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HANDLING DEVICES FOR THE BEAM PORT- AND COLD MODERATOR INSERTS OF SINQ

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ABSTRACT

A total of eight horizontal casings have been installed around the SINQ target block serving as ports for beam extraction or cold moderator insertion. These casings are filled with their operational units, e.g. beam holes with shutters and collimators, the D_2-cold moderator, neutron guide plug etc. These filling units are generally combined with massive shielding material of a total weight of up to 35 tons for each casing. In order to be able to install those heavy but mechanically quite delicate units, and to remove and replace them after being activated during SINQ-operation, a system of devices has been designed at PSI, which allows the required safe and remote handling.

Meanwhile these handling devices, at PSI known as the "yellow machines", are built and commissioned and were operating successfully for the initial installation of the port inserts. Their design principle combines a flexible, rail-carried support carriage with lifting and tilting units for alignment, motorised trolleys or sledges for the insert handling and shielding covers for handling and transportation of activated elements. A computerized control unit allows easy and reliable operation.

1. Introduction

The SINQ target shielding is constructed as a solid block of steel and conrete with a lateral thickness of about 4.5 m around the moderator vessel. In the horizontal plane around the target this shielding has eight penetrations lined with steel casings [1]. Five of them, each with a twin set of two ports at an angle of 10° relative to one another, are foreseen for beam extraction or the insertion of irradiation devices. One other casing, facing the cold moderator at the inside, accomodates the in-shielding part of the neutron guide system [2]. The two remaining ones allow to insert devices for neutron moderation or scattering; those accomodate the insert holding the D_2 cold moderator [3] and a thermal scatterer, respectively.

The three types of casings have different shapes: the ones for the twin ports are rectangular, divided in the middle by a wedge-shaped shielding wing, and stepped threefold to optimize the shielding performance. The rectangular casing for the neutron guide insert is straight

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without central division, and has only one shielding step because it leads into the shielded neutron guide bunker. The casings for the moderator and scatterer insert are cylindrical with a circular shielding step each. Due to the given beam tube arrangement in the moderator vessel the casings are located at different heights with their axes between 1350 and 1585 mm above the floor.

All units which fill these casings are combinded with massive shielding material, the single units weighing typically two to five tons, the neutron guide insert even up to 25 tons.

The most delicate parts to be handled are the so-called hot blocks. They carry the window for the inner HeI barrier and must be fixed helium tight to the front end of each casing. With a weight of about 1.5 tons they need cantilever handling and have to be bolted remotely to the front end flange with a helicoflex metal seal. Cantilever handling is also necessary for the vaccum jacket of the D_2-cold moderator system. All other parts rest on wheels or roller bearings and are self-supporting.

For the purpose to ensure appropriate handling of the filling components of the casings, also - and in particular - when the components are activated after SINQ operation, a set of special devices was designed, built and commissioned at PSI. The principal requirements which these handling devices have to fullfill are the followings:

- They must allow a sufficiently precise and stable positioning and alignment in front of the casings.
- They must ensure a remote and safe handling of all devices with the required precision, considering the combination of heavy weight and fragile and delicate functional units, e.g. the thin-walled moderator vessel, cooling pipes, thermocouples etc.
- Appropriate handling must be ensured also when the components are activated after SINQ-operation. Therefore the handling devices must be completed by shielding boxes and shielding gates such that they allow the handling of activated components and also the transport to hot-cell areas for further processing, repair or conditioning for permanent storage.

2. Technical concept

The base for the handling devices is a transportable rail system and a stable support carriage on steel wheels. Except where fixed rails are installed permanently, the transportable rail system is placed on the floor in front of the casing, briding cable channels in the floor and other unevenesses. The carriage is placed on the rails where it can be moved back and forth parallel to the port axis. Several spindle-driven adjustment devices for lifting and tilting allow the adaption in height and the precise alignment of the carriage.

The real handling device, placed on top of the carriage, consists of a solid base plate of steel, 20 cm thick, which gives the required stability and also serves as radiation shielding towards the bottom. It carries the driving and handling units which are either fixed on sledges or move on guide rails on the plate.

