Government of India
Bhabha Atomic Research Centre
Accelerator Control Division

Ref: ACnD/EMAS/18/609 Date: 4/10/2018

Detailed Engineering, fabrication, assembly, inspection, supply and safe delivery of variable field dipole magnet confirming to the Technical Specification Number: ACnD/XRD/18 dated 3.10.2018.

Dear Sir/Madam,

Quotations are invited for "Detailed Engineering, fabrication, assembly, inspection, supply and safe delivery of variable field dipole magnet confirming to the Technical Specification Number: ACnD/XRD/18 dated 3.10.2018".

Bidder shall quote for deliverables as per technical specifications.

1. No free Issue material is involved (as per section 5.0 of technical specification sheet).
2. Taxes shall be quoted separately. Form AF/H whichever is applicable shall be provided, if required.
3. **The quotation must reach The Head, EMAS, ACnD by 18/10/2018 (12:00 Noon) and must be sent in a sealed envelope super scribed with the reference number & the due date given above. Courier are not allowed in BARC premises; the quotation shall be sent by speed post/registered post.**
4. The address on the envelope should read: **The Head,**
   Electromagnetic Application Section,
   Accelerator Control Division,
   RCnD Bldg., North Site
   BARC, Trombay,
   Mumbai - 400 085.
   (Kind Attn: Elina Mishra, SO/D)
5. The bidder shall complete the job within 12 weeks from the date of firm work order issued to the bidder. The finished components shall be delivered by the bidder at **RCZ stores, BARC, Trombay, Mumbai-400 085.**
6. Head, EMAS, Accelerator Control Division reserves the rights to accept/reject any or all quotations without assigning any reason.
7. In case of technical query, please contact Ms. Elina Mishra or Mr. Vikas Teotia (Extn No: 23943).
8. Delivery charges if any must be clearly mentioned in the offer. Quotation must also indicate the validity of offer. Quotation must also indicate the VAT no and PAN no of the party.
9. Drawings / Sketches must be returned along with the offer.
10. The quotation has to be signed by authorized person with company seal.
11. Payment will be made by cheque only after satisfactory completion of work on production of bill, delivery challan and advance stamped receipt. It may be noted that IT @ 2% and surcharge on tax at 15% shall be deducted from your bills.

Encl.: Technical Specification Sheet no: - ACnD/XRD/18

4.10.18

Sanjay Malhotra,
Head, ACnD

Specification no.	Revision no.	Total pages	Date
ACnD/XRD/18	1	8	3.10.2018

Detailed Engineering, fabrication, assembly, inspection, supply and safe delivery of variable field dipole magnet

1.0 Scope

This specification specifies "*Detailed Engineering, fabrication, assembly, inspection, supply and safe delivery of variable field dipole magnet*".

The variable field dipole magnet being fabricated is to be used as a source of magnetic field for XRD (X-Ray Diffraction experiments) for studying the crystal lattice and atomic structure.

The job includes fabrication of the magnetic yoke and poles as per the drawing in the technical specification sheet. Permanent magnets are to be used to produce the magnetic field. These magnets have to be assembled in an aluminium bobbin. For achieving variable magnetic field, a magnetic plate is introduced with required linear guide system, spring system and handle. The entire magnetic yoke and permanent magnet assembly has to be assembled with the variable field shunt system. For mounting the complete system, an aluminium support bench has to be fabricated. For achieving desired magnetic field and required uniformity, precise fabrication of all the components is inevitable. Packaging and safe delivery is also under the scope of the supplier.

This document is organized as follows:

2.0 Statement of purpose

Under extreme conditions like high temperature and high pressure provide important information about the materials regarding their microscopic interactions through structural evolution of new phases. This is performed by a non-destructive method called X-ray diffraction. In the presence of magnetic field, materials with strong spin-lattice interactions show interesting phenomena due to displacement of atoms. To study these phenomena, dipole magnet is required. The sample studies are done in a varying magnetic field regime, so the dipole magnet should produce a variable magnetic field. This is achieved by employing a shunt magnetic plate in addition.

