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Process Specification – Cleanliness / Contamination Control 65678 PPPL NCSX Vacuum Vessel Sub Assembly

1. PURPOSE

This specification establishes the process parameters required to ensure the cleanliness of the NCSX SE120-002 Vacuum Vessel Sub Assembly, and all sub-components is maintained within the guidelines required by PPPL product specification NCSX-CSPEC-121-02

2. SCOPE

This specification defines the minimum requirements for the control of cleanliness and contamination during receiving, handling, fabrication, assembly, testing, and preparation for shipment to ensure that all vessel components are free of scale, water, dirt, oil, rust, grease, unspecified markings, foreign matter, debris, and contaminants throughout the manufacturing process and shipping to PPPL.

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
PAC – Plasma Arc Cutting
NCR – Non-Conformance Report
UHV – Ultra-High Vacuum

4. REFERENCE DOCUMENTS

PPPL Product Specification NCSX-CSPEC-121-02
ASTM A-380-99 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems (with the exception to any chlorinated products)
MTM QAWI008 – Receiving Ordered Material
MTM Mfg. Routing / Inspection Plan / Quality Assurance Plan 65678
QA-SOP-01 Non-Conformance Control

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

- 3.3.2.10
- 4.2.7

6. EQUIPMENT AND SUPPLIES

MTM Blast Booth
MTM Paint Booth
MTM Wash Booth, High temp / high pressure wash unit
De-mineralizing tanks

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7. TOOLS / PROCESSING MATERIALS

- 7.1. Tools utilized in polishing and lapping operations shall be nonferrous ceramics or nonmagnetic stainless steel, which have never been used on materials other than austenitic stainless / nickel alloys.
- 7.2. Handling, cleaning and wiping will be performed using clean / new cotton cloth, wipes, and gloves.
- 7.3. The following materials are approved for use during manufacturing:
 - 3M Scotch Brite® products
 - 3M Grinding wheels, Abrasive Sheets, and Finishing Film
 - Isopropanol
 - Acetone
 - Crystal Simple Green® specialized cleaner (or approved equivalent)
 - Virgin Aluminum Oxide Blast Media
 - Oil free compressed air
- 7.4. All grinding / polishing / brushing tools and supplies will be dedicated for use on SST / Nickel Alloys only.

8. GENERAL CLEANLINESS REQUIREMENTS (applies to all mfg. operations and procurement)

- 8.1. All handling equipment such as slings, hooks, and lift-truck forks will be protected with wood, cloth, plastic, or rubber buffers, where feasible, to minimize contact with iron surfaces.
- 8.2. All material, parts, and components are to be protected from the elements and road debris during transportation.
- 8.3. If stacking similar components is necessary during transportation, staging, storing, etc., adequate protection must be provided to ensure protection between parts.
- 8.4. Contact with iron, or iron alloy tools and work surfaces will be avoided when possible. If not possible, contacted surfaces will be visually inspected for contamination (using appropriate lighting and magnification), and if necessary, re-cleaned prior to use.
- 8.5. Parts are to be handled by approved lifting equipment only. If other handling provisions / mechanisms are necessary, MTM CFT approval is required prior to use.
- 8.6. The use of plate gripping part clamps is not acceptable.
- 8.7. Metallic straps and/or chains must not come into direct contact with the part surfaces. Nylon straps must be clean (free of excessive dirt, grease, oil, and loose contaminants, etc.).
- 8.8. Where necessary to maintain cleanliness, production components and fixturing will be covered with a protective polyethylene sheet when not being worked on for an extended period of time. Part temperature must be below 150 Degrees Fahrenheit prior to covering.
- 8.9. Fixturing and bracing component surfaces that come into direct contact with the production part surfaces will be made from austenitic stainless steel.

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- 8.10. When it is necessary to weld fixturing and/or bracing in place, attachment tabs (of the same material composition as base material) will be utilized to prevent metallurgical contamination.
- 8.11. Production part cleanliness requirements also apply to the part contacting bracing / fixturing surfaces.
- 8.12. These general requirements also apply to material suppliers, and sub-contractors. It is the responsibility of MTM CFT, Purchasing Department, Production Control, and Subcontract Administration to ensure the requirements are precisely followed by the contractor.

