

King Fahad University of Petroleum and Minerals

College of Environmental Design

Construction Engineering & Management

MASTER OF ENGINEERING REPORT

(CEM-600)

**Design and Construction of Pipelines in
Saudi Aramco**

For

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REPORT ABSTRACT

NAME OF THE STUDENT : MURAISEN MUBARAK AL-HAJRI
TITLE OF THE STUDY : DESIGN AND CONSTRUCTION OF
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The Kingdom of Saudi Arabia is endowed with two major fossil fuel sources, crude oil and natural gas. Saudi Aramco owns and operates an extensive network of refining and distribution facilities. Connecting these facilities are pipelines that differ in sizes. Building a new pipeline is a project that is handled by Pipeline Project Department. Pipeline Project Department is responsible for the design, material procurement and construction of all onshore pipeline projects including cross-country pipelines.

The design and construction pipeline projects in Saudi Aramco are executed through seven phases. The phases are: study and development phase, preliminary engineering phase, funding phase, detailed engineering phase, procurement phase, construction phase and start up phase. The report describes these phases and attempts to identify some of associated problems and proposed solutions.

CHAPTER ONE

INTRODUCTION

The Kingdom of Saudi Arabia is endowed with two major fossil fuel sources, crude oil and natural gas. In this country, Saudi Aramco owns and operates an extensive network of refining and distribution facilities, and is responsible for the gas processing and transportation installations that fuel Saudi Arabia's industrial sector.



Figure 1: Oil and Gas Fields in Saudi Arabia

Saudi Aramco's oil operations encompass the Kingdom of Saudi Arabia, including territorial waters in the Arabian Gulf and the Red Sea totaling more than 1.5 million square kilometers. Saudi Aramco manages oil reserves that exceed 259 billion barrels, about a quarter of the world's total oil reserves. In Figure 1, dark blue areas represent oil fields; Green areas represent gas fields.

Saudi Aramco is recognized for its expertise in transporting of hydrocarbons, while simultaneously being environmentally conscious and a safety and loss prevention practitioner. Punctual product movements between supply and distribution facilities are executed through an elaborate delivery system which encompasses an area of around 2 million square kilometers - constituting the area of Saudi Arabia. Pipelines, marine crude oil tankers, product carriers and hauling trucks, the main components of this delivery system, are operated and maintained by a highly qualified workforce and adhere to the highest industry standards to ensure optimized operational levels.

The pipeline network totals some 20,000 kilometers in length, including links with new oil fields in central and southeast Saudi Arabia. Major pipelines are the Trans-Arabian Pipe Line (Tapline), the Saudi Arabian-Bahrain Pipeline and the East-West Crude Oil and Natural Gas Liquids (NGL) pipelines to Yanbu' on the West Coast. The 1,170 kilometers long NGL pipeline linking Yanbu' and Shedgum is the longest and most advanced gas line ever built (1).

Realizing the importance of pipelines, in this report intends to identify some of the major problems associated with the pipeline design and construction, and to propose solutions.

This report consists of three chapters. Chapter one is an introduction to the report. It gives a background on ARAMCO, and explains the objective of the report. Chapter two provides an introduction on Pipeline Project Department, the phases of design and construction of a project. Chapter Two then presents each phase with appropriate details. Chapter Two provides as well the interfacing Departments in a Project and their roles.

Chapter Three discusses the methodology of collecting the data in this report and type of questions used in the report.

Chapter Four of this report presents the problems in the design and contraction that Project Management Team faces and the proposed solutions for such problems. The report ends with Chapter Five, which summarizes the report and suggests recommendations.

CHAPTER TWO

THE DESIGN AND CONSTRUCTION PROCESS

2.0 PIPELINE PROJECTS DEPARTMENT

The pipeline network in Saudi Aramco expands every year. To construct a new pipeline is a project and it is handled by Pipeline Project Department (PPD). Pipeline Project Department is responsible for the design, material procurement and construction of all onshore pipeline projects including cross-country pipelines and maintains potential projects. The projects managed by this department include new, replacement and modified crude and gas pipelines and all onshore flow lines.

Although Pipeline Project Department was initially formed to handle primarily pipeline projects, projects managed by Pipeline Project Department now include Gas Oil Separation Plants (GOSPs), water injection, sea water supply, and Khuff Gas facilities. While the focus of much of the department's project activities is in Southern Area, PPD is also responsible for the design and construction of oil and gas and related infrastructure projects in the Central and western Arabian region.

Pipeline Project Department is a department within the Project Management administrative area of the Engineering & Operations Services business line (2), as shown in Figure 2.

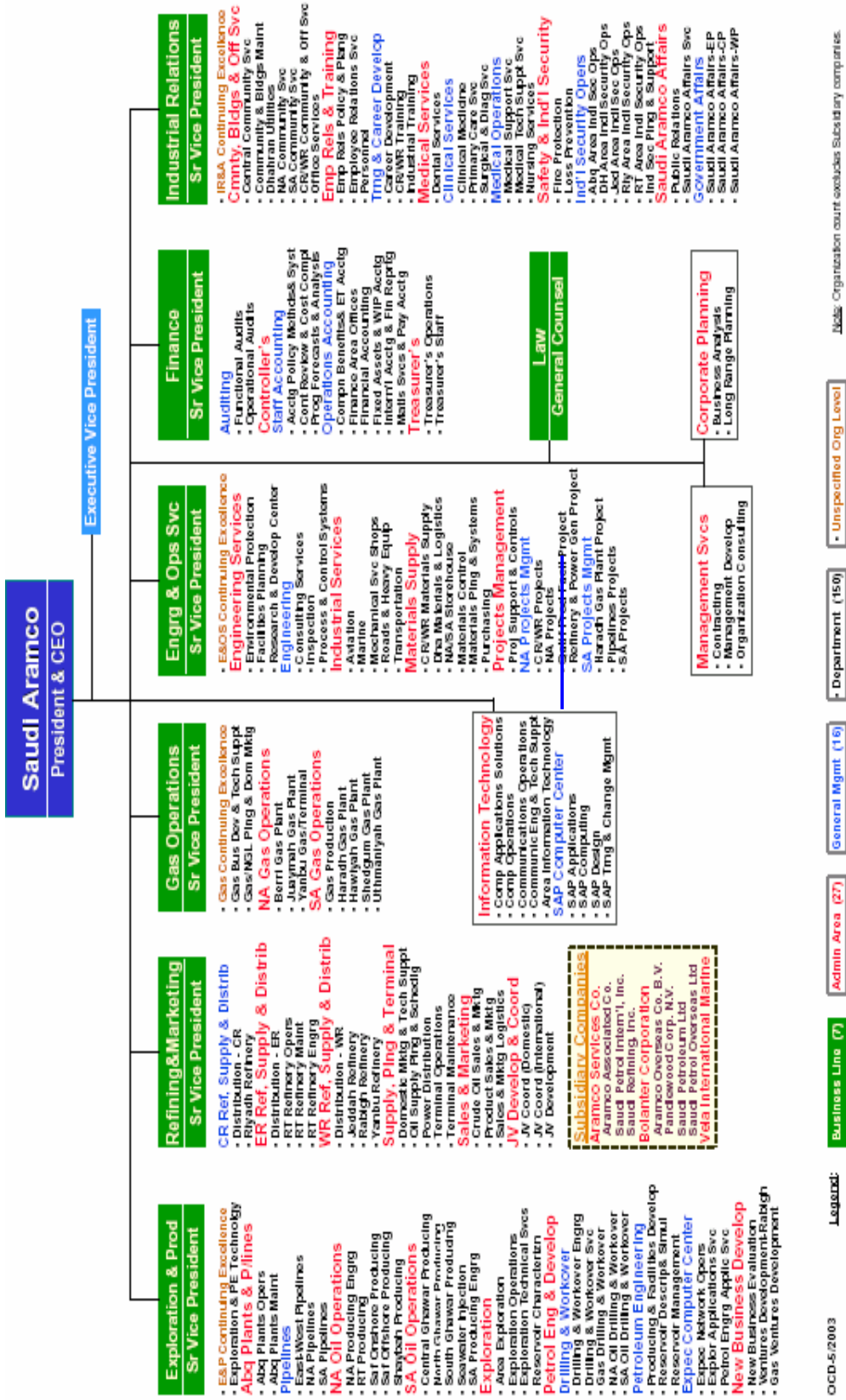


Figure 2: Pipeline Project Department current organization

Legend: Business Line (7) Admin Area (27) General Mgmt (16) Department (150) Unspecified Org Level

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Note: Organization chart excludes Subsidiary companies.

