

# Tender Request and Specification for the Supply, Manufacture, Finishing and Assembly of Mechanical Hardware for the Specialist Amplifiers

## 1 Introduction

This document presents the mechanical hardware to be supplied, manufactured, finished and assembled for the 10J and 100J amplifier pressure and vacuum components. An assembly drawing list (Table 2) is provided to detail the quantity of hardware required. A parts drawing list of manufacturing drawings (Table 3) is also supplied for information, particularly on issue versions. The primary specification for the assemblies and components shall be the issued detail design drawings in conjunction with this specification.

The vacuum vessels included in this contract are all to achieve a vacuum of less than  $1 \times 10^{-9}$  mbar in normal operation and considered 'ultra high vacuum' (UHV) vessels. All supplier processes are to comply with requirements for 'ultra high vacuum' vessels. In operation the pressure and vacuum vessels have optical windows. These will not be free issued to the supplier and therefore the supplier shall manufacture appropriate blanks and dummy optics for testing and trial assembly purposes.

The pressure vessels being manufactured under this contract shall operate at 22bar(g) in normal operation. The pressure vessels form part of Category 1 pressurised system that requires certification under the European Pressure Equipment Directive (PED). This directive imposes specific requirements for material certification and conformity testing that form a part of this contract.

## 2 Scope of Contract & Timescale

The contract covers the supply and delivery of all components necessary, including:

- Supply and Manufacture of components as per the drawings and specification
- Finishing of components as per the drawings and specification
- Assembly of finished/purchased components with off the shelf items as per the drawings (including seals, coated fixings and fasteners).
- Cleaning of components and assemblies to specification
- Functional testing (leak rate and base pressure test) of assemblies including provision of equipment and blanking flanges necessary
- Functional testing (proof pressure test) of pressure vessel assemblies including provision of equipment and blanking flanges necessary
- Packaging and transportation to STFC RAL
- Production of all necessary material certificate to component validation and conformity testing certification as required to meet both this specification and the PED.

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- Making good any deviations from expected quality prior to delivery

The delivery of products shall be delivered in stages as defined below where priority items are numbered in Table 2. Earlier delivery is preferred, especially for stages 1-3.

- **Priority 1** items are required a maximum of **4 weeks** from receipt of order (FROO)
- **Priority 2** items (fully vacuum and pressure tested) are required a maximum of **10 weeks** FROO
- **Priority 3** items (fully vacuum and pressure tested) are required a maximum of **16 weeks** FROO
- **Priority 4** items are required a maximum of **20 weeks** FROO
- **Priority 5** items are required a maximum of **26 weeks** FROO

The quality assurance requirements must have been met for each priority group prior to delivery. A logically linked delivery plan considering the priority of items and their expected delivery (where staged) shall be included in the tender response.

The price shall be broken down to assembly level (i.e. each line in table 1) in the tender response.

### 3 Drawing Lists

Table 1 below shows the assemblies and components that are included in this bundle of work and their priority for testing and delivery:

**TABLE 1**

| Drawing Number | Drawing Name                         | Issue | Quantity | Remarks  | Delivery Priority |
|----------------|--------------------------------------|-------|----------|--|-------------------|
| SL-1040047     | 10J AMPLIFIER VACUUM VESSEL ASSEMBLY | A     | 1        | EXCLUDING WINDOW (SL-1017028) ON VAC WINDOW ASSY (SL-1017029)<br>BLANK EQUIVILENT TO BE MANUFACTURED FOR TESTING | <b>2</b>          |
| SL-1038350     | 10J PRESSURE VESSEL ASSY (D-100X)    | A     | 1        | EXCLUDING CARTRIDGE ASSY (SL-1038026) - USE BLANK FLANGE SL-1038409 FOR TESTING<br>EXCLUDING 10J                 | <b>2</b>          |

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|            |                                       |   |   |  |          |
|------------|---------------------------------------|---|---|--|----------|
|            |                                       |   |   | PRESSURE WINDOW BEZEL (SL-1018694) AND 10J SAPPHIRE WINDOW V3 (SL-1018693) ON 10J PRESSURE WINDOW ASSY V3 (SL-1018697) - BLANK EQUIVALENT TO BE MANUFACTURED FOR TESTING   |          |
| SL-1018694 | 10J PRESSURE WINDOW BEZEL             | B | 7 |  | <b>1</b> |
| SL-1038026 | 10J CARTRIDGE ASSY (D 100 V2)         | A | 1 | EXCLUDING Cr-CLAD CERAMIC Yb-YAG DISC (SL-1002666) on VANE (TYPE 2) ASSEMBLY (SL-1002249)– BLANK EQUIVALENT TO BE MANUFACTURED FOR ASSEMBLY  | <b>4</b> |
| SL-1038409 | 10J PV FLANGE B V2                    | B | 1 | FOR TESTING PURPOSES   | <b>2</b> |
| SL-1040252 | 100J VAC VESSEL ASSY                  | A | 1 | EXCLUDING 100J AMPLIFIER VACUUM WINDOW (SL-1016162) ON 100J VAC VIEWPORT ASSY (SL-1016159)   | <b>3</b> |
| SL-1040710 | 100J PRESSURE VESSEL ASSY V2 (D-100X) | A | 1 | EXCLUDING 100J CARTRIDGE ASSY (D-100X) (SL-1040347) BLANK FLANGE SL-1040713 FOR TESTING<br>EXCLUDING 100J VIEWPORT PRESSURE FLANGE (SL-1011474) AND 100J SAPPHIRE WINDOW (SL-1011476) ON 100J PRESSURE VIEWPORT ASSY V2 (SL-1040712) - BLANK EQUIVALENT TO BE MANUFACTURED FOR TESTING | <b>3</b> |
| SL-1040713 | 100J PV FLANGE B V2 (D-100X)          | B | 1 | FOR TESTING PURPOSES   | <b>3</b> |
| SL-1040347 | 100J CARTRIDGE ASSY                   | A | 1 | EXCLUDING 100J SLAB  | <b>4</b> |

