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EIS IDENT: CSS RISER MOD

GE Nuclear

25A5821 SH NO. 1
REV. 1

REVISION STATUS SHEET

DOC TITLE CORE SPRAY SPARGER DOWNCOMER MODIFICATION

LEGEND OR DESCRIPTION OF GROUPS

TYPE: DESIGN SPECIFICATION

FMF: PEACH BOTTOM 2

MPL ITEM NO.: PRODUCT SUMMARY SECTION 7
B13 D023

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

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PRINTS TO

MADE BY	APPROVALS	GENERAL ELECTRIC COMPANY 175 CURTNER AVENUE SAN JOSE, CALIFORNIA 95125
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EIS

1. SCOPE

1.1 Purpose. This specification provides engineering requirements for the design, fabrication and installation of a modification to core spray sparger (CSS) downcomer pipes in the Peach Bottom 2 reactor pressure vessel. The purpose of the modification is to maintain structural integrity and system functionality of the CSS downcomer pipes which have intergranular stress corrosion cracking (IGSCC) at the upper connecting sleeve weld and postulated cracking adjacent to weld locations 2,3 and 4 as shown in figure 3-1.Design and analysis shall support installation of clamps at any single downcomer location or at any multiple locations including clamps at all four downcomers locations.

2. APPLICABLE DOCUMENTS

2.1 GE Nuclear Energy Documents. The following documents form a part of this specification to the extent specified herein:

a.	886D499	Reactor Vessel, Purchase Part Drawing
b.	136B1908P001	Clamp *(Core Spray Line)*
c.	920D824P001	Core Spray Line
d.	729E458P001	Shroud *(includes Core Spray Spargers)*
e.	104R941G001	Reactor Assembly
f.	194X829G001	Reactor Internals
g.	161F290	Core Spray System, Process Diagram
h.	731E779	Core Spray Sparger
i.	158B8353P001	Bracket *(Core Spray Line)*
j.	E50YP11	Examination for Intergranular Surface Attack
k.	D50YP5	Nickel-Graphite Thread Lubricant
l.	E50YP13	Sensitization Tests for Austenitic Stainless Steel Modified ASTM A262 Practice E
m.	E50YP20	Determination of Carbide Precipitation in Wrought Austenitic Stainless Steel, Modified ASTM A262 Practice A

n. P50YP211 Cleaning and Cleanliness Control of Reactor System Components

o. PDS-119 Packaging Data Sheet

p. 25A5341 Reactor Vessel - Power Rerate

q. E50YP22 Liquid Penetrant Examination

2.2 GE Nuclear Energy Vendor Documents. The following documents form a part of this specification to the extent specified herein:

a. 2754-099 Reactor Vessel As Built Dimensions

b. 2754-100 Reactor Vessel As-Built Dimensions

c. 2754-101 Reactor Vessel As-Built Dimensions

d. 2343-11(1) Shroud

e. 2343-11(2) Shroud

f. 2343-11(3) Shroud

2.3 PECO Energy Company Documents. The following PECO Energy Company documents form a part of this specification to the extent specified herein:

a. UFSAR, Peach Bottom Unit 2.

2.4 US Nuclear Regulatory Commission

a. USNRC IE Bulletin No. 80-13, Cracking in Core Spray Sparger, May 12, 1980

2.5 Codes and Standards. The following codes and standards (issue in effect at the date of the purchase order, or as specified in this specification or its supporting documents) form a part of this specification to the extent specified herein.

2.5.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

a. Section III, Division I, Nuclear Power Plant Components, Subsection NG, Core Support Structure, 1989 Edition.

b. Section IX, Welding Qualifications, latest Edition.

c Section V, Nondestructive Examination, 1989 Edition.

2.5.2 US Federal Register Code of Federal Regulations (CFR)

a. 10 CFR 50 - Title 10, Energy; Chapter 1, Nuclear Regulatory Commission; Part 50, Licensing of Production and Utilization Facilities.

