NUCLEAR ROCKET OPERATIONS

SACRAMENTO PLANT

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WELD PROCEDURE FOR REPAIR OF
LARGE OPENINGS IN CYLINDRICAL SHELLS

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WELD PROCEDURE FOR REPAIR
OF LARGE OPENINGS IN CYLINDRICAL SHELLS

by

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Subject: Weld Procedure for Repair of Large Diameter Openings in
Cylindrical Shells

Enclosure: Sketch 1 - Schematic of Weld Overlay on Large Diameter
Openings in Cylindrical Shells

Introduction:

NRO Materials and Process Department was requested to revise and update the Welding Procedure currently employed in the repair of openings in the cylindrical shells of 5000 psi gaseous hydrogen receivers. These openings resulted from removal of one (1) inch diameter nozzles which penetrated through the laminated shells of the receivers. The original modification procedure was released as Technical Memoranda RN-TM-0313 which supplemented Plant Engineering Specification SPE 65-1764 released in November 1965. Revision of this procedure for application to subsequent receivers is based on experience gained during the development work encountered in repair of VL-6 and VH-74 gaseous hydrogen receivers. The additional GH_2 receivers to be repaired or modified are located in Test Area "E" of Aerojet-General, Sacramento, Plants.

I. SCOPE

The following recommended procedure covers the materials, welding operations, and NDT quality assurance provisions required for modification of receiver nozzle openings to the mechanical plug concept.

II. REQUIREMENTS

A. Contractor's Responsibilities

The Contractor shall be responsible for the quality of all the work performed and shall prepare and submit detailed welding Quality Control and non-destructive test procedures to Aerojet for approval prior to performing the particular operation.

The following items are intended to supplement the requirements of the ASME Boiler and Pressure Vessel Code and shall be included in the welding and non-destructive testing procedures submitted by the Contractor.

B. Qualification of Procedures

Welding procedure qualification tests shall be conducted to meet the requirements of Section IX of the ASME Code and the additional requirements as set forth below. This procedure shall contain full information on all the factors set forth in recommended Form Q-1 of Appendix II, Section IX of the ASME Code and shall be recorded and submitted to Aerojet for review and approval.

C. Qualification of Welders

Each welding operator shall complete qualification tests in accordance with the requirements of Section IX of the ASME Code, as applicable, and shall be provided with a certificate for the type of welding for which he qualifies. Welding assignments shall be made only on the basis of individual qualification for the type of welding involved. The Contractor shall maintain a record of each welder showing data and results of qualification tests and his identification mark.

An identifying number shall be assigned to each qualified welder, which symbol shall be stamped adjacent to each weld on exterior surface only. Low-stress or round bottomed stamps shall be used for metal stamping.

D. Repair of Welded Joints

The repair and inspection of welded areas shall be in compliance with Paragraph UW 38 of the ASME Code, Section VIII. Defects requiring repairs shall be subject to approval of Aerojet-General after written submittal by the Contractor stating the nature, location, number and extent of said rework.

III. WELDING PROCESS

A. Welding process used shall be D.C. manual metallic arc employing the following variables.

<u>Welding Process</u>	<u>Filler Material</u>		<u>Amps</u>	<u>Volts</u>
	<u>Class</u>	<u>Size</u>		
D.C. Manual Metallic Arc	SA 316	1/8	80/120	22/26
	A2, F4	5/32	140/190	22/26
	(E10016 D2)	3/16	180/250	22/26

IV. BASE MATERIAL

A. The base material for welding on the vessel shell is carbon steel, A. O. Smith Specification 1146A, per mill test reports from A. O. Smith and conforms to the ASME Boiler and Pressure Vessel Code, Section IX, Group P-3. The base material used for procedure and/or welder qualification shall conform to the material covered in the ASME Boiler and Pressure Vessel Code, Section IX, Group P-3.

V. OPERATIONAL PROCEDURE

A. Grinding

Prior to welding, clean internal surfaces of weldment by grinding followed by power wire brushing.

B. Cleaning

Locally clean the laminated layers of the weldment using a non-flammable solvent such as FREON. A blower shall be provided for the interior of the vessel and shall be in operation during all cleaning operations to remove toxic fumes.