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|------------|-------------------------------|---|---|---|----------|
|            |                               |   |   | (SL-1009915) ON 100J VANE ASSY (SL-1009910) – BLANK EQUIVILENT TO BE MANUFACTURE FOR ASSEMBLY |          |
| SL-1040347 | 100J CARTRIDGE ASSY           | A | 1 | EXCLUDING 6 OFF. 100J VANE ASSYS (SL-1009910)   | <b>5</b> |
| SL-1011474 | 100J VIEWPORT PRESSURE FLANGE | C | 5 |   | <b>1</b> |
| SL-1026323 | ROLLER SLIDE TRANS MOUNT      | A | 8 |   | <b>2</b> |

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Table 2 below shows the part drawings required for this bundle of work and the quality requirements for specific parts. The key for quality requirements is:

- **V** = component(s) require UHV cleaning and vacuum testing (as 4.5.1 – 4.5.3 and 4.7)
- **C** = component(s) require specialist cleaning (process differs to UHV clean) (as 4.5.4)
- **E** = component requires reference to the material certificates (as 4.1.1)
- **P** = component included in pressure testing (as 4.8)

**TABLE 2**

| Drawing Number    | Drawing Name                             | Issue    | Remarks   | Quality     |
|-------------------|--|----------|---|-------------|
| <b>SL-1038348</b> | <b>10J AMPLIFIER ASSY (D-100X)</b>       | <b>A</b> |   |             |
| <b>SL-1040047</b> | <b>10J VACUUM VESSEL ASSY (D-100X)</b>   | <b>A</b> |   | <b>V</b>    |
| SL-1040034        | ADAPTOR FLANGE (D-100X)                  | A        |   | V           |
| SL-1040035        | 10J VAC SIDE FLANGE C V3                 | A        |   | V           |
| SL-1018080        | 10J G10 BUSH BRACKET                     | C        |   | V           |
| SL-1018480        | 10J VAC VESSEL                           | B        |   | V           |
| <b>SL-1017029</b> | <b>10J VAC WINDOW ASSY</b>               | <b>A</b> |   | <b>V</b>    |
| SL-1017026        | 10J VAC VIEWPORT FLANGE                  | C        |   | V           |
| SL-1017027        | 10J VIEWPORT BEZEL                       | B        |   | V           |
| <i>SL-1017028</i> | <i>10J VACUUM WINDOW</i>                 | A        | <i>Drawings to be provided to enable blank to be made for testing</i> | V           |
| SL-1023808        | PTFE GASKET (10J VAC WINDOW)             | A        |   | C           |
| <b>SL-1038350</b> | <b>10J PRESSURE VESSEL ASSY (D-100X)</b> | <b>A</b> |   | <b>P</b>    |
| SL-1016879        | 10J PRESSURE VESSEL (D-100X)             | C        |   | E, V, P     |
| <i>SL-1018699</i> | <i>C-SEAL 10J VIEWPORT 3.046" OD</i>     | <i>B</i> |   | <i>C, P</i> |

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|-------------------|--------------------------------------|----------|--|-----------|
| SL-1019262        | 10J SIDE FLANGE C-SEAL               | B        |  | P, C      |
| SL-1019263        | 10J MANIFOLD FLANGE C-SEAL           | B        |  | P,C       |
| SL-1019264        | 10J IN/OUTLET C-SEAL                 | B        |  | P, C      |
| SL-1038049        | 10J PV FLANGE B V2                   | B        |  | E, V, P   |
| SL-1040135        | 10J MANIFOLD – LOWER (D-100X)        | A        |  | E, V, P   |
| SL-1040431        | 10J MANIFOLD – UPPER (D-100X)        | A        |  | E, V, P   |
|                   |                                      |          |  |           |
| <b>SL-1018083</b> | <b>10J PV MOUNT ASSY</b>             | <b>A</b> |  |           |
| SL-1018079        | 10J PV BRACKET                       | C        |  | V         |
| SL-1018082        | 10J G10 BUSH                         | B        |  | C         |
|                   |                                      |          |  |           |
| <b>SL-1018697</b> | <b>10J PRESSURE WINDOW ASSY V3</b>   | <b>C</b> |  |           |
| SL-1018693        | 10J SAPPHIRE WINDOW v3<br>(HILASE)   | A        | Drawings to be<br>provided for<br>information  |           |
| SL-1018694        | 10J PRESSURE WINDOW BEZEL            | B        | Blank equivalent<br>also required for<br>testing   | E, V, P   |
| SL-1018695        | 10J WINDOW BACKING RING              | B        |  | E, V, P   |
|                   |                                      |          |  |           |
| <b>SL-1038026</b> | <b>10J CARTRIDGE ASSY (D-100 V2)</b> | <b>A</b> |  |           |
| SL-1038019        | 10J CARTRIDGE SLIDE A V2             | B        |  | V         |
| SL-1038020        | 10J PV FLANGE A V2                   | B        |  | E, V, (P) |
| SL-1038398        | 10J CARTRIDGE SLIDE B V2             | B        |  | V         |
|                   |                                      |          |  |           |
| <b>SL-1002249</b> | <b>VANE (TYPE 2) ASSEMBLY</b>        | <b>A</b> |  | <b>V</b>  |
| SL-1002247        | SPRING RETAINER (TYPE 2)             | C        |  | V         |
| SL-1002263        | VANE (TYPE 2)                        | E        |  | V         |
| SL-1002666        | Cr-CLAD CERAMIC Yb-YAG DISC          | B        | Drawings to be<br>provided to<br>enable blank to<br>be made for trial<br>assembly of vanes | V         |
|                   |                                      |          |  |           |
| <b>SL-1040691</b> | <b>10J ROLLER SLIDE TRANS MOUNT</b>  | <b>A</b> |  |           |
| SL-1025959        | TABLE SHIM BUSH                      | B        |  |           |
| SL-1026324        | MIDDLE SLIDE MOUNT                   | B        |  |           |

