THE HANDLING EQUIPMENT FOR THE

RADIATION SHIELDING BLOCKS

of the CERN Proton Synchrotron

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The PS Tunnel is covered by earth for radiation shielding purposes. Its main access is by the PS Experimental Hall. The floors of the Tunnel and Hall are at the same level.

The Tunnel crosses the main PS Experimental Hall, dividing it into North and South Halls which both will be used in future by physicists who will carry out experiments with beams extracted from the machine.

The area which interests us for the purpose of this report is known as the PS shielding area. The continuity of radiation protection of personnel working in the PS workshop and adjacent offices requires a continuous baryte concrete shielding wall, about 5 metres thick, inside the Experimental Hall on either side of the Tunnel.

However, in order to be able to arrange the necessary channels through this wall for the extraction tubes for particle beams, from the machine to the places in the PS Hall where physicists will set up experiments, it was necessary to build up those walls of a large number of baryte concrete blocks which can be arranged to suit the requirements.

THE SHIELDING BLOCKS

Fig. 1 is a partial plan of the PS buildings which shows the location of the shielding area with the indication of section A-B which we find, enlarged, as Fig. 2.
We distinguish three main sorts of blocks: upper, middle and lower ones. The south wall consists of 11 and the north wall of 10 rows of blocks which fit into the gap between the floor and the ceiling.

The height of the Synchrotron orbit is 1260 mm above floor level. All extraction tubes will therefore have to be arranged in a horizontal plane at the same height. As the standard upper and lower blocks are all about 1100 mm high, it was found suitable to make the middle blocks only 250 mm high. All the blocks have a thickness of 500 mm, the upper and lower blocks weighing about 2.5 tons and the middle blocks about 0.6 tons.

The baryte concrete is rather brittle. It was necessary to protect the blocks from being damaged accidentally during handling by frames of angle iron. Manufacturing tolerances of the blocks are about ± 2 mm.

The blocks should fit the gap between the ceiling and the floor as closely as possible. However, taking into account the general building tolerances and those for the blocks, the gap between the top of the upper blocks and the ceiling may vary from a few millimetres to a maximum of about 35 mm.

In order to prevent radiation from penetrating those gaps, the two end rows of the upper blocks at the laboratory sides of the walls are made ten centimetres higher than the rest of the blocks.

Arrangement and re-arrangement of blocks and extraction tubes can only be done when the FS machine is not running. Each running hour of the machine lost by waiting for re-arrangement of extraction tubes represents a loss of several thousand of Swiss francs in salaries only. It was required therefore that the handling of the blocks had to be carefully studied and organized. The equipment had to be designed to be fool-proof and, as far as possible, electrically powered.

Fig. 3 shows a lifting Girder used for the transport of the upper blocks by cranes. All upper blocks have a transverse cavity of an I-shape corresponding to the I-beam fixed to the ceiling.

Two mobile plates with a welded-on T-profile, attached loosely to the girder and secured by means of a wedge, fit into the I-cavity and thus take the load of the block.

Fig. 4 shows the normal crane transport of a upper block by means of
All lower and middle blocks have, in the centre of their top surfaces, an inserted steel casting into which fits a special bayonet key directly attached either to a normal iron sling for a crane hook, or to a pulley block, as shown on Fig. 5. Thus the workman operating the handling equipment is able to attach and detach a lower or middle block within a few seconds.

SCHEMATIC DESCRIPTION OF THE BLOCK PLACING AND THE NECESSARY HANDLING EQUIPMENT

As can be seen from Fig. 2, the north and south faces of the fixed upper parts of the shielding wall (the so-called shielding bridges which span the complete length of the shielding area) are equipped with wall cranes which can run the full forty metre length of the shielding bridges.

Furthermore, in order to be able to carry the blocks to their final places by means of mobile hoists, I-beams are fixed to the ceiling and serve as runways for the winches.

Mobile screw hoists and electric pulley blocks, which shall be discussed in a little more detail later, complete the equipment. Fig. 6 is a schematic description of the block placing procedure.

THE WALL CRANES

Fig. 7 is a general view of the North Hall shielding area. A wall crane and a number of I-beams can be seen as well as some lower blocks standing on the floor.

The main use of the wall cranes will be to displace the electric pulley blocks and the mobile screw hoists from one I-beam to another. It will not often be necessary to displace concrete blocks laterally by means of the crane as all lateral transports will either be done by means of the railways carriage or of the big overhead cranes of the North and South Experimental halls.

Fig. 8 is a close up view of a wall crane with an electric pulley block. The crane is manually driven. But it is equipped with a cable drum which is connected to wall plugs by means of a flexible cable, and which supplies the electric power to the mobile hoists.
The electric pulley block hangs at the mobile extension of the I-beam which forms part of the crane, and it can be moved on two directions by means of chain drives. It will be used when the upper blocks are to be placed in front of the I-beams, as shown by Fig. 5d.

Three wall cranes are at the disposal of the operating crew. They can be placed on either of the different wall tracks by means of the IS cranes. Thus it is possible to put the maximum number of cranes at work at a place where a rearrangement of the blocks is needed.

THE ELECTRIC PULLEY BLOCKS

They are used for the handling of the lower and middle shielding blocks. They are standard electric pulley blocks of low overall height to give a maximum available lifting height. Lifting and travelling motions are electrically operated and can be controlled remotely by means of a push button hand controller attached to a 6 metre long flexible cable.

