



CONSTRUCTION START UP
(Home Office Activities toward Site)





Edited by Board of ANIMP -
Construction Section

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Welcome

I'm proud to introduce the third volume of a series aimed at boosting innovation and at capitalizing lessons learned in the Construction Sector.

ANIMP's main mission is to support the sharing of Industrial Plant culture all over the world through its technical chapters that merge the experiences in the specialist disciplines of the Associated Companies and Italian Universities.

Special thanks go to: Giordano Gariboldi (and his team) for coordinating the editing process, the authors of this book: Davide Moschetta, Sergio Sturaro, Andrea Iacobelli, Donato Buongiovanni, Ezio Sabato, Filippo Bado and "last but not least" ANIMP's Board of Construction Section for their high technical contribution that made possible the issue.

Antonio Careddu
(President of ANIMP)

Preface

We are pleased to present this booklet that we think will be particularly useful to young people approaching to Construction activities.

Both of us have been, formerly, President of Associazione Nazionale di Impiantistica Industriale (ANIMP), and CEO of the most important Italian EPC Contracting Company (Snamprogetti now acquired by Saipem) which had the widest international experience, and we are fully convinced of the importance of construction activities for a successful implementation of industrial plants projects.

Snamprogetti has always considered construction activities as of the highest importance, considering that a Project is a whole, of which construction, particularly if in critical logistic areas, is one of the most important activities to be considered from the earlier phases of planning and engineering: that is why Snamprogetti has been one of the pioneers in developing and applying the so-called Constructability methodology since many decades ago.

We consider this booklet as reflecting a part of our professional life and we are grateful to ANIMP Construction Section to have involved us in the publishing of these papers that we trust will be a very useful support to professionals involved in construction activities both at home office and on the field.

We hope that everyone could find in this work the opportunity for new starting points to develop ideas and methodologies for projects execution, taking in account the possibilities offered by modern technology, or for further reflections about this amazing matter.

Roberto Piattoli / Maurizio Gatti

Credits and acknowledgements

This is the Third White Book of the ANIMP Construction Section has been published. The story of this book is completely different from the previous ones (*Advances in Plant Modularization*, ANIMP, 2014 and *Proven Practices in Construction Management*, ANIMP, 2015)

The story behind this book started from some documentation produced by Michele Spongano - SAIPEM to whom my gratefulness is addressed both as ANIMP representative and at a personal level.

The title and subtitle synthesize perfectly the content: “**Construction Start-up - Home Office activities development towards Site**”. The aim of this Book is the collection of the best practices that should be put in place during the Project execution and, in particular, Construction start-up in Home Office, for an effective and smooth management of the activities developed at Site both for Construction and Pre-Commissioning/ Commissioning. Disclosing these practices, we perfectly know that the future will surely change and that we will need to continuously review and adapt our approaches to the real and contingent context of our projects. This book aims to be a handy support exactly in this direction: it is addressed to practitioners, due to the important presence of real data and tools for a “plug and play” usage in their companies, and to neophytes, given the global picture of the topic.

The Authors of the book are: Davide Moschetta, Sergio Sturaro, Andrea Iacobelli, Donato Buongiovanni, Ezio Sabato, Filippo Bado who worked at the preparation of this white book with the support of the Steering Committee of ANIMP’s Construction Section as well as the Section’s secretaries Rossella Schiavi and Chiara Scarongella.

At the end, my warm gratefulness is for each member of the Board of the ANIMP Construction Section (mentioned with their affiliation at the end of this book).



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Authors Preface

The Book consists in different sections that cross the disciplines and topics that are to be dealt with during the Home Office phase and include themes related to:

- Handover from the Tender phase to the Operative Project
- Set-up of the Constructability Program
- Definition of the Construction Execution Plan and related activities
- Control of the status of the activities planned at Site (with periodical review of the Construction quantities) as well as of the activities executed (with specific reports and KPIs/ costs monitoring)
- Definition of HSE and Quality Management Systems
- Definition of Temporary Construction Facilities Requirements and relevant Field Running Costs
- Assessment of Risks and Opportunities related to the Site Activities
- Mobilization of Contractor personnel for Supervision and support activities, both in case of direct hiring and in case of Subcontractors deployment
- Approach to the Subcontracting process, from the definition of the strategy to the award of the Subcontracts.

These themes, despite they may have different importance on the Project in relation to Contractual frame, location, magnitude of the Scope of Work, partnerships, presence of Advisors/ PMC, previous experiences in the Country/ type of plant/ Client, they have in any case to be taken into duly account for the entire development of Construction phase, from the Home Office onwards.

With the aim of making clearer the importance of these topics, each section of the Book has been completed with a collection of examples taken from past/ completed Projects demonstrating the applicability and the practicality of the exposed matters.

The aim of this book is to illustrate the Construction activities to be carried out in Home Office:

- a. during the initial phase of the Operative Project, in preparation to the start of the Site activities
- b. to support and monitor Site activities
- c. to receive and analyze periodic reporting addressed to the management of the various business functions (relevant to the progress achieved at Site, the KPIs, the Costs, the statistics, etc.)
- d. the development of new methodologies and systems for the management of Construction activities.

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Table of Contents

1. INTRODUCTION – CONSTRUCTION START-UP: HOME OFFICE ACTIVITIES DEVELOPMENT TOWARDS SITE	9
2. TENDER PHASE & HANDOVER FROM COMMERCIAL TO EXECUTION PHASE	11
2.1 <i>Bid Strategy</i>	11
2.2 <i>Commercial/ Tendering Phase</i>	12
2.3 <i>Contract Award</i>	23
2.4 <i>Transfer of Tender information (Hand Over to Execution)</i>	23
3. THE FIRST OPERATIVE SITE SURVEY	25
4. STARTING THE OPERATIVE CONSTRUCTABILITY	29
4.1 <i>Introduction to the Constructability approach</i>	29
4.2 <i>Preparation Phase</i>	35
4.3 <i>Implementation Phase</i>	40
4.4 <i>Execution Phase and Close Out</i>	41
4.5 <i>Constructability Checklist</i>	42
5. THE CONSTRUCTION EXECUTION PLAN; WBS, SEQUENCES AND STRATEGIES DEFINITION	47
5.1 <i>Erection sequences and priorities</i>	48
5.2 <i>Site Logistic and Temporary Construction Facilities</i>	49
5.3 <i>Subcontracting Plan</i>	50
6. REDUCTION OF THE SITE ACTIVITIES: ALTERNATIVES TO THE STICK-BUILT APPROACH	52
6.1 <i>Modularization approach</i>	52
6.2 <i>Modularized buildings</i>	57
6.3 <i>Preassembly of Steel structures and Pancake approach</i>	59
6.4 <i>Precast Methodology</i>	64
7. PERIODIC VERIFICATION OF CONSTRUCTION QUANTITIES & UPDATING OF CONSTRUCTION PLAN	72
7.1 <i>Follow-up with Site performance and further evaluations</i>	74
8. CONSTRUCTION HSE SYSTEM	76
8.1 <i>Project HSE Plan</i>	76
8.2 <i>Project HSE Organization</i>	78
8.3 <i>Medical examination and training</i>	79
8.4 <i>Risk Assessment</i>	79
8.5 <i>Permit to work</i>	81
8.6 <i>HSE meeting</i>	81
8.7 <i>Incident reporting and investigations</i>	82
8.8 <i>Audits and inspections</i>	82
8.9 <i>Monitoring and review of HSE performances</i>	83
9. SITE QUALITY SYSTEM	84
9.1 <i>Quality Planning</i>	84
9.2 <i>Quality Assurance</i>	86
9.3 <i>Quality Control</i>	87
9.4 <i>Activities of Project Quality Management in Home Office</i>	89
10. TEMPORARY CONSTRUCTION FACILITIES	90
10.1 <i>Bid Inquiry, Subcontract award, permitting and construction of the TCF</i>	91
10.2 <i>TCF Operations and Field Running Costs management</i>	94

11.	THE SUBCONTRACTING PLAN AND THE SELECTION OF CONSTRUCTION SUBCONTRACTORS.....	96
11.1	<i>Definition of the Scope of work split.....</i>	96
11.2	<i>Bidder list definition and Subcontractor qualification.....</i>	96
11.3	<i>Preparation of Subcontractor Tender documentation.....</i>	98
11.4	<i>Purchase Request (PR) Preparation.....</i>	98
11.5	<i>Inquiry management.....</i>	99
11.6	<i>Bid Evaluations.....</i>	100
11.7	<i>Subcontractor Mobilization.....</i>	100
11.8	<i>Variations & Changes.....</i>	101
12.	THE SITE SUPERVISION PLANNING, MOBILIZATION AND LEAN CONTROL.....	103
13.	THE DEFINITION OF THE SITE ORGANIZATION CHART.....	107
13.1	<i>Typical EPC Contractor Site Organization.....</i>	107
13.2	<i>Organization with a Direct Hiring approach.....</i>	110
14.	ANALYSIS OF PERIODIC CONSTRUCTION HOME OFFICE REPORTS.....	112
14.1	<i>Construction Home Office Reports.....</i>	112
14.2	<i>Methodology.....</i>	112
14.3	<i>Site Reports.....</i>	112
14.4	<i>Construction Home Office Reports.....</i>	112
15.	ACTIVATION OF MOBILIZATION PLAN.....	118
16.	METHODOLOGY AND TECHNICS OF COST CONTROL FOR SITE CONSTRUCTION ACTIVITIES.....	121
16.1	<i>Methodology.....</i>	121
16.2	<i>Technics of Control for Site Construction Activities.....</i>	122
17.	THE CONSTRUCTION KEY PERFORMANCE INDICATORS AND THE PRODUCTIVITY ASSESSMENT.....	129
17.1	<i>Methodology.....</i>	129
17.2	<i>Construction Key Performance Indicators.....</i>	132
17.3	<i>Project Key Performance Indicators Collection And Distribution.....</i>	135
17.4	<i>Project Key Performance Indicators Analysis.....</i>	136
17.5	<i>Contractual KPI collection and distribution.....</i>	136
17.6	<i>Contractual KPI analysis.....</i>	136
18.	CONSTRUCTION RISKS AND OPPORTUNITIES.....	137
18.1	<i>Risk Categorization.....</i>	137
18.2	<i>Risk management.....</i>	138
18.3	<i>Risks and opportunities typical of the Construction phase.....</i>	140

1. Introduction – Construction Start-up: Home Office activities development towards Site

The aim of this paper is the collection of the best practices from the perspective of an EPC Contractor that should be put in place during Project execution and, in particular, Construction start-up in Home Office, for an effective and smooth management of the activities developed at Site both for Construction and Pre-Commissioning/ Commissioning (with respect to Time, Costs and risks management), as per below representation.

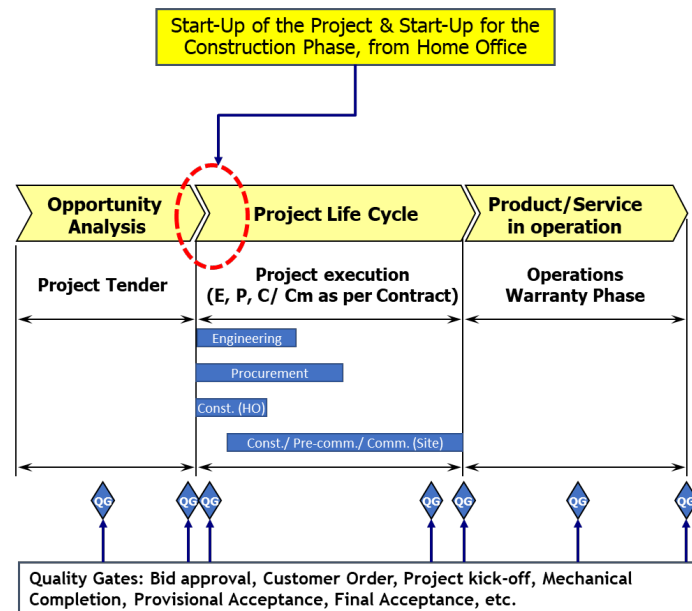


Figure 1 - Applicability of the white book

The paper consists in different sections that cross the disciplines and topics that are to be dealt with during the Home Office phase and include themes related to:

- Handover from the Tender phase to the Operative Project
- Set-up of the Constructability Plan
- Definition of the Construction Plan and related activities
- Control of the status of the activities planned at Site (with periodical review of the Construction quantities) as well as of the activities executed (with specific reports and KPIs monitoring)
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- Mobilization of Contractor personnel for Supervision and support activities
- Approach to the Subcontracting process, from the definition of the strategy to the award of the Subcontracts.

These themes that may have different relevance from Project to Project, in relation to Contractual frame, location, magnitude of the Scope of Work, partnerships, presence of Advisors, previous experiences in the Country/ type of plant/ Client but, in any case, they have

to be taken into duly account for the entire development of Construction phase, from the Home Office onwards.

The paper has been redacted with the aim of supporting the development of the Home Office Construction Team in the day-by-day activities and in the main steps that are mandatory to be fulfilled prior to start the Site activities. In particular, the paper wants to illustrate:

- The preparatory activities that are to be executed in the initial phase of the project allowing for a smooth and rapid Site activities execution
- How to support and monitor site activities as well as how to react to Site unexpected needs
- The periodic reporting to the management of the various business functions of the progress achieved at Site
- The development of new methodologies and systems for the management of Construction activities.

2. Tender Phase & Handover from Commercial To Execution Phase

2.1 Bid Strategy

Bid strategy and Commercial/ Tendering activities can be related to different type of Contracts relevant to scope of works included ITT (Instructions to Tenderers) documentation:

- EPCI (Detail Engineering, Procurement, Construction and installation)
- EPC (Detail Engineering, Procurement, Construction or Workshop/Yard Engineering, Procurement and Construction)
- PC (Procurement and Construction)
- C (Construction)

And different compensation methods; among the others the following are the most diffused ones:

- Lump sum
- Provisional sum
- Unit rates
- Time rates
- Reimbursable.

Contractual conditions and competitive scenario can also affect the bid strategy.

The following paragraphs describe the process that is related to a Tendering phase for an EPC project.

Tendering /Bidding phase is the first part of an EPC Project Life Cycle and is linked to the Project execution bid phase through the phase of Transfer/ Handover from Commercial to Execution team. The Figure 2 shows the main activities developed during the Project life cycle.

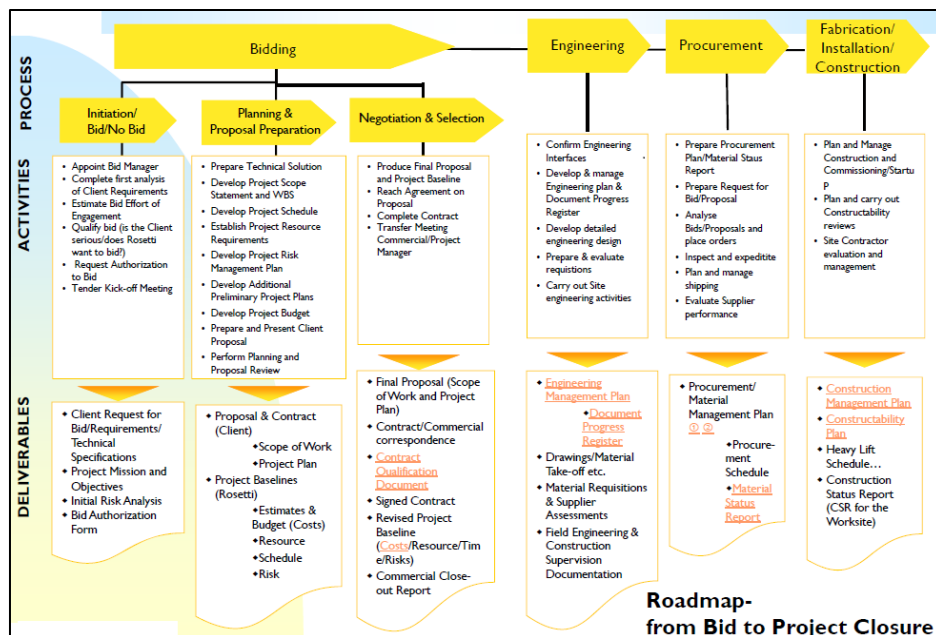


Figure 2 Project life cycle (from Bid to Project closure)

2.2 Commercial/ Tendering Phase

Commercial/Tendering Process involves the following main phases: bid/no bid decision, offer development and preparation, offer signature and transmission to Client, follow-up, project award and contract review and finally transfer of tender to the Operations.

The main macro phases are shown in Figure 3.

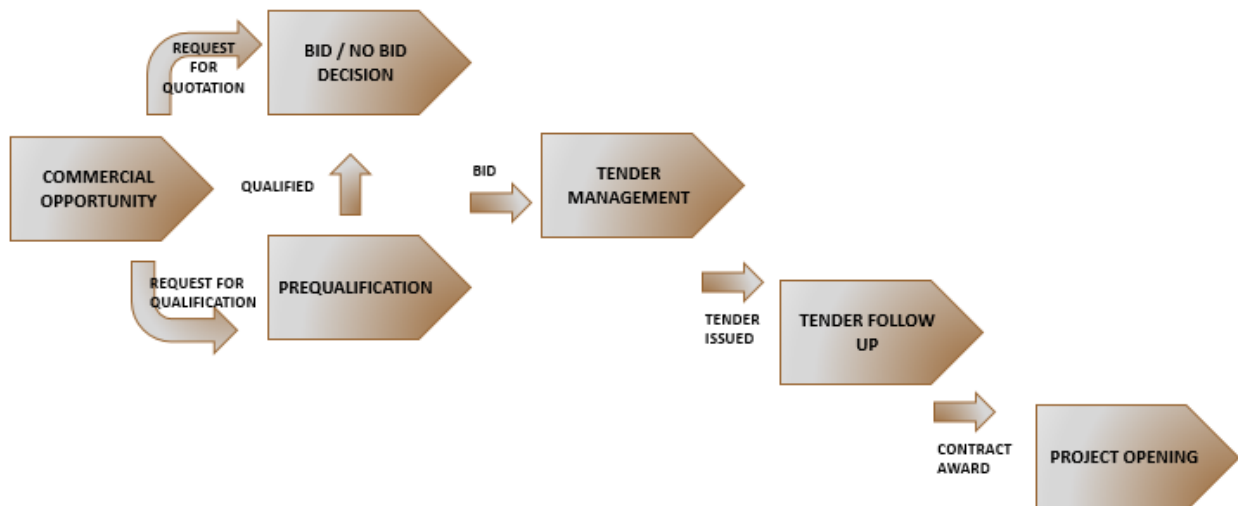


Figure 3 Commercial/Tendering process macro phases

2.2.1 Pre-qualification activity

Competitive tenders usually require a pre-qualification process in order to evaluate supplier competence. Accordingly potential Tenderers, before being invited to formulate an offer for a new project, receive a questionnaire of pre-qualification. The pre-qualification requested by the Clients, both new and consolidate, seeks basically to verify:

- The financial stability.
- HSE Index statistics.
- Quality management attitude.
- Management capability.
- Technical capability.
- Previous similar experiences (for technology, size, location, etc.)
- The allowed workload.

If qualified by the Client, Tenderer Sales Department will receive the Invitation To Tender (ITT), and the Tenderer will evaluate whether to quote or decline the Request for Quotation (RfQ).

2.2.2 Invitation To Tender (ITT)

The Client issues a codified set of documents called Tender Documents that are included within the Invitation To Tender (ITT), which provide a detailed descriptions of the construction service often to be rendered as follow:

- Instruction to Tenderers: general instructions and rules concerning the tender submission mode in which are defined the other section.
- Tender Form: list of the required documents both technical and commercial, who tenderers shall issue to the Client within the bid.
- Form of Contract: list of documents issued by the Client in the ITT that defines the structure of contract when it will be awarded.

The instructions show how to organize the offer, describing the content of each section, both in the technical part and in the commercial one. Often the bid submission consists of three parts:

- Technical Proposal
- Technical & Unpriced Commercial Proposal
- Priced Commercial Proposal

Technical & Unpriced Commercial section usually includes organization chart, execution plans, coordination procedures, HSE and QA\ QC requirements, project schedule, technical exceptions, reference list and similar projects successfully completed in the recent past, etc. The Priced Commercial part contains mainly contractual conditions such as lump sum bid price, terms of payment and/ or milestone payment schedule, schedule of unit rates of personnel, materials and equipment and other details concerning commercial information. This structure is necessary to the Client in order to receive standard offers among the tenderers and even for these latter in order to accomplish bids based on the key factors shown within the tender documentation.

2.2.3 The decision to quote (Bid/ No Bid decision)

Tender preparation requires a not negligible effort in terms of high costs as well as time consumption. All costs borne by Tenderer for/ in connection with the bid preparation and submission, clarification and negotiation (including the attendance at any meetings associated with the tender), normally are for tenderer's account. Furthermore, very often the clients impose the payment of a bid bond¹ for those who decide to participate in the tendering, with the aim of ensuring the submission of multiple bids.

This effort, considering the simultaneous preparation of several complex bids, implies that a thorough evaluation of pros and cons must be performed, considering all involved aspects and personnel both in the tender process as well as for the project execution.

¹ Bid bond: is a cash deposit requested by the owner to all bidder involved during the tendering process, in order to insure that the bidders can comply with the bid contract and also they can accomplish the job as laid out in the contract. Is a proof that the bidder has the capability to take on and implement the project once he is selected during the bidding process.

In order to decide if a proposal can be submitted, the following activities are put in place after receiving a Request for Quotation from a Client:

- Quick ITT documentation analysis
- Definition of the budget cost estimating and timeframe for the preparation and offer submission (in case of tendering that requires considerable engineering resources)
- Available resources in terms of engineering and management to develop the tender activities
- Country situation in which the project should be developed
- Client and possible prestige in participating to the tender
- Specific technical requirements
- Strength points and competitive positions with other competitors.

2.2.4 Tender Management

The Tendering Process normally involves the following areas:

- Tender Management
- Cost Estimating
- Tender Engineering

The Tendering Department works in close synergy with the Sales Department: if the sales activity is to monitor the market, keep the relationships with consolidated Clients alive, identify new potential projects and potential new Clients, as well as participate in the preparation of offers, the objective of the Tender/ Proposal Manager is to prepare the offers according to the Invitation To Tender (ITT) documentation. In this task are supported both by Cost Estimators who prepare the estimate and prepare the cost tables maintaining their traceability and by the Tender Engineering that manages:

- The endorsement of the technical documents of the tender phase
- Tender engineering activities and supports the Tender/ Proposal Manager in the preparation of the technical proposal and related qualifications.

2.2.5 Tender start-up

Once the decision to quote has been taken, Tender/ Proposal Manager will be responsible for the offer preparation, in particular:

- Establishes the planning and distribution of the bidding activities.
- Identifies the main actions for the choice of tender strategy, carefully assessing the resources (staff, times, budget). In Figure 4, the main activities relevant to Tender preparation process are shown.

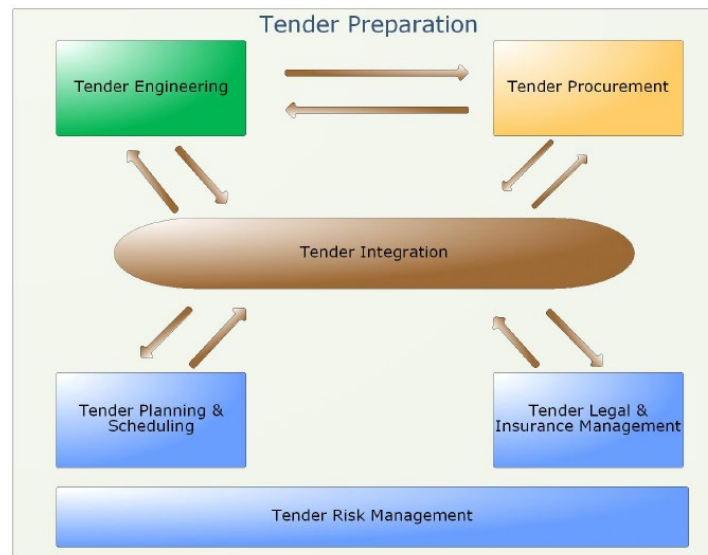


Figure 4 Tender preparation schematic diagram

2.2.6 Planning and offer activities distribution

After evaluating the availability of the ITT documentation and its completeness, the Tender/ Proposal Manager defines a preliminary SoW, the matrix of responsibilities and plans the preliminary activities to be performed (Tender Plan) through the compilation of the Tender Plan Dossier. This document allows clear and precise ordering of all the information necessary for preparing the offer. It is organized as follow:

- Brief summary about Scope of Work (SoW) specifying the goals of each discipline
- Proposal Index organized as requested in the ITT with the corresponding assignments to the tender team involved
- Tender schedule, that is the schedule comprising the detail activities/ steps required to complete the offer split basing on the overall Work Break-Down structure (WBS), if required
- Preliminary Project Schedule, which describes the timing of execution of the Project's activities
- Preparation of Responsibility Matrix, in case of subdivision of scope with Nominated Subcontractors or Partners, if any.

For the most complex offers, the Tender/ Proposal Manager calls and runs the Tender Kick-Off meeting, where explains to all participants in the bid preparation, the evaluations that have led to the Dossier Tender Plan in order to get the completely understanding of the SoW and the tasks to perform by each actor involved.

At this point, the Technical and commercial offers preparation shall start.

2.2.7 Proposal Integration

This is the core of the whole tendering process developed under the coordination of the Tender/ Proposal Manager along with the cooperation of different functions/ services and in particular:

- Engineering (usually specialized in Tenders management, due to peculiar approach and timing)
- Procurement (usually specialized in Tenders management, due to peculiar approach and timing)
- Planning & Scheduling (usually specialized in Tenders management, due to peculiar approach and timing)
- Legal & Insurance Management (usually specialized in Tenders management, due to peculiar approach and timing)
- Risk Management (usually specialized in Tenders management, due to peculiar approach and timing)
- Construction proposal (which should be a figure capable of combining experience deriving from actual Sites with the specific requirements for the Tender)

The bid preparation is an integrated process of responsibility and activities assigned to different persons and corporate functions, both regarding the technical side as well as the commercial one.

Most of these activities are performed simultaneously and the different functions do not act sequentially, but rather they operate in parallel with continuous improvements and exchange moments during the whole process, with the aim of matching Client's requirements in terms of Tender issue.

2.2.8 Technical offer preparation

Engineering team starts to analyze the ITT technical documentation, to assess its completeness and consistency. Through the assessment of the technical documentation, technical queries and deviations can be identified and addressed to the Company. Similarly, any contractual qualification that is identified can be prepared with the support of the legal & insurance management and, in any case, should be validated by the same.

In case of major orders (in terms of magnitude) or where are involved new products/ new technologies/ new major Clients or new typologies of plants, the Tender/ Proposal Manager shall ask the functions that support the offer preparation to identify potential risks and opportunities that are considered significant and that can affect activities performance, resources, time and costs, in case of contract award.

2.2.9 Cost estimate preparation/Price definition

A dedicated Cost Breakdown Structure (CBS) is defined in accordance with the SoW and the price list included within ITT (which coincides with the price breakdown normally presented to Clients), based on the level of detail that has to/ can be achieved in the same proposal development.

The cost estimators collect and elaborate the cost contributions that may come from:

- Cost of materials (with the support of procurement function): it can be obtained through mean of a Bid-for-Bid Inquiry and/ or with proper parametrizations done considering previous similar experiences (provided that Engineering has to support the whole process, where required)

- Management costs and indirect project costs evaluation: supported by the Tender/ Proposal Manager and the services area, based on the requirements included in the SoW
- Definition of the Site-associated costs, which has to include the costs required for the works execution (direct and indirect), supervision costs, site-supplied materials, commissioning costs, utilities costs, etc., as explained also in the following chapters
- Cash flows definition based on the payment conditions required by the Client as well as the Project schedule/ progress
- Updating of cost analysis with the results of risk analysis carried out by Tender/ Proposal Manager

The price to be presented to Client as part of the Commercial Offer is decided evaluating:

- Expected Contribution Margin
- Commercial strategy adopted to increase the probability to achieve the Award of the Contract
- Financial costs (for those not included in costs as, for example, expenses for bank guaranties)
- Risk margin (normally expressed as a percentage of the voices/ items affected by relevant risks).

In the following scheme (ref. to Figure 5) are separately exposed the main activities carried out concerning Engineering, Procurement, Planning/ Scheduling and Risk Management that lead to final offer and cost estimate.

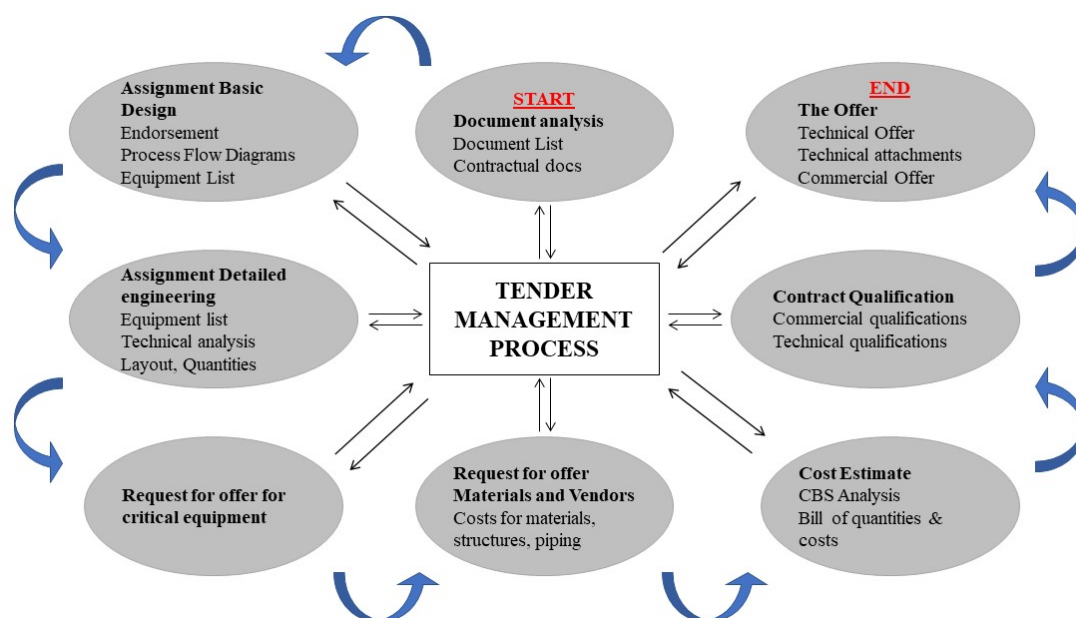


Figure 5 Tender Management Process

2.2.10 Tender engineering

After the tender start-up, the Tender Engineering Manager defines the tender engineering scope of work and it schedules the activities, in collaboration with the Tender/ Proposal

Manager as well as the Cost Estimator Leader. Tender engineering activities mainly involve the following:

- Endorsement of ITT technical documentation (if required by Client in Tender phase)
- Issue of tender engineering documents to allow cost estimate preparation.
- Preparation of Technical queries/ Technical qualification/ Technical deviations
- Procurement engineering activities in order to allow proper evaluation of procurement costs.
- Supporting cost estimate of engineering activities for the project phase.
- Support the development of the construction engineering estimate required to develop a clear analysis of construction activities during execution phase (and associated costs).

2.2.10.1 The endorsement process

Scope of the endorsement is to review FEED documentation provided in the ITT, if it is available, in order to verify the adequacy of the engineering provided by Client which will form the basis for the EPC Contractor's detailed design. To the FEED or any other input information provided by Client, it may be applied the rely-upon information clause (i.e., in case of error, omission or inaccuracy in such information, Contractor is entitled to ask for a Change Order or to claim for time and/ or money).

Contractor (Tenderer) shall focus endorsement activities particularly on the following:

- perform the verification and validation of the received technical documentation
- identify any inconsistencies/ discrepancy among the documents received
- request to the Client any additional information required to clarify the SoW, the inconsistencies and the technical problems that may be present in FEED engineering
- make explicit clarifications, assumptions, choices that are required to validate the engineering of the FEED provided by Client.

2.2.10.2 Construction engineering and study of appropriate construction solutions

During the Tender process, in order to properly assess costs relevant to construction phase, it is often necessary to develop some preliminary studies in terms of verification of suitability of erection activities or assessment of lifting requirements. This is linked to necessity to verify the availability of areas at Site and surroundings, proper means for operations, sequence of activities and construction schedule.

An example of one of these studies is provided in Figure 6, where the erection sequence study for an offshore topside is provided.

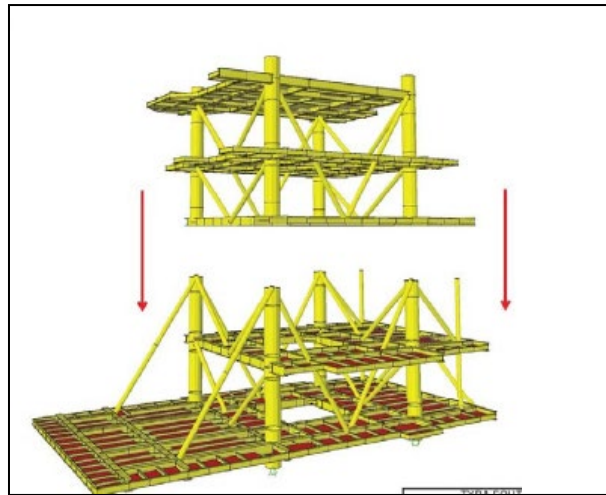


Figure 6 Typical preliminary erection sequence for an offshore topside

An additional example of the studies developed in Tender phase is reported in Figure 7; this kind of study is developed mainly for two reasons:

- assess feasibility of lifting operations (in relation to the surrounding elements which will be present at Site, and other logistic constraints)
- Preliminarily identify the lifting equipment required for a safe execution of the lifting activity.

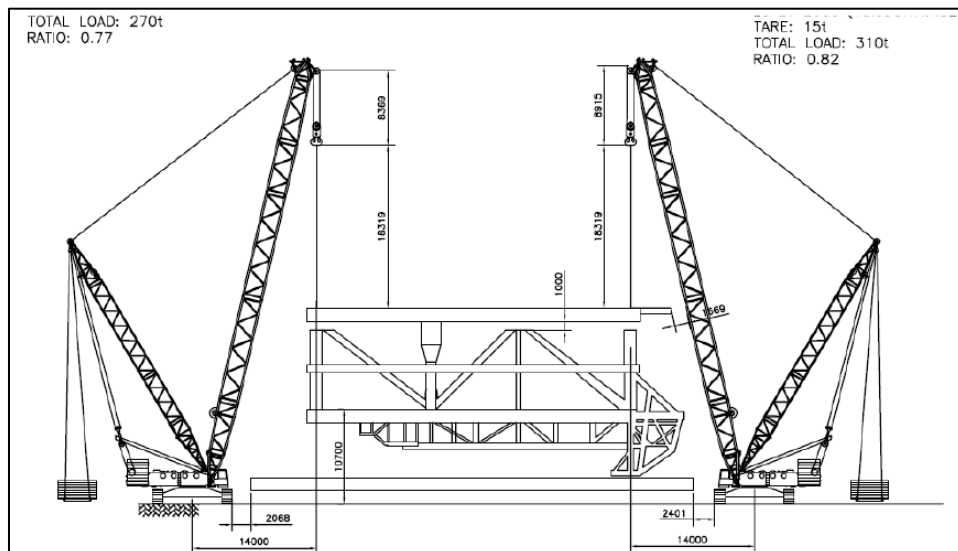


Figure 7 Typical lifting scheme

2.2.11 Tender procurement

Based on the principle that Subcontractors and suppliers/ vendors will play a key role in the execution strategy, their involvement shall be duly estimated during the Tender phase, reflecting as much as possible the strategy defined for the Project in this phase. Consequently, a preliminary procurement strategy needs to be set.

The procurement strategy can involve for instance the decision to purchase all materials loose or to ask Vendors to provide pre-assembled parts of the plants (skids/ packages) or can be related to division of SoW according to a Responsibility Matrix in case of offers submitted with partners or nominated Subcontractors (including module yards). Furthermore, the Procurement strategy includes the definition of additional Vendors that have to be proposed to Client (further than specific requirements in terms of Vendors list included in ITT documentation).

During Tender preparation, Tender procurement activities involves sending to Vendors request for quotation (the so-called Bid for Bid) with the aim of collecting costs and delivery information of items to be procured (in parallel, the Subcontracting division may inquiry the market looking for potential partnerships and/ or market indications on the prices variations). Once the quotations return, begins the process of Technical Bid Evaluation (TBE) in order to properly verify the quality and completeness of the technical offer received.

During the Tender Procurement process, the most important document prepared is the Procurement Plan, which includes the following information:

- Identify critical equipment
- Identify priority of delivery of material requisition from engineering
- ensure that the dates of delivery proposed by the Client (if any) are compatible with construction activities.

Along with the Tendering process, as soon as the information from Vendors are available (through the offers received), the Tender/ Proposal Manager can fill all the information on the Procurement Plan (i.e. delivery time for each item) in order to define the possible dates for issue of Purchase Orders (PO) during the execution phase (considering also construction requirements in terms of delivery of each item at yard construction site).

This information is fundamental since from the dates of the Purchase Order, it is possible to highlight which items are critical according to the Project schedule and consequently to verify if the Procurement schedule is in line with Engineering schedule.

Based on Procurement criticalities (e.g. long lead items - LLI), it can be verified if the dates of issue of Purchase Orders comply with the Engineering schedule during the execution phase.

2.2.12 Tender planning and scheduling

The aim of this activity is to define the Tender Master Schedule (TMS), which is the basis for the Contract Master Schedule (CMS) and involves the analyses of the durations and the sequences to be pursued during project execution, comprising the relevant information resulting from the bid documentation (issued by Client) and the Tender Procurement Plan (issued by Tenderer). Tender planning shall be developed in strict cooperation with the involved disciplines, i.e. Engineering and Construction, in order to validate the dates of issue for the engineering deliverables and the site activities program, as well as the assessment of the available resources.

