 IEEE Transactions on Nuclear Science, Vol. NS-32, No. 5, October 1985

NEW, SEMI-REMOTE HANDLING TARGET STATIONS IN THE FERMILAB EXPERIMENTAL AREAS

D. Eartly, R. Currier, J. Lindberg, S. Sobczynski, W. Strickland
Fermi National Accelerator Laboratory*
P.O. Box 500
Batavia, Illinois 60510

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 has been developed for all of these. Two stations are being operated and two more are under test. The applied system is simple and flexible. It successfully provides semi-remote handling of components 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 1 ft. Consequently, these components must be handled with a shield or in a semi-remote manner. Typically, these components are large (10 to 20 ft long) and heavy, weighing as much as 15 tons. Because they are surrounded by extensive, fixed operational shielding, a semi-remote handling system is required in these stations. Any such system used to install and remove components must be able to position them in x, y and z within a tolerance $\pm$ 30 mils and less. Typically each component such as an electromagnet has extended high-current power, cooling water, and instrumentation leads which run to the outside through slots in the fixed shielding. Component lifting and alignment fixtures must protect these in handling.

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 70 ft in length. This core provides all the necessary beam off personnel shielding required for servicing and includes 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 stations in underground galleries. Economics dictates that the steel shielding be made up as stacks of rough, scrap steel slabs. Thus all alignment and handling guidance of internal components must be established by an independent system.

Between the shielding pile 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. Components are supported by three attached feet which register on these rails. Two feet on the curved rail side have matching curved shoes which locate the component in the transverse directions x, y. The third flat foot on the flat rail levels the component.

The true position of rails in each station relative to a reference line is established and monitored by semi-remote optical survey. New components for a station are optically pre-aligned to the rails using an external fixture which duplicates a section of the baseplate rail system. Here adjustments to the component foot positions are made to establish the future true position of the component in the given station when installed remotely.

To remove (or install) a component in the rail area, the shielding covers are first removed by crane and stored away. Then two simple guide frames are lowered by crane to extend down between the walls and the component. These frames are then bolted to fixed, pre-existing holes along the top edge of the walls. Because of the shielding walls and distance from the radioactive component, this is an acceptable personnel operation. One frame provides a vertical captive track for an existing side roller on each component. It establishes and controls the component longitudinal (z) position in handling. Both frames provide a smooth rub rail surface for two guide ears on each side of the component. The frames substitute for smooth walls. For handling, every component has two fixed lifting pins projecting from each side near its top. The pin positions are precisely known but can vary with the component. To move the component, a lifting fixture with four hooks is used. This fixture is a basic crane spreader bar with interchangeable, bolted on lifting saddles for various width components. The fixture can be extended for use with two cranes.

To attach the fixture to a component in the pile, it is first lowered onto the component in a longitudinally offset position so that the hooks miss the lifting pins. Then it is shifted longitudinally by the crane to engage the pins. Engagement is assured by 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 extended leads on components as they are near the ends. As the component is lifted out, the roller guide track maintains its position to prevent damage to its leads. Removed radioactive components can be remotely placed in transport coffins.

To install a component into the pile, the fixture is used to transport it to a prepared opening. The component is then engaged to the roller guide track projecting above the pile wall. It is then lowered onto the rails. Next the fixture is longitudinally shifted from the pins and it is removed by the crane. Finally the wall guides are removed. The shielding covers are reinstalled with the crane. Keys on the walls guide the covers in reinstallation and prevent component lead damage. All mechanical and electrical connections to the component are then made to the extended leads on the outside of the pile. These flexible leads can be made up manually and tested before additional shielding is restored.

*Operated by the Universities Research Association, Inc., under contract with the U.S. Department of Energy

0018-9499/85/1000-3072$01.00© 1985 IEEE

The positioning and manipulation of beam dumps differs somewhat from what has been described. They are always the last element in a station and are generally the most radioactive.

Beam dumps are handled with the same lifting fixture described before, but they do not use the rail system inside rough walls. Instead each dump module nests in a close fitting box liner which provides smooth surfaces, built in guide slots for the lifting hooks, an upstream spherical (pivot) alignment pad, a downstream alignment pin (rotation), and a longitudinal radiation seal through steps in the walls. Dump modules have complementary wall steps, an upstream alignment socket, lifting pins, a downstream alignment slot, and two downstream leveling feet. Beam dump cooling is provided by a dedicated closed loop water system.

Three stations have been completed, tested, and put into operation. A fourth, now under construction, differs slightly as it consists of two discrete beam dumps disjoint from the rail component station.