In the course of the design procedure it turned out that the requirements for the three types of inserts, i.e. beam ports, neutron guides and cold source, were too different to be served by a single, universal handling device. Therefore, special base plates with specially adapted driving and handling units were built for each of the three types. They are supplemented by a vertical steel plate of 20 cm thickness at the rear end, combined with a cable feedthrough and a cable fold up drum. These cables connect the driving units to the supply and controll units.

Base plate and rear plate are part of the shielding box. When activated parts must be handled this is completed by further steel plates mounted on the sides and covering the top, and by a shielding gate at the entrance. Further shielding gates are foreseen in front of the open casings to shield against radiation when the inserts have been removed.

3. Realisation and performance

In Figs. 1-5 the function of the handling devices is illustrated for selected situations. Fig. 1 shows the mounting of the (unactivated) hot block in one of the twin-port casings. At the top of the figure, the hot block is shown outside the shielding attached to its handling- and bolting device. The latter is hooked-up to the electric traction engine. Inside the casing, a set of three filler plates are inserted to bridge the shielding steps. At the bottom of the figure, the hot block is shown mounted, with tractor and handling device removed to the outside. Because the mounting axes of the hot block and the beam port axis, i.e. the axis of insertion, do not coincide, a specially curved rail is needed inside the casing, which is part of the upper step filler plate.

Fig. 2 shows the same device, now handling parts of the beam ports insert, the so-called high energy shutters. Furthermore, the device is shown complemented by the shielding units, including the two gates at the entrance. One of them is part of the handling device and the other one covers the partly empty (activated) casing.

Fig. 3 shows the handling device, mounting the vacuum jacket of the D_2-cold moderator system. The handling device is shown complemented by the shielding cover. Further, the vacuum jacket is filled with a shielding plug at its rear end which is necessary to enable the hand-operated bolting of the vacuum jacket to the flansh of the casing when activated inside. After this operation the shielding plug is remotely removed to make room for the moderator insert.

In Fig. 4, the same device is shown mounting of the D_2-cold moderator insert, here without shielding cover. The insert, carrying the moderator vessel at its front end mainly consists of heavy steel shielding. It has roller bearings spread out 45° to the side, which move on rails mounted on a spindel driven sledge on the base plate. This sledge pushes the rails with the insert to the edge of the casing to bridge the gap between base plate and casing edge. Then the insert is rolled in pushed by the traction engine.

Finally, Fig. 5 shows the third version of the handling device, serving for the neutron guide insert. The insert waggon shown in the figure is the heaviest part to be handled, weighting about 25 t. Furthermore, it has to be introduced with the highest precission (angular tolerances of $\leq 10^{-4}$ rad) to ensure the correct alignment of the neutron guides in the insert. The device is designed to allow remote exchange of the neutron guides when they are damaged or their performance has degraded after a certain time of SINQ-operation. This exchange is executed through the open bunker roof, using a crane with a magnetic lifting device. Due to the high activation level expected, all the exchange operation must be remotely controlled. This procedure has successfully been tested with the unactivated guide insert.

4. Conclusions

A user-dedicated neutron facility like SINQ with a potential for further development requires flexible and safe handling of the insert devices of the target shielding block: **Safe** in the sense of nondestructive for the components but also ensuring a minimum radiation exposure of the personell involved in the operation, **flexible** in the sense to be able to respond quickly to changes in the users' demand, and to act quickly if components have suffered any damage during the operation and must be repaired or replaced. The concept of the handling devices provided by PSI is expected to meet these requirements. So far, they worked successfully and reliably during the initial installation, which also was a test for the later handling of the components when activated. The knowledge and experience gathered therewith may also be of more general interest.

