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CERN/PS/DL/LEAR/SPEC 80-8
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SPECIFICATION FOR THE LEAR SEXTUPOLE MAGNETS

1. INTRODUCTION AND SCOPE OF THE TENDER

1.1 General

This specification covers the fabrication of the sextupole magnets for LEAR in the South Hall of the PS.

1.2 Description of the sextupole magnets

The sextupoles are of the air-core type. The coils are wound from round copper wire. A central water-tight cylinder provides the cooling.

1.3 Scope of the tender

The manufacturer shall fabricate, inspect, test and deliver completed sextupole magnets, in accordance with this specification which will form part of the contract.

1.4 Inspection and test requirements

Representatives of CERN shall have the right to visit the manufacturer's facilities or those of his sub-contractors involved in this work at any time, to review progress and witness specified tests.

CERN shall be given one week's notice of tests and inspection to be performed under the provisions of this specification. Representatives of CERN shall have the right to witness any or all of these, at CERN's discretion.

Written certified reports shall be prepared by the manufacturer for all tests and inspections performed under the provisions of this specification and must arrive at CERN prior to shipment of the corresponding units.

1.5 Construction drawings and responsibility of the manufacturer

Prior to starting the fabrication, the manufacturer must send two complete sets of construction drawings of the sextupole magnets to CERN for approval. However, the manufacturer must accept full responsibility for the adopted design and fabrication method and for the completed sextupole magnets to conform to the tolerances, tests and requirements specified herein.

1.6 List of drawings

Ensemble Type N, S	E20.1000.2
Ensemble Type N	E20.1001.1
Bobine	E20.1002.1
Tube de refroidissement	E20.1003.1

1.7 Nominal parameters of the sextupoles

The nominal parameters of the three types of sextupoles are summarized in Table 1.

2. FABRICATION OF THE SEXTUPOLES

2.1 General

A cross-section of the three types of sextupoles is shown on drawing E20.1000.2. The type N sextupole (normal) has two sets of coils, which are separated by a cooling tube. Type S sextupole (Skew) has basically the same components but the set of outer coils is turned by 30^{o} with respect to the inner set. The type E sextupole (Enlarged) has no inner coil.

2.2 Iron shield and cooling tube

The iron shield, item 1 on drawing E20.1001.1, shall be made from 5 mm thick steel sheet of quality AC37. Dimensions and tolerances of the cooling tube are shown on drawing E20.1003.1. All parts must be made from stainless steel

2.3 Fabrication of coils

i) The coils are fabricated from insulated copper wire of 1.8/1.9 mm diameter.

ii) The copper wire to be used will be supplied free issue by CERN.

iii) The overall dimensions and tolerances of the coils are given on Drawing E20.1002.1.

iv) The copper conductor supplied is of appropriate length to permit continuous winding. Joints are specifically excluded.

v) The number of turns per coil is given on the coil drawing. It is important to ensure that the number of turns is identical for all coils of the same type.

vi) The coils will be required to operate satisfactorily for many years in a radiation environment. All sextupole material must be chosen with this in mind, and must have the prior approval of CERN.

vii) The conductor must be wound on a straight frame of appropriate form so that the necessary wire length for the forming of the coil is provided.

viii) After removing the frame, the coil must be placed into a suitable press and formed to its final shape.

ix) The coil must be retained in its final shape and baked in an oven for at least two hours at a temperature of 130°C. Thereafter it must be cooled down during at least 1 hour.

2.4 Tests on finished coils

The following tests shall be made on each coil:

i) The dimensions and tolerances of the coil as given on drawing E20.1002.1 shall be checked using an appropriate inspection jig. Tight tolerances are asked on the shape of the coil cross-section and straightness in the parallel limbs of the coil. In the coil ends the tolerances need only be sufficient to ensure satisfactory assembly.

ii) The electrical resistance of the coil shall be measured at 20°C and recorded.

iii) An inter-turn insulation test shall be made by using the coil as a secondary of a transformer, giving at least 2 Volts rms per turn.

2.5 Magnet assembly

The assembled magnets and the required tolerances are shown on drawing E20.1001.1

i) The coils shall be connected as shown on the wiring diagram on the assembly drawing. The joints shall be made by crimping and covered by glass cloth. They must not protrude beyond the iron

shield. Insulated flexible cables of 2 mm diameter and half a metre long shall be crimped onto the four loose ends and passed through the cable exit holes drilled into the iron shield.

ii) To ensure a sufficient insulation of the coils from the iron shield, three Kaptan foils of 125 μ thickness must be placed between the coils and the iron shield. The Kaptan foils will be supplied by CERN.

iii) The coils must then be accurately located in the iron shield and cooling tube, and impregnated in place using a thermosetting resin.

iv) The proposed resin system and curing cycle must have the prior approval of CERN.

2.6 Tests on complete magnets

The following tests shall be made on each complete magnet by means of temporary connections:

i) The electrical resistance of the magnet must be measured between the two electrical terminals and recorded.

ii) An insulation test shall be performed by appling 1 kV a.c. during one minute between the magnet terminals and the grounded iron core, and the ground cooling tube.

iii) The insulation resistance to ground is then measured, at room temperature, and must be higher than 100 MΩ, with an applied voltage of 1 kV d.c.

2.7 Marking and finishing

The steel shell of the magnet shall be given one coat of suitable steel primer followed by one coat of epoxy paint of a colour to be specified by CERN.

The magnet is to be identified by a serial number stamped in an agreed position.

An inspection report must be supplied with each magnet. It shall include the serial number of the magnet and the result of all the specified tests.

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Table 1 - PARAMETER LIST FOR LEAR SEXTUPOLES

Parameters		Type N	Type S (E)	
			Inner coil	Outer coil
No. of elements		12	2	2
Maximum gradient	m^2	15.0	7.0	8.0
Magnet length	m	0.36	0.36	0.36
Overall length	m	0.38	0.38	0.38
Coil inner radius	mm	90/119	90	119
Coil outer radius	mm	113.5/144	113.5	144
Iron shield inner radius	mm	145	145	145
Iron shield outer radius	mm	150	150	150
Conductor Ø (Insulated)	mm	1.9	1.9	1.9
Number of turns/coil		200 + 252	200	252
Copper weight	kg	48	27	21
Total weight (approx.)	kg	65	65 (44)	
Peak current	A	10	10	
Peak current density	A/mm^2	4	4	
Resistance at 20°C	Ω	14.2	6.2	8.0
Inductance	H	0.59	0.59 (0.42)	
Power	W	1650	1650 (950)	