An example of preliminary work schedule developed during Tender phase with dedicated software is reported in Figure 8.

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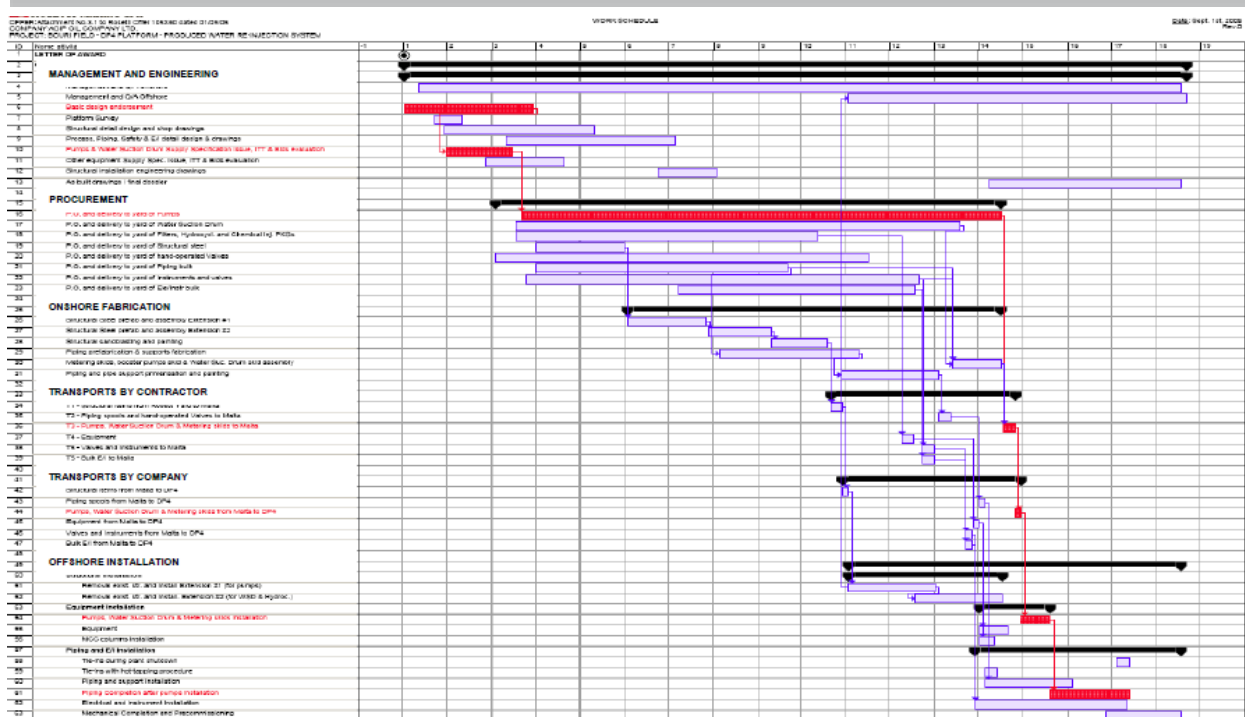


Figure 8 Preliminary work schedule (developed during Tendering phase)

2.2.13 Commercial & Contractual

Tender process, from the point of view of the Tenderer/ EPC Contractor involves also the review and deep analysis of commercial and contractual documents and conditions included in the ITT proposed by Client and normally included in a dedicated section of the ITT itself that will become the core of the future awarded Contract (they may be identified in the contract body as Special Contract Conditions and/ or General Contract Conditions).

2.2.13.1 Tender Legal & Insurance Management

Tender/ Proposal Manager and Sales Manager are usually supported by Legal department in the control of contractual documentation received along with the ITT. Furthermore, Legal department supports in the definition of any necessary insurance coverage and contractual qualifications to be submitted to Client along with the complete set of technical and commercial offer.

2.2.13.2 Commercial / contractual evaluations

Commercial and contractual evaluations are an important step in the offer preparation, since it can strongly affect costs estimation and may require also to issue dedicated qualifications in order to reduce risks related to those conditions. The main issues which are normally addressed may be the followings:

- Liquidated Damages or similar penalties (liquidation of the damage caused by the contractor in case of given contractual nonfulfillment), usually with not-to-exceed limited indicated
- Bank Guarantees (advance payment bond, performance guarantee/ performance bond, retention money), and check of the conditions of release.

- Dates for Mechanical Completion (MC), Provisional Acceptance Certificate (PAC, which normally identifies the duration of the Project) and Final Acceptance Certificate (FAC). It must be controlled if the dates of the related events are verifiable by Contractor.
- Insurances at Contractor's charge
- Invoicing of milestones e payments: to be preferred those leading to a neutral cash flow
- Further analysis of the contractual terms and of the relevant risks will be carried out considering:
 - Typology of the proposed Contract (an EPC contract has different obligations for the partis rather than EP and Site Services as well as different compensation methodologies)
 - The country where the Project shall be executed
 - Any other issues that may arise in relation to the local laws and regulations.

2.2.14 Tender risk and opportunities management

The risk management process, during the last decades, has become an important practice in most project-based organizations, both in Tender and in Operations phases. To be competitive and able to take correct decisions during project development, it becomes crucial to take advantage of the knowledge and past experiences within the organization as well as to properly assess risks and opportunities.

It becomes very important to apply Risk management approach since Tender phase, in order to minimize risks with negative impacts on the Project as well as to maximize risks with a positive outcome (opportunities), ensuring a proactive risk management throughout the whole project and facilitating the delivery of a successful project to the Client.

During the tender preparation, the Tender/ Proposal Manager shall ask the functions involved in the offer preparation to identify potential risks and opportunities that are considered significant and that can affect activities performance, resources, time and costs in case of contract award.

The Functions involved in the analysis of tender documentation, carry out the Risks & Opportunities assessment for the pertaining discipline, basing on a Risk Breakdown Structure (RBS) as a guideline.

The Tender/ Proposal Manager, supported by the Risk Manager, collects and integrates in a unique register (R&O Register) the indications received and it can interface with the functions to define impacts, probabilities of happening and actions that can help to mitigate and/ or maximize the identified R&O. This allow for an assessment of the contingencies that are to be included in the Commercial Offer to be submitted to the Client.

In case of Contract Award, the Tender/ Proposal Manager prepares an R&O summary that shall be included in the Transfer Dossier and shall be communicated during the transfer meeting to the Operational team for proper follow-up and revision.

2.2.15 Clarification phase

Once the technical and commercial offers are submitted, the consequent phase of the Tender starts with the issue (from Client to Tenderer) of the Requests for Clarifications as well as

holding Clarification meetings (normally with the contemporary presence of Tenderer, Client, PMC and Partners, if any).

The Cost Estimating Team assigned to the Tender cooperates in strict conjunction with Tender/ Proposal Manager and departments involved during the Clarification Meetings, updating costs included in the offer aligning the same to:

- The updated requests (received with Bid Bulletins or during the Clarification meetings)
- New documentation received
- Modifications due to technical or commercial negotiations or qualifications
- Different commercial strategy adopted.

At the end of the clarification and negotiation process, the Client decides which Tender is deemed more reliable in the execution of the Project. If the contract is awarded, Tender/ Proposal Manager collaborates in the preparation of the Project Original Budget (that will be made available to the Project Management Team for the Project execution) starting from the Sales Budget, on which the Commercial offer is based.

2.3 Contract Award

Once completed the negotiation phase and agreed the final price, in case of Contract Award, the Client normally anticipate the final setting of the Contract, by sending a Letter of Award (LOA²).

Once received the LOA, it should be accompanied with the negotiated version of the contractual documentation for final check and official acceptance.

The Tender/ Proposal Manager and Sales Manager perform the review of Contract, verifying compliance with technical offer and attached schedule. If the Review gives a positive result, the order is confirmed and the Contract Signature Ceremony, whether required, can take place. If the confirmation cannot be reached directly, a further step of alignment meeting is held, with the aim of cleaning any remaining discrepancy.

2.4 Transfer of Tender information (Hand Over to Execution)

The Transfer of Tender represents the transfer of technical and contractual documentation (inclusive of the schedule and of any other study performed during Tender phase), from Proposal team to Operations one. The transfer is performed after the negotiation phase has been concluded and the LOA has been received from Client. This is true especially if to considered that often the LOA is jointly valid also as Notice To Proceed (NTP), which make the Project Calendar to start (or, equivalently, indicates the Effective Date).

Transfer sessions (technical and commercial) have the scope to put the Project Director/ Manager and the Project Team capable of executing smoothly the Project by transferring the documents in an orderly way divided into:

- Contract documentation with all the technical part and agreed qualifications.

² Letter of Award (LOA): written confirmation of an award of a contract by a costumer (owner or principal) to a successful bidder, stating the amount of the award, the award date, and when the contract will be signed.

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- Cost estimate documentation and offers of suppliers and subcontractors (if any)
- Offer documentation and subsequent revisions.

The main goal of Transfer process is to deeply inform the Project Director/ Manager and relevant Project Team about:

- Scope of Work
- Quantities
- Assumptions
- Qualifications
- Risks
- Priorities
- Opportunities
- Etc.

The 'Focus' in the Transfer Process is the 'Sharing' of elements which define the 'Baseline' for the Project and, consequently, the Target that the entire Project Team shall address.

Commercial Transfer has mainly the scope of transferring the budget and contractual conditions agreed in the Tendering/ negotiation phase.

After Transfer to Execution phase, Tendering and Project Areas remain linked since during Project execution, both intermediate feedbacks and lessons learnt as well as dedicated close out reports (prepared at the end of the Project) provide important elements for Tender Team for new Inquiries.

This circular mechanism, can be represented as a Loop, as shown in Figure 9.

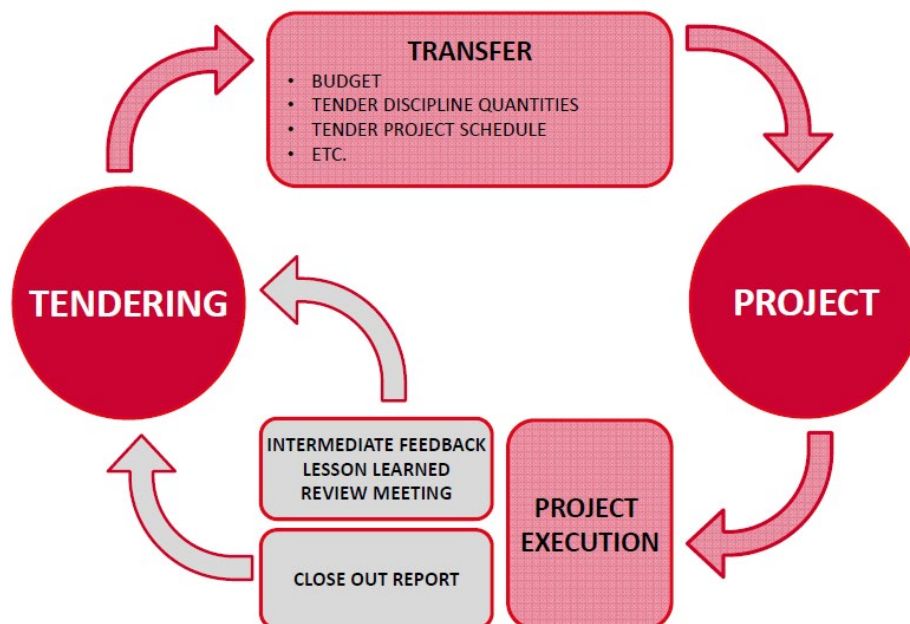


Figure 9 Tendering and Project execution phase – Transfer and feedback scheme

3. The first operative Site Survey

Considering a new acquired Project, in parallel to the definition and confirmation of the contractual requirements considered in the Tender phase as well as indicated in the signed Contract (as described in Section 2), it is extremely important to determine the actual boundary conditions to the Site activities development.

This activity has the aim of defining the available resources/ facilities/ areas at Site (or its surroundings) against the estimated needs for a smooth execution of the Construction phase.

Since it is quite common for an EPC Contractor to execute Projects of a certain complexity in remote/ complex areas, a mandatory step for a proper assessment of these conditions is a Site Survey which shall be targeted to the evaluation of the following main items:

- Site accessibility
- Site conditions and interfaces (which may be with Plants in operation (owned by the same Client or not), other Contractors operating in the same Site/ Area or other on-going Projects in the same Area/ complex)
- Accessibility for areas relevant to TCF and preliminary definition of possible logistic with Site
- Security requirements (due to Project's Country law-imposed, Client's access and security procedures and similar requirements)
- Preliminary accommodation availability, in relation to the strategy to be adopted.

Considering the nature of the survey to be performed, it is important that the participants to the same survey are pertaining to different departments; the designed team shall comprise personnel from Construction Department (both Home Office and Site, with the participation of the Site Manager, if already assigned to the Project, with the aim of combining the different needs for the teams of the department), Engineering (as a minimum having Project Engineering participating, especially in case of interfaces/ tie-ins with other plants/ facilities/projects or in case of preparatory activities required as in case of Site Preparation needed prior to permanent works), Human Resources/ Project Management representatives, in relation to general requirements (e.g. the accommodations) and specific functions which may be required such as Logistic, Security or HSE Departments.

Furthermore, it has to be taken into account the contractual frame: the mentioned positions mentioned above may be duplicated in case of a partnership of any type constituting the Contractor side (Joint Venture, Consortium or equivalent agreements under Applicable Local Laws). A clear example of this can be evinced in Figure 10, where the participants list to the Site visit for a project in Egypt includes key figures from both Partners which were constituting Contractor's Organization towards Client for the Project.

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	Site Visit Report	
	_____ Project _____ Egypt	

Report Issue date: 20th January 2012 Originator:
 Site Visit Date: 10th-12th January 2012
 Location: _____, Egypt
 Attachments: See the list of the Attachments

Project:

Subject of Report : Site Survey at (Egypt)

Attendants:

CLIENT PARTICIPANTS		<u>CONTRACTOR (JV) PARTICIPANTS</u>	
Name	Position	Name	Position
	Project Manager & Director		Project Director
	Production Follow Up Sector Manager		Project Manager
	Project Manager		Project Engineering Manager
	Engineering Manager		Deputy Project Engineering Manager
	Site Manager		System Design Manager
	Project Engineer		Plant Design & Piping
	Piping Leader		Civil Design
			Construction Lead Engineer
			Project Manager
			Dep. Project Manager / Construction
			Technical Manager
			Civil Construction Manager
			Senior Project Coordinator
			Electrical Technical Manager
			Senior Piping Engineer

Sheet 1 of 4

Figure 10 Extract from Site Visit Report

For an effective Site survey, the appointed team shall have a clear idea of the magnitude of the Project, inclusive but not limited to the preliminary construction execution schedule, the personnel mobilization schedule (for EPC Contractor personnel as well as for the Subcontractors), the tie-ins to be executed within operating plants and the key quantities for

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the Project with suitable subdivision (per area, discipline, packages, etc.); this subdivision shall take into consideration both the stick built activities as well as the quantities to be pre-fabricated/ pre-assembled/ modularized (and, consequently, a preliminary idea of Subcontracting plan to be adopted for the Project development) as well as the existence of modules to be built and delivered directly to Site on relevant foundations. This, together with the information of the areas made available by Client can give an idea of the additional requirements for the Temporary Construction Facilities required.

The items previously indicated are not only related to physical constraints/ barriers/ requirements, but they shall also take into account any requirement related to the Local Laws and regulations or Client's operative procedures, in order to identify in advance potential issues/ criticalities which can be solved in a smoother manner.

Consequently, for example, during the first survey, the basic information to be gathered are related to Site location and access ways (for personnel and materials), location of the temporary areas in relation to the Site, status of the areas, existence of visible (aboveground and, if possible, underground) hindrances, availability of facilities like drainage channels/ systems (especially required in case of dewatering or flooding), available services in the area (inclusive of first aid services, fire-fighting facilities and waste disposal services) and existing utilities networks and relevant capacities (potable and raw water, power, sewage, data connection), as well as relevant providers and procedure for connection. In addition to the basic set of information, it is required to investigate the possible routings for oversized/ overweight equipment/ materials and possible modules to be delivered at Site, with the identification of major constraints to these logistic activities and not less important every possible procedure required for accessing/ transiting in the identified routing and any actor involved in the entire step (Administrative, civil or military). This shall include the specific procedure required for the obtainment of the Gate passes necessary to access Site by EPC Contractor personnel and the workforce of the potential Subcontractors.

A clear example of the outcome of a survey of this type can be seen in the Figure 11, where an alternative routing required for administrative reasons has been evaluated during the first Site Visit performed during operative phase of the Project.

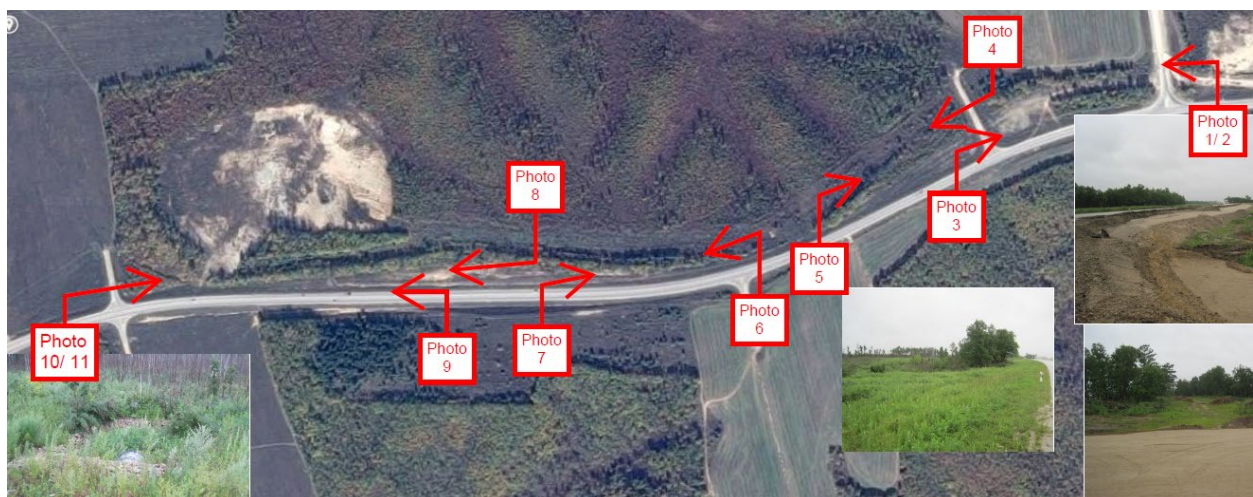


Figure 11 Extract from survey for access way for Oversize/ Overweight items

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The same approach for collecting the information can be adopted for the Site area, as shown in Figure 12: it has been duly noted in the plot plan the location and the orientation in which each photo has been taken and, together with dedicated Report, this document can become the basis for the development of the design as well as for the further steps to be taken during HO Construction development.

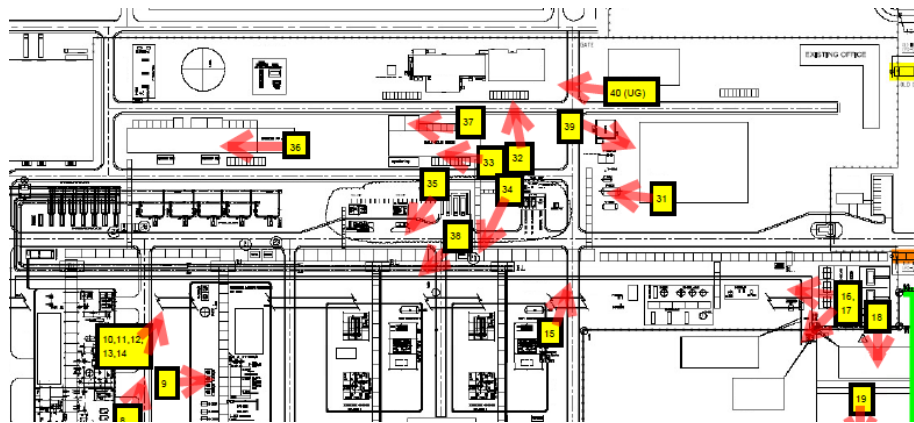


Figure 12 Extract from photographic report from first Site Visit

Attention shall be put towards Security. It shall be taken in due consideration that the country in which the Project is going to be developed can have specific rules of behavior or specific requirements to be fulfilled with respect to the management of expatriate workforce (direct or indirect), requiring for private/ military escorts or for special procedures to be put in place prior to start the massive mobilization of personnel. This may lead also to the impossibility of choosing the accommodation strategy for the workforce, leading to the definition of a unique accommodation camp for the entire workforce rather than apartments rented in the nearest city.

In any case, it shall be assessed the availability of sufficient land (for camps and any other facility required for the construction phase) as well as the existence of a sufficient number of flats for the estimated needs of the Project (especially in case the local conditions may have changed during the final negotiations for events internal or external to the country, such as pandemics, conflicts, economic crisis and similar).

4. Starting the operative Constructability

4.1 Introduction to the Constructability approach

Once the Project has been officially handed over from the Commercial department to the Execution team, one of the first tasks to be accomplished is the set-up of the Constructability Process, which is crucial to identify potential threats and identify the best strategies to be adopted for a successful execution of the Project.

Basing on the magnitude and the criticalities of the Project, as well as whether required in the ITB received from Client, it is possible that Commercial Team prepared some preliminary studies in conjunction with the Construction Operation Group present in Home Office. If these studies have been developed, it is important to hand them over to the team involved in the Project execution phase, since they belong to sequences and execution strategies that have been defined in the Proposal phase; these should be duly taken into consideration, since they are reflected into the budget defined for the Commercial Offer handed over to Client, as described in Section 2.2.

Furthermore, Constructability process shall start as soon as practicable due to its effectiveness. As it can be evinced in Figure 13, from *Construction Industry Institute - CII*, it is clear that the utmost impacts on the Project can be achieved in the earlier phases of the Project (Conceptual design/ Tender/ Engineering) while, once Construction phase is on-going, the impacts are sensibly lower and/ or savings are more complicated to be achieved.

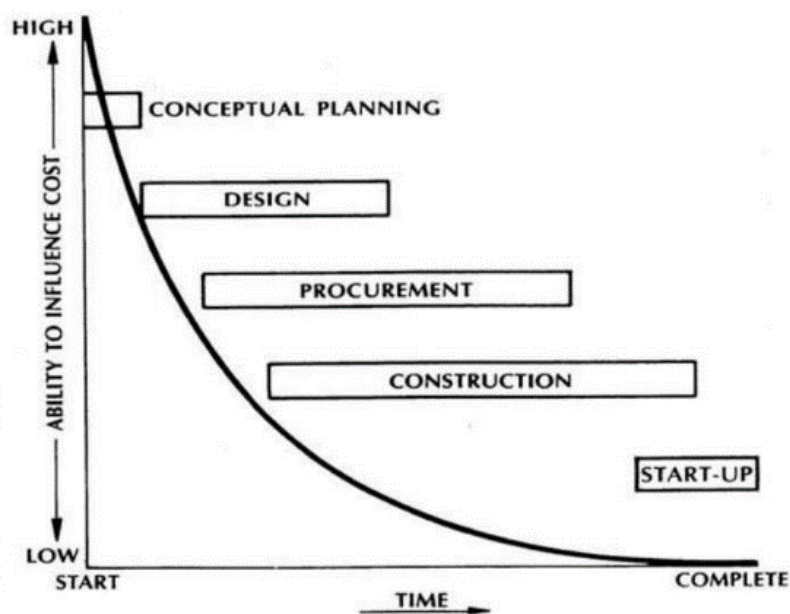


Figure 13 Constructability effectiveness (*Construction Industry Institute - CII*)

Benefits of implementing Constructability, indeed, are maximized when there is the chance to involve specialists with wide construction knowledge and experience from the very beginning of the Project, allowing for an early indication of the strategies to be adopted. Such an early involvement of construction may require an early investment for the Project; however, a proper implementation of the Constructability program counterbalance this investment since it can generate savings in terms of overall costs and/ or schedule reduction. Normally, the savings

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are evident during the construction phase, mainly due to a reduction of the total direct construction man-hours (related, for example, to optimized sequences and standardization of activities).

An earlier implementation of the Constructability program can generate (additional) savings due to the fact that design, procurement and planning are “*construction oriented*”, which results in the preparation of a solid and detailed Construction Execution Plan (as presented in Section 5).

In case of proper implementation and continuous attention towards Constructability, the benefits in terms of time and costs during construction phase will be largely compensating the efforts spent during constructability implementation (Figure 14).

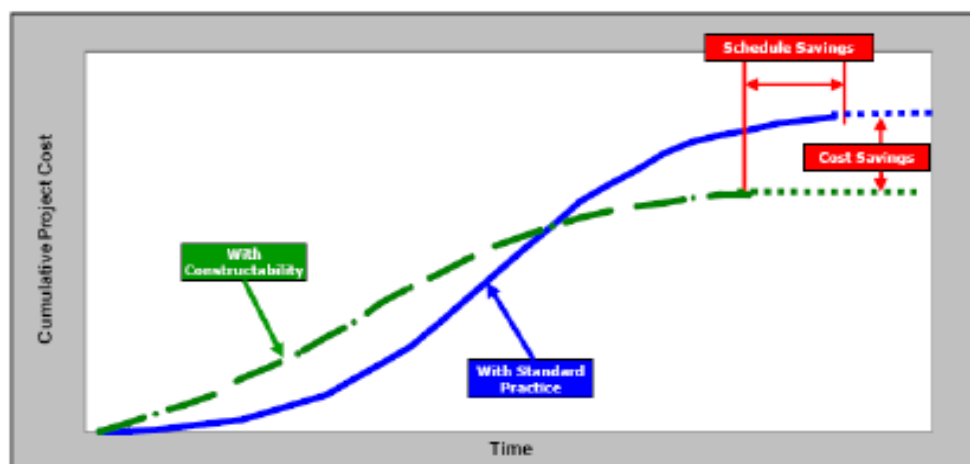


Figure 14 Cost and schedule savings due to an early investment in Constructability Program

These are the reasons for which the sooner the Constructability program is established and implemented on a Project, the greater will be the benefits in terms of Overall Cost and Schedule reduction, since the ability to gain a benefit from each Constructability decision depends on how early it is taken (see below Figure 15).

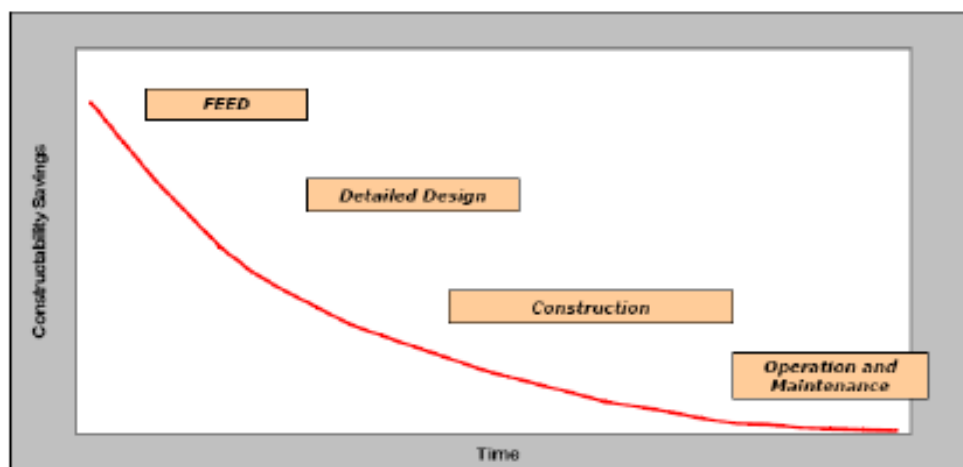


Figure 15 Ability to influence Constructability savings by Project phase

In the operative phase of the Project, the first step to be taken is the issue of the Constructability Plan tailored to the Project, which includes a definition of:

- Composition, roles and responsibilities for the multidisciplinary team which is going to be involved in the Constructability process (e.g. Project Manager, Construction Team, Engineering discipline leaders, Project Control Manager, Procurement Manager).

A typical organization for the Constructability Project Team can be the one reported in Figure 16

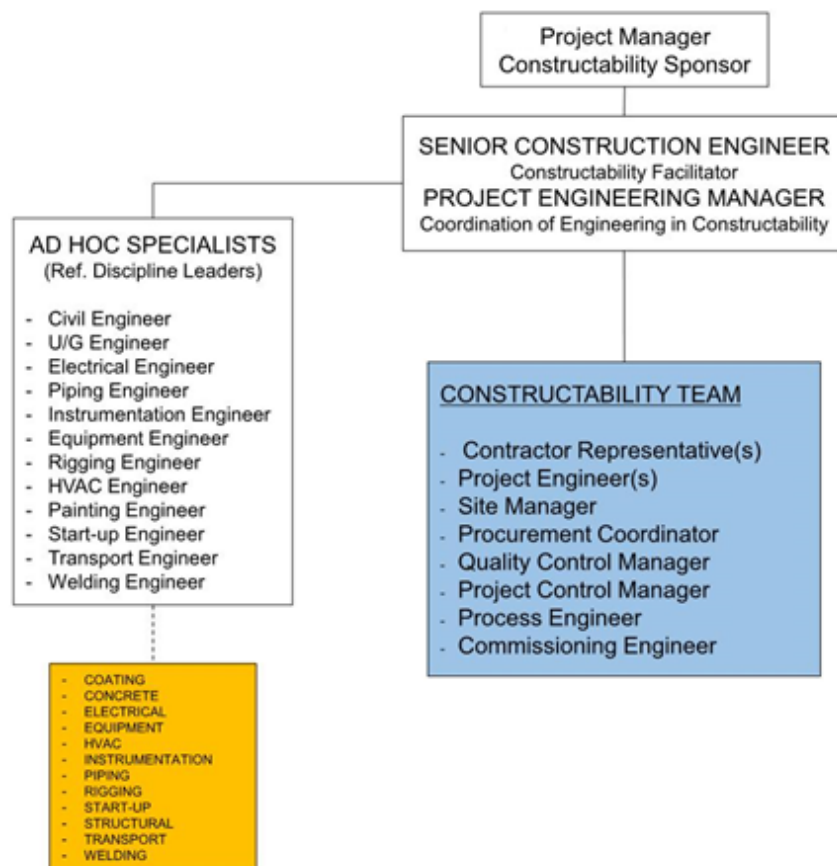


Figure 16 Typical Constructability Project Team

Normally, the organization (composed by the personnel indicated in Figure 16) is organized similarly to what proposed in Figure 17, where the Constructability Coordinator has the responsibility to manage the development of the Constructability process within each discipline involved (potentially, each discipline of the Project).

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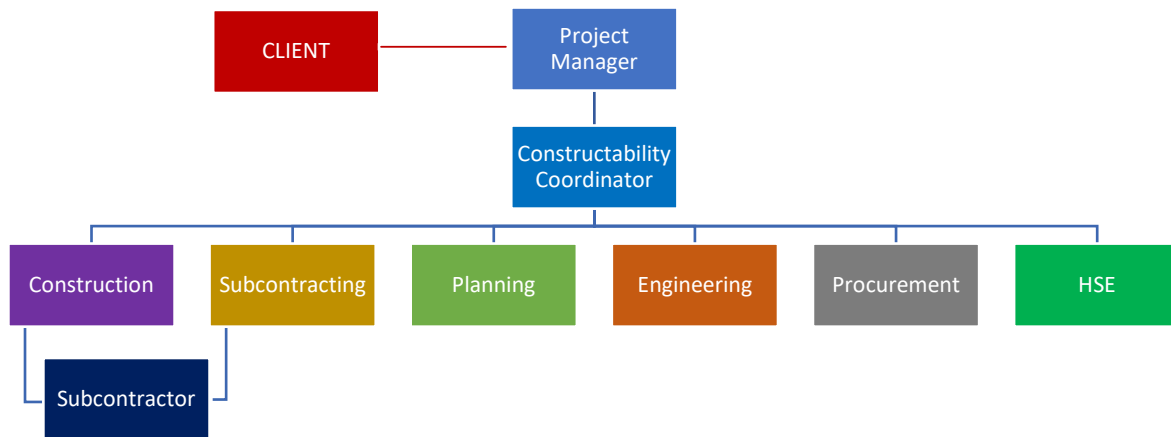


Figure 17 Typical organization involved in the Constructability Process

- Number of the official workshops to be held with the presence of the Clients and their timing; normally the workshops to be held are four, as below indicated:
 - The first workshop is held at the beginning of the Engineering process, with the aim of addressing Design Development
 - The second workshop is typically held immediately after 30% 3D Model review
 - The third workshop is typically held immediately after 60% 3D Model review
 - The fourth workshop is typically held immediately after 90% 3D Model review.

A representation of the typical Constructability Timetable is reported in Figure 18.

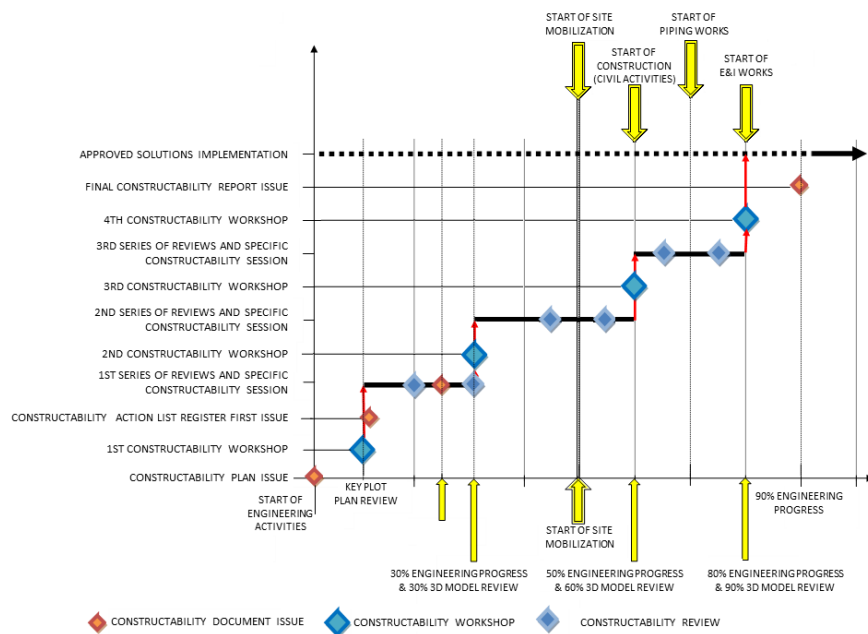


Figure 18 Constructability Typical Timetable

- Timing for the internal review of the Constructability checklist as well as follow up of the decisions with the Action List Register
- First issue of the Constructability checklist.

The major benefits deriving from the implementation of the Constructability approach are:

- Improvement of Safety during Site activities execution
- Improvement of Quality granted to Clients
- Reduction of costs (thanks to an accurate analysis of what may happen at Site)
- Reduction of the overall duration of the Project
- Identification and prevention of Project risks as well as the increase of Opportunities' probability of occurrence
- Growth of awareness and integration between Engineering, Procurement & Construction phases
- Minimization of disruptions due to Scope changes.

These can be achieved through the:

- Development of safe design to minimize HSE risks for the workforce during construction, start-up, operation and maintenance.
- Early identification of construction showstoppers
- Identification of construction constraints
- Identification of works that can be completed in the plant area without a plant shutdown
- Use of standardized design elements, which improves field productivity and reduces the overall costs and schedule.
- Identification of the requirement in terms of construction utilities like water, power etc.
- Use and extent of modularized vs stick-built execution (as an alternative, it can be useful the identification of possible ground preassembly activities)
- Use and extent of pre-casted and prefabricated elements
- Definition of the correct sequences of construction which shall drive the availability of engineering & material deliverables on site
- Optimization in deploying heavy lifting equipment (combining multiple heavy lifts allowing for a single mobilization of higher capacity and most expensive equipment)
- Planning of access routes for cranes, both for construction and for maintenance
- Optimization of heavy lift operations, including mobilization, demobilization and not operative stand-by
- Early definition of the most suitable subcontracting strategy and identification of suitable construction subcontractors
- Timely review of construction permitting requirement and possible constrains during execution
- Analysis of requirements for tie-in execution as well as other works to be carried out in presence of possible shutdowns
- Plant hand-over philosophy
- Identify risks of the surrounding plants affecting site construction and/or being affected by construction activities.

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Basing on the above, it is clear that the workshops as well as the implementation of the Constructability methodology cannot be considered as a review meeting nor as a process internal to the Construction Project Team only. It is rather a continuous process to be implemented within a Project, sponsored by the Project Manager and coordinated and managed by Construction department with the involvement of Project representatives, which integrates construction needs and construction execution plan into the Project execution plan, resulting in an overall benefit to the Project execution.

Only through an effective and early integration of Construction and Operations' inputs into planning, engineering and procurement development, the potential benefits of Constructability can be achieved.

The organization of the Constructability Program shall include representatives of all Project departments in order to make sure that all elements and factors affecting the design, procurement and construction have been properly addressed and assigned to the correct department in charge.

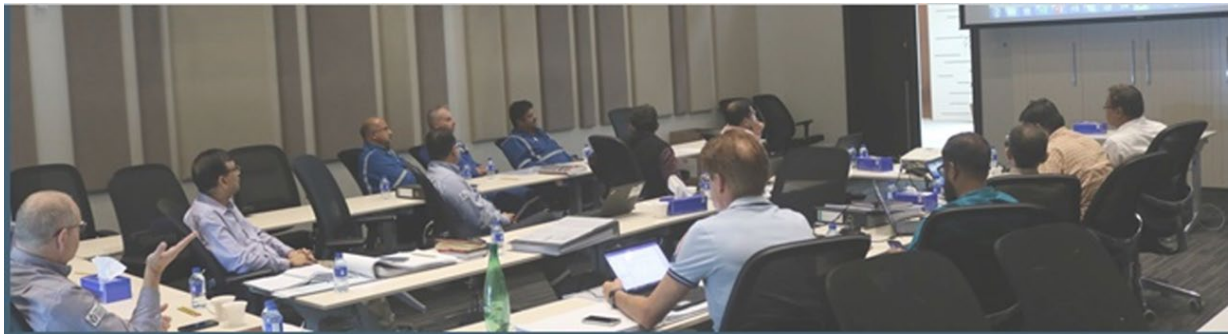


Figure 19 Constructability Session

After the set-up of the Constructability Program, with the definition of the Constructability Plan, objectives and organization, the subsequent Constructability steps consist of the Preparation Phase, the Implementation Phase and, finally, the Execution Phase.