The design and construction pipeline projects in Saudi Aramco go through seven phases, which are:

1. Study and Development Phase
2. Preliminary Engineering
3. Project Proposal to Expenditure Request Approval (ERA)
4. Detailed Engineering
5. Procurement
6. Construction
7. Start up

Figure 3 below illustrates the above mentioned phases.

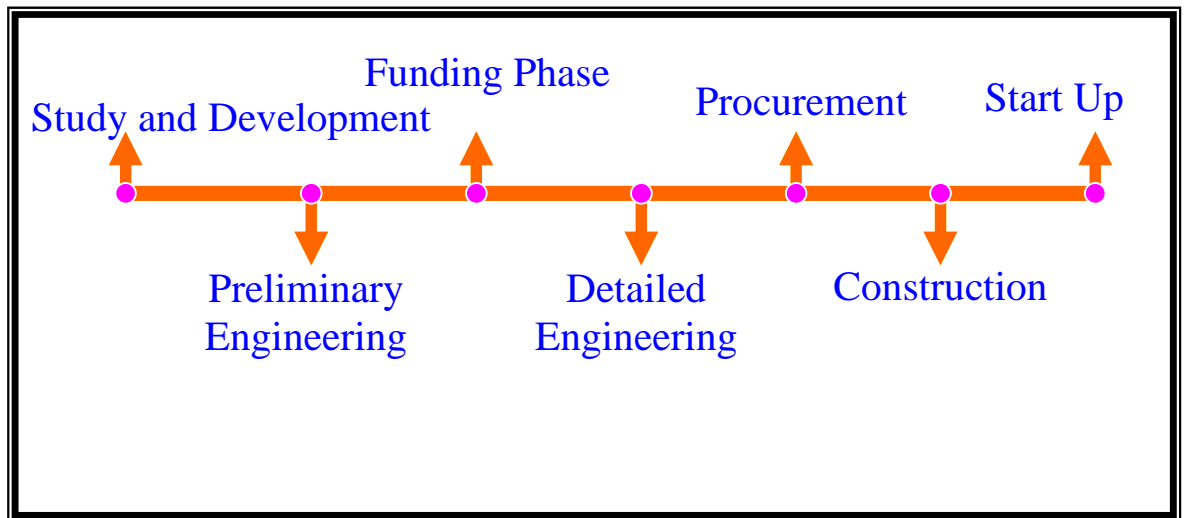


Figure 3: The phases of a pipeline project.

2.1 PHASE I – STUDY & DEVELOPMENT:

The study & development phase of any pipeline project goes through stages, as illustrated in Figure 4, where the outcomes of this phase are:

- Prepare the Business Plan.
- Develop the Planning Brief.
- Produce the Capital Program / Budget Item (BI)
- Develop the Engineering Study Program.
- Develop the Design Basis Scoping Paper (DBSP).

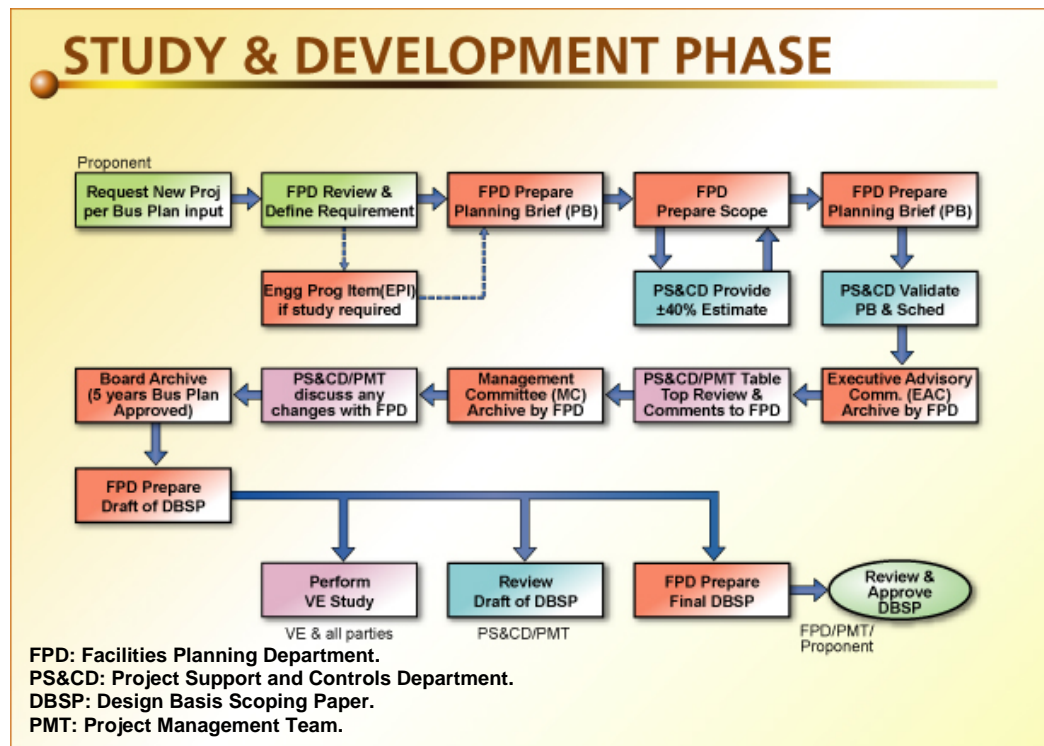


Figure 4: Steps of Study & Development phase.

One of Facilities Planning Department roles is to develop and maintain the Capital Program for Saudi Aramco five-year Business Plans. The Capital Program is a list of projects established to accomplish the Business Line objectives in the five-year Business Plan period.

At the end of November, Facilities Planning Department requests Business Line coordinators, green boxes in Figure 2 represent the seven Business Lines, to submit new projects for inclusion in the Capital Program. Business Line coordinators consolidate inputs from each department in their Business Line identifying potential new projects. These projects will vary in their justifications; i.e. some are justified based on crude Maximum Sustained Capacity, gas production, economics (reliability), safety or other justifications.

Approximately four months prior to the Board's review of the Spring Business Plan, Business Line coordinators submit their new projects to Facilities Planning Department to include in the Capital Program based on guidelines and instructions issued by Corporate Planning. The Business Plan is reviewed by the Executive Advisory Committee, then by Management Committee and finally approved by Saudi Aramco's Board of Directors.

Facilities Planning Department uses the input data received from Business Line coordinators to define the preliminary scope of the new projects. Within one week, Facilities Planning Department submits the scope of new proposed projects for cost estimating to Project Support and Controls Department. Two weeks later, Project Support and Controls Department produces (+/- 40%) cost estimates for all the projects within the Business Plan. Facilities Planning Department then enters the cost estimates as well as project execution schedules in the Capital Program database. Continuous discussions take place between Facilities

Planning Department and representatives from all seven Business Lines regarding the cost, schedule, and justification of the newly proposed projects.

Facilities Planning Department then archives the Capital Program database for the Executive Advisory Committee review, which will take place approximately three weeks later. During this period, Facilities Planning Department further screens the new projects, ranks them among the other projects already in the Business Plan, and generates Planning Briefs for new projects. Planning Briefs give a brief description of the scope and the schedule requirements and are required for all projects included in the five-year Business Plan.

As soon as the Business Plan is archived for the Executive Advisory Committee review, Project Support and Controls Department in conjunction with Facilities Planning Department issues the master scheduling system (MSS) report for the projects in the Business Plan for review at the Table Top meeting. Simultaneously, Facilities Planning Department issues the Planning Briefs to Project Management. At this meeting, Project Management Team and Project Support and Controls Department discuss their comments/problems with the schedule of each project with Facilities Planning Department for further follow up with the Business Line coordinators. This meeting will also validate the planning brief and the schedule.

