

### Assessment of Reformer Inlet and Outlet Pipework System - UK

ERA Technology assessed the remaining life of the inlet and outlet steam reformer pipework systems. This used previous inspection results (replication, hardness and conventional NDE) and the latest operating temperatures to evaluate the sensitivity of remaining life to increased operating temperatures. This enabled the operator to complete a debottlenecking exercise elsewhere on the plant. ERA Technology has extensive experience in modelling the accumulation of creep damage from basic life assessments, through to probabilistic modelling for heater and reformer tube materials.



### Remaining Life Study of Heat Recovery Steam Generators - Malaysia

ERA Technology assessed the cyclic capability of two different designs of Heat Recovery Steam Generators for a large power producer. ERA successfully completed a phased approach to identify critical components, install thermocouples and strain gauges and perform creep fatigue calculations based on the results to establish the susceptibility of the units to increases in cyclic operation. The analysis enabled the operator to understand the limitation of key

components to cyclic operation, optimise shutdown procedures to minimise damaging re-starts and identified the best areas for modification to maximise the remaining life under the new operating conditions. ERA has completed many detailed assessments similar to this, combining the benefits of strain gauging and thermocouple measurements with finite element analysis to prevent failure of major components and optimise remaining life when operating beyond their original design life or conditions.

### Off-Line Life Assessment of Methanol Plant - Saudi Arabia

ERA Technology completed a detailed plant wide remaining life study of a large methanol plant, overseeing the inspection and performing a life assessment as part of a major shutdown. Whilst on-site, ERA provided a team of experienced engineers to work alongside the inspection team; providing auditing techniques, procedures, workscope and reporting. In addition ERA gathered the appropriate supporting data to evaluate the remaining life of all components, covering static, rotating, electrical, civil and instrumentation and control systems. Immediate support was provided on repair options for damaged components. Each component's inspection history and recent results and design data was collated and summarised in a detailed user friendly format. Active damage mechanisms were evaluated using industry best practice for each discipline. The study prioritised the areas of each item for future inspections and provided an estimate of remaining life.

### On-Line Life Assessment of Methanol Plant - Saudi Arabia

A plant wide life assessment study has been completed whilst on-line. Using existing inspection and operational records and design details, ERA Technology produced an assessment of each item of the plant, covering static, rotating and instrumentation and control systems. Each component's inspection history and design data was collated and summarised in an easy to edit format, that makes it straightforward for future updating by local plant engineers. ERA assessed the most likely and active damage mechanisms using specialist

experience, API, NACE and other guidelines, and provided an initial damage tolerance assessment for each item. The instrumentation and control systems were assessed for future manufacturer's support and a priority set for upgrading systems, providing guidance for best practice and performance from different types. The study has enabled the prioritisation of inspection, details of the scope and type of inspection for each component and early warning of active corrosion prior to it becoming operation critical. This will enable the correct information to be gained from the forthcoming inspection and facilitate proper plant management for the next 100,000 hours.



### Review of Stress Analysis and Fracture Mechanics of LPG Sphere - Jordan

A detailed stress analysis, including 3D stress calculation of button repairs, has enabled a detailed Level 3 fitness-for-service using API 579-1/ASME FFS-1 2007 to be completed on a low temperature hydrogen damaged sphere. Thermal, residual, structure and pressure loads were all assessed at an advanced level as part of the assessment. In addition a detailed in-situ inspection and monitoring programme has been provided enabling the spheres to continue in operation until replacement spheres can be constructed.

### Assessment of New Gas Turbine Blades - Europe

The metallurgical analysis of a number of gas turbine blades to fully characterise the manufacturing defects present has facilitated refined acceptability criteria. This has enabled otherwise scrap turbine blades to be retained in service. The assessment provided the level of detail needed to perform a fracture mechanics assessment in order to determine an acceptable level of casting porosity. Combining ERA Technology metallurgical facilities and experience with finite element modelling and fracture mechanics knowledge has enabled ERA to perform the entire assessment, generating an advanced acceptability criterion beyond the OEM recommendations.



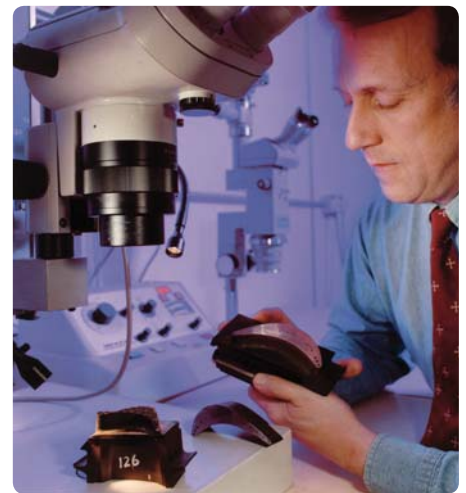
### Life Assessment of Radiant Reformer Tubing - South America

A probabilistic remaining life assessment has been completed for a steam reformer unit. The assessment modelled the radiant catalyst tubes from new through to present time and into the future to predict failure probability. The assessment used ERA Technology specialist in-house software to model the material's creep strain and damage behaviour over time, based on data supplied by the operator. The results of the assessment were reviewed against non-destructive examination (NDE) results and destructive metallurgical assessment of an ex-service tube used to ensure valid representation of the conditions within the furnace were achieved. The results have enabled future inspection and likely retubing dates to be planned, and the sensitivity to changes in future operation to be modelled.

### Strain Gauge and Probabilistic Fatigue Crack Initiation and Growth Prediction for Coke Drums - UK

A number of projects have been successfully completed involving strain gauging and thermocoupling of several coke drums. A recent project used the results (monitored over a one month period) to complete a full probabilistic assessment of the time to fatigue crack initiation and crack growth using specialist software routines developed in-house. Verification of the coke drum stresses has been completed by modelling the quench cycle with finite element analysis, and correlating predictions with the strain data measured.

Additional assessments have involved fracture mechanics testing of ex-service material, as well as failure analysis and root cause analysis of a failed coke drum bottom head. Using a team of experienced metallurgists and mechanical engineers along with process knowledge of these drums has enabled ERA Technology to maximise the life of the drums.



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