MANUFACTURING SPECIFICATION

FLARE

FABRICATION OF VACUUM VESSEL

FLARE-SPEC-04

WP1995

REVISION 0

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1.0 INTRODUCTION AND SCOPE

This specification addresses the manufacturing, inspection, test and Quality Assurance (QA) plan for the fabrication and delivery of vacuum vessel to the Princeton University (PU) Facility for LAboratory Reconnection Experiment (FLARE). The vessel is intended to provide a 1 x 10^{-7} Torr high vacuum environment, and will only be used to hold gases.

Complete compliance with this specification is expected. However, any desired deviations from this specification must submitted to PU for review and must be approved by PU in writing prior to use.

1.1 Definitions of Terms

A. Buyer: Princeton University (PU) will be referred to as the "Buyer."
B. Vendor: The company receiving the contract for the work described in the Specification will be referred to as the "Vendor."

1.2 The Vendor will supply a complete, cleaned vacuum vessel assembly including:

1.2.1 FLARE VACUUM VESSEL
1.2.2 Two FLARE VACUUM VESSEL ENDCAPS
1.2.3 All associated blanks, o-rings, gaskets and hardware required to seal the chamber.

2.0 APPLICABLE DOCUMENTS

2.1 FLARE SOW-04 – FLARE Vacuum Vessel Statement of Work

2.2 STANDARDS and CODES

The following Standards and Codes set forth the minimum requirements. The Vendor is encouraged to recommend superior or more economical designs, processes, or materials. Changes which are jointly agreed to must be formally documented in a signed revision to this specification before being instituted.

1. ASTM American Society for Testing and Materials
   - ASTM A53 and ASTM A530/530M.
2. ANSI American National Standards Institute
3. AWS American Welding Society
   - AWS D 1.6 Classification: Structural Welding Code - Stainless Steel
4. ASME American Society for Mechanical Engineers
   - ASME Boiler and Pressure Vessel Code Section VIII, stamp not required
   - ASME B31.3 Standards of Pressure Piping

3.0 APPLICABLE DRAWINGS

3.1 E-FL600-001 FLARE TOP ASSY vacuum vessel Assembly
3.2 E-FL300-002 FLARE VACUUM VESSEL WELDMENT
3.3 E-FL300-005 FLARE VACUUM VESSEL ENDCAP WELDMENT

4.0 RESPONSIBILITIES

4.1 Princeton University

Michael Kalish will be the technical contact for managing the Vacuum Vessel procurement.

4.2 Vendor

The Vendor shall provide a single point contact to interface with PU.

5.0 REQUIREMENTS

5.1 MANUFACTURING DRAWINGS

1. The Vendor is expected to develop drawings with the details necessary for manufacturing the vacuum vessels. These must be PU approved before use.
2. All tooling drawings are the responsibility of the Vendor

5.2 VACUUM VESSEL MANUFACTURING & TEST PROCEDURES

The final vacuum vessel manufacturing and test (MIT) procedures will be developed by the Vendor and approved by PU.

5.3 TOLERANCES AND DIMENSIONS:

Dimensional characteristics are identified on the vacuum vessel manufacturing drawings as supplied by PU.

5.4 MATERIALS AND PROCESS

All materials used in the construction of the vacuum vessel are called out in the supplied drawings. All materials shall be supplied by the vendor.

1. DEGREASING/CLEANING SOLVENTS:

All vacuum facing surfaces shall be degreased/cleaned by steam cleaning and then using a solvent that is able to remove grease, tar, wax, adhesives, oils and other soils, and is residue free. Solvent selected by Vendor must be approved by PU.

2. VACUUM VESSEL FABRICATION AND INSPECTION:

A. This section describes a recommended procedure for fabricating the subject equipment. In accordance with the Statement of Work [SOW], the selected Vendor shall develop and submit a Manufacturing, Inspection, and Test and Quality Assurance (MIT/QA) plan and manufacturing procedures for approval by PU. Deviations from the approved MIT plan and procedures will require PU approval.