After the Executive Advisory Committee review, the Capital Program is revised to reflect Executive Advisory Committee changes. Then Facilities Planning Department archives again for the Management Committee review. Project Management Team and Project Support and Controls Department discuss any changes with Facilities Planning Department. Also, the changes from Management Committee are archived for the Board of Directors' review and

approval. After the approval of the Spring Business Plan in May, the Business Plan is then updated, following a similar planning process, to be reviewed by the Board in November. This process is called the Business Plan Fall Update. In this review, the Board approves the Business Plan and the annual Capital Budget, which is a list of projects to be funded in the first year of the Business Plan. The Budget Briefs of these projects are presented to the Board for approval (4).

Based on the Planning brief and the project requirements, Facilities Planning Department develops the Design Basis Scoping Paper for the project following the approval of the Capital Budget by the board of directors. Project management team, Proponent, Environment Department usually work very closely with Facilities Planning Department to ensure that the Design Basis Scoping Paper covers their basic requirements of the facility.

The Design Basis Scoping Paper defines “what” is to be built and reflects sizing parameters, design conditions and other special operational considerations. With the Design Basis Scoping Paper as a basis, the “how” to build is developed during the project-proposal phase, handled by Project Management Team. The objective of the Design Basis Scoping Paper is to establish the major design basis, while still permitting the optimization of facility design during project proposal development (5).

After the Design Basis Scoping Paper is developed, it is reviewed by Project Support and Controls Department to check the estimate and the schedule, and it is reviewed and approved by the proponent and Project Management Team.

This is the point of time when the project is turned to Project Management Team and the second phase starts.

2.2 PHASE II – PRELIMINARY ENGINEERING:

The second phase is the development of preliminary engineering, as displayed in Figure 5, which includes:

- Draft Project Execution Plan (PEP).
- Prepare Master Contracting Plan.
- Prepare Project Proposal (PP).
- Produce detailed Expenditure Request (ER).
- Prepare Contract for Detailed Engineering/Construction.

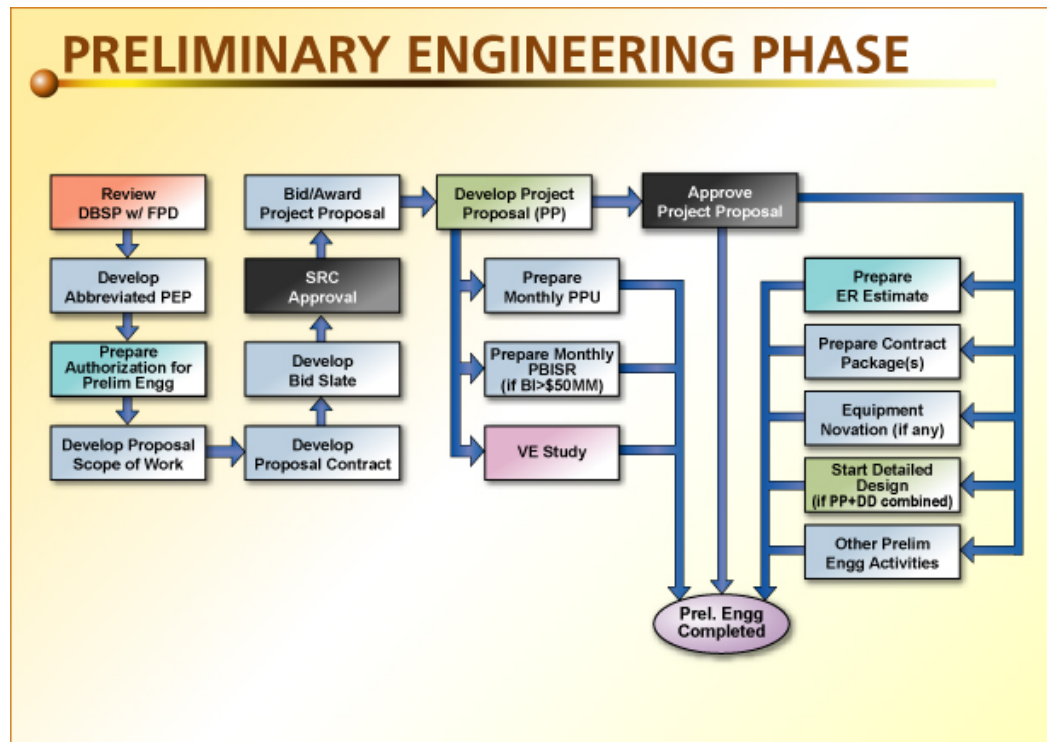


Figure 5: Steps of the Preliminary Engineering Phase

In this phase Project Management Team prepares abbreviated Project Execution Plan which basically states how the project is going to be executed in terms of preliminary engineering, detail design and construction, whether the project can be handled in-kingdom or out of kingdom, whether the project will be handled as one package or more than one. All of this is determined based on the nature of the project and cost/schedule requirements. The Project Execution Plan is approved by executive management of the proponent and Project Management Team. This will secure TC-68 funding. TC-68 Funds are Funds allotted to project management personnel only for the execution of preliminary engineering to develop project proposal scope of work and contract. This funding is usually 5% to 10% of the project cost, and is determined in the Study and Development Phase, based on the nature of the project, and how and where the preliminary engineering to be done (6).

Project Management Team executes a service order to an approved design contractor to prepare the Project Proposal. The purpose of the project proposal is to define exactly the scope of the project in terms of location, capacity, process, equipments needed.... etc. in order to prepare a reasonably accurate Expenditure Request estimate of the actual cost of the project. This will enable management to decide whether to proceed with the project or not. Project Management Team and General Engineering Service Unit, one of the Project Support and Controls Department units, develop the Bid slate. The bid slate is a list of General Engineering Service contractors which Project Management Team and General Engineering Service Unit agree on to invite to bid for doing the project proposal. The Bid slate is taken to Service Review Committee for approval. In the following situations:

- Any Sole Source Service Authorization anticipated exceeding \$2 Million. Also In instances where the estimated value established at the initial procurement was under \$2 Million, but the final contractor's commercial proposal after negotiations exceeds that limit.
- Any service authorization whose value has revised total value exceeding \$2 million shall be promptly reported to the Service Review Committee as an information item.

After the approval of the Service Review Committee, Project Management Team invites the General Engineering Service contractors to submit their bids on the project proposal. Bidders are required to submit proposals of sufficient detail to prepare a $\pm 10\%$ accuracy expenditure request estimate, provide sufficient technical information for proponent review and (where applicable) provide sufficient information to obtain Lump Sum Turn Key (LSTK) or detailed engineering contract bids. General Engineering Service Unit and Contract Review and Cost compliance Department representatives will open the bid box and the lowest cost contractor is selected to do the project proposal. Project Management Team will direct and monitor the design contractor in this stage (7).

If the value of the project exceeds \$50 million, Project Management Team initiates a formal value engineering study. The value engineering study is coordinated with the Value Engineering Unit of the Project Support and Controls Department.

Project Management Team works with Contracting Department representative to develop the construction contract, bid slate, and the bid

review program. The Contracting Department representative sends the contract to the Law Department and Contract Review and Cost compliance Department (CR & CCD) for their review.

The Project Management Team and Contracting Department representative will agree on the construction contractors who will be in the bid slate. Also, they would prepare the bid review program that will identify the best contractor by:

1. Reviewing and evaluating of Technical Proposal
2. Reviewing and evaluating of Commercial Proposal

The purpose of the technical evaluation is to determine whether the bidders understand the specific scope of work and whether their proposals meet the requirement of the scope of work. The technical evaluation should reveal cases where an otherwise capable contractor has failed to plan the use of its resources so as to satisfactorily accomplish the work. The purpose of the commercial evaluation is to identify the bid representing the lowest overall cost to SAUDI ARAMCO. Contract awarding will be explained in section 2.4, detail engineering phase (8).

