MANAGEMENT SUMMARY

This report reviews operating and maintenance issues that result from the cyclic operation of Combined Cycle Gas Turbines (CCGTs). The information has been obtained from plant experience by ETD experts, visits to plants, personal contacts and in-house reports, surveys by questionnaires and recently published literature. It is intended to be read and used by staff at the technical planning level and by senior station staff. The report consists of ten main sections and ten appendices. The appendices cover specific aspects of operation, materials of construction, design choices, and maintenance etc.

To start with the report briefly reviews the evolution of CCGT plants and how this has influenced the ability to cycle. Earlier plants comprised a number of low output gas turbines and HRSGs feeding into a single steam turbine which gave good flexibility, whereas modern units consist of a single large output gas turbine and HRSG. Concern is being felt about the ability of such plants to respond to and combat frequency changes in the Grid. Earlier designs of HRSGs were very poor in cycling situations, primarily because of difficulties with condensate removal. Manufacturers are now aware of these problems, but newer HRSG units are larger and operate in the creep/fatigue range, hence thermal stressing is still a serious concern. This study shows that European organisations have tended to favour the vertical type of HRSG, as this gives good drainage of condensate, and flue gas temperatures are more uniform.

A comprehensive review is given of issues in HRSG cyclic operation including the question of water treatment in such plants. An assessment is given of the factors that govern the choice of oxidation resistant and thermal barrier coatings as there was considerable concern, from operators and other contacts, about the cracking and spalling-off of such coatings. Coating formulation affects blade life and a small number of organisations are now offering procedures to estimate blade lives. It would appear though that most CCGT plant operators are still working to blade lives as dictated by the manufacturers, although these may be conservative in the sense that blade failures are rare. Nevertheless there are clearly problems with blades that crack and coatings that degrade at an unexpected rate, even under base load conditions. Cycling makes this worse.

The Report contains a checklist which gives an estimate of the likelihood of failure of key plant components and shows how this can affect plant operability and forced outages. Examples are given on the benefit of soft starting. The report also reviews the impact that cycling is likely to have on availability and operating costs. The conclusions are that cycling will have only a small impact on availability and that maintenance costs are unlikely to suffer unduly. Even so costs per start are fairly significant, and in this context the poorer load following ability of CCGTs, compared with conventional steam plants, will put the former at a disadvantage. The most serious concern is that the discovery of any cracking of pressure parts in the HRSG can lead to significant outages as the accessibility of HRSG components is normally very restricted. Water treatment issues are of growing concern and are becoming more difficult with the trend to higher pressures.

Damage to Combined Cycle Gas Turbines Due to Cyclic Operation - Operational, Technical and Cost Issues

(*Acronym*: **CCGT Cycling)**

Final Report on a Multi-Client Sponsored Project

ETD Report No. 1012-iip-09

Report Prepared By: **F Starr and I A Shibli**

European Technology Development *Ltd*

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European Technology Development Limited
2 Warwick Gardens
Ashtead
Surrey KT21 2HR
United Kingdom

www.etd1.co.uk

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APPENDICES