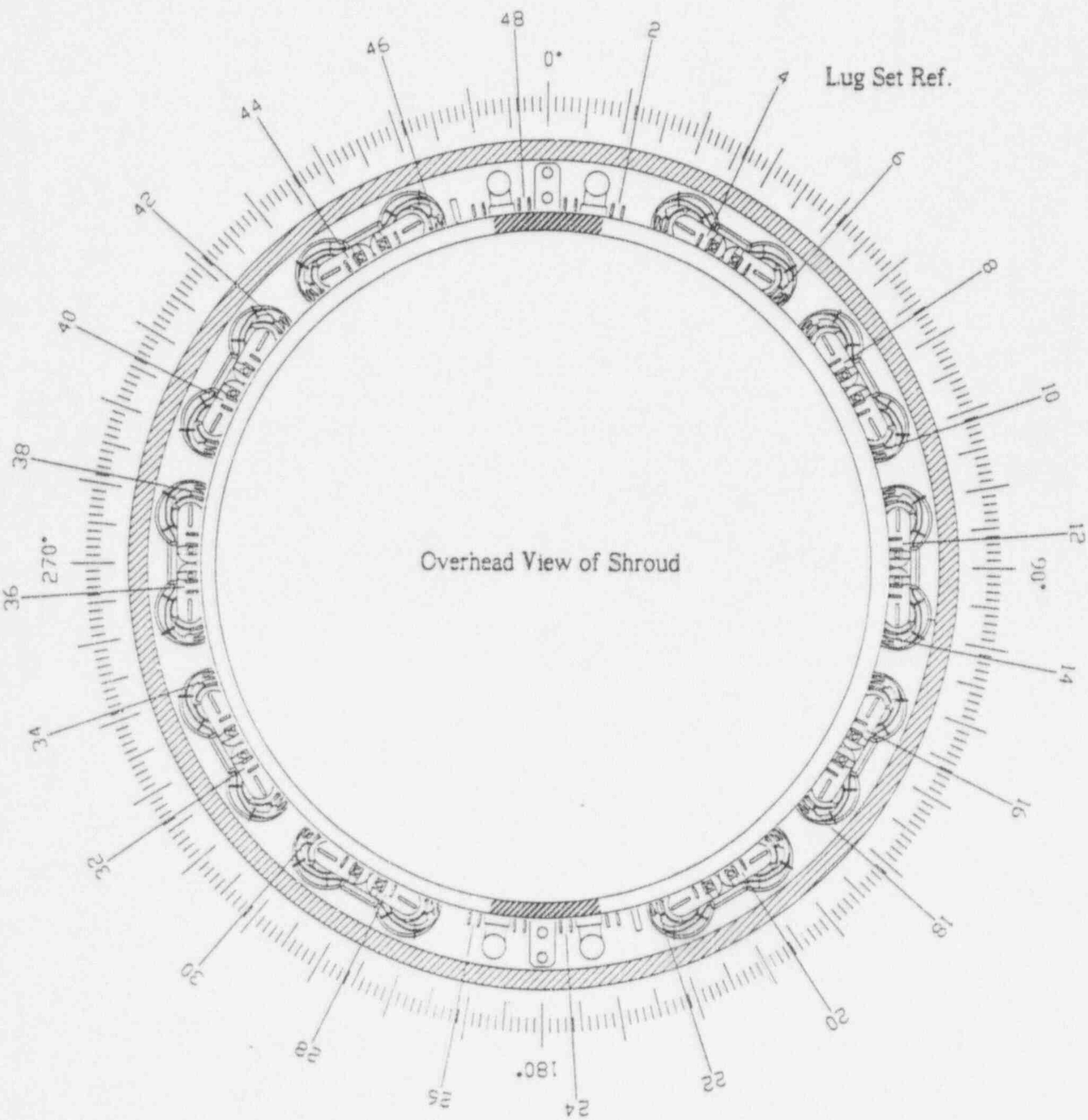
Peach Bottom 3R10 Shroud UT Project 1CK5C September 1995

Shroud Weld H6



Shroud Weld H7

Areas Not Examined



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ATTACHMENT 3

GENE-523-A104-0995
Revision 1
DRF 137-0010-8

Evaluation of the Peach Bottom Unit-3 Core Shroud Indications (Refuel Outage 10)

October 1995

Prepared by:
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Engineering & Licensing Consulting Services

Karina Faynshtein, Engineer
Engineering & Licensing Consulting Services

GE Nuclear Energy
San Jose, CA

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

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EXECUTIVE SUMMARY

UT inspection of the H1 through H7 core shroud welds was performed during refuel outage 10 at Peach Bottom Unit-3. Indications were observed in the inspected areas of welds H1, H3, H4, and H5. Indications were not observed at welds H2, H6, and H7.

This report presents the results of the application of the screening criteria and flaw evaluation calculations for the observed UT detected indications. Structural margin is assured if the observed indications meet the screening criteria or if the calculated safety factors, using the flaw evaluation method, exceed the required safety factors. Screening criteria and flaw evaluation methodology were prepared in a previous analysis.

The flaw evaluation needs to be performed if the flawed condition exceeds the screening criteria. Even if the screening criteria is met, based on assuming that all UT detected flaws are through-wall, it is appropriate to reevaluate the indications using the flaw evaluation methodology to demonstrate the actual structural margin. However, reconciliation using the flaw evaluation methodology is not mandatory to determine the actual structural margin or to justify continued operation.