THE MOBILE SCREW HOIST FOR THE UPPER BLOCKS

Fig. 9 shows a wall crane equipped with a mobile screw hoist used for the transport and the placing of the upper blocks.

It is a very compact and light unit, equipped with three pairs of wheels all of which are electrically powered. The electric motor is strong enough to push a block at its final place even if it should rub against the ceiling or neighbouring blocks.

The screw hoist has a front hook which fits exactly into the front hole of each block.

As the block hangs on the winch its vertical position can be adjusted by means of an eccentric rubber coated roller, see Fig. 10.

When a block is to be placed in the shielding wall it will be placed on to a railway carriage by the overhead travelling crane, see Fig. 4. This carriage is driven underneath the crane, see Fig. 9, whose mobile I-beam has been withdrawn.
Now the upper block is carefully adjusted and aligned with the fixed I-beam, see Fig. 11, such that the crane mobile I-beam can be pushed through the block longitudinal hole to fit the fixed I-beam, to which it is locked by an automatic device. A limit switch makes contact as soon as the I-beam is correctly locked and the screw hoist can now be driven against the block, pick it up and place it in the shielding area, see Fig. 12, and Fig. 13.

When the block arrives at its final place it will be lowered onto the middle blocks. The hook disengages itself automatically from the block, the hoist is driven back onto the crane.

The described operations take roughly one minute per lower block and two minutes per upper block. The bottleneck is really the transport of the blocks from the store on to the railway carriage which is done by fork lifters and/or overhead travelling crane.

When necessary electric pulley blocks and screw hoists are easily interchanged. By means of a special girder the lifting devices are hung at the hook of the overhead cranes, as shown in Fig. 14.

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Fig. 1 - Proton Synchrotron
a) Grue à console avec engin de levage pour blocs supérieurs
b) Grue à console avec palen électrique pour blocs intermédiaires et inférieurs
c) Blocs supérieurs
d) Blocs intermédiaires
e) Blocs inférieurs
f) Poutre annulaire, fondation pour les électro-aimants
g) Chassis et supports pour les aimants
h) Electro-aimant du S.P.

a') Wall crane with mobile screw hoist for the placing of the upper blocks
b') Wall crane with electric pulley block for the lower and middle blocks
c) Upper blocks
d) Middle blocks
e) Lower blocks
f') Ring beam, foundation for the electro magnets
g') Magnet chassis and supports
h') Electro magnets for the P.S.

Fig 2
Fig. 4
Transport of an upper block by crane.

Fig. 5
Attachment of a lower block to a crane pulley block by means of a special bayonet key.

Fig. 7
General view of the North Hall Shielding Area.
Fig. 6 - Placing of shielding Blocks
Placment de blocs de protection

Lower blocks - Blocs inférieurs

a) A wall crane is put in front of the I-beam to be used.
A lower or middle block is placed underneath the crane and the electric pulley block picks it up.

Une grue à console est amenée devant le rail transversal.
Un block inférieur (ou moyen) est posé sous la grue, puis accroché au palan électrique.

b) The railway carriage is withdrawn for the next load.
The electric pulley block carries the block into position.

Le chariot de transport est retiré; le palan amène le bloc à son emplacement final.

c) The block is lowered on to the ground (or, if it is a middle block, on the lower block).
The bayonet key is unlocked and the electric pulley block is withdrawn on to the crane for the next load.

Le bloc est posé sur le sol (ou sur un bloc inférieur s'il s'agit d'un bloc moyen.)
Le crochet à baionnette est dégagé du bloc, le palan est ramené sur la grue.
d) An upper block is placed on a high railway carriage, carried in front of the fixed I-beam and is carefully adjusted. The I-beam of the mobile crane is in its withdrawn position.

Le bloc supérieur est posé sur un chariot de transport puis il est amené devant un rail transversal et ajusté soigneusement. Le bras mobile de la grue est en position retirée.

e) The mobile I-beam is pushed through the block.

Le bras mobile de la grue est poussé à la rencontre du rail transversal.

f) The mobile screw hoist is driven against the block, and its hook lifts the block from the carriage.

L'engin de levage est amené contre le bloc, son crochet soulève le bloc du chariot.

g) The hoist transfers the block from the mobile to the fixed I-beam, and releases it in its position on the lower and middle blocks. The hoist then returns to the mobile crane.

Le bloc est amené dans l'espace vide puis déposé sur le bloc moyen et inférieur, à son emplacement définitif. L'engin de levage se dégage du bloc et revient sur la grue.
Fig. 8
Wall crane with electric pulley block, chain drives for the crane motions, cable drum for the electric power supply to the mobile pulley block.

Fig. 9
Wall crane with screw hoist for upper blocks.
An upper block is standing on a special railway carriage, right in front of the I-beam along which it will be placed.
The operator is ready to drive the mobile crane beam through the block.
Fig. 10 – Front view of screw Hoist

On top the cable drum for the power supply to the mobile hoist. On the left the vertically moved hook and the protruding lever for the switch which actuates the hook when the hoist has been driven against the block. At the bottom the adjustable eccentric roller for vertical adjustment of the block.

Fig. 11 – Upper Shielding Block in Front of I-Beam

Note the holes for the I-beam and the lifting attachment.
Fig. 12
Mobile screw hoist shown transporting an upper block from the crane to the shielding region.

Fig. 13
Upper block shown being placed in position with a few millimetre gap all around it.

Fig. 14
Mounting a screw hoist on a wall crane.