9. RECEIVING INSPECTION OPERATIONS

- 9.1. All material/ components procured by MTM which reference this document within the MTM Purchase Order, at a minimum, will be visually inspected and verified for cleanliness in accordance with ASTM A-380, paragraph 7.2.1., and the following:
 - 9.1.1. Purchased components will be visually inspected for cleanliness. Each piece must be clean to the extent that it is free of dirt, oil, grease, and residue. Each piece (or lot) must be adequately wrapped to prevent contamination.
 - 9.1.2. Standard catalog components (e.g. copper seals, CF flanges, hardware) that are provided in hermetically sealed bags will remain in their sealed container until required for use unless otherwise directed by MTM Engineering. If determined that a sealed bag should be opened, the parts will be re-packaged, and re-sealed accordingly.
- 9.2. As determined necessary by the MTM CFT, additional inspection instructions will be provided within the MTM MIT receiving inspection operation sequences.

10. FORMING OPERATIONS

- 10.1. Prior to use, the functional faces of all tooling (e.g. Forming Dies, Plate Rollers, Press Brake Dies, etc...) will be thoroughly cleaned to remove any dirt, oil, harmful debris, unnecessary marking and/or materials. This will be accomplished by one or more of the following processes.
 - 10.1.1. Remove bonded materials by scraping, or with authorized abrasive products.
 - 10.1.2. Remove loose debris with compressed air.
 - 10.1.3. High pressure washing.
 - 10.1.4. Solvent wipe with Isopropanol (or approved equivalent).
 - 10.1.5. Dry wiping with clean new rags.
- 10.2. The functional tooling surfaces, and production parts will be visually monitored for cleanliness throughout the forming process. If it is noticed during the process, that harmful foreign matter has accumulated on the production panel, or the functional tooling surface, the forming operation will halt until the component is re-cleaned.

11. BLASTING OPERATIONS

- 11.1. As required by the MTM MIT, components will be blast cleaned using virgin aluminum oxide media only.
- 11.2. Surfaces with high tolerance surface finish will be masked off accordingly (e.g. polished vacuum facing surface, machined surfaces, etc...). Afterward, any tape residue will be removed using Isopropanol (or Acetone, followed by Isopropanol) and wiped using clean new rags.

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11.3. Specific blast media grit size, and necessary masking requirements will be stated within the MIT.

12. CUTTING / TRIMMING / WELDING / GRINDING / POLISHING OPERATIONS

- 12.1. All grinding wheels, paper abrasives, and stainless steel wire brushes will be kept segregated for use on either stainless/nickel alloy or carbon steel as applicable. The tools used on stainless/nickel alloy will be marked specifically for use on stainless/nickel alloy only. Unidentified tools, or tools previously used on ferrous material, will not be used on components associated with this specification.
- 12.2. Cutting and trimming will be accomplished by either PAC, or abrasive cutting wheel. If using PAC for finish cuts, the resulting Oxide layer will be completely removed.
- 12.3. For incremental panel trimming during the forming operation, adequate radii will be applied to all edge corners in order to avoid gouging and scraping the forming die material.
- 12.4. Each weld joint and weld joint area (approximately 3” zone) will be cleaned with Isopropanol prior to welding.
- 12.5. Each weld joint will be visual inspected for cleanliness and conformance to the requirements of this specification at the point of fit-up, tack welding, and each inter-pass.
- 12.6. After each weld joint is completed, any oxides or contaminants that reside on the weld surface and heat affected zone will be completely removed.
- 12.7. After all welding is completed, in order to remove any foreign matter, or free iron contamination that may have accumulated during the fabrication process, all affected surfaces, with the exception of machined surfaces, and surfaces with high tolerance surface finish requirements, will be thoroughly cleaned by one or more of the following processes:
- Grinding
 - Sanding
 - Wire brushing
 - Sand blasting

13. HIGH PRESSURE WASHING OPERATIONS

- 13.1. When required by the MTM MIT, parts will be washed using heated, de-mineralized water, and if necessary, a mild non-chlorinated cleaning solution (e.g. Simple Green®, or authorized equivalent), using MTM’s high pressure washer. The spray pressure at the nozzle will be approximately 1,000 to 1,500 psi and the cleaning solution temperature will be approximately 150°F.
- 13.2. Following detergent wash, all parts will be final rinsed with de-mineralized water and wiped dry with clean new rags.

14. FINAL ASSEMBLY OPERATIONS

- 14.1. After the VVSA Period and/or sub-component has been through its final polishing sequence, and prior to assembling the seals, blank-off flanges, and preparing the part for thermal cycling and vacuum testing, all vacuum facing surfaces will be thoroughly cleaned and inspected according to the MTM MIT requirements.

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- 14.2. All seals, covers, and blank flanges will be installed immediately after Q/A cleanliness acceptance.
- 14.3. After vacuum testing and removing the Port Extensions, and all primary manufacturing operations have been completed, any resulting debris and / or contaminants will be removed by blowing with oil free compressed air, and wiping clean with Isopropanol, using lint free wipes.
- 14.4. After the final cleaning is complete, the VVSA will be visual inspected, and certified for cleanliness by a qualified MTM Q/A representative.