Both the screening criteria and flaw evaluation methodology use linear elastic fracture mechanics (LEFM) and limit load concepts to determine the acceptability of the flaws. The limiting flaw length, based on either LEFM or limit load, was used for the allowable flaw size at the H3 and H4 welds.

This evaluation used a NDE uncertainty of 0.4 inches plus half a degree which was added to each flaw end. The results of this evaluation indicate that the screening criteria is satisfied at all weld locations. In addition, the flaw evaluation indicates safety factors well in excess of the required safety factors. Thus, structural integrity over the next two year operating cycle is demonstrated.

1. INTRODUCTION

This report presents the evaluation of the 1995 outage (Outage 10) ultrasonic test inspection (UT) results for the Peach Bottom Unit-3 core shroud. Reference 1-1 presented the core shroud screening criteria and flaw evaluation methodology for Peach Bottom Unit-3. The UT detected indications (See report sheets in Appendix A) were evaluated per the methodology and procedures presented in Reference 1-1.

The evaluation presented in this report (Section 1.1.1) uses the initial screening criteria methodology for circumferential welds along with LOCA and updated loads for seismic events. In addition, the flaw evaluation calculation (Section 1.1.2) is presented which can be used if the screening criteria is exceeded or if a closer estimate of the safety margin is desired. Section 1.1 describes the approach to disposition the indications using the two methods.

1.1 Flaw Disposition Approach

The approach in dispositioning the flaws in the Peach Bottom Unit 3 core shroud is outlined in this section. This approach is consistent with the approach taken to disposition indications at several other BWR plants since core shroud cracking has been observed and is consistent with the BWR VIP methods in Reference 1-2.

Figure 1-2 shows a flow chart summarizing the process of shroud cracking disposition. The initial evaluation, based on the conservative screening criteria, is first performed. This conservative evaluation can be used to quickly disposition the indications based on many simplifying assumptions which clearly illustrate the conservative nature of this screening criteria. Two of these significant assumptions, which have been verified as such since 1993, are i) all indications are through-wall even though all detected indications were found to be part through-wall, and ii) all indications after application of the proximity rules are combined into one single indication which is oriented along the axis of minimum moment of inertia.

A flaw evaluation may be performed if the as-found indications exceed the screening criteria. This flaw evaluation can take into account the actual location and flaw characterization from the UT inspection. Even if the indication meets the screening criteria, it is considered prudent to determine the actual structural safety factor for the flawed condition. This information can also provide additional guidance for future planning and management of core shroud cracking.

The UT detected flaw lengths used in the screening criteria and flaw evaluation calculations included an uncertainty factor on length sizing. This uncertainty factor includes consideration for NDE technique uncertainty and NDE delivery system uncertainty. NDE length uncertainty values of 0.4 inches for NDE method plus half a degree for the delivery system (Reference 1-3) were added to each flaw end in this evaluation. This is a very conservative approach, considering the basis and the latest uncertainty data available from the BWR-VIP (Reference 1-4). The delivery system uncertainty value of half a degree applies only to longer indications which require transversing of the tracker delivery device to locate each end of the indication. The uncertainty value for short flaws (not requiring tracker movement) is actually very small. The larger uncertainty value was applied to all identified indications, regardless of identified length.

The latest BWR-VIP data for NDE technique uncertainties, which were derived from demonstrations at the EPRI NDE Center, reflect substantially lower values for the techniques utilized during the Peach Bottom Unit 3 examinations. Demonstrations #5 and #16 (Reference 1-4) indicate a NDE technique uncertainty value of zero inches. Nevertheless, the larger NDE uncertainty value was applied to maintain the maximum level of conservatism and to utilize data officially submitted to the NRC.

There are areas which could not be inspected during the UT inspection due to obstruction by other components. In the calculations presented in this report, all uninspected areas were assumed to contain through-wall flaws along the entire length of the uninspected zone. The estimated crack growth and uncertainty were added to the assumed through-wall flaws in the uninspected zones. This is likely a conservative assumption based on the UT results for all welds. All indications were found to be part-through-wall.

1.1.1 Screening Criteria

The guiding parameter used for the selection of the indications for further evaluation is the allowable through-wall flaw size, which already includes the structural safety factors. If all of the UT detected indications are assumed to be through-wall, then the longest flaws, or combination of flaws, would have the limiting margin against the allowable through-wall flaw size. In reality, none of the indications are through-wall, and therefore, the criteria and methods presented for this method are conservative. The through-wall characterization of the indications can be incorporated in the flaw evaluation methodology which is described in Section 1.1.2.

The result of this procedure will be the determination of the effective (limit load) and equivalent (LEFM) flaw lengths which will be used to compare against the allowable flaw sizes and selection of indications for more detailed evaluation if necessary. The determination of effective flaw lengths is based on ASME Code, Section XI, Subarticle IWA-3300 (1986 Edition) proximity criteria. These criteria provide the basis for the combination of neighboring indications depending on various geometric dimensions. The effective flaw lengths are summed into one single indication. This single indication is compared with the screening criteria allowable flaw size. Crack growth over a subsequent two year operating and power rerate cycle is factored into the criteria.