(1) Appendix A, General Design Criteria

(2) Appendix B, Quality Assurance Criteria for Nuclear Power Plants

b. 10 CFR 21, Reporting of Defects and Noncompliance

3. DESCRIPTION

3.1 Core Spray Sparger Downcomer Welds. Each CSS (upper and lower) includes two 6 NPS schedule 40 inlet pipes which penetrate the shroud. An elbow and vertical pipe spool are connected to these inlet pipes outside the shroud; the assembly of this elbow and the vertical pipe spool will be referred to as the CSS downcomer. The core spray lines (CSL) connect to the CSS downcomer pipes at the approximate elevation of the top of the shroud. The field welded connection between the CSL downcomer and the CSS downcomer pipe is shown at zone B-16, sheet 1 on reactor assembly drawing 2.1.e. The semi-circular CSL is a 304 stainless steel pipe run internal to the reactor. Its purpose is to carry the core spray system flow from the core spray nozzle thermal sleeve (located at 484.5 inches elevation above vessel zero, at azimuth 120° (N5A), and at azimuth 240° (N5B), see 2.1.a and 2.1.e) to two of the CSS downcomers. The 6-inch CSL laterals are welded to an 7.93 inch outside diameter T-box as shown on 2.1.c. The CSL T-box connection with the core spray nozzle thermal sleeve is a reactor assembly weld as shown on sheet 1, zone B-15 (2.1.e). Each horizontal section of the CSL is supported from the vessel wall by a CSL bracket (158B8353P001) which is welded to the vessel 20 inches from the nozzle, and a CSL clamp (see 136B1908P001 and sheet 4 of 2.1.a), located at 15°, 165°, 195°, and 345°.

3.2 CCS Downcomer Modification Special core spray sparger inspections done in response to IE Bulletin 80-13 (2.4.a) have located defects in these structures , which seem to be with some of the original fabrication and installation welds. Figure 3-1 identifies the downcomer welds and shows a typical defect. A repair (by modification) will be designed to address the potential for cracking in the downcomer pipe from below weld 1 through weld 4.

3.3 Modification Concept. The CSS downcomer modification includes an external clamp assembly which will be mechanically attached to the CSS downcomer at the defect area. The clamp is placed on the CSL downcomer above the junction with the CSS downcomer pipe, as shown in Figure 3-2. Figure 2-3 shows the clamp arrangement for the longer downcomers at the 7.5° and 172.5° locations. A lower clamp is placed at the location of the pipe to lower elbow weld (weld #4). This clamp encircles 360 degrees of the weld. To provide lateral stability at weld locations 1 through 3, the upper clamp is extended downward past these welds. This downward extension encircles the pipe below weld number 3 with an open cage type design which allows for variations in pipe alignment from top to bottom of the joint area and will maintain the pipe | alignment in the event of crack growth to 360 degrees. The upper clamp is joined by a U-bolt to the elbow to provide vertical structural continuity across the defect area

Figure 3-2 shows the clamp arrangement as installed on the longer downcomer pipes at locations 7.5° and 172.5°. The downcomers located at 187.5° and 352.5° are somewhat shorter and the functional requirements can be achieved with the upper and lower clamps integrated into a single assembly.

4. REQUIREMENTS

4.1 Codes

4.1.1 The core spray sparger downcomer is not classified as an ASME code item. Accordingly, this modification is not a code item, but the CSS downcomer modification design shall take guidance from ASME Code, Section III, Subsection NG, as specified in paragraph 2.5.1.a. The original design of the CSS downcomer and CSL used an earlier version of ASME Section III as a guide for design and analysis.

4.2 Safety

4.2.1 The CSS downcomer modification is classified as essential to the safety of the plant according to the definition of Criteria I of the NRC General Design Criteria, 10 CFR 50, Appendix A [refer to paragraph 2.5.2.a(1)]. This classification is based on the core spray sparger function of providing emergency core cooling.