5. References

[1] G.S. Bauer, *Proc. of ICANS-XI,* International Collaboration on Advanced Neutron Sources (1990), 41

[2] W. Wagner and J. Duppich, *Proc. of ICANS-XII,* International Collaboration on Advanced Neutron Sources (1993), I-368

[3] H. Spitzer, A. Höchli, G.S. Bauer and W. Wagner, *Proc. of ICANS-XI,* International Collaboration on Advanced Neutron Sources (1990), 430

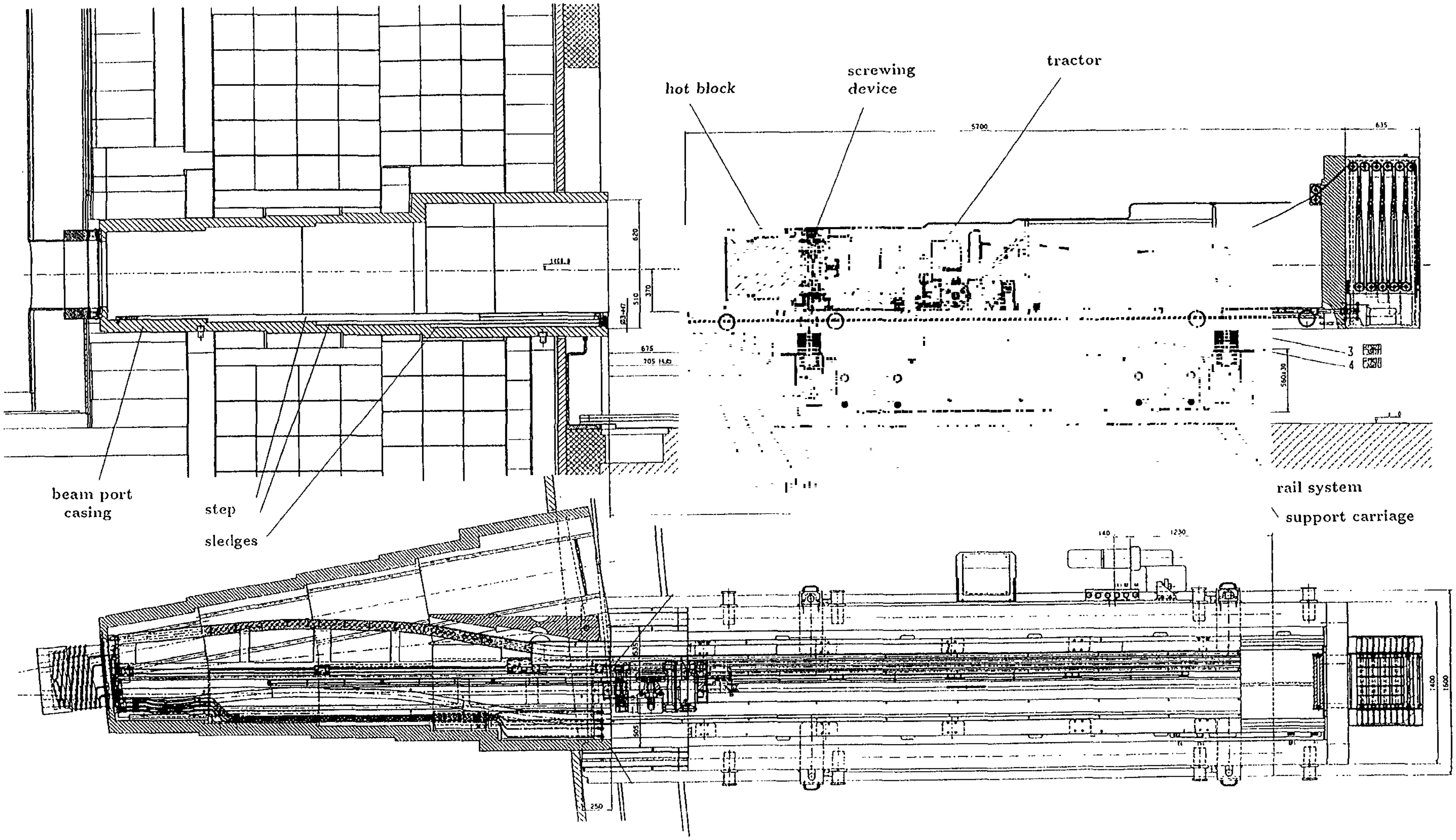

Figure 1: Illustration of the hot block mounting

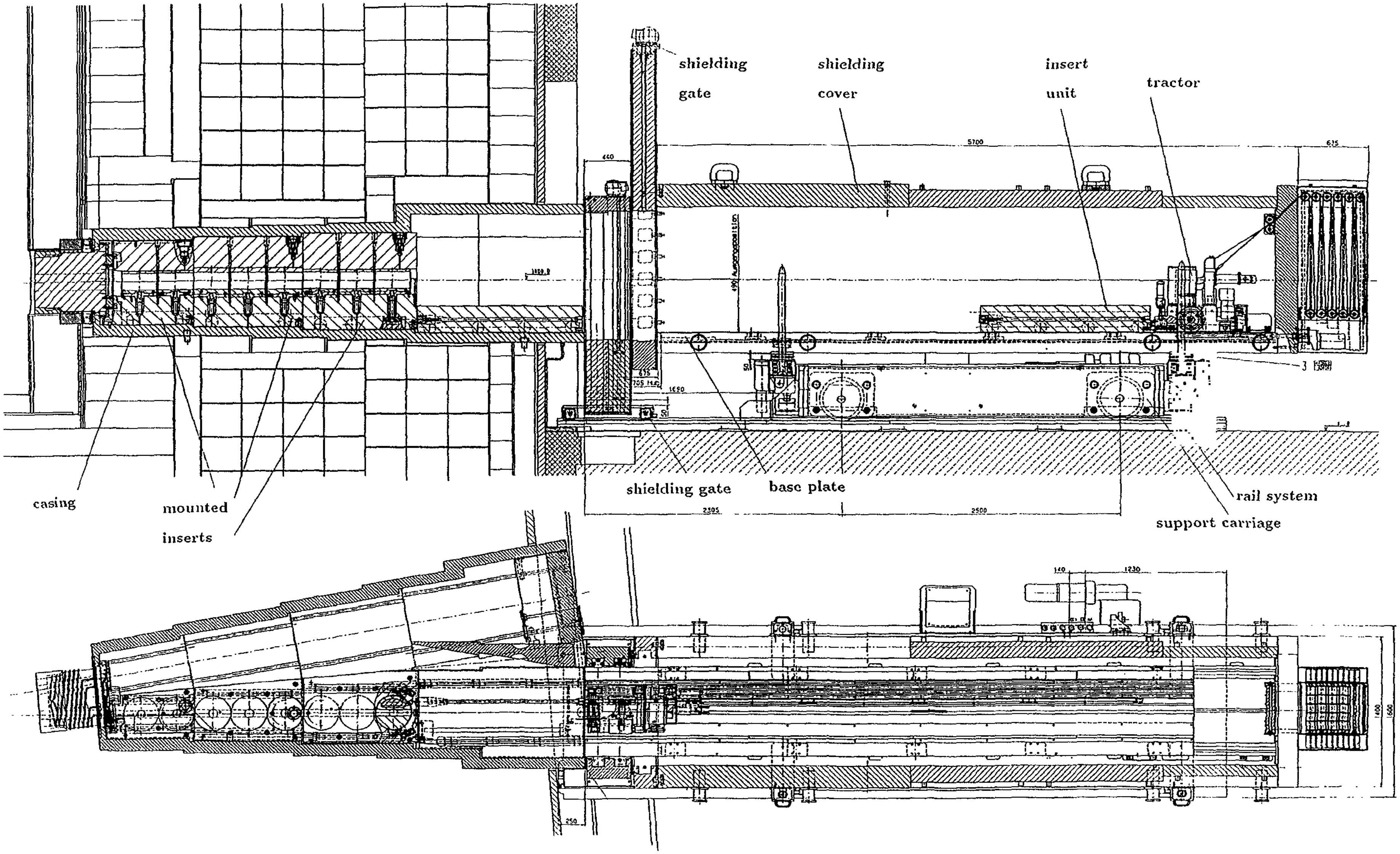

Figure 2: Mounting or exchange of beam port inserts with the shielded handling device