2.3 PHASE III – FUNDING PHASE:

The third phase of a project cycle which, as displayed in Figure 6, includes:

- Expenditure Request Estimate summary Preparation.
- Executive Management Review.
- Management Committee Review.
- Executive Management (EXCOM) Approval of ER.

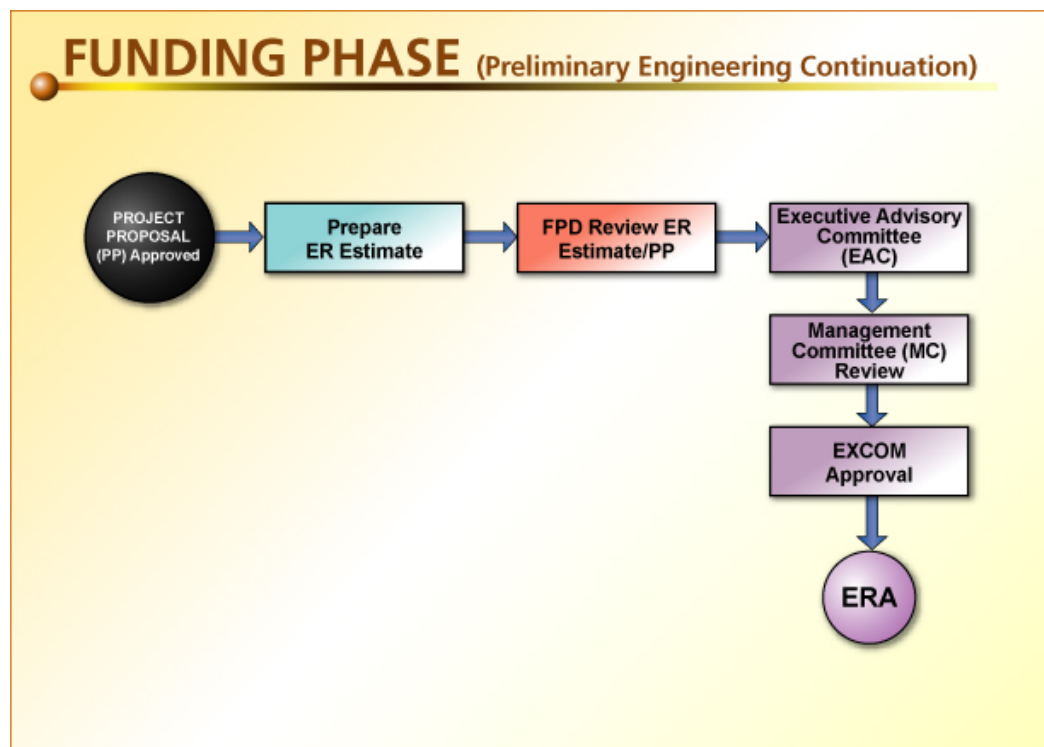


Figure 6: Steps of the funding phase.

After the Expenditure Request estimate is prepared, Project Management Team and Project Support and Controls Department will prepare what is called a 56D estimate, which is really a summary of the Expenditure Request estimate and the project management costs.

The 56D estimate summary is reviewed by Facilities Planning Department. After the Facilities Planning Department's review, the estimate is forwarded to executive management for approval. The executive management may take any of the following decisions, other than approval:

- Cancellation: A proposal to cancel an approved project requires an ER.
- Deferral: Project deferred to next executive management meeting.
- Redefinition: When the total proposed scope changes, additions and deletions considered separately.

Once the Expenditure Request Approval is secured then the project is approved and the project can move to the next phases (9).

2.4 PHASE IV – DETAILED ENGINEERING:

The fourth phase is detailed engineering which, as displayed figure 7, Includes:

- Prepare Design Drawing / Specs.
- Prepare Material Procurement.
- Procure Aramco Material / Direct Charge (DC).
- Prepare Construction Bid Packages.

The objective of detailed engineering is to develop project drawings and specifications, initiate material procurement and prepare construction bid packages.

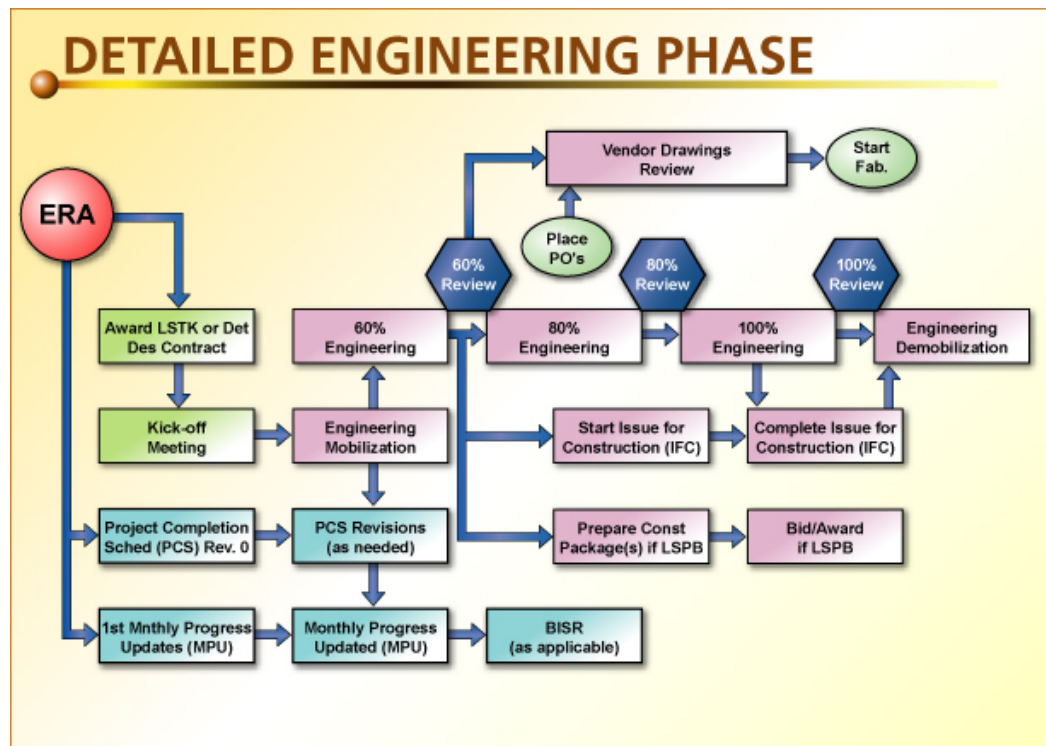


Figure 7: Steps of Detailed Engineering Phase.

Upon Expenditure Request Approved (ERA), the Contracting Department representative issues a letter to invite the approved contractors in the bid slate to a clarification meeting in which the scope of the project will be explained. A site visit may be conducted. The contractors get a copy of the bid package to bid on. Each contractor will submit a technical and a commercial bid.

The technical bid will contain the technical and management aspects of the work, and may include the following, depending on the contract:

- The contractor's proposed organization.
- Resumes of key personnel.
- Functional execution plan (work plan).
- Work schedule, including mobilization and demobilization.
- Manpower plan
- Equipment schedule.
- Safety and Loss Prevention program.
- Quality Assurance program.
- Equipment Rental.
- Subcontract Plan.
- Experience in similar Projects.
- Contractor's material procurement capabilities.

The commercial bid will be based on:

- The lump sum price for doing the scope of work.
- Hypothetical Change Order Quantities and applying them to the bidder's proposed Change Order rates.

The technical bid will be opened first by the Technical Review Team, which consists of:

1. The Project Management Team.
2. The Contracting Department.

The Technical Review Team evaluates the technical proposals against pre-established scoring criteria. Each element of the technical proposal is rated against a scale with an agreed pass score. The overall passing score is 70% of the total points. Any bidder which does not achieve this passing score will be recommended by the Review Team to be disqualified.

After the technical evaluation, the commercial bid will be opened by the Commercial Review Team, which consists of:

1. The Project Management Team.
2. The Contract Review and Cost compliance Department.
3. The Contracting Department.

The Commercial Review Team will open the commercial proposals of those bidders whose Technical proposals have been approved. List the contractors in accordance to their:

1. The lump sum price.
2. Hypothetical change order cost
3. Total of 1 and 2 above.

The lowest of the Total cost will be ranked with number 1 and will be awarded the contract (8).