4.2.2 The CSS downcomer modification shall be designed to meet the applicable requirements of NRC Quality Assurance Criteria, 10 CFR 50, Appendix B [refer to paragraph 2.4.2.a(2)].

4.3 Functional

4.3.1 Installation. The design shall be sufficiently flexible to accommodate the specified full range of tolerances from the drawings and documents identified herein. The design of the CSS downcomer modification shall consider the intention that installation will be done remotely by underwater technicians working from the refueling bridge. Threaded fasteners, which are not otherwise captured by the design, shall be lock welded or fitted with lock welded retainers during installation. Alternatively, threaded fasteners may be locked with mechanical (crimped) retainers which have been previously qualified for in-reactor use. All modification hardware and tooling shall be cleaned and inspected for cleanliness prior to use in the reactor. Previously demonstrated proactive measures shall be taken to prevent loose parts during the installation. The modification design shall be done in concert with the design of any special installation tooling required to minimize the installation time and exposure to the installation personnel.

4.3.2 Structural. The CSS downcomer modification design shall be capable of holding the CSS downcomer pipe and elbow securely together in the event of a crack propagating through the entire circumference at the heat affected zone below weld 1 or at welds 2, 3, and 4, see Figure 3-1. Structural adequacy shall be demonstrated by analysis.

4.3.3 Leakage. Leakage from the modified CSS downcomer pipe shall not exceed the system excess capability for injection at reactor pressure. The system capability is 6,250 GPM per nozzle with the reactor at 90 psig (105.6 psia with the torus at 15.6 psia). The current licensing basis analysis of the loss of coolant accident (LOCA) assumes a minimum of 5,000 GPM per nozzle delivered from the core spray sparger inside the shroud. The licensing basis may require revision to reconcile peak fuel clad temperature and core re-flood capability with the system capability considering all the identified leakage sites.

4.3.4 CSL High Point Vent. An 0.25 inch diameter vent hole is drilled in the CSL cover plate as a high point vent. This existing hole shall be considered in the reconciliation of CSL leakage with the system capability.

4.3.5 Reactor Assembly Interfaces. All reactor assembly interfaces shall be considered in the CSS downcomer modification design. If the minimum clearance for installation of the shroud head and separator assembly, including shroud head bolts is reduced by this modification, the designer shall demonstrate that the reduced clearance is adequate. A worst-on-worst tolerance study showing one half inch of clearance is one acceptable method to demonstrate that the shroud head bolts will clear the CSS downcomer modification.

4.3.6 New Welds. New structural welds introduced with the CSS downcomer modification (if necessary) shall be designed to accommodate their remote visual inspection.

4.4 Design

4.4.1 Operating Conditions. The reactor vessel and core spray nozzle operating conditions for the design and analysis of the CSS downcomer modification are defined in the Table 4-1. The temperatures in Table 4-1 reflect the Power Rerate conditions per 2.1.p.

Startup shutdown and core spray system test are classified as Service Level A conditions, in accordance with ASME Code Section III. Based on the need for the modified CSS downcomer to be fully functional for post-LOCA emergency core cooling/flooding, LOCA shall be classified as a Service Level C condition.

4.4.2 Hydraulic Loading. Hydraulic loading on the CSS downcomer and the CSL shall be calculated, based on the flow rates specified in Table 4-1, and considered in the stress analysis.

