INTERN EXPERIENCE AT

BROWN & ROOT, INC.

AN INTERNSHIP REPORT

by

Stephen Edward Kibbee

Submitted to the College of Engineering
of Texas A&M University
in partial fulfillment of the requirement for the degree of

DOCTOR OF ENGINEERING

May 1979

Major Subject: Mechanical Engineering

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May 1979

ABSTRACT

To document that the objectives of the internship were met, the report examines the organizational approach at Brown & Root and then describes seven major job assignments that were completed by the author during the internship.

The internship report outlines the process by which Brown & Root carries out the design and construction of offshore oil and gas production facilities. The activities of business development, proposal preparation, conceptual engineering, and detailed engineering receive emphasis and are illustrated by examples of important categories of engineering drawings. The report also describes the composition and management of the task forces which carry out the engineering designs.

Seven of the author's assignments are described in detail and include:

- Preparation of description of Brown & Root's capabilities for purposes of qualifying the company for bidding opportunities.
- Preparation of equipment arrangements for a new-style of offshore platform for a sales presentation.
- Preparation of a proposal for the engineering design of gas lift facilities (13 million standard cubic feet per day capacity) for a platform in waters offshore Brunei.
- Preparation of an administrative procedures manual for a project which would supply the engineering design for a 12-inch submarine pipeline, onshore terminal, and offshore platform to handle 60 thousand barrels of crude oil per day.

A supplementary presentation of the author's previous experience

at an oil company permits a comparison of the viewpoints of engineering and construction contractors and oil companies.

TO

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ACKNOWLEDGMENTS

Grateful acknowledgments go to Dr. Peter E. Jenkins for his time and attention since I've been at Texas A&M University. Thanks also go to my Academic Committee members for their time and to the Deans of the College of Engineering for their advice and council.

A very special thanks goes to Mr. Frank R. Redus, my internship supervisor at Brown & Root, whose knowledge, experience and good humor created an excellent environment for learning how an engineering manager works and thinks. Thanks also go to Mr. Doak for his time and for providing an exceptional opportunity for me, to Messrs. Harris Smith, Ted Trahan and Joel Newsome for their time and patience during grueling question-and-answer sessions, and to the rest of the Brown & Root organization.

I am indebted to Ms. Dee O'Sullivan for cheerfully typing preliminary drafts of this report, to Ms. Ila Hilty for producing the graphics and to Ms. Dorothy Edwards for her careful attention to the final draft.

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SECTION 1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

The primary purpose of this report is to document the internship experience at Brown & Root and demonstrate that the objectives of the Doctor of Engineering Internship Program have been met. The general objectives of the Internship Program are stated formally below.

- FIRST GENERAL OBJECTIVE

  To enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served.

- SECOND GENERAL OBJECTIVE

  To enable the student to function in a nonacademic environment in a position where he will become aware of the organizational approach to problems in addition to traditional engineering design or analysis.

In my March, 1978 Status Report (See Section 6.1) these general objectives were reduced to objectives pertinent to my position at Brown & Root. The objectives are restated below.

- FIRST OBJECTIVE

  To make an identifiable engineering or administrative contribution to activities in the life cycle of projects at Brown & Root.

- o SECOND OBJECTIVE

  To become aware of the Task Force Approach used by Brown & Root.

1.2 REPORT ORGANIZATION AND FORMAT

This report has been organized with a view toward clear exposition of my progress toward the Internship Objectives. Progress toward the FIRST OBJECTIVE is documented by presenting a series of assignment reports, with each assignment written in a standard format. Progress toward the SECOND OBJECTIVE is documented by discussing Brown & Root's organizational approach as well as by describing the activities in the life cycle of a project.

To supplement the presentation of the internship experience at Brown & Root, a discussion of my experience at Exxon is made an integral part of this report. This section is organized along the same lines as the section on the Internship at Brown & Root.

Presentation of the two related work experiences provides two complementary views of the problem of installation of petroleum producing facilities. These two views facilitate the understanding of some of the relationships that exist between an engineering and construction contractor an oil company (sometimes referred to in this report as, respectively, a contractor and an operator or client). A summary of these relationships is given early in the report.

This report has been written in accord with the decimal numbering format commonly employed by Brown & Root in formal documents.

1.3 JOB POSITIONS

1.3.1 GENERAL

A summary of my job positions is given in Figure 1.

1.3.2 BROWN & ROOT, INC.

I served a one year internship as an assistant project engineer in Brown & Root's Oil and Gas Production Engineering Department (See the organization charts in Figures 2 and 3). This department was primarily engaged in the engineering design of offshore oil and gas production facilities. My intern supervisor was Frank R. Redus who was a project manager involved in business development, proposal writing and project administration. In connection with the organization chart in Figure 3, I was an assistant project engineer temporarily attached to a project engineer. (A project engineer is sometimes referred to as a project manager or project engineering manager depending on his seniority or current assignment.)

Figure 4 presents a conceptual diagram which indicates my position within the engineering and construction industry.

FIGURE 1

SUMMARY OF WORK EXPERIENCE

	INTERNSHIP	PREVIOUS EXPERIENCE
COMPANY	BROWN & ROOT, INC.	EXXON CO., USA
DEPARTMENTAL ACTIVITY	DESIGN OF OFFSHORE OIL AND GAS PRODUCTION FACILITIES	OPERATION OF ONSHORE OIL AND GAS PRODUCTION FACILITIES
POSITION	ASSISTANT PROJECT ENGINEER	PRODUCTION ENGINEER
DURATION	1 YEAR	2.5 YEARS
ACTIVITY	BUSINESS DEVELOPMENT AND PROJECT ADMINISTRATION	ENGINEERING SUPPORT OF OPERATIONS

FIGURE 2

CORPORATE STRUCTURE OF BROWN & ROOT

Corporate Officers
Brown & Root Inc.
September, 1978

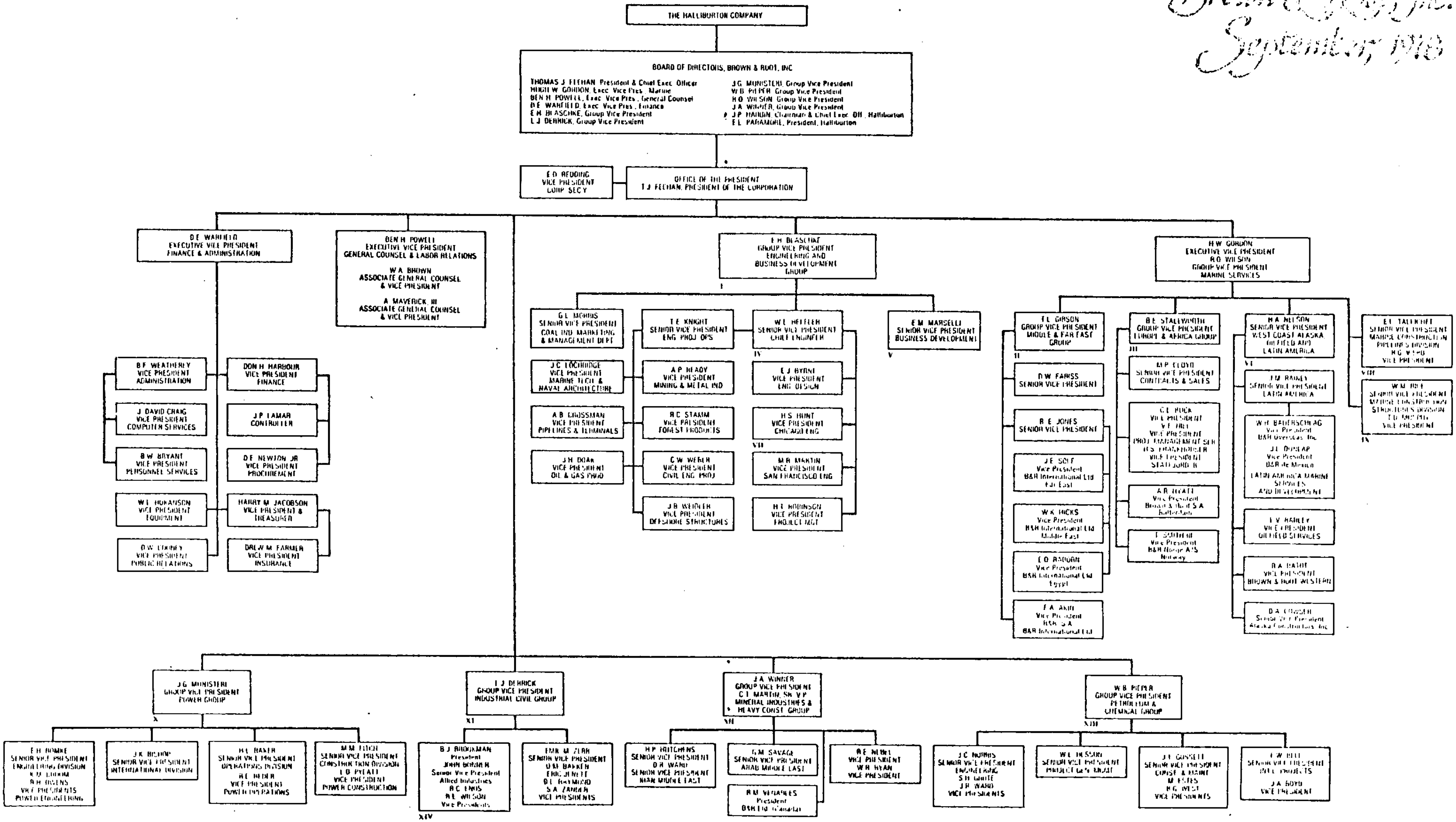


FIGURE 3
OIL AND GAS DEPARTMENT STRUCTURE

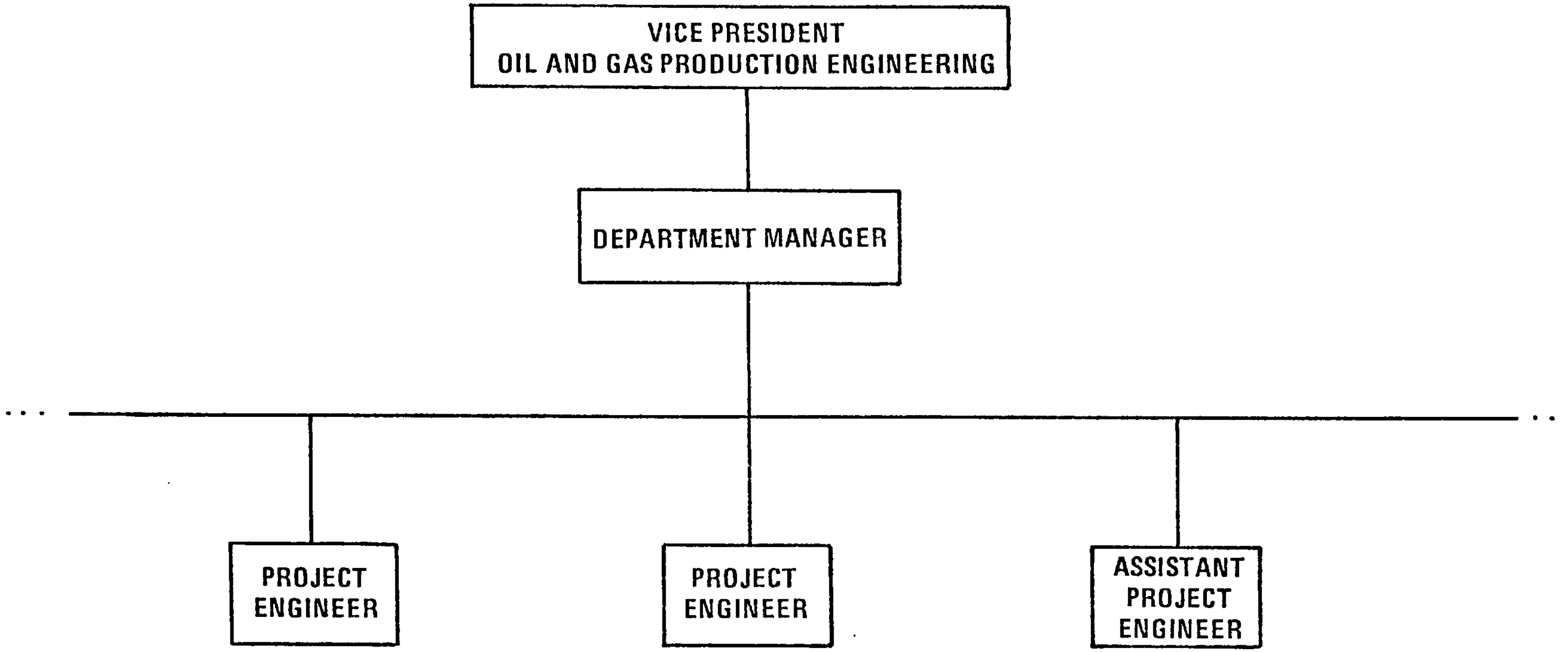
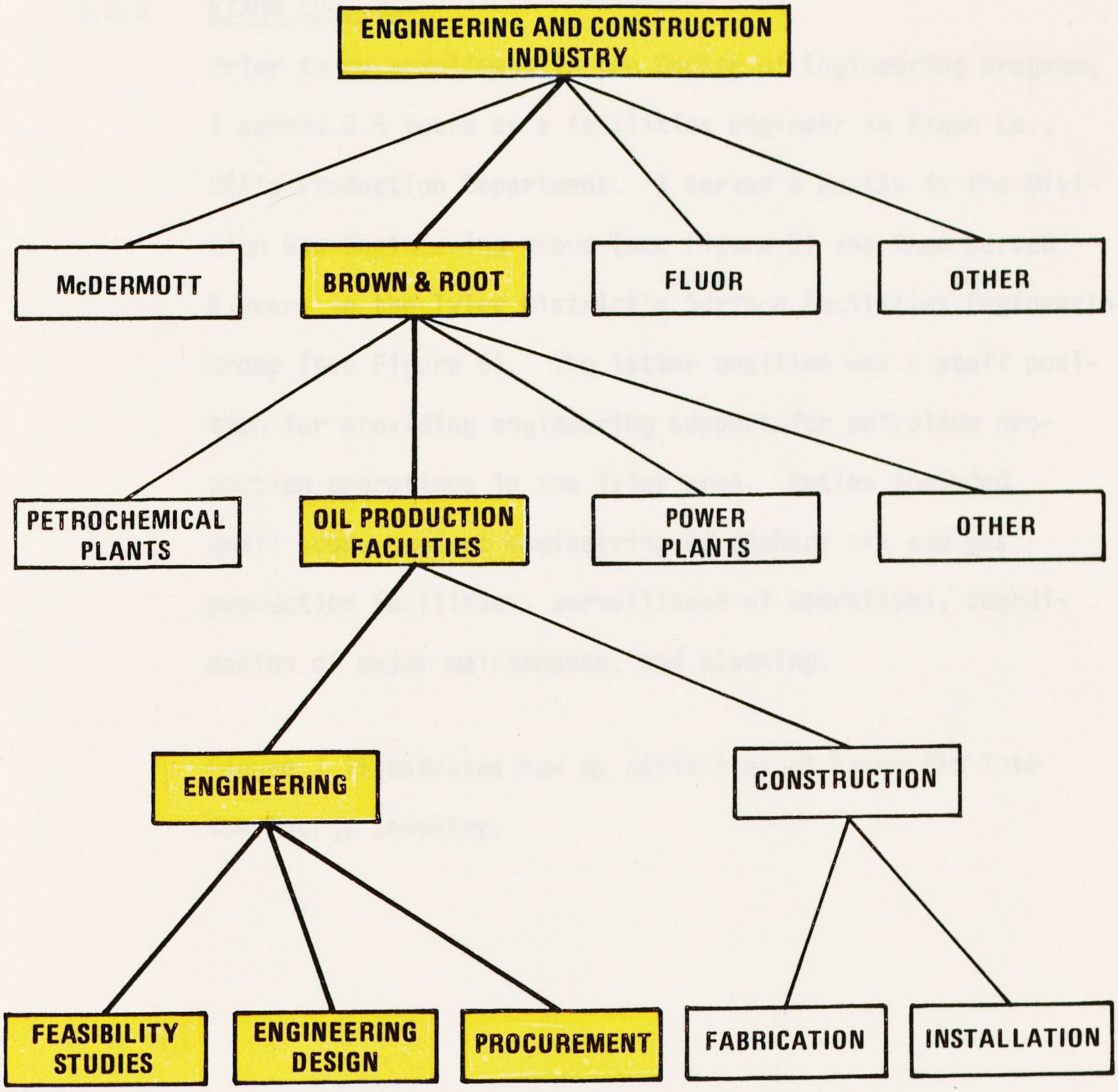


