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Shield Plug-Mounted Hot Cell Manipulator System

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PaR Systems has been providing remotely-controlled manipulator systems for use in hot cells since 1961. These systems traditionally consist of a bridge which traverses crane rails on the inside of the cell walls; a carriage that traverses rails on the bridge; a telescoping mast that provides vertical travel; and an electro-mechanical manipulator. Manipulators are generally 5-7 axes and are supplied with remotely interchangeable grippers.

These manipulator systems are installed as the cell is being constructed prior to the cell "going hot". They undergo a full range of testing and maintenance demonstrations to ensure the machinery is fully functional and maintenance/repair operations are understood by personnel. Some of these systems that were installed and commissioned in the 1960's and 1970's are reaching the end of their useful life and need to be partially or fully replaced.

PaR supplied a bridge and trolley-based manipulator to Oak Ridge National Laboratory (ORNL) Radiochemical Engineering Development Center (REDC) in 1964. REDC produces radioisotopes for use in industry and research and processes more than 70% of the world's supply of 252Cf. The manipulator system in this hot cell was designed for hands-on maintenance and training and was not intended for use in a hot cell, however it installed on the REDC cell and suffered a bridge drive failure in 2008. Since no human access is possible in the cell replacement of the system presented an enormous challenge. Various repair, removal, replacement scenarios did not identify a solution that was workable in terms of cost and the spread of contamination, or potential exposure of personnel.

ORNL proposed a unique shield plug-mounted system that would not require removal of the failed system. The hot cell where the manipulator system is contained has a large (1830mm x 3050mm) ceiling plug. The proposed design provided equivalent functionality, capacity and complete cell coverage. In its retracted position the plug-mounted system can be installed and removed by removing the shield plug.

ORNL provided the design specifications, and hot cell coverage models and a rough working concept in SolidWorks. The concept and requirements were sent to PaR, who refined the concept and provided the detailed design, implementation and testing.

The new design consists of a plug-mounted 360 degree rotating turret and a two-stage horizontally extending boom with 2590mm of reach from the plug centerline. At the end of the boom a telescoping mast is attached with a vertical travel of 4268mm. A PaR M3000 manipulator with seven degrees of freedom is attached to the bottom of the mast.

ORNL fabricated a new shield plug and sent it to PaR's factory for fit-up and testing. The plug was designed to route all manipulator cables through conduits. Cables land on the top of the plug where bulkhead connectors are plugged into the cables that route to the control system. Therefore, installation of the new system is as simple as removing the old plug, installing the new plug with manipulator system attached and making the electrical connections. No personnel are exposed to radiation in the installation of the system.

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