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SEMI-REMOTE HANDLING OF RADIOACTIVE DEVICES IN THE FERMILAB TARGET STATIONS

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ABSTRACT

Six additional, isolated, and self-contained target stations are being built as part of the upgrade of the three Fermilab fixed target Experimental Areas. One new system of shielding and semi-remote component handling via a crane is being developed for all of these. The first of these stations is under test. The system is simple and flexible. It successfully provides semi-remote handling of components from within the shielding of the stations.

INTRODUCTION

Fermilab provides a system of Proton accelerators from which a high energy Proton beam is extracted, split among three experimental areas, and targeted at several stations for experimental purposes.

The components in the Proton Beam Target Stations can acquire induced radioactivity levels of typically 50 Rad/Hr at one foot. Consequently, these components must be moved or handled with a shield or in a semi-remote manner. Typically, these components are large (10 to 20 feet long) and heavy, weighing as much as 15 tons. Because they are surrounded by extensive, immobile operational shielding, a semi-remote handling system is required in these stations. Any remote handling system used to install and remove components must be able to position them in X, Y, and Z within a tolerance ± 30 mils and less. In general, each component such as an electromagnet has high-current power, cooling water, and instrumentation leads which run through perforations in the fixed radiation shielding. Component handling must be done in a way that does not damage these extended leads. This paper describes a system designed to meet the requirement given above and gives details of the alignment system and lifting fixtures used to implement it.

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SYSTEM DESCRIPTION

Each target station consists of a steel shielding core pile surrounding a line of active components (targets, magnets, collimators, sweepers, beam dumps, etc.) up to seventy feet in length. This core provides all the necessary personnel shielding required for servicing when the beam is off. The core piles include shielding covers (plugs) above the components which are removable with overhead 20-ton cranes. Beam-on personnel shielding includes additional layers of removable concrete shielding for surface stations or berm shielding for underground stations in underground galleries. Economics dictates that the steel shielding be made up as stacks of rough, distressed (scrap) steel slabs. Consequently, all alignment and handling guidance of internal components must be derived from a separate system. A schematic of a typical core pile is shown in Fig. 1. Note the component leads extending through the shielding.

All components within the station except for beam dumps and targets are positioned as follows. Between the shielding-pile steel walls, there is an open corridor over a long, rigid, level, reference base with continuous, precision stainless steel guide rails, one on each side. One rail is half round, the other is flat. All components are supported by three attached feet which register on these rails. The two feet on the curved rail side have matching curved shoes which locate the component in the X, Y transverse directions. The third foot on the flat rail levels the component. The curved rail and foot were selected through prototype testing of various forms. This combination proved to be the most self registering, reproducible, and non-damageable system with good load distribution. The curved foot and rail are shown in Fig. 2.

The true position of the rails in each target station relative to a reference line is established and checked by semi-remote optical survey. New components for the target stations are optically prealigned relative to the rails on an external fixture which duplicates a