FIGURE 4

POSITION WITHIN THE
ENGINEERING AND CONSTRUCTION INDUSTRY



1.3.3 EXXON CO., USA.

Prior to my enrollment in the Doctor of Engineering program, I served 2.5 years as a facilities engineer in Exxon Co., USA's Production Department. I served 6 months in the Division Gas Engineering group (see Figure 5) and then served 2 years in the Tyler District's Surface Facilities Engineering Group (see Figure 6). The latter position was a staff position for providing engineering support for petroleum production operations in the Tyler area. Duties included small scope project engineering of onshore oil and gas production facilities, surveillance of operations, coordination of major maintenance, and planning.

Figure 7 illustrates how my activities at Exxon fit into the Energy Industry.

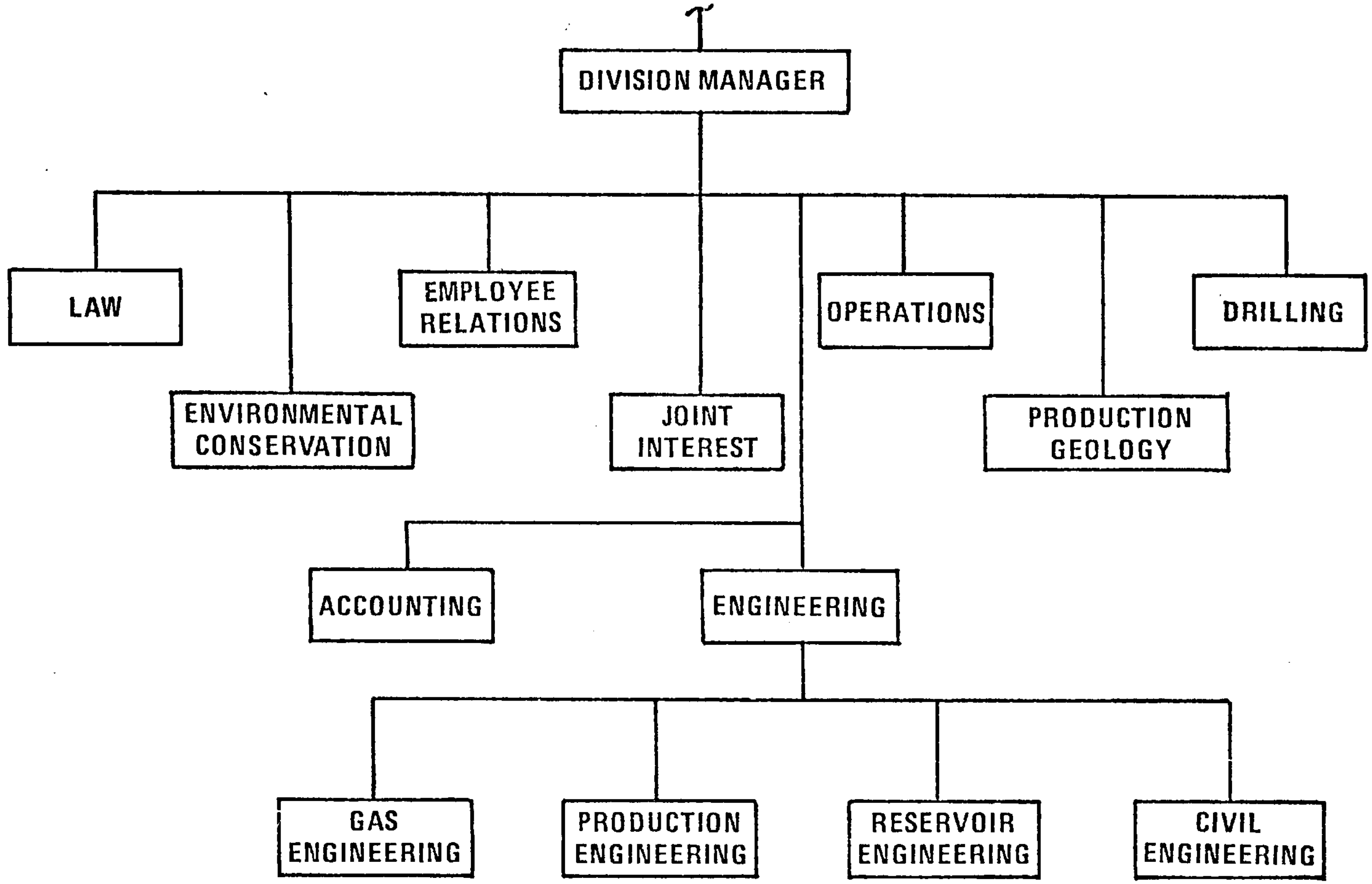


FIGURE 5

EXXON'S DIVISION OFFICE ORGANIZATIONAL STRUCTURE

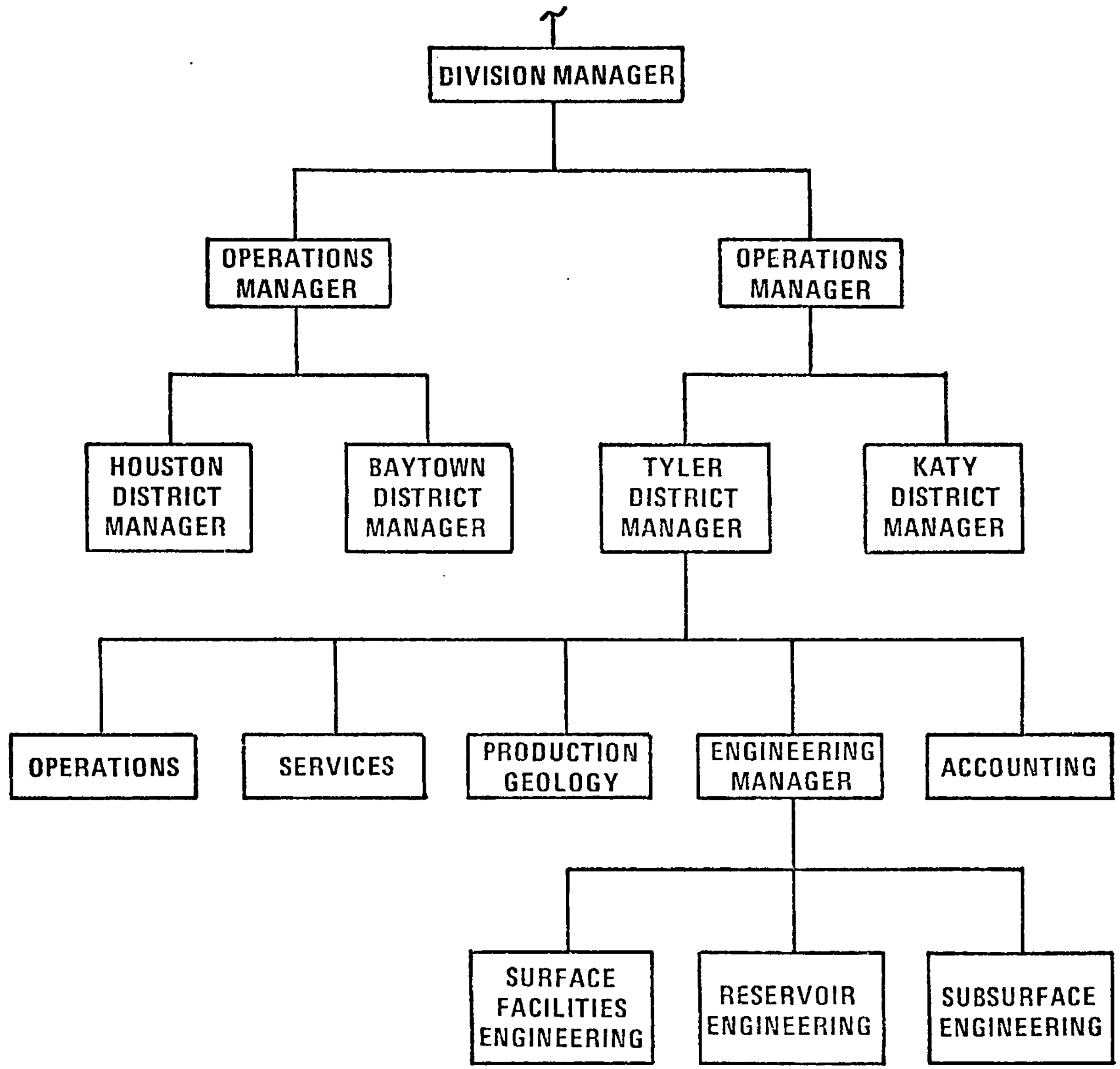
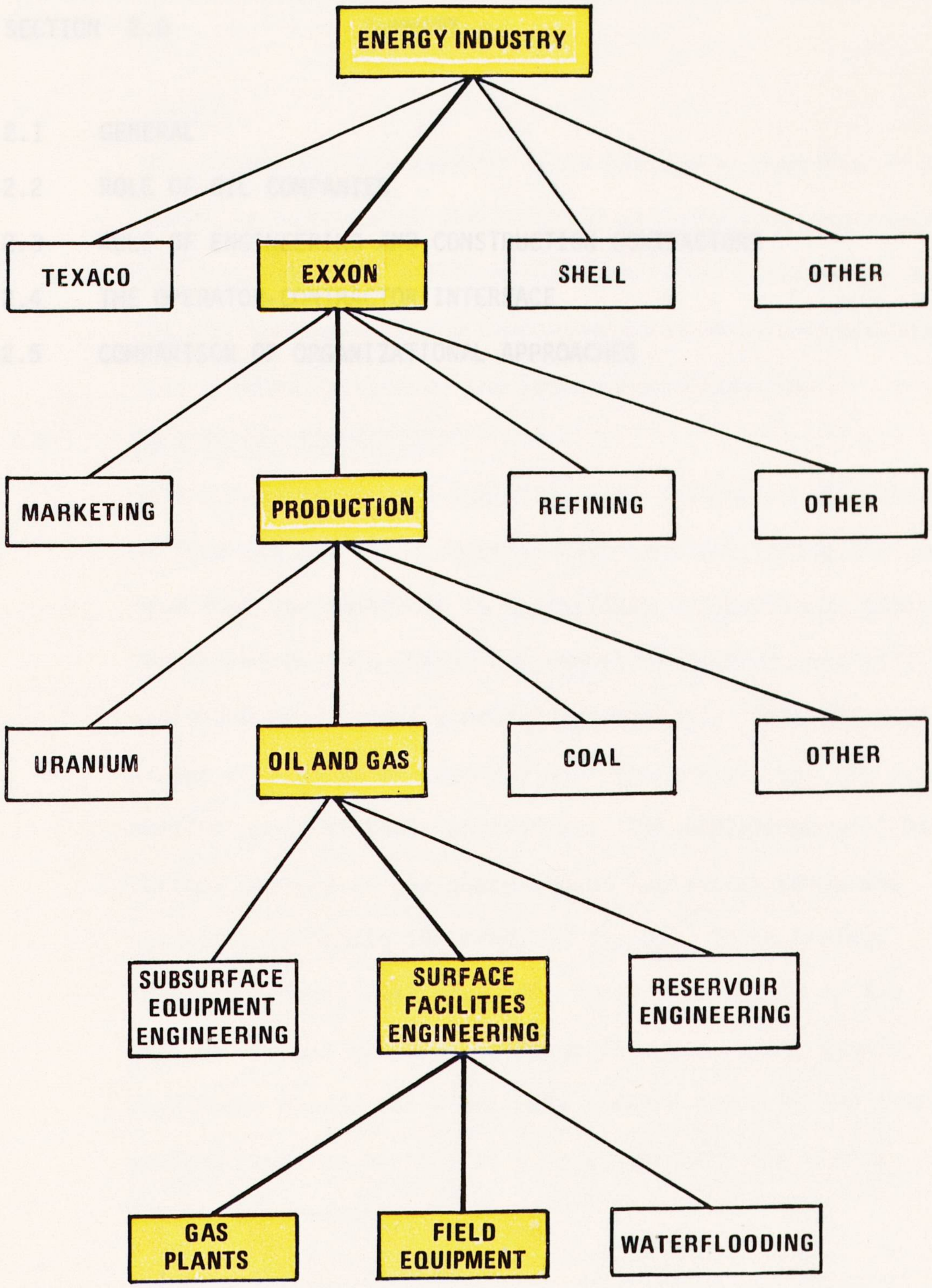


FIGURE 6

EXXON'S DISTRICT OFFICE ORGANIZATIONAL STRUCTURE

FIGURE 7

POSITION WITHIN ENERGY INDUSTRY



SECTION 2.0 SUMMARY

SECTION 2.0 SUMMARY

2.1 GENERAL

The purpose of this section is to present an overview of this report by summarizing the roles of oil companies and contractors and discussing the relationships that exist between the two. The section concludes with a comparison of the organizational approach that I found in each of the two subject companies.