The selection of indications for further investigation can be performed by evaluating the resulting effective flaw lengths. Indications with effective flaw lengths greater than the allowable flaw sizes would require more detailed analysis such as the flaw evaluation method. The screening criteria procedure described here is conservative since all of the indications are assumed to be through-wall and are being compared against the allowable through-wall flaw size.

A summary of conservatisms used in the screening criteria analysis is presented in Table 1-1.

Table 1-1 Conservatisms Included In Screening Evaluation

1. All surface indications were assumed to be through-wall for this analysis.
2. All indications are assumed to be grouped together for the limit load calculation and no credit is taken for the spacing between indications.
3. ASME Code primary pressure boundary safety margins were applied even though the shroud is not a primary pressure boundary.
4. ASME Code, Section XI proximity rules were applied.
5. An additional proximity rule which accounts for fracture mechanics interaction between adjacent flaws was used.
6. Both LEFM and limit load analysis were applied, even though LEFM underestimates allowable flaw size for austenitic materials and is not required per ASME Code Section XI procedures.
7. Fracture toughness measured for similar materials having a higher fluence was used.
8. The bounding crack growth estimated for the subsequent fuel cycles was included in flaw lengths used for evaluation.
9. A bounding NDE uncertainty factor was included in the flaw lengths used for evaluation.

1.1.2 Flaw Evaluation

The flaw evaluation method can take into account the indication characterization information provided by the UT inspection. Specifically, the azimuthal location and depth of the indications can be taken into account when determining the structural safety factor. Crack growth over an operating cycle of two years and power rerate is factored into these calculations. For purposes of this evaluation, all detected flaws and uninspected areas were assumed to be through-wall flaws.

The flaw evaluation methodology (Reference 1-2) can include the assumption of through-wall or part through-wall indications. Both limit load and LEFM are considered in this evaluation. For limit load, analysis can be performed for a random distribution of indications varying in length and depth. In addition, uncracked ligament can also be modeled. The limit load allowable flaw length is defined for the given applied loads. The net-section stress equals the flow stress of the material at the flawed section (with applicable safety factor).

The LEFM evaluation considers the interaction of neighboring indications to establish an equivalent flaw length. The LEFM allowable flaw length is defined when the applied stress intensity factor equals that of the material fracture toughness.

