# European Technology Development Ltd

**Working for Power, Petrochemical, and Process Plant Industries**

# Plant Remaining Life Assessment and Extension

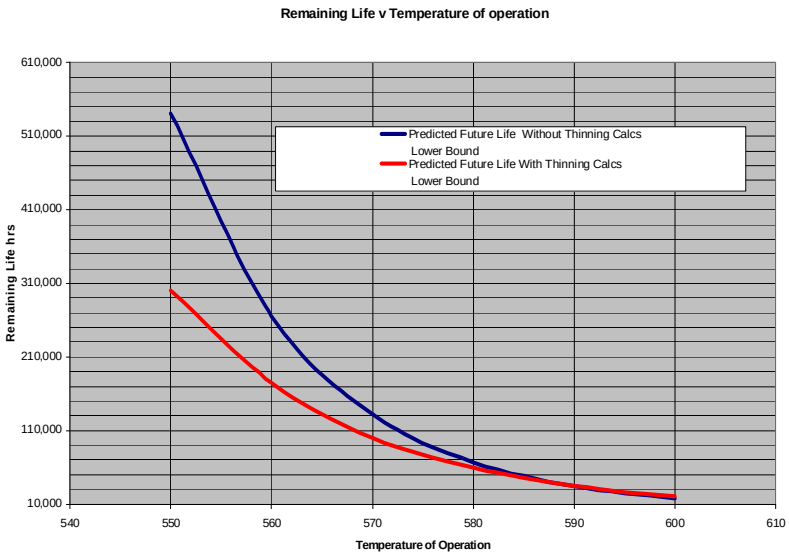
**European Technology Development** has established expertise in life assessment of components from petrochemical and power plant operating in the creep regime. ETD's major areas of expertise are:

- **High Temperature Plant**
  **Creep, corrosion and creep fatigue**

- **Weld assessment and weld repair issues**
  **Failure analysis, cold repair and replication assessment**

ETD can assess the remaining life of plant under operating conditions, offering real increases in safe operating life at little expense. Advanced warning of creep, creep/corrosion and creep fatigue failures can avoid expensive unplanned outages while avoiding undue maintenance or premature replication surveys. Improved repair welds can reduce the delay in returning plant to service and may be suitable for long term service avoiding replacement at the next scheduled outage.

In many boilers and petrochemical heat exchangers the design life of the unit is determined by the creep properties of the heat exchanger tubing. In almost all cases the initial tube thickness will be greater than the theoretical minimum used in the original calculations resulting in lower operating stresses than those used to calculate the design life. The actual life of the tubing depends on the real properties of the tubing, the rate of tube thinning, due to corrosion and/or erosion, and the operating conditions throughout the units life. Tube thinning has the effect of increasing the operating stress on the tube material thus shortening its creep life. Plant conditions may be more onerous than originally expected, reducing plant life, but, in many cases, plant temperatures may be lower than used in the original design or plant operation may have been at reduced load for substantial periods, increasing plant life. As the unit approaches its original design life repeat calculations on the life of the unit, using thinning rates obtained from ultrasonic testing and the units operating history can extend the life of the unit.



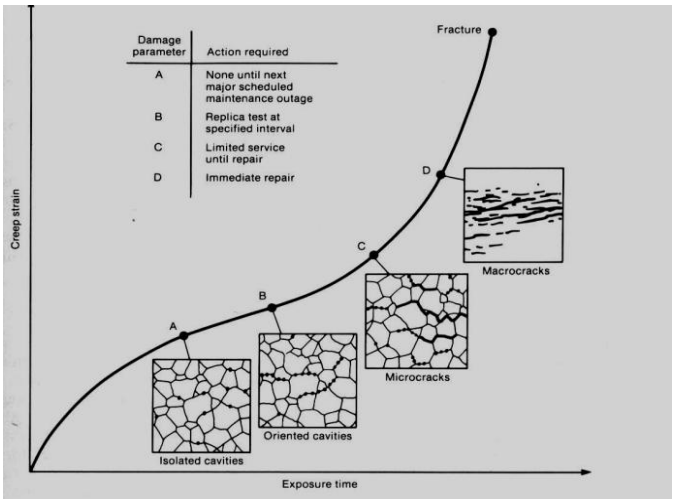

At this stage the actual creep properties of the tubing are unknown and careful choice of the nominal properties is required to ensure plant safety while avoiding excess conservatism, which could result in premature tube replacement or expensive replication and testing programmes. For petrochemical heat exchangers the creep properties are normally obtained from API 530 which uses the Larson_Miller model. This relatively simple model is adopted in