3.0 Details of deliverables and scope of supply

The list of the items to be fabricated, packed and safely delivered to the purchaser includes (reference documents and drawings attached):

Item no.	Description	Quantity
1.	Soft iron yoke with permanent magnets assembly in bobbin	2 no
2.	Soft iron plate with linear guide assembly for variability of field	2 no
3.	Support frame	2 no

The scope of the supplier includes:

- Preparation of manufacturing drawings on the basis of engineering drawings provided by the purchaser. Approval shall be taken from the purchaser on the prepared manufacturing drawings before the start of fabrication.
- Purchase of raw material as per technical specification and produce test certificates for approval from purchaser before procuring.
- Manufacturing of magnet yoke, support frame, complete shunt system with springs and linear guides, etc. as per Para 6.1 of this technical document.
- Assembly of permanent magnets in the bobbin and complete assembly with the magnetic yoke.
- Assembly of the magnetic system with linear motion guide and shunt magnetic plate.
- Geometrical inspection of the fabricated components.
- Packing of the jobs and shipment.

4.0 Vendor Qualification

Suppliers will be qualified based on technical evaluation. As this is a multi-disciplinary work hence supplier must have technically qualified and trained staff for both mechanical and magnetics jobs. Supplier must have required infrastructure and past experience of similar jobs. Supplier will be evaluated based on the information provided by the supplier as requested below. Any deviation from the listed qualification criteria will lead to rejection of the supplier. Purchaser's specialists may visit the supplier facilities for evaluation and for detailed technical discussions.

SN	Type of job	Outsourcing permissible (Yes/No)
1.	Preparation of manufacturing drawings on the basis of engineering drawings provided by the purchaser.	No
2.	Fabrication of Magnet Yokes, aluminium support frames and bobbins and the assembly of shunt system with the linear guide system. Supplier shall have fabrication facilities to meet the geometric tolerances of the job like 3D drafting software, EDM wire cut machine, CNC machine, etc.	No
3.	Geometric inspection using gantry based CMM having better than 5 microns accuracy	No
4.	Nickel plating of yoke	Yes

Purchaser's specialists may visit the supplier facilities for evaluation and for detailed technical discussions. Details to be furnished by the vendor related to facilities and expertise:

Particulars	To be filled by the vendor
Human resource (The supplier must give the complete detail of human resources including Engineers, Consultants (if any), Draftsmen, Technicians, Welder, Assembly Mechanic, quality control inspector, machinist etc.)	
Infrastructure: The supplier must give the details of infrastructure suitable for these jobs such as 3D Drafting software, Manufacturing machines, EDM wire cut machines, electrical and magnetic testing equipment, Assembly room, other tools and tackles, Inspection and Metrology facilities, building head room, overhead crane facility.	

5.0 Details of Free Issue Material to be provided by the purchaser

No free issue material will be provided for the above minor fabrication. All the raw material, components and equipment will be procured by the supplier itself.

6.0 Technical description of the job

This technical specification document includes fabrication, inspection and supply of magnetic yoke and permanent magnet assembly for the variable field dipole magnet. Precise fabrication and qualification of the magnetic yoke are very critical for ensuring field uniformity within desired limits of good field region. The end use of these components demands fabrication within the tolerances and assembly of components which are covered in this document.

6.1 Magnet yoke:

- The yoke consists of two parts of equal geometry, dimension and precision. The entire yoke is to be build out of a single block of soft iron plate using EDM wire cut methodology. This will ensure parallelity and perpendicularity of the frame structure and hence the magnetic field components. The dimensions of the structure are strictly according to the drawings provided in the technical specification sheet (Drawing No: A3-A02VTCA74).
- The two magnet yokes are to be assembled with each other via aluminium bobbin with permanent magnets stacked in the bobbin.
- The raw material specifications are as given below:

  Raw material for magnetic yoke:

  i) Chemical composition

  The percentage of iron in the plates shall be more than 99.5 %.