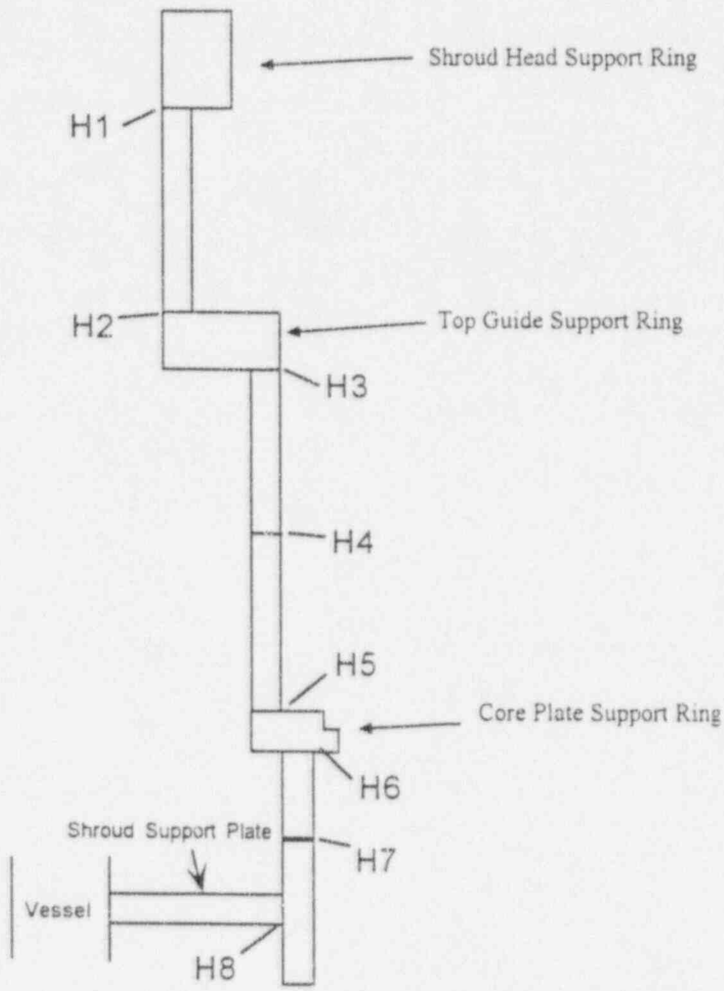

Figure 1-1 Schematic of Core Shroud Welds

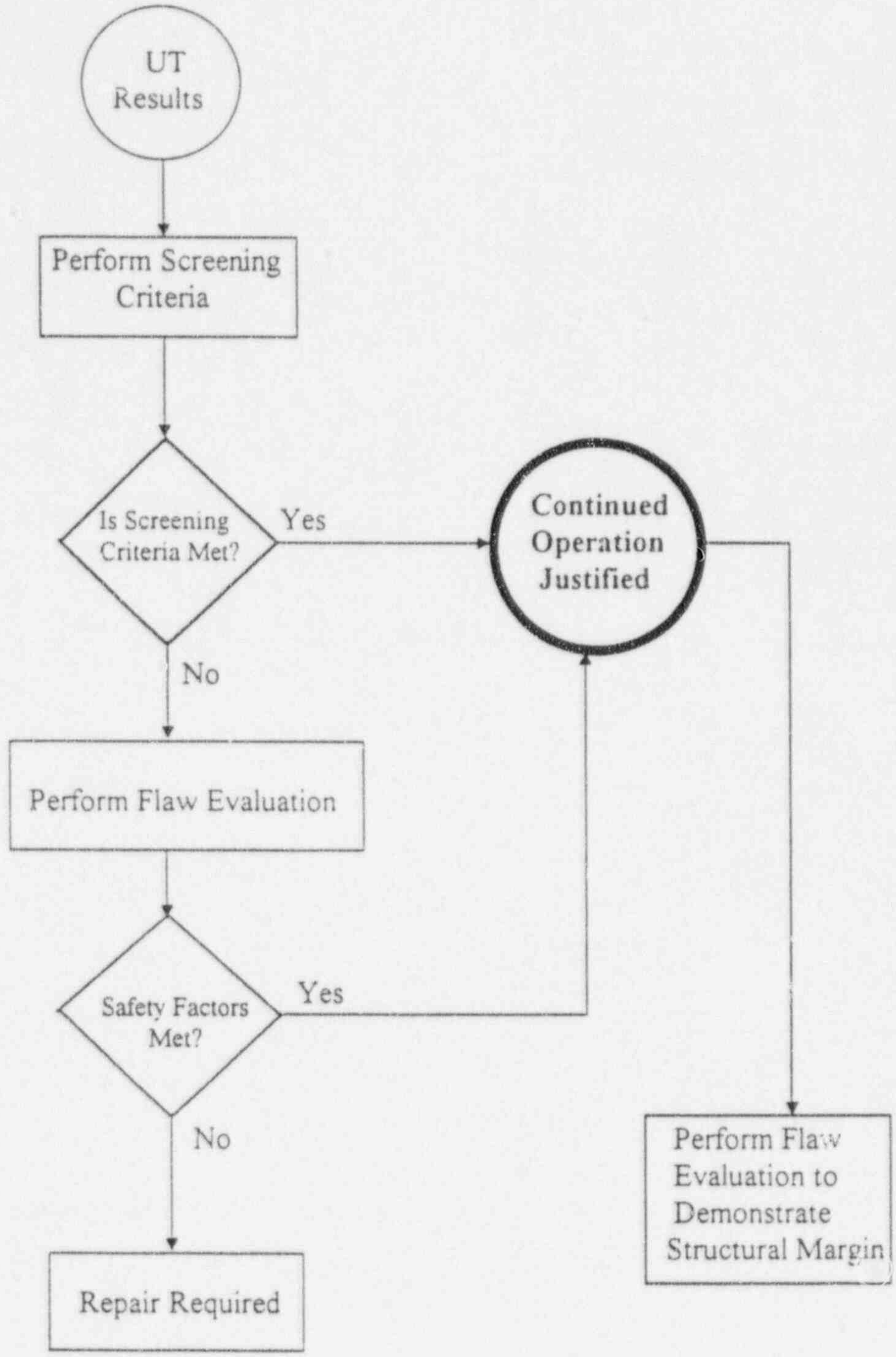

Figure 1-2 Flaw Disposition Procedure

1.2 References

1-1 Screening Criteria and Flaw Evaluation Methodology for the Peach Bottom Unit-3 Shroud Indications, GENE 523-A076-0895, DRF 137-0010-8, August 1995.

1-2 BWR Core Shroud Inspection and Flaw Evaluation Guidelines, GENE-113-0894, DRF 137-0010-07, Rev. 1, March 1995, Prepared for the BWR Vessel and Internals Project Assessment Subcommittee.

1-3 BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard, November 1994.

1-4 Reactor Pressure Vessel and Internals Examination Guidelines, BWR VIP (Draft) Proprietary Report, September 1995.

2. EVALUATION OF UT RESULTS

This section provides the results of the application of the screening criteria and flaw evaluation methodology for the Peach Bottom Unit-3 core shroud circumferential welds. The evaluation was performed using a conservative approach. All uninspected areas were treated as through-wall flaws. Crack growth for one cycle and NDE technique and delivery system uncertainty were added to the end of each indication. In addition, all indications were treated as being through-wall. UT inspection results indicate that all indications are part through-wall.

Appendix A contains the UT examination reports for welds H1 through H7. Indications were not detected at welds H2, H6, and H7. Thus, welds H2, H6, and H7 were assumed to have through-wall indications only in the uninspected regions.

All indication lengths, including the uninspected area lengths, were increased by the assumed length uncertainty (0.4 inches plus a half a degree on length at each flaw end) plus two times the annual rate of crack growth for one 24 month operating cycle at each flaw end.

The stresses used for the flaw evaluation are shown in Table 2-1 (from Reference 1-1). Safety factors were calculated using the Distributed Ligament Length (DLL) computer program (Reference 2-1). The procedure for evaluating the flaws for the screening criteria was:

1) Add crack growth for one cycle and length uncertainty to each flaw end for all flaws and uninspected area lengths from the UT examination reports (Appendix A).
2) Determine if flaws need to be combined based on proximity rules.
3) Sum all effective lengths.
4) Compare length sum to allowable effective length for limit load.
5) Determine equivalent length for any pair of indications and compare to LEFM criteria.