Detailed engineering starts after the contract is awarded. Depending on the kind of contract, the detailed engineering will be done by the construction contractor or not. In Lump Sum Turn Key type contracts, engineering, procurement, and construction are covered by the same contract. The contractor is responsible for the design, procurement and the construction of the facility. Issued for Construction package is developed for the procurement and construction if the contract is a Lump sum Procure build contract.

The Project Management Team invites the involved department to attend a kick off meeting. In the meeting the contractor meets the department's representatives as they address their requirements.

During the development of the design, several reviews take place especially at 60% and 90% design completion stages. During this time, several Saudi Aramco organizations are involved in the reviews like Project Management Team, Proponent, Consulting Service Department, Loss Prevention Department, Environmental Protection Department, and Inspection Department.

Each involved department reviews the 60% detailed design packages to make sure that designed facility meets Saudi Aramco standards and requirement, and make the necessary comments for compliance. The comments will be incorporated in the next package. The same process is repeated in the 90% and 100% detail design stages.

Also, a project completion schedule is put together to forecast incremental monthly progress per engineering, procurement and construction.

As the job progresses, monthly reports are prepared by the contractor to reflect actual versus planned progress through monthly project updates reviewed by Project Management Team.

At the end, 100% detail engineering package is approved by Project Management Team and the Proponent. Then it is submitted to the Saudi Aramco drawing management system, which is drawing database for all the company drawings.

2.5 PHASE V – PROCUREMENT:

The fifth phase is material procurement which, as displayed in Figure 8 includes:

- Long Lead Time Material / Equipment.
- Other Material / Equipment.
- Direct Charge Surplus Material / Equipment.
- Saudi Aramco Materials System Specs (SAMSS).

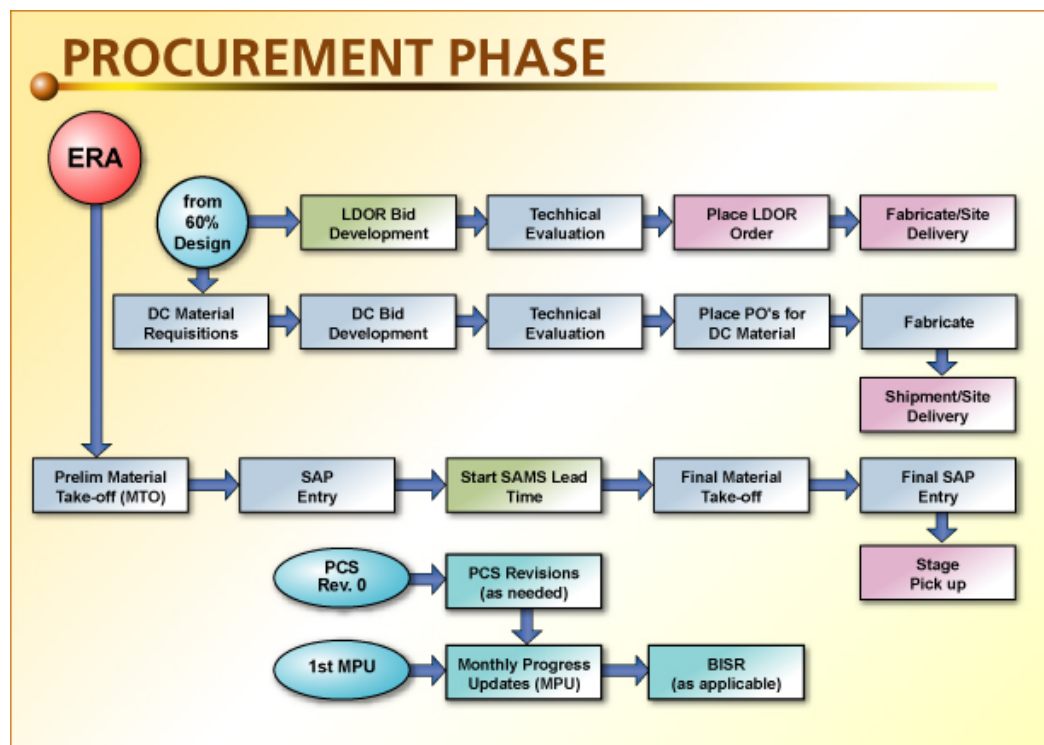


Figure 8: Steps of Procurement Phase.

Material procurement is started along with the development of detailed engineering. Usually At the 60% stage of the detailed engineering, all equipment specifications are complete. Materials are supplied either by Saudi Aramco or by the contractor. For contractor supplied material it will be scheduled and reviewed by Project Management Team and Vendor Inspection Division.

Materials are procured through placement of:

- Direct Charge Purchase orders
- Local Deliver Order Request orders
- Orders from Saudi Aramco Material System.

In Direct Charge material, requisitions are usually developed for long lead items by the contractor and reviewed by Project Management Team and vendor inspection division for approval. After that the contractor can place the order (10).

Local Deliver Order Requests are material available and stored at local vendors and have Saudi Aramco Stock numbers.

The procurement involves bid development, technical reviews, and placement of orders, fabrication and delivery. The contractor will source the material, place and expedite orders. Doing this is very critical because any delay could affect the construction schedule significantly. Project Management Team will monitor the procurement process.

2.6 PHASE VI – CONSTRUCTION:

The sixth phase is Construction which, as displayed in Figure 9, Includes:

- Contract Award (if Lump Sum Procure Build Contract).
- Mobilization.
- Start Construction.
- Progress Monitoring.
- Pre-commissioning.
- Mechanical Completion.

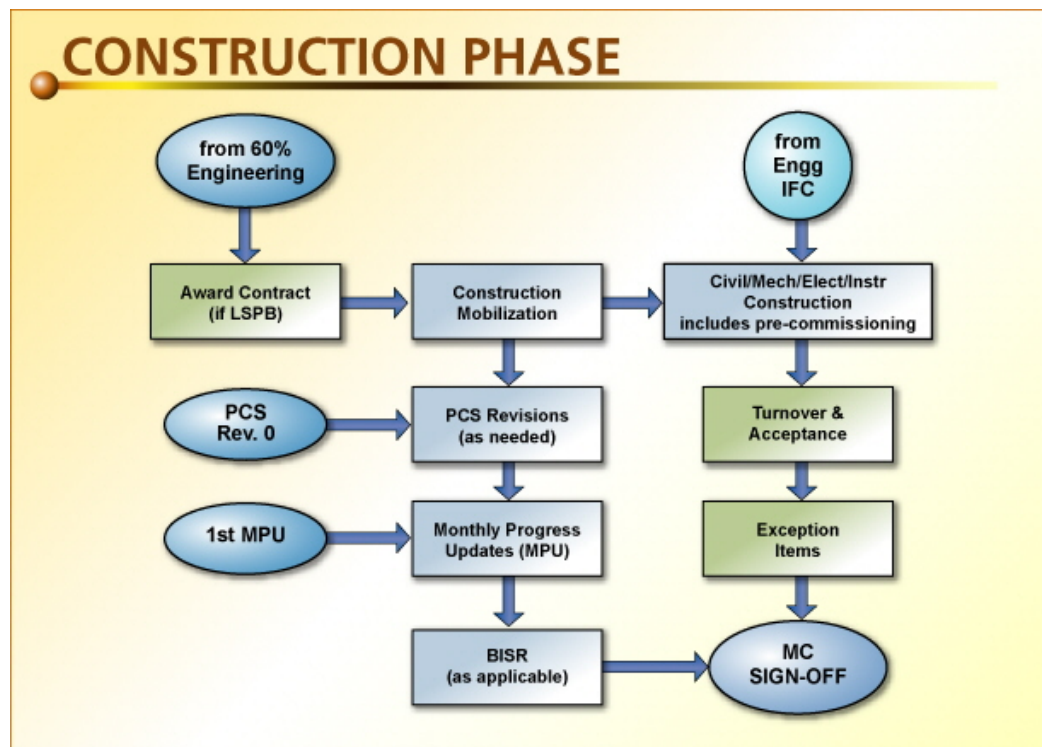


Figure 9: Steps of Mobilization Phase.