Table 4-1 Operating Conditions

Operating Event	Initial Condition in Vessel	Followed by	Core Spray Nozzle Thermal Sleeve and CSL Flow/Conditions	Cycles
Startup and Normal Operation	100°F/0 psig/liquid	100°F/hr heatup to 551°F with water @ saturation pressure, followed by steady state operation	No flow/nozzle thermal sleeve filled with stagnate reactor coolant	216
Shutdown	551°F/liquid @ saturation pressure	100°F/hr cooldown with water @ saturation pressure to 100°F	No flow/nozzle thermal sleeve and CSL filled with stagnate reactor coolant	216
LOCA	551°F/liquid @ saturation pressure	15 sec vessel blowdown	Flow ramps linearly from zero at 10 sec, to 6250 GPM at 30 sec/liquid @ 70°F; pressure in the thermal sleeve is 85 psi above reactor pressure when flow is at rated condition (161F290)	1
Core Spray System Test	100°F temperature ambient pressure/liquid	No change in vessel or outside the thermal sleeve	Flow ramps linearly from zero at 7825 GPM in 20 sec/fluid @ 40°F; pressure in the thermal sleeve is 132 psig when flow is at rated condition	5

4.4.3 Seismic Loading. The seismic analysis shall take into account both partial and complete cracking of the shroud welds. The degree of cracking assumed shall be the maximum crack length permitted without shroud repair and complete cracking with the tie rod repair installed.

The seismic analysis shall consider the assumed fuel properties in Table 4-2 below. The core spray line and the clamp loads shall envelope the loadings resulting from these assumed properties.

TABLE 4-2
ASSUMED FUEL PROPERTIES

CASE NO.	TOTAL WEIGHT KIPS	TOTAL INERTIA, $IN.^4$
1	481.21	5377.00
2	500.42	5370.92

Seismic acceleration of the core spray sparger modification and the core spray line shall be taken as 0.937 g horizontal and 0.22 g vertical under OBE conditions. SSE accelerations shall be 1.33 times OBE accelerations. Ten cycles of OBE load shall apply in combination with steady state operation (551°F saturation pressure) as a Service Level B condition. One cycle of SSE load shall apply with LOCA as a Service Level C condition. A 0.40 inch maximum horizontal end-to-end seismic displacement shall also be assumed for the SSE condition, between the shroud and vessel nozzle attachment points of the CSS downcomer/CSL piping.

4.4.4 Thermal Expansion. Differential thermal expansion induced loads and moments in the CSS downcomer shall be calculated based on the operating conditions in Table 4-1, and considered in the stress analysis. Relative displacement of the CSL end points at the shroud, and the vessel shall be accounted for. The low alloy steel vessel and Inconel 600 shroud support configuration are defined on the GENE vendor drawings listed in paragraph 2.2. Pressure dilation of the vessel shall also be considered. The CSL clamps, see section XC-XC sheet 2 and CSL brackets, see section XK-XK on 104R941 sheet 2, shall be considered in determining CSL thermal expansion loads.

4.4.5 Corrosion Allowance. Exposed austenitic stainless steel surfaces shall have a minimum corrosion allowance of 0.003 inch based on a 40 year life.

4.4.6 Neutron Fluence. The fast neutron fluence ($E > 1.0$ MeV) at the CSS downcomer is negligible, so far as the potential for material effects is concerned.

4.4.7 Service Life. This design is a permanent modification; this modification is to be designed for the life of the plant including extensions.

4.5 Analysis

4.5.1 Structural Analysis. Stress analysis of the CSS downcomer modification shall be performed. The results shall be compared to the allowable stresses given in the ASME Code (reference paragraph 2.5.1.a). Loads and operating conditions shall be as defined above. Stress analysis shall also address the CSL, CSS downcomer pipe and elbow where the modification hardware is

attached. The potential impact that added weight and revised stiffness, resulting from the CSS downcomer modification, may have on the CSL shall also be considered in the structural analysis.

4.5.2 Leakage Analysis. Analysis shall be performed to reconcile leakage from the modified CSS downcomer with the leakage requirement of 4.3.3. This analysis shall consider the possibility that relative movement of the shroud, the vessel and the CSL, due to differential thermal expansion and seismic loading, may increase the initial installed leakage area. The leakage from mechanical features shall be calculated based on their detail design and installation requirements. The CSS downcomer IGSCC defects which are made inaccessible for remote visual examination by this modification shall be assumed to propagate 360° around the downcomer weld heat affected zone.

