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REON TECHNICAL MEMORANDUM

WELD PROCEDURE FOR REPAIR OF LARGE OPENING
IN THE CYLINDRICAL SHELL
OF VESSEL VH-74

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SUBJECT: WELD PROCEDURE FOR REPAIR OF THE LARGE OPENING IN CYLINDRICAL SHELL OF VESSEL VH-74

ENCLOSURE: Sketch 1 - Cross Section Large Opening, Vessel VH-74

I. INTRODUCTION

The REON Materials Department was requested to examine GH_2 pressure vessel VH-74 and prepare recommendations for a weld procedure to accomplish the repair of the 5.5 inch to 6.5 inch diameter opening in the cylindrical shell. Visual examination of this vessel was performed to establish applicable welding and inspection techniques to be applied. The recommendations enclosed are the result of technical discussions between materials, stress, project and field personnel on methods to accomplish the repair of VH-74, and reflect the technical developments of these meetings.

II. CONCLUSIONS

The opening in the cylindrical shell of VH-74 which resulted from removal of the one inch diameter boss should be repaired without re boring to minimize the amount of welding. A weld overlay build-up will be provided to reduce the hole size, thereby enabling the application of the mechanical plug concept to facilitate the repair of vessel VH-74.

III. TECHNICAL DISCUSSION

The opening to be repaired in VH-74 has a uniform diameter of 5.5 inches from the vessel interior surface to approximately the middle lamina. From this

point, the hole has a uniform taper to a diameter of 6.5 inches at the exterior surface. The total thickness of the vessel wall is approximately 6.85 inches.

It is proposed that internal surface of the existing hole be overlayed with deposited weld metal to finish to a diameter of 3.5 inches.

The following recommendations are made to accomplish the satisfactory repair of the large opening in the cylindrical shells of vessel VH-74 and to minimize the risk of inferior weld quality.

IV. REQUIREMENTS

A. Contractor's Responsibilities

The Contractor shall be responsible for the quality of the welding performed and shall prepare and submit a detailed welding procedure to Aerojet for approval prior to welding.

The following items are intended to supplement the requirements of the ASME Boiler and Pressure Vessel Code and shall be included in the welding procedure 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 of 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 welder and welding operator shall have completed 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 is currently qualified. 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, only low-stress or round bottomed stamps shall be used for metal stamping.

D. Repair of Welded Joints

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

V. WELDING OPERATING CONDITIONS

A. Cleaning

1. Obtain information on lubricants, cutting oils or solutions used for the initial removal of the boss weldment and applied non-destructive tests performed on vessel VH-74.

2. Prior to welding clean internal surfaces of existing 5.5 to 6.5 inch diameter hole by grinding followed by rotary wire brushing using a long bristle brush without re boring the hole. Magnetic particle (dry powder)

inspect ground surfaces of the opening for possible cracks or discontinuities in the parent metal layers with special attention given to the pressure vessel ID lamina.

3. It is suggested that methyl ethyl ketone (MEK) solution be used to remove contaminants resulting from initial removal of the boss and subsequent NDT solutions lodged between the laminations. Use adequate safety precautions because of toxicity and flamability of solvents.

B. Welding

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

2. Welding operations shall be limited to favorable weather conditions when the relative humidity is 70% or less.

3. The weld overlay build-up shall be accomplished by the manual metallic arc process using Type E 10016 low hydrogen electrodes per ASTM 316. Maximum diameter of electrode used for the welding operation shall be 3/16 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 dry storage prior to use. After opening electrode containers, electrodes shall be kept in commercial ovens to prevent moisture pickup. Ovens, using temperature control, shall be kept adjacent to the welding operation.

5. Preheating. Weld joints shall be preheated to between 200 and 300 degrees fahrenheit before welding and maintained during interpass welding. Monitoring of preheating of weld area prior to and during weld interpasses shall be with contact pyrometers only.

6. Weld Layer Thickness. The maximum individual layer thickness shall not exceed 1/4 inch.

7. Peening. Each bead of deposited weld metal shall be lightly peened to relieve residual stresses prior to depositing successive weld beads. Peening hammer shall be Chicago Pneumatic Tool Company No. F-C or equal. Peening tool shall be wedge shape, rounded end. Radius of end shall be 1/8 inch minimum.

8. Slag, Weld Spatter and Irregularity of Weld Deposits. Slag shall be removed after each pass or weld deposition. Each pass shall be visually inspected for undercut, lack of fusion, irregularity of weld deposit, slag inclusions and porosity. Repair, if permitted, shall be made prior to deposition of next pass.

C. Operation Sequence

1. Initiate welding from the interior of the vessel on the ID pressure lamina. After cleaning and preheating 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 Sketch 1.

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.

3. Install a formed circular back-up ring of similar material to the Mn-V-Ni shells 0.25 inch thick over the opening on the internal side of the vessel. Support for the back-up ring shall be by mechanical means. Tacking of the back-up ring to the vessel shall not be permitted.

4. The contractor may install ring dams of similar base material (Mn-V-Ni) 0.075 to 0.090 inch thick maximum by one inch high and provide a segmented copper chill ring (Reference Sketch 1). Copper chill ring shall be designed to insure a negligible resistance to weld shrinkage. Additional ring dams may be applied as the weld progresses toward the vessel exterior.

5. Continue the weld build-up using a stringer bead-technique. The weld build-up shall be completed in layers progressing from the back-up plate to the exterior surface of the vessel.

VI. QUALITY ASSURANCE REQUIREMENTS

A. Magnetic Particle Inspection

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 of the Inspector to Aerojet.

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

1. After completion of grinding.
2. After the completion of the initial 0.25 inch of weld overlay.
3. After each successive inch of height of deposited weld build-up.
4. After removal of the back-up plate.
5. After completion of final boring and/or machining operations.

C. Weld and repair procedures must be submitted to Product Assurance Engineering for approvals.

D. Inspection records and tests shall be kept complete.

E. No changes shall be made to any procedures, drawing or specifications without first obtaining the approval of Product Assurance Engineering.

CROSS-SECTION OF LARGE OPENING VESSEL VH-74

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Sketch 1