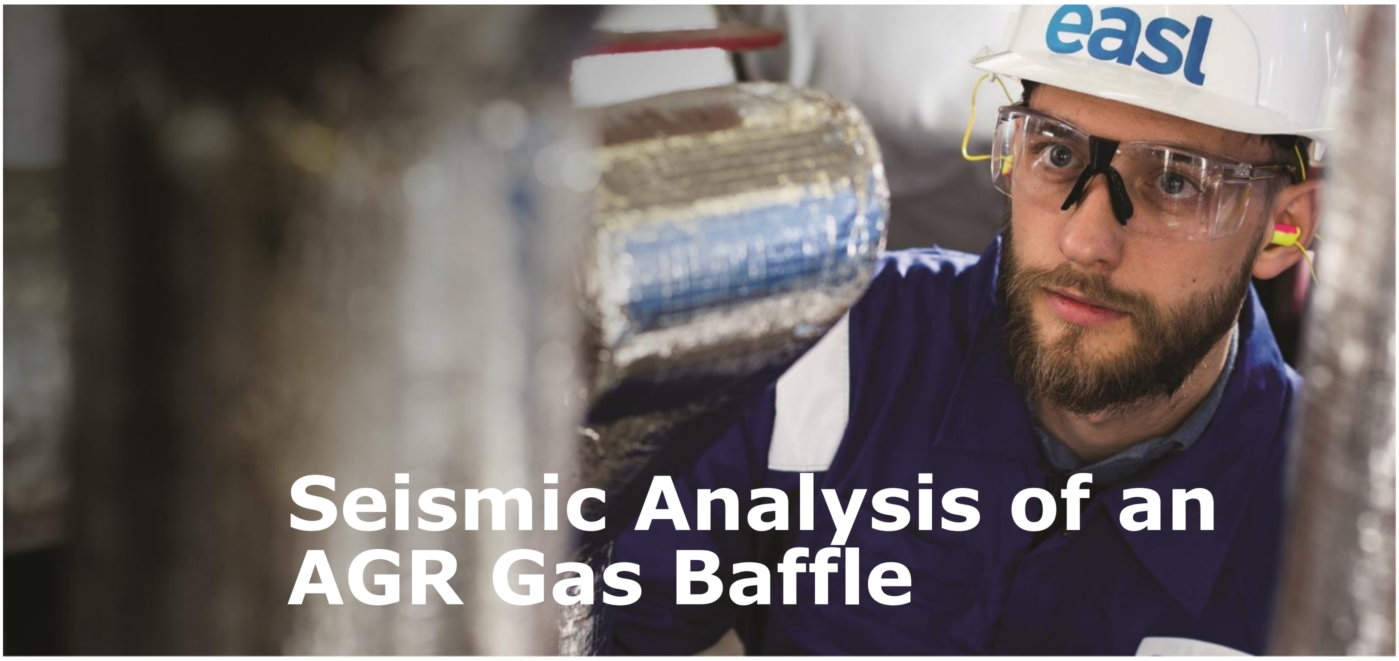


# Seismic Analysis of an AGR Gas Baffle

## Case study

**In a periodic safety review of an advanced gas reactor (AGR) gas baffle safety case, a requirement was identified for establishing structural integrity in the gas baffle and circulator outlet gas duct (COGD) under a reference earthquake with a zero period acceleration of 0.14g corresponding to an annual probability of exceedance of $10^{-4}$. EASL undertook fracture mechanics and ASME III design code assessments at critical locations under combined pressure, temperature and seismic loading. The stresses and strains obtained from this study were subsequently used to demonstrate that the AGR gas baffle design was fit-for-purpose when subject to the reference earthquake.**

## Our approach

The gas baffle and COGD form the pressure boundary around the reactor core: to direct coolant gas flow from the circulators through the reactor core, to house the reactor internal components and to facilitate access to the fuel and control rod assemblies.

Based on cost-effectiveness considerations, inelastic static analysis, response spectrum analysis and direct integration nonlinear time history analysis methods using ABAQUS were carried out. These analyses included various inelastic material models to satisfy different assessment purposes.

The potential effects of some plasticity in the load paths on the dynamic responses obtained under linear assumptions were considered. The inelastic material models were tuned for the expected plastic strains in various regions to avoid overly pessimistic strain predictions.

Different sets of seismic motions were applied to the dual support locations, i.e. support webs and the COGD anchor ring, together with the static displacements due to differential thermal expansion. The complexity in the prescribed boundary conditions was met with the limits in the facilities available in ABAQUS and this was resolved by substantial pre-processing.