4.5.3 Hydraulic Losses. An analysis shall be made for the additional hydraulic loss created by the addition of internal structures (if any) in the internal CSS downcomer flow path. It shall be demonstrated that the additional loss will not result in a flow less than that assumed as a licensing basis, see 4.3.3.

4.6 Materials

4.6.1 Material Control. Material shall be provided in accordance with ASTM Specifications. Material shall be controlled within the fabricator's shops under a quality assurance program which has been determined by survey/audit to meet material traceability and safety grade manufacturing practices as required by the Code of Federal Regulations 10 CFR 50, Appendix B, and 10 CFR, Part 21. Piece part identification shall be in accordance with paragraph NG-4122 of ASME Code, 2.5.1.a.

4.6.2 Allowable Materials. The following are allowed materials and minimum requirements for the CSS downcomer modification components.

4.6.2.1 Stainless Steel Type 304L, 316 or 316L. Stainless steel type 304L, 316 or 316L shall have a maximum carbon content of 0.020 percent. The material shall be annealed at 1900 to 2100°F, holding 15 minutes per inch of thickness, but not less than 15 minutes total, followed by quenching preferably in gaseous nitrogen (LN2) or in circulating water to below 400°F. Sensitization testing shall be performed per the requirements of ASTM A262 Practice E if there is no welding or per E50YP20 when there is welding. Intergranular attack (IGA) testing per E50YP11 shall be performed, except if a minimum of 0.030 inch of material is removed from all surfaces, then IGA testing is not required. If the 550°F ASME Code design or yield strength values are used for the stress analysis, then the materials shall be tested at 550°F to demonstrate a yield strength exceeding the appropriate Section III design yield strength at 550°F.

4.6.2.2 Stainless Steel Type XM-19. Stainless steel type XM-19 shall have a maximum carbon content of 0.04 percent. The material shall be annealed at 1950 to 2025°F followed by cooling at a rate of at least 200°F per minute. A sensitization test per the requirements of E50YP13 or per ASTM A262 Practice E shall be performed.

4.6.3 Welding Materials. The electrodes used shall be E308L or E316L in accordance with SFA-5.4 or ER308L or ER316L in accordance with SFA-5.9.

4.6.4 Control of Miscellaneous Process Materials. Miscellaneous process materials include such things as machining lubricants, liquid penetrants, solvents, tapes, ultrasonic testing couplant, abrasive grit, packing materials, marking materials, weld spatter compounds, and other materials which will be in contact with the part being fabricated. All miscellaneous process materials shall be controlled to prevent contamination of stainless steel (including XM-19) and Ni-Cr-Fe materials. The known contaminants of concern are chlorides, fluorides, sulfur, lead, mercury and all metals with low melting points. In addition, when welding or heat treating is involved, all carbonaceous material and phosphates must be considered harmful on stainless steel which can pick up these contaminants. Parts may be cleaned in accordance with E50YP211 as one method to control contamination.

4.6.5 Use of Water. The use of water in contact with stainless steel (including XM-19) shall be minimized. As soon as any operation involving water is completed, all stainless steel parts shall be thoroughly dried with hot air or other suitable means.

4.6.6 Liquid Penetrant. Liquid penetrant materials shall meet the requirements of E50YP22A or ASME Code Section V, Article 6, as specified in paragraph 2.5.1.c.

4.6.7 Sensitization of Stainless Steel. Austenitic stainless steel base material (including XM-19) shall be supplied in the solution heat treated condition and after the final solution heat treatment, shall not be subjected to any heating above 800°F except for welding. Parts shall not be heat straightened after final solution heat treatment of the material.

4.6.8 Pickling or Acid Treating. Stainless steel base metal (including XM-19) subjected to welding without subsequent solution heat treatment shall not be pickled or treated with acids in any manner.

