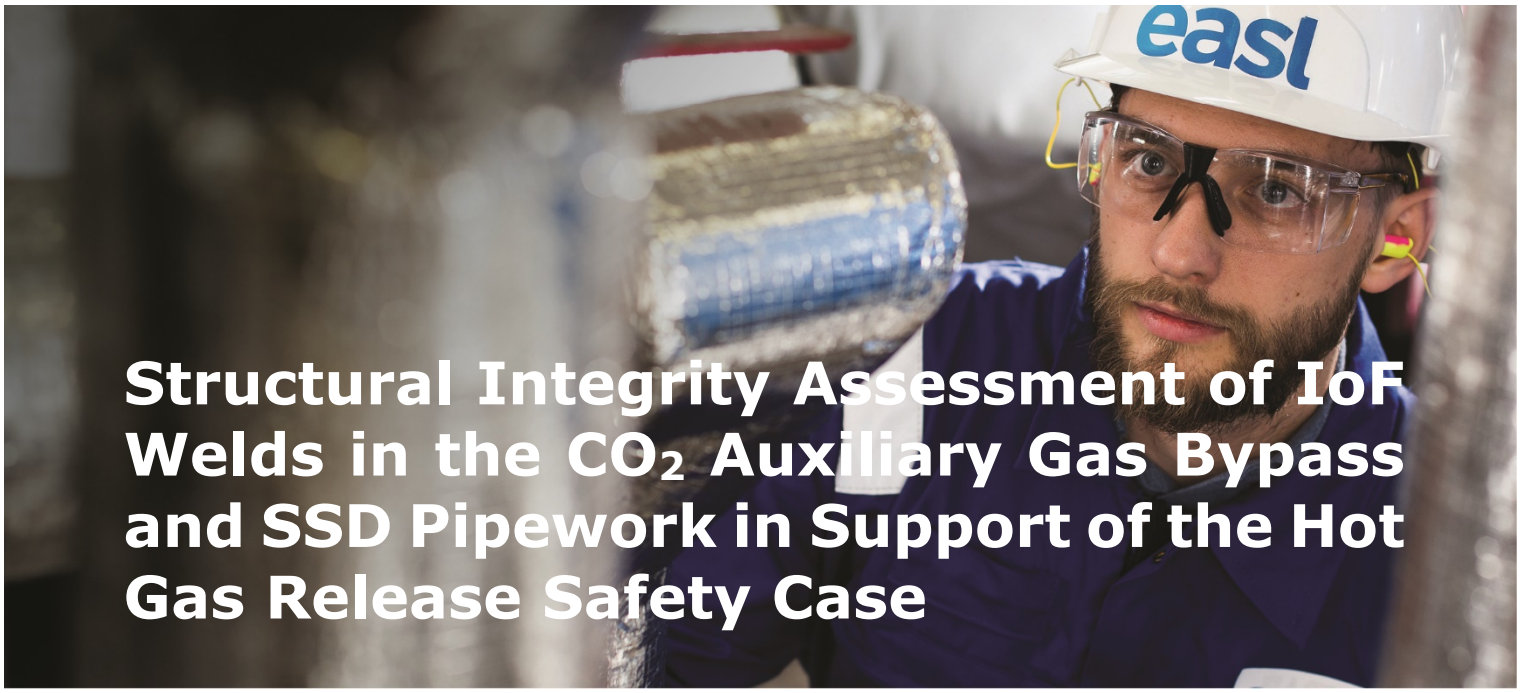


Structural Integrity Assessment of IoF Welds in the CO_2 Auxiliary Gas Bypass and SSD Pipework in Support of the Hot Gas Release Safety Case

Case study

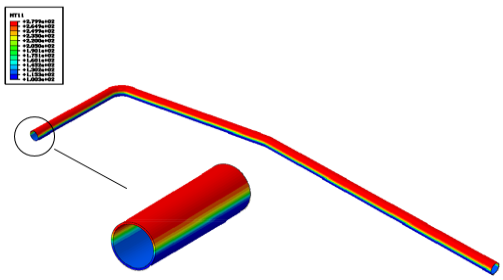
The hot gas release safety case for two of the UK's nuclear power stations is currently being updated. A review of the scope of that safety case identifies that the structural integrity assessment of specific reactor circuit components, to an IoF (Incredibility of Failure) standard, is outdated and has shortfalls against current company standard and practice.

Our approach

Our team presented an updated structural assessment of the IoF sections within the following systems:

- reactor CO2 auxiliary gas bypass pipework (comprising outlet and return); and
- reactor nitrogen secondary shutdown (SSD) pipework.

The assessments consider design code compliance against a current design code ASME III, and defect tolerance using R6. The defect tolerance assessment considers bounding postulated but credible faults and hazards which have a bearing on structural integrity. It also takes account of the actual occurrence of an incident whereby inadvertent flooding of the reactor basement which resulted in some quenching of reactor gas pipework.



The structural assessment considers postulated but credible faults and hazards, including bounding over-pressure and over-temperature faults, seismic loading, imposed loading from pipework failures

outside the IoF sections, flooding/ quenching and exposure to extreme low temperature. The effects of flooding/ quenching are only significant for the auxiliary gas pipework. Exposure to extreme low temperature is only significant for the SSD pipework.

The results

The pipework has been shown to remain code compliant to the appropriate limits of ASME III under all postulated faults and hazards. Flooding/ quenching of the auxiliary gas piping produces significant through-wall transient thermal stresses and in the part-flooded condition produces significant axial global bending from the restraint of bowing. These effects have been considered in a design code assessment against ASME limits.

A discharging event in the SSD piping at extremely low temperatures has been shown to produce relatively low transient thermal stresses but a significant reduction in the fracture toughness and hence the defect tolerance. An R6 assessment demonstrates that the IoF sections of auxiliary gas and SSD piping have high levels of defect tolerance under all credible bounding faults and hazards. Fatigue crack growth is predicted to be small.

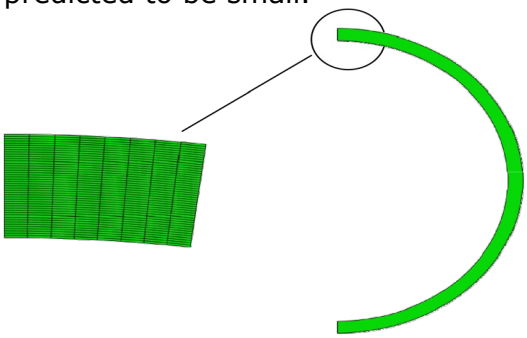


Figure 2 2D FE model for analysis of part-flooded condition

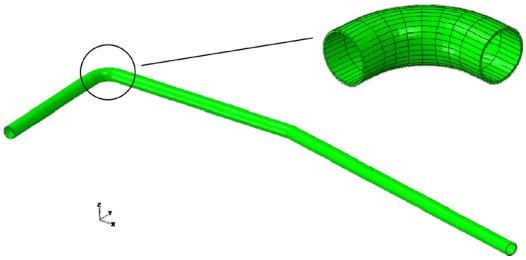


Figure 3 3D FE model for analysis of part-flooded condition

The consequences of a potential pipe break outside the IoF region on the integrity of the IoF regions of the auxiliary gas and SSD piping have been reviewed using guidance provided by the R3 procedure.

Our team carried out structural assessed, to IoF standards, identifying areas where further reviews were required and assessing the compliance of the reactor plant systems and piping for potential hazards.