GE Nuclear Energy

25A5688 SH NO. 1
REV. 2

EIS IDENT: SHROUD STABILIZER HDW

REVISION STATUS SHEET

DOC TITLE SHROUD STABILIZER HARDWARE

LEGEND OR DESCRIPTION OF GROUPS

TYPE: DESIGN SPECIFICATION

FMF: Dresden 2 AND 3

MPL NO: PRODUCT SUMMARY SEC. 7

THIS ITEM IS OR CONTAINS A SAFETY RELATED ITEM ☒ NO ☐ EQUIP CLASS P

REVISION			C
0	RM-01993 MAR 06, 1995		
1	JL TROVATO 3/29/95	RJA	
	CN02416 CHK BY: JL TROVATO ER MOHTASHEMI		
2	JL TROVATO MAY 11 1995	RJA	
	CN02638 CHK BY: ER MOHTASHEMI		

PRINTS TO

MADE BY	APPROVALS	
A. FORTIN 1/30/95	E.R. MOHTASHEMI 3/6/95	GENERAL ELECTRIC COMPANY 175 CURTNER AVENUE SAN JOSE, CALIFORNIA 95125
CHK BY A. FORTIN 1/31/95	ISSUED MAR 6 1995 R.J. AHMANN	CONT ON SHEET 2

MS-WORD

50-237

DRESDEN 2

CEC

DESIGN DOCUMENTS FOR THE CORE SHROUD REPAIR
BOOK #1

REC'D W/LTR DTD 5/24/95...9506020133

50-237 9506020133 5/24/95

1. SCOPE

1.1 This document defines the design and performance requirements for stabilizers for the core shroud which will functionally replace welds H1 through H7. In addition, this design addresses the circumferential jet pump support plate H8 weld assuming that it is cracked completely through and 360 degrees around. A sketch of the welds and their nomenclature is given in Figure 1. All ASME Code requirements are defined in the documents listed in Paragraph 2.1.1.g. This specification herein contains those requirements that are not specific ASME Code requirements.

2. APPLICABLE DOCUMENTS

2.1 <u>General Electric Documents</u>. The following documents form a part of the specification to the extent specified herein.

2.1.1 <u>Supporting Documents</u>

a.	Arc Welding of Austenitic Stainless Steel	P50YP102	Rev. 10
b.	Sensitization Tests for Austenitic Stainless Steel, Modified ASTM A262 Practice E	E50YP13	Rev. 2
c.	Determination of Carbide Precipitation in Wrought Austenitic Stainless Steel (Modified ASTM A262 Practice A)	E50YP20	Rev. 4
d.	Examination for Intergranular Surface Attack	E50YP11	Rev. 3
e.	Age Hardening of Ni-Cr-Fe Alloy X750	P10JYP2	Rev. 12
f.	Liquid Penetrant Examination	E50YP22A	Rev. 3
g.	Reactor Pressure Vessel - Code Design Specification	25A5689	Rev. 1
h.	Reactor Vessel Thermal Cycles	921D265	Rev. 1
i.	Seismic Analysis of Reactor Internals for the Dresden II and Milestone Plants" dated December 1968, (DAR 67).	257HA718	Rev. 0

j. NEDC-32406, Class II, September 1994, "Final Test Report CRD Peformance Evaluation Testing with Driveline Misalignment."

k. Ge Nuclear Energy Document GENE-523-A181-1294, " Dresden Units 2 & 3- Primary Structure Seismic Models" dated December 1994.

2.1.2 Supplemental Documents. Documents under the following identities are to be used with this specification:

a. Reactor Components 383HA715 Rev. 4

b. Essential Components 22A3041 Rev. 1

2.2 Codes and Standards. The following documents of the latest issue (or specified issue) form a part of this specification to the extent specified herein.

2.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code

a. Section III, Appendices, 1989 Edition.

b. Section IX, Welding and Brazing Qualifications, 1989 Edition.

c. Section III, Subsection NG, 1989 Edition.

d. Section XI, Rules for Inservice Inspection, 1989 Edition.

e. Section II, Materials Specification, Latest edition.

