Investigation of the Performance of BCU External Steel Restraints Subject to Steam Release

Case study

For two of the clients UK power stations a weakness in the consolidated safety case for loss of pressure vessel cooling had been identified - guillotine failure of a significant number of welds on superheater headers and their tailpipes could give rise to steam release and/or hot gas release which could threaten the supply of cooling to the associated boiler closure. Earlier assessments had demonstrated that all relevant welds on type 1 superheater headers and tailpipes satisfy High Integrity requirements. EASL were requested by the client to provide evidence that the external steel restraint is capable of maintaining the integrity of a degraded boiler closure during the early stages of a steam release fault generated by failure of the remaining steam side welds. The benefit to the client of this work was that, if such a claim could be made, a safety case could be established without recourse to re-classification of the relevant remaining welds.

Solution

EASL's work was intended to provide evidence that an External Steel Restraint (ESR) is capable of maintaining the integrity of a degraded Boiler Closure Unit (BCU) during the early stages of a steam release fault generated by guillotine failure of steam side welds associated with all four types of superheater header.

The original intent was to achieve this by considering the bounding case of a radial steam jet formed following postulated failure of header weld S5 based on data from a previously published assessment.

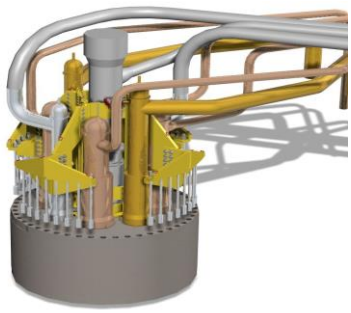

Figure 1 Illustration of ESR in BCU showing headers and tailpipes

In the event, this did not prove possible and hence the scope was expanded to consider all of the steam side welds. The initial approach to the assessment included a review of the findings from other analyses and the reasons why considering only the bounding weld does not suffice.

The steam side welds in the superheater headers and tailpipes in the vicinity of the BCU were reviewed to determine whether weld failure would result in a radial steam jet in addition to an axial steam jet. The radial steam jets judged to arise from steam-side weld failures and the axial steam jets from all header and tailpipe welds were reviewed to determine if they impinge on and damage the pressure vessel cooling water (PVCW) system.

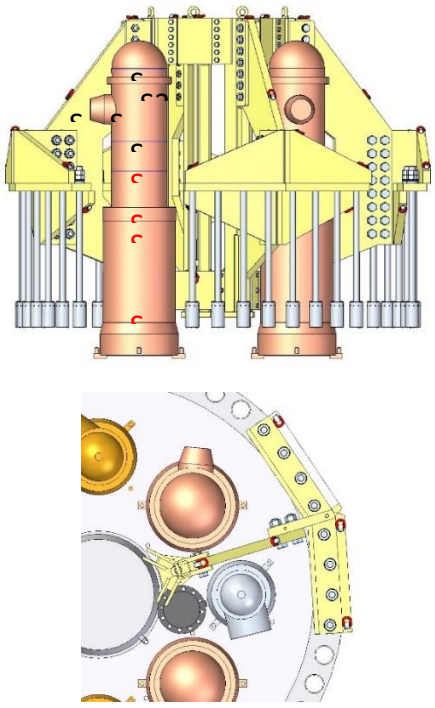

Figure 2 Elevation and plan of ESR in pod showing positions of superheater welds

For all those axial, or, if they could potentially occur, radial steam jets arising from superheater header or tailpipe weld failure that could impinge on and damage the PVCW system, the jets were reviewed to determine if they impinge directly on the ESR. If they do not, then no mechanical effect can accrue. If they do impinge on the ESR, then the mechanical effect was assessed.

Additionally, corresponding thermal effects from steam jets were assessed as they could affect the integrity of the ESR even if they do not impinge directly on the ESR. The thermal effects were reviewed and assessed, considering the effects of elevated temperature on load capacity and deflection of the ESR, and the effects of non-uniform heating.

EASL's deliverable provided evidence that an ESR is capable of maintaining the integrity of a degraded BCU during the early stages of a steam release fault. The findings of EASL's deliverable enabled the client to establish a safety case without the re-classification of further welds.

Other applications

EASL benefited this client by avoiding the need for significant further work. EASL always work with clients to identify cost effective solutions to operational challenges.
If you would like to discuss how EASL can help your business please get in touch.

engineering analysis services ltd.
2 Edward Court, George Richards Way, Altrincham, WA14 5GL
0161 923 0070 www.easl-stress.co.uk