2.2 ROLE OF OIL COMPANIES

In simplest terms, the function of an integrated oil company is to find the petroleum deposits (exploration), bring the petroleum from the reservoir to the surface (production), separate the petroleum into useful components (refining), and sell the petroleum products at a profit (marketing). This discussion of the role of an oil company will exclude all but the production phase of their activities. The discussion will be further limited to the above ground facilities which are necessary to handle the produced fluids. These surface production facilities represent large investments on the part of the oil company and range from the rather simple facilities needed for a one-well onshore field to the complex systems required to produce a large offshore field in a hostile environment.

After quantities of hydrocarbons are discovered, the oil company must determine whether the potential revenues economically justify the risk and expenditures necessary to install the production facilities. This decision depends on factors such as the hostility of the physical environment, characteristics of the reservoir and fluid, market conditions for petroleum products, availability of financing and political climate. The oil company then conducts a feasibility study to assess the economics of developing the field. The oil company may conduct such a study with its own personnel or may utilize outside consultants. If outside consultants are used, their work usually includes the generation of preliminary cost estimates and schedules for technically feasible courses of action. The calculation of economic yardsticks for the project (rate of return, present value of profit, etc.) and the decision to commit funds for the project are the province of the oil company.

After it has been determined that field development is economically feasible, the oil company issues tender documents which describe the conditions and requirements of the project and obtains competitive bids from contractors for the design and construction of producing facilities. Although an oil company may maintain enough engineering and construction capability within the company to handle small projects, it is rare for an operator to be able to handle large projects completely in-house because such capabilities would not be frequently used. The commitment of the operator's financial resources in this manner would not be profitable. The design and construction of the producing facilities may be awarded as separate contracts or both phases awarded to the same contractor. Although the actual design and construction work is the responsibility of the contractor, the oil company designates one or more of its own engineers to monitor the progress of the project and to be cognizant of the salient technical matters. On some large scope projects, the operator may retain consultants to assist in the surveillance of the contractor's work.

After the facility has been constructed and its performance has been proved to be consistent with the provisions of the contract between the operator and the contractor, the oil company begins operation of the facility. For successful operation of the plant, trained personnel must be in place to operate and maintain the facilities, monitor its performance, adjust to new operating conditions and identify profitable opportunities for modification or expansion.

Most of the above discussion pertains only to bringing new reserves into production. However, the preponderance of the oil company's resources are dedicated to operating, maintaining and upgrading existing producing properties. This requires the coordinated efforts of repairmen, equipment operators and other line personnel along with staff professionals such as engineers, accountants, geologists and administrators.

2.3 ROLE OF ENGINEERING AND CONSTRUCTION CONTRACTORS

Engineering and construction companies design and construct facilities ranging from small bridges to massive power plants. This discussion will be limited to the role of engineering and construction companies in connection with the design and construction of offshore oil and gas production facilities. Furthermore, the discussion will concentrate on their engineering activities.

An engineering and construction company secures work by successfully bidding against other similar firms for the execution of a specific project. The project could consist of any combination of feasibility studies, project management, engineering design, procurement, fabrication or installation. It is, therefore, possible for several contractors to be simultaneously involved in different phases of the same project.

A contractor can execute several projects simultaneously. The activity level of a given firm and its profitability generally rises with the rate of development of offshore fields. Contractors usually maintain manpower in excess of current project requirements to enable them to staff-up additional projects on short notice. This approach is more efficient than conducting an all-out hiring campaign after a manpower shortage occurs because the contractor can exercise more selectivity. Another disadvantage of crash hiring is that the new personnel are not familiar with the contractors' modus operandi, causing inefficiency in the execution of a project.

During the Engineering Phase of the project, the contractor is responsible for organizing technically skilled manpower to produce the drawings and specifications from which a qualified construction company can fabricate and install the facilities. This engineering effort generally requires the skills of process engineers, mechanical engineers, electrical engineers, structural engineers, instrumentation engineers, fire and safety engineers, piping engineers, estimators, schedulers, draftsmen and administrative workers. Engineering personnel specify equipment and integrate these components into systems. This requires detailed engineering calculations as well as continuous interaction with material and equipment vendors who supply equipment and information on the application of the equipment. Estimators, schedulers and other administrative workers provide the project management with information necessary to control the time and resources spent on the execution of the project.

The contractor's project management is responsible for the day-to-day direction, coordination and control of the engineering design effort. This includes the early detection of problems and implementation of corrective action. These problems can range from personality conflicts among team members to manpower shortages. Detailed technical questions are sometimes addressed by project management although these should normally be resolved at lower levels in the task force hierachy. During the Construction Phase of the project, the construction superintendent is responsible for organizing the efforts of welders, electricians, millwrights and other craftsmen and equipment operators together with supportive construction engineering personnel. The superintendent also has staff to provide him with the cost and schedule information necessary to control the execution of Construction Phase activites. The finished product of the Construction Phase is a facility ready for operation.

During the progress of the Engineering and Construction Phases of the job, the operator is kept abreast of important developments and can make decisions affecting the direction of the design and construction effort. Throughout the duration of the project, progress reports reveal schedule and cost deviations, completion status of the project and factors which are impeding the progress of the job. During the Engineering Phase, the client approves key drawings and specifications before these are considered to be in final form. However, most contracts explicitly state that such approval does not relieve the engineering contractor of the responsibility for providing an operative design

During the Construction Phase, the client's inspectors check the quality of material and workmanship. The inspection rights of the client are in addition to the quality control responsibilities of the contractor.

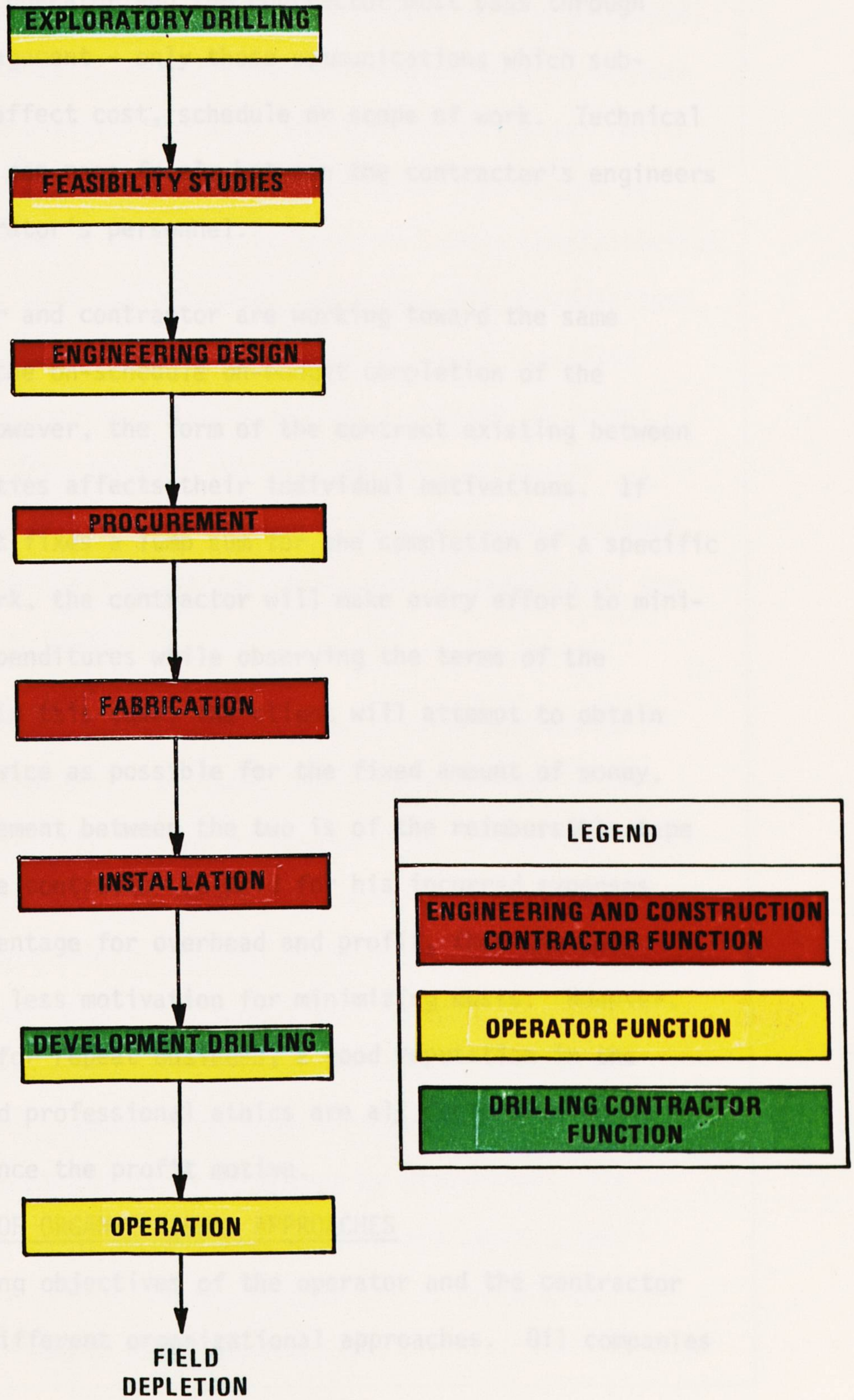
2.4 THE OPERATOR - CONTRACTOR INTERFACE

Figure 8 presents an overview of the events which take place in the process of developing an oil field as well as the involvement on the part of contractors and operators. Discussion and definition of these activities are given later in this report.

A primary communications channel exists between the operator's project management and the contractor's project management. The operator's project manager is responsible to his management for monitoring the project's progress. He is also responsible for obtaining and consolidating inputs from his company's engineering and operations personnel and incorporating these into the project, if possible. The primary information that the operator's project manager needs to do his job comes from the contractor's project manager who must be constantly aware of the project's status for his own control purposes. The operator can always cause a change in the direction of a project, but it is the contractor's project management that directly plans and controls the execution of the project. Therefore, the operator's project manager must always interact with the contractor's project management to affect changes in project execution rather

FIGURE 8

FUNCTIONS OF CONTRACTORS AND OPERATORS IN FIELD DEVELOPMENT



than directly issuing instructions to the contractor's project personnel. This should not imply that all communications between the operator and the contractor must pass through project management - only those communications which substantially affect cost, schedule or scope of work. Technical information can pass freely between the contractor's engineers and the operator's personnel.

The operator and contractor are working toward the same goal, i.e. the on-schedule on-budget completion of the project. However, the form of the contract existing between the two parties affects their individual motivations. If the contract fixes a lump sum for the completion of a specific scope of work, the contractor will make every effort to minimize his expenditures while observing the terms of the contract. In this case, the client will attempt to obtain as much service as possible for the fixed amount of money. If the agreement between the two is of the reimbursible type in which the contractor is paid for his incurred expenses plus a percentage for overhead and profit, then the contractor has less motivation for minimizing costs. However, the desire for repeat business, a good reputation in the industry and professional ethics are all factors which counterbalance the profit motive.

2.5 COMPARISON OF ORGANIZATIONAL APPROACHES

The differing objectives of the operator and the contractor result in different organizational approaches. Oil companies in general strive to maintain the status quo. Even though proven reserves are being depleted and new reserves discovered, the overall effect is a relatively stable operation. This environment is suited to a bureaucratic form of organization - the classic "pyramid" in which authority and responsibility are successively consolidated from bottom to top. This form of organization tends to create specialization of personnel with the attendent advantages and disadvantages. Many oil companies offset this tendency toward specialization by frequently rotating personnel through different positions. This approach not only prevents excessive conservatism in its operations, but also provides excellent management training by giving candidates an overview of the Company's acitivites.

The contractor's business is made up of a collection of transitory projects. In fact, the project manager's job is to successfully "go out of business" as quickly as possible. His goal is to complete the assigned project while making a profit. A task force organizational structure is well-suited to project execution. Under this approach, a team is assembled especially for a project according to its specific needs. The team is drawn from a reservoir of talent which is itself organized by discipline. The specialized skills of the team members are coordinated and directed by the project manager who is responsible for the overall direction of the project.

SECTION 3.0 BROWN & ROOT, INC.

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SECTION 3.0 BROWN & ROOT, INC.

3.1 GENERAL

This section covers the Brown & Root Internship experience per se and documents my progress toward the two internship objectives.

The first topic in this section - ORGANIZATIONAL APPROACH - addresses the SECOND OBJECTIVE of the Intership Program, i.e. "to become aware of the Task Force Approach", in addition to other aspects of the Organization Approach at Brown & Root.

The second topic in this section - ASSIGNMENTS - speaks to the FIRST OBJECTIVE of the Internship, i.e. "making an identifiable engineering or administrative contribution to the activities in the life cycle of projects at Brown & Root", by reporting on several of my assignments.

3.2 ORGANIZATIONAL APPROACH

This section concentrates on the Brown & Root organization and how it functions to design and construct offshore petroleum producing facilities. Although construction activities are discussed to some extent, engineering procedures and organization are treated in more detail.

3.2.1 CORPORATE DESCRIPTION

This section provides a brief general description of the Brown & Root organization in terms of the services that it provides, its history and its organizational structure.

3.2.1.1 SCOPE OF SERVICES

Brown & Root provides engineering, construction and project management services in the area of petroleum production, petrochemicals, power plants, roads, dams, bridges and a host of other industries. These activities are world-wide. Some projects are so large that only a few contractors in the world are capable of executing them - Brown & Root is in this select group of contractors. On the other hand, Brown & Root has also handled many smaller projects such as a highway bridge or a small oil production facility.

3.2.1.2 BRIEF HISTORY

The Company was begun in 1914 by the late Herman Brown who accepted a team of mules in lieu of wages and began contracting to build roads in Central Texas. In 1919, Brown formed a partnership with his brother-in-law, Dan Root, and Brown & Root came into being.