  The maximum permissible values for other elements are as given below:

% weight Composition	C	Mn	P	S	N	Cu
Max Permissible	0.01	0.12	0.01	0.008	0.006	0.03

ii) Physical Properties

S.No.	Parameter	Value
a.	Grain Size (ASTM E 112-12)	Grain size number (G) < 6.0
b.	Microstructure	Ferritic
c.	Specific Gravity (nominal)	7.85 g/cm^3
d.	Ultimate Tensile Strength (nominal)	≥240 MPa
e.	Yield Strength (nominal)	≥120 MPa

iii) Magnetic Properties

Parameter	Value
Saturation Induction B_{sat}	> 2.15 Tesla
Magnetic field Intensity required for 1 T	< 500 A/m
Magnetic field Intensity required for 1.5 T	< 1200 A/m
Magnetic field Intensity required for 2.0 T	< 20000 A/m
μr (max)	> 3200
Coercive Force	< 100 A/m

6.2 Aluminium bobbin and permanent magnet assembly:

- The aluminium bobbin is made of 3 parts: one permanent magnet cage and 2 window frames.
- These three parts will be bolted together while assembling with the soft iron yokes.
- The aluminium cage should be fabricated using EDM wire cut for obtaining precise tolerances for ease assembly of the permanent magnets.
- There are 6 permanent magnets that are to be assembled in the aluminium bobbin. Utmost care should be taken while stacking permanent magnets since these are very strong magnets which if handled carelessly can lead to material damage as well as can cause harm to the personnel handling them.
- Once the magnets have been stacked in the aluminium cage and the window frames are bolted to the cage, the two soft iron yokes will then be assembled to the permanent magnet cage to form a single dipole assembly.
- The properties of the permanent magnets are:
  i) The permanent magnet to be used is nickel plated NdFeB magnets (Neodymium Boron Iron) Magnets whose physical and magnetic properties are described below:

i) Physical Properties:

Sl. No.	Particulars	Values (in mm)	Tolerances
1.	Length	68	-0.05/+0.05 mm
2.	Breadth	50	-0.05/+0.05 mm
3.	Height	24	-0.05/+0.05 mm

ii) Magnetic Properties:

Sl. No.	Parameter	Value		Units
		Minimum	Nominal	
1.	Residual Induction, Br	1.35	1.40	Tesla
2.	Coercive Force, Hc_B	1000	1010	kA/m
3.	Energy (BH)max	46	48	MGOe
4.	Intrinsic coercive force	1335	1355	kA/m

5.	Temperature coefficient of reversible changes in Br	Better than -0.12	%/˚C
6.	Curie temperate	> 300	˚C
7.	Maximum operating temperature	> 150	˚C

6.3 Aluminium frame:

- To mount the magnet on its desired position on the stage to bring the height of the sample to the center of the air gap of the dipole magnet, an aluminium mounting support system is fabricated. The geometry and the dimension is same as that provided in the drawing (Drawing No: A3-A02VTCA75). The structure should be fabricated strictly as per the drawing for proper alignment of the magnet.

6.4 Shunt assembly system:

- For producing a variable field permanent dipole magnet, an external arrangement needs to be provided to as to vary the field in the air gap.
- For achieving this, a U shaped soft iron plate (raw material of the plate will be same as the raw material used for magnetic yoke as given in the section 6.1) with flat base is to be used which shall work as a shunt to bypass the magnetic field and reduce the field at the center of the air gap.
- For supporting this movable soft iron plate, a spring system and a screw guide system with linear bearings is to be employed. The geometry and the dimensions are provided in the drawing of the technical specifications.
- The soft iron plate will slide on a 4 legged support guide system with spring arrangement. Aluminium bush will be provided for stability and repeatability. These springs will provide a balance against the attracting magnetic forces on the plate by the permanent magnet assembly.
- A plate along with the screw and its associated housing will be fabricated as per the drawing for providing desired movement to the soft iron plate.
- A handle is to be provided at the top for easy turning of the screw and hence movement of the soft iron plate.

