

## **N392. Automating Steam Generator Maintenance At Bruce A**

As efforts are made to minimize worker dose and reduce the duration of outages, remote tooling is being used to carry out more and more of steam generator maintenance. One example is the equipment being used for water lance cleaning of steam generator tubesheets and stacked scallop bar U-bend supports.

The aim of the tubesheet lancing program is to remove accumulated sludge to prevent pitting of the Inconel 600 tubes. A CECIL (Con Ed Combined Inspection and Lancing) type system has been developed for the Bruce A steam generators. The key problem was the severe physical access restriction encountered in the area of the tubesheet. The in-bundle components of the robot were designed in three modules to overcome this constraint. The modules are:

- 1) A locomotion module, which allows the robot assembly to traverse along a segmented rail in the boiler no-tube lane.
- 2) A lance barrel or spray barrel which performs the actual lancing operation.
- 3) A tilt module which rotates the lance or spray barrel axially.

CECIL can be controlled from a distance of 50 m. This allows the control area to be located in an area of low radiation background. The operator remotely controls locomotion, rotation and lance insertion/retraction by means of a joystick. The bundle position of the robot is detected by digital encoders and displayed on the control screen. Limits and interlocks are built into the computer software to ensure system operational safety and integrity. Relocation of the complete system from one steam generator to another takes about two hours of setup time.

CECIL was successfully used during unit outages in 1993 and 1994 and tubesheet cleaning of another unit is planned for 1995. The high-volume spray barrel module removed 2201 kg of soft sludge quickly and efficiently from eight steam generators of unit 4 and 2647 kg from unit 3. System unavailability was minimal, as diagnostic testing and operating procedures have been carefully followed.

The straight-ahead hard sludge is equipped with a fibroscope for on-line visual inspection. This is of great benefit because it provides immediate feedback on the effectiveness of any intertube lancing. This saves time, as there is no need to switch back and forth between the water lance and an inspection lance.

*For more, "Automatic steam generator maintenance", Nuc. Eng. Intl., 1995 Remote technology report, pp. 11-12.*