European Technology Development *Ltd*

Damage to Power Plant Due to Cyclic Operation and Guidelines for Best practices

(*Acronym*: Cyclic Operation)

ETD Proposal No. **1096-gsp-prop07**

Proposal Brief

Proposal for a 'Group-Sponsored Project'

By:
European Technology Development
6 Axis Centre
Cleeve Road
Leatherhead, Surrey, KT22 7ND, UK
Tel: + 44 1372 363 111 **or,** + 44 (0)1372 363 112
Fax: + 44 1372 363 222 **or,** + 44 (0)1372 229 164
E-mail: ashibli@etd1.co.uk
www.etd1.co.uk

*(**Note:** This review is a follow-up on an earlier investigation conducted by ETD in 1999-2000 which was sponsored by a number of industries from Europe and North America and which was considered by many as their 'bible for plant cycling'. Since that study many new developments have taken place in this area including the expansion of the plant cycling experience worldwide, use of new materials and designs, new R&D findings and so on. This is thus considered as an appropriate time for the cataloguing and critical review of such experience and for producing guidelines and setting benchmarks that need to be followed to reduce damage to components, increase plant efficiency and reduce cost of plant operation and maintenance).*

Because of changes in demand, and competition from nuclear, gas fired, and now renewables such as hydro, wind and solar power generation, many existing coal fired plants are now subject to cyclic or two-shifting operation. Difficulties involved with two shifting operation include the difficulty of operating the components used in the fuel supply system, general increased wear and tear, and control of metal temperature in critical boiler components (which during rapid start-ups can experience temperature excursions significantly above design). If thermal transients are not controlled then key plant items (such as superheater headers) become susceptible to failure due to thermal fatigue, creep, creep-fatigue and corrosion-fatigue. Boiler tube failures are also exacerbated by two shifting. Furthermore, plant operators are now experiencing cracking and failures in drainage systems that they had installed in the two shifting plant to deal with the condensate removal.

The severe conditions of cyclic operation result in: a) increase in forced outage rate due to the increased component failure frequency, b) increase in operation and maintenance (O & M) costs to keep the unit in operation, c) increase in wear and tear of components due to additional overhauls and maintenance required on cycling units, d) increased costs for plant operating personnel and plant automation to manage the more complex operation of plant seeing larger number of cycles, etc.

The severity of cyclic operation affects **boiler**, **turbine**, **electrical**, and **auxiliary** components. The effect is largely design dependent i.e. some designs are inherently more tolerant of cyclic operation than others, although most of the older plant which were originally designed for base load usage fall in the less tolerant category. Most of the older plants were designed with heavy section headers and pipe work that have a poor response to thermal fatigue. There is also a potential problem with stress corrosion and corrosion fatigue of turbine sections. Finally, generator and switchgear can be susceptible to increased fatigue, wear, and other forms of degradation due to repeated stop-start operation.

The whole aspect of two shifting thus demands closer understanding of the issues involved, better monitoring of the plant operation and behaviour of critical components, better plant management systems, a strategy of component inspection and replacement and proper assessment of costs involved.

Furthermore, ***new alloys such as P91, P911, P92, P122*** *and more recently the use of* ***P/T23*** and ***P/T24*** has introduced a new dimension in that the creep-fatigue behaviour of these alloys especially of the more vulnerable welded sections is even less understood than the conventional alloys and a number of these have failed after a relatively short service duration. Temperature overshoot in the plant cycling regime can result in dramatic drop in the rupture strength of some of these newer alloys resulting in their unexpected early failure.

The question of two shifting is thus becoming a global problem. As such, for this review advice and information on experience will be sought from a number of plant owners, operators, researchers and associated organisations in Europe, Japan, Asia, Africa, North America and Australasia. The review will thus be based on the experts' own knowledge and experience, published literature, and interviews with and information accessed from plant operators and other technical experts.

The **detailed proposal** *(available on request)* describes the route suggested for the study of the above and related issues. The intention is to bring together industry, country/ regional studies

and plant experience and produce a global report highlighting the problems, issues, challenges, and technical and financial implications.

The study is aimed at providing a basis of understanding for plant operators who are involved (or planning to be involved) in two-shift operation. It will provide benchmarks against which to compare your plant performance and which will provide the targets to aim for. The Report will provide easy-to follow guidelines in the form of Tables outlining the problems, maintenance issues related to various plant sections and components and the proposed engineering and strategic solutions.

==========