In 1962, all Brown & Root stock was purchased by the Halliburton Company. Although Brown & Root is a member of the Halliburton Company, it retains its identity and autonomy. Brown & Root accounts for approximately 70 percent of the revenues of the Halliburton Companies.

3.2.1.3 ORGANIZATION

A corporate organization chart was given in Figure 2. The line functions in Brown & Root are those associated with the execution of an engineering or construction contract - Brown & Root's "product". Line personnel are therefore engineers, draftsmen, welders, painters and their managers. Staff personnel are those who function to support the primary activities but do not directly contribute to the design and construction of facilities, e.g. lawyers, accountants and financial analysts.

The Brown & Root organization is a departure from the classic bureaucracy with its pyramidal shape and clear lines of authority. The bureaucratic form of organization is well suited to maintaining the status quo, as in the government. The top of the Brown & Root organization looks like a pyramid, but toward the bottom one finds a collection of task forces.

A totally bureaucratic form of organization would not be well suited to the execution of projects. One would expect to find a bureaucratic structure near the top of an organization like Brown & Root because its upper management strives to <u>maintain</u> profits for the stockholders. The top of this corporate heirachy is not so much concerned with the details of the execution of dozens of projects which are active at any one time. The Brown & Root organization is therefore a combination of task forces and bureaucracy. The dividing line between the two varieties of organization is quite clear in the Oil and Gas Production Engineering Department and exists between the vice president and the project engineers.

3.2.2 LIFE CYCLE OF PROJECTS

Brown & Root is capable of guiding the largest of projects from the feasibility study stage all the way through to the commissioning stage in which the facility is made ready for start-up. Figure 9 provides an outline of the major elements of the life cycle of a project. In many projects, however, Brown & Root does not follow the project from conception to start up, but only participates in some fraction of this whole process. Many clients award portions of the project to different contractors to avoid becoming too dependent on a single contractor. While this approach allows the client to use competition among contractors to its advantage, the resulting discontinuities may also result in coordination problems and schedule delays.

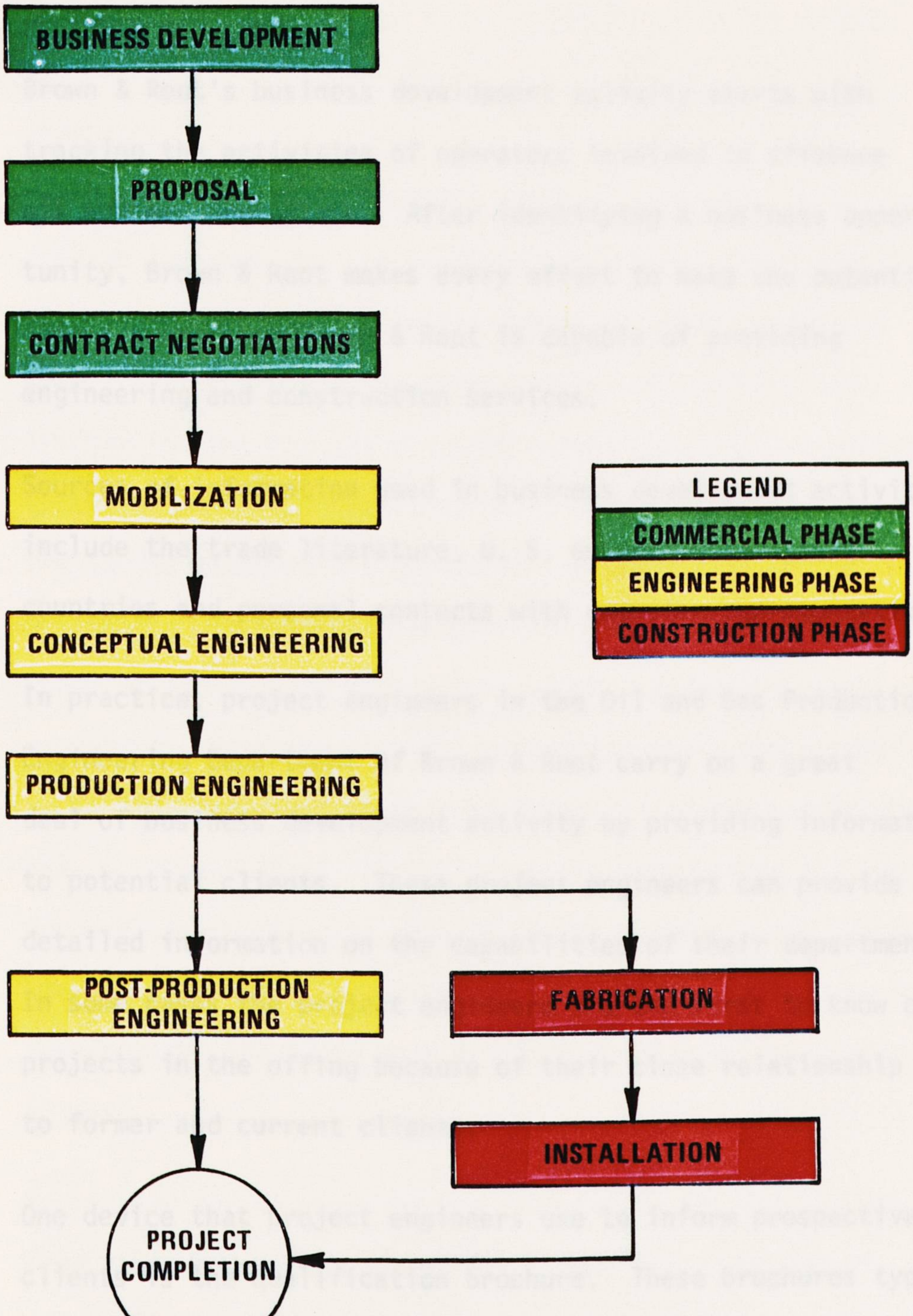
The following discussion of the life cycle of a project is given in three parts - Commericial Phase, Engineering Phase and Construction Phase. In any given project, Brown & Root may be active in only one of these phases or perhaps all three.

3.2.2.1 COMMERCIAL PHASE

This phase includes activities leading up to the signing of a contract - it is the process of securing new revenue for the company. Any contractor is simultaneously dying by completing projects and growing by securing new contracts for work. The Commercial Phase, the growth process, is therefore crucial.

FIGURE 9

LIFE CYCLE OF PROJECT



3.2.2.1.1

BUSINESS DEVELOPMENT

Brown & Root's business development activity starts with tracking the activities of operators involved in offshore oil and gas production. After identifying a business opportunity, Brown & Root makes every effort to make the potential client aware that Brown & Root is capable of providing engineering and construction services.

Sources of information used in business development activities include the trade literature, U. S. embassies in foreign countries and personal contacts with operator representatives.

In practice, project engineers in the Oil and Gas Production Engineering Department of Brown & Root carry on a great deal of business development activity by providing information to potential clients. These project engineers can provide detailed information on the capabilities of their department. In some cases the project engineers are the first to know of projects in the offing because of their close relationship to former and current clients.

One device that project engineers use to inform prospective clients is the qualification brochure. These brochures typically include experience lists showing projects completed by Brown & Root which are similar to the project under consideration, discussion of computing facilities, pictures and other relevant information. A qualification brochure is successful if the prospective client sends the tender documents, i.e. a request for a proposal, to Brown & Root.

3.2.2.1.2

PROPOSALS

A proposal is the contractor's offer, in specific terms, to provide services for the prospective client. The proposal is prepared in response to the tender document, which was sent from the prospective client to the prospective contractor to describe the services required by the prospective client. The client sometimes retains a consultant to prepare the tender document and assist in the evaluation of the proposals. In order to complete the definition of the scope of services to be provided by the contractor, it usually is necessary that the contractor make some assumptions. It is important that these assumptions be documented in the body of the proposal so that after the work begins (if the proposal is successful) changes in the scope of work can be identified. The price estimates given by the contractor in the proposal are based on his interpretation of the scope of work.

Prosposals for engineering are prepared in the Oil and Gas Production Engineering Department under the direction of a project engineer. In a proposal, Brown & Root is offering to sell the engineering and technical labor required to complete the drawings and specifications needed to construct the facility. Equipment procurement and inspection services can also be integrated with engineering services.

In the process of preparing the proposal each discipline staff manager reads the tender document and estimates the number of engineering manhours from his discipline needed to complete the engineering project. The project engineer receives these inputs from the staff managers and has the perogative of adjusting these estimates.

Engineering services are offered on either a lump sum or cost-plus basis usually depending on the instructions in the tender document. It should be noted, however, that cost-plus contracts are more common in engineering projects primarily because it is difficult to estimate with much certainty how many engineering manhours are required for the conceptual studies needed to determine a near-optimal design which the client will approve. In general, a lump - sum contract is most applicable to those situations in which the scope of work can be well defined in the tender documents. As the name implies, a lump sum contract fixes the amount to be paid to the contractor. In this case the contractor has a strong incentive to complete the work on schedule while expending as few resources as possible. Also, since the contractor is taking on a degree of risk in lump sum contract, he typically includes a certain amount of money in the lump sum to compensate for this risk. Conversely, under a cost-plus contract, the contractor provides a cost and schedule estimate in the proposal but is reimbursed for incurred costs and then given a fixed fee or a fee which is a percentage of the costs to cover overhead and profit. In a cost-plus contract the contractor is still motivated to complete the project on schedule for the estimated amount of money in order to please the client and obtain repeat business. However there is clearly less financial incentive to complete the project using a minimal amount of resources, especially if the contract is in terms of cost-plus-a-percentage.

The contents of a typical engineering proposal are shown in Figure 10. The COVER LETTER appears first and gives a summary of the scope of work and an estimated cost for services. The INTRODUCTION describes the salient features of the facilities to be designed by giving flowrates, operating pressures and temperatures and outlining the sequence of process operations.

The SCOPE OF WORK is critically important to the proposal as it describes, in explicit terms, the design work to be done and the documents which will be produced. It is common for the project definition to change after the proposal has been accepted. This baseline takes on crucial importance in a lump sum contract because the contractor must be able to justify the extra charges to the client before additional remuneration can be made by the client. In any case, the

FIGURE 10

TYPICAL TABLE OF CONTENTS

FOR PROPOSAL

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PROPOSAL FOR ENGINEERING SERVICES

contractor must be able to explain departures from his cost or schedule estimates and a good scope of work definition is invaluable in this regard to determine the magnitude and consequences of the changes.

The last section appearing in this typical proposal, TERMS AND CONDITIONS FOR ENGINEERING AND TECHNICAL SERVICES, is a copy of Brown & Root's standard cost-plus-a-percentage-fee contract. Attached to the contract are cost definitions such as engineering salary ranges, reproduction costs, etc.

Construction services are also offered in proposals on either a lump sum or cost-plus basis. The tender document for a construction contract contains drawings and specifications which define the scope of services to be provided by the construction contractor. These drawings and specifications are actually the results of a previous engineering contract. The engineering contractor may or may not be the same as the construction contractor. In a construction contract the contractor is offering to sell construction labor, expendable materials (e.g. pipe and welding rods), the use of specialized construction equipment (e.g. pipe-laying barges and derrick barges), and procurement services for production equipment (e.g. turbines, compressor and pumps).

In Brown & Root, construction work accounts for more profit than engineering work because contruction contracts typically involve larger sums of money, causing the contractor's fee to be larger.

Brown & Root also bids on projects which require both engineering and construction services. In many tender documents the contractor is requested to bid, on a lump sum basis, for the combination of detailed engineering, fabrication and installation. In these cases, the Conceptual Engineering has usually been completed by another contractor who is retained by the client as a consultant to assist in monitoring the performance of the successful bidder.

3.2.2.1.3

CONTRACT NEGOTIATIONS

After the competing contractors have submitted their proposals, the client evaluates the bids and narrows the field down to two or three contractors. Representatives of these contractors travel to the client's offices for discussion of the fine points of the contract. At this time, final contract negotiations occur. The client points out aspects of the contractor's proposal that are unclear or not completely satisfactory from his standpoint. These may be for example, insurance arrangements, currency movement, living expenses for expatriats, or personnel to be assigned to the project. These points are discussed in an atmosphere of give-and-take. Legal technicalities which cannot be resolved by those present, usually engineering managers rather than lawyers, are referred to the legal departments. These legal technicalities are normally of secondary importance. The substantive issues of fee, reports and management controls are resolved by engineering and management negotiators. After each of the short-listed contractors have interacted with the client, the client choses the successful bidder and work begins.

3.2.2.2 ENGINEERING PHASE

This phase includes defining alternative design approaches, preparing construction drawings and specifications, and handling design adjustments during construction. This phase requires the services of professional engineers and managers, as well as designers, draftsmen and other technicians. Although the cost of the Engineering Phase is small compared to the total installed cost of the facility (usually less than 10 percent), the decisions made here are vital to the operability of the facility.

Many operating companies are capable of handling limited-scope engineering, particularly on small onshore production facilities. However, operating companies usually rely on contractors to provide engineering services for facilities which will operate offshore and in other hostile environments. The design of these facilities requires the specialized knowledge that contractors maintain and offer to the Petroleum Industry as a whole. An individual operating company could not afford to maintain these specialized capabilities within their company because they would not be utilized continuously.

3.2.2.2.1

FEASIBILITY STUDIES

These studies define alternative approaches to the design of a facility and identify the approaches worthy of further development. These studies provide the client with preliminary designs, budget cost estimates and schedules needed to determine whether the project is economically feasible. This service provides the client with a relatively quick and inexpensive analysis of the problems associated with the proposed project before the client commits more substantial funds for developing the construction plans. Conceivably, the client could choose to defer or cancel the project based on the results of the feasibility study. A sampling of the technical problems which could be addressed in a feasibility study of an offshore production facility are listed below.

- Subsea pipeline size and operation, i.e. single phase or multiphase flow.
- Platform size and location
- Schedule for field development
- Equipment arrangement
- Process design

3.2.2.2.2

ENGINEERING DESIGN

In the present context "engineering design" refers specifically to the development of the drawings and specifications needed to build the facility. In most cases, once the engineering contract has been awarded by the client, it has been determined that the facility will be built and there is no longer any questions of economic or technical feasibility. The client has great incentive to build the facility as soon as possible to realize oil and gas revenues without delay. Because of the particular importance of time in the engineering and construction process, each contractor has developed procedures for executing projects expediciously. Brown & Root has divided the engineering process into four phases: mobilization, conceptual, production and post-production.

