Case study

Fatigue Life Prediction of High Thermal-Stress Components

EXTREME ENVIRONMENTS

Boiler feedwater nozzles exist in a high-pressure, high temperature environment that can drastically reduce the fatigue life of even the most robust components. During their long design lifetime they will experience a range of beyond design transient loads, and all the while be object to the inevitable thermal stresses caused by passing cool feedwater into a hot environment.

GREATER SOPHISTICATION

We were asked to undertake some detailed fatigue life prediction studies for one such set of nozzles. A previous study had predicted a life far short of the life of the plant, so a more sophisticated approach was required.

CONVECTIVE FLOWS

Firstly, we had to model the thermally driven flow of hot water within the sleeve around the feedwater pipe. This was a significant challenge, as the flows in this narrow slot were entirely governed by natural convection and no data existed. By using our advanced CFD skills we were able to build a computer model and validate the results against some published German experiments on a similar geometry, shown above.

THERMAL TRANSIENTS

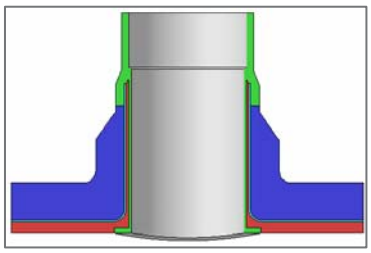
In the next stage we subjected the nozzle models to over twenty different thermal transients, predicting the stresses generated as the ambient conditions changed.

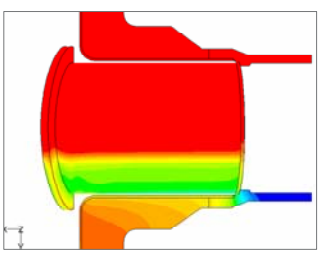
FATIGUE LIFE

The coupled fluid-thermal-structural modelling had given us a complete set of low cycle data and with further high cycle requirements we could predict the fatigue life and critical defect sizes using conventional R5 and R6 analyses (J-integral analysis was not required for this study).

EXTENDED OPERATING LIFE

Ultimately, the analysis was able to predict a greatly extended operating life. The client had no need to undertake expensive routine replacement of the nozzles, and the thorough documentation of the project led to swift regulatory approval.





Temperature distribution in nozzle

Client
Undisclosed

Business need
Assess the integrity of high temperature components

Why Frazer-Nash?
Frazer-Nash has an extensive expertise in thermal analysis using Computational Fluid Dynamics.

For more information please contact **Simon Rees** on **0117 922 6242** or **s.rees@fnc.co.uk**