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|-------------------|---|----------|---|---------|
| SL-1026326        | LOWER SLIDE MOUNT                         | B        |   |         |
| SL-1040690        | 10J VESSEL BEARING BRACKET                | A        |   |         |
| <b>SL-1026017</b> | <b>UPPER SLIDE MOUNT ASSY</b>             | <b>B</b> |   |         |
|                   |   |          |   |         |
|                   |   |          |   |         |
| <b>SL-1039177</b> | <b>100J AMPLIFIER ASSEMBLY (D-100X)</b>   | <b>A</b> |   |         |
|                   |   |          |   |         |
| <b>SL-1040252</b> | <b>100J VAC VESSEL ASSY (D-100X)</b>      | <b>A</b> |   |         |
| SL-1016148        | 100J VAC VESSEL SIDE FLANGE               | C        |   | V       |
| SL-1016165        | HINGE PIN                                 | B        |   | V       |
| SL-1018035        | 100J G10 BRACKET                          | A        |   | C       |
| SL-1040250        | 100J GRE ADAPTOR FLANGE A                 | A        |   | V       |
| SL-1040251        | 100J GRE ADAPTOR FLANGE B                 | A        |   | V       |
| SL-1040359        | 100J VAC VESSEL SIDE FLANGE B (D-100X)    | A        |   | V       |
| SL-1040715        | 100J VACUUM VESSEL V2 (D100X)             | A        |   | V       |
|                   |   |          |   |         |
| <b>SL-1016159</b> | <b>100J VAC VIEWPORT ASSY</b>             | <b>A</b> |   |         |
| SL-1016160        | 100J VAC VIEWPORT FLANGE                  | B        |   | V       |
| SL-1016161        | 100J VAC VIEWPORT BEZEL                   | B        |   | V       |
| <i>SL-1016162</i> | <i>100J AMPLIFIER VACUUM WINDOW</i>       | A        | <i>Drawings to be provided to enable blank to be made for testing</i> | V       |
| SL-1016164        | 100J VIEWPORT PTFE GASKET                 | A        |   | C       |
| SL-1033587        | 100J AMPLIFIER VACUUM WINDOW              | A        |   |         |
|                   |   |          |   |         |
| <b>SL-1040710</b> | <b>100J PRESSURE VESSEL ASSY (D-100X)</b> | <b>A</b> |   |         |
| SL-1040706        | 100J PRESSURE VESSEL V2                   | A        |   | E, V, P |
| SL-1040713        | 100J PV FLANGE B V2 (D-100X)              | A        |   | E, V, P |
| <i>SL-1019113</i> | <i>100J SIDE FLANGE C-SEAL</i>            | B        |   | C, P    |
| <i>SL-1019267</i> | <i>100J MANIFOLD FLANGE C-SEAL</i>        | B        |   | C, P    |
| SL-1033889        | 100J UPPER MANIFOLD                       | B        |   | E, V, P |

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|-------------------|---------------------------------------|----------|---|-----------|
| SL-1033890        | 100J LOWER MANIFOLD                   | B        |   | E, V, P   |
| SL-1018667        | C-SEAL 100J VIEWPORT                  | B        |   | C, P      |
|                   |                                       |          |   |           |
| <b>SL-1040347</b> | <b>100J CARTRIDGE ASSY (D-100X)</b>   | <b>A</b> |   |           |
| SL-1040351        | 100J VANE SLIDE A (D-100X)            | A        |   | V         |
| SL-1040523        | 100J VANE SLIDE B (D-100X)            | A        |   | V         |
| SL-1040714        | 100J PV FLANGE A V2 (D-100X)          | A        |   | E, V, (P) |
|                   |                                       |          |   |           |
|                   |                                       |          |   |           |
| <b>SL-1009910</b> | <b>100J VANE ASSY</b>                 | <b>A</b> |   |           |
| SL-1009905        | 100J GAIN MEDIA FRAME                 | B        |   | V         |
| SL-1009915        | 100J SLAB (120x120)                   | B        | <i>Drawings to be provided to enable blank to be made for trial assembly of vanes</i> |           |
| SL-1009921        | 100J VANE - TRAILING EDGE             | B        |   | V         |
| SL-1009922        | 100J VANE - LEADING EDGE              | B        |   | V         |
| SL-1015495        | SPRING CARRIER                        | B        |   | V         |
| SL-1018990        | SPRING RETAINER                       | B        |   | V         |
|                   |                                       |          |   |           |
| <b>SL-1040712</b> | <b>100J PRESSURE VIEWPORT ASSY V2</b> | <b>A</b> |   |           |
| SL-1011474        | 100J VIEWPORT PRESSURE FLANGE         | D        | <i>Blank equivalent also required for testing</i>                                     | E, V, P   |
| SL-1040711        | 100J VIEWPORT BACKING RING V2         | A        |   | E, V, P   |
| SL-1011476        | 100J SAPPHIRE WINDOW (HILASE)         | C        | <i>Drawings to be provided for information only</i>                                   |           |
|                   |                                       |          |   |           |
| <b>SL-1018037</b> | <b>100J PV MOUNT ASSY</b>             | <b>A</b> |   |           |
| SL-1018024        | 100J PV MOUNT                         | A        |   | V         |
| SL-1018036        | 100J G10 BUSH                         | B        |   | C         |
|                   |                                       |          |   |           |
| <b>SL-1026323</b> | <b>ROLLER SLIDE TRANS MOUNT</b>       | <b>A</b> |   |           |
| SL-1025937        | VESSEL BEARING BRACKET                | A        |   |           |

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| SL-1025959 | TABLE SHIM BUSH        | B |  |  |
| SL-1026324 | MIDDLE SLIDE MOUNT     | B |  |  |
| SL-1026326 | LOWER SLIDE MOUNT      | B |  |  |
| SL-1026017 | UPPER SLIDE MOUNT ASSY | B |  |  |
|            |                        |   |  |  |

## 4 Technical Specification

### 4.1 Materials

#### 4.1.1 Titanium

- Titanium Alloy 6AL-4V has been selected for its mechanical properties. Where material has been specified as Titanium or Titanium alloy on the drawings, it refers only to this alloy. It is not acceptable to exchange Titanium Alloy 6AL-4V for any other Titanium alloy.
- Titanium Alloy 6AL-4V must be sourced from a reputable supplier with an appropriate quality management system.
- All material must be appropriately stored and identified for use on this contract only.
- Titanium Alloy 6AL-4V provided shall possess the following minimum material properties.