- Mobilization. This phase begins after Brown & Root receives formal authorization from the client to proceed with engineering activities. In some cases, this occurs before all of the details of the contract between Brown & Root and the client have been settled. This phase includes activities such as establishing administrative procedures, refining job scope, developing organizational charts for the assigned task force personnel and developing job schedules and cost estimates. Generally, only the project management and lead discipline engineers are active in these activities.
- Conceptual Engineering. This phase begins with a

review of client-provided flow diagrams which indicate the initial design philosophy. These basic flow diagrams could have been generated by the client or could have been produced for the client by another contractor as part of an earlier study. In the absence of client-provided flow diagrams, Brown & Root begins development of their own process flow diagrams. Conceptual Engineering activities include conceptual studies, identification of process design schemes and flowsheet development, equipment layout studies and preliminary major equipment specification.

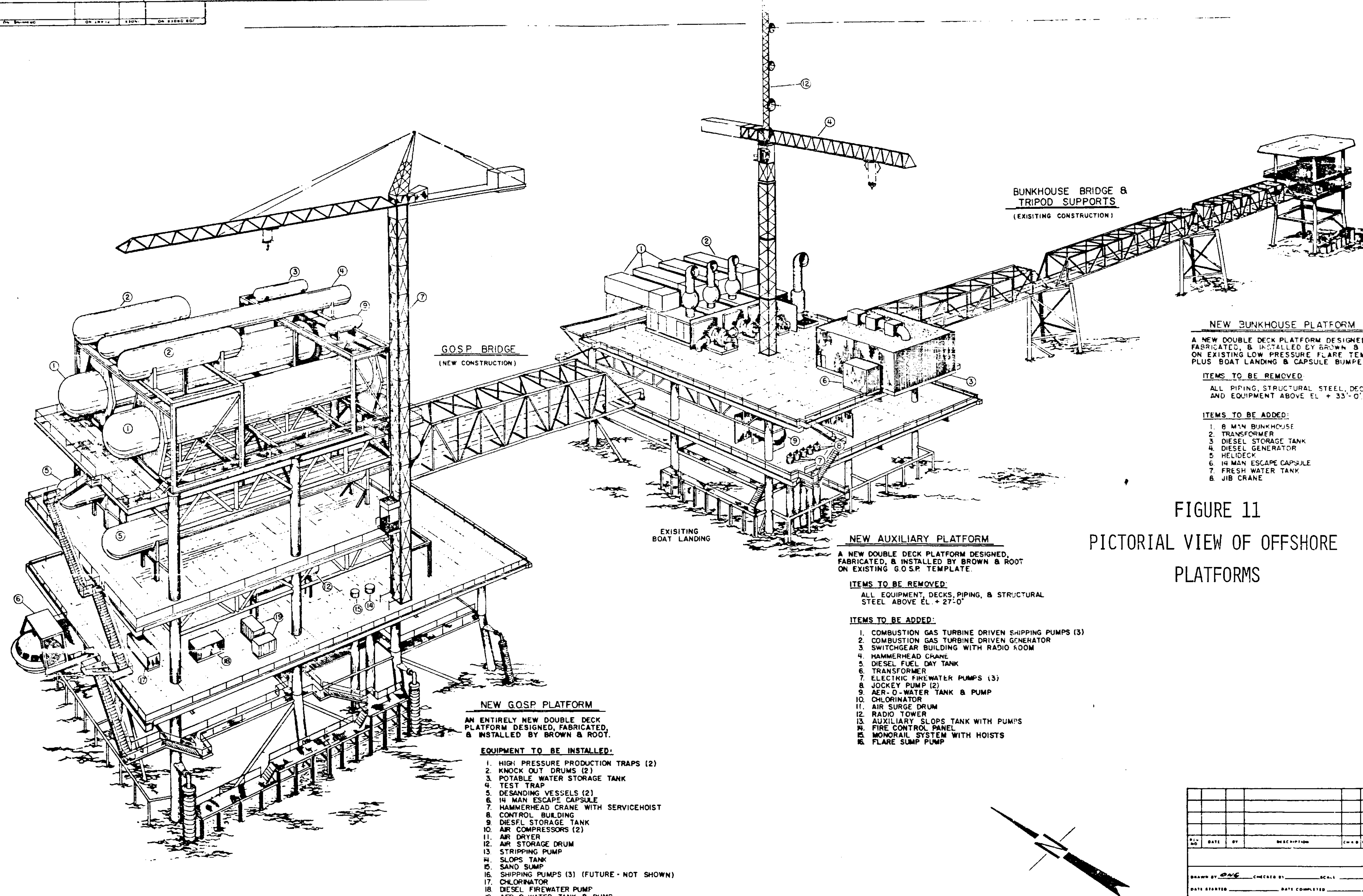
Conceptual studies differ from feasibility studies. Conceptual studies are conducted within the engineering design process and address specific problems which must be solved before detailed designs can be initiated, e.g. flare radiation studies, pump control studies, power distribution studies and fire protection studies.

The thrust of the Conceptual Engineering effort is to obtain client concurrence on the outline of the design which will be detailed in the Production Engineering Phase. For example, it would be illogical to become involved with detailed vessel designs (e.g. wall thickness calculation, nozzle locations, vessel internals or material specifications), before the operating conditions for the vessel (e.g. throughput, compositions, pressures and temperatures) have been established. Premature detailed design efforts can cause a waste of many engineering manhours. Therefore it is necessary to establish a client-approved overall system design before initiating the detailed engineering design.

The documents produced during the Conceptual Engineering Phase cannot be used to construct the facility because they do not contain construction detail. Rather, the purpose of these drawings is to fix the overall system design, i.e. to provide a skeleton which will be filled in by subsequent designs.

Below is a listing of typical scope defining documents with a brief description of the purpose of each. Figures 12 through 17 present examples of the described documents. All of these documents relate to the facilities shown pictorially in Figure 11.

- Flow Diagrams show how the elements of the oil and gas processing system are functionally related. The diagrams also typically identify flowrates, pressures, temperatures and specific gravities at key points in the system. Flow diagrams provide information



NEW G.O.S.P. PLATFORM

AN ENTIRELY NEW DOUBLE DECK PLATFORM DESIGNED, FABRICATED, & INSTALLED BY BROWN & ROOT.

EQUIPMENT TO BE INSTALLED:

1. HIGH PRESSURE PRODUCTION TRAPS (2)
2. KNOCK OUT DRUMS (2)
3. POTABLE WATER STORAGE TANK
4. TEST TRAP
5. DESANDING VESSELS (2)
6. 14 MAN ESCAPE CAPSULE
7. HAMMERHEAD CRANE WITH SERVICEHOIST
8. CONTROL BUILDING
9. DIESEL STORAGE TANK
10. AIR COMPRESSORS (2)
11. AIR DRYER
12. AIR STORAGE DRUM
13. STRIPPING PUMP
14. SLOPS TANK
15. SAND SUMP
16. SHIPPING PUMPS (3) (FUTURE - NOT SHOWN)
17. CHLORINATOR
18. DIESEL FIREWATER PUMP
19. AER-O-WATER TANK & PUMP
20. SALT IN CRUDE MONITOR
21. MONORAIL SYSTEM WITH HOIST

NEW AUXILIARY PLATFORM

A NEW DOUBLE DECK PLATFORM DESIGNED, FABRICATED, & INSTALLED BY BROWN & ROOT ON EXISTING G.O.S.P. TEMPLATE.

ITEMS TO BE REMOVED:

ALL EQUIPMENT, DECKS, PIPING, & STRUCTURAL STEEL ABOVE EL. + 27'-0"

ITEMS TO BE ADDED:

1. COMBUSTION GAS TURBINE DRIVEN SHIPPING PUMPS (3)
2. COMBUSTION GAS TURBINE DRIVEN GENERATOR
3. SWITCHGEAR BUILDING WITH RADIO ROOM
4. HAMMERHEAD CRANE
5. DIESEL FUEL DAY TANK
6. TRANSFORMER
7. ELECTRIC FIREWATER PUMPS (3)
8. JOCKEY PUMP (2)
9. AER-O-WATER TANK & PUMP
10. CHLORINATOR
11. AIR SURGE DRUM
12. RADIO TOWER
13. AUXILIARY SLOPS TANK WITH PUMPS
14. FIRE CONTROL PANEL
15. MONORAIL SYSTEM WITH HOISTS
16. FLARE SUMP PUMP

NEW BUNKHOUSE PLATFORM

A NEW DOUBLE DECK PLATFORM DESIGNED, FABRICATED, & INSTALLED BY BROWN & ROOT ON EXISTING LOW PRESSURE FLARE TEMPLATE PLUS BOAT LANDING & CAPSULE BUMPER

ITEMS TO BE REMOVED:

ALL PIPING, STRUCTURAL STEEL, DECKS, AND EQUIPMENT ABOVE EL + 33'-0"

ITEMS TO BE ADDED:

1. 8 MAN BUNKHOUSE
2. TRANSFORMER
3. DIESEL STORAGE TANK
4. DIESEL GENERATOR
5. HELIDECK
6. 14 MAN ESCAPE CAPSULE
7. FRESH WATER TANK
8. JIB CRANE

FIGURE 11

PICTORIAL VIEW OF OFFSHORE PLATFORMS

REV NO	DATE	BY	DESCRIPTION	CHK'D	CERT	APP'D

DRAWN BY ONG CHECKED BY SCALE
DATE STARTED DATE COMPLETED
OPR'G DEPT ENG DEPT
CERTIFIED DATE

PROJECT PERSPECTIVE
AUXILIARY & BUNKHOUSE PLATFORMS

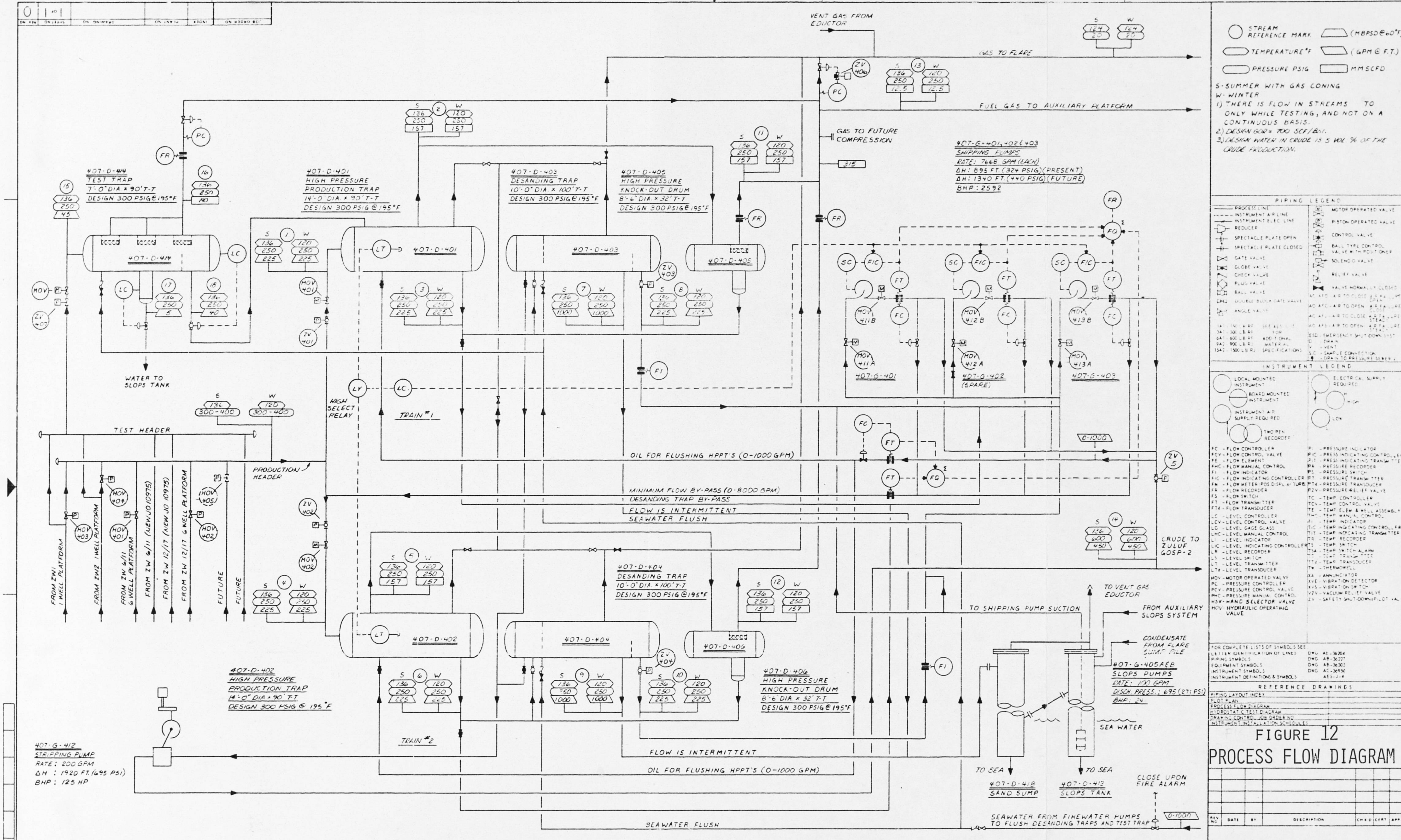
JOB ORDER NO	INDEX	PLANT NO	DRAWING NO	REV NO
				0

needed for piping-layout designs and control system designs among other uses. Figure 12 shows an example of a process flow diagram. Mechanical flow diagrams are produced after process flow diagrams and show more detail on pipeline sizes, valve locations and control systems.

- Equipment Layouts show a view of the placement of equipment on the platform. The flow diagram provides a starting point for the equipment layout design by showing which pieces of equipment are connected by pipelines. The layout designer seeks to minimize pipe costs and maximize operating and maintenance convenience, while producing a safe and convenient equipment arrangement. Figure 13 shows an example of an equipment layout.

- Hazardous Area Classification Drawings show the physical area on the platform in which hazardous gasses or liquids may possibly exist. This affects the standards to which electrical equipment operating in that area is manufactured. Figure14 shows an example of a Hazardous Area Drawing.

