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TECHNICAL SPECIFICATION

EP - 13746 / PPE

SUPPLY OF A PROTOTYPE COMPOSITE CYLINDER FOR ATLAS

Summary

This specification concerns the supply of one prototype of a stable cylindrical mechanical support made in carbon fibre - honeycomb sandwich. (Overall dimensions are 560 mm diameter by 1574 mm length.)

1. Introduction

1.1.GENERAL
The Purpose of the cylinder prototype is to demonstrate that the low mass very high stability requirements of the Atlas inner tracker barrel silicon structure may be achieved with a carbon fibre honeycomb sandwich cylinder.

1.2 SCOPE OF THE SPECIFICATION
This specification concerns the supply of a prototype of a structure for the barrel silicon of Atlas inner detector.

For this prototype, we have chosen for practical reasons the dimensions corresponding to the smaller of the four "final" cylinders. The tenderer must quote for this alternative (A). In addition the tenderer may also quote for alternative (B) based on slightly different dimensions, to benefit from already existing manufacturing tools. The tenderer is also invited to give advice on the choice of materials, and manufacturing method, and to propose alternative solutions.

1.3 ACCESS TO INFORMATION
CERN reserves the right to access all technical information during the entire period of production.
If part of the order is to be subcontracted, it should be clearly indicated in the tender.

2. Detailed description

2.1 DRAWINGS
Design of the cylinder (all fasteners to fix reference marks, detector modules, cooling pipes etc will be defined and added later, and are not part of this tender) is described in the drawings 1-TB-0035-242-00-B and 152227P3A. Stiffness test set-up is described in the drawing 1-TB-0035-243-00-B
CERN reserves the right to make small changes to these drawings at the time the order is placed.

2.2 DIMENSIONAL STABILITY REQUIREMENTS

2.2.1. The structure should be designed with a 0 +/- 0.5 ppm/°C coefficient of thermal expansion (CTE) in the longitudinal and circumferential directions, over a temperature range of -20°C to +30°C.

2.2.2 Under stable working conditions (-10°C +/- 1°C and also 20°C +/- 1°C in a dry nitrogen atmosphere) the dimensional changes in all directions, except through sandwich thickness, should be smaller than 10 microns/meter for a period of one year. Conditions for this stability are: Cylinder flanged, with flange as per drwg.152227P3A, supported on 2 points at both ends in middle plane and loaded with a distributed load of 50 N/m2 on the whole surface of the cylinder.

2.2.3.Under change from assembly conditions (20°C - 50% RH) to working conditions (-10°C - dry nitrogen atmosphere) the dimensional changes in all directions , should be less than 50 microns/meter, (load condition as per 2.2.2)

2.2.4. The stiffness of the cylinder should be such that: Supported, on test rig (see drwg 1-TB-0035-243-00-B) along two generatrices situated at +/- 148.5 mm from the vertical axis, and loaded along all the length of the top generatrix of the cylinder with a total load of 280N . The vertical deflexion (along Y axis) has to be smaller than 0.7mm and the horizontal deformation (along X axis) smaller than 1.1mm on each side of the cylinder.

2.3 MATERIALS

A carbon fibre/cyanate ester honeycomb sandwich structure with quasi-isotropic lay-ups for the skins has been selected, for the cylinder, for its high specific stiffness, high dimensional stability and the tailorability of its CTE to very near zero in the sandwich plane. Same material as skins has been chosen for the flanges.

2.3.1. SANDWICH MATERIAL

For this prototype, material used to make the sandwich should have the following characteristics:

Sandwich total aerial weight:	Max.	1.2 kg/m2
Sandwich overall longitudinal and circumferential CTE:		0 +/- 0.5 ppm/°C
Elastic modulus of skins (quasi-isotropic):		Min. 100 GPa
Shear modulus of the core material:		Min. 22 MPa

The above mentionned parameters can be achieved using, for example, the following materials:

Skins: YLA XN70A/RS-3C (alt: XN50A/RS-3C) Prepreg tape -30 g/m2 - in quasi isotropic lay-up. Adhesion film YLA RS-4A.

Core: CFRP Honeycomb (YLA Ultracor UCF-51-3/8-2.0 or Hexcel HFT-G-327-3/8-2.0V). These honeycomb only exists in hexagonal cell shapes therefore should be heat formed before use.