4.2 Preparation Phase

The Constructability Preparation Phase during EPC Projects is summarized in Figure 20:

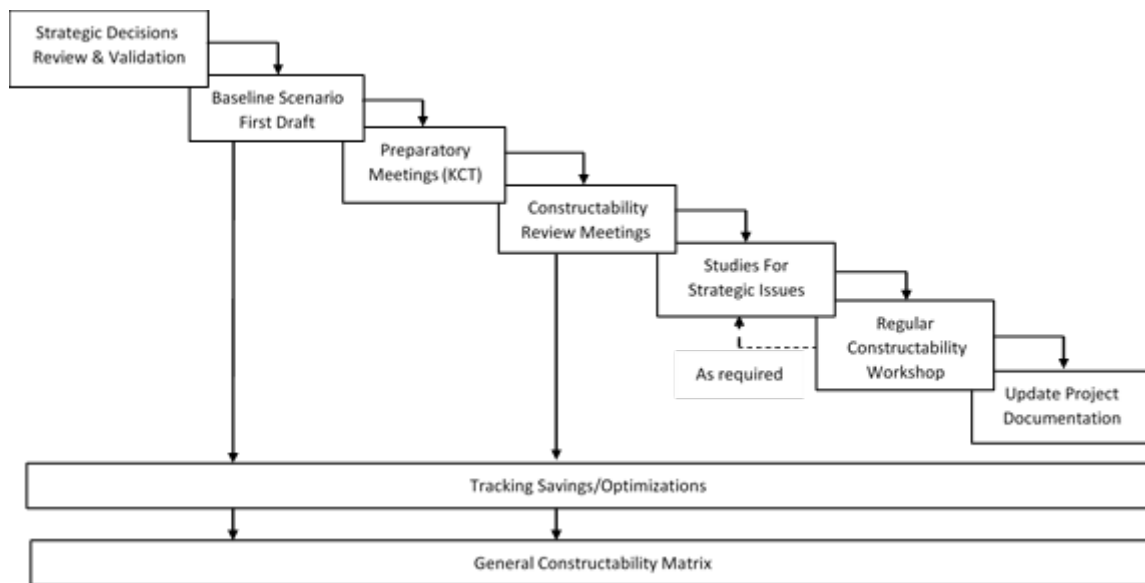


Figure 20 Constructability Preparation Phase

The Constructability process is initiated by the Project Manager, with a preliminary analysis that includes the review of the list of strategic/ detailed decisions and action items prepared during the proposal phase, as well as the identification of any different/ modified/ additional constraint or issue which raised in accordance with latest Project available information. The validation of existing and new topics is consolidated into the Key Constructability Topics list/ Checklist, as presented in the Section 4.1.

The inputs and outputs of the Preparation Phase can be summarized as follows:

- Inputs
 - “Program Set-Up” outcomes
 - Project documentation
 - Lessons learned & Constructability reports of similar Projects
 - Proposal strategic and detailed decisions
 - Budget & schedule
 - Template of tracking of Constructability savings/ optimizations

- Outputs
 - General Constructability matrix by Key Constructability Topic
 - Tracking of savings / optimizations
 - Updated Construction Execution Plan
 - Strategic & detailed decisions incorporated in Project documents (for implementation)

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The preparation of the Baseline Scenario is the preparatory stage before the execution of a Constructability Workshop. Several internal meetings are held with key Project group stakeholders, including without limitation the Construction Coordinator, the Engineering Manager, the Engineering Discipline Leaders and the Planning Manager, with the aim to define the more appropriate Constructability decisions (in terms of safety, cost, schedule and quality) applicable to the Project and to anticipate the possible savings/optimizations associated to each of them.

For the effectiveness of the entire Constructability Program, it is important to define at the earliest the Baseline Scenario, making use of the developed Project Documentation (whether finalized or still in “work in progress” stage), including the main deliverables below reported:

- Detailed Plot Plans and Elevations
- 3D Model
- Item Index
- Modularization Plan (if applicable)
- P&IDs
- Main piping studies
- Major UG piping and cable lay-out
- Main building lay-out
- Project schedule
- Main Project Quantities
- Plant operation requirements
- Shut down and Tie-ins’ schedule
- Interface management
- Subcontracting strategy
- HSE requirements
- Construction man-hours histogram
- Transportation Plan
- Heavy lifting studies
- Camp and/ or Temporary Construction Facilities layout
- Pre-commissioning/ Commissioning/ Start-up sequences.

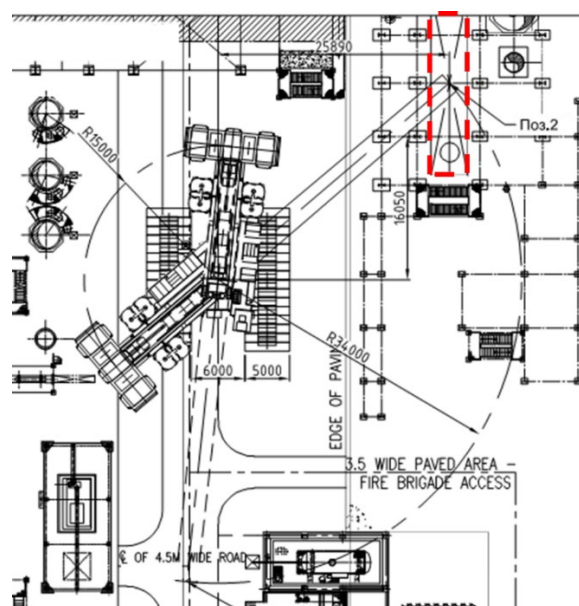


Figure 21 Typical preliminary Heavy Lifting study executed during preliminary phases of Project execution

The Key Constructability Topics vary through all the work disciplines and – as anticipated above - include matters quite generally dealt in the verification of site conditions and Project specifications and requirements (such as AG and UG piping and cables routing philosophies, selection of UG piping materials, selection of pipe-rack and process structures materials, fireproofing philosophy and selection of fireproofing materials, piping prefabrication extent, concrete precast extent for civil works, pre-dressing strategies, etc.), as well as they address very specific Project challenges, driven by the peculiarities of the work and site conditions and which might constitute the “first of a kind” for the engineering and construction execution development (such as very deep and oversize UG lines, modularization development in presence of very restrictive accessibility conditions, heavy lifts of exceptional size and/ or weight, expansion/ revamping/ debottlenecking activities in extremely congested plant sites, etc.).

In particular for the Project challenges, several internal sessions between Construction and other Project departments’ representatives have to be held to discuss in detail the possible solutions and to identify those that satisfy feasibility and erection-ability requirements the most (e.g. change of work priorities, change of construction sequences, selection of construction equipment of exceptional capacity and optimization of the relevant use in the work implementation, change of pre-assembly/ prefabrication extent).

Only after the Baseline Scenario has been defined, the Project Manager can call for an official Constructability Workshop in order to jointly review and validate the decisions taken during the creation of the Baseline Scenario, involving Client as well, if required.

The purpose of this Workshop is to present in a suitable and user friendly way (with schemes, drawings, tables, slides, matrixes) the Baseline Scenario to all the invited representatives of different disciplines, departments, expertise and organizations (i.e. Client, Construction Subcontractor(s), Specialized Subcontractor(s), if any), in order to challenge the decisions taken, enhance the identification of possible Project’s risks, define possible mitigation plans and to generate the list of all the actions that the Project has to carry out during the implementation of the Constructability Program.

As an outcome of the workshop, the Baseline Scenario will be frozen together with the list of the expected actions and targets to be taken in the following weeks (prior to following meeting). These outcomes/ actions/ plans will be reflected in the follow up documentation issued at the end of each Constructability Workshop, including:

- Presentation used during the workshop to describe the Baseline Scenario
- Constructability Matrix/ Checklist (which should include proper log of strategic decisions and relevant implementation methodology)
- Log of all the Constructability check points
- Minute of the workshop
- Constructability report.

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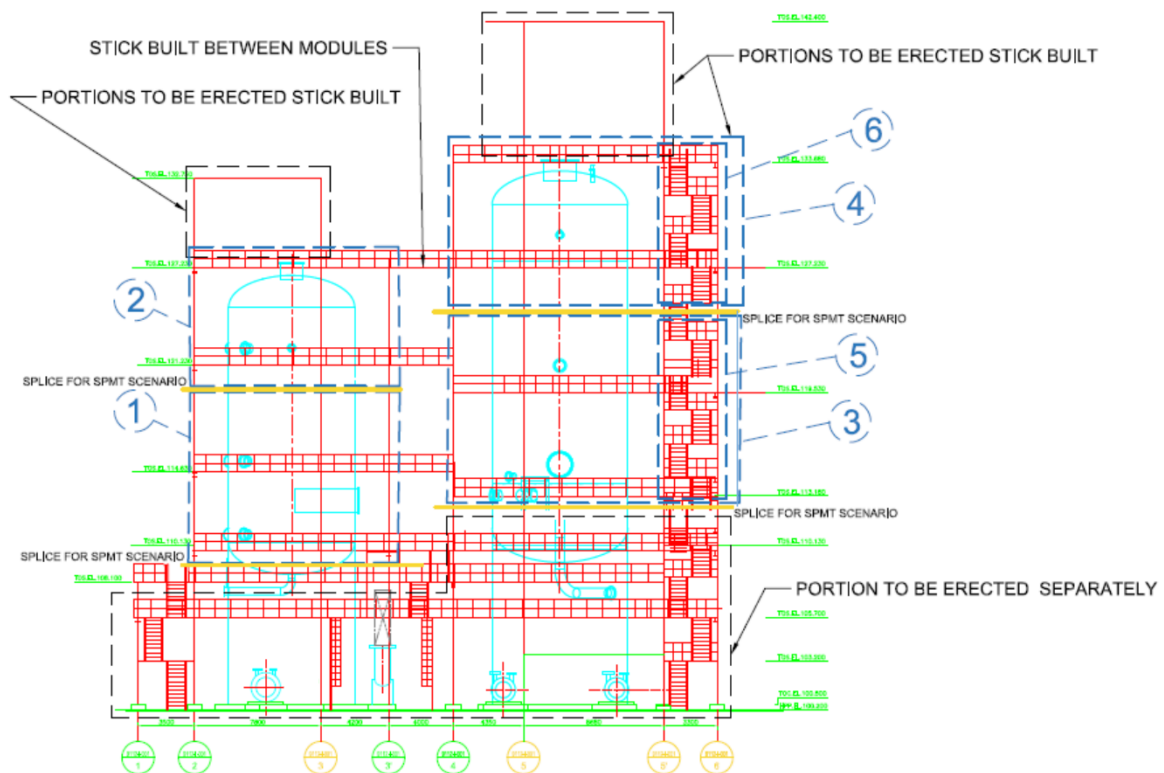


Figure 22 Example of Construction study executed during Constructability development (possible modularized/ pre-assembly approach for a major Structure)

The Constructability Report is a document, issued after each Constructability review meeting, with the summary of the main topics discussed, main items found during the discussion in the phase of challenging the Baseline Scenario, main recommendations for future actions to be implemented and list of points to be further and deeply studied in the future during the Project Constructability Program. In addition, a suggested calendar for the future Constructability review meetings can be part of this report, if deemed necessary to redefine the standard schedule presented in Figure 18.

During the Constructability Workshop, for each Constructability topic, it is identified the person (the “Champion”) responsible to investigate in detail ideas and solutions for the relevant finalization. Champions discuss their assigned topics with other disciplines and departments, focusing on the constraints and challenges identified during the initial Constructability Workshop.

As studies are progressing, discussions go more and more into deep analysis with the support of:

- New documents produced by Process and Engineering
- Meetings and feedbacks from potential vendors and sub-contractors
- Site visits
- Progress of construction studies
- Any other new information

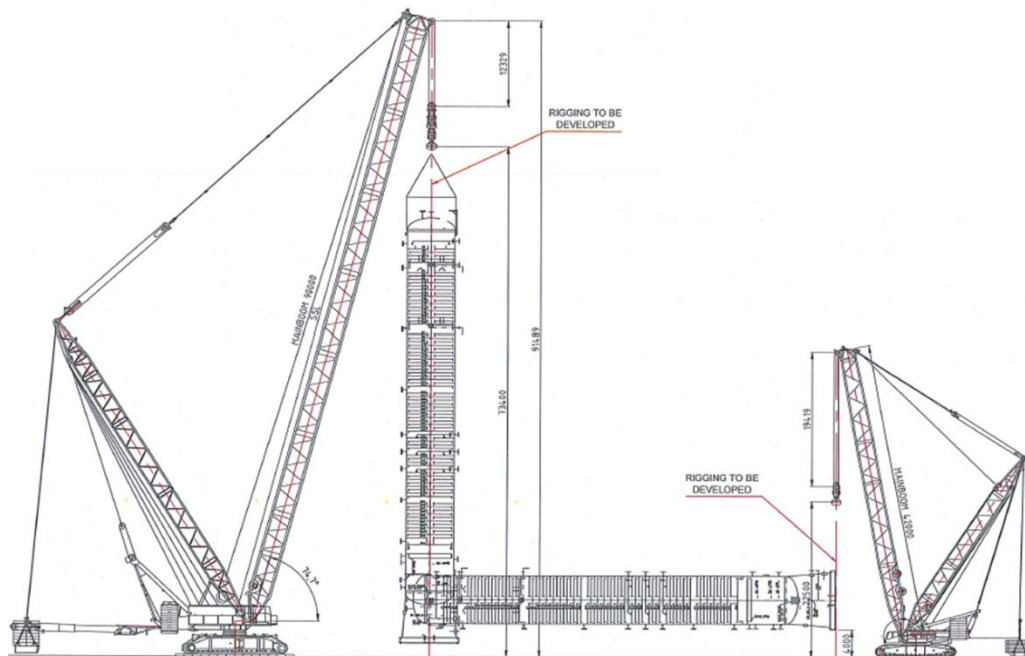


Figure 23 Preliminary lifting study developed for main equipment

As a consequence, the Champions discuss with engineering disciplines and other departments for technical analysis of Constructability detailed topics, analysing the technical aspect of each topic and proposing the optimum solutions in term of design standardization, optimization of resources, construction easiness, cost and schedule. Champions provide status and update of the results of the study Phase on reports issued of regular basis.

Regular Constructability Workshops are organized with all the attendees, whereby the relevant frequency is driven by the progress of the study phase. During these workshops, each Champion presents the progress of relevant points, with ideas and solutions already identified (as, for example, reported in Figure 22), for the relevant review, challenging and validation by the team members and, finally, for the definition of the action plan:

- Further studies if additional investigations are required prior to take a decision
- Implementation of accepted ideas, with relevant forecast closure dates.

All the decisions taken during the regular Constructability Workshops are incorporated by the responsible department in the Project documents, including without limitation the following:

- Plot Plan
- Project Schedule L3
- Construction Execution Plan
- Subcontracting plan
- Engineering basic design criteria
- Detailed design
- Content of Sub-Contract
- Purchase Orders

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The Constructability actions are therefore handed over to the Site Team for the relevant implementation and follow-up.

4.3 Implementation Phase

The Implementation Phase involves the Home Office Team, with the development/ finalization of action items pertaining the Engineering and Procurement portions, as well as the Site Team, with the implementation of the Construction action items and with the execution of regular Site Constructability Workshops for the continuous monitoring, evaluation and verification of the Constructability process.

The actual site conditions (such as accessibility, simultaneous operations scenario, interferences by operations and other initiatives by the Client, unexpected weather conditions, etc.), engineering and procurement deliverables availability, actual work progress of preparatory/precedent activities, work methodologies and abilities by the Construction Subcontractors, can significantly differ from the assumptions and pre-requisites relevant to a Constructability Key Topic, requesting a modification of the pertinent action plan.

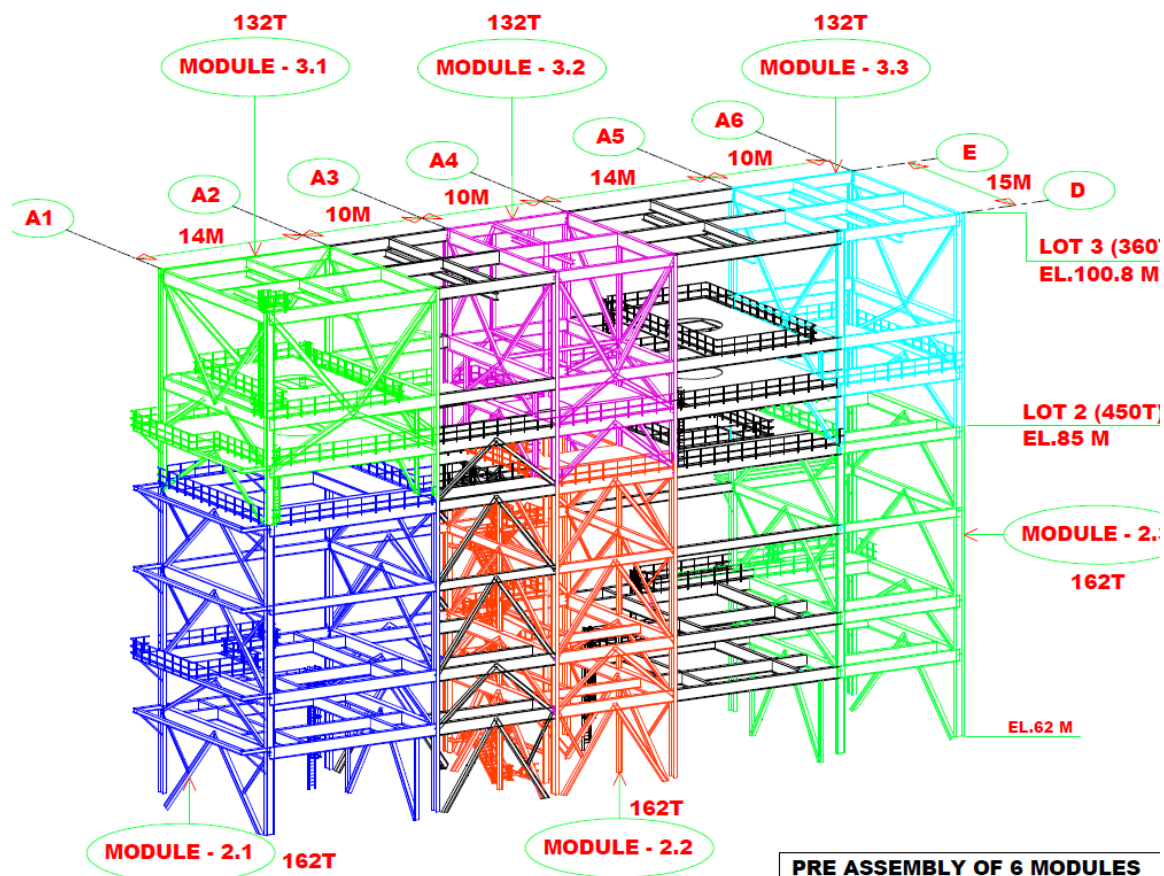


Figure 24 Typical study developed on Site for limiting works at height

In order to avoid work stoppages or productivity losses due to improperly organized work activities, the Site Constructability Workshops are therefore based on an intensive participation of the Construction Subcontractors, in particular in the phase of the development and review of the Construction Method Statements, to anticipate potential issues and to

provide adequate advance notice to study the relevant resolution (repeating the process described in the Preparatory Phase, as per Figure 24).

Monthly reports may be issued to describe the status of the implementation of the Constructability Program to the involved stakeholders, in particular for the update of the entire Constructability log points (detailed Constructability Matrix), including list of still open/ pending points, list of points to be closed in the next month of activities of the Constructability Program, log of construction feedback issued to date.

4.4 Execution Phase and Close Out

The Execution Phase relies on the follow up of the action items execution and with the registration of the relevant feedbacks.

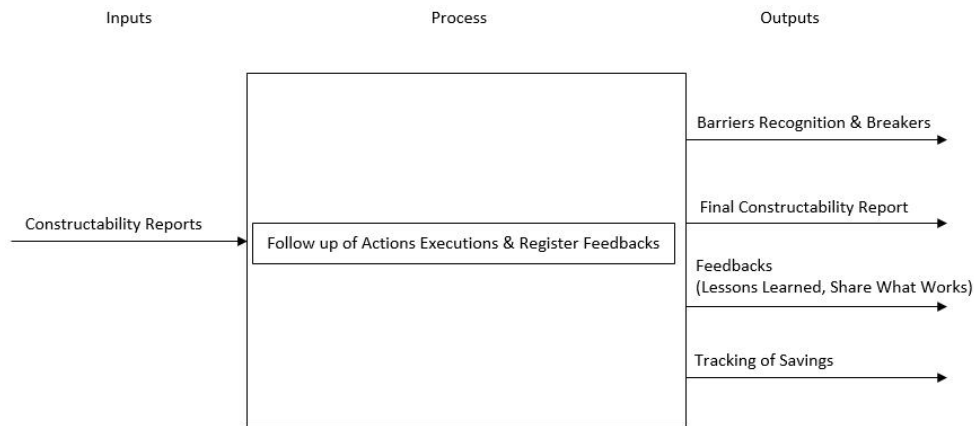


Figure 25 Constructability Operative phase

At the end of a Project, the Final Constructability Report is issued for an appraisal of the main benefits provided to the Project by the implementation of the Constructability Program (providing suggestions for its possible improvement in future Projects), integrated by the final evaluation of the savings made possible by the Constructability Program implementation, as well as by the list (with relevant evaluation) of the main barriers/ challenges that needed to be overcome in due course.



Figure 26 Realization of the study developed in Figure 24

Site's feedback (together with the analysis of the relevant savings, where applicable) is requested for each point of the detailed Constructability matrix, supplemented by the description of any other issue or good practice that may have been discovered during the construction phase. This task requires the full involvement of the Site Team, with the collection of site feedbacks to be continuously monitored and updated during the works implementation and with support and guidance provided to the Site Supervision Staff in order to duly record them.

4.5 Constructability Checklist

With respect to the Constructability Checklist, the first issue is developed starting from the Standard version of Checklist owned by the EPC Contractor, which collects Lessons Learnt from previous Projects as well as good Engineering practices (capable of reducing costs and/ or time required for the activities execution).

This standard checklist shall be discussed at early stage with the disciplines involved (Project Manager, Project Control Manager, Project Engineering Manager supported by the Discipline's specialists, Project Procurement Manager, Commissioning Manager and Home Office Construction team) and shall focus especially on the points deemed critical for a kick start of the Project activities. Among these, during this first approach, it is important to define:

- Piling and site preparation requirements, considering that these are the first activities to start (together with the Additional Soil Investigation, whether required)
- Civil works and plot plan arrangement shall be studied as well as all the applicable Lessons Learnt shall be addressed to the Engineering Discipline Leaders/ Specialists

- Temporary facilities to be installed at Site, considering the team to be deployed at Site (for offices and, in case, accommodation camp sizing), the materials to be received and stored at Site Warehouse (to define requirements relevant to Warehouse, Cold room and open laydown area)
- Preliminary traffic plan/ routing in proximity to Site, taking into consideration the existing constraints (access gates, existing roads, other live plants/ construction sites in proximity)
- Identification of the items deemed as critical for the installation works (e.g. Long Lead Items, heavy equipment), in order to address preliminary transportation/ lifting studies and highlight the erection sequence for these items in the Level 3 Project schedule. An example of a preliminary study developed for constructability purposes is included in Figure 27: in the study it has been identified the cranes positioning, the equipment position and orientation prior to the lifting operations, the different elevations and other possible structures that need to be kept under hold due to their position with respect to the lifting point (which may lead to clashes, or safety risks).

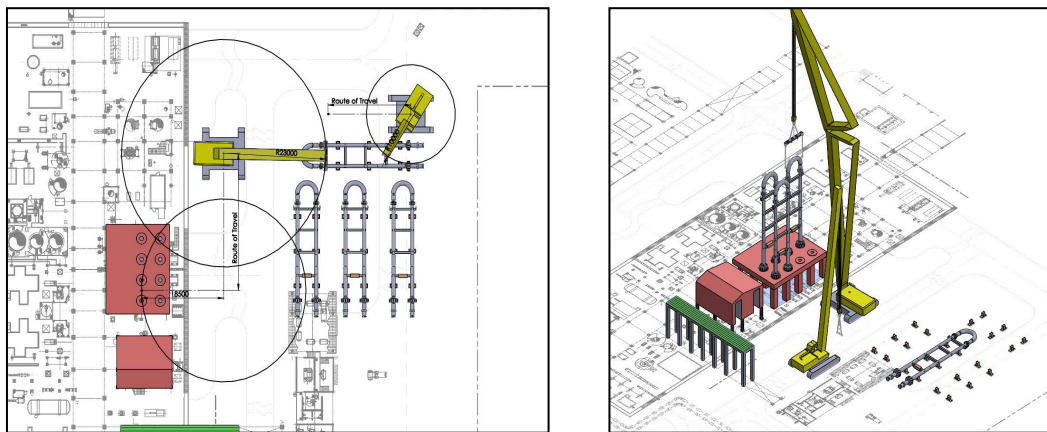


Figure 27 Typical preliminary lifting study

- Applicability of innovative construction approaches and methodologies, such as Modularization, Advance Work Packaging, Site pre-assembly activities (mostly for Steel Structures), considering applicability and convenience (with respect to reduction of man-hours to be spent at Site and/ or costs reduction)
- Basing on the other points, a preliminary Subcontracting Strategy shall be agreed and defined (as a minimum, timing for actions to be included in the Level 3 Project schedule (documentation issuance, bid due dates, alignment meetings, Technical Bid Evaluations and Award of the Subcontracts, as described in Section 12) and the Subcontracts to be awarded (disciplinary Subcontractors vs. General Construction Subcontractors, if it is already possible to choose, basing on the outcomes of the Commercial phase and the available information about quantities, complexity, man-hours and Contract schedule)
- Definition of the preliminary sequence of construction and priorities (the so-called *Path Of Construction*); final sequence shall be defined in conjunction with Commissioning team but, in the meantime, it can be defined considering the Lessons Learnt available in the EPC Contractor's know-how as well as personal expertise of the people part of the team. The outcome of this analysis is similar to what represented in Figure 28, where priorities in plant construction is reported. This can be both the basis for the

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development of the Construction Level 3 Schedule as well as for the development and issue of the engineering deliverables/ drawings and materials delivery at Site.

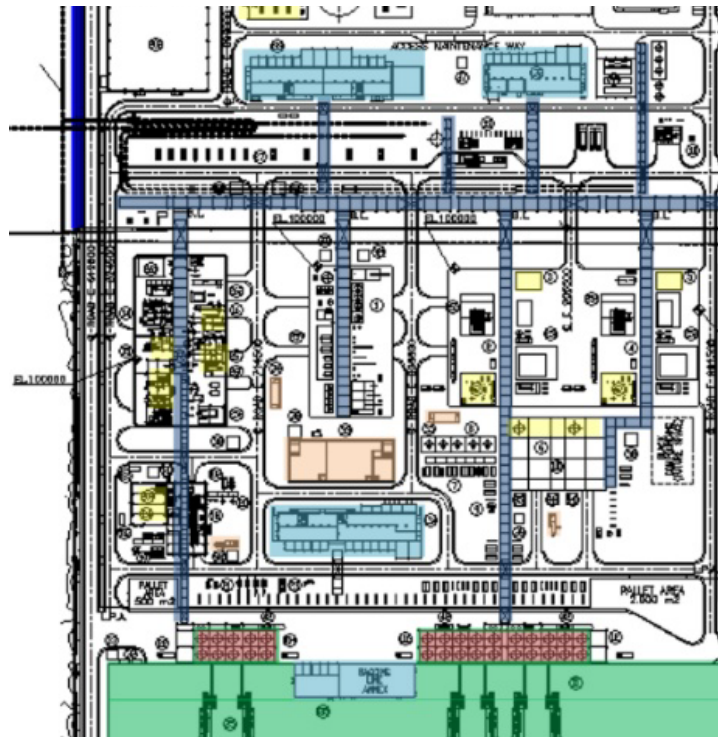


Figure 28 Prioritization of Project main items

Once these issues have been addressed, the Constructability plan, checklist and action list can be issued and periodically updated (normally, the review is effective is performed on a monthly basis) taking into consideration Engineering and Procurement progresses, as well as the process of award for the identified Subcontractors. After this first set of activities, indeed, the process described in the Constructability Plan and the studies to be performed as per Action List Register shall be accomplished.

With respect to the checklist and the action list register it is important to respect the agreed due dated for the analysis, considering the impacts they have on the Project in the early phase. If modularization is applied, for example, the Engineering shall be developed accordingly, taking into consideration the additional items which may be required (e.g. additional stiffening elements); in addition, it is important to set up the activity for the award of a Modules Yard (changing the Subcontracting plan). Consequently, the priorities of the modules and at Site shall coincide and shipments shall be planned accordingly.

In parallel, all these aspects shall be reflected, since its first issue, in the Construction Execution Plan, as they are the core of the construction strategy adopted for the Project (ref. to Section 5).

As an example of the implementation of the Constructability Process, it is possible to refer to the following Figure 29 and Figure 30, which show the lifting activities of a Loop reactor, as studied and presented in Figure 27.



Figure 29 Lifting operation for Loop Reactor



Figure 30 Positioning of Loop Reactor

In general terms, it is important to note that the early identification of critical items/ structures that shall be erected is a primary need: their design and procurement have to be frozen together with all the aspects pertaining to the erection (from transport to storage and installation) have been properly analyzed and weighted.

More in general, the aspect of feasibility and “erectability” are some of the fundamental topics of a wider and essential process within Project execution management. It is important that, at any time, a clear sequence of installation and erection of the plant is available.

It is crucial, indeed, the identification of the critical items and to forecast possible solutions to the main issues that may be encountered during Construction phase, with the aim of reducing the time wastages as well as to have always an alternative work front to be released to the subcontractors (avoiding idle resources and preventing an unsustainable progress curve flattening).

5. The Construction Execution Plan; WBS, sequences and strategies definition

In the first phases after the Award of the Project, the EPC Contractor shall start defining the overall strategy to be adopted in approaching the Project, especially with respect to the Construction Execution.

To do so, there are some elements that constitutes the starting point for this evaluation, such as:

- Scope of Work subdivision and Work Packages forecasted during tender phase
- Potential Subcontracting agreement developed during Tender phase
- Outcomes of market investigations performed during Tender phase, if any
- Constraints to the Site activities execution
- Possibility to apply modularization/ pre-assembly of structures and/ or portions of the plant (both for pipe racks and process units/ structures, as shown in Figure 31 as an example)
- Quantities/ Effort evaluated during the completion of the tender phase prior to final price definition.



Figure 31 Example of pre-assembled structure installation

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In this phase, it is important to condensate all the information available in one single deliverable capable of defining the strategy of execution in a way that it can be shared with the stakeholders involved in the Project, from the Client to the Subcontractors, whether required.

With this objective, the Execution plan should include the organizational structure and activities to be developed in the preparatory phase prior to start Site activities, as well as the approach for Site execution.

These include, as a minimum, the participation of the Construction team to the definition of the Work Breakdown Structure (WBS), the qualification pertaining to Construction team on which the Level 3 project schedule has to be defined, the Site logistic and temporary areas and any other item that shall be addressed for a smooth Site activities execution.

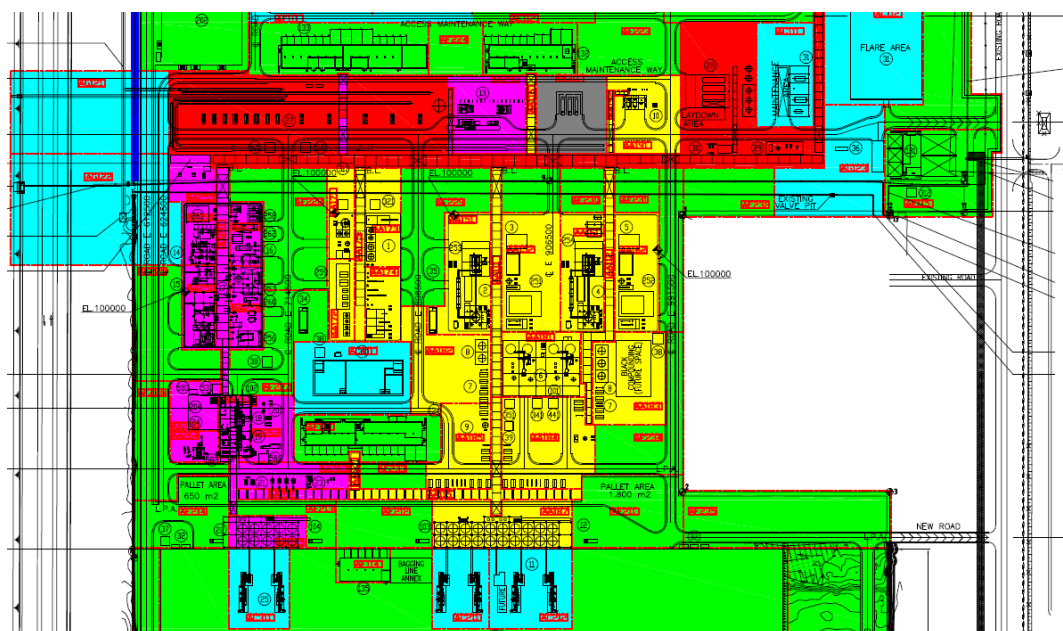


Figure 32 Graphical Representation of a WBS onto the Plot Plan

5.1 Erection sequences and priorities

Proceeding step by step, the first activity to be executed by the Construction team is the participation to the definition of the WBS basing on the latest plot plan available and the actual scope to be delivered to Client within the contractual frame of the Project. This step is crucial since it affects the entire Project development, as well as all the disciplines involved, since it allows a common language for the identification of the items placed on the plot plan, which can be directly linked with the associated deliverables.

Once the WBS has been defined, it has to be established the most suitable sequence of erection which needs to be followed in order to match the contractual milestones, considering the PAC (Provisional Acceptance Certificate) date(s) and the Commissioning & Start-up activities and needs (i.e. the sequence in which the various services/ utilities/ systems shall be commissioned).



Figure 33 On-going Construction Works

This implies that, in order to harmonize the sequence of erection (and commissioning), priorities shall be defined and given to other disciplines in order that all the Project Team follows the same sequence in the Engineering/ Procurement/ Construction/ Commissioning development.

This is part of the principles to be defined in the Execution Plan to be taken into account during the definition of Level III Project schedule, as previously indicated.

In addition to these high-level implications, the Construction Execution Plan shall address specific issues required during the development of the Construction phase, such as the Temporary Areas/ Facilities, the Site Logistic and the preliminary Subcontracting approach which should be undertaken with respect to each discipline.

5.2 Site Logistic and Temporary Construction Facilities

The Site Logistic and the Temporary Areas / Facilities definition are strictly interconnected, since they mutually influence each other. The facilities to be installed are those required to fully support the construction (Site Offices for each Stakeholder, Warehouse, training rooms, workshops, lay-down areas, first aid room, canteen, accommodation camp, if required, etc.) and the relevant location/ layout is subject to:

- Areas made available by Client
- Areas available on the market
- Constraints imposed by the applicable Local Law.

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Figure 34 Temporary areas arrangement

Their definition, combined with the location of the available areas, strongly contributes to the definition of the logistic from/ to Site. Furthermore, considering the development of the activities, it is important to establish location of the ISBL facilities and the accesses to the Site itself, not to create a disruption to the Site works as well as to the existing facilities in the area (e.g. avoiding long queues on public roads, as it has been done for the case represented in Figure 35).

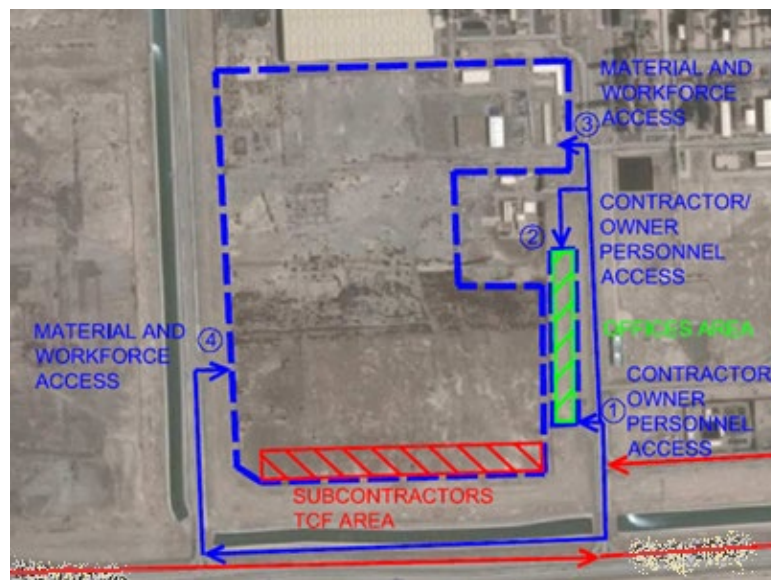


Figure 35 Example of visual traffic plan

5.3 Subcontracting Plan

The last relevant point to be analyzed in the Execution Plan is the possible approach to the various Subcontracts that should be assigned for a proper execution of the Construction phase, with the indication of the methodologies that can be applied (or that are going to be applied) to facilitate the monitoring or development of the works.

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Figure 36 Example of Work Scope Subdivision in Work Packages

These topics are furtherly discussed in Section 11.

