PS-486

Process Specification –Thermal Cycling and Vacuum Testing
65678 PPPL NCSX Vacuum Vessel Sub Assembly

1. PURPOSE

This specification establishes the process parameters required to ensure the assembly, preparation, thermal cycling, and vacuum testing on the NCSX SE120-002 Vacuum Vessel Sub Assembly are performed within the guidelines required by PPPL product specification NCSX-CSPEC-121-02-01.

2. SCOPE

This specification defines the minimum requirements for preparation, assembly, thermal cycling, and vacuum testing the NCSX VVSA 120 Degree Period Assemblies and components when required by the MTM MIT.

3. DEFINITIONS

PPPL – Princeton Plasma Physics Laboratory
MTM – Major Tool & Machine, Inc.
NCSX – National Compact Stellarator Experiment
VVSA - Vacuum Vessel Sub Assembly
MIT – Manufacturing, Inspection, and Test plan (MTM Mfg. Routing)
IDC – MTM Inspection Data Checklist system
QAP – MTM Quality Assurance Planning system
LPS – Liters Per Second
NCR – Non-Conformance Report

4. REFERENCE DOCUMENTS

- PPPL Product Specification NCSX-CSPEC-121-02-01
- MTM Mfg. Routing / Inspection Plan / Quality Assurance Plan 65678
- ASTM E 498 – Standard Test Methods for leak testing
- QA-SOP-01 – Non-Conformance Control
- PS483 – Cleanliness Control

5. PRODUCT SPECIFICATION NCSX-CSPEC-121-02-03 CORRELATION

- 2.1 m
- 3.2.1
- 4.2.1

6. EQUIPMENT AND SUPPLIES

6.1. The following equipment will be provided by PPPL for use to complete the vacuum testing requirements.

- 1500 LPS (minimum) Turbomolecular Pump (TMP)
- 50 LPS (minimum) Mechanical Pump
- Mass-Spectrometer Leak Detector ($1x10^{-10}$ sensitivity)
- Helicoflex Delta® metal O-Rings (as required for the NB Port)
- 10” Ultra high vacuum valves (as required to valve in the leak detector)

6.2. The remaining equipment and supplies needed to complete the vacuum testing will be provided by MTM Engineering (e.g. specified within the manufacturing routing, or existing MTM testing equipment).

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7. VACUUM PERFORMANCE CRITERIA

7.1. The entire vessel (including the port extensions, and spacer as applicable) shall remain leak tight after thermal cycling three times to the maximum operating temperature (375C). No detectable leak greater than 2×10^{-8} t-l/s is acceptable with a base pressure below 10^{-5} torr.

7.2. The total assembly leak rate shall not be greater than 5×10^{-6} t-l/s.

7.3. All leaks shall be documented, and communicated to PPPL, and repaired. The documentation shall include the location of the leak. If a leak requires more than one repair cycle, it must be documented on a NCR.

8. PREPARATION AND ASSEMBLY INSTRUCTIONS

8.1. All components being assembled for vacuum testing must be thoroughly cleaned and verified in accordance with PS483. Cleanliness must be maintained throughout the process of assembly and vacuum testing.

8.2. Lint free gloves will be worn as necessary during the installation of flanges and seals. Note that the oil and dirt transferred from your hands (e.g. fingerprints / smudges) can (and likely will) adversely affect vacuum testing. Effort must be made to avoid touching any vacuum facing surface.

8.3. Purchased finished materials (e.g. copper seals, CF flanges, etc…) should remain sealed and protected prior to installation.

8.4. Team Leader and/or Engineering oversight is required during the installation of all seals and covers.

8.5. Appropriate torque and torque sequencing (e.g. crisscross star pattern tightening according to the manufacturer's recommendations) must be applied to the installation bolts and nuts during assembly.

8.5.1. The applicable torque and torque sequencing information can be obtained from the manufacturer's component catalog technical data (available from MTM Engineering).

8.6. Once all covers and seals are installed, tightened, and the vessel is sealed, the vacuum testing equipment will be attached (e.g. valves, pumps, etc…).

8.7. The pumping system will be installed onto one of the 10" Port Extension flanges (#6, or #10), or onto a minimum length 10" diameter pipe / flange added to the end cap sealing the vessel flange opening. (a final location determination will be made by MTM Engineering after receiving the detail information describing the customer supplied pumping apparatus)

9. THERMAL CYCLING AND VACUUM TESTING

9.1. Preliminary pump down and leak check.

9.1.1. The entire vessel shall be evacuated below 1×10^{-3} prior to thermal cycling. This minimum base pressure shall be maintained throughout the thermal cycling process. A MTM IDC (confirming base pressure) must be completed prior to thermal cycling.

9.1.2. Once the preliminary base pressure is achieved, perform a preliminary leak check using a mass-spectrometer leak detector. No leaks acceptable.

9.2. Thermal Cycling

9.2.1. Once the preliminary base pressure has been achieved, the vessel walls and port extension walls will be wrapped with thermal blankets. The entire assembly will receive a minimum of three thermal cycles as follows: The vessel walls will be heat cycled from room temperature (38C max) to 375C +/-25C. The port extension flanges will be cycled from room temperature (38C max) to only 150C +5C/-15C. The thermal cycle will be documented within the manufacturing routing QAP/IDC provisions. The third thermal cycle is to be held at temperature a minimum of 48 hours.

9.2.2. After the thermal cycling is complete, all heating and insulating apparatus will be removed. The part will return to room temperature.

9.2.3. A supplier certification is required upon completion of the operation.

9.3. Final Vacuum Testing

9.3.1. Once the thermal cycling operation has been completed and certified, the vacuum base pressure will be increased to below 1 x 10^{-5} torr. Once the required base pressure has been achieved, a leak check will be performed to verify conformance to the vacuum performance criteria of this specification.

10. QUALITY ASSURANCE / DOCUMENTATION

10.1. The electronic completion (or "closing / clocking out") of each sequential manufacturing operation within the MTM (Visual Manufacturing®) Routing which includes reference to this document as a task requisite acknowledges compliance to the relevant requirements. The designated MTM employee completing the electronic exchange acknowledges completeness and compliance to the routing instructions.

10.2. When necessary, additional documentation requirements will be provided within the associated MTM IDC, and QAP system.

10.2.1. When an IDC record and/or Inspection report is required, reference to the specific area being tested will be clearly discernable.

10.2.2. When an IDC record and/or Inspection report is required, it will include the following information:

- MTM Work Order number
- Part identification number
- Part description
- Date of inspection
- Gage serial number
- Reference standard serial number
- Inspector signature, or initials, or stamp

10.3. Exceptions / out of tolerance conditions will be documented within the MTM Non-Conformance system per QA-SOP-01.

11. REVISION HISTORY

11.1. Revision A: 22Feb2005 – Initial Release – Doug McCorkle
11.2. Revision B: 26Feb2005 – Corrected document name reference in footer – Doug McCorkle
11.3. Revision C: 02Mar2005 – Added preliminary leak check per PPPL recommendation. – Doug McCorkle