|                     | Tensile Strength | Yield Strength (0.2%) | Elongation | Area of Reduction |
|---------------------|------------------|-----------------------|------------|-------------------|
|                     | (MPa)            | (MPa)                 | (%)        | (%)               |
| Minimum Requirement | <b>895</b>       | <b>829</b>            | <b>10</b>  | <b>25</b>         |

- An inspection certificate is required to independently verify that the material used for the manufacture of pressure components (as identified by P in table 2) meets this specification in compliance with BS EN 10204-2004 Inspection certificate “type 3.1”
- It shall not be permissible for the supplier to transfer inspection certificates (e.g. mill certificates) test results unless the full supply chain traceability is evident from cradle to grave. If this is not achievable, the material properties shall be verified by the supplier by laboratory testing, which the supplier shall source and pay for.
- All components requiring material inspection certificates (as identified by E in table 2) to be appropriately labelled and the reference between material used and a manufactured component part must be clear and consistent. Please see appendix A.
- Labelling of components and certificates with references must be validated by the manufacturers authorised inspection representative (e.g. the supplier’s quality manager), independent from the manufacturer.

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4.1.2 **Stainless Steel**

- Stainless Steel grades 304, 316 and 316L are selected for their good machinability, weldability, clean finish, corrosion resistance and vacuum compatibility.
- It is acceptable to use 316L for any components where the stainless steel grade is 316, 304 or not specified. It is unacceptable to exchange 316L for any other material grade.
- 316L shall be used where welding is part of the manufacturing process.
- It is desirable that any assemblies containing multiple Stainless Steel parts are manufactured from the same grade of Stainless Steel to avoid any difference in appearance. The grade used should be stated in writing to ensure any future order or spares or replacement parts are made from the same material grades

4.1.3 **PTFE**

- PTFE shall be virgin unfilled grade. There are no acceptable substitutes for PTFE.

4.1.4 **TUFNOL 10G/40**

- Tufnol 10G/40 is specified for its insulating properties, very high mechanical strength, low water absorption and good dimensional stability.
- It is not acceptable to exchange Tufnol 10G/40 for any other material or grade.

4.1.5 **O-rings**

- All o-rings to be supplied with 1 spare per o-ring
- All o-rings to be VITON
- O-rings for rectangular grooves have o-rings specified for equivalent circular diameter.
- O-rings must not be spliced (unless a vulcanised joint is made).

4.2 **Machining**

4.2.1 **Tolerances**

- Drawing tolerances must be maintained to ensure successful assembly
- Components that have an important fit within an assembly shall be machined as a matched pair.
- The dimensional tolerances on the drawings must be met after all processes, such as welding or finishing, have been completed.
- Cutting fluids shall be of an inert type. Fluids containing Silicone, Chlorine or Fluorine must not be used for any items required for vacuum service (as identified by V in table 2).
- All traces of cutting fluids to be removed by a degreasing operation shortly after machining for any items required for vacuum service (as identified by V in table 2).

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**4.2.2 Machining Finishes (excluding sealing faces)**

- All components to have a fine machined surface finish, to better than 1.6µm roughness (unless specified better on the drawing or a sealing face).
- All surfaces to be smooth without objectionable tool marks.
- All vacuum surfaces should be free from visible defects such as pitting, cracks or indentations.
- Surface roughness specification applies to all surfaces and is applicable both before and after subsequent application of finish.
- Surface finish should, unless otherwise stated, have a machined finish rather than a shot peened, buffed or polished finish.
- It is desirable that assemblies have the same direction cutting patterns to avoid a mismatched appearance. This also applies to ensure consistent and uniform surface finishes

**4.2.3 Sealing Faces and O-ring Grooves**

- All sealing surfaces on pressure vessel components shall be 0.4µm or better to promote effective sealing (as identified by P in table 2).
- All sealing surfaces on vacuum vessel components shall be 0.8µm or better to promote effective sealing (as identified by V in table 2).
- For flanges with circular seals, the machining of the flange sealing face must have a circular lay
- All sealing faces (including inside grooves) should be polished in the longitudinal direction of the seal (i.e. along the line of the groove for rectangular seals and circular at corners and for circular seals).
- All sealing faces shall be free from radial scratches.
- All sealing surfaces to be suitably protected during finishing processes (such as bead blasting) to avoid damage to the surface. The method of protection must not leave any damage or residue on the surface.
- Sealing surfaces, pressure vessel surfaces and internal vacuum surfaces shall not be marked with dyes, marker pens, paints for labelling.
- Where trapezoidal o-ring grooves are specified, extra care is to be taken to ensure the correct depth. It is recommended that the depth of the groove be measured with the aid of a ball bearing whose diameter matches that of the o-ring cord.
- Where dovetail grooves are specified, consideration must be made to suitably locate the tool entry/exit point or at the location specified on the drawing.

**4.3 Welding**

The welding specification for any welded joint is specified on the drawing. In addition, the following must be adhered to for welded vacuum vessels and flanges.

- All internal welds to be continuous to avoid trapped volumes

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- Any external welds should be stitch welds (not continuous)
- Welds must not protrude from surfaces that could cause assembly issues, for example beyond the sealing surface of a flange.
- Orientation of flanges and components to be checked prior to welding
- All external surfaces to be a clean machined finished with no weld preparation machining visible.
- Cleaned surfaces must not come into contact with oily or greasy objects during welding (including bare hands).
- It is expected that conventional Tig welding process will be used for welding.
- All weld regions must be free from scale, voids, discoloration, blow holes or visible evidence of inclusions.
- Weld repairs are not permitted without prior approval from STFC.

The supplier is welcome to suggest alternative machining or fabrication methods for the vacuum vessel other than welding, where they deem it simpler and more cost effective to do so. A full explanation of any alternative proposals must be included in the tender response.

