Historically, steam-generating boilers were inspected and maintained as single items, driven by legislative requirements.

With new flexibility in goal-setting style regulations, there is a clear opportunity to use a risk based approach for reassessing inspection requirements. Inspection schemes can be optimised after consideration of both the operating conditions of individual equipment items and of the deterioration mechanisms to which they are vulnerable.

The client wanted to extend the intervals between full overhauls of four steam-generating units and asked ABB to carry out a RBI study to achieve this. The units are all over 20 years old with a history of repairs.

**Solution**

The RBI study resulted in the interval between full boiler overhauls being extended to 6 years from 4 years. To achieve this without compromising safety the key outcomes were:

- Limited inspection of key components at intermediate inspections
- Increased use of on-line monitoring of water quality, fuel composition and header temperatures as part of the scheme of examination
- More targeted and repeatable inspections during thorough examinations, including widespread use of non-invasive techniques
- A clear basis for forming a maintenance strategy for the equipment
- Improved operating team’s understanding of what can affect reliability and integrity

We formed a joint team with the client’s staff in order to conduct a detailed review of the operating conditions and maintenance histories of each component.

This approach meant that, rather than being treated as a single item, the boilers were assessed with a group of over 20 individual components.
We considered the deterioration mechanisms for each element and identified actions to mitigate or monitor any developing damage. We established the likelihood and consequences of failures, which allowed clear differences in risk of failure to be highlighted. Where deterioration mechanisms were highlighted, we generated an estimated life until replacement.

**Specific concerns**
The review highlighted the fact that particular boiler components ran a much higher risk of damage occurring. These specific areas were investigated in more detail.

They included:

- Steam drum internal defects. Previous repairs to remove cracking had resulted in thinned areas. We investigated these areas, using finite element analysis techniques to quantify the stress field properly. Next, we carried out fracture mechanics assessments to evaluate the significance of any further defects which might develop in service.
- Creep of steam headers. A number of the headers between tube banks inside the boiler operated in the creep range.
- In order to improve the monitoring of creep life in operation, we measured the temperature on-line to carry out assessments of creep life usage.

**Relief protection**
The inspection intervals of many of the relief streams were increased. This was justified by a review of a large number of test results and subsequent risk assessment.

**Benefits**
- Extending the life of the boiler saved £2 million.
- An increase in on-line operating time.
- A reduction in inspection cost.
- A foundation for maintenance strategy for the equipment.
- A life plan for specific components.

“Key here was to use all available techniques / analysis / historical information from here and other sites - to maximise the interval for each piece of equipment and then set up a maintenance strategy / plan to achieve the required work with the minimum total cost over the operational life of the equipment.”

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<th>Total hours per boiler</th>
<th>1993 - 1998</th>
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<tr>
<td>473</td>
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<td>573</td>
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</table>

**Total hours per boiler**
- Boiler system A
- Boiler system B
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