Guidance on the development and decommissioning of new combined cycle gas turbine (CCGT) plant

GUIDANCE ON THE DEVELOPMENT AND COMMISSIONING OF NEW COMBINED CYCLE GAS TURBINE (CCGT) PLANT

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1 INTRODUCTION

This publication provides guidance on establishing good practice for the safe and structured approach to planning and commissioning of newly built combined cycle gas turbine (CCGT) power plant. It is written from an asset owner/operator perspective.

With the phasing out of coal generation in many countries, new CCGT plant may be built to meet the gap in generating capacity and to help underpin intermittent renewable generation (predominantly wind and solar).

However, given the changing market conditions, consolidation of expertise in fewer and fewer companies, life extension of CCGT assets, and the subsequent retirement of personnel with experience of commissioning CCGT plant, experience of commissioning new CCGT plant is becoming rarer within asset owners/operators.

1.1 SCOPE OF GUIDANCE

This document provides guidance to an asset owner/operator for a structured approach to managing the project risks and programme when developing new CCGT plant.

It first provides background information, including the historical perspective explaining the need for this document, as well as the main assumptions, such as what type of plant is covered in this publication, the regulatory regime being operated in, etc.

Although this publication is primarily intended to cover the commissioning of plant, section 3 provides an overview of the project lifecycle, from considering operations, to tendering, design, construction, commissioning and operation. This information is provided, not for the purposes of providing a complete guide on how to undertake these stages, but rather because successful commissioning of plant requires that certain prerequisites be in place. Therefore, guidance is provided predominantly on those aspects that impact upon the commissioning of plant. Section 4 provides further general good practice guidance.

Section 5 focuses on the commissioning phase of the project lifecycle in much more detail. It identifies the associated high-level activities and main equipment items, and the typical skill sets and resourcing expected for commissioning. A typical Gantt chart is provided giving an estimate of the commissioning timescales. Commissioning team roles are described. Lastly, 'check sheets' are provided from which the asset owner/operator can understand the requirements and develop their specific site commissioning plan.

Section 6 provides guidance on issues that impact upon the resourcing of CCGT commissioning, including project timescales, staffing, training, as well as maintenance schedules.

2 BACKGROUND

2.1 HISTORICAL PERSPECTIVE

2.1.1 Changing market conditions

The worldwide electricity supply markets are often uncertain, with volatile pricing of both fuel costs and electricity charges and billing. The long-term electricity demand, the mix of generation plant to supply that demand and the development of government policies on competitive pricing and lower carbon emissions also add to the unpredictability. CCGT plant suppliers and equipment designers are evolving designs to meet the changing requirements, but the number of service- and main equipment- suppliers are narrowing. First generation CCGT plant has been displaced by the higher efficiency and flexibility of emergent plant, resulting in a change to standard designs from baseload to multi shift operation.

The increased penetration of low carbon power generation, including nuclear, wind turbines, biomass, waste to energy and solar power, has in many countries displaced coal. It is displacing gas turbine (GT) plant due to lower marginal pricing and regulatory requirements driven by de-carbonisation policies. The newer CCGT plant is now being designed to support and exploit the limitations of renewables (that are subject to having to follow the prevailing natural conditions rather than the power demand), to provide active load, voltage and frequency response and enhanced ancillary and active power services. Power plant may include generation combined with energy storage to regain market share.

As governments open up the electricity markets and change energy policy it can create variation and instability in the electricity market, but it can also create opportunities to divest or invest in new power plant. An example of this is the UK, where the energy market has moved from the Electricity Pool, through the New Electricity Trading Arrangements (NETA), the British Electricity Trading and Transmission Arrangements (BETTA) and latterly the introduction of the capacity mechanism that have all placed differing specific requirements on existing and new build power plant.

These changes may create a need for new CCGT power plants to be built.

2.1.2 Potential skills shortage

The life extension of aging CCGT assets, the use of standard modularised new plant designs and the global grouping and alignment of manufacturers and 'turnkey' power plant solutions, mean that new plant commissioning and practical knowledge are being condensed into a smaller pool of experienced people, many of whom are reaching their retirement.

