Four-Piece Servo Manipulator

The Nuclear industry employs many types of general-purpose remote handling tools for handling objects in radioactive environments. Master Slave Manipulators (MSMs) are the most versatile among them. BARC has developed many models of mechanical MSMs and installed them in various nuclear installations. A few models of electrically controlled servo manipulators were also developed. Continuous efforts are being put in to improve the quality of teleoperation. BARC has recently developed a novel design of Servo Manipulator, called Four-Piece Servo Manipulator (FPSM).

FPSM consists of a master arm and a slave assembly. The modular slave assembly has three distinct parts: a slave arm in the hotcell, a through-tube in the cell wall and a motor unit in the operating area. The motor unit of the slave assembly has eight motors for driving five rotary joints, two coaxial telescopic joints and a gripper. Operator can control the slave gripper in the hot cell, by manipulating the master arm handgrip in the operating area. When the operator moves the master arm, the controller drives the slave motors, based on the sensor inputs from the master joints. Motor motions are transmitted to the slave arm and modified to the desired form, using a series of mechanical linkages. The 20-kg capacity manipulator has a maximum reach of 3.8 m.

The unique feature of FPSM is that, it can be installed in hotcells that are designed for mechanical MSMs: any telescopic mechanical MSM can be replaced by the FPSM. The operator-friendly FPSM has a few advantages over the conventional manipulators. Its slave arm is remotely replaceable. Its through-tube is sealed to prevent leakage of contamination from the hotcell. FPSM has low effective friction and reflects only a controlled load to the operator. Electric components of FPSM are not subjected to radiation damage or contamination, as they are kept outside the hotcell. They are also easily accessible for maintenance. In addition, the presence of computer in the control loop enables the operator to modify the input-output relations as required.

- Input received from Design, Manufacturing & Automation Group (DM&AG)