Some of the observed indications at welds H1, H3, H4, and H5 were combined for this evaluation due to the added crack growth and NDE uncertainty and due to the proximity criteria. Table 2-2 shows which indications were combined.

For the flaw evaluation calculations, the first two steps are identical to those for the screening criteria. These flaw lengths (after proximity criteria application) are input into the DLL computer program which accounts for the azimuthal location of the indications (assumed to be through-wall).

The calculated safety factors for both normal/upset and emergency/faulted conditions are shown in Table 2-3. It can be seen from Table 2-3 that there is a large safety margin between the calculated and the required safety factors. Table 2-4 presents the calculated total flaw lengths for the screening criteria.

Weld H4 was found to contain an indication which is greater than 50% of the wall thickness. Through-wall propagation of this indication cannot be ruled out. For an assumed fully circumferential flaw, Reference 2-2 indicates that the flow would occur through a gap of less than 0.002 inches. The estimated flow through such a gap would typically be about 0.05% of total core flow (based on a 0.002 inch gap around the shroud entire circumference and a typical pressure of eight pounds per square inch). Flow of this magnitude will have no impact on plant operation and will not be detectable.

The observed indication at Peach Bottom Unit 3 at weld H4 which was found to be greater than 50% of the wall thickness is projected to grow to a length of 32 inches after one cycle of operation. This indication would then be 5% of the shroud entire circumference. Peach Bottom Unit 3 operates at a maximum pressure of 14 12 psi (Reference 2-3) during normal operation. Therefore, the expected leakage from a through-wall flaw of this length would be less than 0.005% of the total core flow (this takes into account the higher operating pressure than the Reference 2-2 assumption). Therefore, the leakage through this indication would not be significant.

Table 2-1. Primary Membrane and Bending Stresses at the Shroud Welds

Weld Designation	Normal/Upset		Emergency/Faulted	
	P_m (ksi)	P_b (ksi)	P_m (ksi)	P_b (ksi)
H1	0.381	0.117	0.837	0.217
H2	0.381	0.159	0.837	0.293
H3	0.359	0.186	0.787	0.340
H4	0.359	0.355	0.787	0.611
H5	0.359	0.535	0.787	0.944
H6	0.624	0.570	1.053	1.005
H7	0.624	0.728	1.053	1.329

Table 2-2. Combined Indications

H1	Indication #1 and Uninspected area from 340° to 11.20° Indications #5, #6, and #7
H3	Indications #3 and #4 Indication #5 and Uninspected area from 169.75° to 189.20° Indications #8 and #9 Indication #10 and Uninspected area from 352.97° to 11.20° and Indication #1
H4	Indications #2, #3, #4, and #5 Indications #7, #8, #9, #10, #11, #12, and #13 Indications #19 and #20 Indications #21 and #22 Indications #23 and #24 Indications #27, #28, #29, #30, #31, and #32 Indications #34, #35, and #36 Indication #1 and Uninspected area from 349.82° to 9.40°
H5	Indications #2 and #3 Uninspected area from 351.20° to 9.20° and Indications #4, #5, #6, #7, #8, and #9

Table 2-3. Flaw Evaluation Calculated Safety Factors
(Required SF: 2.77 for Normal and Upset, 1.39 for Emergency and Faulted)

Weld Designation	Limit Load		LEFM
	Normal/Upset	Emergency/Faulted	
	SF	SF	SF
H1	88.0	41.9	---
H2	89.1	42.9	---
H3	50.5	24.7	4.2 (faulted)[1]
H4	33.0	17.0	11.6 (upset)[2]
H5	50.3	26.1	---
H6	36.5	21.3	---
H7	39.5	22.6	---

[1] Indication #5, Uninspected area from 169.75° to 189.2°, and Indication #6

[2] Indications #34, #35, #36, Uninspected area from 349.82 to 9.40°, and Indication #1

Table 2-4. Calculated Flaw Lengths vs. Screening Criteria

Weld Designation	Calculated Flaw Length (in)		Screening Criteria Allowable Flaw Length (in)	
	Limit Load	LEFM	Limit Load	LEFM
H1	177	---	501	---
H2	116	---	498	---
H3	304	144	469	376
H4	362	79	460	310
H5	131	---	450	---
H6	134	---	422	---
H7	74	---	414	---

2.1 Consideration of Additional Crack Growth

To demonstrate the margin available in the core shroud welds, additional calculations were performed including an additional cycle of crack growth (total of two cycles beyond outage 10 UT results). Thus, calculations were performed by adding $[2(2\Delta a) + U]$, where Δa is crack growth at each flaw end for one cycle, and U is the length uncertainty. Note that this calculation is for the intent of demonstrating the margin available in the core shroud welds. This calculation also does not account for any new crack initiation.

Tables 2-5 and 2-6 provide the results for these calculations. These results also indicate that the screening criteria and minimum required flaw evaluation safety factors are met with the additional operating cycle of crack growth. Some of the observed indications at welds H1, H3, H4, and H5 were combined for this evaluation due to the added crack growth and NDE uncertainty and due to the proximity criteria. Table 2-7 shows which indications were combined.

