AR/Int. SG/64-4
March 12th, 1964.

SPECIFICATIONS OF THE STEEL SHEET FOR THE CORE OF MAGNET MODEL 1 FOR THE INTERSECTING STORAGE RINGS.

1. Introduction.

The European Organization for Nuclear Research (CERN) in Geneva has started model studies for two new high energy accelerator projects: a 300-GeV Proton Synchrotron (P.S.) and a set of Intersecting Storage Rings (I.S.R.) for the present 28-GeV Proton Synchrotron. CERN is now in the process of inviting tenders for a first model of the I.S.R. magnet: this model may also provide useful information for the 300-GeV project. The layout of the I.S.R. magnet is shown in Fig. 1 and the model in Fig. 2.

This specification concerns the supply of the steel sheet for the magnetic core of the model.

2. Generalities about the Magnets.

The magnet of the I.S.R. will consist of a number of units disposed along two intersecting curvilinear polygons, with regularly distributed field-free intervals. The average diameter of the two "rings" is about 300 m. The total weight of this magnet will be about 10,000 tons.

The magnet of the 300-GeV P.S. would also be made out of a number of units, but of smaller cross section, distributed along a circumference of 2400 m diameter. Its total weight would be about 25,000 tons.

In the I.S.R., the magnetic field will be kept constant during the experimentation, and any variation which may be wanted to permit a change in energy of the stored beam will be slow. The magnetic circuit, however, will be made out of thin steel plates, as in the case of the Proton Synchrotron where the field is pulsed, because precision punching is the most suitable method to achieve the very tight mechanical tolerances imposed on the pole profile. The laminations shall also be shuffled, in order to achieve a more uniform distribution of magnetic properties.

In order that the experience of the model may be significant for the projects under consideration it is necessary that the steel maker may be expected to be an acceptable tenderer for the supply of the steel for the whole magnet in either of them. Therefore he should be able to cope with the delivery schedule of about 1000 tons of steel sheet per month, which would be required in either of the two projects.

3. Dimensions of the Sheets and Quantity required.

The nominal thickness of the steel sheets should be about 1.5 mm.

The external dimensions of the finished laminations are shown in Fig. 4. The dimensions of the steel sheets must be such that the laminations can conveniently be punched out and that edges of badly disuniform thickness are removed in punching. The proposed dimensions of the sheet shall be indicated in the tender: the final dimensions must be the subject of an agreement between the steel-maker, the core-maker and CERN.

The tender should be for 30 tons of steel sheet: the possibility of small changes of this figure to meet the exact requirements of the core-maker should be foreseen.

4. Magnetic Properties of the Steel Sheets.

The I.S.R. magnet shall normally be operated at rather high fields and therefore the most desirable magnetic property of the steel for this magnet is a high permeability at high fields. For the 300-GeV P.S. magnet, however, low-coercivity and high permeability at low fields are equally important. In view of the information expected from the model, these requirements too are taken into account in the following specification.

a) Coercivity. - The coercivity is that value of the magnetizing field which will reduce the induction in the steel to zero from the value existing after complete saturation. The values of the coercivity through the whole delivery must stay within an interval of $\pm$ 0.1 Oersted with respect to a nominal value proposed by the steelmaker. This nominal value should be as low as possible, and in any case lower than 0.8 Oersted.

b) Permeability. - The permeability μ is the ratio of the magnetic induction (in Gauss) to the applied field (in Oersted) measured along the normal magnetization curve. The steelmaker must propose a nominal relationship between the permeability μ and the induction B for the steel. The nominal values of μ must be as high as possible at all field values and in any case not less than:

1) 600 at an induction of 100 Gauss
2) 1200 at an induction of 15 kG
3) 70 at an induction of 20 kG.

The deviations of the values of μ from the nominal relationship, in the range from 100 G to the high-field value at which μ falls under 700 must be:

1) less than $\pm \mu/70$ o/o for values of μ less than 1400
2) less than $\pm$ 20 o/o for values of μ greater than 1400.

Beyond the above range and up to 20 kG the permeability variations must be less than $\pm$ 10 o/o from the nominal value.

5. Magnetic Measurements on Steel Samples.

The magnetic properties of the steel delivery will be tested by CERN by systematic measurements on samples which will consist of 5 rings obtained from the sheets, of internal diameter of 76 mm and external diameter 114 mm.

Two types of samples will be taken:

a) Local samples - One sheet out of 300 will be divided in 30 rectangles and 6 samples will be taken from groups of 5 rectangles, as shown in Fig. 3. These samples will be measured to test the uniformity of the magnetic properties within a plate and from plate to plate.

b) Central samples - Every 40 sheets, a ring will be cut out of the central part of a sheet, which corresponds to the coil window in the finished lamination. Samples will be made by collecting successive rings in groups of 5.

6. Mechanical Properties of the Steel Sheet.

It is required that the sheets in their final conditions be suitable for reliable insulation, for precision punching and for assembling with a large packing factor.

Undevelopable unflatness is especially harmful, because it makes the gap profile move after punching, and must be avoided as much as possible.

Thickness must be as uniform as possible in each individual sheet: it can be said tentatively that the total crown on 1.5 mm thickness should be less than 0.04 mm.

The surface should present no appreciable high spots and should be clean, to make the insulation adhere well.

The mechanical properties of the proposed steel shall be given in detail in the tender. Their final specification must be the subject of an agreement between the steelmaker, the blockmaker and CERN, previous to the signature of the contracts.

7. Steel Samples to be supplied with the Tender.

The tenderer is requested to submit 3 samples of the proposed steel sheet for magnetic measurements. Each sample consists of 5 rings, with an internal diameter of 76 mm and an external diameter of 114 mm, obtained from a steel sheet. The rings must be slowly and carefully machined out of plates of somewhat larger surface, in order not to spoil their magnetic properties. Of course, no thermal treatment of the samples can be permitted. The four samples should be taken from different batches of of the proposed steel sheet, as produced in the factory.

8. Delivery and Transportation.

The steel sheets shall be made available at the factory not later than 3 months from the signature of the contract. They shall be packaged in such a way as to be protected against surface deterioration and damage through handling.

Arrangements and responsibility for transportation to the core-making plant shall be the subject of an agreement between the steelmaker, the core-maker and CERN to be attached to the contract.

Distribution: (Closed)