2.2.2 American Society for Testing and Materials (ASTM)

a. ASTM A-182, Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature.

b. ASTM A-240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

c. ASTM A-262, Detecting Susceptibility to Intergranular Attack in Stainless Steel.

d. ASTM A-479, Specification for Stainless and Heat-Resisting Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

e. ASTM A-480, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

f. ASTM B-637, Specification for Precipitation Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High-Temperature Service.

g. ASTM A-276, Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel.

2.3 ComEd Documents

a. Dresden Station UFSAR.

b. ComEd Technical Requirements document for Dresden/Quad Cities Core Shroud Repair, NEC-12-4056, Rev. 0.

c. ComEd Purchase Order No. 354965.

d. Babcock & Wilcox Stress Report(s): VPF # 1248-436-1 (Dresden 2)
VPF # 2252-181-1 (Dresden 3)

2.4 Other Documents

a. Project Instruction - Shroud Repair for H1 through H7 Welds for Commonwealth Edison Dresden Nuclear Power Station GENE-771-80-1194, Rev.0.

b. BWROG - VIP, Core Shroud Repair Design Criteria.

c. GENE-L12-00819-05, September 1994, "Core Shroud Blowdown Load Calculation During Recirculation Suction Line Break by TRACG Analysis for Dresden Units 2 & 3 and Quad Cities Nuclear Power Stations, Units 1 & 2.

d. DRF B13-01749, Section B-2, "Shroud Fix for Dresden 2 and 3, Design Specification"

e. GENE-771-84-1194, Rev. 2; "Dresden Units 2 &3 Shroud Stabilizer Seismic Report."

2.5 U.S. Federal Register Code of Federal Regulations (CFR)

a. 10CFR50.55a(a)(3), Use of an Alternate to Code Requirements.

b. 10CFR50-Title 10, Energy: Chapter 1, Nuclear Regulatory Commission, Part 50, Licensing of Production and Utilization Facilities, Appendix B, Quality Assurance Criteria for Nuclear Power Plants.

3. GENERAL DESCRIPTION

3.1 The purpose of the shroud stabilizers is to structurally replace welds H1 through H7. Welds H1 through H6 are all of the circumferential welds in the shroud, as well as the (H7) bimetallic attachment weld of the shroud to the shroud support cylinder. These welds were required to both vertically and horizontally support the core top guide, core support plate, and shroud head; and to prevent core flow bypass into the downcomer region. Weld H8 is a circumferential inconnel-to-inconnel weld between the shroud support ring and jet pump support plate which provides horizontal support for the core shroud. It also resists differential pressure and dead loads(vertical). The core top guide and core support plate horizontally support the fuel assemblies and maintain the correct fuel channel spacing to permit control rod insertion.

4. REQUIREMENTS

4.1 Code

4.1.1 The shroud stabilizer components are not classified as ASME Section III Code components. However, material strength properties shall be obtained from the document in Paragraph 2.2.1.a. Material Physical Properties may be obtained from the document in Paragraph 2.2.1.e or documents in Paragraph 2.2.2, or CMTR's as deemed appropriate. Welding qualification shall be performed in accordance with the document in Paragraph 2.2.1.b. The nomenclature for stress intensity used in this document is the same as that used in the document of Paragraph 2.2.1.c.

4.2 Structural Criteria

4.2.1 All structural analysis shall be performed in accordance with the criteria given in the Dresden UFSAR (Ref. 2.3.a), ComEd Technical Requirements Document for Dresden/Quad Cities Core Shroud Repair (Ref. 2.3.b) and BWROG - VIP, Core Shroud Repair Design Criteria (Ref. 2.4.b). All of the load combinations given in Paragraph 4.3.5 shall be shown to satisfy the primary stress limits given in the Dresden UFSAR, with values of SFmin as defined in Paragraph 4.3.6. The appropriate SFmin values have been incorporated into the allowable stress intensity values given in Paragraphs 4.2.1.1 and 4.2.1.2.

4.2.1.1 The primary stresses (Pm, Pl, and Pl + Pb) in the existing shroud (NB-3221-1), during Normal and Upset events, shall be shown to be less than Sm, 1.5Sm, and 1.5Sm respectively. During Emergency events, the allowable stresses are increased by a factor of 1.5 times the values for Normal and Upset events. During Faulted events, the allowable stresses are increased by a factor of 2.0 times the values for Normal and Upset events.

