Strategising a Central Processing Platform (CPP) Commissioning & Start-up in a Complex Mega Scale Project

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Abstract.

Commissioning & Start-Up (CSU) of a facility in Oil & Gas industry, is classically the transitional phase before the start of the Production phase. As every project has its own unique and explicit requirement, it is of paramount importance for a project to have its CSU philosophy to drive the project execution to achieve its project objectives. This paper outlines the project management process, focusing on Network Diagram tools, in Commissioning and Start-up phase for multiple and complex facilities.

The focus of this paper will be on the formulation of the commissioning philosophy for an integrated Commissioning & Start-Up (CSU) strategy which involves multiple packages, centring on a Central Processing Platform (CPP). Proper Work Breakdown Structure (WBS) and Project Management Network Diagram tools are applied in producing a detailed commissioning plan, which guides strategic phasing of commissioning phases and milestones. This is further discussed and deliberated through series of workshops among the stakeholders to gain their buy-in and acceptance.

This method has been adopted in two different projects of about the same magnitude, resulted in clear and focused commissioning execution, and leading to accelerated project delivery. Such positive impact is doable with appropriate execution strategy; whereby potential clashes are proficiently managed, and project execution was steered through clear Commissioning & Start-Up phases/milestones. This paper also recommends the methodology used to produce a Commissioning Network Diagram, which can be used as a guiding principle in managing activities during project execution in an efficient manner.

Keywords: project management; work breakdown structure; network diagram; phases; milestones

1. Introduction

A Central Processing Platform (CPP) facility in the offshore oil & gas field primarily functions for processing fluids coming from the oil or gas wells, depending on the type of development. Commissioning is defined as an act of putting certain items into active service for the first time as intended by design and specifications. It includes dynamic functional

testing and documentation of an assembly, system or sub-system independently or together with associated systems and facilities to ensure that it fulfils its designed purpose and services (PTS 19.40.02, 2015).

The commissioning phase of a CPP facility demands significant planning effort as quite several systems to be properly sequenced to achieve smooth commissioning & start-up (CSU). Unlike a pure greenfield CPP project, strategizing the commissioning of a CPP that is connected to existing facilities or also known as a brownfield, is even more challenging as any issues faced during the process of commissioning may interrupt production at existing facilities. Typically, frequent plant tripping and troubleshooting during commissioning may lead to unplanned production deferment, which could be catastrophic. This opportunity loss is depicted in Figure 1.

Figure 1: Typical plant performance during CSU phase

Source: (Izrie Ghazali et. al, 2019)

This paper aims to demonstrate the methodology used in formulating an Integrated Commissioning and Start-Up (ICSU) by applying related project management processes and tools associated with the commissioning discipline.

In this case, two projects of similar complexity are examined. They are megaprojects consists of several facilities, that is divided into few ‘packages’ for ease of execution. Table 2 & 3 below shows the breakdown of those packages.

Table 2: Summary of Scope of Work (SOW) Demarcation for Integrated Project A

KEY PACKAGES	PROJECT PHASES				
	Engineering (E)	Procurement (P)	Construction (C)	Installation (I)	Commissioning (C)
CPP-A	EPCIC Package 1 (P1)				
WHP-A	EPCC Package 2 (P2)			OIC Package 4 (P4)	EPCC Package 2 (P2)
WHP-B					
Rigid subsea pipeline	By Company's contractor	By Company	By Company's contractor	EPCC Package 7 (P7)	EPCC Package 2 (P2)
Composite subsea cable	EPCC Package 2 (P2)				
Modification of existing platform CPP-B, CPP-B1, CPP-B2, WHP-C	EPCC Package 3 (P3)				EPCC Package 3 (P3)
Flexible subsea pipelines	EPCC Package 7 (P7)				

Source: (Izrie Ghazali et. al, 2019)