- Building Layouts show a top view of enclosed



STREAM NUMBER		1		2		3		4		5		6		7		8		9	
SEASON		S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
PHASE		MIXED	MIXED	GAS	GAS	LIQUID	LIQUID	MIXED	MIXED	GAS	GAS	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
SPECIFIC GRAVITY						0.851	0.849					0.851	0.849	0.851	0.849	0.851	0.849	0.851	0.849
MOLECULAR WEIGHT				22.34	21.85	204.0	200.8			22.34	21.85	204.0	200.8	204.0	200.8	204.0	200.8	204.0	200.8
VISCOSITY CP				0.012	0.012	5.0	5.0			0.012	0.012	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
SAND	NORMAL	16	16			16	16	16	16			16	16	122	122	2.7	2.7	122	122
LB/MB	MAXIMUM	100	100			100	100	100	100			100	100	765	765	16.9	16.9	765	765

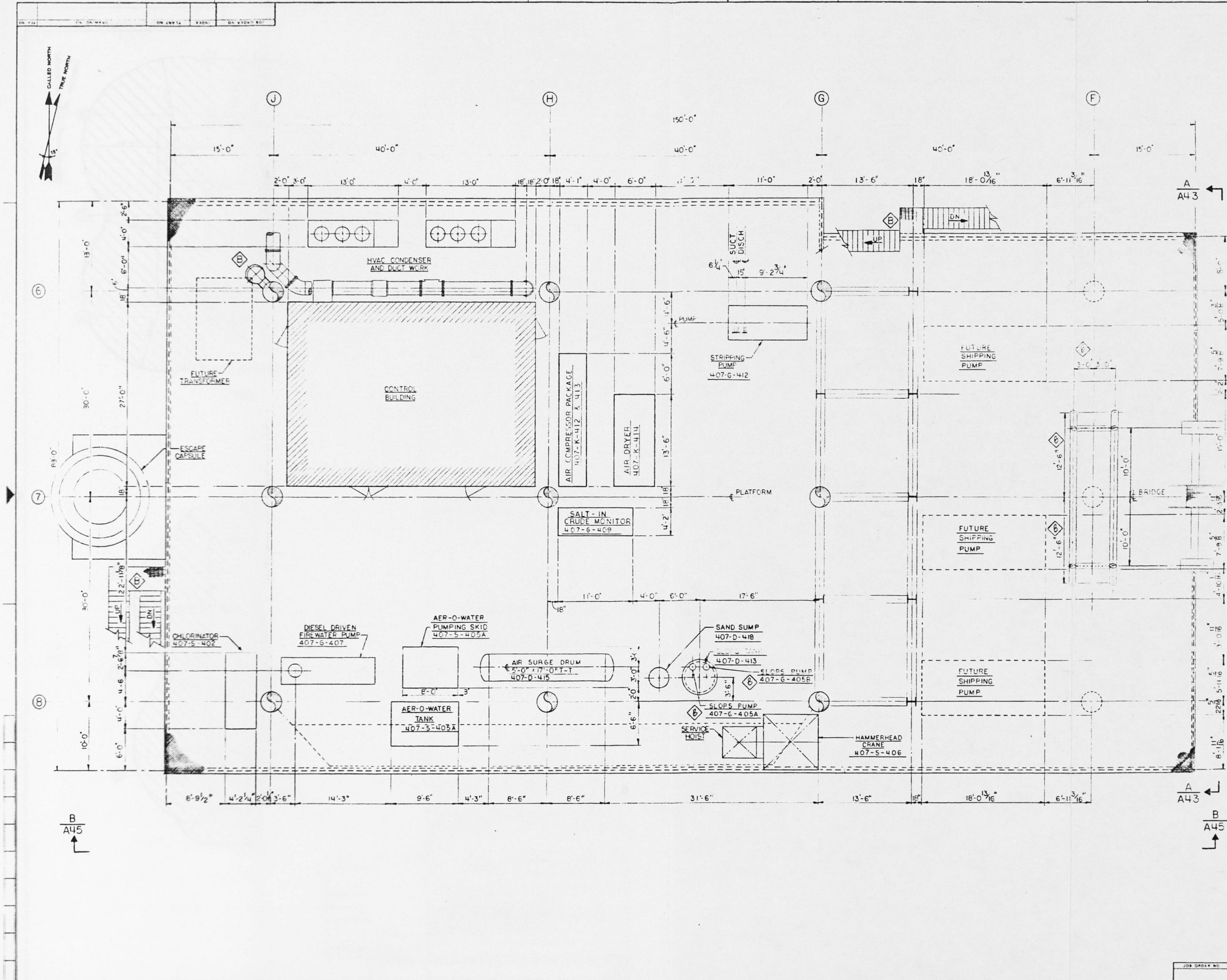
STREAM NUMBER		10		11		12		13		14		15		16		17		18	
SEASON		S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
PHASE		LIQUID	LIQUID	GAS	GAS	GAS	GAS	GAS	GAS	LIQUID	LIQUID	MIXED	MIXED	GAS	GAS	LIQUID	LIQUID	LIQUID	LIQUID
SPECIFIC GRAVITY		0.851	0.849							0.851	0.849					1.02	1.02	0.851	0.849
MOLECULAR WEIGHT		204.0	200.8	22.34	21.85	22.34	21.85	22.34	21.85	204.0	200.8			22.34	21.85	18.01	18.01	204.0	200.8
VISCOSITY CP		5.0	5.0	0.012	0.012	0.012	0.012	0.012	0.012	5.0	5.0			0.012	0.012	1.0	1.0	5.0	5.0
SAND	NORMAL	2.7	2.7							2.7	2.1	16	16					16	16
LB/MB	MAXIMUM	16.9	16.9							16.9	16.9	100	100					100	100

FIGURE 12
PROCESS FLOW DIAGRAM

DRAWN BY J.A.J. SCALE NONE

PROCESS FLOW DIAGRAM

1 OF 10



GENERAL NOTES

ALL ELEVATIONS REFER TO L.S.L.T. AS 0'-0"

REFERENCE DRAWINGS

KEY LAYOUT PLAN	XA-867335
EQUIP. LOCATION PLAN TOS EL.71'-0"	XA-867341

FIGURE 13
EQUIPMENT ARRANGEMENT DRAWING

REV NO	DATE	BY	DESCRIPTION	CHK'D	CERT	APP'D
B	01-06-76	J.R.	REVISED AS NOTED			
A	10-20-76		REVISED PER CUST. COMMENTS			

DRAWN BY M.C. GADNER CHECKED BY ______ SCALE 3/16" = 1'-0"

DATE STARTED 09-13-76 DATE COMPLETED ______

OPR'G DEPT ______ ENG. DEPT ______

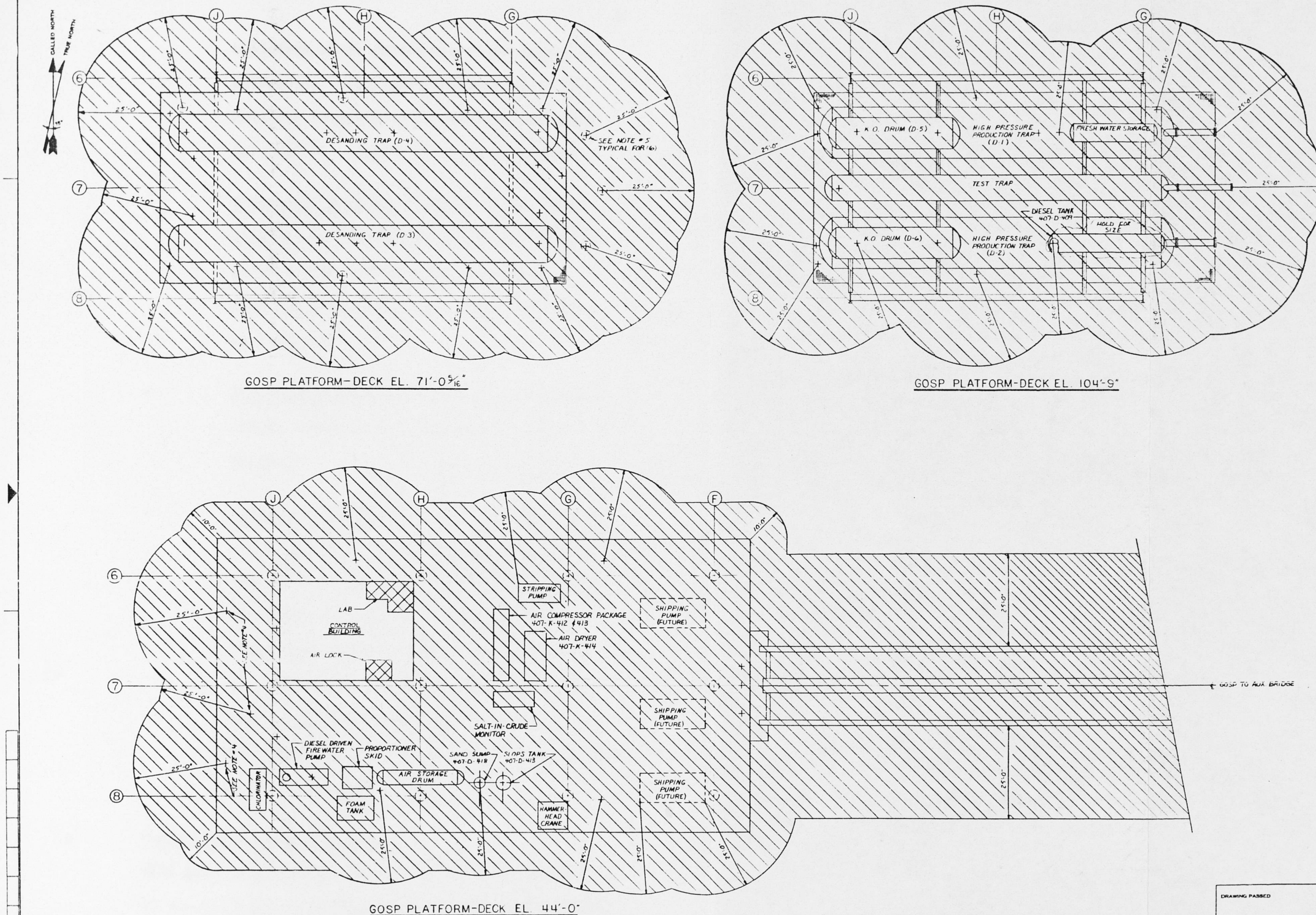
THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED. CERTIFIED DATE

EQUIP LOCATION PLAN TOS EL 44'-0"

PRODUCTION PLATFORM

ZULUF GOSP-1

JOB ORDER NO. | INDEX | PLANT NO. | DRAWING NO. | REV. NO. B



NOTES

1) ALL ELECTRICAL EQUIPMENT INSTALLED IN A CLASSIFIED AREA SHALL BE SUITABLE FOR USE WITHIN THAT AREA.
2) ANY AREA NOT SHADED IS UNCLASSIFIED.
3) THE ENTIRE LENGTH OF BRIDGE BETWEEN GOSP & AUXILIARY PLATFORMS TO BE CLASS I, DIVISION 2, GROUP D, AS SHOWN.
4) HYDROCARBON RELEASE POINTS REFERENCED TO THIS NOTE ARE LOCATED ON DECK EL 71'-0 5/16" BUT ARE CRITICAL TO CLASSIFICATION OF DECK EL. 44'-0".
5) AT DECK EL 71'-0 5/16" HYDROCARBON RELEASE POINTS ENCLOSED WITH DASH LINE CIRCLE ARE LOCATED ON DECK EL. 104'-9" BUT ARE CRITICAL TO CLASSIFICATION THIS ELEVATION.

AREA CLASSIFICATION LEGEND

- CLASS I, DIVISION 2, GROUP D TO A HEIGHT OF 25 FEET ABOVE ANY HYDROCARBON RELEASE UNDER ABNORMAL OPERATING CONDITIONS FOR A HORIZONTAL DISTANCE OF 25 FEET
- UNCLASSIFIED AREA BY LOCATION OR PRESSURIZATION
- CLASS I, DIVISION 1, GROUP D

REFERENCE DRAWINGS

ELECTRICAL - AREA CLASSIFICATION ELEVATIONS - GOSP PLATFORM	P	XA-866426

FIGURE 14
HAZARDOUS AREA CLASSIFICATION DRAWING

SCALE 3/32"=1'-0" (0 5 10 15 20)

REV NO	DATE	BY	DESCRIPTION	CHK'D	CERT	APP'D
0	12-8-76	J.P.	ISSUED FOR CONSTRUCTION			

DRAWN BY J.C. SPEES CHECKED BY DWP SCALE 3/32"=1'-0"
DATE STARTED 09-13-76 DATE COMPLETED 10-14-76
OPR'G DEPT ENG DEPT

DRAWING PASSED
REVIEW AND IS ISSUED FOR CONSTRUCTION
BROWN & ROOT

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED. CERTIFIED DATE

ELECTRICAL-AREA CLASSIFICATION PLANS-GOSP PLATFORM

JOB ORDER NO | INDEX | PLANT NO | DRAWING NO | REV NO 0 buildings which define space and access requirements. Equipment is arranged in the building to maximize convenience and operator comfort. Figure 15 gives an example.