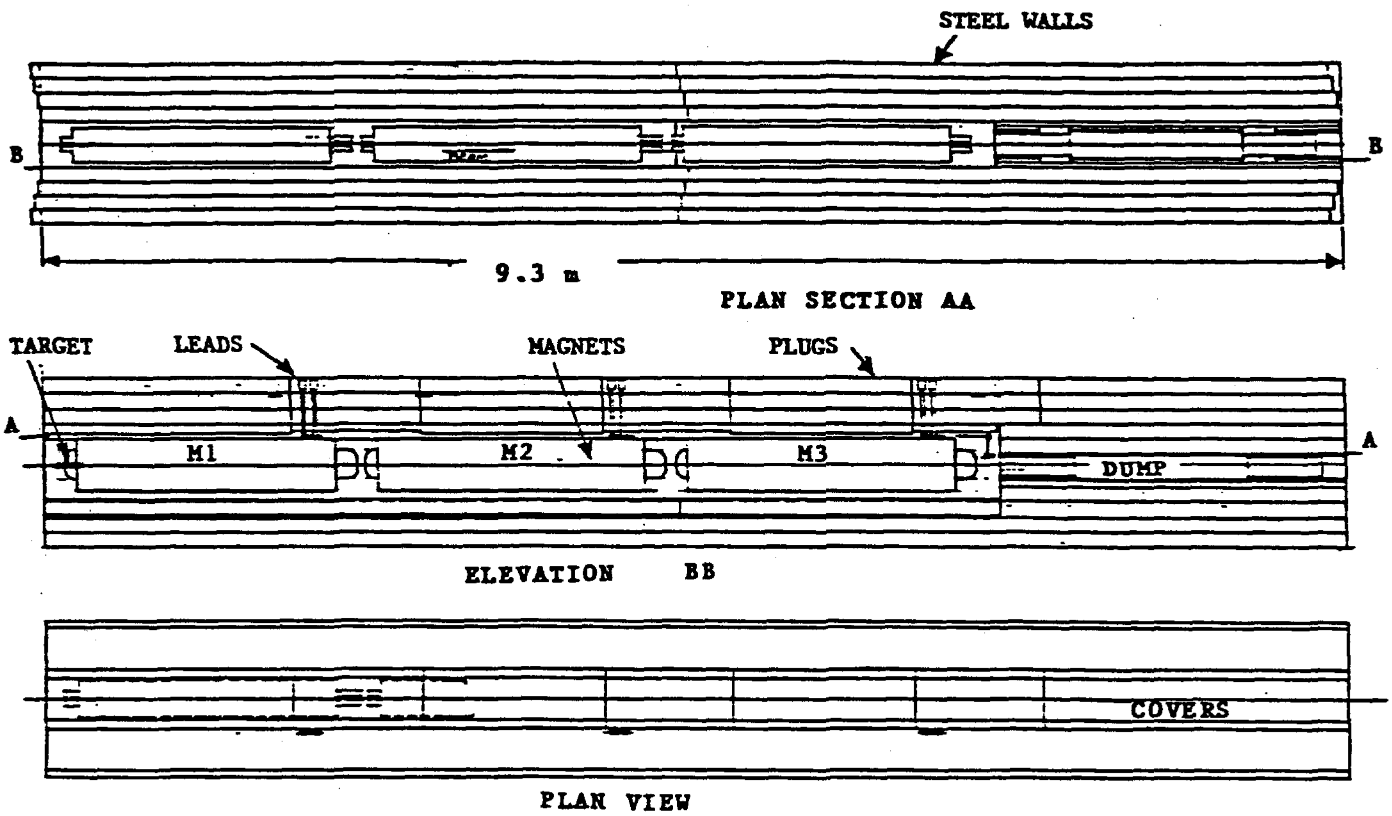

Fig. 1 A Typical Target Station Core Pile Assembly

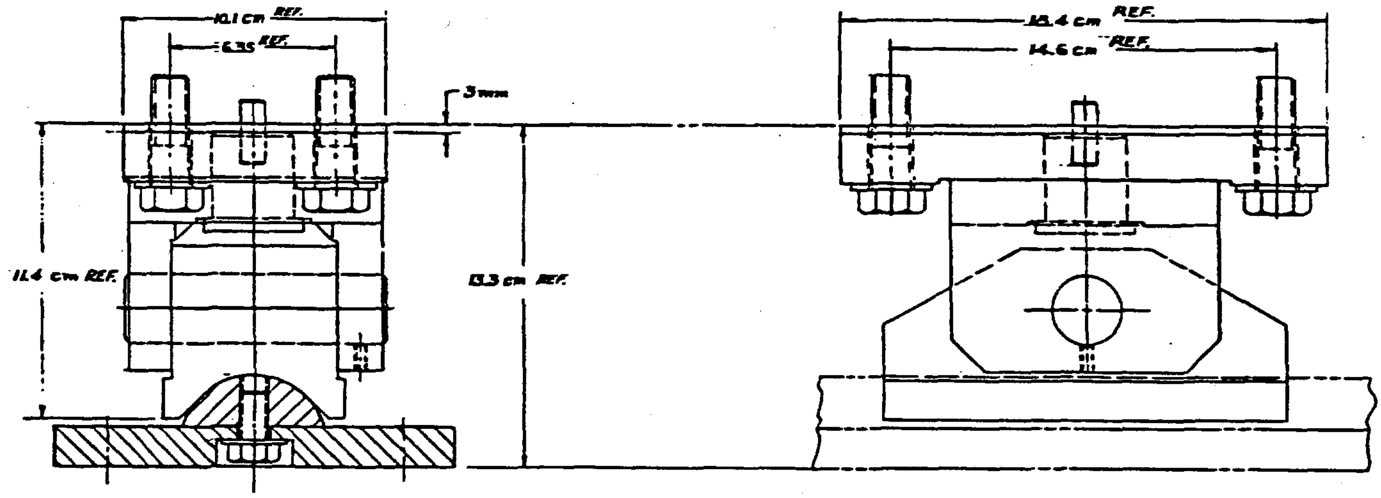

Fig. 2 The Curved Foot And Alignment
Rail For Target System Components

section of the baseplate rail system in each station. Here adjustments to the component foot positions are made to establish the future true position of the component in a given station when installed remotely.

Before installing or removing any component in the rail area, the steel shielding-covers over that component area are first removed by crane and temporarily stored in a bunker or away from personnel. Then two simple guide frames are mounted over the top inside edge of the wall on each side of the open corridor. Because of the shielding and distance from the component, this is an acceptable personnel operation even with a radioactive component in place. These frames mount with bolts to fixed, pre-existing holes along the walls and they extend down between the walls and the component. One frame provides a vertical captive track for an existing side roller on each component which establishes and controls its longitudinal (Z) position in handling. Both guide frames provide smooth rub rail surfaces for two guide ears on each side of the component. These substitute for smooth walls on the pile. For handling, each component (including beam dumps) has two fixed lifting pins projecting from each side near its top. The positions of these pins are precisely known but can vary with the individual component.

To move a given component in or out of the shielding pile, a lifting fixture with four hooks (arms) is used. This fixture is a basic spreader bar with exchangeable, bolted-on lifting arm saddles made for various widths. To handle a component in a pile, the appropriate arms with hooks are mounted and aligned to the fixture. These hooks will engage the four lifting pins on the given component. The fixture includes bar extensions for use with two cranes. It is shown in Fig. 3.

To attach the fixture to a component in the pile, the fixture is first lowered onto the component in a longitudinally offset position so that the hooks miss the pins. Once the fixture is sitting on the component, it is shifted by the crane to engage the pins. Engagement is assured by longitudinal contact indicators, remote inspection, and end caps on the pins. The lifting fixture is designed to flex to assure loading of all four lifting points. The fixture does not interfere with the attached extended leads on components which are constrained to be near the ends. The component is lifted out with the roller guide track maintaining the component position and preventing damage to the leads. Radioactive components removed from these target stations with the lifting fixture can be remotely placed in a shielded transport coffin. The shielded item can be moved by truck to our remote handling complex for repair or disposal.[1]

