

Turbomachinery in Oil and Gas Facilities Project: Execution and Main Challenges



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INTRODUCTION

Turbomachinery is one of the most critical components in any oil and gas offshore facility or onshore plant. So project management teams (PMT) will focus on the effective and efficient execution of the turbomachinery project to ensure that the overall performance of the turbomachinery equipment meets the requirements of the international oil and gas industry standard and practices.

This article aims to explore the execution of turbomachinery in oil and gas facilities and to highlight the main challenges of handling this. But first, we will provide some basic introduction to turbomachinery and its functions.

TURBOMACHINERY BASIC INTRODUCTION

The main components of turbomachinery can be divided into two – the driver and driven equipment. For turbomachinery, the selected driver (also known as the prime mover) is a turbine which can be steam or gas turbine). The most commonly used driver for oil and gas facilities project is gas turbine, which is classified into four groups:

1. Frame type heavy industrial gas turbine
2. Aeroderivative gas turbine
3. Light industrial type gas turbine
4. Micro turbine

Selection of the driven equipment – centrifugal compressor, electric generator or pump – depends on the application of the turbomachinery itself. A typical schematic of turbomachinery package is shown in Figure 1. Depending

on the operating speed of the driver and driven equipment, a gearbox may be required in between to ensure smooth operation of the turbomachinery.

TYPICAL PROJECT STAGES IN OIL AND GAS FACILITIES DEVELOPMENT

In general, there are three important stages in the life of oil and gas facilities, starting from exploration to development and production. This article will concentrate on development, a stage in which Project Management elements are heavily involved. In order to develop an oil and gas facility, a PMT consisting a project manager, resident engineer and various disciplines engineers will be set up to manage each stages of the development. The typical development stages are:

1. Conceptual design
2. Front end engineering design (FEED)
3. Procurement of long lead equipment
4. Detailed design
5. Construction or fabrication
6. Onshore pre-commissioning
7. Transportation or installation (applicable for offshore platforms)
8. Hook up and commissioning prior to handing over to end user

CONCEPTUAL DESIGN

The initial stage is where the concepts of the area development are being explored in order to get the most

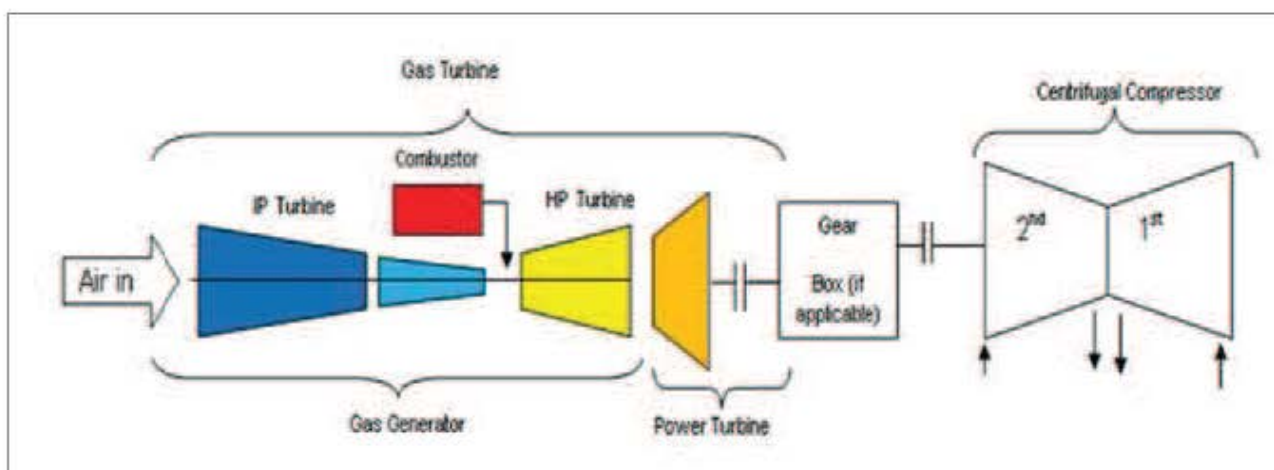


Figure 1: A Typical Turbomachinery Package

optimised design. This stage is crucial and decides whether a project is fit to be developed for the next stage, put on hold, go back to the drawing board or shelved.

During the conceptual design stage, turbomachinery configuration or process selection is one of the major deliverables and determines the total number of turbomachinery required for each facility.