C. Welding Conditions

1. After cleaning and prior to any welding, ensure that the internal and external surfaces of the vessel are dry. Strip heaters shall be used for drying the vessel if moisture is present.

2. Welding operations shall be limited to favorable weather conditions when the relative humidity in the immediate area of the welding operation is 70 percent or less.

3. The weld overlay buildup shall be accomplished by the manual metallic arc process using Type E-10016 D2 low hydrogen electrodes per ASTM A316, also shown in ASME Boiler and Pressure Vessel Code, Section IX, Table 11.2. The maximum diameter of electrode to be used for welding the initial overlay on the vertical wall and one (1) inch of weld buildup at the pressure side of the opening of the vessel shall be 5/32 inch. Welding shall be accomplished using a stringer pass technique. Weaving or oscillation method of weld deposition shall not be permitted.

4. Welding electrodes shall be kept in an electrode oven at 350 to 450 degrees F prior to use after opening of electrode containers. Maximum time electrodes shall be exposed to atmosphere is three hours.

5. Weld area shall be pre-heated to between 200 and 300 degrees F before welding and this temperature shall be maintained during interpass welding. Monitoring of pre-heating and interpass temperature shall be with contact pyrometers only.

6. Pre-heating and interpass temperature shall be accomplished by appropriate resistance heating elements mechanically supported against the internal surface of the vessel. Tacking of the heating elements of the mechanical support to the internal surfaces of the vessel shall not be permitted.

7. Post-heat treatment of the weld is not required under this procedure.

8. Peening of welds will not be allowed under this procedure.

9. After each pass of initial overlay weld, all slag or spatter shall be removed by pickhammer and brush or grinding and then inspected prior to laying down the next successive pass. Each pass shall be inspected for surface defects such as undercut, lack of fusion, irregularity of weld deposits, slag inclusions, porosity and cracks. Repairs, if permitted, shall be made prior to deposition of next pass and recorded.

10. Periodic inspections shall be made by the cognizant Aerojet-General Corporation Field or Welding Engineer throughout the course of the welding operation. The Aerojet-General representative shall be required to inspect each weld pass prior to depositing the succeeding pass during the following operations.

- a. The initial overlay on the vertical wall of the opening.
- b. The initial one (1) inch of weld build-up at the base or pressure side of the opening.

D. OPERATION SEQUENCE

1. After cleaning and pre-heating operations have been accomplished, deposit a weld overlay on the entire cylindrical surface of the opening. The overlay shall consist of a series of stringer passes approximately 1/4 inch in thickness, as illustrated in the attached sketch (1). Upon completion of the welding, grind the entire cylindrical surface smooth in preparation for inspection.

2. Magnetic particle inspect (dry powder method) initial overlay in accordance with the procedures and acceptance of the ASME Boiler and Pressure Vessel Code, Section VIII, Appendix VI, and approved detailed Quality Control and Magnetic Particle procedures.

3. After locally cleaning to remove residual iron oxide, install a formed circular backup ring of ASTM A285 Grade A or B, Firebox quality, condition annealed material to the shell, per sketch (1), over the vessel nozzle opening. The ring shall be supported by mechanical means. Tacking of the ring to the vessel shall not be permitted.

4. Install sections of the cylindrical ring dam fabrication from MT1015 seamless tubing per ASTM A285 condition CSR, ANL, or Norm, compatible with the ASME 0.25 inch vessel laminates. The ring dams shall be 0.062 to 0.094 inch thick by one inch high fitted with machined self-centering segmented copper chill ring (as illustrated in the attached sketch (1)). The copper chill ring shall be constructed to provide a negligible resistance of weld shrinkage. Additional dams shall be installed as the weld progresses.

5. Magnetic particle inspect (dry powder method) after each successive inch of height of deposited weld buildup in accordance with the procedures and acceptance of the ASME Boiler and Pressure Vessel Code, Section VIII, Appendix VI, and approved detailed Quality Control and Magnetic Particle procedures.

SCHEMATIC OF WELD OVERLAY ON
LARGE DIAMETER OPENINGS IN CYLINDRICAL SHELLS

- Notes: (1) Use Back-Up Detail (A), on Nozzle #3 only
(2) Use Back-up Detail (B) on Nozzles #1 and #2.

6. Continue the weld build-up using a stringer bead technique. The weld build-up shall be completed in layers progressive from the back-up plate.