Table 2-5. Flaw Evaluation Calculated Safety Factors
With Crack Growth Assuming Two Operating Cycles
(Required SF: 2.77 for Normal and Upset, 1.39 for Emergency and Faulted)

Weld Designation	Limit Load		LEFM
	Normal/Upset	Emergency/Faulted	
	SF	SF	SF
H1	86.0	40.9	---
H2	88.2	42.5	---
H3	48.4	23.7	4.1 (faulted)(1)
H4	28.4	14.7	11.2 (upset)(2)
H5	49.2	25.6	---
H6	36.1	21.1	---
H7	39.1	22.4	---

(1) Indication #5, Uninspected area from 169.75° to 189.20°, and Indication #6

(2) Indications #34, #35, #36, Uninspected area from 349.82° to 9.40°, and Indication #1

Table 2-6. Calculated Flaw Lengths vs. Screening Criteria
With Crack Growth Assuming Two Operating Cycles

Weld Designation	Calculated Flaw Length (in)		Screening Criteria Allowable Flaw Length (in)	
	Limit Load	LEFM	Limit Load	LEFM
H1	186	---	501	---
H2	120	---	498	---
H3	315	147	469	376
H4	394	82	460	310
H5	137	---	450	---
H6	137	---	422	---
H7	78	---	414	---

Table 2-7. Combined Indications for Two Operating Cycles

H1	Indication #1 and Uninspected area from 340.54° to 11.20° Indications #5, #6, and #7
H3	Indications #3 and #4 Indication #5 and Uninspected area from 169.75° to 189.20° Indications #8 and #9 Indication #10 and Uninspected area from 352.97° to 11.20° and Indication #1
H4	Indications #2, #3, #4, and #5 Indications #6, #7, #8, #9, #10, #11, #12, and #13 Indications #19 and #20 Indications #21 and #22 Indications #23 and #24 Indications #27, #28, #29, #30, #31, and #32 Indications #34, #35, and #36 Indication #1 and Uninspected area from 349.82° to 9.40°
H5	Indications #2 and #3 Indications #4, #5, #6, #7, #8, #9 and Uninspected area from 351.20° to 9.20°

2.2 References

2-1. BWR Core Shroud Distributed Ligament Length Computer Program, GE-NE-523-113-0894, Supplement 1, September 1994.

2-2. BWR Shroud Cracking Generic Safety Assessment, GE-NE-523-A107P-0794, Revision 1, Class III, August 1994.

2-3 Power Rerate Safety Analysis Report for Peach Bottom 2/3, NEDC-32230P, May 1993.

3. SUMMARY AND CONCLUSIONS

This report presents the screening criteria and flaw evaluation results for the core shroud circumferential welds. The screening criteria was calculated using the up-to-date seismic and LOCA loads. UT inspection of the core shroud welds was performed during the 1995 fall outage (Outage 10).

The evaluation assumes all UT detected indications are through-wall even though UT confirmed that they are only part through-wall. By meeting the screening criteria and exceeding the required safety factors using the flaw evaluation methodology, the ASME Code Section XI safety margins are demonstrated to be satisfied.

Both the screening criteria and flaw evaluation methods use linear elastic fracture mechanics (LEFM) and limit load concepts to determine acceptable through-wall indication lengths. The limiting flaw length based on either LEFM or limit load was used for the screening criteria. For the Peach Bottom Unit 3 core shroud, only welds H3 and H4 were evaluated using LEFM.

The screening criteria and flaw evaluation also use the ASME Code Section XI criteria for combining flaws based on the proximity of indications. In addition, a second method for including the interaction between neighboring indication tips was considered for the LEFM allowable flaw size calculation.

Results of the evaluation indicate that the screening criteria is satisfied at all weld locations. In addition, the flaw evaluation indicates safety factors well in excess of the required safety factors. Thus, structural integrity over the next two year operating cycle is demonstrated.

APPENDIX A

UT Inspection Reports for Welds H1 through H7

Shroud Weld H1 Indication Data

Total Scan Length (Deg.)	304.10	Total Flaw Length (Deg.)	14.56
Total Scan Length (In.)	583.83	Total Flaw Length (In.)	27.95
Percentage of Weld Length Examined	84.5	Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	4.8	Circumference (In.)	691.15
Percentage of Total Weld Length Flawed	4.0	Inches per Degree	1.92

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer
1	13.44	16.24	2.80	5.38	0.40	15.38	20.0	ID/Near	45° Shear	60° Long.
2	21.84	23.52	1.68	3.23	0.70	23.22	35.0	ID/Near	45° Shear	60° Long.
3	38.20	39.88	1.68	3.23	0.36	39.02	18.0	ID/Near	45° Shear	60° Long.
4	107.60	109.84	2.24	4.30	0.42	108.98	21.0	ID/Near	45° Shear	60° Long.
5	259.28	262.08	2.80	5.38	0.42	259.54	21.0	ID/Near	45° Shear	60° Long.
6	264.76	265.88	1.12	2.15	0.57	264.46	28.5	ID/Near	45° Shear	60° Long.
*7	268.68	270.92	2.24	4.30	0.73	268.94	36.5	ID/Near	45° Shear	60° Long.

*The deepest through-wall indication sized.

