



ENGINEERING DIVISION

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General Specification for the Vacuum System of the ALBA Beam Lines

<i>Prepared by:</i> Roger Martín Fernández rmartin@cells.es	<i>Checked by:</i> Eshraq Al-Dmour	<i>Approved by:</i> Salvador Ferrer
<i>Authorship:</i> Roger Martín		
<i>Distribution list:</i> Eshraq Al-Dmour Josep Nicolas Eva Boter Jordi Juanhuix Claude Rouget		

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1. Introduction

The “Consorci per l'Explotació Laboratori de Llum Sincrotró” (CELLS) is responsible for the construction and the operation of a new 3rd generation synchrotron radiation facility, named ALBA.

The facility will comprise a 268.8 m circumference 3 GeV electron storage ring, injected from a 100 MeV Linac through a full energy 249.6 m booster synchrotron.

CELLS is going to implement in the first phase 7 beamlines which are under design, at the ALBA synchrotron radiation facility.

All Standard UHV components, non commercial components and vacuum vessels of the beamlines in ALBA are the subject of this specification.

Complete compliance with requirements of this specification is expected. However, any desired deviations and proposals will be reviewed and must be approved by CELLS in writing prior to use.

2. General Information

The present document defined the Technical Terms of Delivery and Acceptance (hereafter referred to as TTDA) as well as a General Specifications for Design, Construction, and Handling of UHV Components for ALBA Beamlines.

Upon request, the customer has to be informed about the current state of the work. He must be given access to all workshops where parts of the order are executed or inspected. This applies to both the contractor/supplier and his sub-contractors. The contractor/supplier has to make available to his sub-contractors all documents required.

3. Preliminary Remarks

- 3.1. The front ultra-high vacuum (UHV) section of the beam line (i.e., front-end) will be connected with the vacuum system of the ALBA storage ring. The end pressure to be achieved is to be less than 1×10^{-9} mbar. Helium leak rate must be below $1 \cdot 10^{-10}$ mbar.l.s⁻¹.
- 3.2. In the high vacuum (HV) section, the end pressure shall be less than $1 \cdot 10^{-7}$ mbar. Leak rate shall be $< 1 \cdot 10^{-7}$ mbar.l.s⁻¹.
- 3.3. The required all-metal UHV components must to be bakeable up to the suitable temperature depending on the application and the materials used.
- 3.4. In the present document, the requirements made on the commercially and non commercially available vacuum components are outlined.

4. Design

- 4.1. The materials used and the construction of the parts must be in compliance with UHV requirements.
- 4.2. Narrow gaps and clearances (unvented holes etc.) within vacuum components must be avoided in order to exclude virtual leaks.
- 4.3. Steel and stainless steel ball bearings must be avoided in vacuum.
- 4.4. Welding between cooling fluid enclosures and parts exposed to vacuum must be avoided.
- 4.5. The surface properties of the sheet metal used in the vacuum section must be in accordance with DIN EN 10088-2, Table 6, "2B". Grinding traces, scratches, oxidation or corrosion marks are not allowed.
- 4.6. CF flanges with a Brinell hardness of 170 to 300 in the range of the sealing lip (knife edge) must be used. The flanges are to be sealed by OFHC copper gaskets with a HV hardness of $50-85 \pm 8.5 \text{ kp.mm}^{-2}$.
- 4.7. The screws used for UHV assemblies shall be silver plated.
- 4.8. The surface finish of Flat Seal Flanges should be N4.
- 4.9. The contractor/supplier has to include a reasonable fraction of rotatable flanges, the position of which has to be agreed upon with the customer during preliminary inspection.
- 4.10. The quality of the weld must be according to the ISO standards: ISO 13919-1, ISO 5817, quality level B: Stringent.
- 4.11. The supplier must qualify the welders for each process according to ISO standards: 9606-1.

5. Preliminary Inspection

- 5.1. The contractor/supplier has to submit the following documents for each vacuum component for preliminary inspection prior to the manufacturing of the vacuum system:
 - Data sheets with all technical information, e.g., bakeability, leak tightness, technical characteristics etc.
 - Calculations
 - Pickling and cleaning plan.
- 5.2. Procurement has to be started only after inspection and release of the above documents by the customer.
- 5.3. Manufacturing of the vacuum components has to start only after the customer has inspected and approved the above documents.

6. Materials

- 6.1. In principle, the materials usually utilized by the respective manufacturer of the components have to be used, provided that they comply with the UHV requirements. The material's compatibility within the vacuum depends on the material's vapour pressure at the operating temperature, permeability for gases and the porosity.
- 6.2. For Stainless Steel materials forming part of the vacuum chamber walls, the contractor shall supply CELLS with material certificates in accordance with ISO 404 confirming the material specification, chemical analysis and room temperature mechanical properties.

6.3. For the absorbers oxygen-free copper, material no. 2.0040 (OFHC-Cu) according to DIN 1787 (UNS C10200), has to be used. GlidCop® (registered trade name of SCM Metals, Inc) dispersion-strengthened copper may also be considered as an option.