7 Acceptance criteria

Following are the acceptance criteria of the components and coils and other relevant parameters:

S.N.	Particulars	Acceptance criteria
1.	Visual	Any signs of damage, deterioration and oxidation shall not be present on any component. No burrs, rough edges and unfinished part of the job will be accepted.
2.	Geometric and dimensional accuracy of sub components and the final assembly	Geometric tolerances of each and every component shall be strictly as per drawings. Geometric inspections shall be done after each step and inspection reports (Annexure A) for all shall be prepared and submitted. The inspection report shall be based on scanned object on gantry based CMM and the deviation shall be compared and reported. The deviation must not be greater than 50 microns (and specified tolerances at

		different critical dimensions). Following are applicable to assembled magnet 1. The air gap aperture shall be determined by measuring the inner distance between the opposite legs of the assembled magnet. This shall not vary more than ± 50 microns of the true value. 2. Height, width and all other dimensions of the magnet shall be within ±50 microns of the specified value. 3. Flatness, parallelity and perpendicularity of different surfaces should be within the specified tolerances. 4. Repeatability of the assembly with values within ± 50 microns. 5. The springs that are used to support the soft iron plate shall be as per the design and dimensions specified.

8 Price and delivery schedule

The supplier shall give overall price and its break-up for all the deliverables mentioned. The overall price will be compared. The supplier shall offer prices in following format.

Item no.	Description	Quantity	Price per unit	Total price
1.	Soft iron yoke with permanent magnets assembly in bobbin	2 nos.		
2.	Soft iron plate with linear guide assembly for variability of field	2 set		
3.	Support frame	2 sets		

The cost incurred in preparation of jigs if any shall be included in the price as mentioned above. The work activity plan shall be as per our requirement. However, supplier shall give their activity schedule as per their resources.

Following program is required for the timescales of fabrication and delivery:

a. Awarding the purchase order : Week 0
b. Preparation of approach paper by the supplier and sketch design : Week 1
c. Preparation of detailed engineering design including 2D and 3D drawings : Week 3
d. Procurement of raw material by supplier : Week 8
e. Manufacturing of Magnet yoke, aluminium support and shunt assembly system : Week15
f. Manufacturing of Aluminum bobbin and assembly of permanent magnets : Week17
g. Assembly of the complete system : Week18
h. Inspection of the magnet assembly : Week19
i. Packaging and delivery : Week20

The supplier can give their own schedule keeping in mind their timescales. Final schedule shall be given to the supplier along with the purchase order.

9 List of concept drawings attached

SN	Drawing title	Drawing Number
1.	General assembly drawing	A3-A02VTCA73
2.	Dipole Magnet with bobbin and permanent magnet assembly	A3-A02VTCA74

3.	Aluminium base support	A3-A02VTCA75

10 List of Annexures

SN	Annexure Name	Particular	Page No
1.	Annexure A	Geometrical qualification tests on the dipole magnet yoke.	7