4.7 Fabrication

4.7.1 Welder and Weld Procedure Qualification. Welders and weld procedures shall be qualified in accordance with ASME Section IX as specified in paragraph 2.5.1.b. Welder qualifications shall include limited access similar to the actual welds to be completed.

4.7.2 Weld Preparation Cleaning. Weld edge preparations and adjacent surface for a distance of at least one inch shall be reasonably smooth and free of oil, grease, disodium or trisodium phosphate, marking materials or other foreign materials during the entire welding cycle, except that approved anti-spatter compound may be applied up to the weld edge. Temperature indicating materials such as crayons and the foils and wrappers used on stainless steel shall be free of low-melting-point metals, sulfur, and halogens. The residue from temperature indicating materials shall be removed prior to welding over these surfaces.

4.7.3 Stainless Steel Welding (including XM-19). Weld layers shall be built up uniformly along the joint and across the width of the joint. Block welding shall not be permitted. Weld starts and stops shall be staggered.

4.7.4 Weld Interpass Cleaning. Welds shall be cleaned free of slag, flux, and other foreign material prior to depositing subsequent beads. Each weld layer shall be examined visually. Any porosity, slag, or other defects which appear on the surface, shall be removed prior to depositing subsequent beads.

4.7.5 Preheat and Interpass Temperature. The maximum interpass temperature shall be 350°F for stainless steel (including XM-19).

4.7.6 Root Pass. The root pass of all full penetration single-sided stainless steel (including XM-19) welded joints (which will be in contact with reactor water during service) 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.

4.7.7 Weld Surface Finish. All welds shall have the final outer surface (OD) ground or machined smooth, removing all weld ripples and valleys and blending the weld smoothly into adjacent surfaces. Welds shall be suitable for ultrasonic (UT) or liquid penetrant (PT).

4.7.8 Underwater Welding. NA

4.7.9 Hardness Control. The hardness of austenitic stainless steel (excluding XM-19) shall be controlled during fabrication to insure that surface hardness does not exceed Rockwell B-92.

4.7.10 Wire Brushes, Grinding Discs, and Grinding Wheels. Stainless steel wire brushes, grinding discs, and grinding wheels which have previously been used on materials other than stainless steel or nickel-chrome-iron shall not be used on stainless steel (including XM-19) surfaces.

4.7.11 Material Cutting. Thermal cutting processes may be used, provided a sufficient amount of material is removed mechanically from the cut surface to eliminate harmful impurities resulting from the cutting process. If arc air gouging is used, oxides shall be removed from the surface. For stainless steel (including XM-19) the interpass temperature shall not exceed 350°F.

4.7.12 Inaccessible Areas. Areas that will become inaccessible after an assembly operation shall be thoroughly cleaned, prior to assembly, to remove contaminants and heat treatment oxides.

4.7.13 Thread Lubricant. Threaded members shall be assembled with D50YP5B or approved equivalent thread lubricant.

4.8 Inspections. Liquid penetrant examination shall be performed on all final machined surfaces of all new hardware per E50YP22A. Liquid penetrant examination shall be performed on all structural welds for new hardware per E50YP22A.

5. PACKAGING, SHIPPING, AND STORAGE REQUIREMENTS

5.1 General. Equipment shall be packaged in accordance with GE to protect it from damage during handling, shipment, and storage at the construction site. Equipment shall be boxed, securely held in place and packaged to maintain the degree of cleanliness required during manufacturing. Handling equipment, strapping, or holddown devices shall be applied so the equipment is not damaged in any way. Packaging, shipping and storage shall be in accordance with ANSI/ASME N45.2.2 - 1978, as specified in ref. 2.1.n.

