

Government of India
Bhabha Atomic Research Centre
Electromagnetic Application and Instrumentation Division

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Date: 4.9.2019

Detailed Engineering, fabrication, assembly, testing, supply and safe delivery of electromagnetic coil for bending magnet confirming to the Technical Specification Number: EmA&ID/TIMSC/19 dated 30.8.19

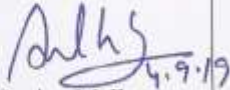
Dear Sir/Madam,

Quotations are invited for "Detailed Engineering, fabrication, assembly, testing, supply and safe delivery of electromagnetic coil for bending magnet confirming to the Technical Specification Number: EmA&ID/TIMSC/19 dated 30.8.19"

Bidder shall quote for deliverables as per technical specifications.

1. No Free Issue material is involved.
2. Taxes and Excise Duties shall be quoted separately. Form AF/H whichever is applicable shall be provided, if required.
3. **The quotation must reach The Head, EmA&ID by 18.9.2019 (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,
Electromagnetic Application and Instrumentation Division,
RCnD Bldg., North Site
BARC, Trombay,
Mumbai - 400 085.
(Kind Attn: Elina Mishra, SO/D)
5. The bidder shall complete the job within 4 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, Electromagnetic Application and Instrumentation Division reserves the rights to accept/reject any or all quotations without assigning any reason.
7. In case of any technical query, please contact Ms. Elina Mishra or Mr. Vikas Teotia (Extn: 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: - EmA&ID/TIMSC/19


Sanjay Malhotra
Head, EmA&ID

Specification no.	Revision no.	Total pages	Date
EmA&ID/TIMSC/19	0	8	30.8.2019

Detailed Engineering, fabrication, assembly, testing, supply and safe delivery of electromagnetic coil for bending magnet confirming to the Technical Specification Number: EmA&ID/TIMSC/19 dated 30.8.19

1.0 Scope

This specification specifies “*Detailed Engineering, fabrication, assembly, testing, supply and safe delivery of electromagnetic coil for bending magnet confirming to the Technical Specification Number: EmA&ID/TIMSC/19 dated 30.8.19*”.

The job includes fabrication of the electromagnetic coil windings for bending dipole magnet. Precise winding of the coil assemblies is also required so as to ensure the specified MMF requirements. Assembly and safe packaging of the electromagnet coils is also in the supplier’s scope.

This document is organized as follows:

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2.0 Statement of purpose

Dipole magnets are used to bend the beam bunch according to the magnetic strength and mass of the charged particle in the beam. To give a certain direction of bending to the beam bunch, the magnet has to have varying magnetic field vector spatially. This is done by a bending dipole magnet. The entry and exit profile of the magnet is crucial as it determines proper entry and exit of the beam. Precise fabrication and winding of the electromagnetic coil is inevitable to achieve the required MMF and thus the magnetic rigidity along with the desired homogeneity.

3.0 Details of deliverables and scope of supply

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

Item no.	Description	Quantity	Reference No.
1.	Electromagnetic coil for bending magnet	2 No.	A3-E00EMCA02

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 yoke as per Para 6.1 of this technical specification.
- Assembly of support frame as per Para 6.2 of this technical document.
- Inspection of the fabricated components as per Annexures A and B.

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. 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.	Coil fabrication including bobbin fabrication, winding, varnish and epoxy potting and hand lapping	No
3.	Coil Electrical and thermal test setups	No

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 detail of infrastructure suitable for this jobs such as 3D Drafting software, Manufacturing machines, coil winding 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 to the supplier. The copper coils of the required cross section for winding is to be procured by the supplier.
- The coil should be ETP (Electrolytic Tough Pitch) grade copper with H-modified insulation.

The physical, chemical, geometrical inspection reports of the raw materials should be provided to the purchaser by the supplier and the raw material shall be purchased only after approval from the purchaser.

6.0 Technical description of the job

This technical specification document includes fabrication, winding, qualification and supply of electromagnetic copper coils for bending magnetic yokes. The end use of these components demands precise fabrication and winding within the strict tolerances which are covered in this document.

The electromagnetic bending dipole magnet deflects the charged particle beam along the radius of the magnet. They are used in particle accelerators and spectrometers for bending the magnet along the required orbit. The current flowing through the electromagnetic coils provide the required MMF for generating the required field in the air gap. Precise winding of the coils is inevitable to produce the required field and the uniformity.

6.1 Electromagnetic coil:

- The electromagnetic coil is a 90 degree bending coil to accommodate the soft iron yoke within it.
- The size of the copper coils to be used and no of turns per coil winding is given in the table below.