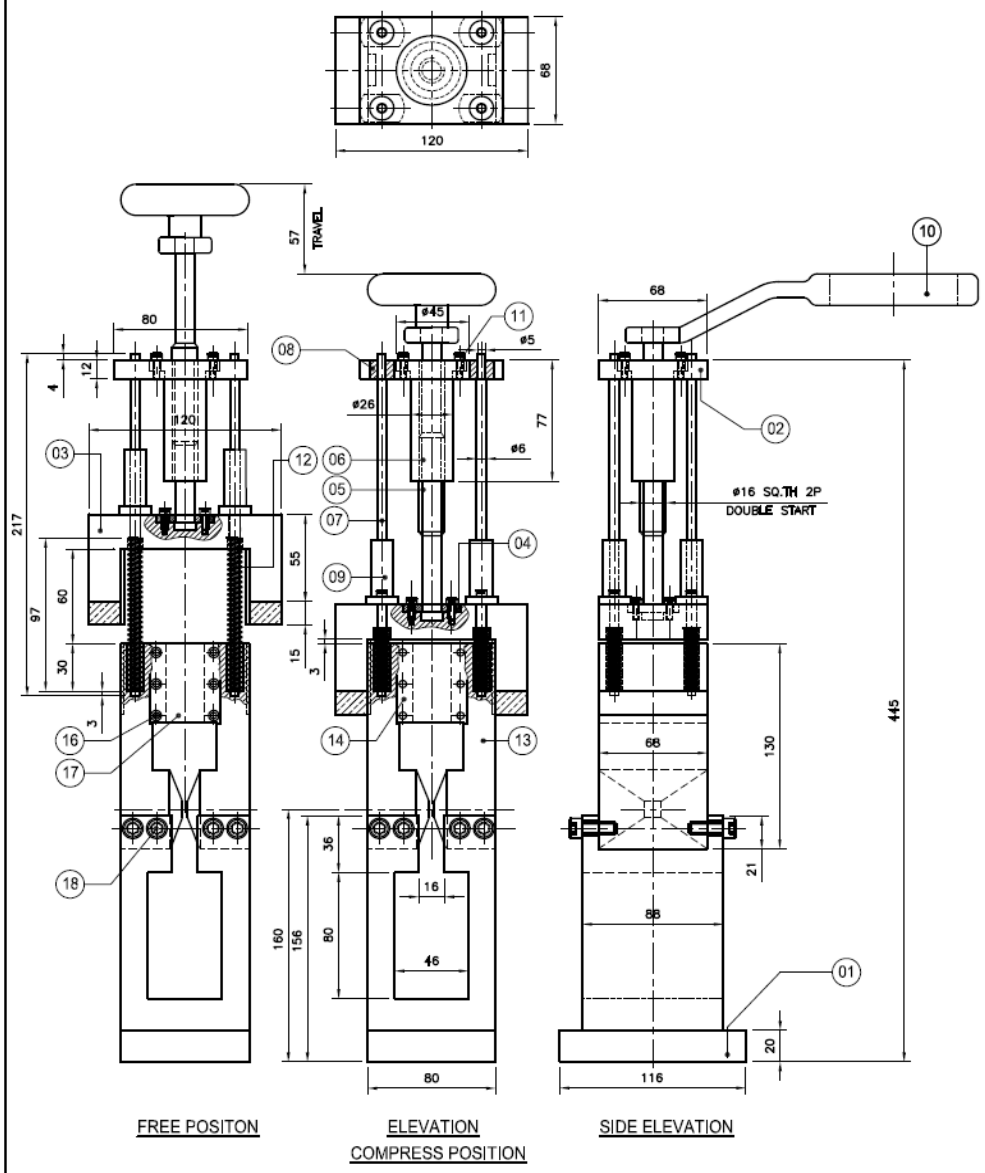
11 General condition:

a. All intellectual property rights belong to purchaser for work done under this technical specification/PO.
b. Supplier shall maintain the authenticity of drawings or any related drawings/document provided by the purchaser.
c. Any fabrication, production or procurement should only be done after proper approvals from the purchaser.
d. All activities would normally be carried with due professional care. However, purchaser shall not be responsible for any loss or personnel accident during execution of the work pertaining to the technical specifications under this PO.
e. Supplier agree to hold in confidence all information provided by the purchaser.
f. Supplier shall collaborate and coordinate all the work sub-contracted to any vendor.
g. Publication if any pertaining to work of related to work under this purchase order can be done only after prior mutual consent of purchaser.
h. All the raw materials required for deliverables except the Free Issue Material mentioned is in scope of supplier and the supplier should quote accordingly.
i. Overall cost of all the items in the deliverables will be compared including packaging, forwarding and safe delivery to BARC RCZ stores and shall be quoted separately. The supplier should not furnish lump sum cost. Basic price, packing, forwarding & safe delivery charges shall be quoted separately.
j. Suppliers shall give complete details of their product & list of users for technical evaluation.
k. Supplier shall submit along with the quotation, compliance certificate adhering to the specifications.

ANNEXURE A

(GEOMETRICAL QUALIFICATIONS TESTS)

- The geometric dimensions of the components shall be strictly as per the fabrication drawings generated.
- Geometric tolerances of each and every component should be strictly adhered to.
- Geometric inspections shall be done after each step by scanning the object on CMM. The inspection report shall be based on scanned object on CMM and the deviation shall be compared and reported. The deviation must not be greater than 20 microns.
- This shall be repeated for all the fabricated components.