The construction phase begins with a contract award to a construction contractor. This was discussed in Phase IV, Detailed Engineering. Subsequently, the contractor mobilizes his personnel and equipment and sets offices and camps to support the project.

Like engineering, this phase involves a lot of monitoring and reporting of the progress. Inspection Department, Loss Prevention, and the proponent work with Project Management Team in monitoring the project.

The proponent establishes the Acceptance Committee and appoints its chairman as soon as construction starts but no later than the 60% stage of actual construction completion. At the first formal meeting of the Acceptance Committee, the Acceptance Committee members, the Project Management Team, Inspection Department, Loss Prevention, and the proponent designate their representatives.

Project Management Team advises the Proponent when the construction stage reaches 60% and request a formal kick-off meeting of the Acceptance Committee to agree on the Punch List system and procedures to be implemented. Project Management Team will request the Acceptance Committee to commence system Punch listing when all major components of a system have been installed and pre-commissioned and Project Management Team has verified that the system is ready for Punch listing. Normally, all Acceptance Committee representatives submit their system punch listing to the Project Management Team within one week of this request.

Four weeks prior to the scheduled Mechanical Completion date, Project Management Team notifies the Acceptance Committee that the facility is complete with the exception of the items on the Master Construction Punch list and ready for MC inspection. At the next Acceptance Committee Meeting, each member of the Acceptance Committee is provided with a list of all outstanding system punch list items with the originator's Yes/No recommendation for each item.

1. Yes item: meaning the item may impact the safe commissioning, start up, and operation of the facility.
2. No item: meaning this item will not impact the safe commissioning, start up, and operation of the facility.

Within three working days of receiving the above notification, the Acceptance Committee Chairman schedules and completes the Mechanical Completion Inspection, which is normally a thorough review of the outstanding system punch list items and an inspection of site conditions.

No later than two days after the Mechanical Completion Inspection, the Acceptance Committee Chairman convenes a meeting of the Acceptance Committee at which time the members will submit any additional exception items relating to incomplete work or other proposed Exception Items arising from the Mechanical Completion inspection. During this meeting, the Acceptance Committee Chairman reviews the members' recommendations of "Yes" and "No" items. Project Management Team will be responsible for preparing the Consolidated Exception Item List for action. Any disputes regarding critical safety items must be resolved prior to the signature of the Mechanical Completion Certificate.

Once the Mechanical Completion Certificate Exception Item List is established, deleting an item from the Exception Item List or changing a "Yes" item to "No" requires the approval of the Acceptance Committee Chairman. The Acceptance Committee and/or their nominees review, on an on-going basis, the Mechanical Completion Certificate Exception Item List to ensure that all "Yes" items that would limit the safe operation of the facility have been completed and signed off.

Project Management Team will notify the Acceptance Committee Chairman, when all of the assigned "Yes" items have been completed and signed off by the originators. Within three working days of receiving this notification, the Acceptance Committee Chairman arranges for an Acceptance Committee meeting to instruct the Project Management Team to route the form with attachment for signature. When all other signatures are obtained, the Project Management Team presents the Mechanical Completion Certificate and attachments to the Acceptance Committee Chairman to obtain the signature of the Proponents representative prior to distribution of the original approved Mechanical Completion Certificate.

The Mechanical Completion Certificate sign off signifies custody acceptance of the facility by the Proponent. After this turnover, routine facility maintenance becomes the Proponent's responsibility. The remaining work to clear "No" Exception Items by Project Management and the contractor can only be accomplished upon issuance of Work Permits by the Proponent.

After Mechanical Completion, Project Management Team is responsible for providing an agreed number of contractor and vendor commissioning and start-up assistance personnel. These personnel are released as soon as possible after the start-up of the facility (11).

2.7 PHASE VII – STARTUP:

The last phase of the Project is the start-up of the facility, which, as displayed in Figure 10, includes:

- Performance Acceptance.
- Site Final Accept Tests.
- System Handover.
- Complete Exception Item Lists.
- Financial Close-out.

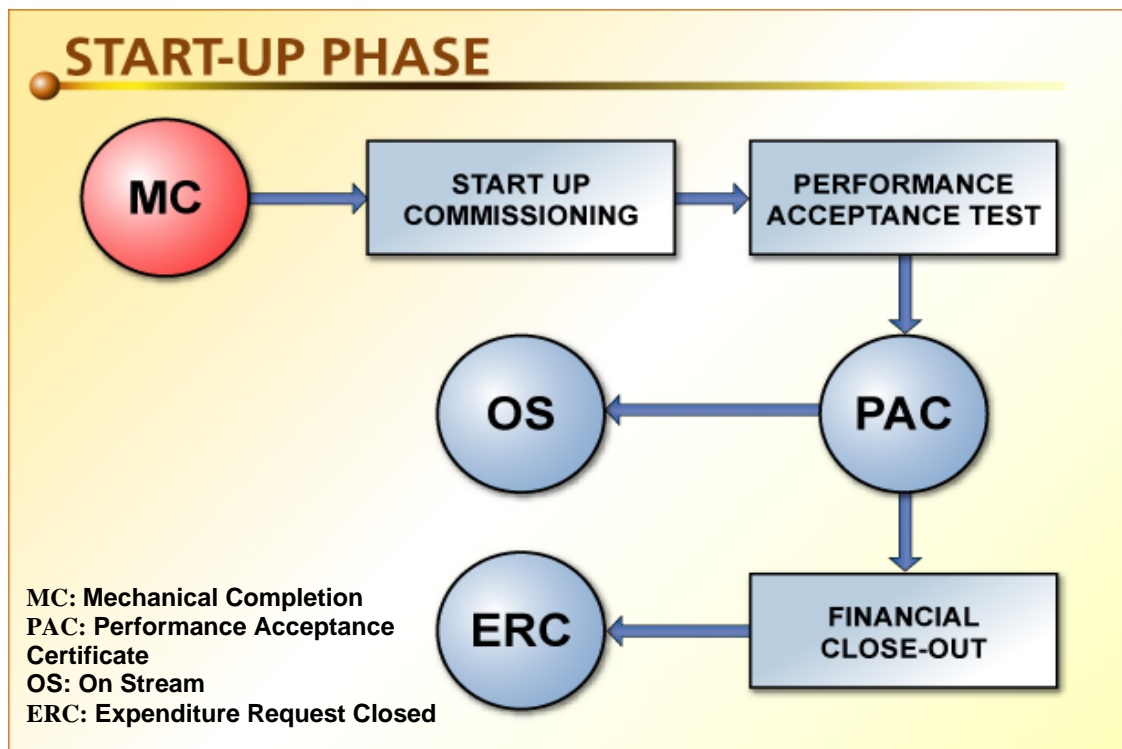


Figure 10: Steps of the Start Up Phase.

Upon approval of the Mechanical Completion Certificate, commissioning and start-up begin. The proponent organization is responsible for these activities with the Project Management Team providing assistance. The Project Management Team, in conjunction with the proponent, is responsible for developing commissioning plans and the proponent is responsible for the development and execution of facility start-up and performance test plans and procedures. The acceptance of the Mechanical Completion Certificate represents the beginning of the commissioning, start-up and initial operating period during which the facility performance should be demonstrated to be in accordance with the approved project scope. The performance period is sixty days after the Mechanical Completion Certificate is signed. During the performance acceptance period the proponent reviews facility performance, relative to operating conditions, in accordance with the approved project scope and prepares a list of performance-related items requiring corrective actions if the facility is not up to performance.

The agreed Performance Acceptance Certificate deficiency items will form the basis of the PAC deficiency item list, which will be attached to the PAC at the time of signing.

A Performance Acceptance Certificate is prepared by the Project Management Team for each facility after the final Mechanical Completion Certificate for the facility has been signed. After the PAC is signed, the facility is put on stream (11).