Areas Not Examined by All 3 Transducers
0° to 11.2°, 167.46° to 192.70° & 340.54° to 0° (Total of 55.90° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

J. L. Anderson OCT 0 7 '95

GE Nuclear Energy

Peco Energy
Peach Bottom 3R10 Shroud UT Project ıCK5C September 1995

Shroud Weld H2 Indication Data

Total Scan Length (Deg.)	304.10	Total Flaw Length (Deg.)	0.00
Total Scan Length (In.)	583.83	Total Flaw Length (In.)	0.00
Percentage of Weld Length Examined	84.5	Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	0.0	Circumference (In.)	691.15
Percentage of Total Weld Length Flawed	0.0	Inches per Degree	1.92

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer

No Relevant Indications Recorded

Areas Not Examined by All 3 Transducers
0° to 11.4°, 167.66° to 192.90° & 340.74° to 0° (Total of 55.90° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

REVIEWED PECO ENERGY BY: J. L. Anderson OCT 07 '95

GE Nuclear Energy

Peco Energy
Peach Bottom 3R10   Shroud UT Project 1CK5C   September 1995

Shroud Weld H3 Indication Data

Total Scan Length (Deg.)	322.32		Total Flaw Length (Deg.)	112.54
Total Scan Length (In.)	582.57		Total Flaw Length (In.)	203.41
Percentage of Weld Length Examined	89.5		Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	34.9		Circumference (In.)	650.67
Percentage of Total Weld Length Flawed	31.3		Inches per Degree	1.81

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer
1	11.20	15.60	4.40	7.95	0.45	10.55	22.5	ID/Near	45° Shear	60° Long.
2	54.20	62.45	8.25	14.91	0.72	57.75	36.0	ID/Near	45° Shear	60° Long.
3	104.70	106.35	1.65	2.98	0.43	106.05	21.5	ID/Near	45° Shear	60° Long.
4	106.90	110.20	3.30	5.96	0.40	108.25	20.0	ID/Near	45° Shear	60° Long.
*5	144.05	169.45	25.40	45.91	0.85	163.10	42.5	ID/Near	45° Shear	60° Long.
6	203.21	232.65	29.44	53.21	0.78	224.50	39.0	ID/Near	45° Shear	60° Long.
7	240.92	250.32	9.40	16.99	0.64	244.54	32.0	ID/Near	45° Shear	60° Long.
8	298.68	309.33	10.65	19.25	0.60	302.30	30.0	ID/Near	45° Shear	60° Long.
*9	310.[illegible]	325.32	14.44	26.10	0.85	323.90	42.5	ID/Near	45° Shear	60° Long.
**10	348.72	354.33	5.61	10.14	0.65	350.10	32.5	ID/Near	45° Shear	60° Long.

*The deepest through-wall indication sized.

** Length sizing of Indication #10 is restricted by the limitation of the core spray downcomer

Areas Not Examined by All 3 Transducers
0° to 11.2°, 169.75° to 189.2° & 352.97° to 0° (Total of 37.68° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

REV[illegible] T.S. SUPPORT GROUP J. C. Ader [signature] OCT 0 7 '95

Shroud Weld H4 Indication Data

Total Scan Length (Deg.)	321.04	*Total Flaw Length (Deg.)*	103.30
Total Scan Length (In.)	580.25	*Total Flaw Length (In.)*	186.71
Percentage of Weld Length Examined	89.2	*Thickness (In.)*	2.00
Percentage of Examined Weld Length Flawed	32.2	*Circumference (In.)*	650.67
Percentage of Total Weld Length Flawed	28.7	*Inches per Degree*	1.81

Indication Number	*Start Azimuth*	*End Azimuth*	*Length Degrees*	*Length Inches*	*Max. Depth Inches*	*Max. Depth Pos. (Deg.)*	*% of Thruwall*	*Initiating Surface*	*Length Transducer*	*Depth Transducer*	*Side of Weld*
1	10.32	11.44	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
2	23.70	26.50	2.80	5.06	**	**	**	ID/Near	45° Shear	**	Upper
3	24.76	25.88	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
4	27.00	28.68	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Lower
5	28.18	29.30	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
6	36.02	37.14	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
7	42.00	45.36	3.36	6.07	**	**	**	ID/Near	45° Shear	**	Lower
8	47.66	51.58	3.92	7.09	**	**	**	ID/Near	45° Shear	**	Upper
9	49.28	54.32	5.04	9.11	**	**	**	ID/Near	45° Shear	**	Lower
10	55.32	57.56	2.24	4.05	**	**	**	ID/Near	45° Shear	**	Lower
11	62.10	67.70	5.60	10.12	0.13	65.42	6.5	ID/Near	45° Shear	60° Long.	Upper
12	63.16	64.28	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
13	72.06	73.18	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
14	83.70	84.82	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
15	96.52	99.32	2.80	5.06	**	**	**	ID/Near	45° Shear	**	Lower
16	113.26	114.26	1.00	1.81	**	**	**	ID/Near	45° Shear	**	Upper
17	124.34	125.46	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
*18	135.36	150.36	15.00	27.11	> 50%	140.16	> 50%	ID/Near	45° Shear	60° Long.	Lower
19	201.02	205.38	4.36	7.88	**	**	**	ID/Near	45° Shear	**	Upper
20	202.08	204.32	2.24	4.05	**	**	**	ID/Near	45° Shear	**	Lower
21	210.98	213.22	2.24	4.05	**	**	**	ID/Near	45° Shear	**	Upper
22	216.02	218.82	2.80	5.06	**	**	**	ID/Near	45° Shear	**	Upper
23	230.40	232.08	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Lower
24	233.70	235.38	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Upper
25	244.84	247.08	2.24	4.05	**	**	**	ID/Near	45° Shear	**	Lower
26	263.70	265.38	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Upper
27	289.96	293.76	3.80	6.87	**	**	**	ID/Near	45° Shear	**	Lower
28	294.32	295.44	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
29	296.50	297.62	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Upper
30	296.56	297.68	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
31	298.24	301.60	3.36	6.07	**	**	**	ID/Near	45° Shear	**	Lower
32	306.08	308.76	2.68	4.84	**	**	**	ID/Near	45° Shear	**	Lower
33	318.28	319.40	1.12	2.02	**	**	**	ID/Near	45° Shear	**	Lower
34	32[illegible].88	339.18	14.30	25.85	0.14	338.38	7.0	ID/Near	45° Shear	60° Long.	Lower
35	325.38	327.06	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Upper
36	340.30	341.98	1.68	3.04	**	**	**	ID/Near	45° Shear	**	Lower