#### 4.4 Laser Etching

Any permanent labelling of metallic parts shall be undertaken using a laser etching process. Laser etch text size and font to be easy to read and located on an external surface as indicated on the drawings. The supplier shall provide a sample of laser etching to enable STFC to approve the chosen size and font. Laser etching shall occur prior to the cleaning phase.

Components that form part of the pressure vessel (as identified by P in table 2) will require permanent labelling such that their reference can be linked to the material certificates and pressure test certificates. The labels to be used can be found in appendix A.

#### 4.5 Cleaning

##### 4.5.1 Clean for Ultra High Vacuum Service (UHV Clean) – SS and Ti Components

Components labelled V in the parts table 2 are required to be supplied clean (as per the definition below) for ultra high vacuum use ( $1 \times 10^{-9}$  mbar). Stainless Steel and Titanium components shall be cleaned using the following procedure:

- All burrs to be removed
- Swarf and cutting material to be cleared from all holes (especially blind holes and threaded holes) using high pressure air-line.
- Residual contamination to be removed by washing out, swabbing or rinsing with a general purpose solvent.
- Scrubbing, wire brushing, grinding, filing or other mechanically abrasive methods shall not be used for cleaning.

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- All machining fluids, greases or dirt to be removed using hot water, detergent and cleaning wipes followed by Isopropanol and a clean lint free cloth prior to any post machining finish. This should occur as soon after the machining process as possible.
- Specific attention is drawn to all holes especially tapped holes where cutting residue and contamination can be difficult to remove
- Specific attention is to be given to welded joints where a die penetrant is used, especially in the voids where a non-continuous weld has been made on external surfaces.
- Spray with high pressure jets at 80°C with a mild alkaline detergent.
- Rinse thoroughly with hot demineralised water until all visible traces of detergent have been eliminated.
- Where bead blasting is specified, this shall occur at this stage (see 4.4.5) and the preceding cleaning steps repeated again after bead blasting.
- Dry in warm clean air
- Immerse completely in an ultrasonically agitated bath of clean hot stabilised trichloroethylene for a minimum of 15 minutes or until the item has reached the temperature of the hot vapour (whichever is longer).
- Vapour wash in trichloroethylene vapour for a minimum of 15 minutes or until the item has reached the temperature of the hot vapour (whichever is longer).
- Ensure all solvent residues have been drained off, particularly in trapped areas.
- Spray with high pressure jets at 80°C using clean demineralised water. No detergent at this stage.
- Immerse in an ultrasonically agitated bath of alkaline degreaser (ALMECO P36) at 60°C for 5 minutes.
- After removal immediately spray with high pressure jets at 80°C using clean demineralised water. No detergent at this stage. Ensure any particulate deposits from the bath are washed away.
- Dry in warm clean air
- Allow to cool in a clean dry dust free environment.
- Surfaces should be checked for signs of contamination by rubbing surfaces with lint free cloth. There should be no sign of dirt on the cloth. If dirt is found, the cleaning process must be repeated.
- Vacuum bake to 250°C for 24 hours using an oil free pumping system.
- Reduce temperature to 200°C and carry out an internal glow discharge using a helium/10% Oxygen gas mix.
- Raise temperature to 250°C for a further 24 hours and then cool to room temperature.
- All cleaning is to be thorough and inspected prior to packaging in Aluminium foil for storage of items in the assembly phase.
- Where cleaning has been undertaken by a subcontractor or storage of items is necessary before assembly, the components shall be vacuum packed.

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Supplier cleaning procedures may be used if given approval by STFC.

#### 4.5.2 **Clean for Ultra High Vacuum Service (UHV Clean) – Be Cu Components**

- Wash with hot clean demineralised water taking care to avoid damage of fingerprint. No detergent to be used.
- Dry in warm clean air
- Inspect surfaces to ensure there is no thick, friable or flakey deposit.
- Repeat cleaning process if thick deposit found.
- A light surface oxidation, resulting in a blackish film, is to be expected and not of concern.

Supplier cleaning procedures may be used if given approval by STFC.

#### 4.5.3 **Clean for Ultra High Vacuum Service (UHV Clean) – Non Metallic Components**

As polymers have a tendency to absorb moisture, any cleaning processes involving water shall be avoided for polymer based materials.

Tufnol, PTFE and any other polymer based materials shall be cleaned using the following procedure:

- All burrs to be removed
- Swarf and cutting material to be cleared from all holes (especially blind holes and threaded holes) using high pressure air-line.
- Components such as inserts to be washed and dried in warm air prior to fitting
- Wiping with Isopropanol and a clean lint free cloth
- Dry in warm clean air

The procedure shall be repeated until there is no residue seen on the cloth after wiping.

#### 4.5.4 **Clean for ISO7 clean room**

Any remaining unlabelled components in table 2 must be cleaned for clean room use (ISO 7, Class 10,000), which is a controlled environment limiting the maximum concentration of particles in the air. Any items entering the clean room must therefore be cleaned as thoroughly as practicably possible to minimise introduction of particles to the room. Minimum cleaning requirements are as per the following procedure:

- All burrs to be removed
- Swarf and cutting material to be cleared from all holes (especially blind holes and threaded holes) using high pressure air-line.
- Residual contamination to be removed by washing out, swabbing or rinsing with a general purpose solvent.

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- Scrubbing, wire brushing, grinding, filing or other mechanically abrasive methods shall not be used for cleaning.
- All machining fluids, greases or dirt to be removed using hot water, detergent and cleaning wipes followed by Isopropanol and a clean lint free cloth prior to any post machining finish such as anodising.
- Specific attention is drawn to all holes especially tapped holes where cutting residue and contamination can be difficult to remove
- Surfaces should be checked for signs of contamination by rubbing surfaces with lint free cloth. There should be no sign of dirt on the cloth. If dirt is found, the cleaning process must be repeated until there is no dirt on the cloth.
- All cleaning is to be thorough and inspected prior to packaging and as appropriate, in preparation for further treatment i.e. anodising
- Cleaning of components to be repeated after finishing treatments and prior to assembly.