15. VISUAL INSPECTION/ CLEANLINESS VERIFICATION OPERATIONS

- 15.1. At key intervals identified within the MTM MIT (e.g. prior to assembly / vacuum testing, and at final inspection), the VVSA components / assemblies will be visually inspected for cleanliness and certified in accordance with ASTM A-380 paragraph 7.2.1, and 7.2.2, by a qualified MTM Q/A representative(s). Appropriate lighting and equipment will be used to ensure the necessary level of cleanliness is achieved.

16. PRECAUTIONS REQUIRED TO PREVENT RECONTAMINATION

- 16.1. Once a vacuum facing surface has been cleaned, extreme care must be exercised to ensure that it does not become re-contaminated. The following precautions should be observed during the cleaning, cleanliness verification, assembly operations, and thereafter:
 - 16.1.1. The vacuum surface should never be touched with bare skin. Clean lint free gloves should always be worn and arms, etc., covered up.
 - 16.1.2. When necessary, involved personnel should wear a hat or hood, and possibly cover the mouth and nose.
 - 16.1.3. All tools should be clean (entirely), so not transfer contaminants to clean gloves.
 - 16.1.4. Smoking and the use of internal combustion engines should be avoided near an open / cleaned vacuum system.
- 16.2. Immediately after cleaning, all vessel openings will be covered with their respective (clean) cover-plates, or fit with clean temporary protective covers and/or masking to avoid re-contamination.
- 16.3. When determined necessary to maintain cleanliness, the entire VVSA will be covered with polyethylene at all times when not being worked. Tape may be used to secure the polyethylene, but the adhesive surface of the tape should not be allowed to come into contact with highly polished / functional surfaces of the part. If tape does come into contact with the part, the residue will be removed using Isopropanol (or Acetone, followed by Isopropanol).
- 16.4. Once the interior has been cleaned, certified and the vacuum flanges and seals have been assembled, the interior will be considered at its final stage of cleanliness. It will remain in this condition through delivery to PPPL.
- 16.5. During subsequent processing and handling of the finish cleaned assembly, appropriate care will be taken, as necessary, to avoid contamination / recontamination (e.g. appropriate masking, covering the unit with polyethylene sheet, avoiding areas where debris producing activities are being performed, etc.)

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16.6. If the part does become contaminated after final cleaning and certification, the condition will be documented within MTM's Non-Conformance system. Remedial disposition (e.g. spot cleaning using the appropriate method listed above) will be provided by Engineering.

17. SHIPPING OPERATIONS

17.1. Shipping personnel will ensure all protective covers have remained securely in place prior to, during, and after loading for shipping. If it is noticed that a cover has become loose, or damaged, the appropriate Q/A, and CFT personnel will be notified for visual inspection, and to provide remedial disposition prior to proceeding.

17.2. The entire vessel component will be covered and wrapped to ensure the vessel is properly sealed, and cleanliness is maintained throughout shipping. This will be confirmed by the appropriate Q/A, and CFT representatives prior to covering and shipping.

18. QUALITY ASSURANCE / DOCUMENTATION

18.1. The MTM MIT will specify all in-process and final inspection documentation requirements. All quality documentation will be compiled electronically utilizing MTM's integrated IDC and QAP systems

18.1.1. At a minimum, the MTM MIT will require documentation for all contractual features and/or physical requirements (e.g. final component features / final material condition).

18.1.2. To ensure compliance is maintained throughout the manufacturing process, interim / additional documentation requirements will be provided within the associated MTM IDC, and QAP system

18.1.3. When an IDC record, or QAP document is completed, reference to the specific area being tested will be clearly discernable. The record will include the following information (as applicable):

- MTM Work Order Number
- Part Identification Number
- Part Description
- Part Serial Number
- Date of Inspection
- Gage Serial Number
- Reference Standard Serial Number
- Inspector Signature / Acknowledgement, Initials, or Stamp

18.1.4. For all MIT operation sequences that include this document as a task requisite, but do not specify physical inspection records or documentation, the electronic completion ("clocking out") of each sequential manufacturing operation within the MTM (Visual Manufacturing®) routing confirms compliance to the applicable requirements. The MTM employee completing the electronic transaction (which completes and closes the operation sequence) personally acknowledges completeness and compliance to the routing instructions.

18.2. All un-authorized exceptions / out of tolerance conditions according to MTM MIT will be documented within the MTM Non-Conformance system per QA-SOP-01.