BOILER TUBE FAILURE PREVENTION AND MANAGEMENT

Acronym: **BTF Guidelines**

ETD Report No**: 1180-tp-175**

Lead Authors: **F Akther, C A Smith**

Report Checked by: **Dr D G Robertson**

January 2013

ETD Consulting, Fountain House, Cleeve Road, Leatherhead, Surrey, KT22 7LX, UK
Tel: + 44 (0)1372 363 111 **Fax:** + 44 (0)1372 363 222 enquiries@etd-consulting.com
www.etd-consulting.com **BS EN ISO 9001: 2008 Certified VAT No: 733600853**
ETD Consulting is a trading name of European Technology Development Ltd, Registered in England No: 3553836

ETD Project No: 1180-tp-proj11

ETD Report No: 1180-tp-175

European Technology Development Limited
Leatherhead, Surrey
United Kingdom
enquiries@etd-consulting.com
www.etd-consulting.com

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF ILLUSTRATIONS

Page

EXECUTIVE SUMMARY

Boiler Tube Failures (BTF) have resulted in increasing numbers of leaks due to thermal fatigue, overheating, corrosion/erosion and original weld defects. Although tube failures may not necessarily lead to catastrophic consequences, they do cause loss of availability of the plant, and this can be quite costly. Implementation of a boiler tube failure prevention program has been proven to save the plant operators millions of dollars by just maintaining the availability and reliability of the plant. This project was involved in preparing easy to follow *best practice guidelines* for BTF prevention and management. Usually plants have their own program/ procedure / or some sort of formal or informal documents to follow to prevent or minimize BTF. Boiler performance is greatly influenced by the successful execution of a BTF program; hence, it is important to understand issues or factors that may influence the effectiveness of the BTF program.

As a part of the project a survey was carried out to study the actual plant operator experience of BTF prevention. A number of utilities worldwide operating conventional (coal, oil & gas fired) and CCGT plants participated. The survey involved collecting data on plant operator experience on BTF prevention covering all key aspects related to BTF prevention program, boiler maintenance and technical issues. A number of BTF prevention programs from the project participants and/or those available from international reputable organizations have been reviewed. Quantitative analysis of various plants' boiler performance was performed in order to gain deeper understanding of the execution of their BTF programs and their success, degree of success or lack of it. Various performance metrics such as plants' forced outage factor (FOF), planned outage factor (POF), loss of availability, reliability etc. were analyzed and benchmarking of plants BTF prevention programs was performed. The plant data in conjunction with the boiler performance analysis was used to identify the more or less successful BTF prevention programs which were then used for the preparation of best practice guidelines.

The success of the BTF prevention programs has been found to vary from utility to utility in terms of boiler performance. Most of the units showed better performance with respect to the percentage (%) rate of Availability than that of the percentage (%) rate of Reliability performance. The reliability performance is directly related to the forced outage factor (i.e., forced outage hours), which means that the units with low reliability performance are experiencing higher number of forced outages due to BTF. Whereas, the availability performance is related to both forced outage factor and planned outage factor, therefore, a good control of both the forced and planned outages is required to reduce the loss of availability.

Frequency of tube failure was also determined for all the conventional and CCGT plants studied. Thus highest percentage of annual waterwall tube failure frequency was determined for two conventional plants (identified as plants F and G in the report). But these plants experienced fewer failures for other tubes such as superheater, reheater, economizer etc. and showed good availability and reliability performance. This showed that these plants were controlling their forced outages by following appropriate BTF program. Another plant studied (identified in the report as plant N) also showed a low FOF value and good reliability but low availability performance. Low FOF value (i.e. low forced outage hours) and good reliability performance reflect a good control and management in preventing and reducing the undesired forced outages. However, the plant experienced higher planned outages thus affecting its availability. To achieve overall good performance a plant must show both good availability and reliability.

The survey revealed that the plants studied incorporated all major important steps/ measures in their BTF programs to prevent/ reduce tube failures. In spite of this some plants still experienced higher frequency of tube failures. The main problem for these utilities can be the proper

implementation of the BTF program. The state of-the-art understanding of BTF mechanisms, root causes, maintenance, NDE and cycle chemistry are not by themselves sufficient to reduce the unavailability due to BTF. Thus without an overall corporate approach, management support and philosophy document, the goals will not be reached, and unavailability will continue to increase.

A *best practice guideline* has been developed after reviewing a number of BTF programs and analyzing their performances. The best practice guideline may be enhanced by integrating a risk based method. ETD's risk based methodology 'Riskfit' has been described in this report. It has been shown that the integration of the BTF program into *risk-based management* will allow the plant operator to manage risks associated with boiler tube failures through understanding of the probability or likelihood of failures and their consequences (i.e. related to run/repair/replace decisions). Such an integrated program will therefore be beneficial for power plant operators in outage planning, for example, in that it will help them to plan outage intervals and prioritize inspection and maintenance activities. It also offers long-term benefits by reducing the number of forced outages and improving plant safety/integrity and reliability.

In **summary**, managing boiler tube failures can help reduce forced outages, thus minimizing revenue losses and costs associated with tube repair/replacement. Implementation of a BTF prevention program has proved to improve plant performance by maintaining the availability and reliability of the plant. The integration of risk based management with the BTF program can help to prioritize inspection and maintenance activities. In addition, a properly implemented BTF program can support plant life management and extension. ***For example, sudden shutdown stresses due to forced outages would have a negative impact on the life of many other (in particular thick section) components and the implementation of a successful BTF program will help to reduce such additional risks and help with overall plant integrity and life extension.***