NON-DESTRUCTIVE TESTING AT CHALK RIVER

In 1969 Chalk River recognized the need for a strong group skilled in non-destructive test procedures. Within two years a new branch called Quality Control Branch was staffed and working. This branch engages in all aspects of non-destructive testing including development of new techniques, new applications of known technology, and special problems in support of operating reactors.

The Quality Control Branch at the Chalk River Nuclear Laboratories was formed in 1971 in response to more stringent requirements for pre-service and in-service inspection of nuclear plants. In particular, the publication in 1970 of a new section of the ASME Boiler and Pressure Vessel Code (Section XI, In-service Inspection of Nuclear Reactor Coolant Systems) for light water reactors, caused the Canadian Atomic Energy Control Board to require more stringent in-service inspection of CANDU (Canada Deuterium Uranium) reactors. The consequences were far reaching, affecting the design, manufacture, and operation of CANDU reactor components. In 1975 the Canadian requirements for periodic inspection of nuclear plants were documented in CSA N285.4, Periodic Inspection of CANDU Nuclear Power Plant Components. The branch engages in all aspects of non-destructive testing, including development of new techniques, applications of existing methods, and routine shop inspection. There are eight professionals in the branch, bringing together specialists in non-destructive testing, metallurgy, and computer technology, and generalists in physics and engineering. They are supported by eight technologists and six shop inspectors. After four years of problem solving at the CANDU reactor sites and heavy water plants this highly skilled team has accumulated a depth and breadth of experience not obtainable within the confines of the laboratory. The urgent demands of the Pickering, Bruce, and Gentilly generating stations have resulted in highly directed development programs bounded by compressed time schedules.

During the past year the problem of detecting and evaluating cracks in pressure tubes has taken priority over all others. When the magnitude of the problem at Pickering Unit 3 first became apparent in September 1974, non-destructive methods for inspecting pressure tubes in the reactor and in the laboratory were quickly developed. Radioactivity was the main source of difficulty in both cases. Laboratory specimens had to be inspected under water or behind shielding by remotely controlled devices; installed pressure tubes had to be inspected remotely because of high radiation fields in the reactor vault.

Ultrasonic and eddy current scanning systems were designed, built, and tested in record time. The ultrasonic transducers, eddy current probes, and basic inspection techniques were all conventional; hence our main contribution was in automating the scanning mechanisms and data recording systems for remote operation and readout. Transducers and probes were moved by electric motors controlled by logic circuits. Instrument signals and probe position data were continuously recorded on magnetic tape or paper charts. It was essential that the equipment perform reliably when operated by relatively unskilled personnel on a three shift schedule, and equally important that the inspection records be easily interpreted and free from error.

This job and others at reactor sites have confirmed the main objectives of the branch, i.e., to apply conventional non-destructive techniques to the special problems of nuclear plants and to transfer the resulting technology to the nuclear industry. In effect, the laborious manual methods of ultrasonic and eddy current inspection are being replaced by computer methods. More important, the traditional advantage of radiography, the permanent film record, is being challenged by greatly improved methods for storing, displaying and printing out ultrasonic and eddy current signals. The individual skill of the field inspector is no longer as important as it was, provided he is supervised by a specialist who can interpret the magnetic tape and paper chart records.

The trend to computerization is widespread and no doubt will continue. A furtner development is to analyse the data by mini-computer in real time, in which case the knowledge and skill of the non-destructive testing expert must be programmed into the computer. The transition to fully automated analysis will not be sudden or complete; it will take place gradually as confidence and experience accumulate. This experience must come simultaneously from field studies and the laboratory.

The Chalk River team is well equipped to solve difficult problems on short notice and has had considerable success in transferring non-destructive testing technology to the nuclear industry. Although our emphasis has been on short-term goals directly related to the CANDU program, we have successfully applied advanced technology, such as acoustic emission, to determine the crack initiation process in Pickering pressure tubes.

There are no Canadian manufacturers of non-destructive testing instruments and little incentive for most industries to spend any money on advanced inspection methods. With the exception of the aircraft industry and the nuclear industry, traditional shop inspection is generally adequate. As a result, design engineers and production managers for the most part have had no training in the theory and application of non-destructive testing and rely entirely on tradesmen inspectors. In the nuclear industry this situation is no longer satisfactory. There is already a strong reaction from one manufacturer who claims that new ultrasonic inspection standards specified by the customer are resulting in unnecessary and undesirable weld repairs.

Our Chalk River experience in exposing development engineers to intensive training in non-destructive testing leads to the observation that many design engineers and maintenance engineers would benefit greatly from similar training. In order to specify reasonable inspection standards for manufactured components and exercise sound engineering judgment in specifying periodic inspection procedures for operating components, a detailed technical knowledge of modern non-destructive testing methods is essential. The consequences of production delays and in-service failures are now so costly that prime responsibility for inspection procedures can no longer be delegated to the shop floor inspector.

J.W. Hilborn

*