The Fixed Assets and Work-in-Progress (FAWIP) Accounting

Department begins preparations for the closeout of all job orders associated with the facility upon acceptance of the Mechanical Completion Certificate. Project Management Team assists in the financial closeout of the project and maintains project records and files. At this stage the Expenditure Request is closed (12).

2.8 INTERFACING DEPARTMENTS IN A PROJECT

The Project Management Team relies on the cooperation of many other Saudi Aramco organizations for the successful execution of the project. These organizations have their own particular interests in either insuring the project compliance of the related policies, procedures and instructions, or in assisting the project management in the execution of related functions.

The following provides a summary of the most frequently involved organizations:

2.8.1 MATERIAL SUPPLY ORGANIZATION

Material supply organization is Saudi Aramco sole organization for planning, procuring, shipping, receiving, storing and issuing Saudi Aramco material. Its mission is to provide, through managing the supply chains, the right material and associated services to support maintenance, operations and project requirements at the right time and cost in support of the Company operations.

2.8.2 LOSS PREVENTION DEPARTMENT

The Loss Prevention Department is a service organization responsible for developing and monitoring company policies and procedures that aim to prevent accidents and minimize losses. Saudi Aramco believes that the responsibility for safety belongs with line organizations. This belief places

accountability with operating departments to ensure that safety is integrated into day-to-day operation.

2.8.3 INSPECTION DEPARTMENT

Inspection Department responsibilities in projects are to ensure compliance with the Company Engineering Standards. Inspection personnel work full or part time on project teams reviewing designs, purchase documents, contractor quality plans and assessing how effectively contractors implement their quality systems. The Project Management Team deals regularly with several inspection department divisions including:

- Vendor Inspection: for approval of material vendors (suppliers), resolution of vendor quality issues. Reviews at contractor design/procurement offices.
- Project Inspection: for all types of construction site inspections.
- Inspection Assessment Group: for reviews of construction contractor quality systems and follow-up actions resulting from these reviews.

2.8.4 CONTRACTING DEPARTMENT

The procurement role of the Contracting Department includes involvement in developing the contracting strategy, the contract itself, and the list of bidders, as well as coordinating all interaction with the bidders, controlling the submission and opening of bids, participation in technical and commercial evaluations , and preparing award recommendations and final contracts for signature.

The Contracting Department provides other services and control functions such as receiving and leading the resolution of contractor claims, processing contract amendments and change orders, and providing contract information services.

2.8.5 ENVIRONMENTAL PROTECTION DEPARTMENT

The mission of the Environmental Protection Department is to provide leadership on environmental issues to all areas of company operations. This will help in cost effectively reduce the risks to public health and the environment. Also, Environmental Protection Department monitors operation to assure that they are conducted in an environmentally responsible manner.

2.8.6 PROJECT SUPPORT AND CONTROLS DEPARTMENT

Project Support & Contract Department includes the following operating divisions:

2.8.6.1 Project Controls Division

Contains the scheduling, cost, and information technology groups. These groups provide oversight and support for Project Management Teams in fields pertaining to planning, scheduling, and cost.

2.8.6.2 Estimating Services Division

Provides a range of estimating and value engineering services to Project Management. These services range from early study estimates, to change order estimates.

2.8.6.3 Project Support services Division

Provides supplemental manpower services to project management via Construction Technical Services, Miscellaneous Technical Services contracts, and General Engineering Services contracts.

2.8.6.4 Surveying Services Division

Provides a full range of hydrographic, land, geodetic and photogrammetric surveying and mapping services.

2.8.6.5 Best Practices Team

Provides Project Management Team with strategies, techniques, methods or procedures that have been found to produce results of the highest value to an organization.

2.8.7 FACILITIES PLANNING DEPARTMENT

Facilities Planning Department provides advice, consultation, and leadership in the formulation and coordination of corporate investment plans and long term future business strategies to maximize the value of hydrocarbon

resources to the kingdom. The functions of Facilities Planning Department include:

- Developing alternatives for proposed capital project
- Conducting feasibility engineering studies with emphasis on technical and economic justification
- Preparing design basis Scoping Papers which are the basis for project proposals
- Reviewing project specifications with Project Management to insure economic design and conformance with Design Basis Scoping Paper
- Preparing Expenditure Requests to obtain project funding
- Field Management Queries covering a variety of areas including technical ,economic ,strategic and confidential subject.

2.8.8 FINANCE

There are several finance related departments which provide support or interface with the Project Management Team, including:

- Programs, Forecast & Analysis Department.
- Capital Programs, Forecast & Analysis Division.
- Fixed Assets & Work in Progress Accounting Department.
- Projects Accounting Division.
- Internal Auditing.
- Contract Review and Cost Compliance Department.

2.8.8.1 Programs, Forecast & Analysis Department

Programs, Forecast & Analysis Department is a staff organization within Finance which develops the framework for the Company's planning activities, critically reviews organizational expenditure, manpower, and capital submissions. This includes the cash flow implications of these submissions. Programs, Forecast & Analysis Department also provides Management with timely evaluations of progress versus those plans so Management may make informed business decisions.

2.8.8.2 Capital Programs, Forecast & Analysis Division

Capital Programs, Forecast & Analysis Division is responsible for providing counsel and financial advice on major investments made by the Company.

2.8.8.3 Fixed Assets & Work in Progress Accounting Department

This department is a service department within Operations Accounting. It is responsible for tracking, monitoring and analyzing expenditures pertaining to Corporate-wide projects in progress under approved capital, non-capital, exploration and development program and records capital assets into the Fixed Assets Accounting System. It is also responsible for analyzing financial data and verifies approval authority before recording changes resulting from retirements, disposals or transfers of assets and administers a periodic asset verification program (inventory) to insure the adequacy of safeguarding assets.

2.8.8.4 Projects Accounting Division

This division is responsible for major capital projects (greater than \$2 million) accounting, review, analysis, and entry of assets records into the Fixed Assets Accounting System. The Division is responsible for monitoring expenditures to make sure that expenditures do not exceed the approved funds and that projects are mechanically complete on the date stipulated in the Approved Expenditure Request or Project Change Request.

2.8.8.5 Internal Auditing

The Engineering & Project Management Audits Division (E&PMAD) provides audit/consulting services to its clients in the Engineering Services and Project Management Administrative Areas. Audits in the Project Management Administrative Area deal primarily with controls over the accumulation and reporting of Saudi Aramco's project costs to Executive Management. In addition, project engineering/construction costs and contractor invoices are reviewed for compliance with contract terms and the Company's Contracting Policies and Procedures.

2.8.8.6 Contract Review and Cost Compliance Department

Contract Review and Cost Compliance Department has the primary responsibility for the Finance functional review of contracts. In this capacity, Contract Review and Cost Compliance Department acts as a Financial Advisor for contract procurement and administration, within the limits mandated by the Executive Management and included in Saudi Aramco Contracting Manual. In addition, Contract Review and Cost Compliance

Department reviews all submittals to the Services Review Committee and prepares position papers for the Senior Vice President, of Finance.

With regard to contract procurement, Contract Review and Cost Compliance Department reviews the terms and conditions of pro forma contracts, works as a core member of Saudi Aramco Bid Review Team, in the following activities:

1. Evaluation/negotiation of commercial proposals,
2. Development of award recommendations, and
3. Performing the final price review.

After the contract award, the Department assists proponents in various aspects of the contract administration. This includes:

1. Change Order negotiation under lump sum contracts
2. Review and approval of Internal Administration Procedures
3. Review of invoices under General Engineering Services and other cost reimbursable contracts
4. Assistance to Project Management in administering Program Management Contracts, both in-Kingdom and Out-of-Kingdom
5. Review/negotiation and settlement of contractor claims
6. Preparing ad hoc reports to contract proponents from Contract Information Systems (2).

CHAPTER THREE

METHODOLOGY

3.0 METHODS OF COLLECTING DATA

The data in this report was collected by interviewing people working in the Pipeline Project Department. They are asked to identify the problems associated with the process and the solution to such problems. The project engineers in the Department were asked to provide their input either verbally or written depending on their place. The interviewers were asked two specific questions:

Q1: List major concerns that you face? And how to handle them?