On the other hand, in parallel to the definition of the WBS, it has to be defined the Cost Breakdown Structure (CBS), which has the aim of defining the most suitable method for the Cost accounting and monitoring, giving the opportunity to keep under control the status of the Project and of the Budget (ref. to Section 16 for further details).

6. Reduction of the Site activities: alternatives to the stick-built approach

In the last years, the Construction sector has seen the diffusion of several techniques capable of improving Site performances reducing the activities to be executed directly on site in various case, such as, for example:

- Adverse weather/ climatic conditions which prevent smooth execution of the activities at Site
- Significant cost for the workforce deployed at Site, which leads to a minimization of the manhours to be spent at Site to reduce/ optimize as much as possible CAPEX
- Reduce risks associated to the safety concerning the execution of the works (e.g. minimization of works at height)
- Schedule requirements with respect to the construction execution period, which require for the parallelization of the activities to the maximum applicable extent.

Among these techniques, the most diffused and impacting in the industry are the following:

- Application of modularization concepts
- Application of preassembly of high structures with implementation of the so-called pancake approach
- Application of precast in lieu of cast-in-situ.

6.1 Modularization approach

The main target of modularization is to build in specialized Yards/ Shops portions of the plant, both in process areas as well as considering pipe racks (so-called Modules) achieving the result of moving hours off-site to a dedicated facility with higher productivity, where quality and safety standards are substantially higher. In addition, in this way it is also possible to achieve a cost saving for the Project and a better planning (especially in terms of predictability).

On the other hand, the implementation of a modular approach leads to a need for a faster design finalization compared to the “classical” stick-built approach, in order to allow an early start of modules fabrication activities at Yard and let the advantages above mentioned to become effective.

For these reasons, it generally requires an increased effort from the Engineering disciplines at the early project stage and a greater versatility in procurement and post-order/ logistics services, which demand an adequate organization and appropriate budget availability.

6.1.1 Modularization approach analysis

The main target (and advantage) of the application of the modularization approach is to move working hours Off-Site to a specialized Facility with a higher productivity and reduced labor rates. However, several additional benefits are deriving, such as:

- Reducing the volume of Site Activities to be executed, it is possible to reduce the number of resources deployed on Site (with consequent reduction of accommodations, wages, etc.), in addition to the mentioned lower labor rate (which normally is the most impacting benefit)

- Improved Safety, due to the fact that activities are transferred to a well-organized workshop, which is normally a protected environment where only a reduced number of activities is executed at height (and consequently just a limited number of resources is working at height)
- Higher Construction Activities Effectiveness, in relation to the fact that the working conditions/ working environment in a shop are more favorable for the execution of the activities with less negative impacts, along with the fact that there is a general higher availability of skilled manpower working with better equipment and tools. In addition, the fact that a yard generally has a permanent organization, there is a more friendly/ organized working environment, which enhance workers' performances
- More Schedule Certainty/ Lower Schedule Risks in relation to the mentioned higher Construction Activities Efficiency combined with a reduced risk of shortage of resources and equipment combined with the easier chance to work on a 24/7 basis to recover delays thanks to the covered (and thus not subject to the atmospheric events) and lit environment.

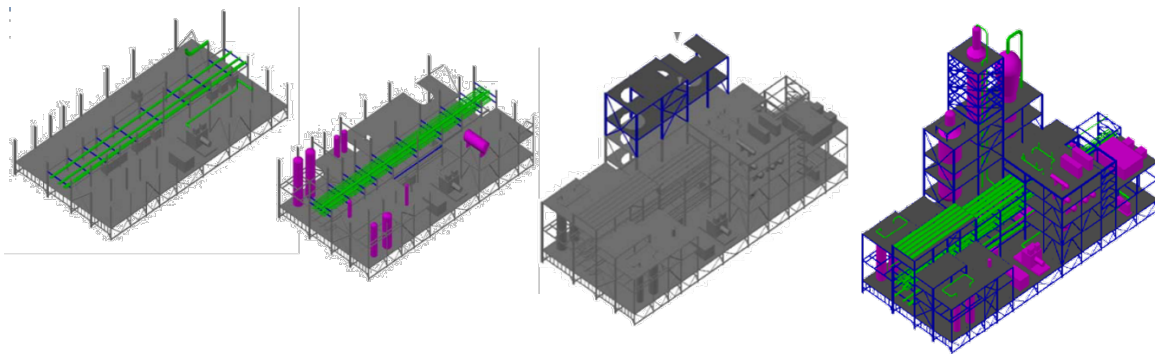


Figure 37 Modules fabrication methodology

Despite these positive aspects of the modularization implementation, this methodology has also some drawbacks that shall be considered while evaluating if to apply this approach, such as:

- Availability of experienced Module Fabricators to whom the modules fabrication should be awarded
- Necessity to have an early design freeze, allowing for anticipated supply activities and consequent delivery of materials to the yards (not to delay site milestones)
- More complex logistics management, related to the need of having one additional operative center which shall be coordinated and which needs to be properly fed with relevant supplies
- Procurement and Scheduling management shall be flexible: POs issue and Post Order Services must be versatile and continuously focus on starting dates of fabrication activities at yard
- Logistics and transport constraints to be carefully considered, since there is the need of adequate facilities and accesses for load out/ dispatch from fabrication shop and unloading/ receipt at project Site
- Interface with Logistics Department and selected Transportation Company for the organization of modules transport and definition of reinforcement design needed to secure the shipping

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- Supervision Team shall be deployed at selected Yard to ensure compliance of fabricated modules with design and Project procedures
- There is less flexibility in relation to design changes at Site, as well as limited capacity to react to errors/ mismatches.



Figure 38 Module under fabrication

6.1.2 Modules Go/ No Go Decision

The first step, prior to start any design or to issue advanced Purchase Orders for the supply or relevant materials, it is important to undertake the Modules go/ no go decision. Normally, this is based upon dedicated cost analysis which has to demonstrate the potential convenience of the modules approach with respect to the stick-built erection method.

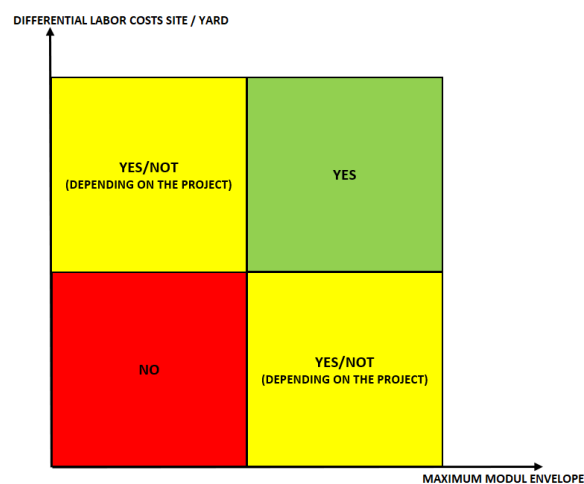


Figure 39 Modules approach convenience - general scheme

Typically, in case logistic constraints impose significant limitations to the maximum module dimension and weight and the labor differential cost between Site and Yard(s) is low, the modular convenience is not envisaged (“No area” in Figure 39). On the contrary, in case modular envelope can be led to high extent and/ or Yard labor rates are significantly lower than Site labor rates, the modularization approach is a viable option for the Project (“Yes area”

in Figure 39). A more detailed analysis is requested whether the result presents a high degree of uncertainty (YES / NO Areas in Figure 39).



Figure 40 Aerial view of a fabrication Yard

Generally, the items considered in this evaluation are the following:

- Quantities associated to the modules
In this case, it is important to estimate the quantities that would normally be installed with a stick-built approach and that may be shifted in one or more modules. In this case, in addition to the quantities shifted from Site to Yard, it is necessary to assess also the additional steel quantities related to the modular approach, required mainly for the transportation and lifting phases. The quantities related to the modules can be estimated in different ways, basing on the knowledge of the items under evaluation; these approaches vary from the detailed Bill of Quantities (BOQs), the Key quantities or the application of density factors (e.g. kg/m³) taken from similar past experiences. Furthermore, it has to be considered in the cost balance, the additional material to be purchased in this specific case, as a separate cost (separate from the other points of this list).
- Potential Yards Locations
Modular solution cost strictly depends on actual Module Yard locations. The impact of this item is double since it impacts on the Transportation costs as well as on the labor costs associated with the Modules fabrication costs. In detail:
 - Fabrication costs: these are evaluated taking into consideration the basic concept of the manhours (explained in Chapter 7), which are evaluated considering the Standard manhours and the specific productivity associated with the average productivity of the area where each yard is located. Once the magnitude of the works has been defined, it is converted into a cost considering the labor rates applicable to the relevant area
 - Transportation costs: with respect to modules transportation, it has to be considered that this cost item shall consider the transportation from the Yard to the loading dock and from the off-loading facilities to Site (usually by SPMT)

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and the sea transport (by barge or vessel), inclusive of the loading/ unloading operations required to accomplish this phase. In addition, it has to be considered that the rental of transportation mean has a considerable cost and, thus, a proper transportation plan has to be put in place, to maximize the transported volume per each trip of the barge/ vessel.

- **Additional personnel to be deployed in the Yard**
It has to be considered that a Quality team, a Supervision team and Material Management team should be deployed in the Yard, to grant compliance with Project procedures and standards.
- **Additional design costs**
The development of modules' design requires for additional engineering effort, which has to be duly considered during the evaluation of modules convenience.
- **Additional cost**
It may be required to consider additional costs in relation to unloading facilities (whether this kind of facilities are not available close to Site), temporary staging area (if the number/ size of delivered modules does not allow for a quick transportation to Site and installation), applicable importation/ transit fee/ taxes, temporary works for roads improvement, etc.



Figure 41 Modules loaded and secured for transportation from Yard to Site

An example of the outcome of the modularization convenience analysis is shown in Table 1. In this case, looking at the grand total of the sum of the costs associated to the implementation of the modules approach, it is possible to evince that for each of the yards considered the modularization costs are higher than the costs associated to the stick-built approach. This means that, referring to Figure 39, the Project sets in the “No Area” (red one), for which the modularization approach is not convenient.

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Item	Cost Impacts	SMH Qty	EMH Unit	Rate (\$/Qty Unit)	Stick-Built	Yard #1	Yard #2	Yard #3	Overall K-factor	Comments/ Notes
A Modules fabrication, delivery, installation and connection										
A.1	Field Labor Cost	325,000	650,000	\$ 28	\$ 9,100,000				2.00	
A.2	Yard #1 Labor Cost	250,000	500,000	\$ 20		\$ 5,000,000			2.00	
A.3	Yard #2 Labor Cost	200,000	320,000	\$ 30			\$ 6,000,000		1.60	
A.4	Yard #3 Labor Cost	320,000	800,000	\$ 40				\$ 12,800,000	2.50	
A.5	Additional Steel for Modules (incl. Shipping Steel)	300	Tons	\$ 3,500		\$ 1,050,000	\$ 1,050,000	\$ 1,050,000		Applicable to any Yard among the considered ones
A.6	Ship Prep - Off-Site Modular	60,000	m3	\$ 1.06		\$ 63,600	\$ 63,600	\$ 63,600		Applicable to any Yard among the considered ones
A.7	Hook-up cost (All disciplines)	42,500	85,000	\$ 28		\$ 1,190,000	\$ 1,190,000	\$ 1,190,000	2.0	Applicable to any Yard among the considered ones
SUBTOTAL (A)					\$ 9,100,000	\$ 7,303,600	\$ 8,303,600	\$ 15,103,600		
B Additional Costs										
B.1	Additional Detail Design Cost	6,500	Hrs	\$ 100		\$ 650,000	\$ 650,000	\$ 650,000		
B.2	Shipping Costs - Sea Transport from Yard #1	1	Trips	\$ 4,500,000		\$ 4,500,000				Cost estimate based on one single shipment. Hypothesis to be confirmed with additional analysis.
B.3	Shipping Costs - Sea Transport from Yard #2	1	Trips	\$ 4,000,000			\$ 4,000,000			
B.4	Shipping Costs - Sea Transport from Yard #3	1	Trips	\$ 3,500,000				\$ 3,500,000		
B.5	Off-Loading, Staging and Setting of Modules at site		Lump Sum			\$ 430,000	\$ 430,000	\$ 430,000		
B.6	EPC Contractor's personnel at Module Yard	150	MMths	\$ 15,000		\$ 2,250,000	\$ 2,250,000	\$ 2,250,000		Considered on average 15 people over a 10 months period
B.7	EPC Contractor's personnel saving at site	(45)	MMths	\$ 15,000		\$ (675,000)	\$ (675,000)	\$ (675,000)		Considered to move an average of 3 people from Site to yard for 15 months
B.8	Taxes, custom duties and cargo insurances					EXCLUDED	EXCLUDED	EXCLUDED		
B.9	CLIENT's personnel at Module Yard					EXCLUDED	EXCLUDED	EXCLUDED		
SUBTOTAL (B)						\$ 7,155,000	\$ 6,655,000	\$ 6,155,000		
GRAND TOTAL (A+B)					\$ 9,100,000	\$ 14,458,600	\$ 14,958,600	\$ 21,258,600		

Table 1 Example of outcome of modularization convenience analysis

6.2 Modularized buildings

An alternative easier to achieve is the application of the modularization approach to the buildings (inclusive of the substations and control rooms) if the specific requirements of the Project allow for this kind of solution.



Figure 42 Example of modularized substations

As previously explained, also in this case the purpose of adopting a modularized solution is mainly to move hours Off-Site, to a specialized facility. In this case, the Yards considered are normally suppliers of a plug-in building completed in all its aspects, for which it is only required the connection between modules on Site.

The modules are defined by dividing into several parts the building layout, defining modules whose dimensions depend on logistic constraints for shipment and transportation at Site. The dimensions of each module shall be the closest possible to the maximum transportable envelope, allowing both to minimize the total number of modules as well as to reduce the

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quantity and complexity of internal connection between the equipment/ systems and modules interconnections.

In principle, each single module is completed with the installation of all services (light, power sockets, HVAC, smoke detection, etc.) and the installation of the equipment according to the type of building that usually are:

- Switchgears, MCC, UPS, etc. for Substations
- DCS, ESD and other panels for Instrumentation rooms/ buildings.



Figure 43 Example of Modularized Control Room

The convenience in adopting a modularization strategy can depend on several factors, such as:

- Local plant conditions, in terms of logistic related to the road dimensions, transportation costs, etc.
- Local manpower costs versus Yard's manpower costs
- Material sourcing
- Geometrical features of the building: they can make the transportation more complicated (if it presents bulky dimensions, or dimensions are not suitable for the road transportation), even resulting in damages.

Fabrication of modules in specialized workshops presents many advantages as previously indicated, however it is required a major effort of Engineering and Procurement, which have to guarantee the timely feeding of drawings and equipment at module assembly workshops. Therefore, the decision to move in this direction, must be taken at the very early stage of Engineering.

The solution of modularized buildings is particularly convenient in offshore installations, in locations with extreme weather conditions (which compromise the Site productivity), in areas

where the specialized manpower is limited and where the manpower to deployed on Site is particularly expensive.

On the other hand, technical requirements like blast proof resistance of the building limit and, in some more severe cases, prevent the applicability of this solution with economical convenience for the Project.

Such requirements lead to a tailored modules definition and manufacturing, considering that, for example, modules' walls could be realized in stainless steel, providing further protection in case of explosions.

Two main scenarios can be identified:

- No blast proof resistance required
In this case, modules are fabricated according to a series production, with standard requirements and geometrical features. A key-factor that can affect the decision-making process are related to the cost of manpower at site versus the additional cost of modules fabrication and delivery at Site
- Blast proof resistance required
This requirement leads to higher production times, as the module manufacturing is not standard and must respect stricter parameters. The fabrication cost is certainly higher and, therefore, the choice of this type of module is usually limited to offshore applications or extreme site conditions, while in most of the cases, buildings are fabricated at Site in traditional way.



Figure 44 Modularized building installation with SPMT

6.3 Preassembly of Steel structures and Pancake approach

An alternative to the application of the modularization is the preassembly of steel structures, which is normally applied to:

- (Portions of) big complex structures
- Smaller/ minor steel structures
- Small portals/ assemblies defined by Construction Subcontractors
- Small modules designed at the last-minute during construction to speed up Works.

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While the last two cases are situations that presents at Site while construction works are ongoing, the first two are conditions that ca be studied and developed since early engineering phase with the aim of improving the efficiency and safety of Site activities.

Once the structures that potentially could be pre-assembled, it can be evaluated the possibility to adopt the pancake approach, which is an extensive preassembly of steel structure by levels, i.e. through means of fully preassembled floors completed with:

- Structural Steel (main and secondaries structures)
- Gratings and chequered plates
- Handrails
- Minor equipment, to the applicable extent.

The pancake approach allows to maximize the opportunities of Steel Structure Preassembly, since it allows the assembly of the structures directly on Site (limiting the issues with the maximum envelope transportable). With this methodology, Civil Works and Steel Structures Works become “fully” uncoupled, giving the chance to start paving activities prior to the beginning of the mechanical (steel structures included) installations. Moreover, it allows for the optimization of the Heavy Lift campaign since pancakes and equipment are erected in sequence by the same crew using the same high-capacity crane already present on Site for the heavy equipment lifting.

On the other hand, however, challenges are maximized as well, since there is a more stringent sequence of events that shall happen and there is an extremely reduced capacity to react to mistakes/ field changes, as explained in Section 6.1. For this reason, commitment of Project Management Team is necessary.

Summing up the opportunities and having a PROs and CONs analysis of the method it is possible to evince what reported in Table 2 here below.

OPPORTUNITIES		CHALLENGES AND THREATS	
Safety	Works at height are reduced	Challenges	Additional planning effort required from Project early phases and involvement of Construction Subcontractor
Productivity	Works at height are reduced	Areas Availability	Availability of Staging area for Pre-assembly
Productivity	Optimized access to working area	Transportation and rigging	Extra cost, Field routing constraints
Simultaneous work fronts	No constraints to civil works due to steel structures erection	Engineering costs	Costs for additional design and increased quantities
Productivity	Optimized equipment erection (always from top)	Post-Order activities	Early delivery of structural steel in lots 100% feasible
Heavy Lifts optimization	Erection of Equipment and Structural Steel with same crane and same crews		
Schedule	Possibility to work simultaneously at different elevations		

Table 2 Opportunities - Threats deriving from pancake approach implementation

Normally, for proper application of the method, it is necessary to have both the blessing (and the commitment) of Project Management Team as well as a dedicated Constructability session, which shall include a consistent Engineering Team. A typical path forward may be the following:

- Design for each Pancake (battery limits, completeness, etc.); design of the pancake approach shall be defined at the earliest, since it is necessary to proceed with preliminary structural checks as well as with advanced supply of steel structures
- C.O.G. (center of gravity) definition, floor weight and sling unfactored tension have been extracted from each pancake's floor and communication to subcontractor responsible for the lifting
- The top parts of the columns should have been designed in order to accommodate both lifting lugs and bolted splice connections
- Meaningful piece marks coding, by Steel Structures' Vendor, to facilitate Shop and Site works
- Temporary vertical bracings may be considered since the beginning to preserve connections between main beams and columns. A lifting test carried out at Site can easily allow for the definition of safer and easier lifting method that shall be put in place. It is important to define at the earliest the lifting methodology adopted (Figure 45), since it may affect the design and could require for the modification of the structure.

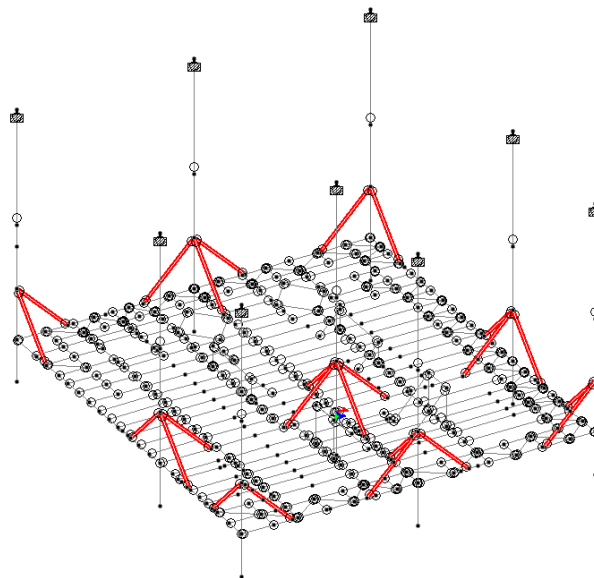


Figure 45 Example of study of the lifting system

Following principles so far presented, it is possible to evince in the following pictures the examples of the various stages.

Once the design has been completed, the preassembly of the floors shall start in a dedicated area, which could be both in Site surroundings as well as in a selected ad-hoc shop, where it is possible to work in parallel to multiple levels of the various structures selected for the pancake approach application, as per Figure 46.

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Figure 46 Floor under preassembly

Once a floor is ready it shall be transferred to the staging area (for reference, a staging area is represented in Figure 47), waiting for the installation, if the preassembly does not take directly place in this area. This is important because it shall grant continuous work front availability to the activities on Site because the basic principle is to improve Site performance rather than causing disruptions to the ongoing activities.



Figure 47 Staging area

From the staging area, the floors are then headed to Site for the erection, as per Figure 48. This phase consists in the lifting to the floor's final position through mean of the lifting system presented in Figure 45 and its relevant connection to the already-in-place portion of the structure, ready for the consequent stick-built activities to be performed.

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Figure 48 Lifting of a pancake floor

Once the lifting of the floor has been completed, the Site crews can proceed with the stick-built installations, as per Figure 49.



Figure 49 Completion of lifting operations for a pancake's floor

In Figure 50, finally, it is represented the typical sequence to be adopted on Site for the erection of the pancake floors in combination with the stick-built portions, in theoretical perfect integration, as explained in the previous step-by-step representation.

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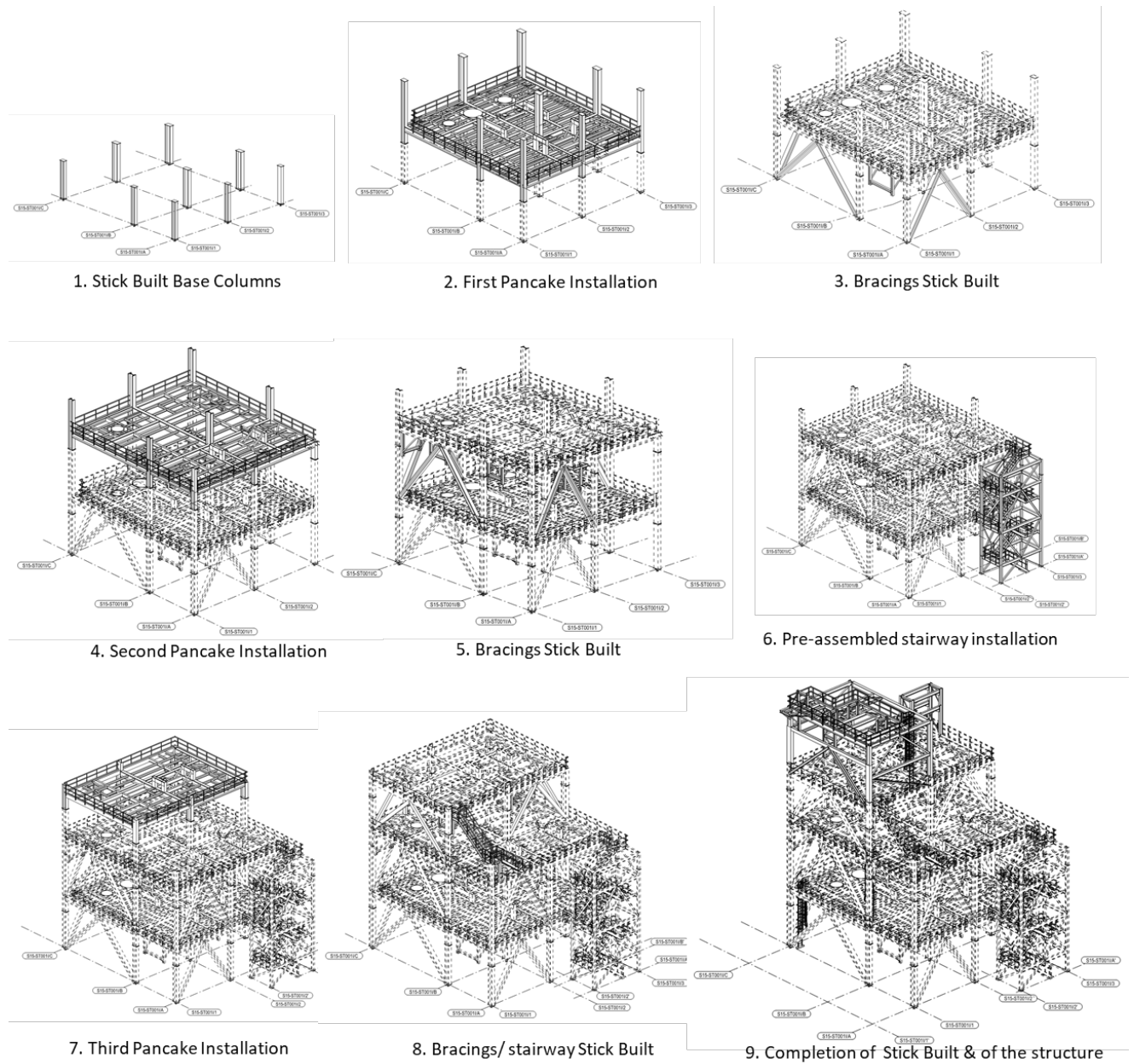


Figure 50 Typical erection sequence of a structure applying pancake methodology

6.4 Precast Methodology

Another interesting methodology consists in the application of the precast principle avoiding (totally or partially) the concrete cast in situ.

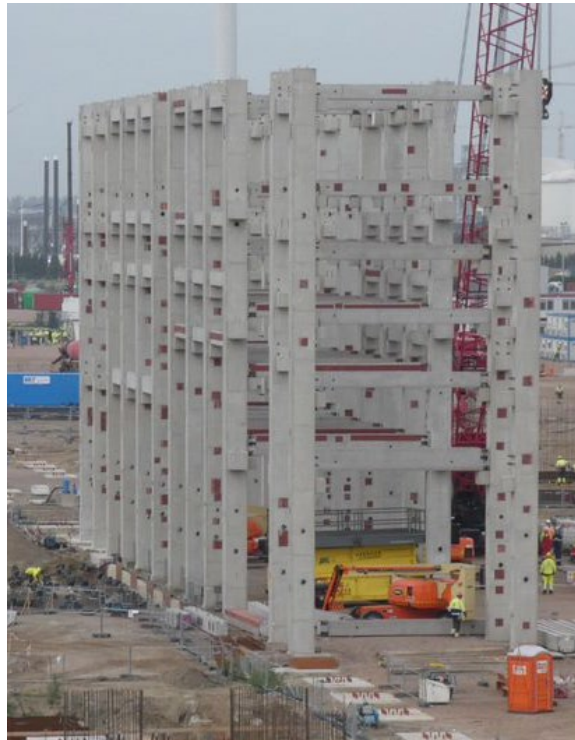


Figure 51 Structure constituted of precast elements

The main advantages of the precast solutions are easy to identify and refer to:

- Reduction of the amount of work to be done at site with consequent reduction of manpower needed at Site
- Allow the completion of underground and paving works prior to the arrival at Site of precast elements
- Reduction of the duration of the construction activities (with evident benefits for the entire Construction Schedule) considering that activities are moved to a shop where quality and productivities are higher and they are executed in parallel to the preparatory/ preliminary activities
- In case of process/ interconnecting structures, the precast elements constitute an alternative to the fireproofing, which is more expensive and more complicated to be applied
- The application of precast elements can be a reliable trade-off solution between stick-built (concrete cast in situ) and full modularization (exploiting steel structures).

On the other hand, there are some concerns, similar to those identified for the modularization methodology application, such as:

- Duration of engineering activities is longer and shall start (and should be completed) in due time to properly feed the fast and extensive shop precasting activities
- Productivities of precasting shops shall be taken in due account, considering it has to fulfill site requests (and dedicated personnel deployed) without causing disruptions nor delaying Site activities (but also without excessively anticipating Site activities)

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- The need for embedded plates for support anchoring can be a very expensive problem to solve in case of late modifications or mistakes (regardless of the origin of the issue, being this caused by engineering, production phase in shop or construction site)
- Mixed structures of concrete and steel leads to expensive and complex connections requiring special solution to overcome the different erection tolerances and the impossibility to modify the concrete precast elements.

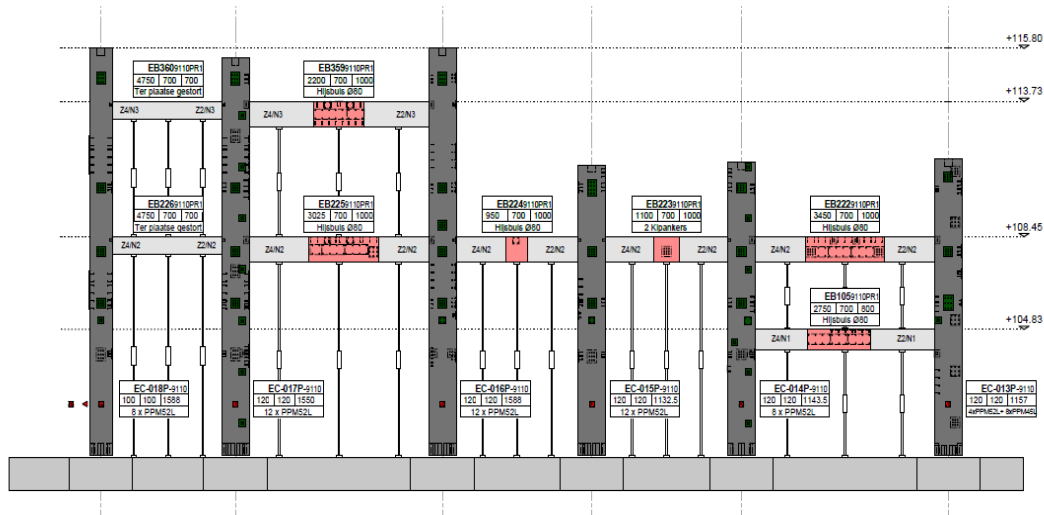


Figure 52 Structure decomposition required for precast approach definition

The precast approach adopted can be of the following types: full precast application, partial precast and integration of precast and cast in situ in the same structure.

Each of the mentioned solutions have strength and weakness points which shall be taken in advance both regarding the Site conditions as well as in relation to the structure to be built.

6.4.1 Full Precast

In case of full precasting approach, the structure is totally composed by precast elements prepared at a precast shop, which are then delivered at Site and erected similarly to a steel structure, provided that suitable connection system has been considered.



Figure 53 Erection of column with a full precast approach

The advantages of this kind of application are various and can be summarized as follows:

- Minimization of the activities to be executed at Site, for precast elements erection: this appears clear once considering that no cast in situ activities for the structural elements are required
- Considering the minimization of works at height it can be avoided the installation of scaffoldings, exploiting only cherry pickers for the connections/ erection works
- Quality of the precast elements is higher than the quality achievable in Site with cast-in-situ approach (thanks to better working environment and tools/ equipment).

Obviously, this application has not only positive consequences, but it has also drawbacks, such as:

- Precast elements' transportation to erection position is more difficult, especially in case of congested sites
- Bigger capacity cranes are generally required for bigger elements (or for those elements that shall be installed at height)
- Structural elements are limited to columns and beams
- Connection between various elements is provided through mean of special elements that require dedicated studies and may lead to additional constraints with respect to space availability, rebars congestion, position of embedded plates, etc.
- Corbel under beams required especially in case of heavy loads

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- Connections suffer of many geometrical constrains and load limits.

6.4.2 Partial Precast

With this approach, the structure is composed by precast elements prepared at shop, delivered at site and combined with portions casted directly on site to create the requested assembly strength.

This technic can be applied in case of excessive loads (in relation to the transportation and lifting constraints, for example), section too small combined with rebars too dense to allow a proper use of full precast system.

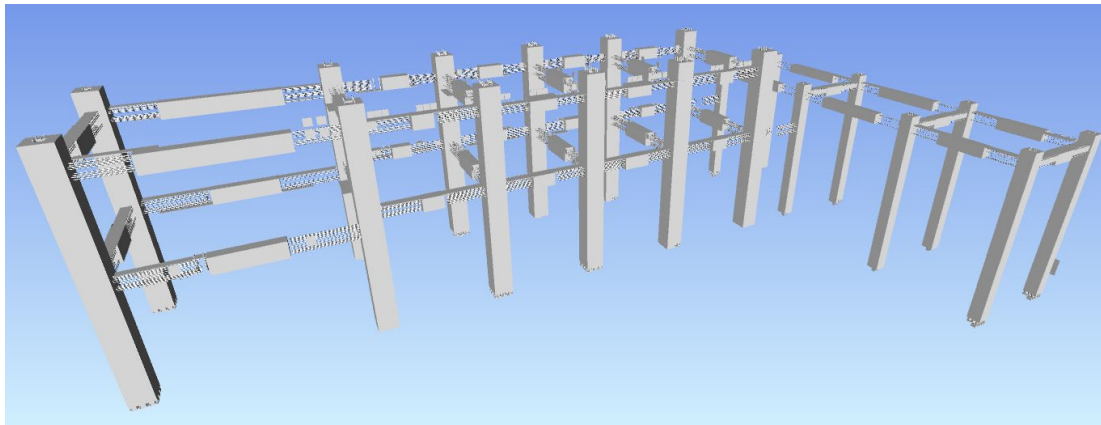


Figure 54 Identification of the elements to be fabricated in shop and portions to be cast in situ

It is clear that this kind of approach allows for more degrees of freedom in the structural design, considering that a (considerable) portion of the works are still be executed on Site (casting in situ the concrete); this is, in addition, is combined to an easier management of the elements, which generally have less/ cheaper embedded items.



Figure 55 Erection of structure with a partial precast approach

On the other hand, there are some concerns in relation to the application of this hybrid methodology, such as:

- Increased site activities (with respect to the full precasting but, in any case, with less activities if to compare this case with the 100% cast in situ concrete). In these terms, it is to take into account that there are bigger efforts in relation to rebars preparation, concrete pouring, embedded items management, etc.
- Requirements of scaffolding and thus execution of works at height (which were avoided in the case of full precasting)
- Longer execution time for the activities (further extended considering the period of concrete curing)
- Quality of the structure may be lower, in relation to the partial execution of the activities on site, normally with worst environmental conditions if to be compared with shop's conditions.

6.4.3 Precast Integrated In Cast In Situ Structures

The third approach herein presented in relation to the precast applications is the integration of the precast approach with cast in situ portions, similarly to what explained in Section 6.4.2, but with a specific focus on buildings erection. In particular, it is applied to those buildings in which the full precast of elements cannot be achieved due to the slabs to be installed within the building, in relation to the geometries, density of penetrations or, as per Section 6.4.2, in relation to constraints in their transportation or erection.

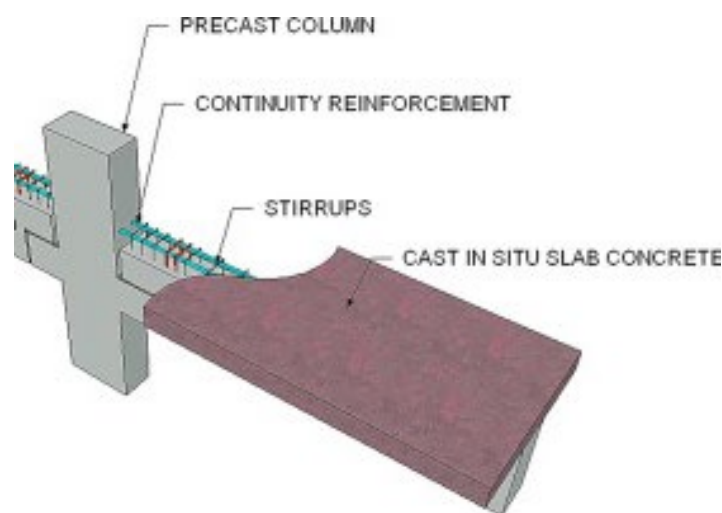


Figure 56 Explanation of the combination of precast elements and cast in situ portion

Thus, normally, the main structure is constituted of precast elements which are then linked/connected with wet joints realized during the slabs pouring.

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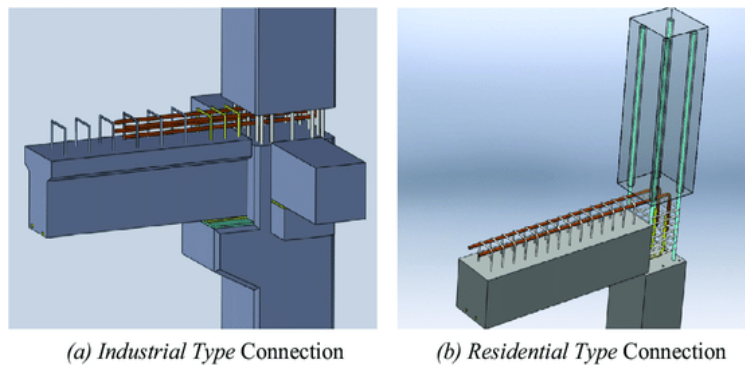


Figure 57 Examples of applicable connections

While comparing this approach with the standard adopted for building 100% cast in situ, the advantages area easily to identified in the following bullets:

- This approach can be adopted for the majority of the buildings
- Time required to complete the erection of the building is reduced, considering that a part of the activities has been executed in a shop (where the performance, in general, is higher)
- Less need for scaffolding and other temporary supports required in the building casting activities
- Possibility to manage minor changes in the design on site, especially when these are related to the floors.



Figure 58 Example execution of an integration of precast approach and cast in situ activities (1/2)

On the other hand, there are some disadvantages which shall be taken into consideration while evaluation the application of this methodology:

- Congestion of rebar at nodes can generate difficulties of execution
- Multistorey buildings require for an execution floor by floor, limiting the parallelization of the erection activities
- Connection of the precasted elements shall be done through mean of wet joints
- Intermediate phases (before final pouring) need to be studied and temporary support shall be defined accordingly.