7. Handling and cleaning

7.1. For the assembly to be completely compatible with the UHV environment, a high degree of cleanliness will be necessary at all stages of production to guarantee an acceptably low outgassing rate and weld integrity.

7.2. All machining work is to be carefully controlled to ensure that no foreign material is embedded in the surface of the material.

7.3. All mechanical cold working operations must exclude the use of heavy organic lubricants since these can be retained to some extent in the surfaces after the process.

7.4. During and after final assembly the components must be handled in special clean and dust-free areas only. This especially applies to final inspection.

7.5. Machining coolants shall be water soluble and sulphur free and shall be subject to CELLS approval.

7.6. During any unavoidable work on the inner and sealing surfaces of the chambers and when handling the components, wearing of clean, lint-free gloves is required to prevent contamination of the vacuum-facing surfaces.

7.7. To prevent re-contamination of the vacuum-facing surfaces by hydrocarbons, only appropriate pumps and leak detectors have to be used for evacuation of the chambers and leak detection. Turbomolecular pumps with hydrocarbon-free fore pumps are considered as suitable.

7.8. The plate material is to be cleaned before any cutting or forming operation commences. It will be sufficient to swab with acetone or similar solvent. If a guillotine or press is to be used, the blades should also be cleaned with this solvent.

7.9. The tenderer is requested to submit a detailed description of the proposed cleaning procedure (with the cleaning agents to be used) with the tender. However in Appendix I is specified one proposal for UHV components made of Stainless Steel.

7.10. After cleaning the vacuum surfaces must be protected against accidental contamination.

8. Identification

Each component must be provided with a heat-resistant identification at an appropriate and visible point, e.g., on external surfaces of a flange. The identification must contain the following information: name of the manufacturer, year of manufacture, name of material, serial number.

9. Acceptance at the Manufacturer's Workshop

The results from acceptance tests at the manufacturer's workshop have to be documented by the contractor/supplier in a test record. This record is to be added to the documentation.

10. Testing, Shipping and Packaging

- 10.1. The sequence of operations for the factory acceptance test on each completed and cleaned component shall be as follows:
- Visual internal and external inspection.
 - Vacuum leak test and desorption test after a bakeout of the component up to a temperature compatible of the material treated. A He-leakage rate of $< 1 \cdot 10^{-10}$ mbar.l/sec Visual inspection of the sealing surfaces of flanges immediately prior to protective packing for dispatch.
 - Coolant flow tests (for blockage, pressure drop, water leaks...etc)
 - The vacuum components and in particular the flanges and their sealing edges have to be subjected to visual inspection prior to packaging. Any defect on the knife edge of any flange of a vacuum chamber results in rejection of the vacuum component. An inspection record has to be provided.
- 10.2. For shipping, the sealing surfaces of the flanges must be covered by a reliable protection to prevent damage.
- 10.3. For storage and shipping each vacuum chamber must be backed filled with dry pure nitrogen at a slightly above atmospheric pressure, according to the standards of UHV practice.
- 10.4. These tests must be performed, documented and submitted to CELLS for all the components under UHV conditions.
- 10.5. Upon submission of the documentation including the confirmation of the acceptance test at the manufacturer's workshop, the incoming goods will be inspected at the customer's site.

11. Leak Tightness

- 11.1. The ultra-high vacuum components have to be submitted to an integral leak test using the Helium vacuum leak test method (leak rate $L < 1 \cdot 10^{-10}$ mbar.l s⁻¹ incl. background). The leak test is to be carried out by spraying all surfaces, welds, and flange seals with helium.
- 11.2. The leak detection shall be done with a suitable helium leak detector; the roughing system of the leak detector must be composed of dry (oil free) pumps.
- 11.3. In above tests, the sensibility of the measurement setup shall be determined with an external calibration leak.

12. RGA Scan Analysis

- 12.1. Test records with RGA scans. In these tests, the sensitivity of the measurement setup must be determined with an external calibration leak. This calibration must be carried by a certificated company.
- 12.2. Total and partial pressure (residual gas analysis RGA from 1-200 AMU) must be performed after cooling down to room temperature from a 24h bake out at the suitable temperature.
- 12.3. The residual gas analysis of each vacuum vessel must show that hydrocarbons contamination defined by the total partial pressure of all masses greater than 28 (with exception of mass 44) is less than 1% of the total pressure.

APENDIX I: Cleaning Procedure for Stainless Steel components

This is one proposal for the procedure for cleaning the UHV components made of Stainless Steel:

- Wiping off the major impurities
- Elimination of cutting oil or paste with a fast degreaser
- Through pre-cleaning of the entire surface on a wash table
- 10 minutes high pressure washing, using hot, demineralised water in the cleaning basin.
- 20 minutes in ultrasonic bath at 80°C using a special cleaner
- Rinsing the cleaning remains form the ultrasonic bath using hot and demineralised water in cleaning basin
- Intensive drying at 60-80°C in a dryer
- The cleaned parts should preferably be sealed in PE foil or packed dust free in aluminium foil.
- The cleaned and packed parts are then transported from the cleaning room.

The manufacturer is requested to submit a detailed description of the proposed cleaning process (with the cleaning agents to be used).