The supplier may alternatively choose to clean all SS and Ti components in the bundle as specified in 4.4.1 and this is acceptable to STFC.

#### 4.5.5 Bead Blasting

Stainless Steel vessels are to be bead blasted to remove any scaling or deposited surface films. Requirement for bead blasting will be indicated on the drawings.

- Glass, alumina or silica beads are acceptable
- All beads must be virgin beads (not used for bead blasting before)
- Beads must have been stored appropriately to avoid contamination of the beads (particularly with respect to oils and greases)
- Beads to be used in a water or air jet
- Jet pressure to be adequate to strip surface films away without causing contaminants or beads to be driven into the surface.
- A sample of bead blasting should be made if process duration and jet pressure are not known.
- Vacuum cleaning process to be undertaken both before and after the bead blasting process.

#### 4.6 Assembly

The supplier will assemble the goods to ensure that they are fit for purpose and in preparation for the testing phase, with due regard to the cleanliness requirements stated, by ensuring:

- Nitrile gloves are worn when handling cleaned components during assembly
- Assembly to occur in a clean, dry and dust free environment (ideally a clean room)

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- All UHV cleaned components covered in clean Aluminium foil and sealing faces protected when not directly being assembled (before and after assembly of the components)
- Components are assembled square and flat
- Seals are appropriately made and fitted dry
- Care is taken not to damage any sealing faces
- All fittings and fasteners shall be appropriately tightened for purpose or as specified on the drawings.
- Good engineering practise to be employed when tightening the sealing joints, i.e. all fasteners to be tightened slowly in a sensible sequence to avoid uneven loading on the seal during assembly.
- Key overall dimensions must be measured and recorded at this stage.
- The supplier must supply all seals for assembly and testing, noting that some seals are one use so spares for multiple testing may be required.
- For the vane assemblies, the supplier shall manufacture an Aluminium dummy optic as per the supplied drawing to verify that the Beryllium copper strip has been appropriately assembled.
- Care must be taken not to damage or deform the fingers on the Beryllium copper strip and appropriate precautions taken when handling the Beryllium copper.

A final clean of the assembly shall occur before packing to remove any contamination occurring during the assembly process

#### 4.7 Vacuum Testing

The supplier will be responsible for undertaking the testing specified below. Testing must occur in a clean, dry and dust free environment with due regard for cleanliness as described in the previous section.

The purpose of the testing is to verify the quality of manufacturing, in particular sealing face tolerances and finish, and that the cleaning processes have been appropriately applied.

STFC shall be invited to witness this testing.

##### 4.7.1 10J and 100J Vacuum Vessel

The 10J AMPLIFIER VACUUM VESSEL ASSEMBLY and 100J AMPLIFIER VACUUM VESSEL ASSEMBLY require vacuum testing to verify their leak rate and minimum base pressure.

The base pressure requirement for the vessels during testing is high vacuum (less than  $1 \times 10^{-7}$  mbar). The vacuum leak rate of the full assembly must be better than  $1 \times 10^{-9}$  mbar.l/s using a mass spectrometer with Helium gas detection (This specified leak rate takes precedence over any alternative leak rates that may be specified on drawings)

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It is expected that the supplier will evacuate the vessel through one of the available ports using a mass spectrometer and use Helium gas to probe all welds and seals.

The supplier is responsible for supplying any equipment for testing, for example blanking flanges and seals. It is acceptable to use Aluminium or Stainless Steel for the blanking flanges. The blanks must be cleaned to the appropriate standard to avoid contamination (see section 4). Similarly, all vacuum pumps (backing and turbo molecular pumps) shall be oil free.

All sealing faces and seals must be dry. Due to the presence of optical windows in the system, it is not permissible to use vacuum greases, putty, epoxy or silver tape on any part of the assembly at any stage during assembly or testing. Attainment of leak rate and base pressure must occur with dry seals and with fixings appropriately torqued.

**4.7.2 10J and 100J Pressure Vessel**

The 10J PRESSURE VESSEL ASSY (D-100X) and 100J PRESSURE VESSEL ASSY (D-100X) require vacuum testing to verify their leak rate and minimum base pressure.

The base pressure requirement for the vessels during testing is high vacuum (less than  $1 \times 10^{-7}$  mbar). The vacuum leak rate of the full assembly must be better than  $1 \times 10^{-9}$  mbar.l/s using a mass spectrometer with Helium gas detection (This specified leak rate takes precedence over any alternative leak rates that may be specified on drawings)

It is expected that the supplier will evacuate the vessel through one of the available ports using a mass spectrometer and use Helium gas to probe all welds and seals

The supplier is responsible for supplying any equipment for testing, for example blanking flanges and seals. It is acceptable to use Titanium or Stainless Steel for the blanking flanges. The blanks must be cleaned to the appropriate standard to avoid contamination (see section 4). Similarly, all vacuum pumps (backing and turbo molecular pumps) shall be oil free.

To meet the requirements of the priority schedule STFC suggest that the pressure vessel is tested using the spare side flanges (10J PV FLANGE B V2 and 100J PV FLANGE B) instead of the cartridge assemblies.

All sealing faces and seals must be dry and all fixings torqued to specified rating. Due to the presence of optical windows in the system, it is not permissible to use vacuum greases, putty, epoxy or silver tape on any part of the assembly at any stage during assembly or testing. Attainment of leak rate and base pressure must occur with dry seals and with fixings correctly torqued.

The supplier should note that the seals for the pressure vessel are designed for one use, so remaking of flanges should be avoided where possible.

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## 4.8 Pressure Testing

The purpose of the pressure test is to ensure that there are no manufacturing or material defects in the assembly. The proof test pressure specified is 1.43x the working pressure of the final assembly in accordance with the PED.

It is anticipated that the supplier would perform the pressure test directly after the vacuum testing so no change to the assembly or components would be necessary, in particular the seals. It is acceptable to use the same seals and blanking flanges used for the vacuum testing provided that the supplier has ensured that the thickness of the flanges is sufficient to withstand the test pressure.