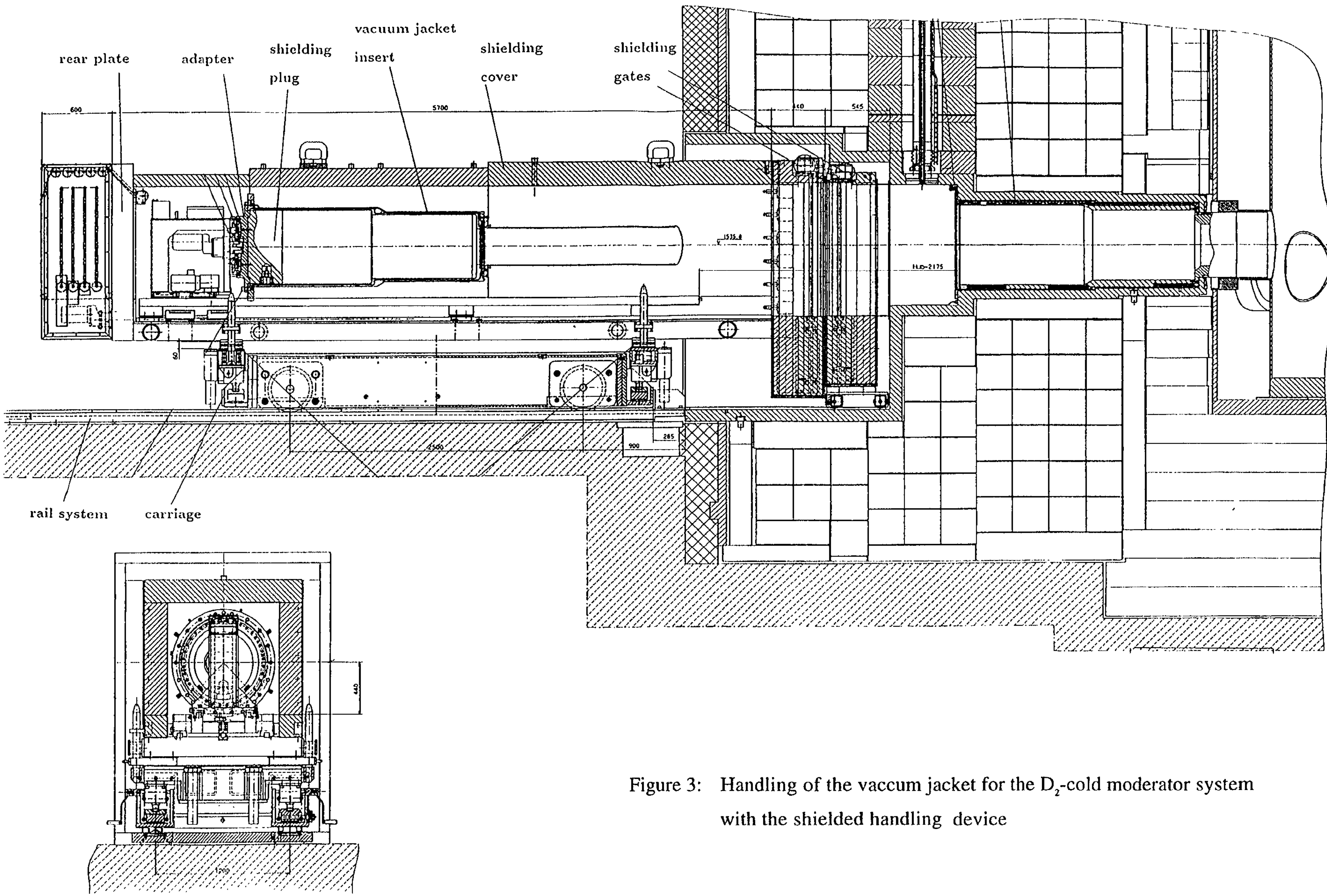

Figure 3: Handling of the vaccum jacket for the D_2-cold moderator system with the shielded handling device