However the tenderer is invited to propose an equivalent or better solution in alternative (B).

2.3.2 SANDWICH EDGES AND INSERTS

The edges of the sandwich should be completely closed with appropriate close-outs, integrating the 16 M3 inserts for end-flange fixation at both ends (see drwg. 1-TB-0035-242-00-B). Carbon fibre end rings, fill foam or another technique may be

proposed by the tenderer to close the cylinder ends. The technique proposed should be clearly explained in the tender.
The tenderer should also propose the suitable inserts for this application. Each insert should have at least the following load bearing capability:

- Normal tensile and compressive load: min. 3000N
- Shear load: min. 1000N
- Screwing torque min. 3.0 Nm

The inserts proposed should be clearly described in the tender.

2.3.3 END-FLANGES MATERIAL
Carbon fibre-cyanate ester laminate flanges with the following properties will be fixed (using the 16 inserts shown on drwg. 1-TB-0035-242-00-B) at both ends of the cylinder, The purpose of these flanges is to increase the circumferential stiffness of the cylinder and provide attachment points for the cylinder fixation.

Elastic modulus of flange laminate (quasi-isotropic)	min 100 GPa
In plane CTE of end flanges	0 +/- 0.5 ppm/°C

These characteristic may be achieved with the following materials:
YLA XN50A/RS - 3

However the tenderer is invited to propose an equivalent or better solution.

2.3.4. MATERIAL SAMPLES FOR VALIDATION
The following samples of the sandwich and flange materials should be made and tested by the manufacturer, to allow for validation of the mechanical properties prior fabrication of the structure. A written report should be submitted to CERN for approval of the prototype manufacture.
Samples of skin material for sandwich:

- 4 flat skin pieces 230mm x 25mm x 0.2mm thickness (2 in 0° and 2 in 90° direction of the skin), for tensile tests to measure Youngs modulus of skins.

Samples of sandwich flat plates:

- 4 flat pieces 400mm x 50mm x 6mm thickness for 4 points bending tests.
- 4 flat pieces 50mm x 50mm x 6mm thickness for flatwise tensile strength tests.

Samples of sandwich edge including inserts.

- 2 flat samples with 4 inserts each for insert load tests, exact definition to be agreed before order is placed.

Samples of flange material:

- 4 flat plates 230mm x 25mm x 3mm thickness for tensile test .

The test procedure shall adhere to a recognized certification norm (eg ASTM, ISO; DIN etc...) and should be clearly specified in the tender.
The tenderer is invited to propose alternative or supplementary relevant tests, if he considers the ones described above are not sufficient to guarantee the quality of the structure.

2.3.5. MATERIAL SAMPLES
Another batch of samples, similar as per 2.3.4. manufactured with same batches of material and cured exactly as the cylinder and flanges should be provided by the manufacturer to allow for quality control tests of the sandwich and flanges mechanical properties.

2.4 METHOD OF MANUFACTURING

A complete description of the manufacturing method and sequence, including possible post fabrication treatments should be produced in the the tender.

3) Documents

In the three weeks following the placing of the order, the supplier will forward a detailed manufacturing schedule. Any modification to this schedule will be notified to CERN immediately.
Manufacturing drawings will be sent to CERN for approval before the start of the fabrication. These drawings will give precise information about proposed materials.

Before shipping the cylinder, the following documents should be supplied by the manufacturer:
-Material certificates indicating batch number and date of manufacture.
-test certificates of raw materials
-attestation of curing procedure

4) Quality control and tests

4.1 FACTORY CHECKS AND TESTS
The supplier will perform a complete geometry and weight check of the cylinder and provide a metrology report. (exact procedure to be agreed between CERN and tenderer, thus should be specified in tender).
A loading test to check the stiffness of the cylinder with and without flanges according to 2.2.4 will be made in the factory prior to delivery. The test rig will be provided by CERN.

4.2 INSPECTION
The supplier should give notice to CERN at least one full week prior to these tests, in order that representatives may be present. CERN reserves the right to carry out any tests in order to check the characteristics and the quality of the finished product.

5) Packing, transport and delivery

Supplier shall be responsible for the safe and appropriate packing, transport and delivery to the CERN - Meyrin (Switzerland) site.

The box shall be clearly marked with the order number and all the necessary information to allow for a safe delivery.