E. Defects

1. Any cracks or blowholes that appear on the surface of any pass of welding shall be removed by chipping, grinding or gouging before depositing the next successive pass of welding. Defects disclosed by magnetic particle inspection shall be described in detail in a formal report submitted to Aerojet with the proposed method of repair. Aerojet approval on the method of repair will be required prior to initiating the repair operation.

F. Removal of Backing Ring

1. Backing ring shall be removed by chipping, machining or grinding.
2. All surface defects shall be repaired and the surface shall be blended to the vessel contour by grinding.
3. Magnetic Particle inspect in accordance with accepted procedures and repair as indicated.
4. Reinspect per Item 3.

G. Welder Identification

1. Each welder shall place his mark adjacent to the weld immediately after completion on the exterior of the vessel only.
2. Non-stress stamps only will be permitted.

H. Final Inspection

1. Radiograph inspect the completed weld overlay prior to machining the bore or sealing surface.
2. Liquid penetrant inspect the nozzle bore and sealing surface after completion of final boring and machining operations.

VI. QUALITY ASSURANCE REQUIREMENTS

A. Non-Destructive Inspection

1. All magnetic particle inspection shall be performed in accordance with the procedures and acceptance criteria of ASME Boiler and Pressure Vessel Code, Section VIII, Appendix VI, using dry powder methods. Submit detailed procedures and qualifications on the Inspector to Aerojet-General for approval.

2. Magnetic particle inspection shall be performed at the following stages of the welding operation:

- (a) After the completion of the initial 0.25 inch of weld overlay on sidewall.
- (b) After each successive inch of height of deposited weld buildup.
- (c) After removal of the backup plate.
- (d) After removal of any defect and prior to weld repair.
- (e) After rework of any weld defect.

Magnetic particle inspection using the "prod" technique shall not be applied to the interior surfaces of the receivers under any condition.

3. All radiographic inspection shall be performed in accordance with the procedures and acceptance criteria of ASME Boiler and Pressure Vessel Code, Section VIII, Paragraph U-51. Submit detailed process procedures and qualifications of the Inspector to Aerojet-General prior to performance of work. The radiographic film after processing shall be delivered promptly to Aerojet-General Corp. for review and final approval. Any radiographs which do not conform to the required standards of quality, definition, intent, or purpose must be re-radiographed and the films resubmitted promptly to Aerojet-General at the Supplier's expense.

4. Radiographic inspection of the nozzle weldment shall be performed after completion of all welding. Removal of the weld backing plate and any rework required therefrom shall have been completed prior to radiographic inspection.

5. Liquid penetrant inspection shall be performed in accordance with the procedures and acceptance criteria of the ASME Boiler and Pressure Vessel Code, Section VIII, Appendix VIII, using visible dye penetrants.

6. Visible dye penetrant inspection shall be used to inspect the nozzle bore and finish machined sealing surface.

B. Procedure and Process Approvals

1. Special processes such as, but not limited to, welding, weld repairing, quality control, non-destructive testing and inspection and any subcontracting thereof, require approval or certification of process equipment, procedures and personnel, as indicated in the applicable specifications and standards. Approval of all procedures must be established with Aerojet-General prior to fabrication under this scope of work.

C. Certification of Materials

1. Each shipment of materials such as welding electrodes, backup rings or plates shall be accompanied by two (2) legible copies of chemical test reports identifiable with specification requirements and materials submitted. These reports shall contain the signature of the responsible representative of the agency performing the test and must assure conformance to the specification requirements.

D. Records and Reports

1. All records and reports covering materials and processes such as, but not limited to: non-destructive test inspections, material certifications, process certifications, repair operations, discrepancy reports, shall be maintained complete and current at all times.

E. Process Certification

1. Copies of the certification for processes covered by specification such as, but not limited to: welding, magnetic particle inspection, radiographic inspection, and liquid penetrant inspection, etc., shall be submitted stating that the specific processing was performed to specification requirements. The certification shall list the applicable specifications including revision letter(s) or number(s) to which the processes conform, and the name of the agency that performed them.

F. Deviations

1. No changes or deviations shall be made from any approved procedure, drawing or specification without first obtaining approval of Aerojet-General Product Assurance Engineering.