B. Welding shall be performed in accordance with the requirements of ASME B31.3. Visual weld inspection shall be performed in accordance with the acceptance criteria of ASME B31.3, category D. Use of dye penetrants is prohibited.

C. All vacuum sealing welding shall be on the vacuum facing side (internal) and performed according to AWS D 1.6 using the inert shielded Gas Tungsten Arc Welding (GTAW, AKA TIG) process, and must not be finished by grinding or any other mechanical abrasion.

D. Weld regions on the finished vacuum surface shall be free from visible sign of inclusions, scale, crevices, voids, holes of any kind and any defect that may cause a leak.

E. All vacuum surfaces shall be free of cracks, scale, pilling or delamination, or defects of any kind. Extreme care shall be taken to protect the knife sealing edges and sealing surfaces.

F. All vacuum facing parts to be welded must be cleaned within 48 hours **prior** to welding.

G. Welding processes must guarantee that the flange surfaces will not be distorted by the welding operation. Weld distortion of, in particular, large diameter surfaces would prevent proper o-ring sealing. The vendor shall explicitly address this requirement in the quotation by indicating compliance with this directive, or proposing a detailed alternate fabrication method that will be used to obtain the same results. In either case, the flatness, perpendicularity, circularity, and concentricity of the flanges with respect to the tubular part of the vessel shall conform to the applicable drawings.

H. Unless specified on the drawings, and excluding weld areas, all chamber interior vacuum surface finishes will be less than 62 micro inches.

I. Operations to vacuum surfaces shall not cause contaminants to be embedded into the surface. Therefore, the use of abrasive resin/rubber bonded wheels, abrasive cloths, burnishing, honing, sanding or shot blasting, and cutting with dull tools is prohibited. Techniques permitted for improving of the vacuum exposed surface are slurry blasting with alumina or glass beads, electro-polishing, 300 series stainless steel brushes and hand finishing with ScothBriteTM (Grade A). Ceramic bonded abrasives, tungsten carbide or diamond wheels/tools of 60 grit or finer may be used. These tools shall be new or have been previously used on 300 series stainless steel only. Any type of acid treatment is prohibited.

J. Machining of vacuum surfaces shall be performed using a water-soluble cooling fluid that is free of silicone, sulfur, phosphorus, or halogens. The recommended cutting fluid is Trim Sol.

K. Vacuum Vessel Endcaps will be base on "ASME Flanged and Dished" heads, with the dish radius = head diameter, and the knuckle radius = 6% head diameter. Vendor deviation from this design will require PU written approval.

L. All vacuum flanges, including mating flanges will be standard ISO-LF or Conflat design. The exception to this rule will be the custom large endcap joining flanges, as specified in the drawings. The required flanges are called out on the supplied drawings. Rubber plugs and plates of any functional material may be used to temporarily seal ports that do not have blanks for leak checking purposes.

M. All non-vacuum exterior surfaces will be free of oil and debris.

N. All edges will be de-burred, and have a minimum 0.01” bevel.

3. VACUUM VESSEL ASSEMBLY:

Prior to assembly, PU appointed staff will be allowed onsite access to inspect individual components of the vacuum vessel.

The vendor shall assemble all parts of the vacuum chamber assembly for final leak checking. Parts shall be assembled with appropriate clean gloves in a clean assembly area.

It is imperative that all sealing surfaces and gaskets be clean and free of debris during assembly. Small amounts of PU approved vacuum grease will be allow on sealing o-rings.

In assembling the vacuum vessel and associated blank flanges, all bolts or studs shall be tightened carefully step-by-step in proper cross sequence to ensure an even pressure on flanges. For the ISO-LF clamp flanges, the vendor must provide the middle of the manufacturer recommended range for number of clamps for each flange.