4.2.1.2 The stresses (Pm, Pm + Pb, and Pm + Pb + Q) in the repair hardware (NG-3221-1), during Normal and Upset events, shall be shown to be less than Sm, 1.5Sm, and 3.0Sm respectively. During Emergency events, the allowable primary stresses are increased by a factor of 1.5 times the values for Normal and Upset events. During Faulted events, the allowable primary stresses are increased by a factor of 2.0 times the values for Normal and Upset events. Secondary stresses are not required to be evaluated for Emergency and Faulted events.

4.2.2 The values of Sm and Sy as well as any other required material property shall be obtained from the document in Paragraph 2.2.1.a (ASME Code, Section III Appendices), except for alloy X-750. The values of Sm and Sy for alloy X-750 at operating temperature are 47,500 psi and 92,300 psi respectively. These values must be verified from the Certified Material Test Reports (CMTR's). The value of Sm must be determined using the method of Appendix III from the document of paragraph 2.2.1.a. If Certified Material Test Reports (CMTR's) are used to determine stress allowable values, the value of Sm for XM-19, or for stainless steel may be determined using the method in Appendix III of the document in Paragraph 2.2.1.a.

4.2.3 Stress limit values for bolts shall be from Subsection NG-3230 of reference Document 2.2.1.c.

4.2.4 The maximum permanent deflection of any point on the shroud adjacent to either the H2 or the H3 weld shall be less than 2.1 inches divided by SFmin, during all of the load combinations specified in Paragraph 4.3.5. The maximum permanent deflection of any point on the shroud adjacent to either the H5 or H6 weld shall be less than 0.75 (Reference 2.1.1.j) inch divided by SFmin, during all of the load combinations specified in Paragraph 4.3.5. The maximum transient elastic deflection during the seismic event adjacent to either the H5 or H6 weld shall be less than 1.68 inches, and adjacent to either the H2 or H3 weld shall be less than 5.4 inches, each divided by SFmin specified in Paragraph 4.3.6. The allowable deflections are in part based on test data from the document in Paragraph 2.1.1.j.

4.3 <u>Design Requirements</u>

4.3.1 <u>General</u>. The shroud repair hardware shall be designed to horizontally support the top guide, core support plate, the fuel assemblies and the shroud head. The shroud repair shall be designed to prevent upward displacement of the shroud. The shroud repair shall be designed for 40 years, to include 30 effective full power years. The shroud repair shall be removable. Because any existing defects in the shroud horizontal welds will not be removed by implementing this repair, the requirements of IWB-3142 cannot be met. Therefore, approval of this alternative code repair must be granted by the office of the NRR.

4.3.2 <u>Spring Preload</u>

4.3.2.1 <u>Installation Preload</u>. All of the springs shall be installed with a preload due to bending deflection greater than the deflection resulting from the limiting design upset condition, exclusive of seismic events. The required installation spring bending preload is 0.07 inch for the upper springs, and 0.01 inch for the lower springs. (Middle spring is installed without bending preload).

4.3.2.2 <u>Preload Relaxation</u>. The design shall consider an End-of-Life preload relaxation of 5% for the upper springs near the H2 and H3 welds and a relaxation of 5% for the middle spring near the H4 weld and a relaxation of 5% for the lower springs near the H5 and H6 welds. Preload relaxation value of 5% is based on the reference document 2.4.d.

4.3.3 <u>Environmental Conditions</u>

4.3.3.1 <u>Temperature</u>. The design temperature for the repair hardware is 575 degrees F. The operating temperature is 550 degrees F. Operating temperature shall be used for emergency and faulted evaluations. For upset transient (scram with loss of feedwater pumps) condition use 300 degrees F based on report #11 in reference 2.3.d.

4.3.3.2 Radiation. The maximum neutron radiation level (flux) at the shroud stabilizers in the shroud vessel annulus is 3.3E11 neutrons/cm^2/sec. This will not affect the properties of the stabilizer materials for the design life specified in Paragraph 4.3.1.

4.3.3.3 Water Chemistry

	Power Operation	Cold Shutdown/ Refuel (max Values)
Conductivity (@25°C)	0.3 umho/cm	2.0 umho/cm
Chloride	5.0 PPB	100 PPB
Sulfate	5.0 PPB	100 PPB
pH @ 25°C)	7.0	5.3 - 8.6
Dissolved Oxygen (HWC)	20 PPB	NA
Dissolved Oxygen (NWC)	300 PPB	7.0 PPM

4.3.3.4 Water Flow in the Annulus

a. At and above the jet pump suction inlet 98,000,000 lbs/hr.

b. Below the jet pump suction inlet - 34,200,000 lbs/hr.