The best option depends on the technical requirement of each project, which may include cost, space constraint, overall plant availability and reliability, as well as total cost of ownership (TCO). The TCO concept is becoming more popular nowadays, where instead of looking at lower capital expenditure (CAPEX), the project needs to look beyond by including the operational cost (OPEX) during the expected life of the field to come out with the overall best solution.

FRONT END ENGINEERING DESIGN (FEED)

The next step is Front End Engineering Design (FEED). The main purpose of FEED is to develop a more detailed scope of the chosen development concept, strategise the overall project execution plan and provide a more refined cost estimation for the selected development concept. At this stage, one of the main deliverables for the turbomachinery engineer is to come out with a detailed technical specification and datasheet, specifying the requirement for the equipment requisition. The technical specification should clearly spell out the project specific requirement.

During FEED execution, the rotating engineer needs to start engaging with potential turbomachinery equipment suppliers in order to obtain basic technical information of the equipment and auxiliaries, including the overall dimensions. This is crucial in order for the project to come out with overall platform mechanical layout, which basically indicates where equipment will be located, the numbers of platform decks, the overall platform size and the weight.

PROCUREMENT OF LONG LEAD EQUIPMENT

Long Lead Equipment refers to the critical equipment which requires long delivery (usually more than one year) and fall under critical path in the overall project schedule. Depending on the overall project execution plan, the procurement of long lead equipment may start at the end of FEED stage, before the Detailed Design Phase or concurrent with Detailed Design Phase.

During the procurement stage, the technical specification obtained from the FEED stage is sent to bidders for them to come out with technical bid proposal. The technical bid proposal will be strictly evaluated to ensure compliance with the project technical requirements. The successful bidder will be awarded to supply the equipment, and usually it will overlap with the next project stage i.e. Detailed Design Phase.

Usually, the rotating engineer also acts as the package engineer and handles the turbomachinery equipment vendor. One of the main tasks is to manage the equipment design phase conducted by the vendor, and to follow up with the equipment manufacturing schedule, inspection and testing plan (ITP). Apart from that, the rotating engineer will also be involved in critical equipment testing as identified in the ITP, to ensure the equipment meets the technical criteria as specified in the contract.

DETAILED DESIGN

The Detailed Design phase is carried out once the project has been sanctioned for actual development, where the deliverables from Conceptual and FEED phase will be expanded further for detailed engineering. Besides, the procurement of various equipment will also be conducted concurrently during this phase and result in choosing the specific vendor for each item of equipment.

One of the most important activities in Detailed Design is Vendor Data Incorporation (VDI). Based on the engineering data provided by each particular vendor, the data has to be incorporated and integrated with the main platform. For rotating equipment especially turbomachinery, the VDI activities include integration with other disciplines. The major deliverable for Detailed Design phase is to bring the overall platform design to reach a certain standard or maturity identified as Approved For Construction (AFC).

CONSTRUCTION/FABRICATION

Once the drawings reach AFC level, it is time to proceed with the platform construction phase, where the actual platform will be built and fabricated at a suitable onshore fabrication yard. As part of the construction works, the rotating engineer will be involved in the planning phase prior to the actual construction. Once the deck is ready, the equipment can be installed per its location on the platform deck.

Once the turbomachinery is properly installed, the next stage will involve detailing works such as equipment levelling, alignment, interconnecting piping/cables tie-in and installation of other auxiliaries system equipment.

ONSHORE PRE-COMMISSIONING

For onshore pre-commissioning works, the critical activities involved in turbomachinery equipment are:

- Lube oil flushing
- Hook up of ship loosed instruments
- Unit Control Panel (UCP) power up
- Motor start up test from Motor Control Centre (MCC)
- Gas turbine dry crank test

Ultimately, if the onshore pre-commissioning works are able to achieve dry crank at the fabrication yard, this is a big achievement and indicates that the turbomachinery has been successfully installed and able to link to the UCP. Depending on project sequence, schedule and priority, not all projects are able to achieve the dry crank stage. The dry crank refers to the ability to start the gas turbine using the UCP, by utilising the motor starter or hydraulic starter up to the turbine crank speed. Due to unavailability of fuel gas at the onshore fabrication yard, the gas turbine will be shutdown safely, indicating that the dry crank has been achieved.

TRANSPORTATION/INSTALLATION (APPLICABLE FOR OFFSHORE PLATFORMS)

Once the platform fabrication has been completed at the fabrication yard, the platform has to be transported to the offshore location with a barge or installation barge. When it reaches the site, the platform installation will be conducted accordingly via an installation barge.