Table 2: Summary of Scope of Work (SOW) Demarcation for Integrated Project B

KEY PACKAGES	PROJECT PHASES				
	Engineering (E)	Procurement (P)	Construction (C)	Installation (I)	Commissioning (C)
CPP-A - EPCIC	EPCIC Package 1 (P1)				
WHP-D	EPCIC Package 2 (P2)				
BROWNFIELD (HOST TIE-INS)	COMPANY'S CONTRACTOR (P3)		COMPANY'S CONTRACTOR (P4)		
REJUVENATION			COMPANY'S CONTRACTOR (P4)		
FLEXIBLE PIPELINE	COMPANY'S CONTRACTOR (P5)				COMPANY'S CONTRACTOR (P4)

SUBMARINE CABLE	COMPANY'S CONTRACTOR (P6)	COMPANY'S CONTRACTOR (P5)	COMPANY'S CONTRACTOR (P6)

Source: (Smooth Start-up Program, 2019)

By referring to both tables above, both projects commissioning are of high complexity as it involves multiple work streams that consist of new facilities, brownfield tie-ins, and existing field production. Each is managed by different stakeholders from various contract packages, not to forget the Asset Owner who owns and manages the existing production.

2. Methodology

This paper will be referring to Project A to explain how a network diagram is developed and applied in the commissioning phase of a project. This section explains the methodology used in producing the Integrated Commissioning and Start-Up (ICSU) strategy. The effort is started with reviewing the pre-requisites items, which will be explained in section 2.1. After all the pre-requisites has been satisfactorily identified, we will look at how the commissioning network diagram is established. The outcome of the network diagram exercise is then deliberated at the result and discussion section.

2.1 Study the pre-requisites

To effectively produce the ICSU network diagram, a few studies on the project documents and characteristics need to be conducted. In this case, careful re-examinations are performed on few subjects:

- i) Facilities detailed engineering deliverables
- ii) Feedstock (input) & receiving facility readiness (output)
- iii) Key milestones

The details of each item mentioned above are discussed in the following subsection.

2.1.1 Facilities Detailed Engineering Deliverables

Each facility has undergone a detailed engineering phase, with the deliverables are divided by each engineering discipline. The team undertook the effort by performing a desktop review on important engineering drawings and technical specifications. The task is divided among the team, according to their discipline, which are:

i) Process

For process engineering, Design Basis Memorandum (DBM) is the mother documents that explain the basis of the facility design. It also contains important information such as the system available on the facility, the design capacity, and general equipment information. This document is reviewed together with process engineering drawings such as Process Flow Scheme (PFS), Process Engineering Flow Scheme (PEFS) or also known as Piping & Instrumentation Diagram (P&ID).

ii) Mechanical

For mechanical discipline, further understanding on critical equipment is established. The equipment of interests is fuel gas conditioning skid, gas turbine compressors, seawater lift pumps, and various mechanical static skid and rotating equipment. The minimum turndown and maximum capacity of each equipment is analysed to further determine the commissionability and sequence.

iii) Electrical

In electrical discipline, the study is focused on power generation philosophy, power distribution philosophy, and electrical Single Line Diagram (SLD) drawings. Power generation system for a CPP is typically designed with Gas Turbine Generators as the main power, with backup diesel engine driven generator as the auxiliary or backup power system. Attention need to be given to the power distribution as well, as equipment that receive power from Normal switchboard will be not be able to be commissioned early, and this will affect commissioning sequence.

iv) Instrumentation & Control

For instrumentation & control, further understanding via desktop review on shutdown philosophy is performed. Control signals coming from CPP may cause trip to the existing platform, which will interrupt current production. Temporary control signal masking and staggered unmasking is applied to reduce the production deferment risk.

2.1.2 Feed availability and Receiving Facility readiness

To ensure a successful commissioning campaign, it is of paramount importance for a commissioning engineer to study the available feed and the receiving facility requirement. This is done by analysing each system that is available onboard the CPP, what medium is processed, what product does it produce, and where the product will be transported. This information is then linked with the data from other facilities, which includes the new wellhead platforms and existing wells.

