Joint Research Project

Integrity of Corroded Bolted Flanged Joints on Offshore Installations

Research
Industry
Collaboration
Risk Assessments
Good Practice
Nut
Process
Stress
Proximity

Integrity

FEA
Validation
Safety
Corrosion
Reputation
Bolts
Guidance
Hazards

Corroded bolted flanged joints are widespread on the UKCS and establishing their condition and ongoing integrity is important for safe and reliable operations.

Despite the prevalence of such joints, there is currently a lack of evidence based guidance on corrosion allowance and discard criteria for studs, bolts and nut assemblies. As such, many operators have developed their own internal guidance and methods which can vary widely.

It is important that an accurate assessment of the condition of such assemblies can be made and that the remaining strength and therefore likely remaining lifespan can be estimated to allow better targeting of Risk Based Inspections.

Through an empirical testing programme, this project aims to provide an evidence base to underpin integrity decisions. Benefits are expected to be safer, more reliable, efficient operations.

HSE JOINT RESEARCH CENTRE
HSE has a longstanding history of supporting science and research to address a range of cross-sector safety issues. Building on this heritage, the HSE Joint Research Centre provides a platform to identify and co-fund applied research projects that are of interest to both industry and regulatory bodies.
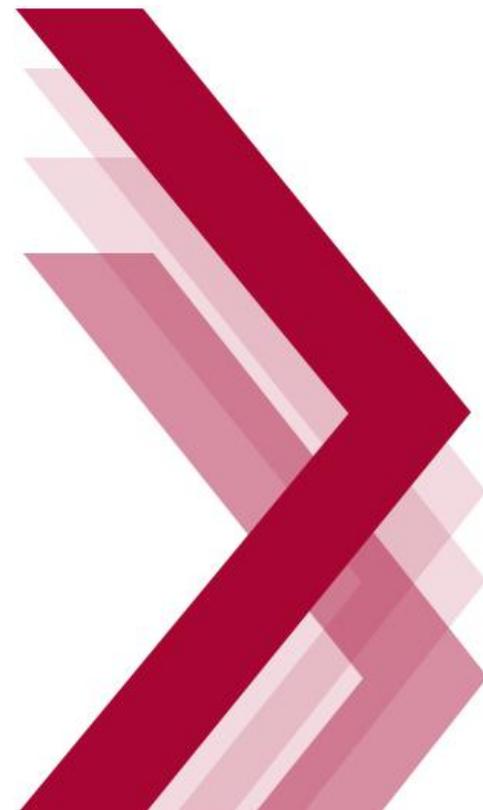
Overview of Technical Work Packages

This joint research project will be delivered by a series of distinct but interrelated work packages. The specific details will be defined and agreed on a collaborative basis via the steering committee which shall be formed by project sponsors. The committee will be a partnership of industry and the regulator (HSE). The work will be led by scientific & engineering specialists at HSE supported by their regulatory colleagues using sub-contractors if appropriate. Project co-sponsors will have a key role in also providing information and industrial application insight.

Work Package 1: In-Service Corrosion and Integrity Management

The aim of this work package is to develop a thorough understanding of the corrosion mechanisms pertinent to bolted flanged joints and how these are currently managed. It is envisaged that a thorough understanding of in-service corrosion mechanisms will be developed through dialogue with the project sponsors, reviewing applicable literature/procedures and previous studies. In addition, it is anticipated that data/insight will be gained through the analyses of ex-service specimens from the work undertaken in WP2.

Deliverables

- Report covering corrosion mechanisms pertinent to bolted flanged joints and an overview of previously conducted work to include testing methodologies.
- Table comparing existing partner approaches to key aspects of the integrity management process, with particular emphasis on discard criteria/performance standards for corroded flanged joints.

Work Package 3: Accelerated Exposure and Performance Testing

The aim of this work package is to determine whether there is a correlation between the (corroded) visual appearance of a joint and its integrity. It is expected that this work package will involve exposing new uncorroded test samples to an accelerated salt spray environment for set durations and then testing to establish their strength. Preliminary work setting the specifics of the initial exposure testing has already been completed under the auspices of an HSE research project.

A range of bolt/flange material combinations will be investigated with the test matrix including variables such as: bolt size; orientation and; exposure time. The visual appearance and test data from this work package could be used to further refine the FEA model detailed in WP2.

Deliverables

- Report outlining exposure and empirical testing conducted along with observations on visual appearance, dimensional change and tensile strength reduction.
- If established that a relationship exists, a visual reference sheet to permit an estimate of strength reduction from visual observation.
- Discussions with relevant parties as to the applicability/viability of the results being used to revise existing guidance.

Work Package 2: Preliminary Performance Testing

The aim of this work package is to generate preliminary data to help inform integrity related decisions. Decommissioned specimens shall be sought, ideally taking the form of intact small size close-coupled flanged joints with various but consistent, levels of visible corrosion. In practice, if ex-service joints are not available the basis of the work will be on recovered constituents. These will be inspected to establish general condition and extent of corrosion. The geometry of the key constituents will be assessed and characterised using a number of parameters such as: total depth of metal loss; dishing of nut faces; relative loss at each end of nut and; bolt shank thinning. This data will be used to inform a parametric study using finite element analysis to determine which aspects of the geometry change due to corrosion metal loss are most important to the strength of the joint. Informed by the above, new test samples will be manufactured and tested to determine yield, ultimate strength and failure mode. The test samples will have varying degrees of metal loss to simulate corrosion damage. The results from these tests will be used to validate the finite element model. The model could then be used to investigate a wider range of metal loss scenarios to determine levels at which strength is significantly reduced.

This work package will be delivered in a comparatively shorter timeframe than the exposure tests outlined in WP3.

Deliverables

- Report outlining the empirical test plan and results - preliminary assessment on effect of material loss on tensile strength reduction
- Validated FEA model

PRICE AND PROJECT DURATION

The total funding required for this joint research project is estimated to be up to £400k depending on the specifics of the programme of work. It is therefore anticipated that with financial support from HSE, each other project sponsor would need to contribute between £20k-40k depending on the total number of participants. The project is anticipated to commence Q3 2017 and take 18 months to complete, with preliminary findings for WP1 and WP2 completed within 6 months.

For further details or on how to join please contact David Johnson, 01298 218217, david.johnson@hsl.gsi.gov.uk