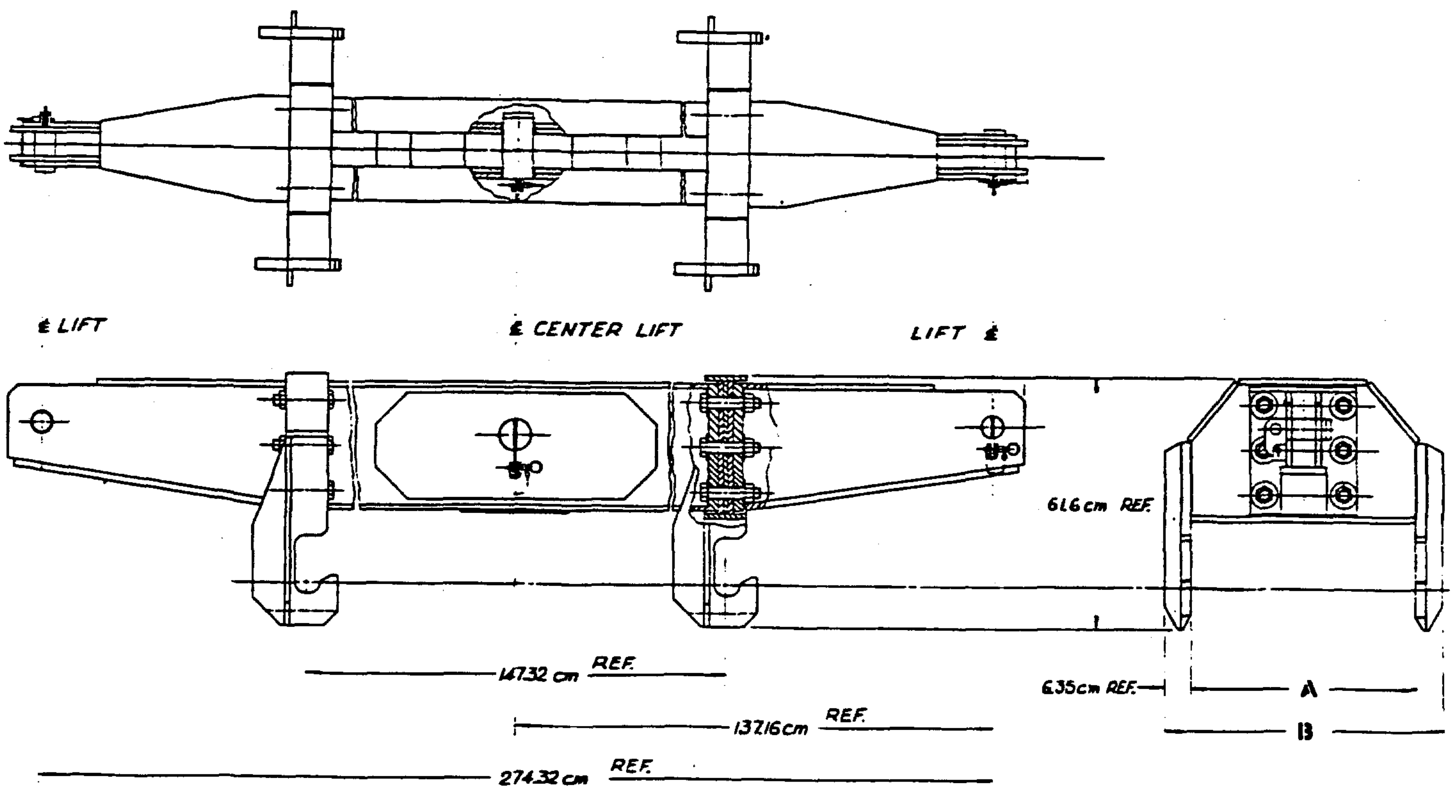

Fig. 3 The Lifting Fixture For Target Station Components

To install a component into the pile, the fixture is used to transport the component to the properly prepared opening in the pile. The component is then engaged to the roller guide track which projects above the wall and is then lowered onto the rails with the crane. The curved feet lead the component into position as they engage the rails. Then the fixture is longitudinally shifted from the pins and removed with the crane. This is indicated in Fig. 4. When manipulation is complete, the guides are removed and the shielding covers are reinstalled with the crane. Keys on the shielding walls guide the covers in re-installation and prevent damage to the component leads which extend up through slots in the covers when in place. All mechanical and electrical connections to components are made up to these extended leads on the outside of the core pile. With the shielding in place, flexible connections to these leads can be made up manually. Once they are complete and certified, any additional operational shielding is restored.

As mentioned earlier, the positioning and manipulation of beam dumps and targets differs somewhat from what has been described. Beam dumps are always the last elements in the stations and are generally the most radioactive. They are accessed by removing two layers of covers. Beam dumps are handled with the same lifting fixture described above, but they do not use the rail system. Because of radiation considerations, each dump nests in a special liner (box) which provides smooth faces, built-in lifting guide slots, spherical alignment pads, and a longitudinal radiation seal by means of steps (jogs) in the walls. The dump modules include steps which match the liner. Dumps are positioned by means of attached leveling feet as well as sockets which mate with the spherical alignment pads on the liner. This is shown in Fig. 5. Targets are always at the upstream end of the station and are subject to frequent change. Usually there are multiple targets which must be alternately positioned into or scanned through the beam by a manipulator. To reduce the irradiation of drive motors, encoders, switches, wiring, etc., the manipulator is translated away upstream of the targets by cantilevering the targets on an extended support. This allows for easy manual handling of the targets and/or manipulator.

We have successfully tested a prototype system with these new features and are presently installing the first of new stations.

