Improved NDT for Full Volumetric Inspection of Critical Welds in Subsea Sensors for the O&G Sector

JOINT INDUSTRY PROJECT OUTLINE

PROP310532

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Summary

This Joint Industry Project (JIP) will address the problems that manufacturers of subsea sensors for the oil and gas sector face where full volumetric inspection of critical welds is required by API standards. Currently manufacturers have to either design larger welds than necessary to adhere to standards or use substandard inspection techniques potentially allowing serious defects to remain in the welds during service. The project in two phases each over 12 months, will develop and qualify innovative and improved NDT techniques and procedures specifically designed to detect the types of defects that occur in the small, autogenous electron beam and laser welds that form the pressure boundary of subsea sensors.

The output from the project will be a Best Practice Guide for the sponsors of the project providing detailed guidance for the volumetric inspection of the different types of welds found in subsea sensors. The Guide will include evidence from experiment and modelling that manufacturers can use to support technical justifications for inspection qualification and advice regarding automation and personnel training and certification. The project will align with the requirements of API-6A for Subsea Equipment with a plan to present the JIP findings in the relevant committee. More precisely, API subcommittee 17 (Subsea Production Equipment) has invited TWI to update them on the progress of the project through presentation at their periodic meetings and will offer feedback on findings of the best practice guide. This will place the best practice guide in a position where it can be incorporated into relevant industry accepted standards.

TWI is inviting a consortium of sponsors for the project from companies in the oil and gas sector who are specifying, manufacturing and operating subsea sensors. The consortium of sponsors will have exclusive access to the Best Practice Guide for a period that the consortium agrees. The project will enable manufacturers and operators of subsea sensors to achieve better compliance with current standards and a more reliable product through improvements in the quality of welds and the reduction of defects with competitive advantage and benefits to safe and continuous production.

Introduction

Subsea oil and gas (O&G) production relies on subsea sensors to provide data for the control of production of a subsea well to the topside monitoring and control station. This data is critical to controlling the integrity of the well infrastructure and to the management of the assets of the field in terms of recovery, production rate and safety. Typically, such sensors are part of the Christmas tree at the wellhead of a completed well for the monitoring of flow, pressure and temperature of flow for effective reservoir production and safety management. The safety and reliability of these sensors and the avoidance of leaks in service are therefore high priorities for manufacturers and operators of subsea sensors.

These types of sensors are usually assembled using autogenous electron and laser beam welding. Currently, manufacturers typically use surface inspection techniques, helium leak and pressure testing for the detection of welding defects. However, according to the API-6A specification, there is also a requirement to perform volumetric inspection of Wellhead and Christmas Tree equipment using either radiography or ultrasonic testing.
Currently lack of access for ultrasonic inspection or large and complex material paths inhibiting radiographic inspection are limiting the coverage for volumetric inspection of a significant percentage of the typically small, autogenous welds forming the pressure boundary of subsea sensors. Manufacturers cannot therefore meet the standards that industry requires for subsea sensors with their current approach to inspection. They are then left with the choice of:

- Having larger instruments then necessary with larger non-autogenous welds in order to meet the volumetric inspection criteria, increasing cost through all stages of the system lifecycle (manufacturing, transportation, deployment and decommissioning), or

- Accept non-conformances and the possibility that potentially serious defects will remain in the welds with the possibility that these may lead to a leak during service.

There is therefore a need to develop and qualify improved NDT for the full volumetric inspection of critical welds in subsea sensors.

Approach

The work for this project will take place over two phases each for a duration of 12 months.

Phase 1

Task 1

- Review the common joint designs, and qualification and inspection requirements for subsea sensors in existing standards referenced by the O&G industry. This will include the API standards and their key references to identify where 100% volumetric inspection is currently a mandatory requirement. Best inspection practices and their suitability for small electron beam and laser welds for subsea sensors will be reviewed and identified.

Task 2

- The designs and locations of welds within subsea sensor assemblies, including the materials used, will be reviewed. Based upon a review of the weld geometries and welding methods, typical flaw types and likely dimensions of interest will be specified. Samples of subsea sensors, along with CAD drawings for performing subsequent trials, will be sought from the sponsors.

Task 3

- Establish outline NDT techniques based upon knowledge of flaw morphology, code requirements and prior experience. Computer modelling of the inspections will be carried out to determine the efficacy of the technique(s) for the welds concerned and the techniques modified as required. Based upon this, written preliminary NDT procedures will be established. Where 100% volumetric inspection is deemed not feasible, suitable alternative methods for assessing weld quality will be recommended.

Phase 2

Task 4

- Design and manufacture test coupons containing flaws of similar morphology to those identified as of most relevance and reflecting the worst case configurations.

Task 5

- Conduct inspection trials to demonstrate the effectiveness of the technique(s) on the representative test coupons. The subsea sensor assemblies will be inspected by X-ray computed tomography (XCT) to validate the results obtained. Where necessary, the assemblies will be sectioned to identify better minimum radiation paths to facilitate high resolution inspection data in order to confirm size of, and tolerance to, weld flaws present. Based upon these trials the effectiveness and limitations of the test methods and procedures used will be determined.

Task 6

- The results of the test coupon examination will be analysed statistically to determine accuracy and repeatability of the derived procedures.

Task 7

- At the end of the project a Best Practice Guide will be produced providing detailed guidance and evidence to support technical justifications for the inspection of welds in subsea sensors by volumetric test methods. Comment will be made regarding automation of the selected NDE technique(s) and personnel training and certification. Feedback from API sub-committee 17 will be incorporated into the best practice guide to maximise chances of uptake into the relevant standards.

Benefits

- Increased confidence in performance, safety and reliability of subsea sensors.
- Current weld practices can be retained without costly redesigns to meet current standards.
- Identification of short-comings of current oil and gas standards for application to sub-size weld validation.
- Best practice guidelines that will enable manufacturers to know when to implement volumetric or alternative inspections during manufacture, leading to improved safety and reliability of subsea sensors.
- Documented evidence supporting industrial acceptance of volumetric or alternate inspection techniques on samples provided by JIP Sponsors
- Adoption of cost effective inspection solution which satisfies requirements of relevant codes, standards and industry stakeholders and offers potential cost reduction across sector.

Deliverables

Sponsor group meetings to report on progress and agree the next period's work programme will be held every six months. Progress reports will be prepared and issued ahead of the Sponsor Group meetings. Regular updates on progress will be provided by e-mail between meetings. A final report will be prepared at the end of the project, giving the developed test procedures and all details and the results of the project including:

- D1 - A comprehensive review document, including a full review of current standards and detailing best inspection practices and their suitability for small electron beam and laser welds for subsea sensors Month 12
- D2 - Best Practice Guide for Qualification and Inspection of Welds in Subsea Sensors by Volumetric Test Methods – Month 24

Price and Duration

The overall estimated price for each phase is £200,000 (excluding VAT), which requires £25,000 per company, per phase from each of the 8 sponsors. It is anticipated that the project will commence with an agreed scope of work with a minimum of 5 Sponsors.

Further Information

For further information on how a Joint Industry Project (JIP) runs please **visit our JIP section** or scan the QR code.

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