August Newsletter:

Corrosion Reliability Inspection Scheduling CRIS-Joint Industry Project

A joint industry project CRIS was launched in December 2000 to complete the work started in RACH. RACH (Reliability Assessment for Containers of Hazardous materials on offshore structures) was initiated in 1996 and was supported by EU (THERMIE), HSE, Shell UK Exploration and production, and Marathon Oil U.K. Limited. It identified the important role of corrosion in pipework and assessed available NDT equipment in terms of Probability of Detection and accuracy of sizing. It also initiated studies of Corrosion Reliability modelling and utilised this information with POD data and various limit state functions to give corrosion reliability inspection scheduling data.

The CRIS Project will complement the work done in RACH in providing a comprehensive set of POD data for currently used inspection technique and establishing a reliability based inspection scheduling software package as a tool that can be confidently used by industry.

The main areas of the CRIS Project are:

Corrosion Modelling

It is now well established that internal corrosion of offshore topside pipeworks manifests itself in several forms. The most common forms of corrosion are; CO_2 corrosion (sweet corrosion), H_2S corrosion (sour corrosion) in the produced fluids and oxygen corrosion in water injection systems. These forms of corrosion are by far the most prevalent forms of attack encountered.

This section outlines the background, types of internal corrosion damage in offshore topside pipeworks and proposes corrosion prediction models for both (i) production and (ii) water injection systems. Recommendations on an approach when assessing damage in topside facilities will be presented. A review of types of corrosion mechanisms and the available models is also presented.

POD Trials

CRIS will include complete POD / POS trials on radiography and other selected techniques. These will be conducted on an extended sample containing a wider range of defect sizes and the results will be certified by Bureau Veritas

For POD information there is requirement for detection of 29 defects in a group of 29, within a size range, for a lower bound 90% population POD with 95% confidence. POD data needs to provide the defect size range where the POD curve first reaches 100% but also the nature of the inspection performance at smaller defect sizes. This information is needed in the reliability analysis conducted for probabilistic inspection scheduling. CRIS will produce an increased sample of defects so that this data can be obtained from POD trials. The techniques used in the CRIS POD trials are:

1. LIXI PROFILER, Lixi Inc.
2. MFL PIPESCAN, Silverwing (UK) Ltd.
3. ULTRASONIC A-SCAN, The Test House Ltd.
4. TELETEST, Plant Integrity Ltd.
5. SLOFEC, Kontroll Technik GmbH

6. SCAR, Oceaneering International Ltd.

7. CHIME, Veritec Ltd.

Reliability And Inspection Scheduling

RACH produced limit state function programs to be used in conjunction with COMREL or an appropriate alternative. In addition fatigue crack propagation programs used in conjunction with COMREL, were made available to the project (the RISCREL program). One further set of programs for burst pipe scenario is needed to complete the analytical requirements for corrosion reliability.

One of the difficulties in using the reliability approach is that a wide range of disciplines is needed to produce the software, but the user often has a background in only one discipline. For this reason the methodology will be fully established in CRIS with worked examples and guidance on the limits to all parameters will be established.

CRIS will include the following:

a) Programs for interfacing limit state functions with COMREL or an appropriate alternative for corrosion (metal loss), fatigue life estimation, and fatigue crack growth.

b) Establishment of methodology for the CRIS software with worked examples.

c) Checking of software for the limits to all parameters.

Validation

The software package (CRIS) requires validation before it can be used routinely in industry. This can be done in two ways; with specially adapted laboratory trials and with the aid of an Operator who is implementing a similar inspection plan. Given that the defect sample is to be extended an opportunity is available for laboratory trials, and hence both approaches will be used in CRIS.

Validation work through case studies will be conducted in CRIS and will involve:

a) Select a case study (service and laboratory to be included).

b) Specify a degradation mechanism and rate of loss of section.

c) Develop the β index for the case as a function of time.

d) Update the β index values from periodic service or laboratory data.

e) Evaluate the accuracy of the inspection schedule used in the software.

The project Final Report will be produced in electronic format and will contain the following:

1. Report on all NDT trials data, methods and procedures as well as the POD data in electronic format.
2. Report on corrosion modelling, including degradation, rates and scatter, and a review of types of corrosion mechanisms and the available models.
3. Report on Reliability Inspection Scheduling software plus worked examples.

4. Report on validation work, based on laboratory and service studies.

CRIS is scheduled to end in June 2004 and a follow on project CRIS II is planned.

CRIS II aims to finalise development of quantitative procedures to ensure full life integrity of pipelines/facilities through integration of fracture mechanics, inspection reliability, corrosion modelling, operational history and defect assessment procedures. It will utilise a highly innovative approach to providing full life integrity of pipelines, flowlines and facilities bearing in mind the non-uniform nature of internal damage caused by different corrosion processes.