Cross section of the coil	Wire Gauge	No of turns
60 mm X 95 mm	5 mm X 2 mm	460

- The current passing through these coils generate a MMF which in turn generates magnetic field needed for beam steering. The MMF depends on the no. of turns of the coil and thus the total no. of turns should be exactly what is specified for the required MMF to be achieved.
- Each coil winding set must be identical and the properties should be such that they can be used interchangeably.
- The coils are made of rectangular cross section (5 mm x 2 mm) annealed copper conductor and vacuum impregnated with vacuum compatible varnish. The finished coils shall behave in all respects as rigid units so that relative movements between turns due to the action of magnetic forces and thermal strains inside the windings are excluded.
- The complete coil assembly must be epoxy potted to make it as a single rigid structure for mounting on the magnet yoke.
- The insulation to be used in the coil windings is H-modified class of insulation which has a temperature range of 180°C. The insulation is to be transparent.
- The coil ends of each leg shall be connected to electrically insulated flexible copper connecting wires through terminal blocks. These blocks should be direct mounting type on the yoke of the DC. These wires from the terminal blocks should be brought out for connecting with the power supply.
- The technical specifications of the coil windings of the frame is listed below:

Sr. No	Parameter	Value	Unit
1.	Nominal current	13	A
2.	Maximum current	15	A
3.	Maximum stabilized voltage	5.3	V
4.	Resistance	0.41 ± 0.0205	Ω

5.	Conductor size	5 mm x 2 mm	
6.	Number of turns	460	Turns
7.	Number of layers per winding	27	Layers
8.	Number of turns per layer	17	Turns
9.	Nominal current density	1.3	A/mm ²
10.	Maximum current density	1.5	A/mm ²
11.	Maximum power dissipation	70	watts
12.	Temperature rise	25	°C
13.	Weight of each coil	22	kgs (approx.)

- The environment in which insulation and winding operations are to be done should be completely free of dust, metallic particles and other contaminants.
- The coil winding should be done using a single continuous length of cable without any joints or overlaps.
- Appropriate mandrel must be used on which winding should be done and the conductor should be kept under proper mechanical conditions.
- To fill in all the pores in the coil winding, it shall be vacuum impregnated with H class varnish.
- A layer of thermally conductive epoxy shall be applied for protection.
- No epoxy shall be applied on leads.

6.2 Assembly of the magnet yokes, packing and shipment:

- The electromagnetic coils are to be properly packed in wooden boxes and to the purchaser with all the geometric and electric qualification test certificates and reports.

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.
2.	Geometric and dimensional accuracy of sub components and the final assembly	Geometric tolerances strictly as per drawings. Geometric inspections shall be done after each step and inspection reports (Annexure A) for all shall be prepared and submitted.
3.	Qualification of electromagnetic coils	<ol style="list-style-type: none"> 1. Hi-pot Test between coil terminals and magnet yoke: Leakage current less than 5 micro Ampere at 1000 V DC. 2. Ring test: Compared with reference coil. (G_o, No G_o test) 3. Resistance: 0.41 ± 0.0205 Ω 4. Turns: 460 (No deviation permitted)
4.	Thermal qualification	<ol style="list-style-type: none"> 1. After 12 hours of continuous operation, voltage across coils for fixed DC current shall be noted. (For each coil) 2. Combined thermal heat run test with voltage tapping on individual magnet. (Applicable to magnet assembled in frames).

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.	Electromagnetic coil for bending magnet	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 2 |
| d. Procurement of raw material | : | Week 4 |
| e. Winding of coil | : | Week 6 |
| f. Qualification of coil and Functional acceptance test | : | Week 7 |
| g. Delivery | : | Week 8 |

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.	Electromagnetic coil for bending magnet	A3-E00EMCA02

10 List of Appendix

SN	Appendix Name	Particular	Page No
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2.	Appendix B	Electrical Qualifications	7

11 General conditions

- All intellectual property rights belong to purchaser for work done under this technical specification/PO.
- Supplier shall maintain the authenticity of drawings or any related drawings/document provided by the purchaser.
- 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.
- Supplier agree to hold in confidence all information provided by the purchaser.
- Supplier shall collaborate and coordinate all the work sub-contracted to any vendor.
- Publication if any pertaining to work of related to work under this purchase order can be done only after prior mutual consent of purchaser.
- All the raw materials required for deliverables except the Free Issue Material mentioned is in scope of supplier and the supplier should quote accordingly.
- Overall cost of all the items in the deliverables will be compared which will also include packaging, forwarding and safe delivery costs to BARC RCZ stores.
- Suppliers shall give complete details of their product & list of users for technical evaluation.
- Supplier shall submit along with the quotation, compliance certificate adhering to the specifications.