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Figure 59 Example execution of an integration of precast approach and cast in situ activities (2/2)

7. Periodic verification and comparison of construction quantities & updating of Construction Plan

After the handover from Commercial team to the Execution one of the documentation relevant to the Project (ref. to Section 2), having set up the Constructability on the Project (ref. to Section 4) as well as having produced the first operational Construction Plan (ref. to Section 0), it is important to keep it updated taking into consideration the development of the Project.

If, with respect to the Constructability, the process is naturally evolving thanks to the checklist and the action list periodical update, the Construction Execution plan and the Level 3 Project Schedule shall be updated considering:

- Constructability analysis outcomes (relevant to sequences, strategy for the prefabrication, erection, subcontracting strategy, etc.)
- Update of estimated manhours for the Site activities (basing on the variation of the Bill of Quantities issued by relevant Engineering disciplines).

These points are different steps/ aspects of the Project development. Once revised quantities are available, the Bill of Quantities (BOQ) are updated on a regular basis (generally agreed with Project Management team) from each Engineering discipline. These revised BOQs are handed over to Construction Organization which is responsible for the calculation of the Construction Direct Manhours associated to the quantities of the Project which allows for an assessment of the magnitude of the Project.

Normally, this calculation is developed in two steps: the first is the calculation of the standard manhours, which are obtained applying a productivity owned by Contractor (defined from its historical database).

The standard manhours have the aim of defining the manhours required for the execution of an activity in ideal conditions, i.e. with trained workforce, all materials/ tools/ consumables available, in proper environmental conditions and with no disruptions/ interruptions during the execution of the activity under evaluation. This calculation has to be performed for the totality of the activities that are to be performed for the Project and are a reliable and versatile way of classifying Projects; in particular, the definition of the manhours associated allows for:

- Assessment of the magnitude of the works (and relevant variation)
- Forecasted preliminary peaks of mobilization both for Contractor and Subcontractors
- Possible approaches to be adopted that may allow for a successful execution of the Project.

Once the evaluation of the standard manhours has been completed, a summary similar to the one included in Table 3 can be prepared. The fact that the Project is approx. 4.950.000 Smh means it is a mid to large size Project that may to be approached considering a split of the Civil Works in several Work Packages, due to the Local Subcontractors performances.

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Discipline	Activity	Unit for Key Qty	Key Qty	SMH
Civil Disc.	Site Preparation Works	m3 (earth movement)	203,527	151,525
	Piling Works	m (piles)	53,776	72,229
	Civil Works - Work Package 1	m3 (concrete)	25,864	268,464
	Civil Works - Work Package 2	m3 (concrete)	14,280	271,836
	Civil Works - Work Package 3	m3 (concrete)	26,436	466,722
	Civil Works - Buildings - Work Package 1	m3 (concrete)	5,400	119,717
	Civil Works - Buildings - Work Package 2	m3 (concrete)	11,779	185,464
Mech. Disc.	Steel Structures Works	KG	10,279,106	238,176
	Equipment Installation Works	KG	14,989,167	456,175
	Piping Works (inclusive of Shop Fabrication & Erection)	ID (LB)	566,299	1,406,568
	Insulation Works	m2	155,472	305,536
	Painting Works	m2	249,617	90,344
Elec.	Electrical Works	m (cables)	1,502,680	390,191
Instr.	Instrumentation Works	m (cables)	2,126,802	522,340
Total				4,945,288

Table 3 Summary after Standard Manhours calculation

Nevertheless, this estimation relies only on the ideal conditions for the Project execution and the same estimation shall be translated in the Project Environment.

For this reason, once the standard manhours are made available, a specific K factor is applied in order to estimate the expected manhours starting from the standard manhours. The K factor is a complex element which has the aim of summarizing all the conditions which may affect the Site management and the activities execution. In particular, it has the objective of taking into account the specific climatic conditions of Site's location (a severe climatic condition can heavily affect workers' performances), the average efficiency of the workforce locally available with respect to the ideal workforce (with the hypothesis of trained and experienced workers, with all tools and equipment available, availability of construction materials as well as required consumables), the working conditions (in case of peculiar procedures/ activities to be put in place), the type of Site (a Brown Field, typically, has much more complications rather than a Green Field, due to the existence of Client's Permit To Work (PTW) System and Permits given by Operation Dept.) and the activities to be performed (i.e. if some works rely on equipment only, such as piling works or site preparation activities, the K factor associated will be different from welding activities or cable laying).

As a consequence, considering the nature of the aspects which are summarized into the K factor, it is clear that it is not necessarily a constant number through disciplines nor it is constant during the entire duration of the Project, because the boundary conditions and/ or the constraints may sensibly vary during the life of the Project and/ or discipline by discipline.

Discipline	Activity	Unit for Key Qty	Key Qty	SMH	K factor	EMH
Civil Disc.	Site Preparation Works	m3 (earth movement)	203,527	151,525	1.10	166,678
	Piling Works	m (piles)	53,776	72,229	1.10	79,452
	Civil Works - Work Package 1	m3 (concrete)	25,864	268,464	1.30	349,003
	Civil Works - Work Package 2	m3 (concrete)	14,280	271,836	1.30	353,386
	Civil Works - Work Package 3	m3 (concrete)	26,436	466,722	1.30	606,739
	Civil Works - Buildings - Work Package 1	m3 (concrete)	5,400	119,717	1.35	161,618
	Civil Works - Buildings - Work Package 2	m3 (concrete)	11,779	185,464	1.35	250,377
Mech. Disc.	Steel Structures Works	KG	10,279,106	238,176	1.25	297,720
	Equipment Installation Works	KG	14,989,167	456,175	1.20	547,410
	Piping Works (inclusive of Shop Fabrication & Erection)	ID (LB)	566,299	1,406,568	1.40	1,969,196
	Insulation Works	m2	155,472	305,536	1.20	366,644
	Painting Works	m2	249,617	90,344	1.20	108,412
Elec.	Electrical Works	m (cables)	1,502,680	390,191	1.15	448,719
Instr.	Instrumentation Works	m (cables)	2,126,802	522,340	1.15	600,692
Total				4,945,288	1.28	6,306,045

Table 4 Expected manhours calculation from SMH

7.1 Follow-up with Site performance and further evaluations

In a later stage, during Site activities execution, the K factor can be updated in consequence of other factors such as the availability of IFC drawings and materials or the jeopardization of the work-front, which bring inevitably to a loss of efficiency in the works execution.

An example of the control and update procedure that may adopted has been reported in the Table 5.

This is constituted by the combination of the Current Estimate developed so far (with indication of both Standard and Expected Manhours) and the performance of the selected Subcontractors working at Site. In this simple representation it is possible to evince:

- Variations in the quantities, which implicitly cause variations in the Standard & Expected manhours
- Differences between internal estimation and the estimation provided by the selected Subcontractor (especially with respect to the K-Factor)
- Performances of the deployed Subcontractors (subject that will be treated in Section 14.4.1)

Sn	Discipline - Work Package Wise	Current Estimate			Subcontractor (SBC) Estimation		Site Performance		
		SMH (A)	Est. K-Factor (B)	EMH (C = A x B)	EMH (D)	K-Factor (E = D / A)	Cum. Earned Mhrs (F)	Cum. Spent Mhrs (G)	Actual K-Factor (H = G / F)
1	Site Preparation Works	151,525	1.10	166,678	129,842	0.86	106,764	101,500	0.95
2	Piling Works	72,229	1.10	79,452	52,800	0.73	59,828	57,985	0.97
3	Civil Works - Work Package 1	268,464	1.30	349,003	252,459	0.94	221,021	204,994	0.93
4	Civil Works - Work Package 2	271,836	1.30	353,386	758,515	2.79	152,074	296,021	1.95
5	Civil Works - Work Package 3	466,722	1.30	606,739	237,318	0.51	43,583	60,389	1.39
9	Building Works - Work Package 1	119,717	1.35	161,618	357,069	2.98	105,777	246,820	2.33
10	Building Works - Work Package 2	185,464	1.35	250,377	195,035	1.05	55,094	108,989	1.98
15	Steel Structures Work - Work Package 1	161,697	1.25	202,121	113,664	0.70	131,697	145,751	1.11
16	Steel Structures Work - Work Package 2	89,952	1.25	112,440	111,923	1.24	58,657	78,982	1.35
18	Piping Works - Work Package 1	763,606	1.40	1,069,048	1,200,886	1.57	512,390	716,673	1.40
19	Piping Works - Work Package 2	678,268	1.40	949,575	1,205,531	1.78	349,715	718,608	2.05
24	Mechanical Works - Work Package 1	280,619	1.20	336,743	312,295	1.11	154,078	222,743	1.45
25	Mechanical Works - Work Package 2	198,461	1.20	238,153	237,538	1.20	88,203	145,229	1.65
28	Painting Works - Work Package 1	44,579	1.20	53,495	39,326	0.88	20,327	39,613	1.95
29	Painting Works - Work Package 2	50,125	1.20	60,150	80,200	1.60	32,531	81,664	2.51
32	Electrical Works - Work Package 1	94,503	1.15	108,678	31,469	0.33	21,345	45,562	2.13
33	Electrical Works - Work Package 2	297,457	1.15	342,076	436,432	1.47	82,089	117,770	1.43
34	Instrumentation Works - Work Package 1	90,466	1.15	104,036	93,670	1.04	34,628	46,632	1.35
35	Instrumentation Works - Work Package 2	433,570	1.15	498,606	484,749	1.12	67,042	38,376	0.57
36	Insulation Works - Work Package 1	250,847	1.20	301,016	353,355	1.41	23,408	48,821	2.09
37	Insulation Works - Work Package 2	58,393	1.20	70,072	13,429	0.23	16,386	244,10	1.49
	TOTAL	5,028,501	1.28	6,413,462	6,697,506	1.33	2,336,637	3,547,530	1.52

Table 5 Comparison between Home Office Estimation and Site Recorded Performances

Once the manhours are available, these are transferred to Project Control Team which can update the resourced schedule that has, consequently, impacts deriving both from a change in the quantities and, where applicable, from the variation of the K factor. The outcomes may be marginal and thus an update of the other analysis and strategies developed is not required; alternatively, the variations may be significant. If this is the case, the Construction Plan (which includes the overall strategy/ approach to the Construction phase, the sequences and even the priorities, in serious cases) may require to be revised or amended/ modified in order to react in the most fruitful manner for the Project to this kind of impacts (positive or negative) coming from the previous estimations or from the Site Performances.

The mentioned variations may occur on different scale and may involve just a single area of the Site (for example as a consequence of a change of the loads to be borne by the soil/ the foundations or the steel required to sustain air coolers mounted on top of the Interconnecting Pipe Rack) or a single discipline (due to a change in the applicable standards and norms or for the intervention of an appointed Institutional Agency/ Controller).

In any case, the studies and analysis crucial to guarantee a smooth execution of the activities on Site are to be revised considering mostly the impact in the area/ discipline which they refer to and, after this, the studies shall analyze the modifications to the adjacent plant areas or to the disciplines/ activities which follows (e.g. delays or change in the erection sequences due to performed analysis).

8. Construction HSE System

Health, Safety and Environment are important aspects in every construction project; incidents and accidents can affect the people, the property and the environment and they can have serious consequences for the project in terms of delay, reputation and costs. The implementation of a suitable HSE management system helps in preventing losses and damages and it ensures a flawless project execution.

8.1 Project HSE Plan

The Project HSE Plan is the principal document that governs the HSE management system, it is developed from pre-construction information provided by the Client and by the organization's technical departments. The Project HSE Plan shall take into account any applicable legislation as well as contractual requirement and relevant standards/norms and shall integrate these constraints with the Contractor's policy.

For those organizations where a formal HSE management system is implemented the Project HSE Plan is a bridging document that links the corporate system to the project system by adapting it to the context in which the project is executed and the requirement of the Client and of the country where the Project is to be executed.

The Project HSE Plan shall be prepared before construction works start (considering it has to be approved and then shared with all the Subcontractors working at Site) and shall address as a minimum the following aspects:

- **Project description, project scope and project duration:** the Project HSE Plan shall contain a description of the context in which the project takes place, a description of the scope of work and a brief view of the project schedule (Gantt)
- **Project HSE objectives:** the document shall contain a list of HSE objectives that the project aims to achieve - e.g. zero LTI (Lost Time Injuries), maintain the LTIR or the TRIR (Total Recordable Incident Rate) below a certain value (usually lower than the threshold suggested by international organizations such as IOGP - International Association of Oil & Gas Producers), zero oil spills, no regulatory violations, etc.
- **Project HSE organization, roles and responsibilities:** the document shall outline HSE roles and responsibilities (it has to be noted that the HSE organization chart can be included in the document but it can also be kept as a separate document, to avoid the need of revising the Project HSE Plan every time there is a change); every position in the Organization chart shall be described in the plan indicating and all relevant duties, responsibilities and liabilities on Site
- **Fit for duty and training requirements:** the document shall outline what are the medical and training requirements necessary to work on the project (e.g. pre-employment medical checks, alcohol and drug testing, statutory HSE training, project HSE induction, equipment operator training, certifications, etc.). Normally, this set of requirements is summarized in the form of a training matrix
- **Site HSE rules:** the document shall outline the HSE rules to be followed while on Site such as prohibitions (e.g. no smoking, no alcohol and drugs, no weapons, etc.) and obligations (e.g. speed limits, pedestrian walkways, mandatory PPE, etc.). It is not unlikely to have established a disciplinary procedure in case of rules breaking as well as an incentive scheme to reward virtuous workers
- **Risk assessment:** the document shall identify the methodology for assessing the risk (e.g. qualitative risk assessment, quantitative risk assessment, HAZID, JHA, etc.) and provide an initial evaluation of the risk. The risk assessment is a live document that

identifies the hazards and provide the control measures required to reduce the risk to an acceptable level, it is supposed to be revised frequently as long as the project progresses; for this reason it is usually kept as a separate process, to avoid the need of revising the entire plan every time there is a change

- **Regulatory authorization and permits:** the document shall describe what authorizations and permits are required prior to/or during the execution of the work. This portion may include statutory authorizations (e.g. environmental permits, aviation permits for high cranes/structures, etc.) as well as project level permits (e.g. hot works, critical lifting activities, confined space entry, etc.)
- **HSE meetings and HSE communication:** the plan shall identify which HSE meetings are to be held and relevant frequency during the project execution (e.g. kick-off meeting, weekly HSE meeting with subcontractors, daily coordination meeting, etc.). The document shall identify also communication initiatives regarding HSE (e.g. toolbox talks, HSE campaigns, incentive schemes, etc.)
- **Emergency response:** the document shall contain a layout of the site with indication of muster points, location of first aid kits and emergency response equipment, the document shall outline the initial emergency response procedures and indicate the emergency response numbers. It happens very often that the emergency Response Plan is issued as a separate document, especially if the Project is located within an existing facility/ industrial area (in this case the same plan has to be shared with the coordination team of the plant/ area)
- **Incident reporting and investigation:** the document shall identify a process for reporting accidents/near-miss cases and shall define how these events shall be investigated (e.g. investigation performed by the supervisor or by a team of people, what investigation technique shall be used, etc.)
- **Audits and inspections:** the Project HSE Plan shall define the types and the frequency of audits and inspections to be carried out during the project (e.g. management walkthrough, internal and third party audits, item-specific inspections, etc.)
- **Monitoring and review of HSE performances:** the Project HSE Plan shall identify a set of leading and lagging KPI (Key Performance Indicators), these indicators shall be monitored throughout the course of the project and be subject to periodic reviews. For further information, refer to Section 14.4.

The HSE plan is a live document and changes as the project evolves, it shall be approved by the ultimate person responsible for HSE (usually the Project Director/ Manager and/ or the Site Manager), every time a change is made the document owner needs to approve it again. The document must be made available to all Subcontractors prior to Subcontracts award, to have full endorsement of the requirements therein indicated.

8.2 Project HSE Organization

The HSE organization of the project is strongly influenced by Project size and complexity; the diagram reported in Figure 60 represent the typical organization chart for the HSE department of a small - medium size project.

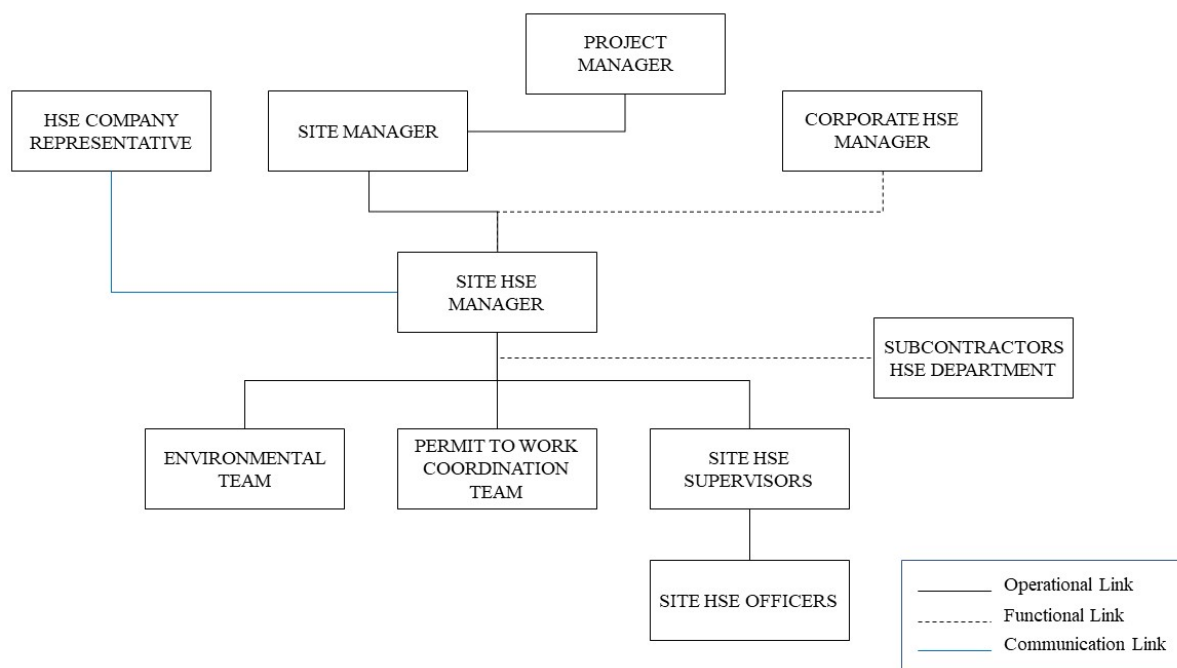


Figure 60 Typical HSE Organization Chart

At project level, the HSE Manager is the head of the HSE Project Team; this is a senior position that reports directly to the Project Manager and functionally to the corporate (Construction) HSE department. The HSE Manager is also in charge of liaising with the Client and with authorities in relation to project health, safety and environmental matters to be reflected on Site works.

Below the HSE Manager there are the HSE Supervisors; these are usually technicians with extended field experience. Usually, each Supervisor is assigned to a specific area or discipline within the Site. Furthermore, every HSE Supervisors has a team of HSE Officers (the numerosity of the team is defined by complexity, size of the area, direct workers to control, etc.); these are usually junior positions with limited field experience, which are assigned to limited areas/ subareas or to specific tasks, reporting to HSE Supervisors and HSE Manager.

Depending on the size of the Project there might be other positions required: larger projects may require a HSE Director with multiple Project HSE Managers reporting to him and/ or Deputy position(s). The HSE Manager may need a HSE Engineer who act as technical safety to reviews lifting plans and technical documents, or may need a HSE administrator who manage all the aspects related to medical examination, trainings, KPIs, etc.

In many projects, contractual requirements impose a ratio of HSE personnel in relation to the number of workers, often this ratio is 1/25 or 1/50.

8.3 Medical examination and training

The HSE department shall define what medical examinations and training courses are required to work on the project; these requirements shall consider both local legislation and the provision of the contract. Required medical examinations usually include a pre-employment medical screening and may include specific examinations for certain works (e.g. alcohol and drug test for equipment operators).

Training requirements shall include statutory HSE training and the HSE Induction; in case these trainings do not cover completely the scope of work, additional training shall be delivered according to project needs.

In Table 6 is reported an example of a typical project HSE training matrix.

POSITION	HSE INDUCTION	PERMIT TO WORK	USE OF CRANE	USE OF FORKLIFT	USE OF AWP	ELECTRICAL WORKS	LOCK-OUT TAG-OUT	CONFINED SPACE	FIRST AID	FIRE FIGHTING
Project Manager	MANDATORY									
Administration Worker	MANDATORY									
Construction Manager	MANDATORY	MANDATORY								
Construction Supervisor	MANDATORY							MANDATORY IF REQUIRED BY THE JOB		
Construction Foreman	MANDATORY									
Crane Operator	MANDATORY		MANDATORY							
Forklift Operator	MANDATORY			MANDATORY						
AWP Operator	MANDATORY				MANDATORY					
Electrician	MANDATORY	MANDATORY				MANDATORY	MANDATORY	MANDATORY IF REQUIRED BY THE JOB		
Construction Worker	MANDATORY									
HSE Manager	MANDATORY	MANDATORY							MANDATORY	MANDATORY
HSE Supervisor	MANDATORY	MANDATORY							MANDATORY	MANDATORY
HSE Officer	MANDATORY	MANDATORY							MANDATORY	MANDATORY
Commissioning Manager	MANDATORY						MANDATORY	MANDATORY IF REQUIRED BY THE JOB		
Emergency Responders	MANDATORY					MANDATORY		MANDATORY	MANDATORY	MANDATORY

■ MANDATORY ■ MANDATORY IF REQUIRED BY THE JOB

Table 6 Typical HSE Training Matrix

The HSE department shall maintain up to date a register with all the information related to medical examination and training of project personnel, this allows the project to monitor expiry dates and to ensure that all documents are updated; furthermore, it allows for an easy retrieval of any record required by the authorities, by the Client or by external auditors.

8.4 Risk Assessment

Risk assessment is a key aspect of the HSE management: it is a systematic method of looking at work activities, considering what could go wrong, and deciding what control measures shall be implemented.

A preliminary risk assessment should be carried out during the planning phases of the project based on experiences from similar past projects; the results should be taken into consideration during design and constructability studies in order to eliminate the hazards at source, where possible.

The risk assessment shall be reviewed and updated before setting up the construction site; ideally this review should consist of a HAZID (Hazard Identification) session executed in team by involving the key stakeholders of the project. During the HAZID session, a facilitator will lead a brainstorming exercise that consists of analyzing the various phases of the job,

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identifying the hazards related to each phase and defining what actions shall be implemented to reduce the risk.

The HAZID can be split in several sessions to assess separately each different phase of the project (e.g., site preparation and civil works, steel erection, E&I installation, pre-commissioning & commissioning, etc.).

Here below (Table 7) is made available an example of a typical spreadsheet used to record HAZID sessions.

ITEM	ACTIVITY	HAZARD	CONSEQUENCE	EXISTING CONTROLS	LIKELIHOOD	SEVERITY	RISK RATING	ADDITIONAL CONTROLS	ACTIONS	TARGET	STATUS	LIKELIHOOD	SEVERITY	RISK RATING

Table 7 Typical HAZID spreadsheet

As stated earlier, the risk assessment is a live document and it shall be reviewed and updated any time that a change/ modification/ variation is introduced to the project, as well as consequently to incidents or accidents.

The information contained in the risk assessment shall be made available to every person who works on the project and communicated to the subcontractor’s supervisor who shall pass it to the workforce.

Very often, a further level of risk assessment takes place at field level, it is called JSA (Job Safety Analysis) or JHA (Job Hazard Analysis) and consists of a document which is filled out directly in the field by the foreman and relevant team. The JSA/ JHA breaks the job into steps and for each steps analyzes what are the hazards and what are the mitigations that should be implemented. This allows the workers to think in advance about the job they are going to do and to address specific hazards that couldn’t be foreseen when the HAZID was carried out (e.g. presence of ice, etc.). Here below (Table 8) is an example of a typical JHA form.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	MITIGATIONS TO BE IMPLEMENTED

Table 8 Typical JHA form

Usually, the definition of a JSA/ JHA is considered mandatory for the release of the PTW to Subcontractors. In this sense, the first mitigation of the risk is being sure that the working team is aware of the risks it may face. To strengthen this knowledge, the JSA/ JHA is often attached to the relevant Method Statement (produced by the same team) in order to have full correspondence among the set of operations to be performed and the identified risks.

8.5 Permit to work

Most projects have a permit to work (PTW) system in place. The permit to work system is usually applied to the works to be executed on Site by Subcontractors, especially for those hazardous activities for which a special PTW is required (e.g. hot works, confined spaces, critical lifting, energy isolation, etc.).

The permit to work system is usually administered by a dedicated department but it is strongly related with HSE because the issuance of the permit is subject to checking that several aspects are fulfilled in order to ensure that the job can be carried out safely (e.g. gas testing, energy isolation, paperwork, etc.).

The permit to work system is also a very important tool to manage SIMOPS (Simultaneous Operations): by controlling the various activities the project can ensure that no operations may impact the safety of personnel or equipment and the environment of another operation.

8.6 HSE meeting

During the course of the project several HSE meetings take place to discuss Health, Safety and Environmental aspects; the type and the frequency of these meetings may vary from project to project.

The following is a non-exhaustive list of the most common HSE meetings held during Construction:

- **HSE meeting with the Client:** this can be a meeting fully dedicated to HSE or a general meeting where HSE is discussed among other disciplines; in this second case, however, HSE is usually discussed at first, considering its relevance as a discipline and as a matter. During this meeting, ideas, observations and concerns (raised by the Client toward Contractor or by Client/ Contractor towards Subcontractors, if they participate) are discussed, a Minute of Meeting is prepared and follow-up champion is assigned.
- **HSE meeting with the project team:** as per previously presented meeting, also in this case the meeting can be fully dedicated to HSE or can be a general meeting where HSE is discussed among other disciplines. Usually, during this meeting, the HSE Manager updates the project team about the situation in relation to incidents, observations, KPIs, audits, criticalities in relation to future activities and similar topics of interest for the entire team.
- **HSE meeting with subcontractors:** this is usually a meeting fully dedicated to HSE which involves the HSE Manager, HSE Supervisors as well as the Site Manager and HSE manager of each subcontractor. During this meeting, concerns and observations are communicated to subcontractors for their prompt rectification. KPIs, results of audits and criticalities are also shared and discussed with subcontractors.
- **Toolbox meeting:** this is a short pre-job meeting held on site by each Supervisor/ Foreman with its team before commencing the daily activities; during this meeting the

workforce receive instructions about the task to be executed along with HSE tips related to the activity. This is also the time when the information discussed during management meeting are cascaded to the workers.

8.7 Incident reporting and investigations

The HSE department is responsible for collecting and tracking any incident/ accident/ event that takes place during the course of the project. The mentioned events include fatalities, LTI (Lost Time Injury), RWC (Restricted Work Cases), MTC (Medical Treatment Cases), FAC (First Aid Cases), NM (Near Misses), Environmental Impacts and Property Damages.

When an incident occurs, the HSE team shall conduct an investigation to determine the causes of the incident and to identify what corrective actions shall be implemented to prevent recurrence. Depending on the severity of the incident the investigation could be carried out by a single person or by a team, which may include an Investigation Team Leader and several subject matter experts.

The investigation techniques vary as well, depending on the incident type and it may go from a simple 5 WHY approach to a complex fault tree analysis.

8.8 Audits and inspections

During the course of the project, continuous monitoring of the activities shall be executed through audits and inspections.

Inspections are executed on daily basis by the project HSE team and they are recorded using dedicated forms.

Inspections tend to focus on physical facilities, hazards, and controls. On the other hand, audit addresses the same kinds of concerns, but also goes beyond immediate hazards to examine behind-the-scenes workplace safety systems and additional human factors. Audits are usually executed by involving subject matter experts to analyze more in details particular aspects (e.g. lifting, commissioning, etc.).

The project HSE team shall prepare an audit plan that identifies the audits to be carried out over a period of time (generally a year); the audit plan shall take into consideration the various disciplines and different areas of the project as well as the schedule.

Dedicated audits should be executed on subcontractors and suppliers to evaluate their HSE performance before contract award as well as during the execution of the job.

8.9 Monitoring and review of HSE performances

The project shall define a set of leading and lagging KPIs that shall be monitored during the course of the work. These KPIs should include leading and lagging indicators.

Leading indicators are proactive measures that measure prevention efforts and can be observed and recorded prior to an injury (e.g. number of training hours, number of audits, number of inspections, number of observations, etc.).

Lagging indicators are reactive measures that track negative events (such as an injuries) once they have already occurred (e.g. number of LTI, TRIR, number of environmental spills, etc.).

By monitoring the trend of the selected KPIs, it is possible to understand how the project is performing in term of HSE. These information are important because they can be used to drive continuous improvement, improving HSE performances and assessing possible weak areas.

9. Site Quality System

Within an EPC Contractor and within Projects (under execution or executed) includes four main phases that can be identified in the process of applying the Quality Management System:

- Quality Planning
- Quality Assurance
- Quality Control
- Activities of Project Quality Management in Home Office

The proper application of the Quality Management System consists in the application of planning, execution, monitoring and close-out of all project quality-related activities (which include the Quality Assurance and Quality Control). In this sense, the application of the Quality Management System is the deployment of the Corporate Quality Management System at Project level, taking into account the specific requirements of Contract, country law and regulation, Client specifications, applicable international codes and standards.

9.1 Quality Planning

At Project Start-up, the Project Quality Team shall plan and define all project quality-related activities, tools, procedures and targets that shall be implemented to achieve a successful performance from the point of view of the Quality management, such as, for example:

- Project Quality resources
- Project Quality Goals
- Project Quality Deliverables (to be issued both to Client and to Subcontractors/ Vendors as well as the internal ones, if any)
- Project Quality Tools
- Project Quality monitoring activities (audits, inspection, etc.)
- Project Quality Awareness Program

Project Quality Team is led by a Project Quality Manager (which once deployed at Site becomes the Site Quality Manager), usually reporting to the Project Director/ Manager (and once deployed on Site it is reporting to the Site Manager) and made up of several quality specialists depending on the specific Scope of Work.

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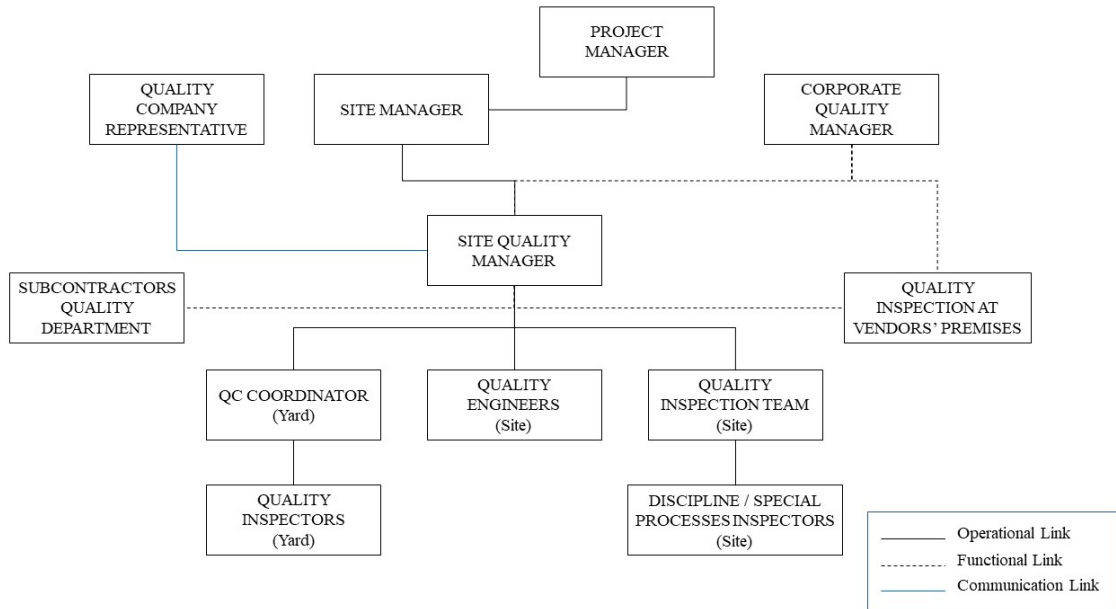


Figure 61 Typical Quality Organization Chart

The Site Quality Plan is the master document regulating the application of the Quality Management System on Site and it specifies which procedures/ tools/ resources shall be applied/ requested with relevant timing within the Project/ in relation to specific processes within the same project.

The Quality Plan is set up in order to represent the overall management of Quality for the execution of the Project; the Site Quality Plan has the same wish but a specific focus on the Site Activities. This Plan satisfies/ includes Client's requirements and specifications and it is based on principles and rules of Corporate Quality System.

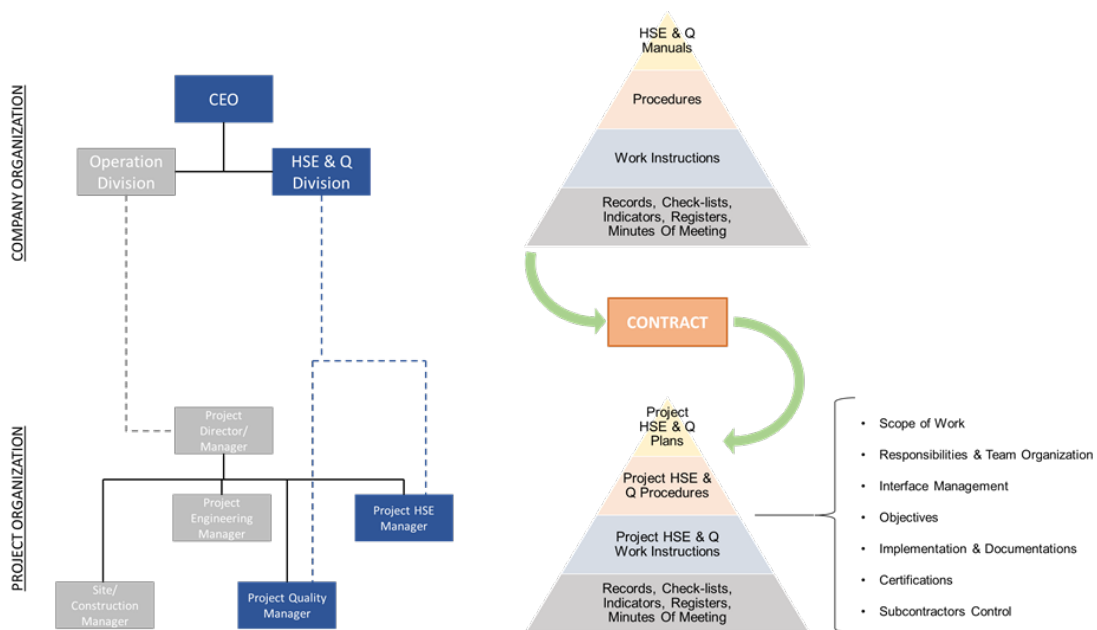


Figure 62 Link between Company and Project structures

9.2 Quality Assurance

With the aim of assuring a full compliance and observation of set Quality Requirements, the following Quality Assurance activities are carried out during project execution:

- Issue (to the concerned parties), review, application and continuous review of Quality Procedures, Work Instructions, Inspection and Test Plans.
According to contractual milestones, the Quality Team shall prepare remaining required quality documentation. Generally, the following are the minimum deliverables issued:
 - Project and Site Quality Plans
 - Project and Site Quality Audit Plans
 - Quality Control Plans / Inspection and Test Plans; normally they are developed discipline-wise (e.g., Structure, Piping, Coating, Electrical & Instrumentation) but they can also cover specific subdiscipline or set of activities (e.g. earthworks, electrical motors installation, etc.)
 - Welding Management and Control Procedures
 - Non-Destructive Testing Control Procedures
 - Surface Treatment Procedures
 - Dimensional Control Procedures
 - Material Identification and Traceability Procedure
 - Calibration and Management of Measuring Devices
 - Final Dossier Procedure
 - Quality Reporting
 - Internal as well as periodical external reports to Client, which are required to track quality issues and inform about the status of the Project Quality Management System
 - Monitoring of identified KPIs, analysis of trends
 - Quality Audits and Reviews
Audit is a systematic, independent and documented process for obtaining evidences/ information/ parameters with respect to some pre-determined topics. On the collected data, an objective evaluation is performed, with the aim of assessing the relevant performance, basing on criteria which have to be defined prior to the audit execution. Internal audits, including those performed on Subcontractors and Suppliers, are part of the Quality Management System. They are planned and executed in order to ensure that the applied Quality System is compliant with its purposes and that it fulfils applicable requirements as well as to identify melioration/ corrective actions
 - Non-conformities & corrective actions management
A Non-conformity is a non-fulfilment of a requirement/ procedure as it is stated within the Project or applicable norms. The Corrective Action is the action required to eliminate the cause of the opened non-conformity and to prevent relevant recurrence. The Non-Conformity Control System aims at tracking any non-conformity identify during any phase of the Project activities, especially in relation to activities executed by Suppliers and Subcontractors, both working on Site or located in yards and workshops. Non-Conformity may be opened by any person working on Site or at Vendor premises (inclusive personnel from Contractor, Client or any Third Inspection Party) while the corrective action is to be accomplished by the enterprise which has caused the non-conformity itself.
 - Quality Training Program
-

Usually, the Project and Site Quality Managers are supported by a dedicated Staff in any location in which Project-related activities are executed. The Site Quality Manger (and Home Office team) is responsible, especially for the development and implementation of a program for quality training ensuring that:

- Project Personnel is aware of the quality requirements as defined in Statutory Requirements, in the Contract and relevant Exhibits, in the Project Technical Specification and applicable codes
- All the applicable quality-related procedures and work instruction specifically developed for the project are diffused, understood and properly applied by the Project staff

This quality awareness program is carried out by means of toolbox talks and quality inductions meetings carried out at least at the beginning of each critical activity. The quality induction meetings, toolbox talks and trainings are recorded in reports

- Final Dossier Preparation, Verification and Handover
Contractor will prepare all Final Documentation as specified in Contract/ Applicable Specifications and according to a specific “Project Final Dossier Procedure” to be issued and submitted to Client for review and/ or approval. This procedure becomes extremely important because it strongly influence the commitment and the control to be kept on the activities executed by Subcontractors, which shall be adequately staffed to face all the required activities.