4.3.4 Physical Interfaces

4.3.4.1 The shroud repair hardware shall restrain the shroud during all of the load combinations in Paragraph 4.3.5. The allowable permanent motion is dependent on the safety significance of the portion of the shroud under consideration. The allowable permanent motion for those portions of the shroud, which affect control rod insertion, is given in Paragraph 4.2.4. For the remaining portion of the shroud below H3, the allowable permanent motion is determined such that the reflooding of the inside of the shroud up to two thirds of core height is assured. For the portion of the shroud above H2, the allowable motion is 2.56 inches, which assures that the core spray lines are not impacted by the shroud (note-1). The allowable motion of the Shroud Repair Hardware shall be less than 0.55 inch near the jet pump riser brace to prevent impact (note-2).

Note(s): 1) 2.56 inches is estimated from; Shroud Dwg 718E861, Rev.6 and Reactor Assembly Dwg #104R861, Rev. 10.

2) This dimension will be verified by the installer.

4.3.4.2 The shroud repair hardware must provide features which facilitate handling during installation and removal. The upper and lower springs shall be movable without removing the tie rod and without welding, in order to permit inspection of the reactor pressure vessel with GERIS 2000. The upper springs must also permit inspection of the core spray line and the previously designed clamp modification fix.

4.3.4.3 All parts shall be captured and held in place with a method that will last for the design life given in Paragraph 4.3.1.

4.3.5 Load Combinations. The load combinations that the shroud and the shroud repair shall be analyzed for are from the Dresden UFSAR, ComEd Technical Requirements document for Dresden/Quad Cities Core Shroud Repair, and BWROG - VIP shroud design criteria recommendations. The limiting Normal/Upset event is an Operating Basic Earthquake (OBE), plus Normal pressure differences, plus dead weight plus Thermal Load. The Emergency 1 event is a Design Basis Earthquake (DBE), plus normal pressure differences, plus dead weight. The Emergency 2 event is a main steam line LOCA plus dead weight. The Emergency 3 event is a recirculation line LOCA plus dead weight. The Faulted 1 event is a Design Basis Earthquake (DBE), plus a main steam line LOCA, plus dead weight. The Faulted 2 event is a Design Basis Earthquake (DBE), plus a recirculation line LOCA, plus dead weight. Additionally, an analysis shall be performed for the upset thermal case of a loss of feedwater pump transient, as defined by report #11 in reference 2.3.d.

4.3.5.1 The pressure differences for normal/upset and faulted conditions are given in the table below. The pressure inside the shroud is higher than that outside of the shroud, and the pressure is higher below the core plate than above the core plate (Ref. 2.3.b).

Component	RRLB Faulted Condition/ Normal/Upset Condition	MSLB Faulted Condition
Shroud Head and Upper Shroud	7 psi	12 psi
Core Plate	17 psi	20 psi
Lower Shroud	25 psi	30 psi

4.3.5.2 A new seismic analysis based on the documents in Paragraph 2.1.1.i , 2.3 and 2.4 shall be performed which includes the shroud stabilizers. The shroud stabilizers shall function for the entire continuum from an uncracked shroud to a fully cracked shroud. Therefore, multiple conditions must be analyzed, for both the DBE and the LOCA events. As a minimum, the following shroud conditions shall be analyzed:

a. The OBE in both the E-W and N-S directions for:

1. Uncracked shroud

2. Hinge at all welds

3. Hinge at H3

4. Hinge at H4

5. Hinge at H7

b. The DBE in both the E-W and N-S directions for:

1. Uncracked shroud

2. Hinge at all welds

3. Hinge at H3

4. Hinge at H4

5. Hinge at H7

6. Roller at H1

7. Roller at H3

8. Roller at H4

9. Roller at H7

The limiting seismic loads on the stabilizer are given in the table below (Ref. 2.4.e).