The stresses and strains (inelastic) obtained from this study were subsequently used in fracture and ASME III design code assessments which included cumulative strain and high-strain low-cycle fatigue checks.

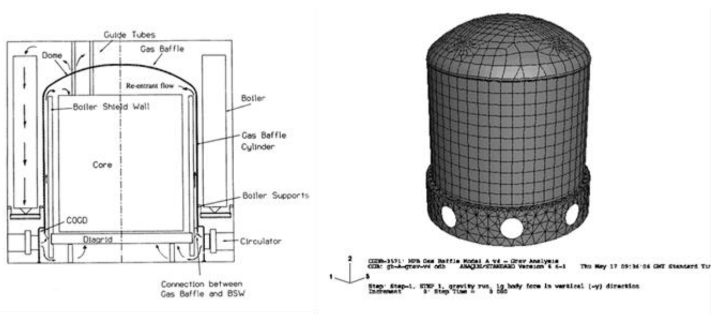


*Figure 1 Global model of gas baffle and COGD.*

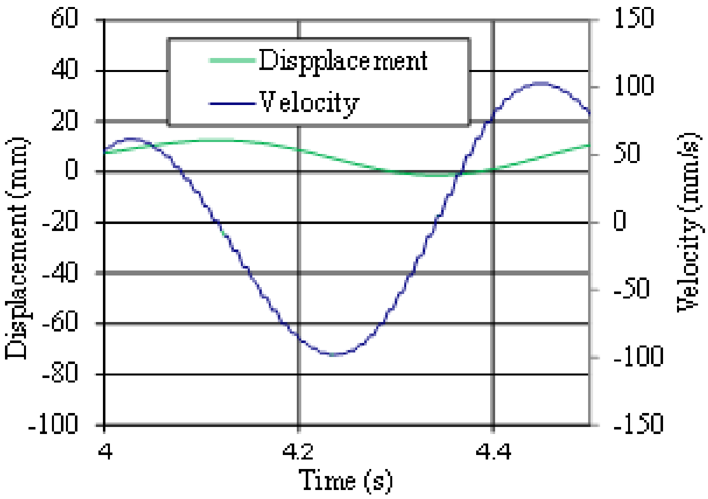


*Figure 2 FE predicted displacement and velocity histories at a node in gusset plate.*

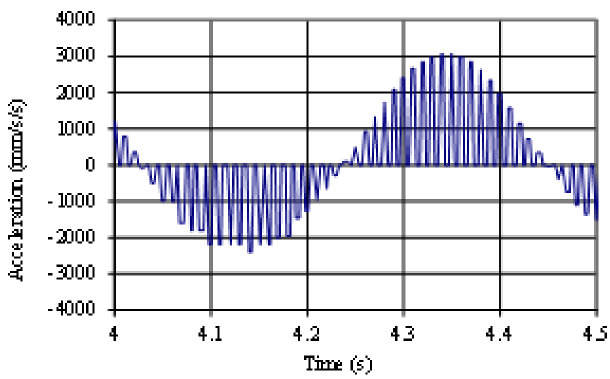


*Figure 3 FE predicted acceleration history at a node in gusset plate.*

# Results

Standard validation exercises were carried out to underpin confidence in Finite Element (FE) modelling and analysis. Horizontal acceleration time histories at selected locations from both analysis were compared and no natural frequency shifts were identified. In the vertical direction, the comparison confirms that the major global responses were the same, although high frequency accelerations were observed. Further interrogation of results found that the frequencies of high acceleration peaks were greater than 90Hz.

As the gusset plates and castellations were primarily subjected to large reversal cyclic displacement loading over the period of seismic strong motion and the pressure and temperature loads were small, no large membrane stress was expected. The seismic strong motion was expected to last for less than 10 seconds for the UK. Therefore, the main concerns for these components were the strain limit and low cycle fatigue issues. The analysis predicted a maximum equivalent plastic strain (cyclic) of 0.092%in the gusset plates and castellations.

# Conclusions

The study showed that the objectives for the finite element modelling and analysis were heavily dependent on the assessment strategy. Recognising the limitation in the capability of the material models readily available in the commercial FE analysis software, substantial engineering appraisal and validation were required to provide the high confidence required for the safety case.

# Safe operation

**The complex technical challenges were met within the tight timescales specified. EASL demonstrated that the AGR gas baffle design was fit-for-purpose when subject to the reference earthquake.**

**If you would like to find out how EASL can help solve your manufacturing plant issue, please get in touch with our experts.**

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