**The deepest through-wall indication sized.*
*** Thru-wall dimension not obtained due to flaws being below our sizing threshold. (0.10")*

Upper	34.48	(Deg.)
Lower	68.82	(Deg.)
Without Overlapping	93.78	(Deg.)
Upper	62.32	(In.)
Lower	124.39	(In.)
Without Overlapping	169.50	(In.)

Areas Not Examined by All 3 Transducers
0° to 9.4°, 170.02° to 189.40° & 349.82° to 0° (Total of 38.96° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

[illegible] Energy Co. [illegible] OCT 0 7 '95

Shroud Weld H5 Indication Data

Total Scan Length (Deg.)	326.80	Total Flaw Length (Deg.)	24.64
Total Scan Length (In.)	590.66	Total Flaw Length (In.)	44.53
Percentage of Weld Length Examined	90.8	Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	7.5	Circumference (In.)	650.67
Percentage of Total Weld Length Flawed	6.8	Inches per Degree	1.81

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer
1	141.52	144.88	3.36	6.07	0.11	142.34	5.5	ID/Near	45° Shear	60° Long.
2	319.34	324.38	5.04	9.11	0.20	322.34	10.0	ID/Near	45° Shear	60° Long.
*3	325.38	328.18	2.80	5.06	0.23	326.14	11.5	ID/Near	45° Shear	60° Long.
4	333.78	336.58	2.80	5.06	0.14	334.54	7.0	ID/Near	45° Shear	60° Long.
5	338.26	339.38	1.12	2.02	0.20	338.46	10.0	ID/Near	45° Shear	60° Long.
6	336.26	338.50	2.24	4.05	0.11	337.02	5.5	ID/Near	45° Shear	60° Long.
7	339.62	341.86	2.24	4.05	0.11	340.38	5.5	ID/Near	45° Shear	60° Long.
8	344.10	346.90	2.80	5.06	0.18	345.42	9.0	ID/Near	45° Shear	60° Long.
9	348.02	350.26	2.24	4.05	0.10	348.22	5.0	ID/Near	45° Shear	60° Long.

*The deepest through-wall indication sized.

Areas Not Examined by All 3 Transducers
Areas Not Examined: 0° to 9.20°, 174.20° to 189.40° & 351.20° to 0° (Total of 33.20° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

J.C. Ardell OCT 0 7 '95

GE Nuclear Energy

Peco Energy
Peach Bottom 3R10 Shroud UT Project 1CK5C September 1995

Shroud Weld H6 Indication Data

Total Scan Length (Deg.)	288.52	Total Flaw Length (Deg.)	0.00
Total Scan Length (In.)	506.08	Total Flaw Length (In.)	0.00
Percentage of Weld Length Examined	80.1	Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	0.0	Circumference (In.)	631.46
Percentage of Total Weld Length Flawed	0.0	Inches per Degree	1.75

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer

No Relevant Indications Recorded

Areas Not Examined by All 3 Transducers
0° to 9.2°, 166.96° to 219.20° & 349.96° to 0° (Total of 71.48° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

J. L. Anders OCT 07 95

GE Nuclear Energy

Peco Energy
Peach Bottom 3R10 Shroud UT Project 1CK5C September 1995

Shroud Weld H7 Indication Data

Total Scan Length (Deg.)	322.64	Total Flaw Length (Deg.)	0.00
Total Scan Length (In.)	565.93	Total Flaw Length (In.)	0.00
Percentage of Weld Length Examined	89.6	Thickness (In.)	2.00
Percentage of Examined Weld Length Flawed	0.0	Circumference (In.)	631.46
Percentage of Total Weld Length Flawed	0.0	Inches per Degree	1.75

Indication Number	Start Azimuth	End Azimuth	Length Degrees	Length Inches	Max. Depth Inches	Max. Depth Pos. (Deg.)	% of Thruwall	Initiating Surface	Length Transducer	Depth Transducer

No Relevant Indications Recorded

Areas Not Examined by All 3 Transducers
0° to 9.4°, 170.92° to 189.40° & 350.52° to 0° (Total of 37.36° Not Examined)

Limitations: Core Spray Downcomers and Lifting Lugs

REVIEWED FOR ENGINEERING SUPPORT GROUP J. L. Adna OCT 07 '95