The 10J PRESSURE VESSEL ASSY (D-100X) and 100J PRESSURE VESSEL ASSY (D-100X) each require pressure testing under the following conditions:

- Room temperature
- 32 bar(g) internal pressure
- Helium gas to be used as testing medium (hydrostatic testing is not permitted)
- Fittings correctly torqued

The test conducted shall be a 30 minute pressure drop test. The pressure shall be monitored throughout the test using a calibrated pressure transducer. The vessel shall be pressurised with helium and the pressure recorded. After 30 minutes, the pressure will be recorded again. The pass criteria for the test is a deviation in pressure of less than 0.5bar between the two recorded readings.

It is necessary for this proof pressure test to be witnessed by an independent inspection body and certification to be issued. STFC use Lloyds British for their site testing.

STFC shall be invited to witness this testing.

The supplier is responsible for ensuring a safe system of work is implemented for the pressure testing phase and that appropriate measures are taken to mitigate the risks of the test.

## 4.9 Storage and Packaging

- Nitrile gloves must be worn during and handling or packaging after cleaning and testing have been completed.
- The items should be packaged in assembled form, as required for testing of the assemblies, where feasible and in particular where seals are used. The supplier must send STFC a proposed packing list prior to packaging of items.

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- All vacuum cleaned components shall be wrapped in clean Al foil (at least over apertures) and where possible vacuum packed.
- Bubble wrap and sealable plastic bags shall be used as a packaging material for components and assemblies (outside the clean layer).
- Additional protective packaging of assemblies is to be such that the assembly is not damaged during transportation or storage.
- Sealing faces must be especially protected to avoid surface scratches and damage, with the method of packaging removal considered. The location of sealing faces should be labelled on the outside of the packaging.
- Where items need to be stored between cleaning and assembly or testing phases, the clean items should be appropriately packaged with foil and vacuum packing to avoid contamination during storage.
- Cleaned items shall only be stored within a clean dust and grease free environment.
- All packaging is to be labelled, with the component or assembly drawing number, quantity (if more than one) and with any other information deemed necessary by the supplier.

## 5 Communication

The supplier is expected and encouraged to raise any concerns or questions where any query arises, no matter how small, insignificant or inconsequential they appear.

Similarly the supplier is expected and encouraged to voice their concerns or opinions if a design or assembly does not appear correct.

Any recommendations on simple design changes that facilitate the achievement of our quality expectation are welcome from the supplier.

The technical contact for any queries or concerns shall be Ian Hollingham ([ian.hollingham@stfc.ac.uk](mailto:ian.hollingham@stfc.ac.uk), 01235 445702).

Any deviations from the specification or drawing must be agreed in writing by both parties.

Where any changes to the drawing are required, from a supplier request or STFC necessity, the drawing shall be re-issued by STFC at a higher version (based on increasing letter from A – Z). Upon the receipt of a newly issued drawing, all copies (hard or electronic) of previous versions must be deleted by the supplier to prevent incorrect manufacture of parts.

## 6 Quality Assurance, Control & Testing

The supplier shall provide details of their quality assurance programme and specific processes including tests and inspections they intend to carry out so as to ensure that finished product meets this specification. Activities will include retention of material

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certificates, proposed inspection of components manufactured in house or by sub-contractor, testing procedure of completed assemblies and documentation produced.

A quality inspection and test plan shall be provided by the contractor together with the processes and procedures that they intend to follow and all testing and confirmatory quality checks that they shall carry out on product to assure conformity to this specification.

This shall, as a minimum, cover the following areas:

- Materials sourcing including material certificates, verification, record keeping and cross referencing of material to part.
- Manufacturing processes (QC on machining, finishes, cleanliness etc.) and record keeping
- Welding process (including QC on prior cleaning, process conditions, alignment or component, inspections, etc.)
- Cleaning and bead blasting process (including QC on process pressures, process source materials, inspections, etc.)
- Assembly and testing of finished product including verification QA and vacuum leak rate testing
- Pre-delivery inspection process and sign-off by an appropriately qualified person (e.g. the contractors Quality Manager).

STFC reserve the right to enter the contractor’s premises or those of any of their subcontractors at any time during the execution period of the contract in order to undertake quality inspections. The visits will focus on verifying that processes and quality control requirements, as stipulated by the contractor in their quality inspection and test plan are being applied appropriately.

The attention of the contractor is drawn to the following:

Appendix B shows the minimum quality verification that STFC wish to directly witness, however, STFC anticipates that the supplier will wish to undertake significant additional QC activities. These should be detailed in the quality inspection and test plan.

STFC is particularly interested in the welding and cleaning process, including preparation techniques, and will require a list of expected sub-contractors selected by any contractor for the undertaking of this process.

STFC will require evidence of the understanding of and previous experience of adequately cleaning machined components and assemblies for vacuum service (UHV vacuum) and ability to test vacuum integrity of assembled vessels and pressure test assembled vessels.

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## 7 Appendix A – Reference Labels

The 10J PRESSURE WINDOW BEZELS require specific labelling to reference them to the sapphire windows that are later diffusion bonded to the bezel. Each bezel requires a unique identifier as per the table below:

| N | Drawing Number | Drawing Name       | Unique Reference          |
|---|----------------|--------------------|---------------------------|
| 1 | SL-1017027/A   | 10J VIEWPORT BEZEL | HiL-SAPPH-WIN-60-13-1-UK3 |
| 2 | SL-1017027/A   | 10J VIEWPORT BEZEL | HiL-SAPPH-WIN-60-13-1-UK5 |
| 3 | SL-1017027/A   | 10J VIEWPORT BEZEL | Tbc                       |
| 4 | SL-1017027/A   | 10J VIEWPORT BEZEL | Tbc                       |
| 5 | SL-1017027/A   | 10J VIEWPORT BEZEL | Tbc                       |
| 6 | SL-1017027/A   | 10J VIEWPORT BEZEL | Tbc                       |
| 7 | SL-1017027/A   | 10J VIEWPORT BEZEL | Tbc                       |