		DBE	
Component	OBE	Emergency	Faulted
Upper Spring	67,000 lb.	134,000 lb.	140,000 lb.
Middle Spring	12,000 lb.	23,000 lb.	24,000 lb.
Lower Spring	93,000 lb.	186,000 lb.	190,000 lb.
Set of 4 Tie Rods (each)	96,000 lb.	310,000 lb.	169,000 lb.* 310,000 lb.*

* 169,000 lb. (DBE/Faulted for combination with MSLB LOCA pressure)
* 310,000 lb. (DBE/Faulted for combination with RRLB LOCA pressure)

4.3.5.3 Two steady state thermal conditions shall be evaluated. The first is Normal operation with the shroud at 550 degrees F, and the stabilizer assembly at 538 degrees F. The second condition is an Upset transient (scram with loss of feedwater pumps) with the shroud at 433 degrees F, and the stabilizer at 300 degrees F. The number of events is defined by 921D265 (document 2.1.1.h), except for upset transient condition which are 10 cycles. (Reference 2.3d)

4.3.5.4 During the recirculation line LOCA event, based on the document in Paragrpah 2.4.c., there is a maximum resultant force applied to the shroud of 169,000 lbs, with a moment of 13.0E6 in-lb acting at the base of the shroud. This is due to asymmetric pressures imposed on the shroud. This force exists for a sufficient time (~5 seconds) to be treated as an equivalent static force. The accoustic component is bounded by the steady state blowdown component.

4.3.6 Required Safety Factors. The minimum safety factors (SFmin) shall be 2.25 for Normal and Upset events, 1.5 for Emergency events, and 1.125 for Faulted events. These are based on GE Design Safety Standards for Boiling Water Reactors (NEDE-1037D, Class II, 71NED 15, June 1971) These SFmin will be used to determine the acceptable displacements.

4.4 Materials. ASTM specification material is acceptable for the Shroud Repair. CMTRs are required for all material. Materials shall be highly resistant to Intergranular Stress Corrosion Cracking (IGSCC) or Irradiation Assisted Stress Corrosion Cracking (IASCC).

4.4.1 The springs shall be made of nickel-chrome-iron alloy X-750 (UNS N07750). The cobalt content shall be limited to a maximum of 0.09%. Alloy X-750 shall be purchased per ASTM B-637 and age hardened per P10JYP2. Alloy X-750 material shall be tested per E50YP11. In lieu of testing per E50YP11, all finished components may incorporate the removal, after solution heat treatment, of a minimum of 0.030 inches of material from all surfaces of the original raw material form.

4.4.2 The components may be made of either 304, 304L, 316, or 316L material with a maximum carbon content of 0.02%, and annealed at 1900 to 2100 degrees F followed by quenching in circulating water to a temperature below 400 degrees F. The tie rod material shall be tested per E50YP11 and E50YP20. The maximum hardness shall be R_B 90 for 304 and R_B88 for 304L. The maximum hardness shall be R_B 92 for 316 and 316L. XM-19 with a maximum carbon content of 0.04% may also be used for fabrication of the tie rods. XM-19 shall be annealed at 2,000 $\pm$ 50 degrees F, followed by rapid cooling, and shall be tested per E50YP13, or per ASTM A-262 Practice E.

4.4.3 Other parts shall be made of any of the materials listed in Paragraph 4.4. The filler material for any required weld buildups on 300 series stainless steel shall be Type 308L per P50YP102. All assembly welds shall satisfy P50YP102.

4.5 Leakage Due to Repair. Zero leakage is not required. However, the design shall control the Normal and Upset operating condition leakage to prevent cavitation of the jet pumps. The leakage after any required load combination shall be limited such that core flooding to 2/3 the height of the core is assured.

4.6 Inspections. Liquid penetrant examination shall be performed on all final machined surfaces of all stabilizer components, and on all structural welds in accordance with the requirements E50YP22A.

4.7 Fabrication

Welding requirements are only included herein as a repair contingency.

4.7.1 Welder and Weld Procedure Qualification. Welders and weld procedures shall be qualified per the document in Paragraph 2.2.1.b. Welder qualifications shall include limited access similar to the actual welds to be completed.

4.7.2 Root Pass. The root pass of all full penetration single sided stainless steel welded joints shall be made by the GTAW process. Protective gas back-purging is required for all full penetration single sided welded joints until a minimum of 3/16 inch of weld thickness is completed.

4.7.3 Weld Surface Finish. All welds shall have the final outer surface suitable for liquid penetrant examination. The final surface shall meet the hardness requirements of Paragraph 4.4.