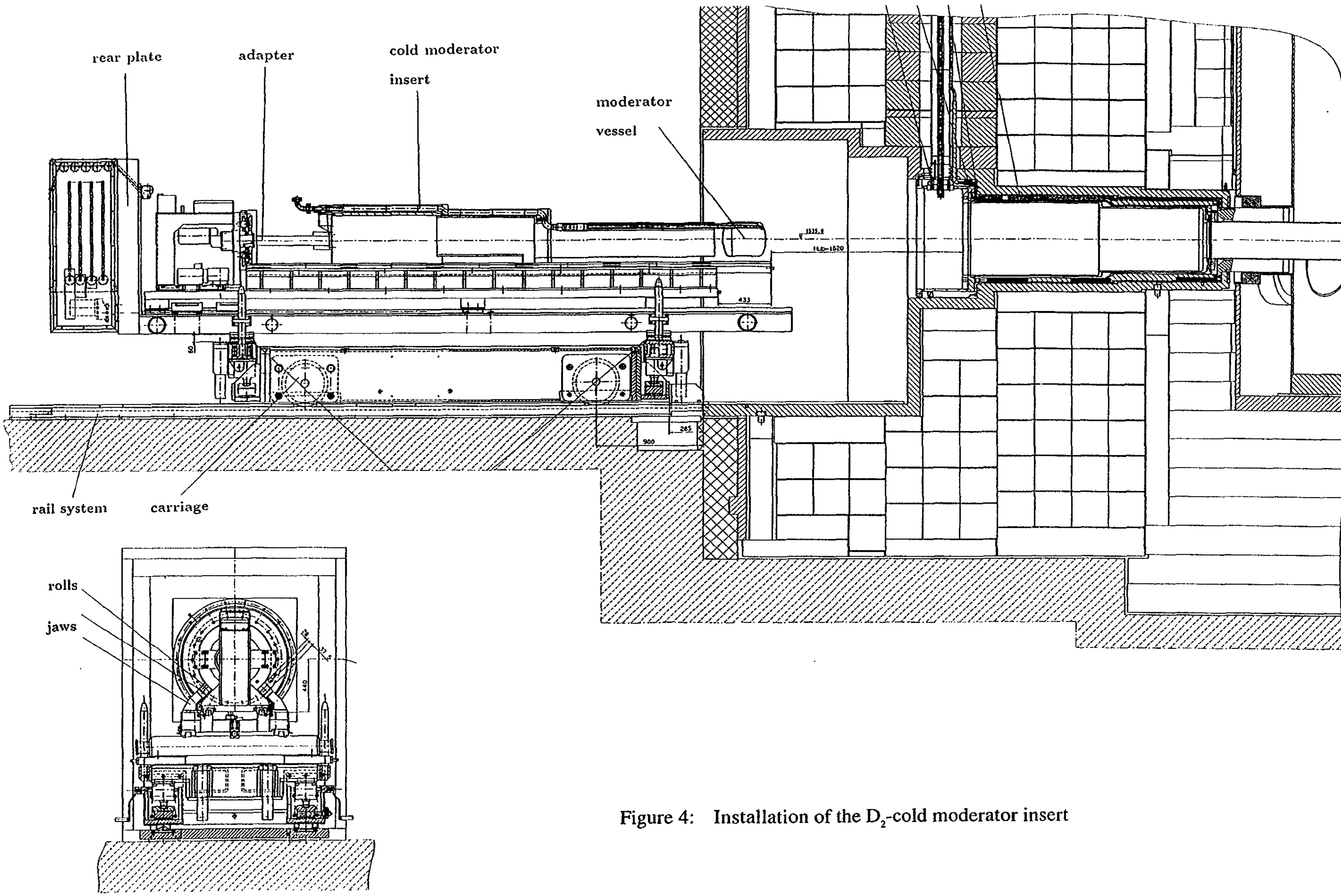

Figure 4: Installation of the D_2-cold moderator insert