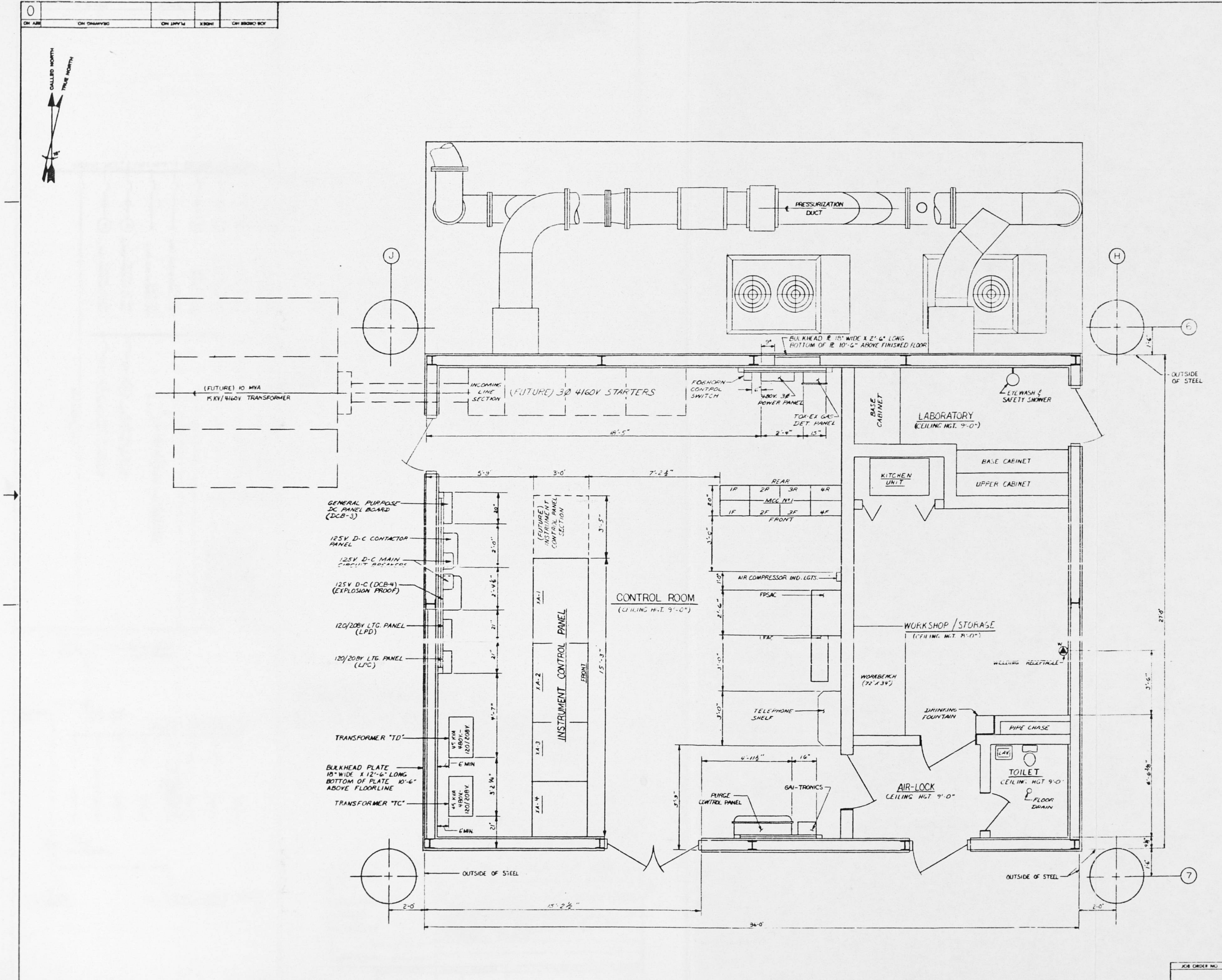
- <u>Electrical One Line Diagrams</u> shows schematically how electric power is distributed at different voltage levels to the main electric power consumers. Figure 16 gives an example.

- <u>Instrument Schematics</u> describe the control system logic used to actuate alarms and shutdowns. Figure 17 gives an example.

- <u>Schedules and Manpower Estimates</u> establish a baseline which is used to measure the contractor's performance during the Production Engineering Phase. Some schedules and manpower estimates are made as early as the proposal stage, but those published at the end of Conceptual Engineering reflect the refined scope of work and provide an excellent management control tool.

o <u>Production Engineering Phase</u>

This phase begins with the issue for client approval of the Scope Defining Documents. At this point, these documents should represent the final thinking of both



NOTES

1) BELOW D.C. LIGHTING & POWER PANELS, INSTRUMENT CONTROL PANEL GAS FIRE & PURGE PANELS & MOTOR CONTROL CENTER PROVIDE FLOOR PENETRATION CLEARANCE.

FIGURE 15
BUILDING LAYOUT
DRAWING

REFERENCE DRAWINGS

ELECTRICAL - PENETRATION PLAN & DETAIL CONTROL BUILDING	P	1A-B66433
ELECTRICAL - LIGHTING & COMMUNICATIONS PLAN CONTROL BUILDING	P	1A-B66461
ELECTRICAL - GROUNDING PLAN CONTROL BUILDING	P	1A-B66462
ELECTRICAL - POWER INSTRUMENTATION & FIRE PLAN CONTROL BUILDING	P	1A-B66463

DRAWING PASSED
REVIEW AND IS ISSUED FOR CONSTRUCTION
BROWN & ROOT

SCALE 1/2"=1'-0"

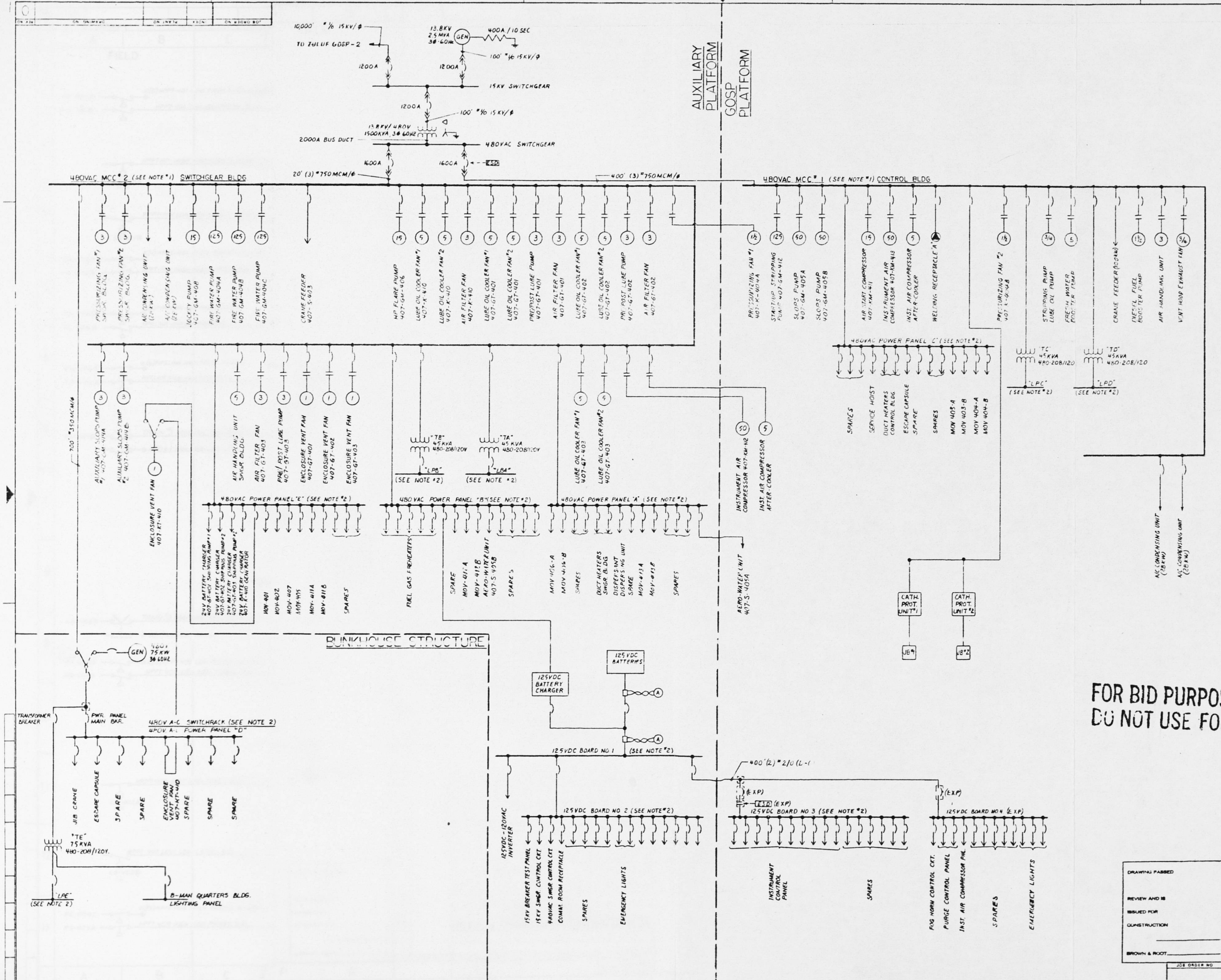
REV. NO.	DATE	BY	DESCRIPTION	CHK'D	CERT	APP'D
0	1-31-77	JCS	ISSUED FOR CONSTRUCTION			

DRAWN BY R. HARRIS CHECKED BY J.C. SPEES SCALE 1/2"=1'-0"
DATE STARTED 08-23-76 DATE COMPLETED 10-01-76
OPR'G DEPT ENG. DEPT
THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED. CERTIFIED DATE

ELECTRICAL - EQUIPMENT LAYOUT
CONTROL BUILDING - GOSP PLATFORM

JOB ORDER NO | INDEX | PLANT NO | DRAWING NO | REV. NO. 0

15
40



NOTES

1) FOR MCC STARTER & BREAKER SIZES SEE DWG'S XA-866365, XA-866366, XA-866367 & XA-866369
2) FOR POWER PANEL, LIGHTING PANEL & DC BOARD BREAKER SIZES & CKT NO'S SEE DWG'S XA-866451, XA-866452, XA-866453, & XA-866454.

LEGEND

ESD - EMERGENCY SHUTDOWN
LP - LIGHTING PANEL
EXP - EXPLOSION PROOF

FIGURE 16
ELECTRICAL ONE-LINE
DRAWING

FOR BID PURPOSES ONLY
DO NOT USE FOR CONSTRUCTION
MAY 19 1977

REV NO	DATE	BY	DESCRIPTION	CHK'D	CERT	APP'D
0	01/31/77	J.P.	ISSUED FOR CONSTRUCTION			

DRAWN BY DWP CHECKED BY J.P SCALE NONE
DATE STARTED 9-27-76 DATE COMPLETED 11-9-76

ELECTRICAL - ONE LINE DIAGRAM
OVERALL PLANT

BROWN & ROOT

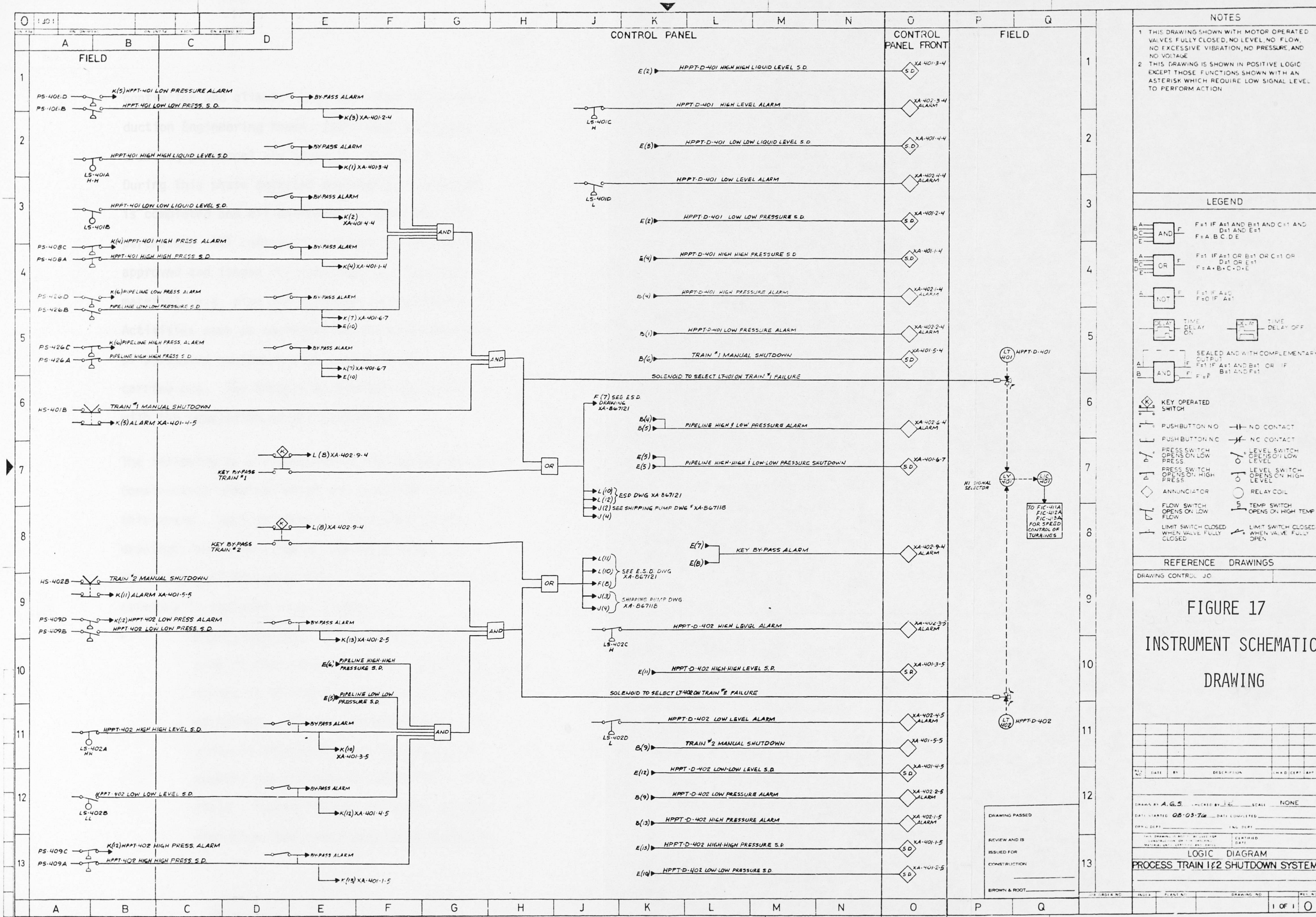


FIGURE 17

INSTRUMENT SCHEMATIC DRAWING

contractor and client. With the start of the Production Engineering Phase, additional engineering and drafting personnel are added to the task force. During this phase detailed engineering and design is completed and all equipment is specified and purchased. All construction drawings are completed, approved and issued for construction. All bulk material, e.g. pipe and fittings, is purchased. Activities such as coordinating the configurations of purchased equipment with piping designs are carried out. The Production Engineering Phase ends with the completion of all purchasing.

The following is a discussion of the categories of Construction Drawings which are completed during this phase. Each category includes many types of drawings, but only a few of the major types are identified and discussed here. Only one drawing per category is included as an example.

- <u>Piping Drawings</u>. Piping Plans show a top view of pipe routing and the location of valves in relation to vessels and other equipment. Piping Elevations show side views of pipe routing to supplement and clarify the information contained in Piping Plans. Piping Isometrics, which are made from plans and elevations, show three-dimentionally the routing of individual pipes. Piping Spool, drawings showing sections of pipe, are made from Piping Isometrics and are given to field welders to fabricate sections of piping. Figure 18 gives an example of a Piping Plan.

- <u>Instrument Drawings</u>. Instrument Point and Line Diagrams show the location of instrumentation on the platform. Instrument Piping Details show how the basic components of an instrument station (e.g. tubing, valves and instruments) are connected. Figure 19 gives an example of an Instrument Piping Detail Drawing.

- <u>Structural Drawings</u>. Jacket Elevations and Plans show the size and arrangement of the structural members of the jacket which is a space frame. Module Support Drawings show the size and arrangement of the frame members which support one or more pieces of equipment and associated piping. Figure 20 gives an example of a Jacket Elevation.

