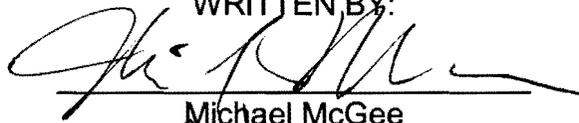


**FERMILAB**  
ACCELERATOR DIVISION  
MECHANICAL SUPPORT DEPARTMENT

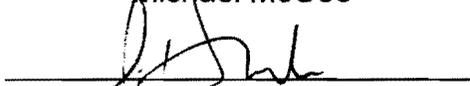
**NOvA/ANU**  
**NOvA ME Target Specification**

SPECIFICATION No.  
**1320.000-ES-296248**

WRITTEN BY:



Michael McGee



Patrick Hurh

APPROVED BY:



Paul Derwent

REVIEWED BY:



James Hylen

DATE ISSUED:  
01-FEB-2011

**Introduction:** This Engineering Specification provides requirements and guidelines related to the Fabrication and Assembly of the NOvA Medium Energy (ME) Target at STFC-Rutherford Appleton Laboratory as per the Accord (of the same name) signed in February, 2011. Exceptions and substitutions to the provisions listed herein are allowed over the course of manufacture subject to Fermilab review and approval.

**Documentation of the Manufacturing Process:** Manufacturing processes regarding the NOvA ME Target shall be documented including, at minimum, documentation of required Quality Assurance steps, any processes that deviate from drawings or specification, and material procurement documentation/certificates. All documentation shall be provided with the Target upon delivery.

**Materials:** Principal materials are listed on the final IHEP drawings and in Table 1, below. Also, corresponding acceptable substitutions are listed given each original material. All materials substitutions are subject to Fermilab approval prior to manufacture.

Table 1. IHEP Target drawing material listing with corresponding substitution.

Basic Material	IHEP Alloy/Grade	Substitution Alloy/Grade
Aluminum	AD0, AD1	1060 or 1100
Aluminum	AMg6	6061-T6 or 6082-T6
Aluminum	Duralumin D16T	7075
Beryllium	PF-60	None
Graphite	ZXF-5Q	None
Stainless Steel	A304L	316L
Steel	Carbon Steel	316L
Steel	Alloy Steel 40X	316L

**Target Fin Fabrication and Alignment:** The target core is a row of 48 graphite segments. Segments of the target core shall be cut from ZXF-5Q precision ground plates of Poco Graphite, Inc. of sizes 7.4 mm x 100 mm x 150 mm (all surfaces ground flat to +.127 mm/-.000 mm) with tolerances for all dimensions  $-0.025$ ,  $+0.13$  mm by the electrical discharge machine and finally machined by the grinding machine. A 10 mm diameter hole located at the segment center, 46 mm from the bottom in 24 of the 48 graphite segment will be machined. Surfaces of target segments shall be carefully cleaned after machining with pure alcohol according to the IHEP drawing 9229-02-00-01. Refer to item E in QA Section regarding fin alignment.

**Coatings and Special Processes:** “Hard coat” anodized coatings for aluminum NOvA ME Target components shown in Table 2 are generally 10  $\mu$ m in thickness achieved by standard industrial anodization process. The following specification from IHEP may be used as a guide:

Before anodizing any component, the part shall be carefully cleaned of grease and oil and etched in a 60 °C (+10 °C) solution of NaOH with the concentration of 50:100 g/l during one min.

Components are anodized in a water cooled bath filled with a solution of sulfuric acid of grade “X” or “X4” (Russian standard, GOST 4204-77):

- A) The electrolyte concentration shall be of 200 g/l ( $\pm 10$  g/l).
- B) The electrolyte temperature shall be maintained at 10 °C (+5 °C).
- C) The current density shall be of 2 A/dm<sup>2</sup> (+0.05 A/dm<sup>2</sup>).
- D) The duration of anodization shall not be less than 50 min. (+2 min.).

After anodizing the component shall be rinsed in flowing water at the temperature 10 °C (+5 °C) during one hour.

Table 2. List of IHEP ME Target anodized parts.

IHEP Target Drawing #	Component
9229-00-00-06	Bolt
9229-01-00-00	Cooling Tube, interior surface only
9229-02-00-02	Pressing Plate
9229-02-00-03	Pressing Plate
9229-02-00-06	Bracket
9229-02-00-08	Plate
9229-02-00-10	Rod
9229-02-00-11	Flange
9229-02-00-12	Flange
9229-02-00-13	Nut
9229-02-00-14	Bolt
9229-02-00-15	Bushing
9229-02-00-16	Washer
9229-02-00-17	Bolt
9229-02-00-18	Plate

**Vacuum and Preparation:** All parts should be cleaned according to industry standards for high vacuum (degrease/ultra-sonic bath, ethyl alcohol wipe, and pure water rinse) prior to assembly. All assembly shall be done in a manner consistent with high vacuum practices (with the use of appropriate gloves, clean area and clean tools). Leak check of completed assembly shall be performed using a helium (He) mass spectrometer (no detectable leak at a sensitivity of 1e-9 atm-cc/sec or equivalent).

**Target Cooling Tube Fabrication and Assembly:** Target cooling tube inlet and outlet bellows shall be purchased in accord with IHEP drawing 9229-02-11-00. The bimetallic adaptor (aluminum to stainless steel) shall be purchased in accord with IHEP drawing 9229-02-20-00. However, a substitution for the Target cooling tube

bellows and bimetallic adaptor is permissible and subject to Fermilab approval prior to manufacture. Each welded joint shall be tested using a He mass spectrometer to vacuum standard specified.

Hydraulic pressure testing per ASME B31.3 shall follow final assembly of the target cooling tube to (175 psig) held for not less than 30 minutes unless otherwise specified. No leak is acceptable.

**Quality Assurance:** STFC/RAL will provide documentation for certain critical quality assurance examinations as specified:

- A) Radiographic examination of all welded joints in the target fin water cooling circuit. Joints shall be required to satisfy the acceptance criteria for ASME B31.3 (2004) Normal Fluid Service (Table 341.3.2). In addition, finished cooling circuit shall pass a hydrostatic pressure test at 175 psig.
- B) Non-destructive examination of target vessel cooling jacket welded/brazed joints including, at minimum, in-process examination (as per ASME B31.3 (2004) Para. 344), hydrostatic pressure test at 175 psig and visual inspection (as per ASME B31.3 (2004) Para. 344.2).
- C) Leak check of completed assembly using He mass spectrometer (no detectable leak at a sensitivity of  $1E-9$  atm-cm<sup>3</sup>/sec).
- D) Budal monitor electrical circuit connectivity (less than 1 ohm resistance) and isolation to ground (greater than 1 M-ohm resistance at 100 v).
- E) Graphite target fin tip alignment of +/- 0.3 mm relative to a theoretical straight line extending from the first target tip edge to the last target tip edge.

**Shipment to Fermilab:** The Manufacturer is responsible for the proper packing or crating to ensure that damage will not occur during shipment. The water passages shall be purged with clean compressed air to ensure that the water passage is clear of any and all contaminants and moisture prior to shipment. The water passages of the target shall be properly capped to prevent contamination, which would subsequently degrade the low conductivity nature of the target cooling system.