EFFICIENT AND RELIABLE INSPECTION THROUGH THE USE OF OPTIMISED NDT

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The construction of the first Pressurised Water Reactor to be built in the United Kingdom is now well under way at Sizewell in Suffolk. Permission to proceed with Sizewell 'B' was given by the UK government following the successful application which became the key topic in a Public Inquiry into the further development of nuclear power, held in the early 80's.

The effectiveness of current non-destructive testing (NDT) methods and techniques was one of the many aspects of the safe and reliable operation of the proposed PWR which were scrutinized during the Inquiry. Inspection research and development activities within the then UK Atomic Energy Authority (now known by the trading name of 'AEA Technology') culminated in the participation in several test trials. These trials (the UK 'Defect Detection Trials' and the international 'PISC II' exercise) produced vital evidence, on the capability of optimised ultrasonic techniques to detect and size defects of concern in clad RPV's, for use in the Inquiry. Other work was reported in the Light Water Reactor Study Group Report published in 1982 and updated in 1986.

The implementation of an efficient and reliable on-site inspection is considered to be dependent on the successful blending of three main ingredients:

- optimised inspection design
- efficient inspection reliability assessment
- effective inspector training.

Current activities within AEA Technology are thus aimed at feeding the knowledge and experience on what constitutes optimised and reliable inspection technology, developed for the UK programme, into the LWR nuclear reactor community worldwide.

Inspection Design

There is an increasing worldwide need for Plant Operators to meet statutory requirements for all matters relating to plant safety, including inspection. In the USA, for example, the introduction of Appendix VIII to Section XI of the ASME Boiler

and Pressure Vessel Code has created the necessity to demonstrate and prove the performance of ultrasonic inspection procedures, equipment and personnel to detect and size flaws.

Stemming from its involvement in the UK PWR programme AEA Technology can now offer a range of inspection design services to nuclear utilities and inspection vendors to help satisfy their inspection requirements.

These include:

- The design of performance demonstration test assemblies.
- The design and optimisation of inspection techniques and procedures.
- Providing assistance with the verification of the adequacy of existing techniques procedures.
- Formulating the technical justification for extending performance demonstration qualifications to a wider range of nuclear component geometries and materials.

A range of computer-based modelling programmes has been developed and tested to aid the inspection design process. These include design programmes for complex geometry components (such as nozzles), difficult to inspect materials (such as austenitic welds) and quantitative analysis programmes for predicting the behaviour of ultrasound/defect interactions.

Recent activities include:

- Design development and commissioning of a 'time-of-flight' diffraction test head for a gas-cooled reactor RPV inspection.
- Inspection design for BWR nozzle/vessel welds in Sweden.
- Inspection design for PWR steam generator, pressuriser, EGS nozzle inspections.
- Development of automated flaw detection for austenitic/ferritic components.

Inspection Reliability Assessment

The process of transferring an optimised NDT technology to the site environment, so that it operates reliably, is not without difficulty.

In common with most man-machine interactions human error in the NDT context is almost certainly the single most likely cause of unreliability. A wide variety of skills are used in the practice of NDT and a considerable number of interactions occur between humans and equipment during a typical inspection.

AEA Technology became aware of the importance of such human error problems following their involvement in the UK and international NDT Test Trials (PISC II) involving several inspection organisations using a range of ultrasonic techniques.

Although many of the teams performances were excellent, errors were made, even under the near laboratory conditions used in the trials. The PISC management board, for example, recognised the need to identify the causes of such errors, assessing their importance and of finding a way to correct them. AEA Technology personnel are now leading the PISC III Action 7 initiative to meet this need.

Identifying potential sources of error in an inspection before they occur is a closely associated activity. A methodology known as 'SHERPA' (Systematic Human Error Prediction Analysis) has been developed to assess and optimise the contribution of the human operator to the overall reliability of an inspection.

Thus, through these two streams of work, AEA Technology has developed advanced skills in inspection reliability assessment and error reduction in NDT.

Some recent activities:

- Reliability audit for inspection of a pumped water storage power station.
- Audit of ultrasonic inspections carried out on the UK Prototype Fast Reactor at Dounreay.
- Assessment of NDT operators on airframe inspection.

Inspector Training

Even the most well-proven, optimised and reliable NDT technique can fail to perform in its task if applied by inadequately trained or inexperienced operators.

The United Kingdom and indeed most parts of the technological world operate accredited establishments and national schemes for the training and certification of manual operators or inspectors. However, a wide range of semi- and fully-automated inspection systems are now in widespread use,

particularly for nuclear plant inspections. These often have to be carried out in remote, hostile and inaccessible environments on complex geometry components.

AEA Technology has recognised the need to ensure that adequate operator training can be provided for such job-specific and equipment-specific tasks.

The range of automated equipment now available worldwide is extensive and clearly no organisation would attempt to offer training on specific inspection equipment. Training can, however, be offered on the generic components of such equipment: such as the methods of data gathering, analysis and display using digital computers and the basic understanding and application of the more advanced inspection techniques such as 'Time of Flight Diffraction' and Synthetic Aperture processing.

Considerable experience has also been gained in the fabrication of test components containing realistic flaws. Such test components are essential for training purposes on job-specific task and can be used by manual or automated systems operators.

An alternative method of training, to the use of conventional test components, is to use simulators. These become increasingly attractive as the test components become larger, more complex and hence more costly. Simulators have the capability to offer a wide range of flaw types and sizes (using data gathered on realistic or real flaws) in a variety of components. An ultrasonic simulator, known as 'Simone', has been developed by AEA Technology and is being marketed as the world leader in this technology. An eddy current simulator is also being developed.