The 100J VIEWPORT PRESSURE FLANGES require specific labelling to reference them to the sapphire windows that are later diffusion bonded to the bezel. Each bezel requires a unique identifier as per the table below:

| N | Drawing Number | Drawing Name                  | Unique Reference               |
|---|----------------|-------------------------------|--------------------------------|
| 1 | SL-1011474/C   | 100J VIEWPORT PRESSURE FLANGE | D100X-W-SAC-165-HPUC-20-16 / 1 |
| 2 | SL-1011474/C   | 100J VIEWPORT PRESSURE FLANGE | D100X-W-SAC-165-HPUC-20-16 / 2 |
| 3 | SL-1011474/C   | 100J VIEWPORT PRESSURE FLANGE | D100X-W-SAC-165-HPUC-20-16 / 3 |
| 4 | SL-1011474/C   | 100J VIEWPORT PRESSURE FLANGE | D100X-W-SAC-165-HPUC-20-16 / 4 |
| 5 | SL-1011474/C   | 100J VIEWPORT PRESSURE FLANGE | HIL-W-SAC-165-HPUC-20-16 / 5   |

The 10J Pressure Vessel components require labelling with the following logic

Project - Drawing number – issue – year of manufacture – unique numbering 1,2,3...

| N | Drawing Number | Drawing Name                  | Unique Reference         |
|---|----------------|-------------------------------|--------------------------|
| 1 | SL-1016879/B   | 10J PRESSURE VESSEL (D-100X)  | D100X-SL-1016879-B-17-1  |
| 1 | SL-1040431/B   | 10J MANIFOLD - UPPER (D-100X) | D100X -SL-1040431-A-17-1 |
| 1 | SL-1040135/A   | 10J MANIFOLD – LOWER (D-100X) | D100X -SL-1040435-A-17-1 |
| 1 | SL-1038049/A   | 10J PV FLANGE B V2            | D100X -SL-1038049-A-17-1 |
| 2 | SL-1038049/A   | 10J PV FLANGE B V2            | D100X -SL-1038049-A-17-2 |

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|---|--------------|-------------------------|--------------------------|
| 1 | SL-1018695/B | 10J WINDOW BACKING RING | D100X -SL-1018695-B-17-1 |
| 2 | SL-1018695/B | 10J WINDOW BACKING RING | D100X -SL-1018695-B-17-2 |
| 1 | SL-1038020/A | 10J PV FLANGE A V2      | D100X -SL-1038020-A-17-1 |
| 2 | SL-1038020/A | 10J PV FLANGE A V2      | D100X -SL-1038020-A-17-2 |

The 100J Pressure Vessel components require labelling with the following logic

Project - Drawing number – issue – year of manufacture – unique numbering 1,2,3...

| N | Drawing Number | Drawing Name                  | Unique Reference         |
|---|----------------|-------------------------------|--------------------------|
| 1 | SL-1040706/A   | 100J PRESSURE VESSEL V2       | D100X-SL-1040706-A-17-1  |
| 1 | SL-1040713/A   | 100J PV FLANGE B V2 (D-100X)  | D100X -SL-1040713-A-17-1 |
| 2 | SL-1040713/A   | 100J PV FLANGE B V2 (D-100X)  | D100X -SL-1040713-A-17-2 |
| 1 | SL-1033889/B   | 100J UPPER MANIFOLD           | D100X -SL-1033889-B-17-1 |
| 1 | SL-1033890/B   | 100J LOWER MANIFOLD           | D100X -SL-1033890-B-17-1 |
| 1 | SL-1040714/A   | 100J PV FLANGE A V2 (D-100X)  | D100X -SL-1040714-A-17-1 |
| 2 | SL-1040714/A   | 100J PV FLANGE A V2 (D-100X)  | D100X -SL-1040714-A-17-2 |
| 1 | SL-1040711/A   | 100J VIEWPORT BACKING RING V2 | D100X -SL-1040711-A-17-1 |
| 2 | SL-1040711/A   | 100J VIEWPORT BACKING RING V2 | D100X -SL-1040711-A-17-2 |

These references shall be used for verification of material used for each component and for verification that the components have been pressure tested.

Supplier shall request confirmation of the unique references from STFC prior to laser etching.

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## 8 Appendix B – STFC Inspection and Test Plan

| Inspection and Test Plan  |                                   |   |  |  |                    |        |  |         |
|---|-----------------------------------|---|--|--|--------------------|--------|--|---------|
| Specialist Bundle - Amplifiers  |                                   |   |  |  |                    |        |  |         |
| Quality Control Requirements: A - Approval, I - Inspection, S – Submission, V – Verification, H – Hold Point, W – Witness |                                   |   |  |  |                    |        |  |         |
| No  | Activity                          | Ref Document                                    | Acceptance Criteria  | Frequency  | Responsible Person | QC Req | Resulting Documents  | Remarks |
| 1   | Material                          | Design drawings and Manufacturing Specification | Mechanical properties achieved   | Every component labelled E in specification parts list | STFC               | H, V   | 3.1 certificate or independent material test certification |         |
| 2   | Machining, Finishing and Cleaning | Design drawings and Manufacturing Specification | Visual inspection, measurement of some critical dimensions,                            | Sample of components, when high priority list complete | STFC               | H      | Sign off sheet, photographs                                |         |
| 3   | Assembly                          | Design drawings and Manufacturing Specification | Measurement of critical assembly dimensions, trial fit of dummy optic in vane assembly | Each assembly prior to testing                         | STFC               | W, H   | Sign off sheet, photographs                                |         |
| 4   | Vacuum Integrity and Cleanliness  | Design drawings and Manufacturing Specification | Leak rate and base pressure achieved.  | Each assembly  | STFC               | W, H   | Sign off sheet, photographs                                |         |

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|---|------------------|-----------------------------|---|----------------------|------|---|---|--|
| 5 | Pressure Testing | Manufacturing Specification | Drop pressure test held pressure for 30 minutes | Each pressure vessel | STFC | W | Certification from inspection authority |  |
|---|------------------|-----------------------------|---|----------------------|------|---|---|--|

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