part for historic reasons, as it is favoured by American researchers, and in part as it can be extrapolated to very low stresses such as those found in the petrochemical industry. In contrast, the Boiler industry normally uses more complex models, such as those outlined in BS PD 6525. While these models are more complex and more accurate, they can only be extrapolated to around 30MPa before the underlying predictive relationship breaks down. In those cases where petrochemical plant is running at higher pressures, the safe working life can be increased by using the more complex creep models.

Thus simple calculational checks, based on recorded data, may result in an increased life for the plant. Only where such checks fail to predict sufficient remaining life is further work necessary. If the rate of tube thinning is high, it may be necessary to replace the tubes and this is mainly found in the petrochemical industry where tubing is typically retired at half the design thickness.

In boiler plant, tubing rarely suffers high rates of thinning. The life of high temperature components, such as superheaters, is normally limited by the creep properties. Thus, creep testing of tubing can demonstrate properties above the minimum values used in life calculations and further extend life.

The main method used in many plants is to undertake replication surveys. Here suspect components, and especially the HAZ's of weldments, are checked for the presence of early




signs of creep damage in the form of creep cavities or microcracks. While the results of these surveys can also be used to estimate the remaining life of the plant this is an expensive and labour intensive process. Here ETD has the necessary expertise to carry out replica surveys and assess replicas, according to recognised standards, giving independent advice on the timing and targeting of survey work.

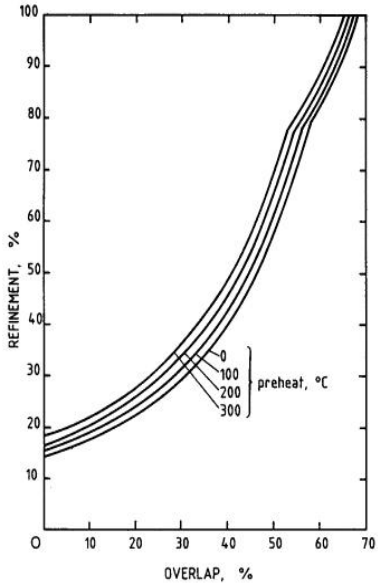
Life Fraction v Replica Assessment

| Nordtest (NT NDT010) | VGB TW 507 | Neuber And Waddel | Description | Recommendations Nordtest only | Consumed Life Fraction 1¼Cr½Mo-EPRI |
|---|---|---|---|---|---|
| | 0 | | as-received | | |
| 1 | 1 | | no creep cavities | None | 0-0.14 |
| 2 | | A | single cavities | Re-examine after 20,000hrs | 0.05-0.47 |
| | 2a | | isolated cavities | | |
| | 2b | | numerous cavities No preferred orientation | | |
| 3 | | | coherent cavities | Re-examine after 15,000hrs | |
| | 3a | B | numerous orientated cavities | | 0.27-0.53 |
| | 3b | | chains of cavities | | |
| 4 | | C | creep cracks (micro) | Re-examine after 10,000hrs | 0.29-0.84 |
| 5 | | D | Creep cracks (macro) | Issue immediate warning | 0.7-1.0 |

ETD also has experience in the use of repair welding and in repair welds completed without PWHT (Cold Welds).

These welds require careful excavation preparation, and rely upon control of heat input, during the first few weld runs, to obtain a high level of tempering in the HAZ of the repair weld.

Weld consumables for such welds are chosen to minimise residual stresses and are typical either undermatched ferritic consumables or nickel based consumables.




2 Dependence of single-layer HAZ refinement on overlap and preheat temperature

Both have their own advantages, with feritic consumables allowing ultrasonic inspection but giving a risk of Type IIIa cracking at long service times. These cold welds have been used as temporary repair welds for some time but, with improved techniques, may now be left in service for much greater periods.

## Contact Details

ETD Ltd, 6 Axis Centre
Cleeve Road
Leatherhead
Surrey, KT22 7RD, UK

Phone: + 44 (0)1372 363111
Fax: + 44 (0)1372 363222
Email: enquiries@etd1.co.uk