9.3 Quality Control

The Quality team has to ensure that the quality of the purchased materials received on Site as well as the construction activities comply with the requirements and the specifications set as explained in Section 9.2.

The main activities carried out by the Quality Control consist of:

- Inspection and Testing
The Inspection and Test Plans (ITP) define the inspections and the tests that must be carried out during the Project’s phases as well as the specifications and the procedures governing the same tests and the acceptability criteria.
Inspections and tests on Site/ Yards/ Workshops are usually carried out by qualified, experienced operators, certified according to applicable international schemes and standards, under the coordination and responsibility of the Site Quality Manager.
Typical inspections, quality control activities and tests are, but not limited to:
 - Dimensional Surveys
 - Visual Testing (VT)
 - Non-destructive testing, inclusive but not limited to:
 - Penetrant Test (PT)
 - Magnetic Particles Test (MT)
 - Ultrasonic Test (UT)
 - Manual and Mechanized testing, such as Time-Of-Flight diffraction (TOFD), Phased Array Ultrasonic Testing (PAUT), B-Scan and C-Scan
 - Radiographic Test (RT)
 - Flange Management Control
 - E&I Tests

- Coating and Surface Treatment Inspections
 - Pressure and Leak Testing

 - Quality Control of Vendors and Subcontractors

Contractor shall employ only qualified Vendors and Subcontractors; the qualification can be internal to Contractor only or shall involve Client too, as per provisions stated in the Contract.

In case of Contractor need to subcontract part of works or to purchase materials from any organization not listed in the “Approved Subcontractors List” (if any), then Contractor shall:

 - Assess the proposed Vendor/ Subcontractor;
 - Apply for and obtain the Client’s prior written approval to include the vendor/ subcontractor in the approved list.

Site visits and quality audits may be organized at Subcontractors’ or Vendors’ premises to assess the capabilities and evaluate the performance. Client has the right to attend and actively take part to such audits. The objectives of the evaluation process are:

 - Evaluate the potential Vendor/ Subcontractor in terms of health, safety, environment, quality, resources, schedule, engineering, procurement, experience, financial and legal aspects or any other aspect related to the scope
 - Evaluate the level of Subcontractor involvement to be planned in terms of health, safety, environment, quality, resources and management.

 - Quality Records

All quality records are issued and reviewed as per the applicable quality procedures, work instructions and Inspection and Test Plans; the original records are usually filed at Quality Control Team.

The aim of the quality records is to provide evidence of conformity to requirements and effectiveness of the quality management system.

Quality records management is carried out in accordance with Contract and Applicable Specifications.

The quality records (including the intermediate records such as Non-Conformity Reports) are part of the Project final documentation that Contractor will prepare and transmit to Client.

Filing is an essential activity to ensure traceability and to timely retrievable the necessary records.

 - Material Identification and Traceability

The correlation between the different products / materials and the relevant source certificates is documented through a “Materials Traceability System”, typically reporting at least the following information: construction drawing number and revision, item or tag or mark, position, heat, plate, serial number, purchase order, quantity, and certificate number.

 - Mechanical Completion, Pre-commissioning and Commissioning Check Sheets Database

Quality check sheets for Mechanical Completion, Pre-Comm. & Commissioning are aimed at checking that systems and subsystems have been designed and constructed according to Project requirements relevant to their final use and destination.

Typically, the check sheets database for Mechanical Completion, Pre-Commissioning & Commissioning are organized by systems, sub-systems, tags and disciplines.
-

Each tagged item has its specific check sheets related to the different applicable disciplines. If during the check any punch item is raised, this is going to be registered in the database to track its follow-up and closure.

When all the check sheets have been completed by system/ by sub-system/ by discipline, the Completion certificate is issued and signed by all the involved parties.

The above-mentioned certificates allow starting the following Pre-commissioning and Commissioning phases.

At the end, it is possible to trace all tests carried out and the status of punch items by means of dedicated reports.

9.4 Activities of Project Quality Management in Home Office

Typical activities of Quality Management in Home Office are:

- Planning of resources (this stage usually starts since the tendering stage)
- Quality assurance activities
- Quality documentation management
- Coordination of control of Vendors/ Suppliers/ Subcontractors
- Participation in the definition of the Inspection and Test Plans
- Support in selecting adequate Subcontractors.

10. Temporary Construction Facilities

One of the first activities which shall start with proper timing is, for sure, the installation of the Temporary Construction Facilities required for the Project. It is important to consider the Temporary Construction Facilities as the combination of any buildings, machinery, tools, equipment, materials and other items of whatsoever nature required for the construction of the Plant defined in the Scope of Work of the Project. These facilities include also any accommodation camp/ compound to be built by and for the Contractor, Client (whether requested and stated in the Contract) and, in case, for Subcontractors.



Figure 63 On-going installation of an accommodation camp

This activity is sensitive for two main reasons:

- The decisions regarding the facilities to be designed/ installed are strongly affecting the Construction and Commissioning phases during their entire life. The potential risk is that the facilities, during the progress of the Project, may transform from a support to the activities to a Constraint to their execution. In this regard, in any case, an adjustment may be done, but the associated costs may be considerably higher
- The decisions regarding the facilities that are going to be installed are based on preliminary information subject to detailed development of the Project. The staff to be deployed (hence the dimensions for the offices and the accommodation facilities, if any), the quantities (thus the requirements relevant to the lay down areas and the covered Warehouse) and the Construction and Commissioning schedule are indeed based on preliminary inputs and may also vary substantially.

For the mentioned reasons, the reliability of the available information shall be assessed and proper contingency (i.e. spare desks/ office) shall be accordingly forecasted. This evaluation step shall be taken in an early stage of the Project, immediately after the set-up of the constructability, basing on the information included in the technical proposal handed over by the Commercial department; it is important that Constructability process has been defined and set-up because process it may allow for a better assessment of the reliability of the available information.

Sn	Offices Partitions	Peak included in Mobilization Plan	Requirement for TCF			Delta (workspaces)
			Q.ty	Occupancy	Total	
1	Site Manager Office	3	3	1	3	0
2	Site Manager Secretary Office	6	6	1	6	0
3	Project Director/ Project Manager Office	2	2	1	2	0
4	Commissioning Manager Office	2	1	2	2	0
5	Commissioning Team Office	60	8	8	64	4
6	Logistic/ Administration Manager Office	2	1	2	2	0
7	Logistic/ Administration Team Office	6	1	6	6	0
8	Contract/ Subcontracts Administration Manager	2	1	2	2	0
9	Contract/ Subcontracts Administration Team	14	3	5	15	1
10	Site Project Control Manager	2	1	2	2	0
11	Material Management Team	15	2	8	16	1
12	Project Control Team Office	15	2	8	16	1
13	Site Quality Manager Office	1	1	1	1	0
14	Site Quality Team Office	48	5	10	50	2
15	Site HSE Manager Office	1	1	1	1	0
16	Site HSE Team Office	33	7	5	35	2
17	Construction Manager Office	8	8	1	8	0
18	Field Supervision Office	90	12	8	96	6
19	Field Engineering Office	22	4	6	24	2
20	Document Control Team	10	5	2	10	0
21	Security Office	2	1	2	2	0
22	Vendors, Visitors & Guests	30	4	8	32	2
23	Total	374			395	21

Table 9 Facilities sizing: from Mobilization Plan to Site Offices

10.1 Bid Inquiry, Subcontract award, permitting and construction of the TCF

Once requirements have been set, inquiry documentation shall be prepared for the market investigation (following what described in Section 11). It shall be taken in consideration that the Bid Inquiry shall be started as soon as practicable, bringing to the Award of the selected Bidder in due time with respect to the date in which the facilities shall be made available for occupancy/ operations. This is required because between the award of the Contract to the selected Subcontractor and the occupancy of the facilities, the following minimum activities shall be accomplished:

- Design finalization by the Subcontractor, who shall adapt the requirements set by Contractor to the materials and the solutions that may be provided by relevant suppliers. This step includes the preparation of the general arrangement (ref. to Figure 64 for an example) as well as the detailed layout of each of the facilities to be installed, leading to the preparation of the BOQs, sizing of utilities, connections, etc.
- Purchase Order placement, fabrication and delivery of the materials, in parallel to Subcontractor's mobilization at Site and preliminary activities execution
- Erection and testing activities
- Connection to the existing utilities' networks, whether applicable (at tie-in points given by Client or Utilities providers)
- Obtainment of the permits required for the installation and/ or occupancy of the facilities.

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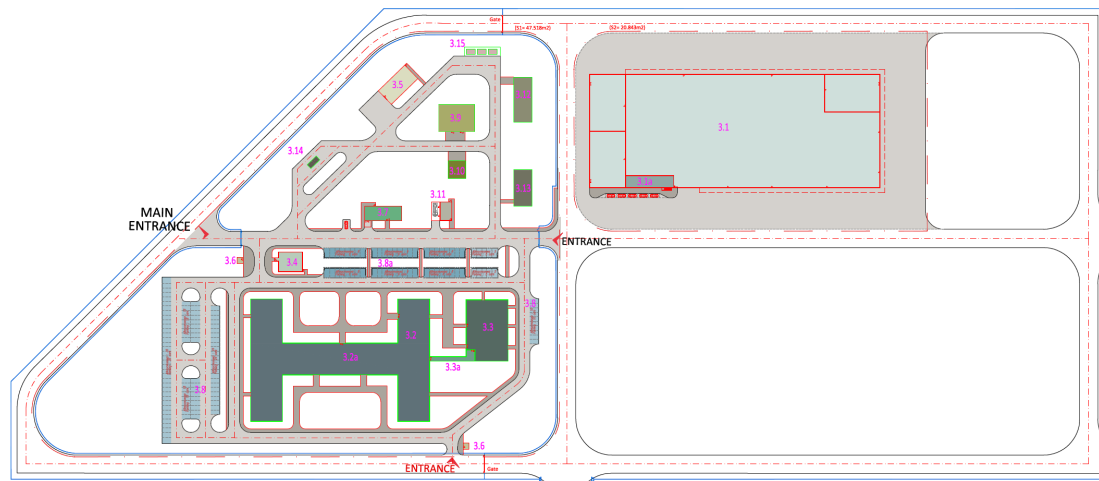


Figure 64 General Arrangement for the TCF

In case of tight schedule leading to facilities occupancy, the parceling of the facilities completion may be a solution to be exploited, especially if suitable to Project needs and in case Subcontractor's activities can be divided and sequenced in proper manner. This means that accommodation buildings as well as offices may be split and erected accordingly to the defined order of delivery priority. The first lot to be handed over shall be available prior to the start of other activities on Site and the following lot(s) shall mandatorily follow the forecasted mobilization curve defined by Contractor.

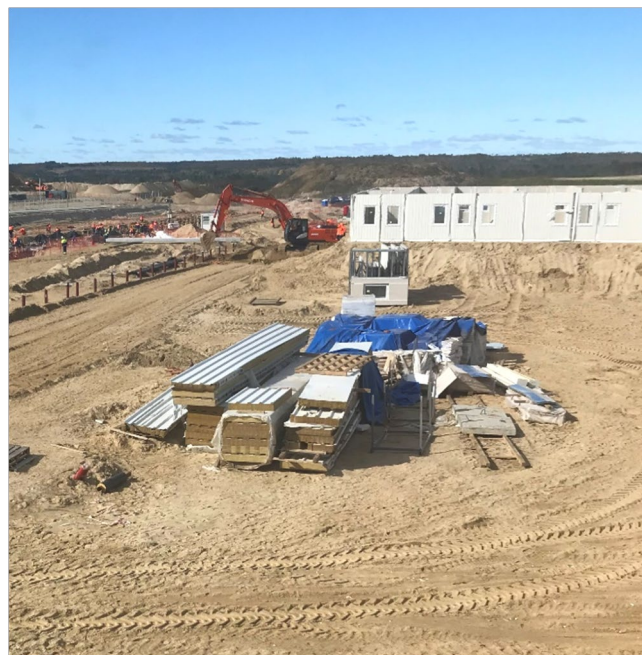


Figure 65 On-going installation works

An example of the mentioned approach can be evinced in Figure 66. Considering that the full capacity for the facilities was not required during the first period of the site activities, the

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erection of the Camp facilities as well as the other Site Facilities has been parceled in order to accommodate the forecasted personnel (evaluated with a contingency with respect to the mobilization plan) in order to have the facilities ready step by step, allowing for a smoother and easier organization of the activities for the Subcontractor in charge.

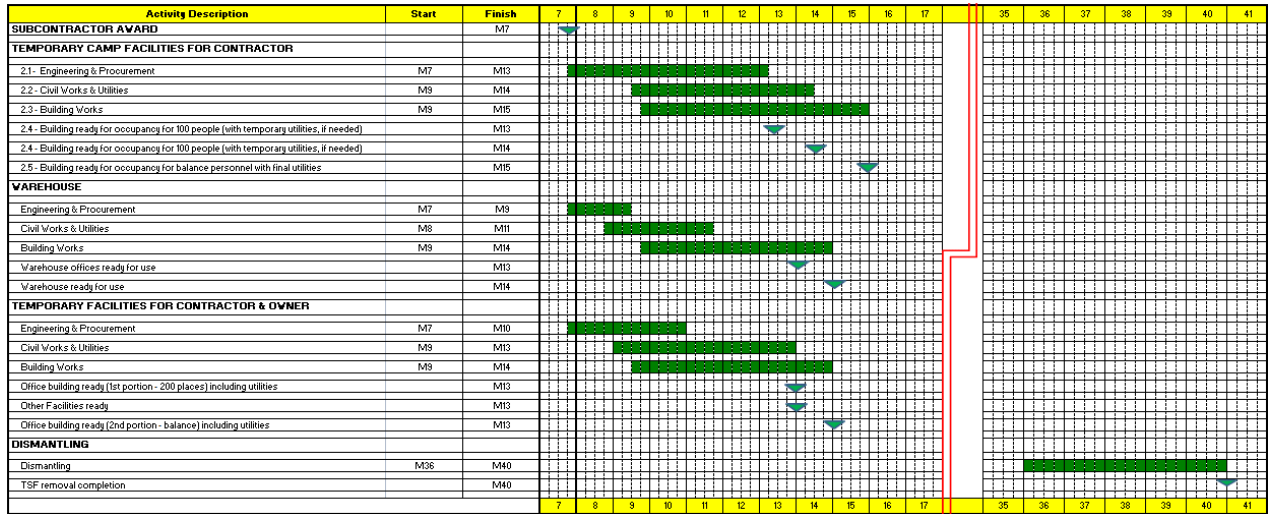


Figure 66 Example of parceling during facilities erection

This kind of approach allows for a subsequent installation of the facilities tailored on the actual needs of the Projects, following the mobilization plan forecasted in the previous phases, as represented in Figure 67.



Figure 67 Final configuration of the facilities presented in previous figures

10.2 TCF Operations and Field Running Costs management

Once the installation of the Temporary Construction Facilities has been completed and they are ready for occupancy (means that erection of the building has been completed, all systems for utilities have been completed and tested and all the required inspection by Third Parties and any Authorization needed from Local Authorities has been received), it is time to start running the Facilities.

This means that it has to be granted at any time that facilities and systems are working and available (inclusive of utilities) and any apparatus that may broke shall be repaired or replaced, granting for the reinstatement of the out-of-service item. In addition, it has to be ensured the continuous supply of fuels and consumables required for the operations (e.g. the diesel required for power generation, chemicals required for waste water treatment based on osmosis process, etc.) and the various services required for the Site/ facilities management (catering, logistics, car rentals, etc.).

Normally, the approach adopted is to have specific subcontractors specialized in the provision of such services, in a full-catering scheme, in which the company responsible for catering executes the other activities required (cleaning and housekeeping, waste management, first aid, security, personnel provision, etc.).

As an alternative, the full range of required services is subcontracted to specific companies which are responsible just for one duty. In this case, the EPC Contractor shall foresee additional personnel to follow-up the quality of the services provided as well as to ensure that requirements are satisfied at any time, especially if the duties have to be provided for an accommodation camp as well.

An approach that is normally adopted is the definition of a Matrix of responsibility which clearly states who is responsible of which activity. In this way, it is easier to ensure that all the requirements and needs for the personnel occupying the facilities are addressed. An example of this matrix is reported in Table 10.

Number	Description	Contractor's responsibility	Construction Subcontractor	Operation Subcontractor	Notes
1	Temporary Construction Facilities				
1.1	Temporary Construction Facilities				
1.1.1	Provision of land for TCF installation	X			Areas provided by Owner and handed over to Construction Subcontractor
1.1.2	Temporary Construction Facilities installation, inclusive of buildings, utilities generators (water, heating, power), fence, gates, parking		X		
1.2	Temporary Construction Facilities Utilities				

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Number	Description	Contractor's responsibility	Construction Subcontractor	Operation Subcontractor	Notes
1.2.1	Electrical power by diesel generators, water and heating system for Contractor's TCF		X		
1.2.2	Fuel for Utilities generation and other chemicals/ fuels/ oils required for TCF Operations			X	
1.3	Temporary Construction Facilities Operation				
1.3.1	Waste disposal management and transportation to local authorized waste facilities			X	
1.3.2	Security of OTHER Subcontractor buildings and fence.	X			Each Subcontractor deployed is responsible for it own security
1.3.3	Reception service for Contractor TCF			X	
1.3.4	Internal temporary roads cleaning and maintenance, intended as ordinary cleaning, snow removal and water drainage.			X	
1.3.5	Medical services with necessary personnel, equipment and ambulance for Contractor's TCF.			X	
1.3.6	Catering services and facilities on site.			X	

Table 10 Preliminary matrix for tracking duties relevant to the TCF management

In any case, at this point, the Field Running Costs are included in the Subcontractors' accounting and easier to be tracked and controlled, both for the Project costs management (ref. to Section 16) and for other commercials offers in similar areas/ contexts.

11. The Subcontracting Plan and the selection of Construction Subcontractors

Having defined the approach to be adopted for the execution of the Project, which has to be duly reflected in the Construction Execution Plan (and other operative plans relevant to the other phases of the Project, such as the Engineering Execution Plan, the Procurement Execution Plan and the overall Project Execution Plan), it is required to proceed with the definition of the Subcontracting plan and the market investigation looking for the most suitable Subcontractor(s) for the Construction works to be executed on Site.

The standard process to effectively approach this sensitive phase of the Project execution, can be identified as explained in the following sections.

11.1 Definition of the Scope of work split.

Considering a preliminary scouting which may have been executed prior to the Tender definition and/ or the Approved Subcontractor List made available in the Contract, which can help to understand the typology of the players available in the local market (discipline, size, capabilities) and considering the overall scope of work to be subcontracted, the aim of this phase is to divide the entire scope into Work packages which are to be assigned separately (an example of how this subdivision can be made is reported in Figure 68) or, in case of favorable conditions, that can be combined into larger Work Packages to be awarded to the Subcontractor deemed more adequate for the execution of the related activities.

	PROCESS TRAIN 1	UTILITIES AREA	PROCESS TRAIN 2	PROCESS BUILDINGS	LOGISTIC AREA	NON-PROCESS BUILDINGS
HVAC	Work Package 7					Work Package 8
CIVIL	Work Package 1		Work Package 3	Work Package 4	Work Package 1	
STEEL STRUCTURES	Work Package 2				Work Package 5	Work Package 8
MECHANICAL						
PIPING						
PAINTING						
INSULATION						
HEAVY LIFTS						
ELECTRICAL	Work Package 6					Work Package 8
INSTRUMENT.						
SOIL INVESTIGATION	Work Package 9					
PILING	Work Package 10					
SITE PREPARATION	Work Package 11					
TCF	Work Package 12					

Figure 68 Visual Subcontracting Plan - Work Scope subdivision

11.2 Bidder list definition and Subcontractor qualification.

Once the Scope of Work has been split according to the estimated market receptivity, basing on the Approved Subcontractors List and the preliminary market investigations performed up to this point in the Project (inclusive those executed in the commercial phase), it is necessary

11.3 Preparation of Subcontractor Tender documentation.

In parallel to the definition of the Bidders List as well as to the Subcontractor qualifications, it is necessary to prepare the set of documentation required for a proper inquiry and to issue the Request for Quotation package to Bidders. This shall include, as a minimum:

- Technical documentation, with a detailed description of the Scope of Work; this shall comprise requirements proper of the works to be performed for the construction of the plant/ facility object of the Project as well as any ancillary requirement that may affect Subcontractor's operations, such as Site conditions, safety/ security requirements set by Client or EPC Contractor HSE department, Quality Control requirements (imposed by Client or the same EPC Contractor) and any other constraints that shall be taken into account (relevant, for example, to the Temporary Construction Facilities, the waste management, the use of dumping areas, etc.)
- Commercial documentation, which shall include a draft of Contractual and Commercial Conditions, to be respect in the submission of the offer(s) and during the execution phase. Among the others, it is included the Price List to be used by Bidders to submit their quotation, according to the codes and the methodologies used by EPC Contractor
- Schedule for the execution of the works; this can be a high-level schedule but it has to indicate clearly, as a minimum, the start and completion dates and milestones which are relevant for the execution of the relevant activities. If the status of the Project allows for it, it is possible to include progress s-curves or similar way to indicate the progress that shall be maintained by Subcontractor during the execution of the works
- Instruction To Bidder (ITB) Document and relevant cover letter, which have the aim of indicating to the Bidders the detailed content of their offer, giving a general overview of the Project, contacts and miscellaneous information, including the Due Date for the offer submission.

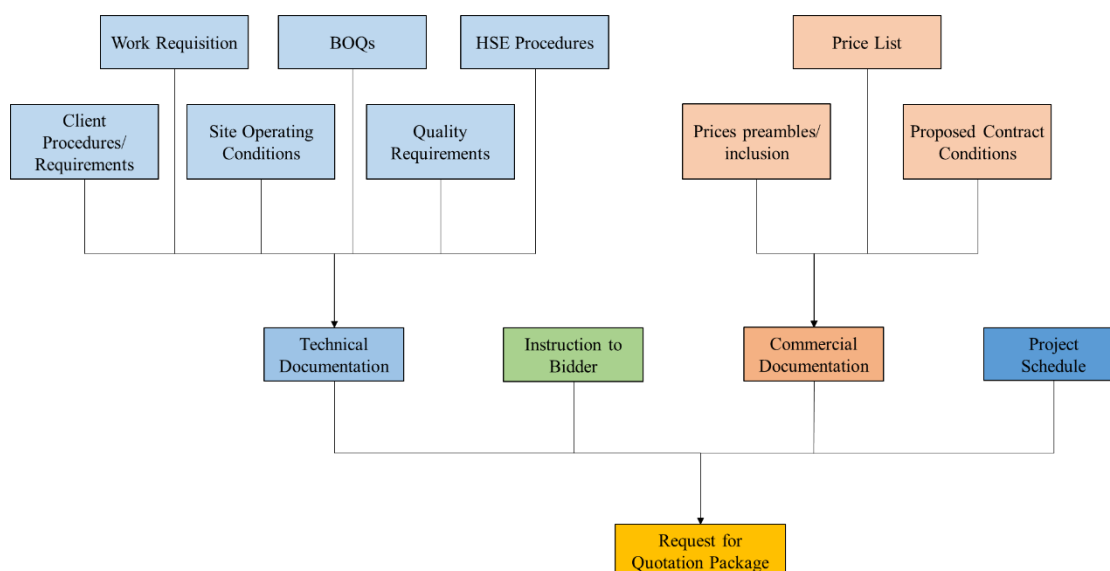


Figure 70 Documentation management required for the issue of a Request for Quotation

11.4 Purchase Request (PR) Preparation

After having divided the Scope of Work in Work Packages adapted onto the capabilities of the locally available companies and having defined the Bidder List as well as the entire set of

documentation to be submitted, during the completion of this last step, it is required to define the budget to be allocated to the specific Work Package. This can be defined starting from the Original Budget defined for the Project basing on the key quantities or considering the expected manhours vs the manhours load for the entire Project and, due to its sensitiveness, shall be produced by Cost Control function and approved from Project Management.

The PR constitutes the basis for proper invoicing procedure by Subcontractor and it's the payment basis for the relevant invoices, considering that the PR itself includes the basic terms of payment (e.g. unit prices or lump sum basis) and the forecasted schedule for the duration of the execution. It is important to note that in case of Scope Changes the PR shall be modified (and re-approved) accordingly, taking into consideration the addition of other Work Packages, Extra Works, Amendments, etc.

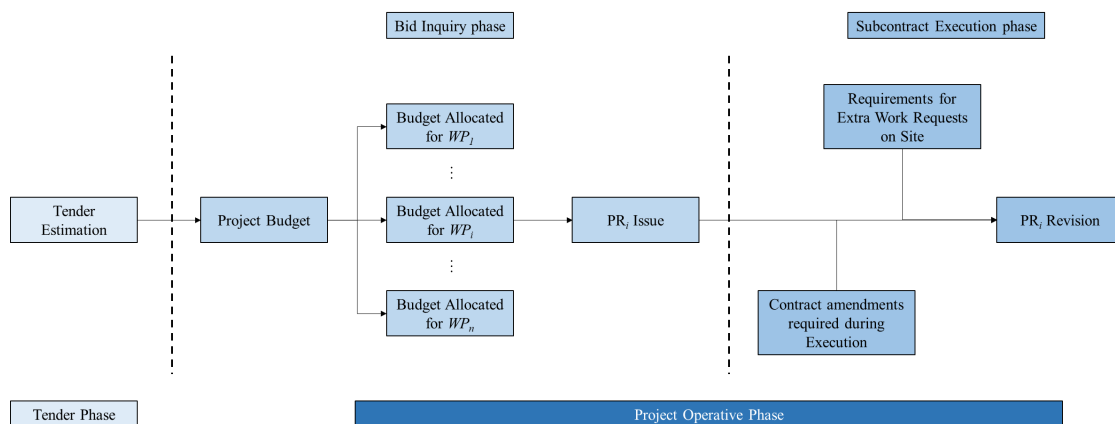


Figure 71 Flow for Purchase Request Issue and revision

11.5 Inquiry management

Once all the previous steps have been accomplished, the Tender documentation is submitted to the Bidders for the preparation of their Technical and Commercial offers.

It is not unusual during the tender execution to have the submission of more than one offer by the Bidders. This happens because the first offer submission is usually preliminary and it has to be aligned with the replies to the Lists of Clarifications/ exclusions/ deviations that Bidders normally present to the EPC Contractor. After this first submission, alignment and clarification meetings are held (eventually with the presence of the final Client and with the participation of the specialists involved in the preparation of the technical documentation) in order to clarify the misunderstanding and misalignment between the parties, as well as aligning the offers received from the Bidders.

In case before the submission of the revised offers the Scope is changing or additional constraints/ information have to be communicated to the Bidders, Bid Bulletins are issued. They can be addressed to a single Bidder if they are needed to reply to specific questions or they can be shared with all the Bidder if the information is new or may be a benefit for the inquiry.

11.6 Bid Evaluations

Once the alignment meetings have been held and the last revision of the quotations (both technical and commercial) have been submitted, the personnel (departments) involved in the preparation of the technical documentation and during the alignment meetings is asked to issue the technical bid evaluation, which has the aim of judging the technical acceptance of the Bidders and their offers. In parallel, the economical bid evaluation is performed, with proper comparison of the final prices and, among those which are acceptable, it is selected the Company to whom ask the last price prior to Contract finalization and relevant Award.

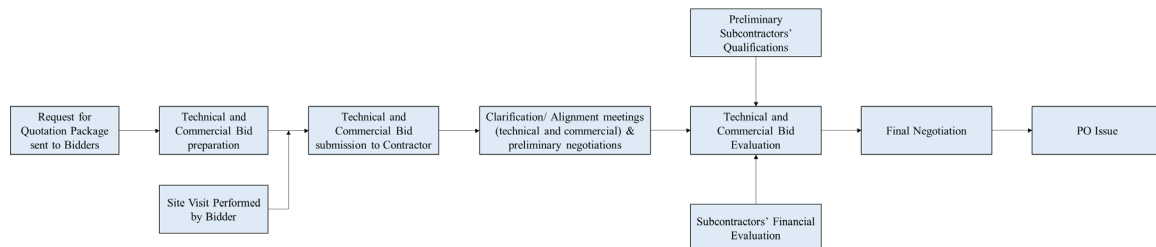


Figure 72 Flow diagram from RFQ Issuance to PO Issue

11.7 Subcontractor Mobilization

After the Award, the Subcontractor shall mobilize on Site and start its activities, as it is usually set in the Contract.

The mobilization phase includes the following main steps:

- Block Visa obtainment, if required
- Organization Set-up
- Early team mobilization at Site
- Set-up of support facilities, including establishment of preliminary local contracts (equipment rental, support services, site offices, etc.)
- Set-up of local logistic for personnel and materials.

All these actions should be performed according to the plans provided by Subcontractor in the Tender phase, since it is normally asked to submit its preliminary Execution Plan in the early phase of the Tender stage (ref. to Figure 73 for an example of the mobilization plan issued by a Subcontractor).

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Figure 74 Installation of the Subcontractor's Warehouse workshop, according to Mobilization schedule

12. The Site Supervision Planning, Mobilization and Lean Control

One of the most meaningful and strategic decision during preparation of construction execution and therefore one of the key topics within a Construction Execution Plan is the organization and management of the site supervision team.

Such group of professionals have the crucial duty to lead site execution phase towards the achievement of main Project targets:

- Safety
- Quality
- Schedule
- Efficiency

The activities are initiated in home office and then progressively shifted to site, where, after completion of home office contractual duties, leadership of operation will be headed.

Site execution is articulated in the sequencing and partial overlapping of different work disciplines. A typical sequencing of activity is as follow:

- Site preparation
- Site embankments (partial), if required
- Foundations (rack first and immediately after basins and other process foundations)
- Underground service (deepest first)
- Site embankments (completion), if required
- Paving (concrete and asphalt)
- Tie-ins
- Structural steel erection
- Fireproofing
- Piping erection on pipe racks
- Piping prefabrication
- Heavy Lift Equipment dress-up before the erection (if feasible)
- Equipment and vessel installation
- Piping Around equipment installation (large bore first)
- Piping small bore
- Electrical installation
- Instrument installation
- Painting and insulation

The pursuing on above said major targets passes through the management and matching of different main leading factors:

- proactive and integrated planning management
- availability of engineering deliverables
- availability of material
- timely mobilization of required resources (manpower and equipment)
- proper supervision, coordination and surveillance of construction subcontractors
- fulfillment of contractual requirements

- smooth interfacing with all Project counterparts and stakeholders

The specific Project characteristics (Location, Client, type of contract, Subcontracting strategy) drive the definition of the Site Supervision Team in terms of size, composition, level of skill, nationality etc.

The key responsibility roles have to be identified at the earliest:

- Site manager
- Construction Managers
- HSE Manager
- Quality Control Manager
- Commissioning Manager
- Logistic and Administration Manager

Said professionals must actively participate in the home office construction phase (considering the term construction in its wider meaning of Site activities execution, therefore including pre-commissioning, commissioning and start-up), to have the possibility to familiarize with Project challenges and start driving the future execution strategies.

In principle, it has always to be considered as an opportunity to have a high rate of local resources on board. Therefore, a prompt acknowledgement of local environment - in terms of professionals' availability / skill levels, recruitment requirements and local labor laws – has to be achieved, if needed through local agencies or partnerships. Said local establishments are needed to support expatriate personnel timely mobilization as well.

One of the key Project deliverables to be issued taking into account technical and economic aspects is “Site Supervision deployment bar-chart” which indicates the roster of the roles composing the team, their “typology” (payroll personnel, consultants or local) and their time of mobilization.

Said deliverable is obviously a live document, to be progressively populated with names, modified when needed according to the Project master schedule, periodically updated and distributed within the Project Team; in fact, it represents a key guide for several functions: Project Management, Site Supervision, Human Resources, Cost Control.

The driving principles considered to build-up the site activities management organization are:

- Complete coverage of all main functions with an adequate number of specialists, committed to Project targets
- Capability / skill of appointed individuals in the key positions to ensure a proactive management of the specific challenges
- Unambiguous responsibilities and lines of communication
- Synergic mix-up of competencies and background
- Centralized management to avoid conflicts and inefficiencies

The Site Supervision Team is led by Site Manager, who is the single point of reference for site activities reporting to Project Management, is typically articulated into the following main functions:

- HSE
- Quality Control
- Construction Supervision
- Project Control (Planning & Cost Control)
- Field Engineering
- Material Management
- Administration
- Subcontract Management
- Pre-commissioning / Commissioning (PC&C)

The mobilization to site of personnel involved in the home office Project activities has always to be maximized, especially – but not only – within field engineering team.

As said above, the leader is the Site Manager, but when construction works are close to completion and the pre-commissioning and commissioning phases are then taking over, the operational responsibility has to be progressively transferred to the Commissioning Manager, who leads the PC&C team.

In order to have a smooth and structured transition from construction areas to PC&C systems logics the PC&C management team mobilization has to be properly anticipated and disciplines' supervision resources sharing maximized. These two steps significantly improve the hand-over process and finally improve schedule and Project's economics, both in terms supervision costs and of completion timing.

From an EPC Contractor perspective, the main target that Supervision Team has to pursue is to optimize the use of field resources in accordance with the schedule, therefore the anticipation of needs/ requirements planning for the coming weeks are key tasks that shall be managed by Site team.

The purpose is achieved by aligning and monitoring resources availability and qualifications, work front available and forecast construction target, in order to realize a sustained, optimized and smooth construction execution.

Planning process is based on availability and management of three key data:

- Construction Target (quantity & man-hours)
- Available Work Front
- Work Construction Capacity (max quantity & hours that the available resources can execute, or the gap in terms of resources to be filled in).

The objective is to ensure that during the Project phases the alignment and monitoring of Engineering and Procurement deliveries with the agreed requirements from construction to regularly feed the site and to realize a sustained and smooth creation of work front for all construction subcontractors. Planning and Workfront management ensure during site phase, the identification and management of field construction requirements in terms of construction sequences and predecessors' status, and other site conditions (accessibility, scaffolding hindrance, etc.).

Workfront management ensures:

- the smooth execution of subcontractor's construction works thanks to the availability of engineering documentation and materials (procured or prefabricated/ precast/ preassembled) on site as required, with benefits on:
 - Subcontractors' costs,
 - Subcontractors' productivities,
 - Construction to hand-over schedule, with benefits also on Contractor's supervision costs,
 - Risks of claims from Subcontractors.
- the confidence on the overall project schedule, in particular securing deliveries connected to critical and subcritical paths, especially in presence of liabilities toward the Clients
- visibility and quantification of generated work-front, creating a common language and shared vision with subcontractors and partners of the real actual situation.

13. The definition of the Site Organization Chart

As said in the previous paragraphs, the driving principles considered to build-up the Site Team are based on:

- Proper coverage of all main functions with an adequate number of specialists, according to Project features and targets
- Adequate capabilities / skills to ensure a proactive management
- Unambiguous responsibilities and lines of reporting
- Strategy/ approach adopted for Construction execution
- Synergic mix-up of competencies, background, seniority, familiarity with Project.

13.1 Typical EPC Contractor Site Organization

The hierarchical levels and lines of reporting are typically summarized and represented through an Organization Chart, which represents a key document within a Project Execution Plan, with the important purpose to explain graphically to the internal and external stakeholders the various hierarchical levels, roles & responsibilities, reporting lines and management strategy.

The complexity and the level of details of an Organization Chart strictly depends on the Project specific features and requirements.

Typically, the Site Organization Chart is an appendix of the Project Organization and refers – for clearer representation purposes – to its own detailing appendixes with lower details

Here below (ref. to Figure 75) a typical site Organization Chart.

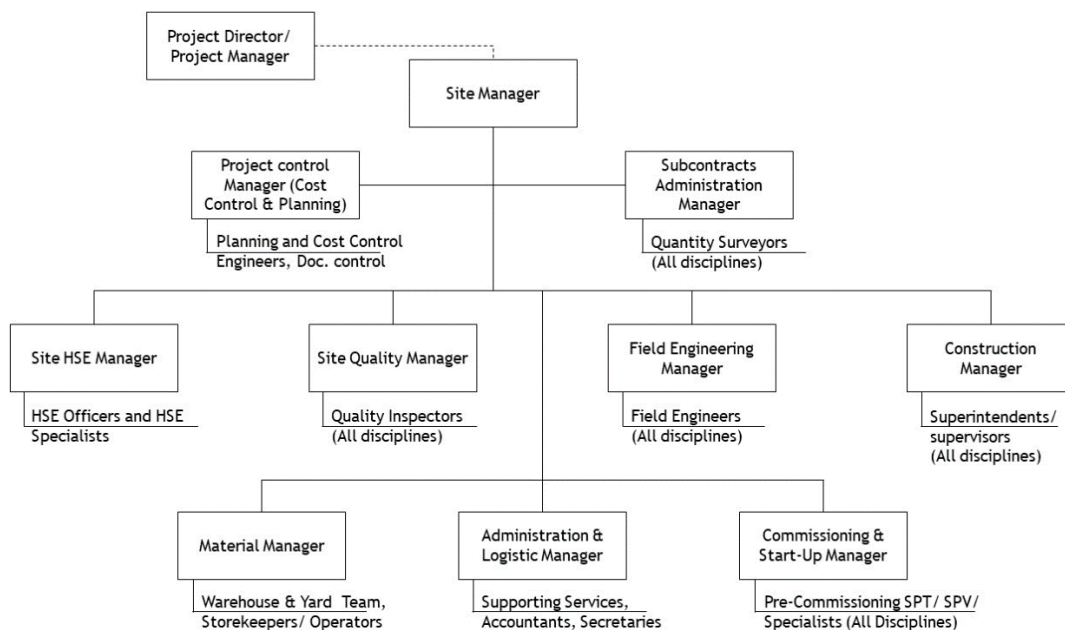


Figure 75 Typical Site Organization Chart

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The Site Manager is appointed as the leader of the Site Organization, who reports to Project Management team and has to look after the proactive and smooth coordination of a team structured on the following main functions:

- HSE
- Quality Control (QC)
- Construction Supervision
- Project Control (Planning & Cost Control)
- Field Engineering
- Material Management
- Administration
- Subcontract Management
- Pre-commissioning / Commissioning.