Another important item to note is the design capacity of the system, the available demand, and the minimum turndown of any specific equipment in a particular system. This is important for Performance Test Run planning later. Figure 4 and 5 below are the examples of the systems that summarized the findings from the exercise conducted.

Figure 4: Sample of Input and Output of System

Figure 5: Sample of Input and Output of System

2.1.3 Key milestones

Milestones are significant point or event in a project [2]. A project might have single or several key milestones that have been set forth earlier in the contract. In this case study, the overall integrated project has its milestone, whereas each package contractors that are part of the integrated project, have their specific contractual milestones. For the commissioning phase, typically two important milestones are normally coined:

1. Ready for Start-Up (RFSU) – milestone date where the contractor has completed the offshore hook-up or construction activity, commissioning of non-hydrocarbon system has been completed, and the facility is ready to receive hydrocarbon feed for process commissioning.
2. Notice of Provisional Acceptance (NPA) – milestone date where the facility has completed commissioning activity, and the Performance Test Run (PTR) has been conducted.

Having a single RFSU milestone from the CPP facility as a reference for the overall integrated commissioning activity might not be effective, as other packages will be focusing on their commitment dates. To mitigate this, a few commissioning and start-up (CSU)

Milestones are introduced to align all packages commitment date towards one common objective. Figure 6 below shows the relationship between the integrated Project Milestone, individual packages contractual milestone, and the CSU milestone.

Four CSU milestones are introduced to align the commissioning plan among all packages with clear objective, summarized in table below:

Table 7: ICSU milestones & objectives

Phases	Milestones / RFSU	Objectives
1	Ready for Fuel Gas Introduction (RFGI)	i. Commissioning CPP-A Power System
2	Ready for Process Gas Introduction (RFPGI)	i. Pressurize & Commission CPP-A gas compressor recycle run ii. Subsea cable commissioning
3	Ready for Gas Export (RFGE)	i. Export Gas Sales to WHP-C
	Ready for Facility Integration-A (RFFI) Complex A	i. iWAG Injection ii. OG to AI conversion iii. HP & LP Crude Flow Conversion iv. PW & FWS flexi pipeline commissioning v. Final logic integration

4	Ready for Facility Integration-B (RFFI) Complex B	i. GI & WI flexi pipeline commissioning ii. WI, GI, IWAG injection iii. Vent to Flare Conversion iv. HP crude flow conversion v. Final logic integration

After all these prerequisites information are collected and properly understood, these requirements are documented and utilised as a basis and guiding principle to produce the Integrated Commissioning & Start-Up (ICSU) network diagram.

3. Producing the Network Diagram

After all the pre-requisite studies are completed, the information is gathered and need to be arranged properly in order to produce a good commissioning sequence. The network diagram tools are selected for this purpose.

Network diagram is a graphical or schematic representation of the logical relationships among the project activities and milestones (PMI, 2017, Chapter 6, p. 194). It is an output in Sequence Activities process, in Schedule Management Knowledge Area. Figure 8 below shows the simplified network diagram.

Figure 8: Simplified Network Diagram

Nodes or boxes are used to represent activities while the arrows with a left to right convention to show activity dependencies. It is useful to determine a project's critical path when developing the Commissioning & Start-Up (CSU) schedule. It may also be used to plan, track, and report the progress during the ICSU execution stage.

To develop the network diagram, the Work Breakdown Structure (WBS) for the CPP facility is defined based on the company's standard guideline, and it is recorded as one of the approved commissioning deliverables called System Definition. This System Definition is then used to develop a high level commissioning activity list and milestones. This activities list is then used as the lowest level, represented as each box in the network diagram.