6.0 TEST AND INSPECTION REQUIREMENTS

The Vendor has sole responsibility for dimensional inspection of all vacuum vessel components. Results of the inspections and tests are to be provided to PU as part of the Process History (reference FLARE-SOW-04). The vacuum vessel manufacturer shall notify PU in advance to permit PU's representatives to witness any of the inspections or tests, either in process or final acceptance.

6.1 IN-PROCESS TESTING AND INSPECTION:

These tests are to be performed during the manufacturing process.

Visual Inspection:
A visual inspection of all welded joint shall be made to ascertain complete flow of weld material into the joint area. There must be no visible sign of inclusions, scale, crevices, voids, holes.

Verify and visually inspect that vacuum sealing weld surfaces are clean prior to welding.

6.2 FINAL ACCEPTANCE TESTING AND INSPECTION:

These tests and inspections shall be performed once the vacuum vessel is cleaned, assembled, and in a deliverable configuration. PU will be given prior notice as to when testing can begin. An acceptable date for testing must be agreed upon by both parties.

All test data, including results, shall be recorded in the vacuum vessel Manufacturing Package. If the vacuum vessel fails any of the tests, a Nonconformance Report [NCR] documenting the failure shall be generated and provided to PU.

A. Dimensional Inspection:

A dimensional check shall be made on each finished vacuum vessel component to verify that it meets the tolerance requirements as stated in the applicable drawings. This inspection can be performed prior to cleaning.

B. Vacuum Testing

a. The vendor will leak check the completed assembly to the specified values:
   1. No individual leak greater than 1x10^-7 SCC/Sec helium is allowed
   2. The global leak rate will not exceed 1x 10^-6 SCC/sec helium.

b. Viton o-rings, mating flanges, and required hardware for leak checking shall be provided by the Vendor, and preassembled by the Vendor prior to leak check.

c. If the vendor can not peform the leak check PU can come to the vendors sight to perform the leak check depending on the proximity of the vendor to PU. With PU provided pumping, gauges and helium leak checker, PU appointed staff perform helium leak checks on the vacuum vessel assembly.

d. If leaks are found, only appropriate stainless steel weld repair is allowed. Epoxy, glue, grease, or other patch type repairs are prohibited. The vendor must provide an onsite welder and other staff necessary to expedite repairs.

7.0 QUALIFICATIONS

See Vacuum Vessel Statement of Work (FLARE-SOW-04)

8.0 ENVIRONMENT, SAFETY, AND HEALTH

N/A

9.0 QUALITY ASSURANCE REQUIREMENTS

See Vacuum Vessel Statement of Work (FLARE-SOW-04)

Upon receipt of QA documents, PU will inspect all components visually and test using the appropriate equipment to ensure compliance with the contract specifications or other contract agreements and that no damage has occurred during shipping. Failure during any of these inspections or tests will require rectification by the vendor as part of the contract conditions. Successful completion of these inspections and tests shall be the basis for final acceptance.

10.0 SHIPPING STORAGE AND HANDLING

See vacuum vessel Statement of Work (FLARE-SOW-04)

10.1 Extreme care is required at all times to avoid causing damage to vacuum surfaces, especially sealing surfaces.

10.2 Powder-free latex, vinyl or cotton lint-free gloves shall always be used when handling cleaned vacuum components.

10.3 After the component has been cleaned, and tested, it must be packed carefully in such way to ensure that it remains clean and free from damage during shipping or storage.

10.4 Assemblies must be secured for shipping so that they are not susceptible to contamination or weather and water damage

10.5 All non-sealed flanges and mechanically assembled joints must be protected where possible and wrapped in new oil free aluminum foil and plastic covers for the purpose mentioned in Section 10.1 above.

11.0 WARRANTY

See Vacuum Vessel Statement of Work (FLARE-SOW-04)

12.0 ATTACHMENTS

N/A

13.0 DOCUMENTATION AND DELIVERABLES

See Vacuum Vessel Statement of Work (FLARE-SOW-04)