REFERENCES:

1. J. F. Lindberg et al., Proceedings of the 26th Conference On Remote Systems Technology, American Nuclear Society (1979).

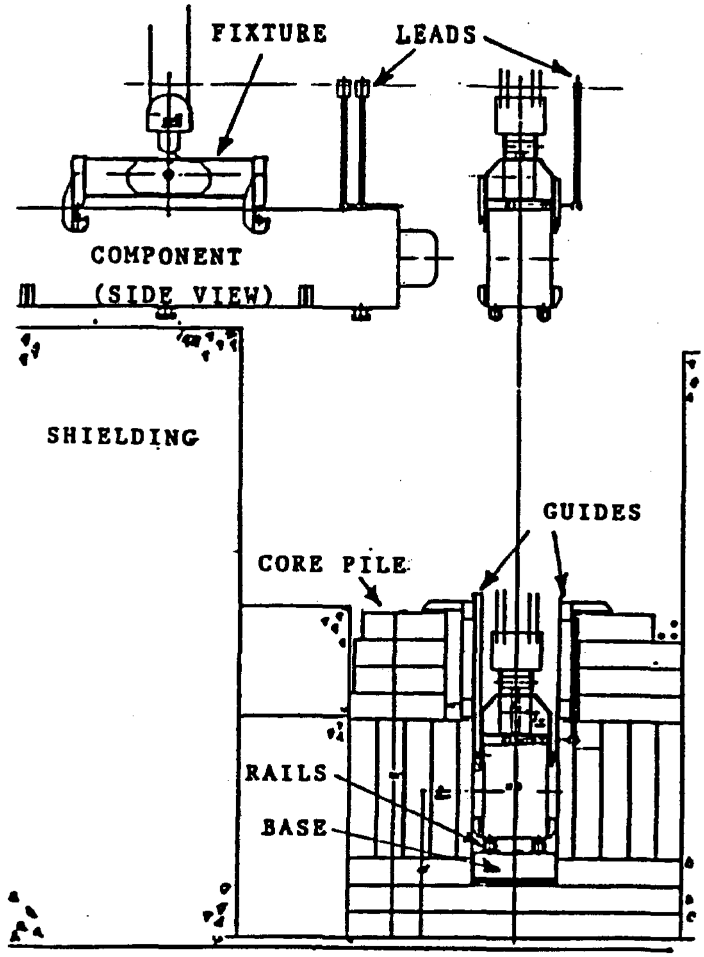

Fig. 4 Component Manipulation In A Typical Target Station

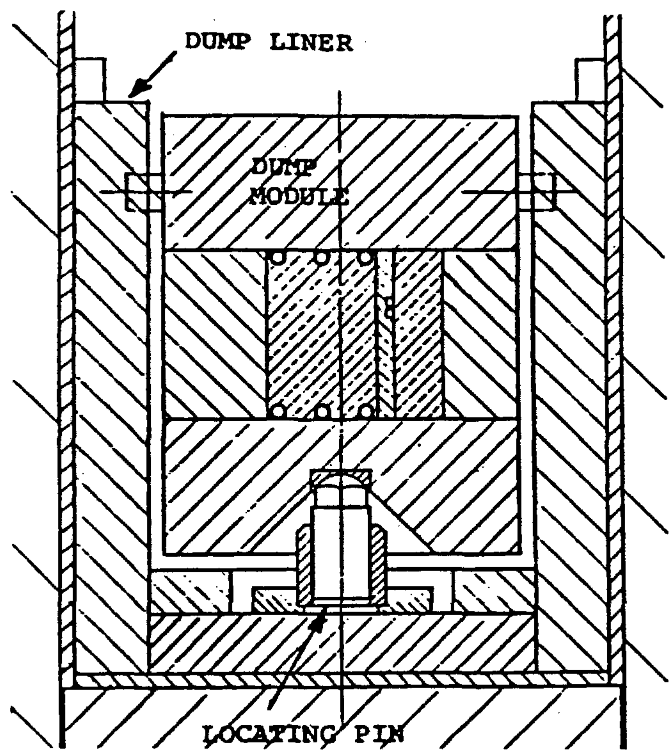

Fig. 5 Section View Of A Typical Dump Module