BILL OF MATERIAL

SR.NO.	DESCRIPTION	QTY.	MATERIAL	REF. DRG . NO.
01	AL BASE PLATFORM	01	AL–T6061	
02	TOP PLATE	01	AL–T6061	
03	SHUNT	01		
04	SCREW LOCK PLATE	01	AISI 304	
05	SCREW	01	AISI 304	
06	SCREW HOLDING BUSH	01	AISI 304	
07	LINEAR BRG GUIDE ROD	02	AISI 304	
08	BUSH	02	BRASS	
09	LINEAR BRG. LMH 6L	04	THK MAKE	
10	HANDLE	01	AISI 304	
11	HEX. SKT. HD.CAP SCREW M4x10	08	IS:2269 Gr. A2–70 (AISI 304)	
12	SPRING WIRE DIA 1–OD 9	04	ENCONEL X–745	
13	PM DIPOLE	01		
14	BOBBIN	01	AL–T6061	
15	FREE	–	–	
16	HEX. SKT. HD.CAP SCREW M4x10	06	IS:2269 Gr. A2–70 (AISI 304)	
17	MAGNET 12x20x50 LG	06	STD.	
18	HEX. SKT. HD.CAP SCREW M8x10	08	IS:2269 Gr. A2–70 (AISI 304)	

TITLE:–

G. A. OF TUNABLE DIPOLE MAGNET

APP'D.

SACLE 1:1

DR'N	29.05.2018	PROJECT
DRG. CHK'D.		
DES'D.		
DES'N		

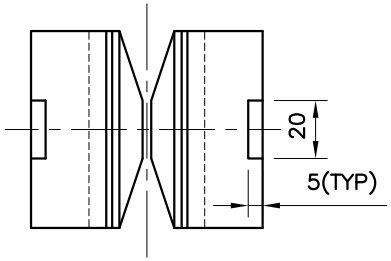
ALL DIMENSIONS ARE IN mm

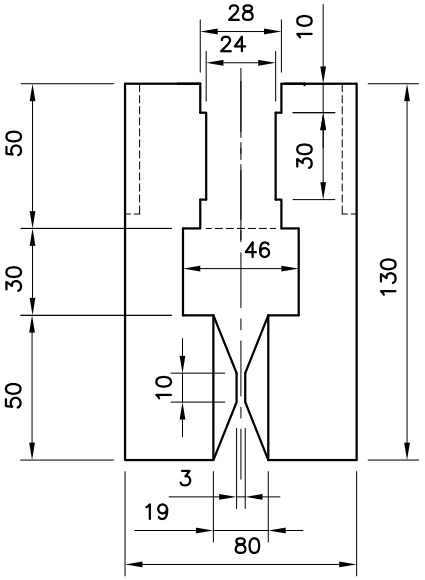
REV. DATE 09.02.2018

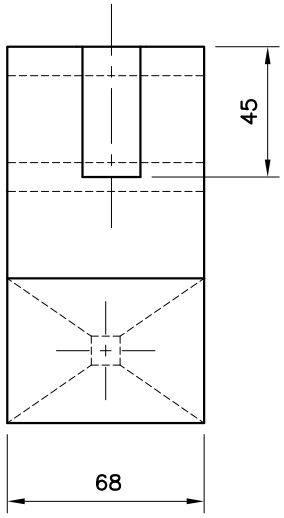
GOVERNMENT OF INDIA
BHABHA ATOMIC RESEARCH CENTRE
ACCELERATOR CONTROL DIVISION.