Q2: List suggestions to improve the process?

The main problems and the suggested solutions for those problems are detailed in the Chapter Five.

CHAPTER FOUR

THE PROBLEMS AND SOLUTIONS

4.0 INTRODUCTION

Out of 47 project engineers in the Pipeline Project Department, 14 have participated in the interview. The participation percentage (30%) was reasonable though the project engineers were busy in their projects. The respondents identified the following problems:

1. Design drawings at 60% and 90% design are not reviewed well.
2. Vendor drawings and third party inspectors do not meet with Saudi Aramco Standards.
3. Contractors don't develop a resource loaded (manpower and equipment) Critical Path Method schedule on Primavera.
4. Delay of Work Permits, or not getting them on a timely basis from the Proponent.
5. Ensuring that the Contractor Quality Control personnel work independently from the construction personnel.
6. Major scope changes are made at 60% detail design by proponent support departments.
7. Interface with many other ongoing projects.
8. Dealing with different proponents for same project.

9. Lack of knowledge of contractors and experience in Electrical, Instrumentation and Communication work since, they represent much smaller part of the project.
10. In large pipeline sizes, fabrication and delivery of large size pipes, valves and fittings are an area of concerns.
11. Material availability at site during construction.
12. Start up procedures and activity plans have to be completed in advance.
13. Inadequate engineering site visits lead to design problems during actual construction.
14. Missed material can cause big delays.

This chapter will be divided into three sections. Each section will discuss the problems and, what phase may have this problem happen and the solution of the problems. Three problems and solutions will be discussed, the problems are:

- Review of detailed design.
- Material issues.
- Project has too many proponents.

4.1 REVIEW OF DETAIL DESIGN

As mentioned in Chapter Two, Section 2.4, the detail design is issued for review when the design completion at 60% and 90%. In this procedure, a copy of the detail design, for example, the 60% detail design, is sent to the proponent and other departments such as Loss Prevention, Consulting Services Department, Project Support, Construction Department etc.

People who are assigned to the design reviews do not have the spare time to perform good review against the Saudi Aramco standards and standard drawings. As a result there are a lot of errors on the approved Issued for Construction drawings that require clarification with Consulting Services Department during construction or require field design changes. This extra work during construction can be avoided if the design review process could be improved. Also, A Possible solution to this is to have a dedicated staff of people from these departments to form a team specifically to do the design reviews Also, when the proponent and support departments review the 60% detail design, they come up with major scope changes, which will have a cost and schedule impact. Agreeing on a specified scope at the early stages of the project and sticking to it can solve this.

4.2 MATERIAL ISSUES:

As mentioned in Chapter Two, Section 2.5, in the Procurement Phase, if the contract is Lump Sum Turn Key contract then the construction contractor will secure all material needed in the project. Sometimes this will lead to problems like:

- Materials availability
- Material not complying with Saudi Aramco standards

4.2.1 MATERIAL AVAILABILITY:

The Project sometimes needs special large pipeline sizes, the fabrication and delivery of large pipes, valves and fittings are areas of concern. These and other not off the shelf items will delay the project if not handled with care. Also, if any of these items are missed in the procurement phase or failed in working in the construction phase, a marginal time will be required to replace that material which will impact the schedule. A solution to this situation is that, in the detail design ensure sufficient engineering and details is done in the procurement documents. Also, advancing the procurement dates as early as possible will allow time to correct and re-order if necessary. Provide a detailed review and survey of all materials needs to ensure that all the materials are ordered and shipped on time.

The project management can also consult the proponent in the materials and have their input and advice of previous history of good and bad materials in previous projects.

4.2.2 MATERIAL NOT COMPLYING WITH ARAMCO STANDARDS:

Materials do not comply with Aramco standards happen when designers do not properly review the vendor drawings and specifications. Another reason for that, in Lump Sum Turn Key contract, the contractor will hire third party inspection to witness the inspection of fabricated items. The problem happens when third party inspection are not aware of the Saudi Aramco standards. Contractor will require a lot of field modifications to bring the equipment up to standards delaying the mechanical completion date.

The equipment arrives on site with too many violations to the standards, as a result of inadequate Aramco or Contractor Vendor inspection. The possible reasons for inadequate Contractor Vendor inspection are:

1. The contractor does not point out the items that are missed by Saudi Aramco Project Management Team because this could result in delays in delivery of the equipment, which the contractor will be blamed for, eventually, and might pay compensation for it.
2. The contractor uses a cheap vendor to get the maximum profit possible out of the project especially when the contract is a Lump Sum Turn Key.

The possible reasons for inadequate Saudi Aramco Vendor Inspection are inexperienced inspectors.

A possible solution is to have the design contractor prepare a check off sheet when reviewing the vendor drawings to ensure that the vendor drawings meet the design specifications and also the Saudi Aramco standards. As far as third party inspection, the Lump Sum Turn Key contractor (responsible for

inspection) should provide an inspection package to the third party inspection staff. This package should include copies of the relevant and applicable Saudi Aramco standards.

Also, provide experienced inspectors, request the contractor to follow up with the vendor during manufacturing of equipment in the factory so that the inspector can spot the violation(s) ahead of time for example the vendor inspector may pay a visit to the factory at 30%, 70% and 100% completion.

4.3 TOO MANY PROJECT PROPONENTS

In a project, each area has its own proponent. Like for example, if the project is a pipeline from a refinery to a bulk plant, the project scenario is the project has a proponent for the shipping facilities, a proponent for the pipeline itself and a proponent for the receiving facilities.

Having to deal with different proponents for the same project, or more and to secure their acceptance and satisfaction throughout the project and finally to get their final signatures of the important project document like the Mechanical Completion Certificates and the Performance Acceptance Certificates is not a simple task.

A solution for dealing with different proponents for some project could be that at the beginning of the project, the proponents assign a representative that can represent them on all sites, arrange the different tasks and procedures, and coordinate during testing and commissioning. This representative can have a small group, which the members come from different proponent areas to ensure that all issues and concerns are covered. This representative can help the project and the Project Management Team to

push the activities and the scheduled activities that require proponent interference and support. He also can correspond in a timely manner to the Project Management Team any concerns or problems that the proponent have and any issues done on one site he will ensure replications and preparation of the other sites for the same.

CHAPTER FIVE

SUMMARY AND RECOMMENDATIONS

In the report a brief introduction about Saudi Aramco was given. The report gives a background on the Pipeline Project Department position in the company and its role.

Also, the report include project phases are covered for a pipeline project starting from the study and development phase, then going through the preliminary engineering, funding, detailed engineering procurement, construction phases and ended up with the start up phase.

The Project Management Team interfacing with other departments in a project was discussed. The report also, focuses on these problems in pipeline projects and their solutions. The first problem talked about the review of the detailed design and the lot of errors on the issued for construction drawings dew to lack of review. The solution was to form a team from the concerned departments to be dedicated for the design reviews. The second problem was materials issues, which consists of materials availability and materials not complying with ARAMCO standards and the suggested solution for the materials availability was to advance the procurement dates as early as possible, provide a detailed review and survey of all materials. While the suggested solution for the materials not complying with ARAMCO standards was to provide experienced inspectors, and prepare a check off sheet, done by the contractor, to ensure that the vendor drawings meet the design specifications and also the Saudi Aramco standards. The last problem was

too many project proponents to a project and the suggested solution was to assign a representative by the proponents of the project that can represent them on all sites. This representative can have a small group, which the members come from different proponent areas to ensure that all issues and concerns are covered.

5.0 RECOMMENDATIONS FOR FUTURE STUDIES:

The following recommendations are provided for the future studies:

1. The study concentrated on the project engineers in pipeline project department. Further study can have input from other interfacing departments.
2. The report had problems from most of the seven phases, concentrating one phase and finding the problems and solutions might be efficient.
3. It is also recommended to use a multiple choice questionnaire rather than essay type, which was used in the report, but it will need to mention all type of problems that might occur in a project.
4. A study can be done on the problems that face the contractor in the phases of the project and the solution starting from the contractor point of view.

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