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Introduction
WANDA develops NDE methods for in-service inspection (ISI) of nuclear power plants (NPP) to maintain high safety standards with the continued life extension of the existing plants. Main focus is to improve ISI reliability by increased modeling understanding, developing performance estimation methodologies and to raise the level of NDE competence of concrete infrastructure.

During the first two WANDA years the research has concentrated on different NDE topics. Ultrasonic (US) tests on fatigue cracks in test tube. The propagation of the US in stainless steel weld and the impact of the weld on defect detection is evaluated. Probability of detection for ultrasonic inspection has been one of the topics. Also modelling of magnetite detection with Eddy Current inspection on Steam Generator tubing have been successful.

As a new topic the NDE research on concrete have been started. At this point the state-of-the-art survey in NDE concrete research is done and the readiness to plan a wall mock-up for future needs is achieved.

POD estimation
New methods for estimating probability of detection (POD) for typical austenitic stainless steel pipe weld has been made. With the developed technique, POD could be estimated with limited number for actual physical flaws by generating additional data files using flaws from three scanned flaws for inspectors to evaluate. Figure 1 shows the data from which the flaws were acquired and figure 2 shows different emulated flaws. Figure 3 shows the estimated POD for different inspectors.

NDE of NPP concrete infrastructure
The inspection of NPPs concrete structures present challenges different from those of conventional civil engineering structures. As a result, there is a need for NDE of RCS to be able to undertake compliance testing, collection of specific data or parameters, condition assessments, and damage assessment.

The research is divided into three main areas addressing the review of NDE methods and monitoring of concrete performance:
1) Design and construction of a test mock-up for continuous long term testing and monitoring (greater than 20 years) of a reinforced concrete containment wall. Common defects during the construction process will be simulated in the mock-up, in addition to the natural time dependent deterioration of the concrete. The representative defects are i) honeycombing, ii) air filled voids, iii) water filled voids, iv) cracks and delamination of concrete and iv) corrosion of the reinforcement steel.

2) Assessment of the available NDE and monitoring methods
3) Applying the probability of detection (POD) methodology to NDE concrete structures.

Figure 1. view along the weld from the data, as acquired, with the crack signals marked with red rectangles. Green rectangles show unflawed regions that were removed and re-introduced to study the possibility that the manipulation itself causes detectable changes.

Figure 2. view along the weld with scaled cracks introduced to the data. The true depth of the crack is 4.0 mm and it is here scaled to equivalent crack sizes of 1.7, 2.5, 3.2 and 4.0 mm. Crack areas marked with red rectangles.

Figure 3. Computed POD curves from combined inspectors and separated in terms of the real crack sizes with points and curves showed in red, green and blue corresponding to original crack sizes of 1.6, 4.0 and 8.6 mm, respectively. The solid lines show best estimate curves and dashed lines show 95% confidence bounds.

Figure 4. Schematic overview of the reinforced concrete - thick-walled concrete structure.

Figure 5. A schematic description of the NDE selection matrix. The selection on based on (i) the building materials used, (ii) the defects affecting the NPP concrete structures, and (iii) the inspection schedule for concrete structures.

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