Principle Aims Of CRIS II

- to incorporate extensive data bases of inspection reliability modelling, probability of defect/damage detection (POD), changing operational conditions, limit states and static strength into an integrated integrity predictive modelling
- to establish new probabilistic inspection scheduling methodology
- to provide quantities approach/software to full life integrity of pipelines, flowlines and facilities as affected by changing operating conditions and updated inspection and corrosion data.

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Best Practice for the Procurement and Conduct of Non-destructive testing – Part 2: Magnetic Particle and Dye Penetrant Inspection

HSE has published on its web site (http://www.hse.gov.uk/dst\NDT2.pdf) recommendations to improve the inspection of conventional pressurised equipment, developed by a drafting committee with representatives from industry and HSE. Part 1 addressed manual ultrasonics and was reviewed briefly in the March Newsletter. Part 2 reviews current practice in magnetic particle and dye penetrant inspection. The measures in the current document are recommended by HSE to promote good practice and apply to in-service inspection of existing plant and to repairs. They are not intended to replace relevant technical standards but to identify the many factors which are important in the choice and application of the two methods to make them as effective as possible in use. A table listing 'additional measures' is appended indicating their need for three different levels of effectiveness, according to the reduction of probability of failure that it produces in particular cases. If the probability of failure is high then the inspection effectiveness should also be high (i.e. level 3). The additional measures listed relate to text sections, identifying the need for additional requirements. The report also includes a list of the 19 relevant technical standards relating to the two techniques. Additional parts to this Best Practice guide are being prepared.

SAMCO – Newsletter

The thematic network SAMCO (Structural Assessment, Monitoring and Control) is aimed at becoming a focal point of reference for industries, consultants and other organisations interested in the transfer of knowledge and technology in the field of assessment, monitoring and control of

structures of relevant civil and industrial interest particular the transportation infrastructure. An electronic copy of the latest newsletter from the SAMCO network is available on-line at http://www.samco.org/letter/Issue12.pdf . Items included are:

- Bridge management tin the SAMCO database
- Prognosis of train traffic induced vibrations by means of the in situ train simulation
- 5th SAMCO workshop in January 2004-08-02
- Details of the 7th SAMCO workshop in Rome to be held in June

The web site (www.samco.org) also gives details of a forthcoming workshop on 'Harmonisation', to be held in Ispra in September which aims to enable international collaboration, harmonise communication and to standardise data and protocols.

International Workshop on Structural Health Monitoring 2005

Stanford University, Stanford, CA , September 12-14, 2005.
The purpose of the workshop is to assess the current state of the art technologies in this field and to discuss and identify key and emerging issues in research and development that are critical and unique in structural health monitoring. There is a call for papers in the fields of: Sensor and Actuator Development, Sensor Network/System Integration, Signal processing/Diagnostics/Prognostics, Modeling/Simulations/Design Optimization, Implementation/Lessons Learned and Applications. The date for submission of abstracts is Feb. 1st 2005.

Structural integrity monitoring - Acoustic-emission detection using in-fibre Bragg grating laser sensors –Cranfield University

This was a 2 year ROPA award with the aim to investigate the potential of fibre Bragg grating lasers as sensors for acoustic emission (AE) signals and was a collaboration between groups headed by Prof. Tatam (optics) and Prof. Irving(materials).

The development of Health or condition monitoring systems, together with usage monitoring systems offers considerable cost and safety benefits in the maintenance of safety critical structures such as aircraft, powerplants and large civil structures. Work in the past decade has shown that the use of fibre optic multiplexed strain sensors such as fibre Bragg gratings (FBG's) has considerable advantages over conventional strain gauges in application to large structures, because of the relative ease of installation, freedom from EMR interference and the stability of the mean strain output. However, structural impact or fracture events are associated with the generation of acoustic stress waves, typically in a frequency range between 100 kHz and a few MHz. Detection of the acoustic emission (AE) generated in these events has been established as one of the main non-destructive testing techniques for monitoring structural health and integrity. For airframe and large civil structures in particular, the monitoring of impacts and damage using the AE detection method is important for safety and cost reduction. FBG AE strain sensors would have considerable advantages over conventional piezoelectric sensors, such as immunity to electromagnetic interference, ease of installation and multiplexing capability. AE detection using fibre grating lasers offers not only the advantages associated with FGB sensors, but also the potential to measure AE signals with much higher sensitivities than FBG sensors.

The research has demonstrated that the use of fibre grating based laser systems has potential as a non-destructive measurement technique for ultrasonic waves generated in structures due to damage or impact events.

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Non-Destructive Testing of Highway Bridges - new Highway's Agency report

ADVICE NOTES ON THE NON-DESTRUCTIVE TESTING OF HIGHWAY STRUCTURES **BA 86/04,** issued May 2004, ISBN: 0 11 5524185. This includes advice on assessing the conditions in grouted ducts in post tensioned concrete, surveying the structure of masonry arch bridges, use of the impact-echo technique. See http://www.official-documents.co.uk/document/deps/ha/dmrb/index.htm (go to volume 3, section1 , part7)