EI Research report

Issues associated with aging combined cycle gas turbine (CCGT) assets

RESEARCH REPORT: ISSUES ASSOCIATED WITH AGING COMBINED CYCLE GAS TURBINE (CCGT) ASSETS

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CONTENTS

Contents continued

Page

Annexes

LIST OF FIGURES AND TABLES

Page

Figures

Tables

FOREWORD

With the first combined cycle gas turbine (CCGT) power plants being commissioned in the 1990s, and with an expected life of approximately 20 years (not including the possibility of life extension), it is clear that a large number of plants will be (or are being) managed in an 'aged state' until a decision is made to decommission them.

This research report was commissioned to explore the risks that aging CCGT plant components impose on people, environment and the wider plant.

This research report has drawn on many existing sources from the public domain, together with input from practitioners from the power utility industry and good practices from other high reliability industries.

Based on this research, the report identifies:

- example failures to plant that can arise through the wear and tear of aging;
- the expected severity of such as failure, and its likelihood, and
- guidance for additional preventative measures to prevent or mitigate such failures.

It covers the gas turbine (e.g. filter house, compressor, turbine, etc.), steam and water plant (e.g. tube banks, steam turbine, condenser, etc.), electrical equipment (e.g. generator, cables, switchgear, etc.) and auxiliary systems (e.g. the oil systems, control and instrumentation (C&I) and civil structures).

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1 INTRODUCTION

Combined cycle gas turbine (CCGT) electrical generation plant constitutes a significant contribution to the world energy mix – roughly 30 % or more in some countries – with the first CCGT plants commissioned in the early 1990s. The Energy Institute (EI) has produced guidance on preservation and commission of CCGT plant (see *Guidance on the preservation and recommissioning of existing combined cycle gas turbine (CCGT) plant* and *Guidance on the commissioning of new combined cycle gas turbine (CCGT) plant* respectively). However, CCGT plants have an expected life of approximately 20 years (not including the possibility of life extension). Therefore a large number of plants will increasingly be managed in an 'aged state' until a decision is made to decommission them. Whilst there is extensive experience in managing aging assets in other sectors (such as coal, offshore oil and gas and onshore refining plant), managing aged CCGT is a relatively new experience.

Older plants are often forced to run in ways which were not anticipated when they were designed; this has an impact on the risk profile of these plants. For example, market forces and renewables push older plant to lower tier due to competition from these sources (e.g. due to the efficiency of new plant) – this may affect how operators invest in maintaining or renewing older plants. Regarding aging CCGT plant, there are several areas for clarification, such as:

– identifying emerging technical issues;
– assessing the associated risk for people, plant and environment, and
– identifying what guidance will be needed in the near future to enable operators to manage the risk to as low as reasonably practicable (ALARP).

This high-level report has been written to provide CCGT plant managers with guidance in consideration of the above issues.

This report cannot cover all of the hazards associated with an aging CCGT plant and should be applied with care, common sense and engineering judgement.

1.1 WHAT IS AGE?

As discussed in Health and Safety Executive (HSE) RR 509, 'Ageing is not about how old your equipment is; it's about what you know about its condition, and how that's changing over time'. There are four main factors which influence how the condition of a CCGT plant may change over time:

– time (since commissioning);
– number of running hours;
– number of starts (and the associated ramp rates) and trips, and
– number of hours spent offline (e.g. mothballed plant).

Each of these factors brings with it different modes of plant degradation, which may (or may not) be more likely to occur depending on the operating regime of the plant (for example corrosion of storage tanks, creep of high temperature pipework and fatigue of small bore connections, to highlight just three issues).

The mode of operation (historical and future) of the plant is therefore significant in understanding many aspects of its age in terms of technical issues.

Once the age of the plant is understood, the resulting hazards can be better managed. There are a number of techniques which can be employed, from adapting maintenance, monitoring and inspection routines to performing detailed design and fitness-for-service analysis to develop a safety case for continued service, repair or rerating, for example.

2 SCOPE

The scope of this report covers CCGT plant as represented in Figure 1. It is recognised that this encompasses a large number of components, numerous configurations and a variety of manufacturers. Moreover, many components in a CCGT plant are not unique, but are well understood from the wider industry, for example electrical equipment, civil structures and ancillary systems.

Therefore, this report provides detailed discussion focused on the gas turbine and heat recovery steam generator (HRSG) systems, and more general information on the items of equipment not specific to CCGT plants, referring to other documents where possible.

This report does not cover components such as bypass stacks and dampers, and desalination plants.

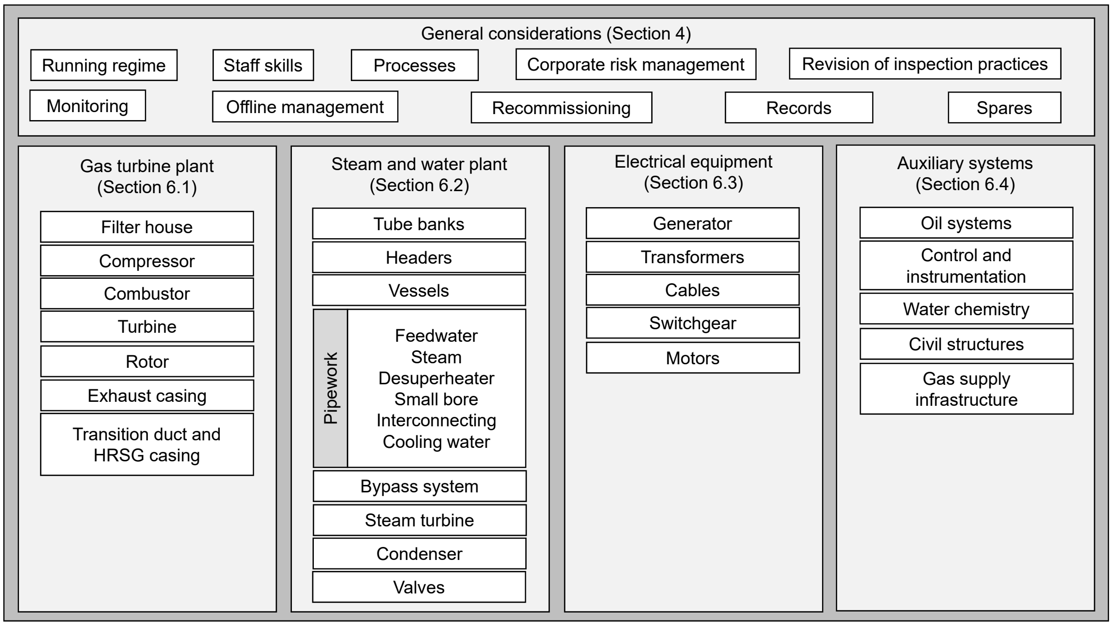

Figure 1: CCGT plant overview