DRG. No.
A3–A02VTCA73

SH 1 OF 1 DATE

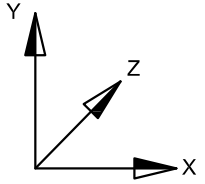


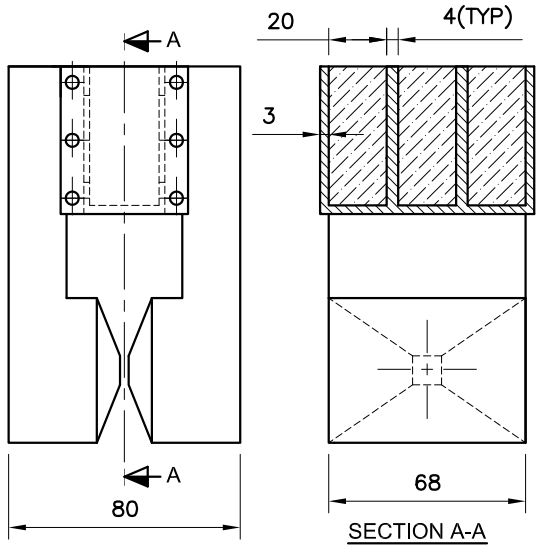




SECTION A-A

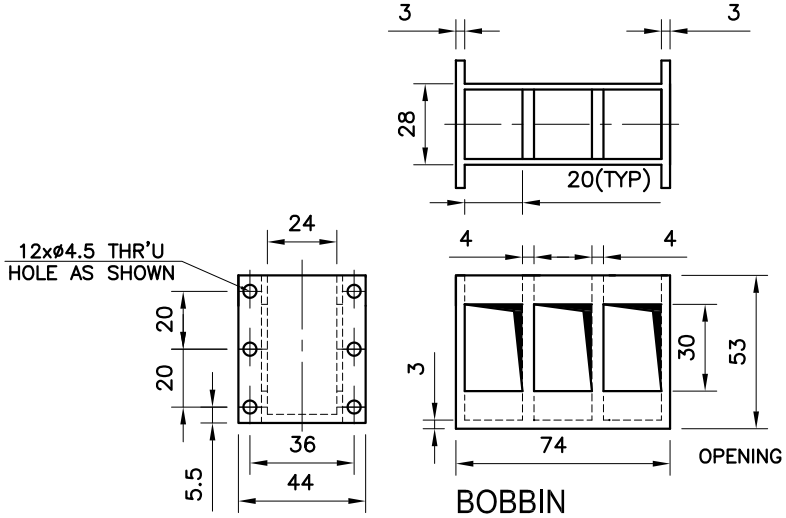
DIPOLE MAGNET





SECTION A-A

SUB ASSY OF DIPOLE MAGNET , MAGNET & BOBBIN



BOBBIN

REV	ZONE	CHANGE MADE	DATE	INITIAL

DEVIATIONS FOR LINEAR DIMENSIONS AS PER IS:2102

CLASS OF DEVIATION	RANGE OF NOMINAL DIMENSIONS					
	ABOVE	0.5	3	6	30	120
	UPTO AND INCLUDING	3	6	30	120	315
FINE		±0.02	±0.05	±0.1	±0.15	±0.2

TITLE:–

DIPOLE MAGNET & BOBBIN ASSY

APP'D.