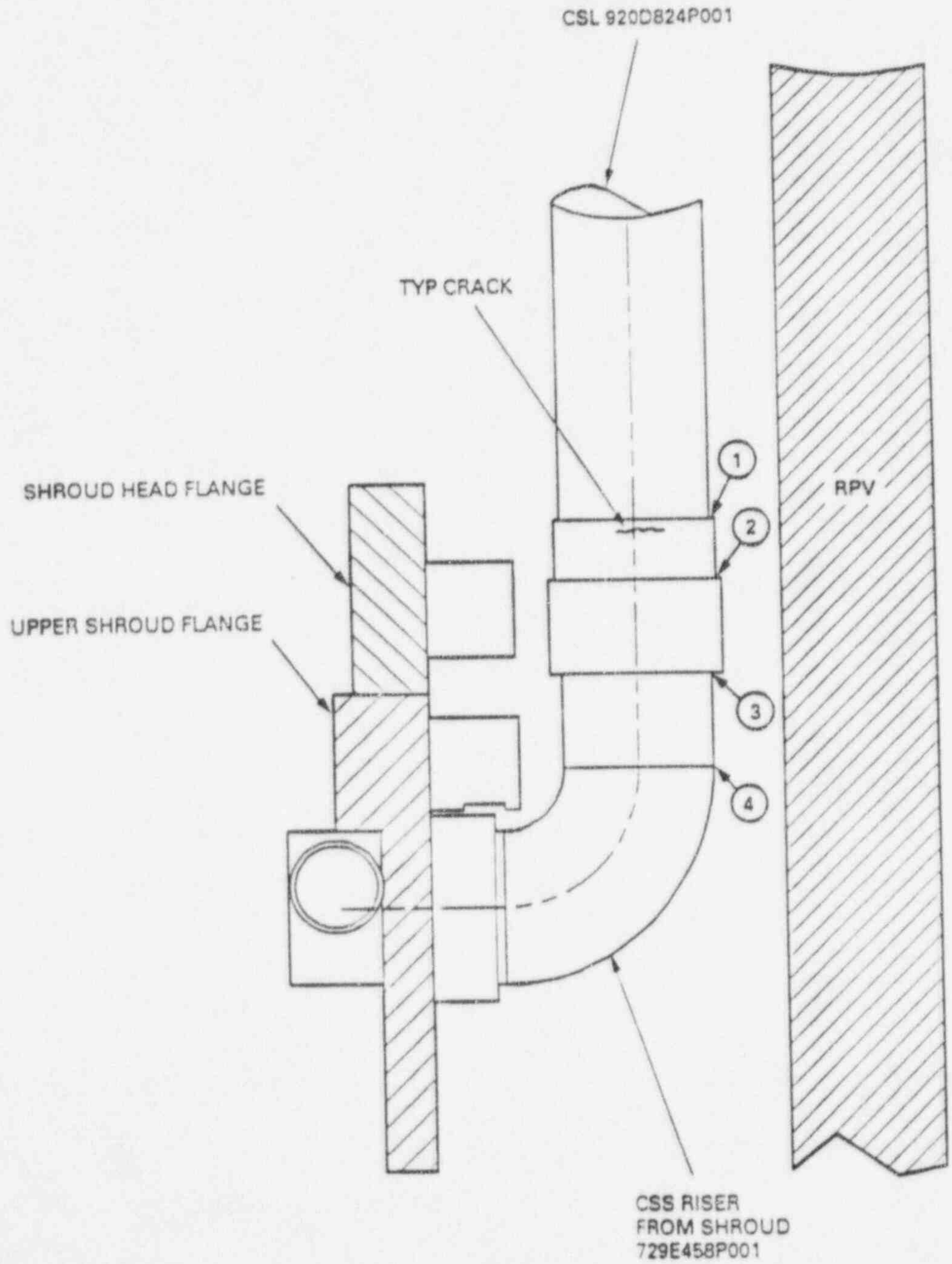

Figure 3-1. Core Spray Sparger Riser/Downcomer

