

N110. Robotic Maintenance Systems For Nuclear Power Plants

Robotic maintenance systems can reduce both outage durations as well as radiation exposure of personnel. A 15-fold reduction in personnel exposure has been demonstrated using a remote, tube-rolling system. Despite the obvious advantages, applications of robotics to nuclear power plant maintenance continues to pose challenges to robotic system designers. Since maintenance tasks were not adequately addressed by the original component designers, robotic systems must contend with limited access, obstructed work spaces, and hostile environments.

At present, remote technology is being routinely used to perform three significant activities in nuclear power plants: steam generator maintenance, refueling, and reactor vessel in-service inspection. Although refueling is performed using remote technology, there remains a high degree of direct human interaction. The operator of the fuel handling bridge is located on the bridge during all fuel-handling activities, despite the presence of a substantial level of background radiation. Although position encoder information is available to the operator and is used to achieve desired positions, the refueling system is operated in a manual mode. The fuel-handling system represents the state-of-the-art of remote system design of the mid-1960s and has not benefitted from the last 25 years of computer development.

Tokyo Electric Power Company has recognized this shortcoming and installed improved refueling systems at several plants. The improved system is intended to reduce time required to move fuel and reduce overall radiation exposure of system operators. These goals were accomplished by automating the process under computer control, improving positioning precision of the machine and removing the operator to a remote console in a climate-controlled booth in a low radiation area within the reactor building. Like the refueling systems, the remote systems available for performance of steam generator maintenance have undergone more regeneration than the refueling systems in response to the problems experienced with steam generators. However, they have retained a high level of human interactions. The operator's station has been moved progressively farther from the steam generator, such that operation is now done from outside the containment building, reducing personnel radiation exposure. The high level of human interaction, however, serves to limit productivity and quality by introducing the possibility of human error. Even in the repetitive task of performing eddy current inspections, manual operation of the system is still the predominant mode.

In-service inspection of PWR vessel welds has been performed successfully using large multi-axis manipulators which require removal of all fuel and reactor vessel internals to access the weld locations, and so the inspection is virtually assured to be on critical path. Many welds in BWRs, however, have not yet been inspected due to restricted space in the jet pump area.

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