SACLE 1:1

DR'N	RBC 29.05.2018	PROJECT
DRG. CHK'D.		
DES'D.		
DES'N		

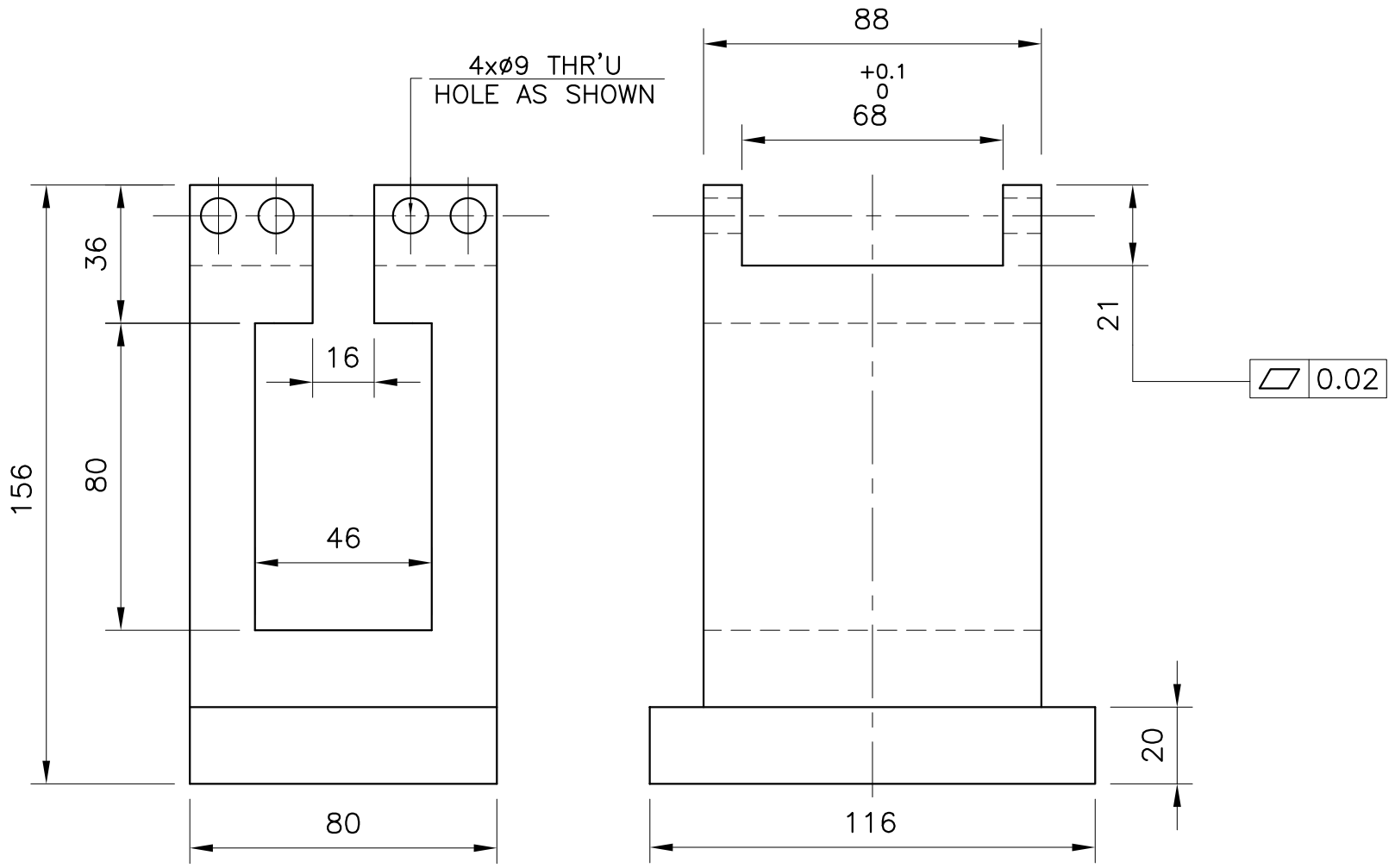
ALL DIMENSIONS ARE IN mm

REV. DATE 09.02.2018

GOVERNMENT OF INDIA
BHABHA ATOMIC RESEARCH CENTRE
ACCELERATOR CONTROL DIVISION.

DRG. No.
A3–A02VTCA74

SH 1 OF 1 DATE



MATL : AL T-6069
QTY. : 1 NOS/ASSY

NOTES:–

1) ALL LINEAR DIMENSIONAL TOLERANCES AS PER IS:2102 (MED)
2) UNLESS OTHERWISE STATED:–
   a) MACHINE ALL OVER.
   b) SURFACE FINISH TO BE 3.2 OR BETTER.
   c) REMOVE ALL EXTERNAL SHARP CORNERS AND EDGES BY CHAMF. TO 0.5x45°
3) GEOMETRICAL TOL. OF SURFACE FLATNESS 0.02 UNO.
4) DO NOT SCALE THE DRAWING.

REV	ZONE	CHANGE MADE	DATE	INITIAL

DEVIATIONS FOR LINEAR DIMENSIONS AS PER IS:2102

RANGE OF NOMINAL DIMENSIONS						
CLASS OF DEVIATION	ABOVE	0.5	3	6	30	120
	UPTO AND INCLUDING	3	6	30	120	315
FINE		±0.02	±0.05	±0.1	±0.15	±0.2

TITLE:–

ALUMINIUM BASE PLATFORM

APP'D.

SACLE 1:1

ALL DIMENSIONS ARE IN mm

DR'N	RBC 02.07.2018	PROJECT
DRG. CHK'D.		
DES'D.		
DES'N		

REV. DATE 09.02.2018

GOVERNMENT OF INDIA
BHABHA ATOMIC RESEARCH CENTRE
ACCELERATOR CONTROL DIVISION.

DRG. No.
A3–A02VTCA75

SH 1 OF 1 DATE