HOOK UP AND COMMISSIONING PRIOR TO HANDING OVER TO END USER

Hook up refers to the ship-based items which cannot be installed for safety reasons and to avoid damages during the transportation of the platform from the fabrication yard to offshore.

The project is finally about ready for the commissioning stage. Usually, what is given priority for commissioning will be utilities such as power generation, water and safety devices. This is important to ensure that the platform is ready for habitation by personnel. Once the utilities are in place, the project should gear up for process related commissioning, including the turbomachinery equipment. The turbomachinery is required to be put under continuous endurance test for 72 hours prior to handover to the end user or operation team.

TURBOMACHINERY PROJECT EXECUTION MAIN CHALLENGES

There are various challenges faced in handling turbomachinery packages in oil and gas facilities projects, so due diligence should be taken into account during its execution. These include (but are not limited to):

Availability of good and sound database of turbomachinery (technical and commercial)

Good design will result in minimal error and mistake in the later stages. Therefore, the assumption during the early stage of design (particularly Conceptual and FEED) needs to be as accurate as possible, even though during that time, a specific vendor has not been selected yet. The risk of having a wrong assumption can be reduced if the PMT or design consultant house can build a database of turbomachinery equipment. This data can be collected from previous projects, vast networking, international journals and a good alliance with turbomachinery vendors.

Coming up with good turbomachinery technical specifications

The debate on whether it's better to have fantastic technical features or fit-for-purpose technical features, will always be on-going. Eventually, the technical requirements must be considered between these two because whatever is written in the technical specification will be translated into project cost. If the technical specification is too rigid and gold-plated, it will result in very expensive equipment. On the contrary, if the technical specification is too simple and vague, it will jeopardise the quality and PMT will be exposed for additional change order during the actual job execution.

Handling world class turbomachinery vendors

For oil and gas turbomachinery, the market is shared between a few international turbomachinery vendors such as Solar Turbines, General Electrics, Rolls Royce and Siemens. So a rotating engineer and lead package engineer should demonstrate his or her interpersonal skills as a project manager in order to manage these world class vendors. A combination of good technical knowledge and great project management skills will be the perfect recipe when handling unexpected occurrences.

Managing design changes

During the project execution, there can be various reasons for design changes such as wrong assumption used during FEED, lack of proven data during early stage of the project, human error etc. Furthermore, turbomachinery involves a multi-disciplines engineering so the lead package engineer should broaden his or her competency in other disciplines as well, as this will help the team to come out with solutions for each design changes issues.

Managing technical exceptions and deviations

Every turbomachinery vendor has its own standard equipment, and so will request for long list of technical exceptions. These exceptions must be evaluated in detail by each discipline engineer to check whether the request is acceptable, to avoid added cost and schedule impact.

Again, good technical judgement and due diligence are necessary to ensure every decision made is supported by technical evidence, and recorded for future reference.

Managing expectations of end user or stakeholders

For oil and gas projects, the end user is usually the operations department. As this is one of the important stakeholders, it would be beneficial to get the personnel involved from as early a stage of the project as possible, such as conceptual design, right up to the handing over. Change in personnel may also create an issue, since different employees have different experiences and points of view. Therefore, it is very important to ensure continuity. Record all changes if any, to enable the new personnel to understand the history behind each decision made earlier.

Delay of project schedule/delivery

It is very important for the package engineer to ensure that the vendor is able to honour the contractual delivery date for the packages. Any delay will have a domino effect on the platform fabrication schedule as it will interrupt the equipment installation schedule. Proper planning must be made by the PMT by including additional schedule float to buffer any potential delivery delay. It is very important for the lead package engineer to monitor and manage the overall package schedule. If the schedule starts to slip, it is necessary to ask the vendor to identify the reason and come up with a catch-up plan.

CONCLUSION

Turbomachinery is the heart of any oil and gas facility project, so its execution as well as the main challenges that may be faced during its execution should be taken care of diligently. Turbomachinery, which comprises the driver and the driven equipment, is typically used for the Mechanical Drive and Electric Power Generation.

Of all the stages in the lifespan of an oil and gas facility, the elements of Project Management are substantially important in executing the turbomachinery related projects and demand a competent rotating engineer to be in charge. Various challenges may have to be dealt with when handling the turbomachinery execution, including deficiency of sound database of turbomachinery, mixed consideration between having fantastic or fit-for-purpose technical features, delay of project schedule/delivery as well as the management of world class vendors, design changes, technical exceptions and deviations as well as the expectations of end user/stakeholders. ■

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