One thing to note that determining the dependencies between activities are also important. Mandatory dependencies are those that are legally or contractually required or inherent in the

nature of the work (PMI, 2017, Chapter 6, p. 191). Specifically, this commissioning activity is predominantly determined by the specific system or equipment requirements. Other determining factors would be shutdown requirement, availability of actual feed, etc. Discretionary dependencies (preferred, soft logic) is determined based on a project-specific Commissioning Philosophy. Typically, it would require the system in a facility to be commissioned in the following orders:

1. Safety system
2. Living Quarters (LQ) system
3. Power system
4. Utility system
5. Process system

After the draft network diagram is completed, an internal workshop within Project Management Team (PMT) and asset owner is conducted to gain feedback on the produced Commissioning Network Diagram, and at the same time rolling out the ICSU strategy. This workshop is arranged in such a way that it is a project management review that largely covered the planning process group focusing on time and risk management knowledge area, as per PMBOK Guide. The workshop has successfully met its objective and the ICSU strategy is cascaded down to all packages contractors and further refined at their respective packages level for them to update their execution plan.

4. Results and Discussion

The network diagram of Project A is presented in broken down into four parts, following the CSU milestones that is explained earlier in section 2.1.3:

Figure 9: Commissioning Network Diagram Phase 1 (RFFGI)

The diagram illustrates the commissioning process for a new gas engine (BNCPP-B) into an existing power plant (BNCPP-A). The process is divided into several phases and activities:

- Phase 1: Full Commission BNCPP-B Power System** (Starts at Point A)
- Phase 2: Ready For Gas Export** (Ends at Point F)
- Key Activities and Systems:**
  - Gas Engine Power System:** Includes Gas Engine Control System, Gas Engine Safety System, Gas Engine Monitoring System, and Gas Engine Protection System.
  - Gas Engine Control System:** Includes Gas Engine Control System, Gas Engine Safety System, Gas Engine Monitoring System, and Gas Engine Protection System.
  - Gas Engine Safety System:** Includes Gas Engine Safety System, Gas Engine Monitoring System, and Gas Engine Protection System.
  - Gas Engine Monitoring System:** Includes Gas Engine Monitoring System, Gas Engine Protection System, and Gas Engine Safety System.
  - Gas Engine Protection System:** Includes Gas Engine Protection System, Gas Engine Safety System, and Gas Engine Monitoring System.
- Key Milestones and Points:**
  - Point A:** Start of Phase 1.
  - Point B:** Completion of Phase 1.
  - Point C:** Start of Phase 2.
  - Point D:** Completion of Phase 2.
  - Point E:** Start of Phase 3.
  - Point F:** End of Phase 3.
- Legend:**
  - System power source from Normal LV DB:** Indicated by a red arrow.
  - Activity by P1 (SRE):** Indicated by a red box.
  - Activity by P4 (Signal PL Team):** Indicated by a blue box.
  - Activity by P2 (OPPL):** Indicated by a green box.
  - Activity by P3 (Flexible PL Team):** Indicated by a yellow box.
  - Activity by P5 (OTIS):** Indicated by a purple box.

[illegible]

[illegible]

5. Conclusion

i) Accelerated first gas achievement via clear and commendable ICSU Strategy and smooth ICSU execution.

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- ii) Well mitigated risk of production deferment to the existing assets waiting for final integration with the new facilities.
- iii) Avoidance of expensive standby of resources including the manpower and marine spreads, which could have caused by the misalignment of individual offshore execution schedules developed by Package Contractors; and
- iv) Timely achievement of facilities handover and proactive prevention of scope creep.

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References

2017, A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Sixth Edition, *14 Campus Boulevard Newtown Square: Project Management Institute, Inc.;*

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**23-25 April, 2021
Prague, Czech Republic**

2009, Commissioning and Start-up Management Manual, PETRONAS Project Management System (PPMS), version 2.0; and

2015, PETRONAS Technical Standard (PTS) 19.40.02: Facility Handover.

2018, Bokor CPP Smooth Start-Up Program Workshop Report,

Izrie Ghazali et, al, 2019, Commissioning and Start-up of Complex Mega Scale Report Integrated Gas Field and EOR Development, SPE/IATMI Asia Pacific Oil & Gas Conference and Exhibition held in Bali, Indonesia, 29-31 October 2019.