

1.12.5. INSPECTION OF CANDU REACTOR FUEL CHANNELS

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Fuel channel pressure tubes are critical components at the heart of the CANDU reactor core which require periodic inspection to demonstrate continued fitness for service. The inspection scope typically consists of ultrasonic testing of pressure tube material and a number of measurements performed on a fuel channel. The measurements may include pressure tube gauging (diameter and thickness), pressure tube sag and location of garter spring spacers. A CANDU reactor consists of a large tank, the calandria, which is penetrated by several hundred horizontally mounted fuel channels containing natural uranium fuel bundles. The fuel channel consists of a 104 mm diameter, 4.3 mm thick Zirconium – Niobium pressure tube, inserted into slightly bigger calandria tube, and two stainless steel end fittings at the ends of the fuel channel. Garter spring spacers maintain separation between pressure tube and a calandria tube.

Ontario Power Generation; Inspection, Maintenance & Commercial Services Division operates a variety of inspection systems to perform non-destructive examinations of the fuel channels. At the core of those systems is an ultrasonic probe module which contains several ultrasonic probes interrogating inspected tube from several angles at the same time. The ultrasonic inspection system utilizes high frequency ultrasound (10 MHz and 20 MHz) in order to achieve high degree of detectability of small flaws and high accuracy of flaw sizing. The inspection is performed in several phases:

- Ultrasonic system calibration;
- Ultrasonic flaw detection and pressure tube gauging;
- Sizing of detected flaws;
- Pressure tube sag measurement;
- Determination of garter spring locations.

Detection of the flaws is performed using several criteria, including reflector amplitude criterion. Sizing is performed using a variety of B-scans acquired with various probes in both pulse echo and pitch catch configurations. The sizing accuracies achieved are in 20 to 40 microns range for certain flaws.

Pressure tube gauging is performed by ultrasound and the data is collected simultaneously with the flaw detection scan.

The inspection systems in use by Ontario Power Generation and previously by Ontario Hydro have successfully inspected hundreds of pressure tubes in Canadian and foreign CANDU reactors over the last 20 years.