ANNEXURE A
(GEOMETRICAL QUALIFICATIONS)

- 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.

ANNEXURE B

(ELECTRICAL QUALIFICATIONS)

- The following electrical qualification tests need to be carried out with the coil assembly before assembly.

1. Winding Material Specifications

Sr. No	Parameter	Value
a)	Wire Gauge	
b)	Grade of conductor	
c)	ISO standard for winding material	
d)	Class of insulation	
e)	Thermal class	
f)	Chemical Base of insulation: (Modified polyester/Polyamide)	

2. Coil Specifications

Sr. No	Parameter	Value
a)	Total no of turns	
b)	Total no of windings	
c)	No of turns per layer	

3. Electrical Parameters

Coil No.	Dimensional Check					Remarks
	Resistance	Inductance @ 100 Hz	Q @ 100 Hz	Inductance @ 1 kHz	Q @ 1 kHz	Pass/fail

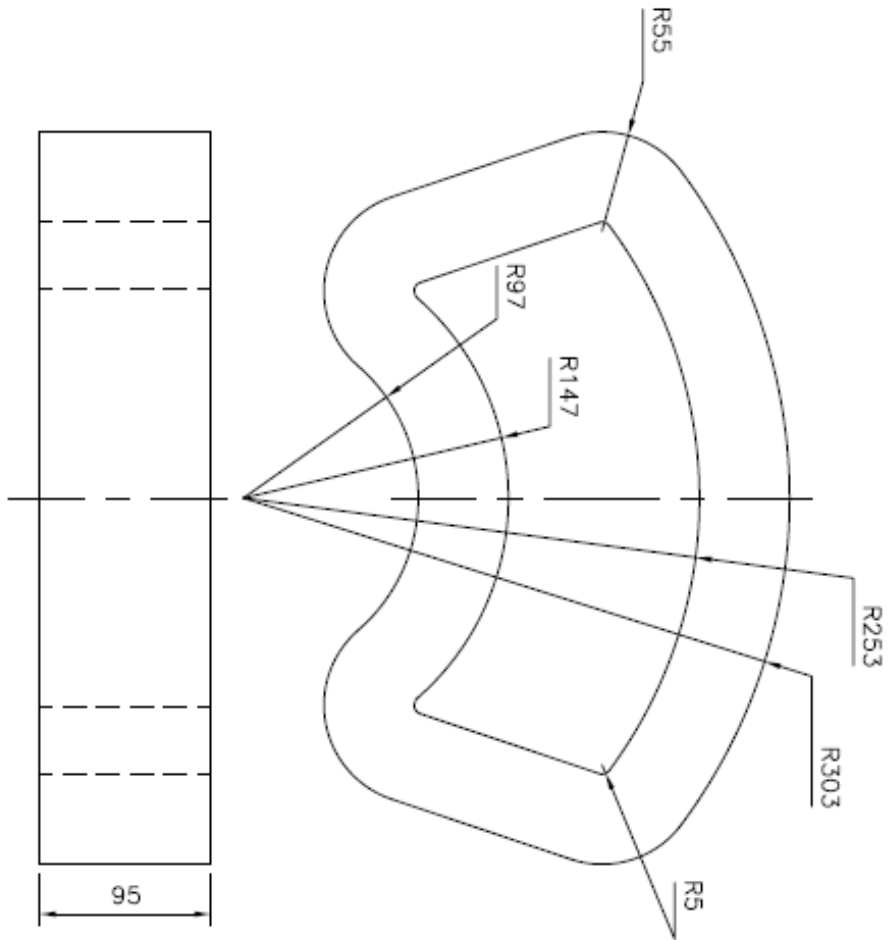
4. Ring Test

Coil No.	Pass/Fail

5. Hipot Test

Coil No.	Leakage Current Between Coil and Dummy Core

A maximum leakage current of 5 μ A is allowed at a coil to core voltage of 1000 V DC.



NO. OF TURNS : 480
 COIL CROSS SECTION : 5x2
 MATERIAL : ETP COPPER WITH H MODIFIED INSULATION
 QTY. : 2 NOS.

COIL FOR BENDING MAGNET

DR'N. RBC 03.09.19		PROJECT GOVERNMENT OF INDIA BHABHA ATOMIC RESEARCH CENTRE ELECTROMAGNETIC APPLICATIONS & INSTRUMENTATION DIVISION		App'D.
DRG. CHK'D. DES'N. CHK'D.		ALL DIMENSIONS ARE IN mm DATE 03.09.2019		SCALE 1:1
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