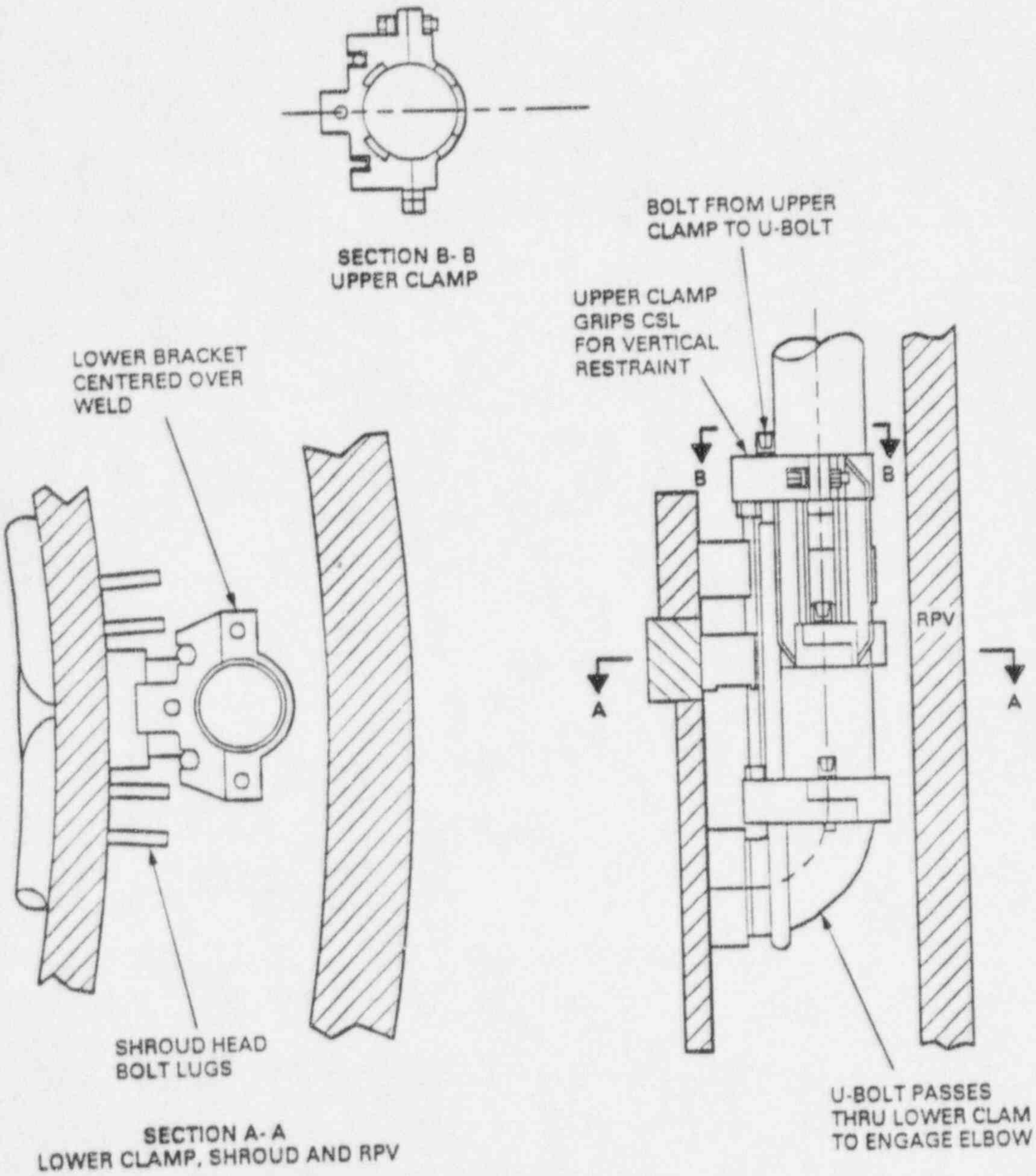

Figure 3-2. CSS Riser Repair Concept