HSE and QC functions ensure that activities execution are always focused on Project Safety and Quality targets. Their structures are built-up in order to guarantee leading and coverage, but Safety and Quality are the absolute priority for everybody on site, and therefore they need to count on the support of all other functions' members.

For HSE there must be a manager, a representative certified according to local requirements (if needed by Law), and a line of officers / supervisors

With respect to the QC, leadership must be taken by a manager, supported by a Deputy (who is in charge during manager's rotational leaves) and by an adequate number of inspectors.

Construction Supervision has to lead and coordinate subcontractors' works on site, following scheduled sequences and proactively adapting them to the dynamically changing boundary conditions (availability of deliverables, SIMOPS, impact for weathers, interface with external stakeholders etc.)

Construction Supervision team is typically organized in different levels of management:

- Construction Manager(s)
- Area Superintendent(s)
- Discipline Superintendent(s)
- Discipline Supervisors and Assistants.

Subcontracts Management team has to manage the relationship with subcontractor(s) in the smoothest way, ensuring that all the duties set to be as contractual provisions are mutually met and, if not, finding the way to track and solve deviations.

In addition, this team has the duty to guarantee that activities performed by subcontractors are correctly measured and promptly compensated. Therefore, the Subcontract Manager is supported by Discipline Quantity Surveyors.

Project Control team ensures the proper management of:

- Cost Control (tracking the costs versus the budget and defining forecasts and trends)
- Planning (providing support to Construction Supervision to achieve targets, reviewing progress and productivities reports prepared by subcontractors, building-up progress for weeks to come, controlling work-fronts).

Project Control is also responsible to collect information from different functions and keep main Project stakeholders updated through periodical reports.

Field Engineering team manages all aspects of engineering at site, providing the necessary support to maintain scheduled progress targets. Therefore, relevant main duties are:

- Ensure availability of latest revisions of drawings at any time
- Management of any modification due to unexpected deviations
- Management of field revision of drawings/ documents, where necessary
- Communication with home office organization to solve possible design problems detected at Site during construction
- Management and control red marked “as built” drawings
- Support to field material procurement team, whether required
- Clarification process to technical queries issued by Subcontractors.

In a standard organization, the Field Engineering Team is composed by:

- Field Engineering Manager
- Discipline Field Engineers (with discipline leaders mobilized from home office organization, with the aim of granting continuity in the design development)
- Document Control Coordinator / Operators
- Draftsmen / 3D operators, to the applicable extent.

Material Management team supervises all aspects related to Project itemized and bulk material that is progressively delivered to the dedicated facilities (warehouse and lay-down(s) and yard(s)) from receiving/ identification/ control to storage/ preservation and controlled release to subcontractors for installation.

The Material Manager team is typically led by a Material Manager supported by Storekeepers, Warehouse Operators, Equipment Operators and Clerks; direct workers are usually provided by subcontractors, as part of their contractual duties. The Material Manager strictly cooperates with Planning management and Supervision to identify actual and future work fronts availability driven by material.

Administration Management team looks after all aspects related to:

- Management of personnel mobilization, recruitment (if applicable), payrolls, demobilization
- Personnel accommodation, local transportation, assistance

- Site office facilities maintenance and janitorial services
- Finance, invoices, banking
- Management of interfaces with Local Entities and Authorities, Custom Duties (if applicable)
- Management of local purchase orders
- General supporting services (IT support, translation / interpreting, secretarial).

Pre-commissioning / Commissioning team ensure the preparation and the execution of the activities needed to the final hand-over to Client of the Project scope of work. The transition from the pure construction approach by Area to the one focused to the completion by System is one of the most critical phases within a Project life. Therefore, the timely mobilization of key Pre-commissioning/ Commissioning people, the full coordination among functions and the maximized sharing of resources are certain key aspects for a successful execution.

The team is led by a Commissioning / Start-up Manager normally supported by:

- Pre-Commissioning Engineer(s)
- Pre-commissioning/ Commissioning Superintendents
- Pre-commissioning/ Commissioning Discipline Supervisors.

A necessary condition that Site Supervision team shall have is the capability to look ahead and to be as much as possible proactive rather than reactive. In this perspective it is essential to support its activities with adequate IT based management tool, especially in QC, Planning, Material Management and Pre-commissioning/ Commissioning.

It has to be clearly underlined that the specific composition of all supervisory functions basically depends on the size of the Project, on the extent of the scope of work (especially in terms of hand-over duties) and strongly on the subcontracting strategy, since the organizational scheme significantly changes having at Site a well-structured general construction subcontractor rather than several discipline subcontractors, less organized and structured.

13.2 Organization with a Direct Hiring approach

In case of Direct Hiring (DH) for the Construction execution, the DH team operates with a separate structure for the execution of the activities, but it shall integrate with the Project Team with respect to all the remaining departments.

Resources will be added in other departments in a number proportional to the direct resources without adding managerial resources except for an additional dedicated Construction Manager.

The use of the DH team makes it necessary the deployment of an Asset team that will take care of the maintenance of the vehicles and equipment used for the execution of the work, and a separate warehouse for consumables, PPE and Tools will be established.

All DH personnel are usually accommodated in the project camp or in dedicated buildings/ compound if available close to the project.

Below (Figure 76) a sample of DH organization chart:

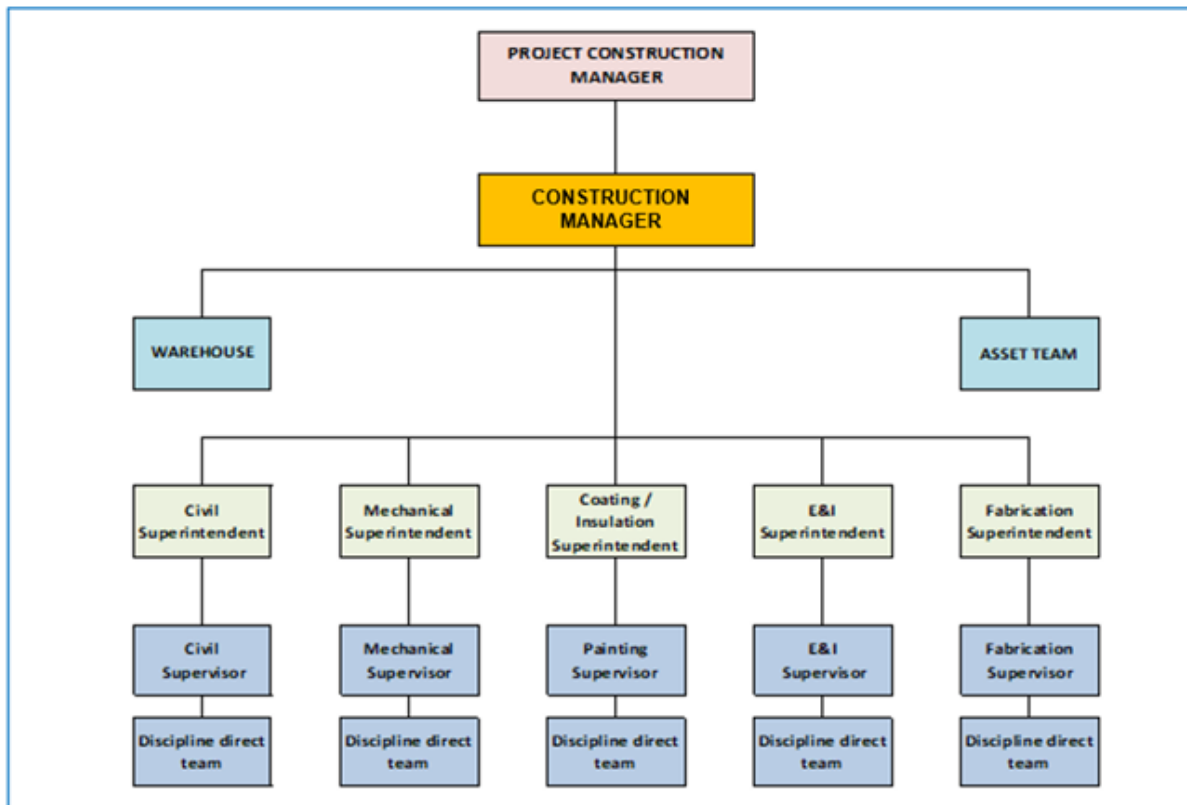


Figure 76 Typical Site Organization chart in case of direct Hiring

The DH Construction Manager on weekly basis will meet the Project Management team to define strategies and execution plans and to verify if the progress is in line with the plan. DH Team follows the project master schedule and shall create level 4 internal program to monitor their activities at micro level. DH Team shall submit daily / weekly physical progress and monthly schedule feedback to project team accordingly.

All subcontractor related to the execution of DH activities (example: scaffolding, insulation etc.) will be under DH Construction Manager responsibility. He/ she has to verify and plan their work progress and performance and intervene with the support of Project Manager in case of delay or failure.

14. Analysis of periodic Construction Home Office Reports

14.1 Construction Home Office Reports

The Scope of the periodic Construction Home Office Reports is to detail activities performed by Construction Sites for construction activities and to distribute them to the various Home Office Functions, in order to:

- allow Company Management Team to monitor Site activities and address criticalities
- set up construction weekly reports to be analyzed with Client during Site weekly meetings
- assess Project construction activities, in terms of achieved performances (with respect to safety, progress, quality, etc.)
- provide Construction management and Project management with Site data and general trends on different construction areas (Site activities progress and criticalities, QA/ QC, HSE).

14.2 Methodology

Construction Home Office, and in particular the Function of Construction Operation, is committed to monitor Site's trends, guaranteeing complete and punctual periodical reports and ensuring distribution of synthetic information within the Home Office involved Company Functions and Management.

To this purpose, a group of Site personnel (usually Site Project Control team, Site HSE Manager and Site Quality Manager) are in charge to issue periodical reporting on behalf of Site Manager, while in Construction Home Office a group of Construction Engineers, Construction Methodologies & Systems, Construction HSE and Construction Quality Engineers are dedicated to collect and elaborate on periodical basis the data received from Sites.

14.3 Site Reports

The Site Reports prepared at Site and sent to Construction Home Office usually are the following:

- Weekly Construction Project Summary Progress Report
- Monthly Construction Project HSE Report
- Monthly Project Construction QA/ QC and Mechanical Completion Report
- Quarterly Project Site Organization Chart
- Final Construction Site Report.

14.4 Construction Home Office Reports

Based on the information received from the Project Sites a group of Home Office Engineers shall prepare the following reports.

14.4.1 Construction Summary Progress Report - Overall Sites

The inputs received by Weekly Construction Project Summary Progress Report are analyzed and replicated into this report which is organized on tabular shape (Figure 77) in order to give in a single sheet a general overview of the monthly and cumulated progress by discipline.

In details, for each Project, it summarizes as minimum the following data:

- Contractual milestones
- Progress by discipline (both indicating the progress achieved in the month and the cumulated from beginning of the project) and overall progress (with the same principle of the disciplines' progresses)
- Subcontractors' manpower at site (direct vs. total), actual and planned
- Contractor's Personnel at site (indirect and staff for both construction and commissioning and total)
- Subcontractors' productive spent Man-hours
- Construction Standard Man-hours according to current approved Project Construction Schedule
- Subcontractors' cumulative efficiency (Estimated and actual)
- HSE statistics in terms of LTI, LTIF, TRI, TRIR (cumulative of the year) and Total Man-hours as for HSE statistics for each project and for the overall.

The report is prepared on a monthly basis and distributed to the Company's Management.

		CONSTRUCTION SUMMARY PROGRESS REPORT										<i>Week Nr. xx</i>				
		OVERALL SITES										<i>Cut Off: dd-Mmm-yyyyy</i>				
		<i>Issue Date: dd-Mmm-yyyy</i>														
CONTRACTUAL MILESTONES	PLANT		Project 1		Project 2		Project 3		Project 4		Project 5		Project 6		CONTRACTUAL MILESTONES	
	JOB NUMBER															
	Contract Type															
MILESTONES	EFFECTIVE DATE															
	CONTRACTUAL DATE															
	MECHANICAL COMPLETION EXPECTED DATE															
CONSTRUCTION SUMMARY																
DISCIPLINE	PLANT		Project 1		Project 2		Project 3		Project 4		Project 5		Project 6		TOTAL PLANTS	
	JOB NUMBER															
	PROGRESS [%]															
SITE PREPARATION WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
TEMPORARY CONSTRUCTION FACILITIES	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
FILLING WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
CIVIL WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
UNDERGROUND	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
STEEL STRUCTURES WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
PIPING WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
EQUIPMENT & MECHANICAL WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
ELECTRICAL WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
INSTRUMENTATION WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
PAINTING WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
INSULATION WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
BUILDINGS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
HVAC WORKS	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%
TOTAL CONSTRUCTION	WEEKLY PROGRESS [%]														0.00%	0.00%
	CUMULATED PROGRESS [%]														0.00%	0.00%

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

SUBCONTRACTORS MANPOWER AT SITE				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
DISCIPLINE	PLANT									
	JOB NUMBER									
SITE PREPARATION WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
TEMPORARY CONSTRUCTION FACILITIES	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
ACCOMMODATION CAMP	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
PILING WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
CIVIL WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
UNDERGROUND	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
STEEL STRUCTURES WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
PIPING WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
MECHANICAL WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
ELECTRICAL WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
INSTRUMENTATION WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
PAINTING WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
INSULATION WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
BUILDINGS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
HVAC WORKS	CURRENT WK. AVERAGE (Nr.)	ACTUAL	(MAIN) SUBCONTR. NAME							0
			SUBJECT							0
TOTAL CONSTRUCTION	CURRENT WK. AVERAGE (Nr.)	ACTUAL	TOTAL	0	0	0	0	0	0	0
			TOTAL	0	0	0	0	0	0	0

PERSONNEL AT SITE				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
CONTRACTOR PERSONNEL AT SITE	PLANT									
	JOB NUMBER									
TOTAL PERSONNEL	CURRENT WK. AVERAGE (Nr.)	ACTUAL	INDIRECT STAFF							0
			CONSTRUCTION							0
TOTAL				0	0	0	0	0	0	0

EARNED MANHOURS				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
EARNED MANHOURS	PLANT									
	JOB NUMBER			0	0	0	0	0	0	0
TOTAL CONSTRUCTION				0	0	0	0	0	0	0

SPENT MANHOURS				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
SPENT MANHOURS	PLANT									
	JOB NUMBER			0	0	0	0	0	0	0
TOTAL CONSTRUCTION	CUMULATED SPENT MANHOURS	CURRENT (up to Dec (yyyy) YYYY	DIRECT							0
			DIRECT	0	0	0	0	0	0	0

STANDARD MANHOURS				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
TCH STANDARD MANHOURS	PLANT									
	JOB NUMBER									
TOTAL DISCIPLINE	CURRENTLY	STANDARD MANHOURS		0	0	0	0	0	0	0

EFFICIENCY				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
EFFICIENCY	PLANT									
	JOB NUMBER									
TOTAL DISCIPLINE	CUMULATIVE K EFF.	K - ESTIMATED								0.00
		K - ACTUAL		0.00	0.00	0.00	0.00	0.00	0.0	0.00

HSE STATISTICS				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	TOTAL PLANTS
HSE STATISTICS	PLANT									
	JOB NUMBER									
TOTAL HSE STATISTICS (OSHA)	LTI (LOST TIME INJURY) (Nr.)	CURRENT	DIRECT INDIRECT STAFF							0.00
	LTI F (LOST TIME INJURY FREQUENCY) (Nr.)	CURRENT	DIRECT INDIRECT STAFF							0.00
	TRI (TOTAL RECORDABLE INCIDENTS) (Nr.)	CURRENT	DIRECT INDIRECT STAFF							0.00
	TRIR (TOTAL RECORDABLE INCIDENTS RATE) (Nr.)	CURRENT	DIRECT INDIRECT STAFF							0.00
	TOTAL MANHOURS (as per HSE Statistics)	CURRENT	DIRECT INDIRECT STAFF							

Figure 77 Typical Construction Summary report

14.4.2 HSE Performance Indicators for Overall Sites

Inputs received by “Monthly Construction Project HSE Report” from each Project site, are analyzed and reported onto the Quarterly Site HSE Performance Indicators; this report is organized on tabular shape (Figure 78) in order to give a quarterly overview of the HSE Indicators achieved at sites compared to the International Benchmarks and of HSE related cumulative data.

In details, for each Project, it summarizes the following HSE Indexes:

- Man-hours Worked (and Man-hours Worked without Lost Time Injury)

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

- Lost Time Injury Frequency (and relevant International Reference benchmarks according to OGP Contractor's and OSHA)
- Total Recordable Injury Rate (and relevant International Reference benchmarks according to OGP Contractor's and OSHA)
- Fatalities, Lost Workday cases, Restricted Workday Cases, Medical treatment cases, First Aid Cases, Near Misses, Unsafe act/unsafe conditions, Total training hours
- Environmental Incidents, Total hazardous waste, Total nonhazardous waste, Total water consumption, Total combustible consumption for vehicles, Total combustible consumption for power production, Total energy consumption.

CONSTRUCTION HSE PERFORMANCE INDICATORS

GENERAL CUT OFF - dd.mm.yyyy

Project No./ Name/ Construction Site & Location	MHSW		OSHA				OGP				EAL		LWIRC		LTI	
	Man hours Worked	Man-hours Worked without LTI	LTPF - (LT x 200,000 / Total Man-hours)	TRIR - (TR x 100,000 / Total Man-hours)	LTPF - (LT x 200,000 / Total Man-hours)	TRIR - (TR x 100,000 / Total Man-hours)	LTPF - (LT x 200,000 / Total Man-hours)	TRIR - (TR x 100,000 / Total Man-hours)	Fatalities	Lost Work Day Cases	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started
	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started
Project 1 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
Project 2 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
Project 3 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
TOTAL PROJECTS																
Contractor																
Subcontractors (included Consortium Partner)																
Year yyyy																

CONSTRUCTION HSE PERFORMANCE INDICATORS

GENERAL CUT OFF - dd.mm.yyyy

Project No./ Name/ Construction Site & Location	RWC		MTC		TRI		FAC		NM		UAC		TTH		TTH / TMW	
	Restricted Workday Cases	Medical treatment cases	Total Recordable Injuries (LTI+MTC+TRI)		First Aid Cases		Near Misses		Unsafe act/unsafe conditions		Total Training Hours (including TTI & TTIART)		Total Training Hours / Total Manhours worked (%)			
	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started		
Project 1 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
Project 2 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
Project 3 (cut-off mm-yyyy)																
Contractor																
Subcontractors																
TOTAL																
TOTAL PROJECTS																
Contractor																
Subcontractors (included Consortium Partner)																
Year yyyy																

CONSTRUCTION HSE PERFORMANCE INDICATORS

GENERAL CUT OFF - dd.mm.yyyy

Project No./ Name/ Construction Site & Location	EI		THW		TNHW		TWC		TCCFV		TCCFP		TEC	
	Environmental Incidents		Total hazardous waste (in kg)		Total Non-hazardous waste (in kg, including domestic waste)		Total water consumption (raw water & potable water, in liters)		Total combustible consumption for vehicles, including cranes (liters of fuel and gas)		Total combustible consumption for power production (in liters)		Total energy consumption by power network (in kWh)	
	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started	Year yyyy	Since Project started
Project 1 (cut-off mm-yyyy)														
Contractor														
Subcontractors														
TOTAL														
Project 2 (cut-off mm-yyyy)														
Contractor														
Subcontractors														
TOTAL														
Project 3 (cut-off mm-yyyy)														
Contractor														
Subcontractors														
TOTAL														
TOTAL PROJECTS														
Contractor														
Subcontractors (included Consortium Partner)														
Year yyyy														

Figure 78 HSE Performance Indicators

14.4.3 Site Annual Site HSE Statistics

All the data collected by the “Monthly Construction Project HSE Report” from each Project site, are analyzed and synoptically elaborated in order to evaluate the actual HSE performance of the year and summarized in a dedicated report, the “Site Annual Site HSE Statistics”.

Often, this report is organized also in the format of a presentation that gives an overview of selected Key HSE Indicators, analyzes the performance trends over many years and compares those with the available industry’s International Benchmarks (such as International Association of Oil & Gas Producers – IOGP).

The presentation is covering as a minimum the following topics:

- Company Safety Performance of the current year in terms of:
 - Lost Time Injury Frequency “LTIF” (and relevant International Reference benchmarks according to IOGP Contractor’s and OSHA)
 - Total Recordable Injury Rate “TRIR” (and relevant International Reference benchmarks according to IOGP Contractor’s and OSHA)
 - First Aid Cases “FAC”
- Summary with HSE indexes from each project site for the current year
- Fatal accident rate “FAR”, LTIF, TRIR in the last 3 years rolling
- FAR, LTIF and TRIR, five-year rolling averages
- Company Safety Performance in the last 5 years
- Safety KPI compared with Competitors and IOGP Benchmarks in the last two years
- Environmental KPI of the current year - Environmental Incidents, Total hazardous waste, Total nonhazardous waste, Total water consumption, Total combustible consumption for vehicles, Total combustible consumption for power production, Total energy consumption
- Site HSE training activities in the last years.

14.4.4 Construction Quarterly KPI General Cut Off

Construction Quarterly KPI General Cut Off Inputs received by “Monthly Project Construction QA-QC and Mechanical Completion Report” produced by each Project site, are analyzed and collected into the “Construction Quarterly KPI General Cut Off”; this report is organized on tabular shape (as shown in Figure 79) in order to give in a single sheet a quarterly overview of the Key Performance Indicators achieved at sites compared to the Corporate Targets.

In details, for each Project, it summarizes the following KPI as minimum:

- Site Contractual Milestone missed
- Concrete Cube-Cylinder Test Failure
- Weld Repair Rate of radiographic tested joints
- Piping Isometrics (Large bore - ≥ 2): percentage reworked against total
- Change work on site: percentage of total amount against subcontracted amount.

The last column of the table reports the Corporate Targets for each KPI.

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

KPI	PXXX Project Name Location	PXXX Project Name Location	PXXX Project Name Location	PXXX Project Name Location	TARGET
	Construction Progress: xx%	Construction Progress: xx%	Construction Progress: xx%	Construction Progress: xx%	
SITE CONTRACTUAL MILESTONES (missed)					
CONCRETE CUBE - CYLINDER TEST FAILURE					
WELD REPAIR RATE (%) OF RADIOGRAPHED JOINTS					
PIPING ISO'S >2" % Reworked Vs. Total					
CHANGE WORKS ON SITE % of total amount of Subcontracted Works					

• Note for PXXX Project Name: _____

Figure 79 KPI monitoring

Finally, all the above Construction Home Office Reports shall be distributed to the Company's Management, for any follow-up action which may be requested.

15. Activation of Mobilization Plan

After the hand-over of the Project from Tender phase to the operative phase, having defined the first execution schedule and the preliminary subcontracting strategy, an EPC Contractor shall define the Mobilization plan and start the consequent mobilization of the personnel.

During the tender phase, a preliminary mobilization plan has to be defined to allow for the preparation of the final technical and commercial offers; starting from this preliminary estimation, the resources shall be distributed considering the following main factors:

- Actual duration of the activities: it has to be confirmed the duration of the scheduled activities and the personnel required for relevant execution shall be adapted accordingly
- Subcontracting plan: the adoption of a certain (different) subcontracting strategy may affect the number of resources required for the execution/ supervision of the activities, considering that an increase in the number of subcontractors may lead to a higher number of interfaces between subcontractors and with other stakeholders involved in the project
- Specific requirements: these may be set by the contract or by local Laws and may require for specific key figures to be mobilized or for specific nationalities required in the organization chart; one crucial matter is usually concerning the local content (also called In-Country Value – ICV) which imposes to any company working in the country to have mobilized a minimum percentage of local personnel hired in the area/ region/ country, depending on the cases, in addition to a threshold of minimum local purchases/ direct workforce deployment
- Origin of the personnel, which shall be defined according to local personnel availability, requirements for the obtainment of the visas for Expats, problems in obtaining visas for certain nationalities and similar
- Duration of the shifts (weeks/ days on site vs. days off), which may be different basing on the nationality of the involved personnel.

Discipline	Mar-2018 Month 1	Apr-2018 Month 2	May-2018 Month 3	Jun-2018 Month 4	Jul-2018 Month 5	Aug-2018 Month 6	Sep-2018 Month 7	Oct-2018 Month 8	Nov-2018 Month 9	Dec-2018 Month 10	Jan-2019 Month 11	Feb-2019 Month 12	Mar-2019 Month 13	Apr-2019 Month 14	May-2019 Month 15	Jun-2019 Month 16	Jul-2019 Month 17	Aug-2019 Month 18	Sep-2019 Month 19	Oct-2019 Month 20	Nov-2019 Month 21	Dec-2019 Month 22	Jan-2020 Month 23
Site Management	-	-	-	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1	1	1	-
Site HSE Team	-	-	1	1	6	7	7	7	7	7	7	7	7	7	7	7	7	5	4	4	4	4	-
Security	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-
Site Quality Team	-	-	1	1	3	3	4	4	4	5	6	7	11	11	12	12	12	12	9	9	7	-	-
Subc. Administration	-	-	-	2	3	3	3	3	3	3	4	4	4	4	4	4	4	3	3	3	3	-	-
Project Control Site Team	-	-	-	2	2	3	3	4	4	4	4	4	4	4	4	4	4	4	4	3	3	-	-
Material Management Team	-	-	-	-	-	-	-	-	1	2	3	3	4	4	4	4	4	4	3	3	3	-	-
Field Engineering Team	-	-	-	1	1	1	2	2	3	4	5	5	6	7	7	7	7	7	4	4	-	-	-
Document Control Group	-	-	-	1	1	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	-	-
Preservation	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-
Site Administration Team	-	-	2	4	4	4	5	6	6	6	6	6	6	6	6	6	5	5	3	3	3	2	-
IT	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Procurement Team	-	-	-	-	-	-	-	-	1	2	2	2	2	2	2	2	1	1	-	-	-	-	-
Civil Supervision Team	-	-	1	2	2	3	3	3	3	4	4	4	4	4	4	4	2	2	1	1	1	1	-
Steel Structures Supervision Team	-	-	-	-	-	-	-	-	1	1	1	2	2	2	2	1	1	-	-	-	-	-	-
Mechanical Supervision Team	-	-	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	2	1	-	-	-	-
Piping Supervision Team	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	4	4	4	2	2	-	-	-
E&I Supervision Team	-	-	-	-	1	1	1	1	1	1	1	1	1	2	2	4	4	4	4	4	4	-	-
Grand Total	-	-	2	8	27	31	35	38	41	47	54	57	65	68	71	72	67	62	47	43	29	5	-

Figure 80 Example of Mobilization plan (split considering Site teams/ disciplines)

Based on the above points, the resources required both for supervision and for services supporting the construction (e.g. field engineering, Quality Control, Project control, etc.), shall be distributed on the plan having care of:

- Covering adequately the activities having at any time some responsible personnel on duty for each discipline during the execution (with proper overlap prior/ after the rotation leaves)
- Having care of distributing the personnel having a ramp-up period, a peak and then a gradual demobilization of the resources, as it happens to relevant activities development
- Assigning nationalities basing on the local requirements/ limitations (e.g. out of controlled areas, expatriates cannot supervise/ execute activities without military/ private escorts).

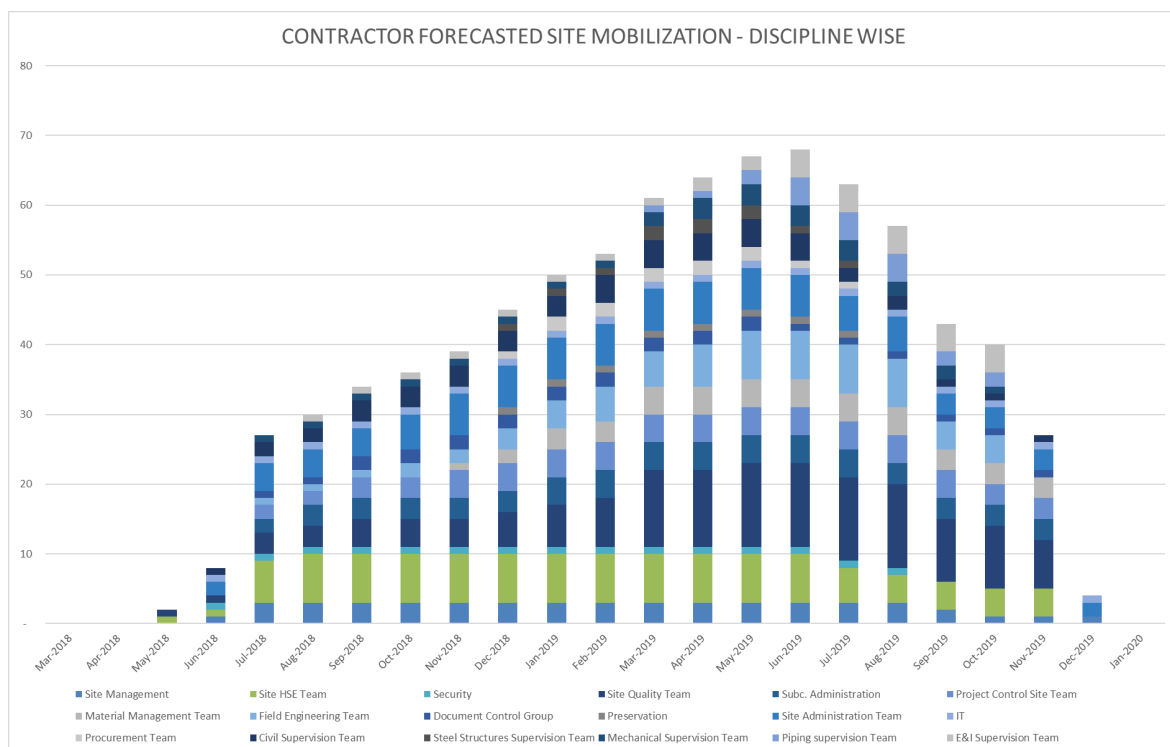


Figure 81 Histogram of forecasted Contractor presence at Site

Once the full mobilization plan has been defined, it has to be approved by the Project Management, which has the responsibility of the budget management.

The moment in which the first mobilization plan has been approved, the hiring process for the figures identified can start, in due time in order to allow for the execution of the activities and not creating disruptions to their execution.

16. Methodology and Technics of Cost Control for Site Construction Activities

16.1 Methodology

Site Cost Control activities at Site are based on the process of identifying in detail all cost elements part of the Phases belonging to the Site activities, monitoring and evaluating the estimate to completion in accordance with the most modern techniques part of the Project Management methodologies reflected in the following Standard Cost Breakdown Structure:

- Site management & Temporary Construction Field / Field Running Cost, which include:
 - Construction Supervision
 - Vendors Supervision
 - Temporary Facilities e Field Running Cost
- Construction Works
 - Construction / Erection activities
 - Pre-commissioning and Commissioning activities
- Procurement/ Post Order, Shipping and related services
 - Local Purchased Material
 - Vendor assistance and other supplied services
- Guarantee Period
 - Cost Born during the Guarantee Period.

Cost Control activities are also focused on:

- Establishing and periodically updating the Site Cost Control Report; this shall be duly checked by the Project Control Manager, approved by the Site Manager and transmitted to Project Director/ Project Manager for final authorization
- Managing the collection of all site documentation necessary to evaluate the revenues amount for the Construction Contractual value of the executed works for its reporting in the Payment Approval Certificates to be submitted to Client prior to issue to Client itself the approved invoice
- Supporting the Contract Manager and the Project Director/ Project Manager in case of Claim or Change Orders under discussion with/ addressed to Client
- Strict Monitoring of Local Purchase Orders starting from the issue of the Local Purchase Request through the deployed tracking system/ register
- Develop and updating Cost Control Report, which may be required to be regularly issued for Client consideration in case of Cost-plus fee contracts or similar contractual frames, referring to contractual unit cost rather than to actual cost.

This approach allows for the definition of a cycle which continuously repeats and that gives to the EPC Contractor the possibility to be more accurate in the development of its technical and (especially) commercial offers towards Clients, as shown in Figure 83. This means that a more

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

aggressive strategy in a known/ established market may be adopted reducing in any case the risks for major losses (due to the fact that other projects have been completed and executed, with relevant Lessons Learnt and suggestions for new initiatives).

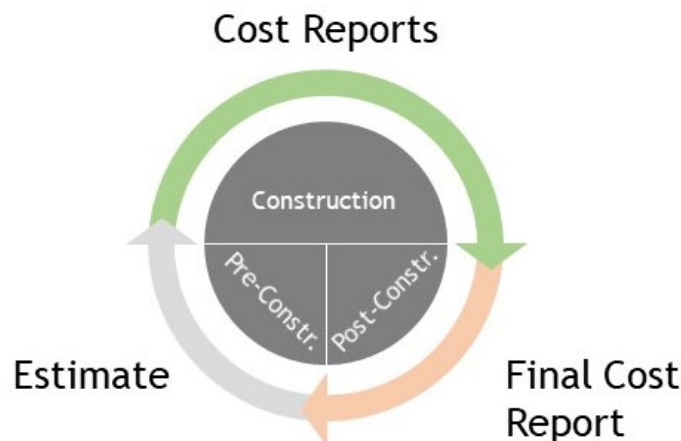


Figure 83 Cyclical management of Cost Control

16.2 Technics of Control for Site Construction Activities

16.2.1 Cost Elements Identification

During the development of the Original Budget, all Cost Elements pertaining to Construction activities have to be identified upon the review of the Construction Cost Estimate attached to the Sale Budget (and thus constituting a significant part of the commercial offer) together with the Constructability Review performed during the Proposal Phase, if any. This joint review is important to ensure that all potential costs have been considered at the earliest.

In particular, for the cost that can arise at Site during construction activities, the following indicators should be assessed:

- **Site Management:** with respect to this source of costs at Site, it has to be taken into account the personnel to be mobilized for the Supervision of the activities and other tasks that need to be carried out at Site. In particular, it is necessary to consider:
 - Number of Man-Months/ Man-Days associated with the personnel which is going to be mobilized
 - Origin of the personnel (considering that this may heavily affect the associated costs)
 - Personnel Qualification Cluster for the positions under mobilization (an example can be the subdivision of the personnel in following categories: Manager, Superintendent, Supervisor, Assistant).

In addition to above, part of Site Management Cost shall include personnel insurance cost, pocket money or per diems, visas obtainment/ management, travel expenses, accommodations, etc.

- **Temporary Construction Facilities (TCF) and Field Running Cost (FRC):** this macro-category includes:

- The cost for the installation of the TCF (inclusive of rental/ supply of the facilities) and the utilities required for their operation. In the first phases (and during tender stage) this evaluation is performed starting from the resources deployment's histogram extract from the preliminary assignment. From this, it is evaluated:
 - The total surface for the offices required to locate the peak of resources forecasted at Site (and relevant number of working positions) as well as the surface of satellite offices, if deemed necessary, and any other facility required for the execution of the construction works
 - The total surface required for the accommodation camp to accommodate the peak of personnel forecasted (with relevant number of beds/ buildings), in case of camp needed
 - The requirements for the other services (as, for example, the meals to be provided at Site canteen, if foreseen, the number of meals to be provided at camp, if any, for the catering service, utilities generation/ consumption cleaning of the facilities, maintenance service, Personal Protective Equipment (PPEs), etc.).
- Evaluation of the costs associated to Client TCF and FRC as per Contractual Requirements, inclusive of:
 - Personnel Transportation Costs (in case, inclusive of car rentals, drivers, maintenance for cars, etc.)
 - Diesel Generators, if needed for power generation, together with required fuel
 - Water Supply, to the applicable extent (may be required the supply of potable water and/ or sanitary water for toilets)
 - Waste Management, Pest Control, janitorial services
 - Security, if requested
 - Gardening, if requested
 - Satellite offices
 - Stationery
 - Medical Expenses
 - Other FRC (for meals, supporting staff such as secretaries, etc.)
 - PPEs.
- Construction Works executed by Subcontractors or through the application of a direct hiring scheme (as presented in the Section 13). This evaluation shall be performed subdividing the activities that shall be performed into the pertaining disciplines, focusing on:
 - Quantities to be erected, available starting from Material Take-Offs (MTOs), Bill Of Quantities (BOQs) or Material Requisitions (MR)
 - Quantities Price Lists (QPLs) developed during the Proposal Phase, with relative Method of Measurement utilized for the evaluation
 - Direct Standard and Expected manhours (as explained in the Section 7)
 - Constructability Reviews

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

- Equipment (especially larger cranes or specific ones, such as piling rigs) required for the execution of the activities.

At this point, it is possible to define the Original Budget. After its approval, the Project Director/ Project Manager shall assign the Target Budget to all the functions involved, inclusive of Construction Operations and Construction Subcontract function. This is, in theory, less or equal to the Original budget and it represents the allocated resources for the single discipline for the execution of the pertaining activities (as, for example, the award of the subcontracts or the mobilization of the resources on Site).