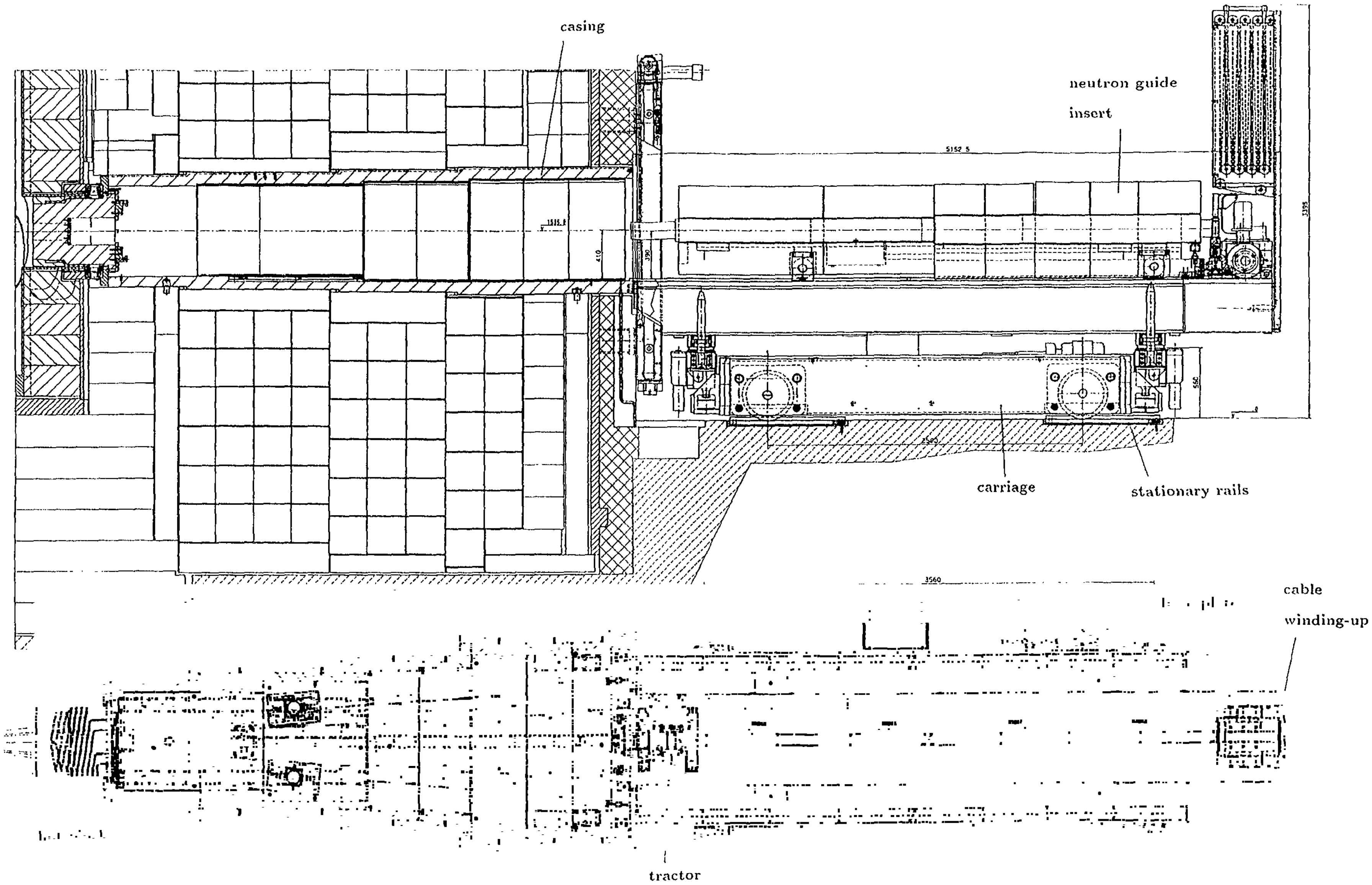

Figure 5: Handling of the waggon carrying the neutron guide inserts.