5. QUALITY ASSURANCE

5.1 The shroud repair hardware components are Safety Related as referenced in Paragraph 2.1.2.b, and design, fabrication, and installation activities shall be controlled per GE Quality Assurance Manual #QAM-001, revision 4 which satisfies 10CFR50 Appendix B, in order to assure safe and reliable components.

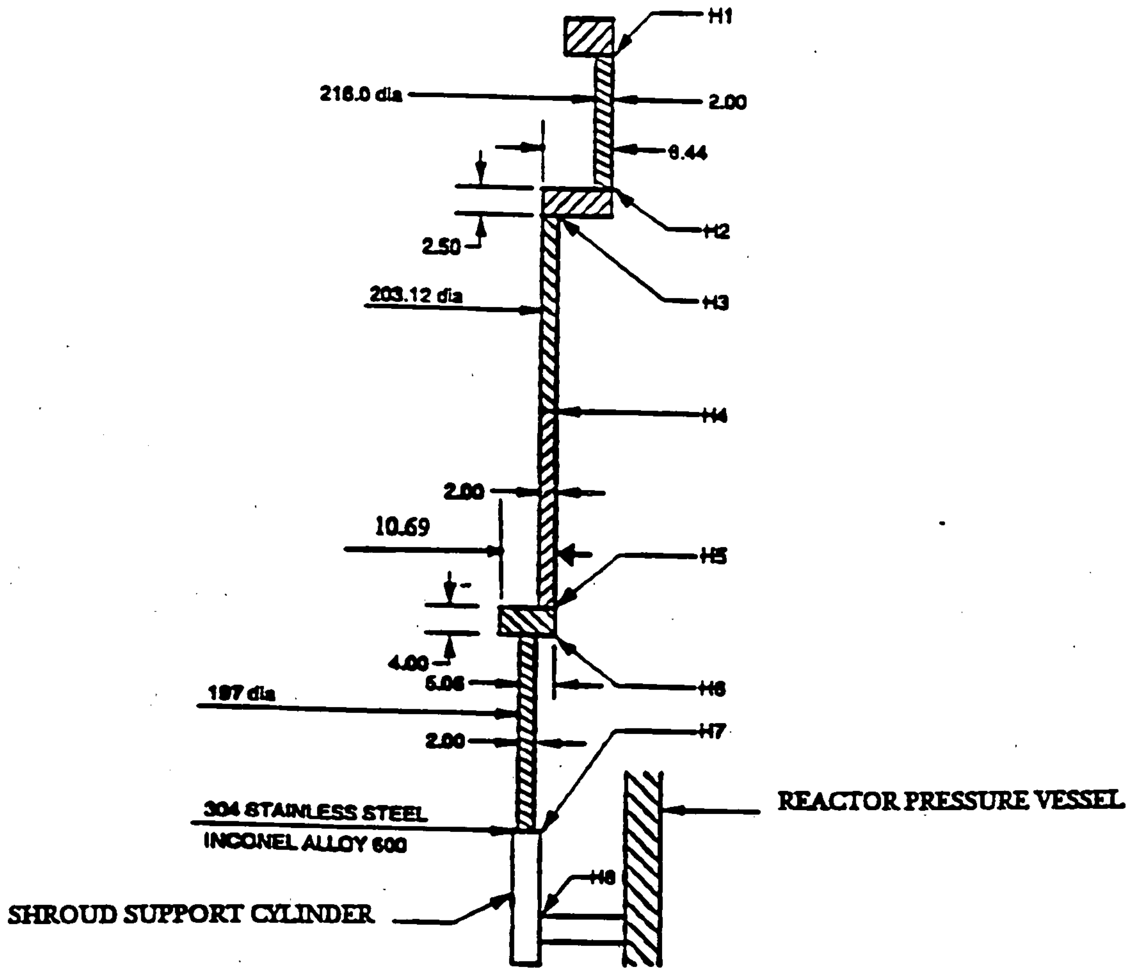

Figure 1. Horizontal Weld Locations In Shroud

NOTE: All dimensions are in inches.

Enclosure 1

GENE Design Specification, 25A5688, Revision 2

Dresden 2 and 3 - Shroud Stabilizer Hardware

k:\nla\dresden\shroud\d52495.wpf