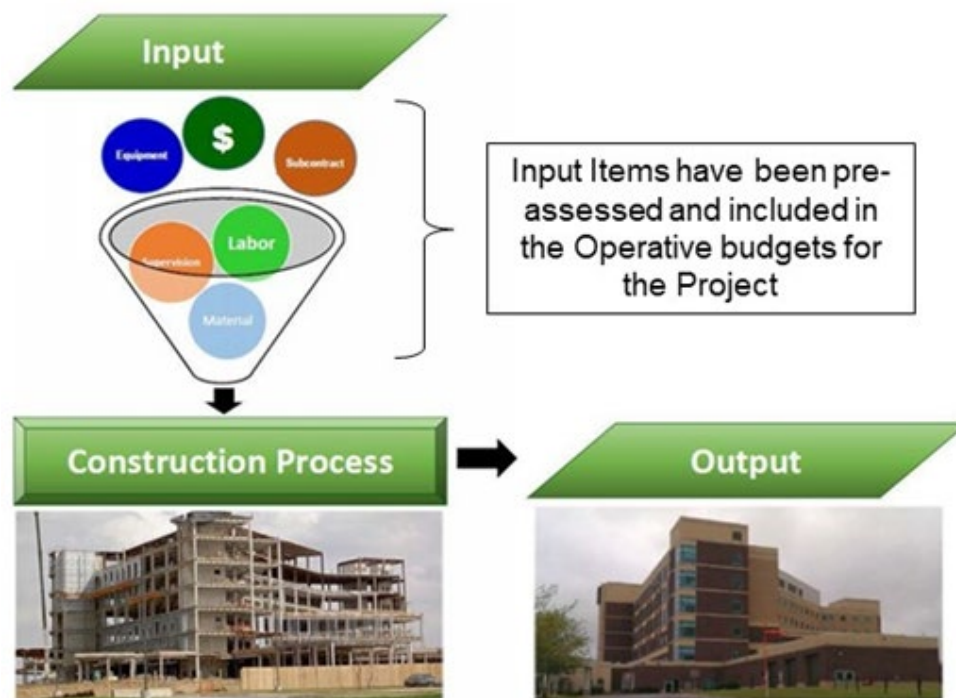


Figure 84 Conceptual scheme of Project execution

16.2.2 Cost Elements Monitoring and Assessment of Estimating to Completion

Considering that the Target Budget has been communicated with the disciplines, they shall perform the Estimation to Completion basing on the same Target Budget; in principle with respect to Construction phase, this activity shall be executed as follows:

- Site Management
Team from Construction Operations department (at the beginning of the Project) and Site Manager (once assigned to the Project), shall review the Resources Mobilization Plan in accordance with the communicated target budget based on the identified clusters, analyzing all technical aspects related to the Temporary Construction Facilities and Field Running Cost and shall develop the relative Mobilization Plan. Obviously, this is a live document, that will be constantly

updated to follow Project's needs and progress as well as unexpected events or particular requests from Client.

Vendor Supervision, in terms of Man Months availability, is normally endorsed by Construction Operations function, which manage Vendors' assistance at Site during installation (and by Commissioning function with respect to the assistance during commissioning and Start-up) while the Daily Unit Rates shall be addressed to Procurement function, which normally negotiates the same prior to Pos award. Specific Purchase Order positions shall be included in each Purchase Order requiring Site Vendor assistance indicating quantity (days, month) and unit rate. In case of lump sum budget, the Purchase Order shall unequivocally describe the measurement and compensation of part of the given lump sum service.

During the development of the Project, normally on a monthly basis, the responsible function for the management of the Resources Planning/ mobilization shall transmit to Project Control Manager the Resources Mobilization Plan duly updated in accordance with Project needs, contractual requirements and the approved target budget.

- Temporary Construction Facilities and Field Running Cost

After analyzing all technical aspects with respect to the peak of manpower predicted on Site, Site Manager shall update the plan for the utilization of the Temporary Construction Facilities and related Field Running Cost.

The Project Cost Control Engineer shall monitor through the assignment of relative budget all Subcontract Services and Local Purchase Orders (not referred to Project Plan) issued by the local legal entity based on the specific requests for approval by Site Manager and final authorization by Project Director/ Project Manager.

On periodic basis, Project Cost Control Engineer shall extract the status of Purchase Orders and after a rigorous analysis of each Purchase Order shall carry out a realistic estimate to completion assessment based also on the status of the construction schedule under execution and, if and when required, to execute cost evaluation impacts linked to Extension of Time.

In case of any discrepancy versus the target budget, Project Cost Control Engineer shall immediately inform the Site Manager and after relevant approval shall convey the updated forecast amount to Project Director/ Project Manager for final authorization.

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

Job Cost Forecast												
Managed Rite Construction \\DESKTOP-GU5R6U\USAGE100CON\Sample Company												
Job: 221 - Bike Path for Rte 66 Bike Path for Rte 66 Hwy 66 Barstow, CA 99999		Cut Off By: Period			As Of Period: 2015 6		Default Forecast Method: Percent Complete Click the [+] button above column M to override the forecast method for individual cost codes.					
Cost Code	Description	Hours	Dollars	Actual To Date		Forecast		Cost At Completion		Variance		
		Total Budget	Total Budget	Hours	Dollars	Value	Unit	Hours	Dollars	Hours	Dollars	%
2000	SITE WORK	250	20,225	-	-	-	%	-	-	250	20,225	100%
2452	Bike Path Paving	56	71,506	-	-	-	%	-	-	56	71,506	100%
2454	Bike Path Striping and Signage	14,500	17,274	-	-	-	%	-	-	14,500	17,274	100%
2456	Bike Path Landscape	-	49,473	-	-	-	%	-	-	-	49,473	100%
9300	Ceramic Tile	-	-	-	4,550	-	%	-	-	-	-	0%
Report Totals		14,806	158,478	-	4,550	-	-	-	-	14,806.00	158,478.25	100%

Figure 85 Example of the status of a PO (with actual expenses/ progress and space for estimates at completion)

- Construction Works

After having received the Target Budget, Construction Subcontract shall review the Subcontracting campaign in accordance with the strategy of the Project Execution Plan approved by Project Director/ Project Manager and the received Target Budget; obviously, as presented in Section 11, the proposed strategy shall be followed by the issue of the formal Work Requisition(s) by relevant Engineering functions which are endorsed by Home Office Construction Team on the Project which prepares the remaining technical documents required for the Request For Quotation.

During the development of the Project and prior to the issue any Subcontract, Project Control Manager shall update the current forecast based on the best information received by Subcontracting during the critical phase of Subcontractor Bid Evaluation focusing on the exclusions submitted by the Bidder.

In case of any variation in the Quantities and/ or the Scope, Cost Control function shall immediately evaluate the Current Forecast analyzing in detail the quantities in case of overruns, informing Site Manager and Project Director/ Project Manager about any impact.

During the development of the Site Activities, the Project Control Manager (or appointed resource) shall receive from Site Administration Manager the “Construction Subcontracts Administration Monthly Report” (or equivalent report) for further analysis of the accrued status with particular attention to the approved “Extra Works”.

For each single Subcontract, the Project Control Manager shall allocate a target value for Extra Works. Basing on this, the Site Manager should not approve, nor Site Administration Manager should not negotiate additional Extra Works exceeding this amount, if not formally authorized by Project Director/ Project Manager.

Site Administration Manager and Project Control Manager shall collaborate in order to provide to Site Manager and Project Director/ Project Manager the correct evaluation of the current forecast for Construction Works through the analysis both in terms of claims received from the Subcontractors and in terms of Extra Works Request still to be approved.

In case of any variances versus the target budget, Cost Control function shall immediately inform the Site Manager and, after his approval, it shall convey the updated forecast amount to Project Director/ Project Manager for final authorization.

Basing on the above, with the aim of giving full visibility on the status of the Project, the Project Control team shall prepare a dedicated report on Subcontracting plan (an example has been made available in Figure 86) indicating the following information:

- Original/ Revised Budget
- Target Budget
- Variances of the Original/ Revised Budget versus Target Budget
- Committed resources (Subcontract Amount)
- Latest Work Progress Payment Amount
- Estimate to Complete
- Estimate at Completion (Current Forecast).

Description of Work	Schedule of Values	Installed To-Date %	Installed To-Date \$	Materials Stored - Not Installed \$	Installed & Stored To-Date \$
Mobilization	\$1,200	100.0%	\$1,200		\$1,200
Site preparation	\$14,800	100.0%	\$14,800		\$14,800
Concrete foundations & sidewalks	\$22,200	100.0%	\$22,200		\$22,200
Plaza equipment	\$29,500	100.0%	\$29,500		\$29,500
Seeding & landscaping (Subcontract)	\$12,300	100.0%	\$12,300		\$12,300
Totals	\$80,000	-	\$80,000	\$0	\$80,000
Less: 10% Retainage					(\$8,000)
Total Net Payment To-Date					\$72,000
Less: Previous Payments					\$38,790
Total Net Payment Due					\$33,210

Figure 86 Example of the report on the Subcontracting status, with relevant estimates

16.2.3 Site Cost Control Report

The Site Cost Control Report is the official document that presents the Forecast Amount for the Phase linked to the Site activities, as presented in Figure 87.

The first issue of the document shall be transmitted after the commencement of the construction activities assessable and prior the mobilization of the Site, in order to have all forms and models for next issues set according to contractual needs and site development.

This report shall be composed at least by the following Sections:

- Cost Summary Level
- Project Variances Analysis
- Subcontractor Cost Status

Errore. Per applicare Heading 1 al testo da visualizzare in questo punto, utilizzare la scheda Home.

- Subcontractor Detailed Cost Status (Discipline/ Scope of Work wise)
- Subcontractor Detailed Cost Status
- Construction Supervision Cost Status (Man-months included)
- Vendor Supervision Cost Status (Man-months included)
- Vendor Supervision Detailed Cost Status (Man-months and other detailed expenses such as visas and travel expenses, etc., according to the Cost Breakdown Structure presented in Section 16.1)
- Vendor Supervision Cost Status
- Temporary Construction Facilities & Field Running Cost Status

Project:		Report #: 8						
Client:		Period Ending: 8/31/20XX						
Location								
P.O. #	Vendor	Description	Budget at Completion	Paid To-date	Committed To-date	Estimate To Complete	Estimate at Completion	Variance at Completion
SC001		Fabricate/Erect Tanks	\$550,000	\$280,000	\$625,000	\$0	\$625,000	(\$75,000)
SC002		Civil Work	\$2,800,000	\$1,380,000	\$2,500,000	\$400,000	\$2,900,000	(\$100,000)
SC003		Above Ground Electrical	\$1,450,000	\$120,000	\$1,200,000	\$250,000	\$1,450,000	\$0
SC004		Mechanical Work	\$4,400,000	\$1,800,000	\$4,500,000	\$0	\$4,500,000	(\$100,000)
TOTALS			\$9,200,000	\$3,580,000	\$8,825,000	\$650,000	\$9,475,000	(\$275,000)

Between the September 1 and the September 30 reports, the following took place.

The subcontractors were paid the following amounts.

- o SC001 - \$150,000
- o SC002 - \$400,000
- o SC003 - \$200,000
- o SC004 - \$900,000

The amount of subcontract SC002 was increased by \$400,000. (Estimate To Complete was reduced by a like amount).

The amount of subcontract SC003 was increased by \$250,000. (Estimate To Complete was reduced by a like amount).

The Estimate To Complete for SC001 was increased by \$60,000.

The Estimate To Complete for SC004 was increased by \$40,000.

Figure 87 Example of Site Cost Control Report

17. The Construction Key Performance Indicators and the Productivity assessment

The main scope of the Key Performance Indicators (KPIs) is:

- to measure and to monitor the performances of some critical activities in the Project, as applicable on the basis of project scope (E, P, C/ Cm or possible combination of the phases), comparing the same performances across Projects and eventually to enhance their process
- to evaluate the effectiveness of the corrective actions taken
- to analyse the progress made in achieving the objectives.

KPIs' targets set the Company quality objectives for the Project execution.

17.1 Methodology

17.1.1 Definition

An EPC Contractor (as any other Company) prior to choose the best Project Key Performance Indicators, should undertake some steps, in order to have an effective implementation of this methodology, such as:

- detailed definition of the organizational processes
- definition of the requirements relevant to the mentioned organizational processes
- definition of qualitative and quantitative measurements of the performances (to allow comparison with respect to a target value and across projects)
- determination of the variants and having adjusted the processes to meet the short-term objectives.

The Key Performance Indicators are then split in:

- internal to the Company
- for the Project.

KPIs measurement is often defined at a contractual level within the Projects; in addition, it is not unusual that KPIs defined by Clients differs from Project KPIs as defined by the Company. For this reason, a system for monitoring the double set of KPIs is put in place.

The Key Performance Indicators definition is based on Company Objectives, results of measurements and reviews, possible modifications proposed by the Process Owners or emerged during KPIs review meetings.

In case of changes, the Key Performance Indicators are revised accordingly by System Quality, which is normally the owner of this subject.

During the periodical Company's Quality Management Review Meeting, a target value is assigned/ reviewed for each KPI to cope with Company Objectives. KPI target values are recorded in the Project KPI Target List. Different or additional KPIs can be planned for a Project to cope with specific contractual request and/ or local/ legal regulation.

In case Client requests to use its own calculation methods or to set different KPI targets than the ones foreseen by Company on Project KPI Target List, as mentioned before, this additional set of Contractual KPIs with relevant targets shall be included in project planning documents (PQP and SQP) and in project reporting to Client.

17.1.2 Characteristics

A Key Performance Indicator is normally intended to have the following characteristics:

- Quantifiable - in a numerical and mathematical format
- Measurable - on legitimate data independent of factors outside the Company
- Practical - it integrates with current Company processes
- Directional - it helps to identify the processes trend
- Operational - they can be related to the practical context to measure an actual change
- Critical/ Operational - it relates to the urgency which the Management shall take its own decision with
- Synthetic - it's expressed by a simple or composite variable
- Significant - it must represent the business phenomena to which it refers.

In addition, the Key Performance Indicators should have predetermined time frames that divide the analyzed process into different checkpoints.

The Key Performance Indicators allow to measure the Project's performance as they are represented by quantitative or qualitative variables that are still comparable (lead time of today's order-delivery cycle compared to yesterday, or of Alfa compared to Beta).

To each Key Performance Indicator is associated a variable which represents its measurement (e.g. lead time → time).

Thanks to the Key Performance Indicators, the Project Management can not only measure Project phenomena in time and space, but can also plan and schedule the activities (defining measurable objectives in the short and medium term), measure the deviations (gaps) between expected objectives and results obtained, and take the necessary actions to correct gaps, i.e. can manage with methodology the Company and/or the Project (planning - control - timely corrections).

17.1.3 Performance Measurement

The performances are numerous and differentiated:

- some are general in nature and therefore can be found in all processes such as, for example, evaluations of cost, time, quality and value
- others are proper of specific processes such as, for example, productivity performance, versatility and flexibility in production processes.

The measurement of the Key Performance Indicators in the Project activities and processes requires the definition of a system of indicators that allows to represent, in a unitary and prospective framework, the ability of the Company to pursue its short, medium and long-term objectives.

It is not a system of measures which only take the results achieved from a static analysis perspective, but which is also able to highlight the ability of the Company to adapt to changes in the external environment, from a dynamic analysis perspective.

The Key Performance Indicators could be classified as shown in Table 11, based on the applicable criteria used for the measurement:

Criteria	Performance measurement
Objectivity	Quantitative
	Qualitative
Value	Economical
	Non economical
Completeness	Final
	Intermediate
	Global
	Partial
Measurement Time	Forecasted
	Achieved
Time frame	Short term
	Long term
Adjustability	Flexibility
	Elasticity
Relevance	Strategic
	Operative
Scope	Control
	Continous improvement
	Organizational education

Table 11 Performance Measurement

Another method of classification of the Key Performance Indicators is based on:

- Costs' measurements

A first and fundamental indication of the efficiency of the processes can be obtained by measuring the costs necessary for the performance of the individual activities and processes as a whole. A satisfactory (though not uncriticized) control system to ensure management has a medium to long-term vision is the Activity-Based Costing (ABC); this methodology assigns costs to each activity/ process basing on its actual consumption.

- Time measurements

The time factor has taken an extraordinary importance as a factor of competition. Being measurable in a direct manner (not like the costs which may have an arbitrary attributions), there is a wide spread of time measures in Project management. The main measure of time performance normally is the so called "lead times", i.e. the actual execution time required for the completion of a process. Other time measures can be the time to market, rate of introduction of new products, time to order, rate of stock rotation. In any case, it is more complicated apply these additional measures to an EPC Project (or similar) but are more frequently used in the manufacturing/ production environment.

- Quality measurements

The measurements pertaining to the quality of the execution of a process are the most varied and complex to analyze. For a correct interpretation of the measurements, it is useful to distinguish the quality produced (or quality of the processes) from the perceived quality. The quality produced consists in the objective validity and effectiveness of the ways in which the process and its output are carried out, while the perceived quality can be defined as the conformity of the offer with respect to the Client's expectations.

17.2 Construction Key Performance Indicators

A list of typical Key Performance Indicators collected by Site personnel (normally on monthly basis) during Construction Phase is included in the following Table 12:

Site Construction Targets	Measuring means	Evidence	Applicability		Monitored by
			Foreign Sites	Italian Sites	
HEALTH & SAFETY LTIF (Lost Time Injury Frequency)	Cumulative worked hours from the beginning of each year	Site Monthly progress report	X		Site HSE Team
HEALTH & SAFETY TRIR (Total Recordable Injury Rate)	Cumulative worked hours from the beginning of each year	Site Monthly progress report	X		Site HSE Team
IF (Indice di Frequenza Infortuni - INAIL)	Cumulative worked hours from the beginning of each year	Site Monthly progress report		X	Site HSE Team
IG (Indice di Gravità – UNI 7249:2007)	Cumulative worked hours from the beginning of each year	Site Monthly progress report		X	Site HSE Team
SITE CONTRACTUAL MILESTONES	Progress measurement	Site Monthly progress report	X	X	Site Project Control Team
CONCRETE CUBE-CYLINDER TEST FAILURE	During Testing	Site Monthly progress report	X	X	Site Quality Team
REINFORCING BAR TEST FAILURE	During construction	Site Monthly progress report	X	X	Site Quality Team
WELD REPAIR RATE OF RADIOGRAPHED JOINTS	During radiographic activities	Site Monthly progress report or Welding database output report	X	X	Site Quality Team
PIPING ISO'S >2" modifications		Site Monthly progress report	X	X	Site Quality Team
CHANGE WORKS ON SITE		Monthly Change Work Status (C.W.S)	X	X	Site Contract Management Team

Table 12 Summary of Construction KPIs

17.2.1 Lost Time Injury Frequency

LTIF is monitored by Site HSE Team. It is calculated as follows:

$$\text{LTI FREQUENCY} = \frac{\text{LTI}}{\text{Worked hours} \times 200.000}$$

Where:

- LTI is the sum of Fatalities and Lost Workday Cases in the year, according to OSHA recordkeeping criteria (OSHA Part 1904 "Recording and Reporting Occupational Injuries and Illness")
- Worked hours are the hours worked in the year.

17.2.2 Total Recordable Injury Rate

TRIR is monitored by Site HSE Team. It is calculated as follows:

$$\text{TRIR} = \text{TRI RATE} = \frac{\text{TRI}}{\text{Worked hours (in the current year)} \times 200.000}$$

Where:

- TRI means the sum of Fatalities, Lost Workday Cases, Restricted Work Cases, Medical treatment beyond First Aid, loss of consciousness and any other significant injury or illness diagnosed by a physician or other licensed health care professional (OSHA Part 1904 "Recording and Reporting Occupational Injuries and Illness").
- Worked hours are the hours worked in the year.

17.2.3 IF/ Lost workday Frequency Index - INAIL

IF is valid for Italian Construction sites and is monitored by Site HSE Team. It is calculated as follows:

$$\text{IF} = \frac{\text{Lost Workday cases (with more than 3 days away from work)}}{\text{Worked hours (in the current year)} \times 1.660.000}$$

Where:

- Lost Workday cases to be included are those implying more than 3 days away from work
- Worked hours are the hours worked in the year.

17.2.4 IG/ Severity Index - UNI 7249:2007

IG is valid for Italian Construction sites and is monitored by Site HSE Team. It is calculated as follows:

$$\text{IG} = \frac{\text{Days away from work} + \text{conventional days of permanent disability}}{\text{Worked hours (in the current year)} \times 1.000}$$

17.2.5 Site Contractual Milestones

This KPI is monitored by Site Control based on site project schedule and the milestones defined as per Contract with the Client (or Subcontractors).

17.2.6 Concrete Cube or Cylinder Test Failure

This record is monitored by Site Quality Team in cooperation with Civil Supervision Team.

It is calculated as follows for each specific design mix:

$$\frac{\text{Number of failed tests}}{\text{Number of tests performed}}$$

It shall be expressed as a percentage; tests are to be performed for each specific mix by an authorized Third-Party Laboratory.

17.2.7 Reinforcing bar test failure

This record is monitored by Site Quality in cooperation with Civil Supervisor.

It is calculated as follows for each kind of casting steel and bar's diameter:

$$\frac{\text{Number of failed tests}}{\text{Number of tests performed}}$$

The tests shall be made by a Third-Party Laboratory. It shall be expressed percentage wise.

17.2.8 Weld Repair Rate of Piping Radio graphed Joints

This record is monitored by Site Quality Team in cooperation with NDT & Welding Inspection Team.

It is calculated as follows:

$$\frac{\text{Number of joints to be repaired}}{\text{Number of controlled joints}}$$

It is normally expressed as a percentage.

17.2.9 Piping ISO > 2" modifications

This record is monitored by Site Quality Team in cooperation with Piping Supervision Team and the Field Engineering Team.

It is calculated as follows:

$$\frac{\text{Number of isometrics modified at site}}{\text{number of isometrics sent to fabrication by Subcontractor}}$$

The ratio shall be expressed percentage wise.

The isometrics relevant to modification requested and recognized by the Client shall not be considered. Indeed, the estimation shall be done exclusively considering the ISO modified due to design mistakes leading to Site modifications.

17.2.10 Change work on site

Change works on site are monitored by Site Contract, which is the first interface for managing subcontractors at site. This KPI shall be calculated as follows:

$$\frac{\text{Amount of change works recognized to all Subcontractors}}{\text{Amount of subcontracted works}}$$

Note: change works considered for the KPI calculation shall not include the changes requested from the Client.

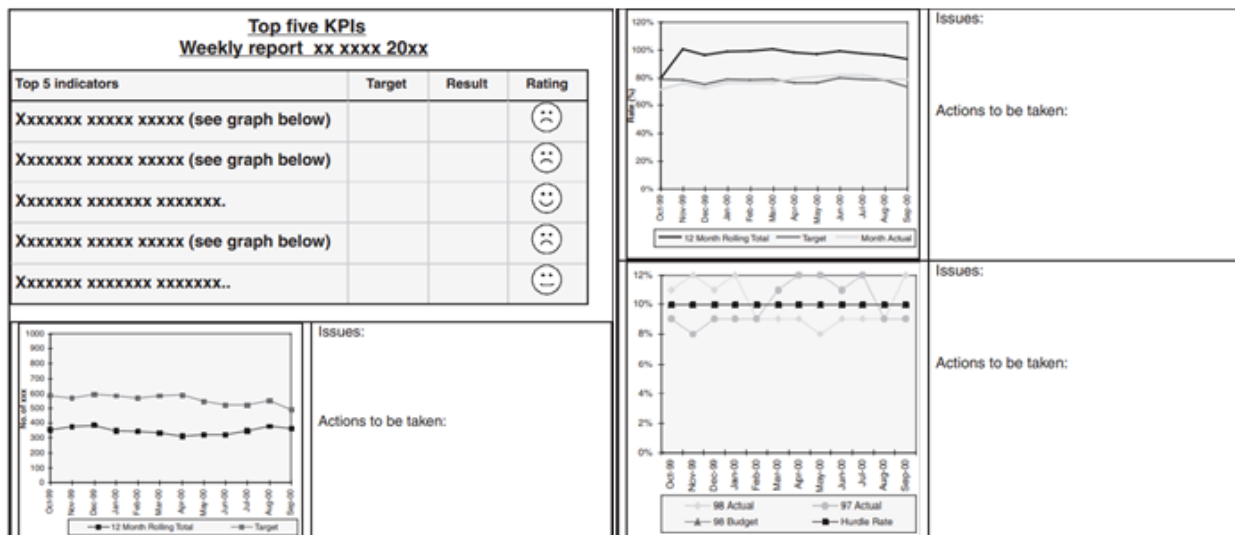


Figure 88 Example of KPI Monitoring tool

17.3 Project Key Performance Indicators Collection And Distribution

A Responsible person/ department for each KPI is identified in Table 12. They are the first responsible for the analysis and identification of performances' contributing factors.

KPIs are measured by the Responsible of Measurement as reported in Table 12, which normally is the person that execute the calculation of the associated measures of each KPI.

Each Responsible of KPI, or a delegate, communicate its own KPI result to Project Control Manager, for tracking and reporting purposes.

Project Control Manager gathers all the Project KPIs results and prepares with the collaboration of Project Quality Manager the Project KPI report for the approval of Project Director/ Project Manager and relevant distribution.

Project Control Manager publishes the Project KPI approved report distributing it to the Project Team on a monthly basis (normally, within the first week of the month), while it is normally distributed to the Company Top Management on a quarterly basis.

17.4 Project Key Performance Indicators Analysis

A first analysis is made by Project Director/ Project Manager in collaboration with Project Control Manager and Project Quality Manager, with the aim of approving the Project KPI report.

Basing on management's view, Project Director/ Project Manager can decide to include KPIs analysis during foreseen periodical project internal meeting.

In case of need, Project Control Manager/ Project Quality Manager, in agreement with Project Director/ Project Manager, may call a specific review meeting to highlight deficiencies and/ or opportunities for improvements and to define and address related actions. Attendees are selected according to the individuated topics, including the Responsible of relevant KPI and/ or relevant Head of Department, as deemed necessary.

Prior to the submission to the management, in due time, Project Director/ Project Manager can prepare a note with comments on the results of his project to highlight topics to the Company, including root cause analysis, explanations, corrective actions, etc.

Possible agreed actions are communicated in cascading to involved parties and, when necessary, the Lesson Learned process starts.

17.5 Contractual KPI collection and distribution

Contractual KPI results are distributed to Client during periodical meeting and through periodical reporting that are usually defined in the Project Coordination Procedures and/ or in the Contract. The same applies to the report formats, which usually are defined in the Project Coordination Procedures or in Project Reporting Procedures (as applicable) or, alternatively, are attached to the Contract.

In case that Contractual KPIs differ from Project KPIs, the responsible for each additional/ different Contractual KPI, or appointed delegate, communicate the result of the respective performance to the relevant focal point.

The Responsible for Contractual KPI is identified in the project documents (PQP and SQP) as well as the Responsible of the relevant Measurement.

The focal point gathers all relevant KPIs results and prepare KPI report for the approval of Project Director/ Project Manager or appointed delegate (typically the Site Manager, if the KPIs are relevant to the construction phase of the project) prior to issue to Client.

17.6 Contractual KPI analysis

The results of Contractual KPIs performances are analyzed by Project Director/ Project Manager (in cooperation with Project Quality Manager and Project Control Manager) or by Site Manager (in cooperation with Site Quality Manager and Site Control Manager) depending on the involved processes and by the applicable Project Coordination Procedures.

Generally, the analysis is performed before the periodical meeting with Client, where possible corrective actions are proposed, agreed and followed-up. The follow-up of action implementations, for next meetings, are ensured by the same focal point indicated in Table 12.

18. Construction Risks and Opportunities

Construction phase (inclusive of pre-commissioning and commissioning) undoubtedly constitutes the most critical phase and, as a matter of fact, its success determines the success of the entire project and, at the same time, its chances of success rely on how the upstream phases (Engineering and Procurement) have been developed and carried out. In addition, it is the phase in which the risk with greatest impacts may occur, considering that, on average, the Construction costs represent the 35-40% of the total Project cost as well as taking into consideration that the execution of this phase relies on other companies (subcontractors).

In other words, Construction phase can be considered as the moment of truth for the entire project since:

- The effectiveness of the measures forecasted and implemented with the aim of limiting risks and enhancing opportunities are actually measured
- Unexpected and unknown events happen (or not)
- Time to complete the Project/ react to unexpected events gets shorter.

It is well known that among the main challenges that an EPC Contractor shall face during a project execution, time compaction is nowadays quite common and, therefore, its combination with the minimization (or even a reduction to zero) of the available floats, amplifies the severity of project risks.

Several definitions of Project risk (and Project opportunities) exist; among the others, there are the following:

Project Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project's objectives. These two types of risks are called respectively threats and opportunities (PMBOK – Fifth Edition)

Project Risk is an unfavorable outcome of uncertainty. Project Opportunity is a favorable outcome of uncertainty (ECRI Glossary – Rev.1)

18.1 Risk Categorization

Risks can be categorized as:

- Known Risks, i.e. those risks that have been identified and analysed; this means that for these risks it may be possible to plan responses/ counteractions with the aim of mitigating/ avoiding negative effects
- Unknown Risks, i.e. those risks that cannot be managed proactively. It is thus not possible to plan for a countermeasure or for an action that prevents relevant negative effects
- Business Risks: they may be threats or opportunities which lead to different profits (with respect to the forecasted together with Commercial offer submission) or, in the worst cases, to economic losses. Normally, the Risk Management methodology aims at facing Business risks

- Insurable Risks: they are threats out of project/ risk management control; consequently, an insurance is usually the only action that can be taken by the EPC Contractor.

When a risk event occurs, it ceases to be uncertain, and thus:

- threats which occur can be called either “issues” or “problems”
- opportunities which occur are usually called “benefits”.

In any case, regardless of the typology of risk (i.e. both in case of a threat and of a possibility), Project risks have to be managed; this discipline is called “Risk Management”. While few years ago it was still considered as a “best practice” to be put in place, nowadays it has become a fundamental step to be taken in the life of a Project.

18.2 Risk management

Basically, in EPC Contractors organization there is a dedicated function / department as well as a defined position among key figures in a Project Organization chart, dedicated to the Risk Management process and continuous analysis.

According to ISO 31000:2018, the Risk management:

- creates and protects value
- is an integral part of all organizational processes
- is part of decision making
- explicitly addresses uncertainty
- is systematic, structured and the timeframe of implementation shall be defined
- is based on the best available information
- is tailored to the project
- takes human and cultural factors into account
- is transparent and inclusive
- is dynamic, iterative and responsive to change
- facilitates continual improvement of the organization

Basically, Risk Management is a choral, systematic and iterative process that integrates:

- risks identification
- risk analysis
- risks evaluation
- planning of responses
- monitoring/ review of risks and relevant responses.

All the above steps are shown in the hereunder Figure 89.

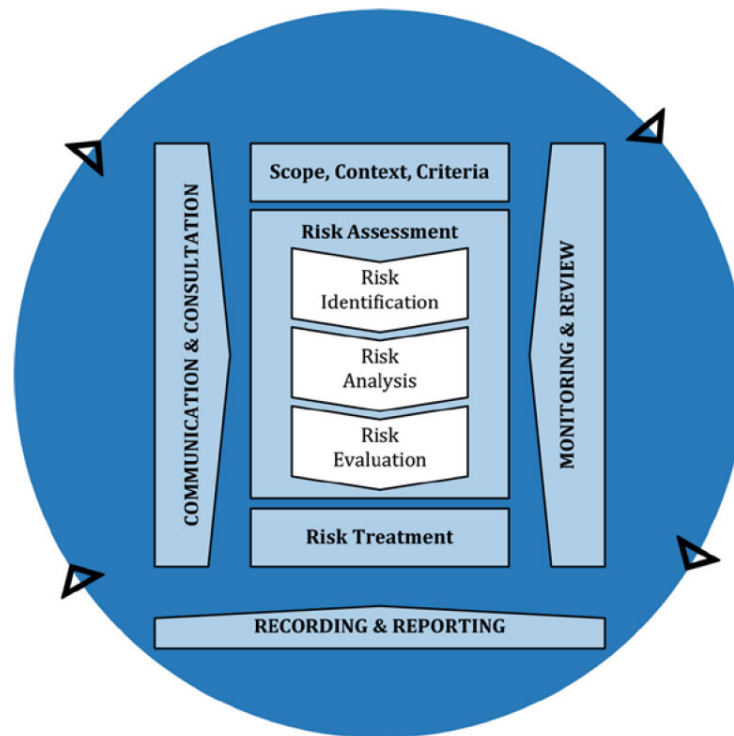


Figure 89 Risk management process

Through specific tools and dedicated sessions, risks are identified, measured/ rated and specific controlling measures are defined. Any action undertaken and every analysis performed is customized to the peculiar Project features. This allows to have a general common approach to the Projects with (theoretically) enhanced positive effects on the specific initiative. The general aim is to reduce threats to acceptable levels and the maximization of the opportunities through the definition of new strategies of adaptation of existing ones, already adopted in other initiatives.

Realistically, in the Project Management, the majority of the opportunities consist in the anticipation/ avoidance of threats; therefore, the success of a Project depends on strategies and actions that have been undertaken well in advance with respect to the Construction phase.

One of the main tools, largely exploited in the risk management, is the Risks Breakdown Structure which constitutes the checklist to drive risks identification. It is typically structured in 3 levels (functions, activities and topics, meaning the specific risks to be considered) and the vast majority of the subjects have a direct or indirect impacts on site activities, therefore each and every topic has to be carefully and jointly analyzed and shared. An example of a Risk Breakdown Structure is reported in Figure 90.

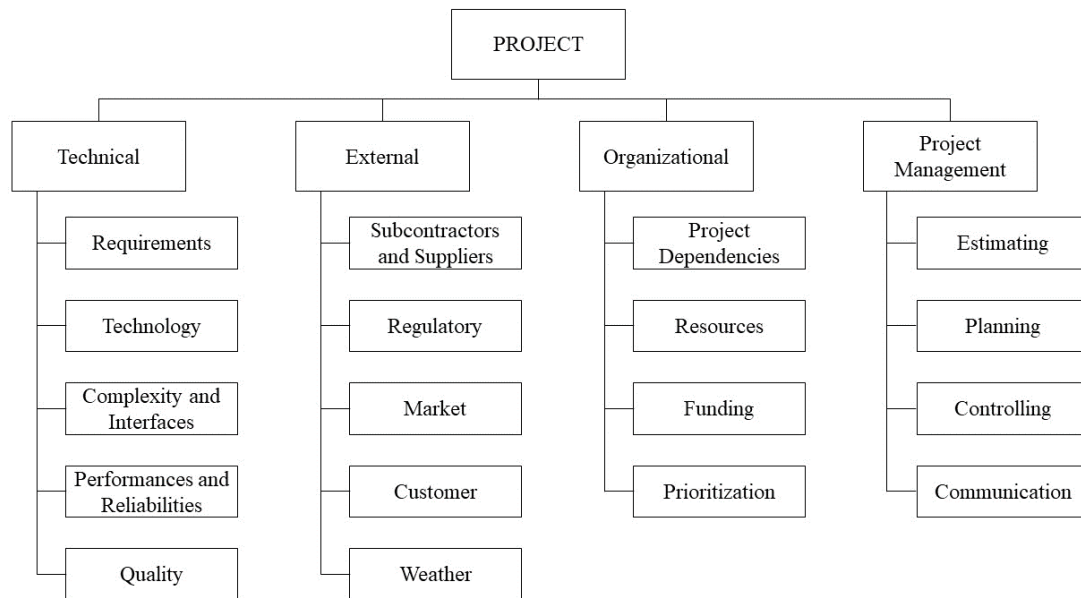


Figure 90 Typical example of the Risk Breakdown Structure

18.3 Risks and opportunities typical of the Construction phase

When the function “execution” is involved in the risk management, the areas in which risks are investigated/ identified are normally the following:

- Subcontractors: usually, the risks relate, among the others, to the following aspects of the portion of the activities which have been subcontracted:
 - capability
 - suitability
 - financial solidity
 - productivity
 - performances.

- Execution strategy: this area is wide and can easily overlap with other disciplines/ items/ areas of risks presented in this list. It basically aims at collecting all the risks deriving from the process explained in Chapter 5, and includes, among the others:
 - Subcontracting scheme
 - Prefabrication/ pre-casting possibilities
 - Influence of the weather on the activities’ execution
 - Material control
 - Modularized vs stick-built approaches
 - Work front management
 - Supervision
 - Management tools.

- Construction manpower, inclusive but not limited to:
 - availability of manpower by trades (considering Project’s timing)

- local content requirements
- utilization of foreign workers limitations / process needs
- presence of labor unions and/ or other organizations.

- Site logistics and area/ facilities availability; among the others:
 - area availability vs estimated needs
 - storage facilities available/ to be installed
 - utilities availability
 - site congestion
 - local administrative procedures.

- Testing/ Pre-commissioning/ commissioning, inclusive of:
 - execution strategy
 - subcontractors experience
 - specific process requirements
 - limit of responsibilities
 - Client personnel availability / expertise
 - critical tie-ins
 - spare parts & consumables
 - local content requirements.

In addition to the list above, which are threats correlated to the Construction phase and with implication in the same period, it is worth to repeat that there is a considerable number of topics/ threats/ issues pertaining to the other functions/ phases of the Project and that may become a risk during the Construction phase (or may have severe impacts during the same).

Some of them may be easier to identify or include in the Risk Management (delayed Engineering deliverables, lack of inspection during Procurement phase, wrong material transportation plan, etc.) but others could appear less evident but equally impacting if not properly and timely tackled, such as:

- permitting/ critical applications to Authorities plan
- custom duties clearance
- engagement of local communities
- local certifications
- security requirements
- concurrent projects
- IT architecture/ performance.

The above list is not exhaustive and each of the proposed topics, depending on the peculiarities of a Project, may become a way to a lethal threat, if disregarded or a boosting opportunity if properly controlled.

The basic concept to be taken in mind is that Construction is where the majority of risks tend to become true and the way they have been managed – in terms of care and timing – influences the success of the entire Project.



ANIMP is the Italian Association of Industrial Plant. Established in 1974, ANIMP is the “meeting center” where Engineering Companies, Manufacturers of Plant Components and Universities may develop innovations and share common experiences to foster the construction of reliable and efficient industrial plants.

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