This, along with the decrease in the level of power plant staffing required due to increased automation and, possibly, the de-structuring of long-term training and apprenticeship schemes, whilst maximising the commercial viability of each individual site, has led to a significant decrease in the number of trained and suitably qualified and experienced personnel (SQEP) available worldwide within the generation industry who are readily available for CCGT project commissioning.

This has left a skills shortage for CCGT commissioning and operation of plant. Typical solutions for managing this risk include the following:

- Use of former coal plant staff (where retraining may be necessary).
- Greater reliance on the original equipment manufacturers (OEMs) for commissioning expertise (with cost and longer-term knowledge implications).
- Recruitment and on-the-job training once a site is mobilised (targeted and planned to meet the project timescales when required, rather than retaining staff for future potential requirements).
- Use of retired staff and engineering consultancy to support new recruitment and training.
- Maintaining or reinstating apprentice and training schemes.

Both the opportunities and the risks should be considered, balanced and costed when developing new CCGT plant. The lack of skills base in the technology being considered (especially if a novel or upgraded design), or a lack of awareness of safety requirements, means that the asset owner/operator may need to place more reliance on third parties and contractual mechanisms to mitigate their risk exposure. Such arrangements should be subject to close scrutiny to ensure that they are relevant and prevent further unintended risks arising.

Asset owners/operators should always look to develop their understanding of the main plant elements (especially for the operation and maintenance of the new plant). This publication suggests that the opportunity for knowledge capture from the OEM during commissioning should be maximised through close engagement between staff from within the organisation and the OEM commissioning team. Direct knowledge transfer related to the equipment being installed should be recorded (recruiting if necessary) and retained for plant operation. This process will be assisted further by the setting up and use of a common project risk register and completing the check sheets provided within this publication.

2.2 THE PLANT

The guidance in this publication is based on a 'generic CCGT plant', covering the following plant items:

- Civil structures:
  - site preparation, site security, fences, etc., buildings, infrastructure, roads, piling, and heating, ventilation, and air conditioning (HVAC).
- Gas/combustion turbine (GT/CT).
- Exhaust ductwork, including blast/bypass stack (if provided).
- Heat recovery steam generator (HRSG) and pressure pipework, pressure relief and steam bypass.
- Steam turbine (ST) and condenser.
- Generator(s).
- Distributed control system (DCS) and other control systems.
- Safety instrumented systems (SIS) plant protection (may also be covered by the main equipment supplier via governor protection, etc.). These may be supplied by a single OEM or, more commonly, multiple equipment suppliers under a main contractor.

- Balance of plant (BOP):
  - electrical: switchgear, transformers;
  - mechanical:
    - pipework: high pressure (HP), cold and hot reheat and low pressure (LP) steam pipework and pressure relief, and
    - pumps, motors, valves, actuators, instrumentation.
  - control:
    - environmental monitoring.
- Common services:
  - cooling and closed circuit cooling water system;
  - fire systems, and
  - fuel system and storage (gas).
- Water treatment plant (WTP) and desalination plant (if required):
  - dosing systems;
  - drainage systems;
  - bulk chemical storage, and
  - batteries and uninterruptible power supply (UPS).

The list shows the diversity of equipment and hence the potential for multiple equipment suppliers required to be coordinated to deliver a new CCGT plant. This 'diversity' is further increased where the CCGT is only one part of a larger project (e.g. incorporating multiple power trains, desalination plant, combined heat and power schemes, etc.).

In any case, and particularly where the asset owner's/operator's plant differs from the list of plant in this publication, the guidance in this publication should be tailored to the particulars of the plant.

2.2.1 Desalination plant

For guidance, a typical desalination plant has been included in the check sheets. Typically for current new plant it will more likely be reverse osmosis (RO) plant, rather than multistage flash (MSF) or multi effect discharge (MED) and in future plant may incorporate graphene based filters.

The main desalination equipment will be in addition to the CCGT plant and should be integrated into the site work programme. It will likely consist of:

- cooling water intake pumps;
- sea water intake pumps;
- filters/pre-treatment and backwash;
- HP pumps;
- sampling systems (inlet and discharge);
- ultraviolet light (UV) lighting, chemical storage and dosing systems;
- tanks, valves, pumps and pipework;
- discharge, dilution tank and solids treatment;
- desalination plant instrumentation and monitoring and control system, and
- civil works.