- <u>Electrical Drawings</u>. Routing Plans show the arrangement of the electric disturbution system on the platform. Detail Drawings

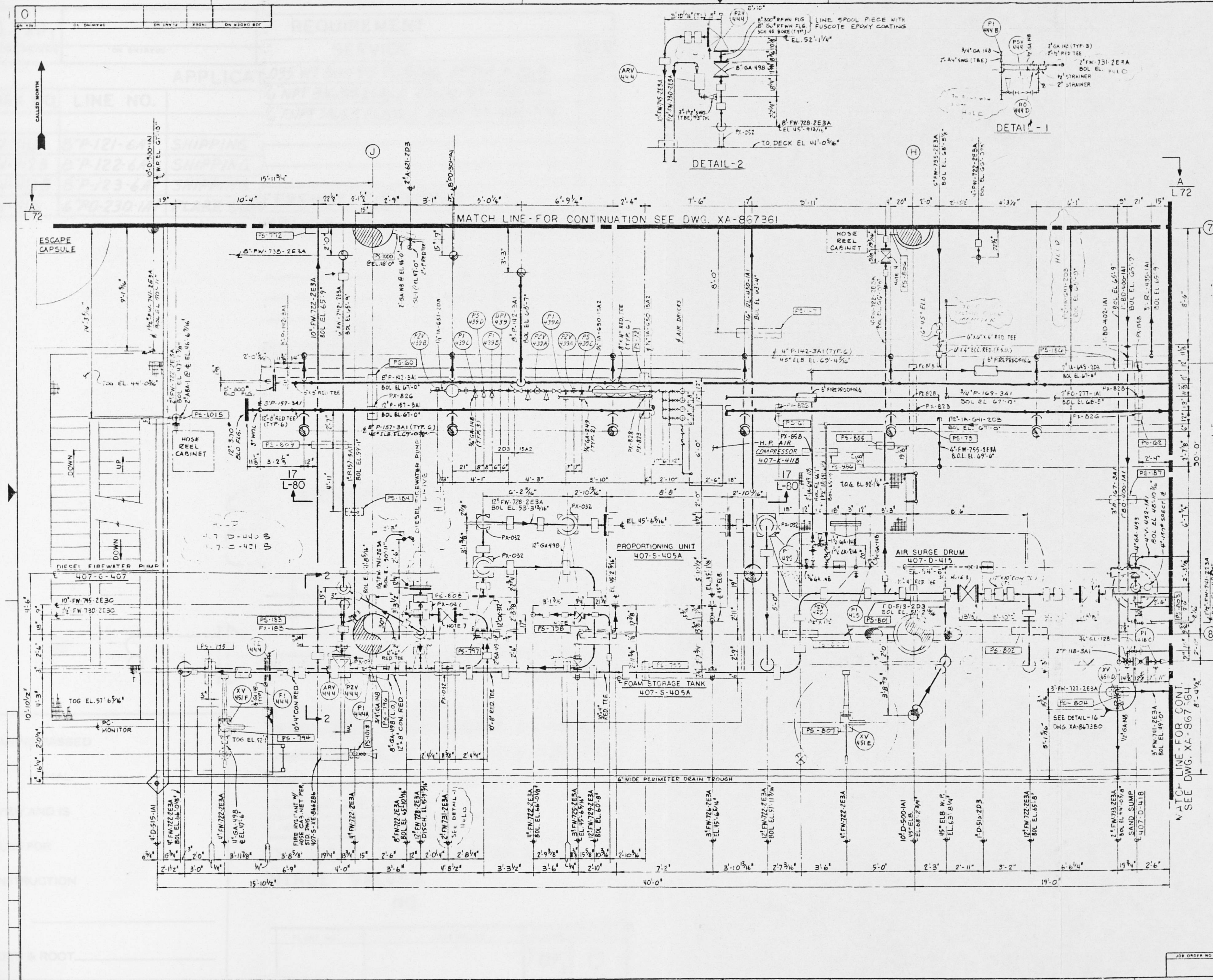


FIGURE 18

PIPING PLAN DRAWING

GENERAL NOTES

1. ALL ELEVATIONS REFER TO I.S.L.T. AS 0'-0"
2. SEE DWG XA 867435 FOR PIPE SUPPORT DETAILS
3. 10"GA-498 VALVES REQUIRE EXTENSION STEMS & 2'-8" HIGH FLOOR STANDS @ EL. 71'-0 3/16"
4. 4"GA-498 VALVE REQUIRES EXTENSION STEM & 2'-8" HIGH FLOOR STAND @ EL. 71'-0 3/16"
5. SEE DWG. XA-867435 FOR PIPE SUPPORT DETAILS.
6. [X.X.X] NUMBER IN RECTANGLE INDICATES PIPE SUPPORT.
7. 8"GA-498 VALVE REQUIRES EXTENSION STEM AND 2'-8" HIGH FLOOR STAND @ EL. 71'-0 3/16"
8. FIREWATER BRANCHES TO HYDRANTS AND HOSE REEL CABINETS WILL HAVE 3" THICK FIREPROOF INSULATION.

REFERENCE DRAWINGS

PIPING DRAWING INDEX G25P	XA 867336
EQUIPMENT LOCATION PLAN EL. 44'-0"	XA-867342
PIPING PLAN-EL 71'-0" WEST	XA-867352
PIPING PLAN-BELOW EL 44'-0" SOUTHWEST	XA 867361

FOR BID PURPOSES ONLY
DO NOT USE FOR CONSTRUCTION
MAY 19 1977

0 1 2 3 4 5
FEET

DRAWN BY SCV CHECKED BY H.S.R. SCALE 3/8" = 1'-0"
DATE STARTED 9-17-76 DATE COMPLETED 04-01-77

PIPING PLAN-ELEVATION 44'-0" SOUTHWEST
PRODUCTION PLATFORM

REV NO 0

0	1 OF 1				
REV. NO.	SHT. NO.	DRAWING NO.	PLANT NO.	INDEX	JOB ORDER NO.

APPLICATIONS

MARK NO.	LINE NO.	SERVICE
FCV-411B	8"P-121-6A1	SHIPPING PUMP G-401 MIN. FLOW
FCV-412B	8"P-122-6A1	SHIPPING PUMP G-402 MIN. FLOW
FCV-413B	8"P-123-6A1	SHIPPING PUMP G-403 MIN. FLOW
PCV-415	6"PO-230-1A1	FLARE SUMP PUMP DISCHARGE

MATERIAL REQUIREMENT

B & R S/N	NO.	NO.	SERVICE	QTY
82970120	88B	01-596-975	1/4" O.D. x .035" WT 304 SS TUBING ASTM A-269	20'
82113120	94B	03-374-615	1/4" O.D. x 1/4" NPT 316 SS MALE CONN-SS-400-1-4	1
82034520	96C	03-374-458	1/4" O.D. x 1/4" FNPT 316 SS FEMALE CONN-SS-400-7-4	1

REFERENCE DRAWINGS

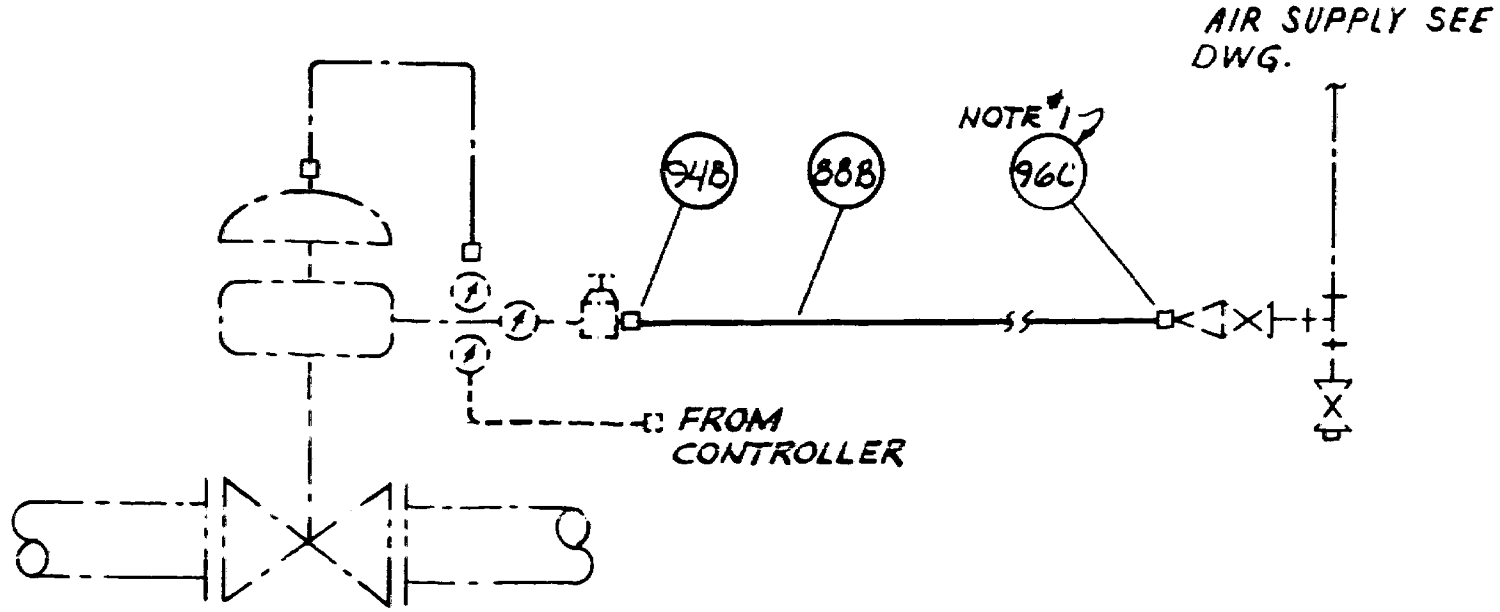
DESCRIPTION	IDX	DWG. NO.

NOTES

1. ALL TUBE FITTINGS TO BE "SWAGELOK"

FIGURE 19

INSTRUMENT PIPING DETAIL DRAWING



REV. NO.	DATE	BY	DESCRIPTION	CHK'D	CERT.	APP'D

DRAWN BY R. COBB CHECKED BY A.G.S. SCALE: NONE

DATE STARTED 01-05-77 DATE COMPLETED 4-22-77

OPR'G DEPT. ____ ENG. DEPT. ____

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATERIAL UNTIL CERTIFIED AND DATED

CERTIFIED DATE DH 4-22-77

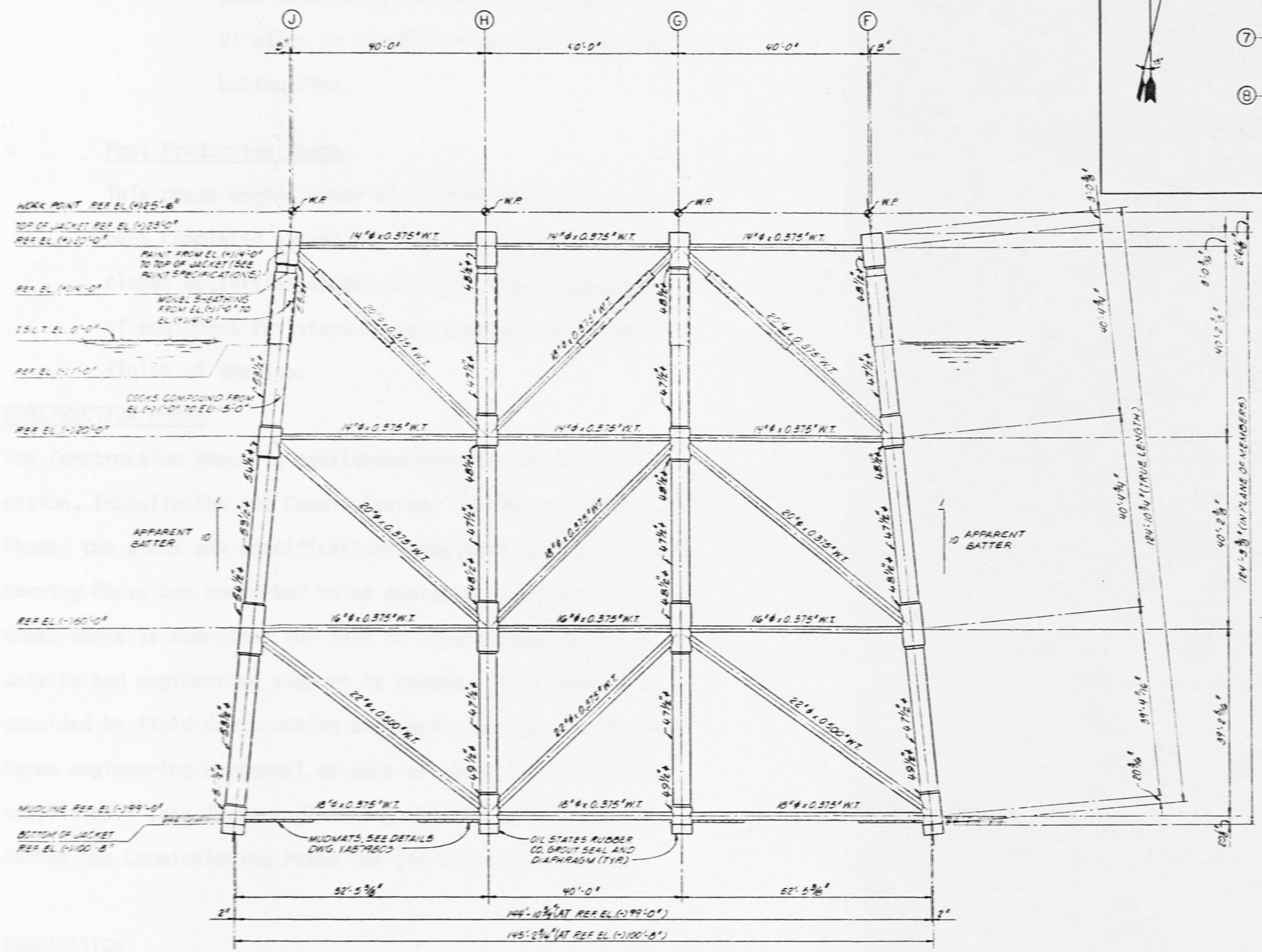
DRAWING PASSED FINAL REVIEW AND IS ISSUED FOR CONSTRUCTION

BROWN & ROOT ____

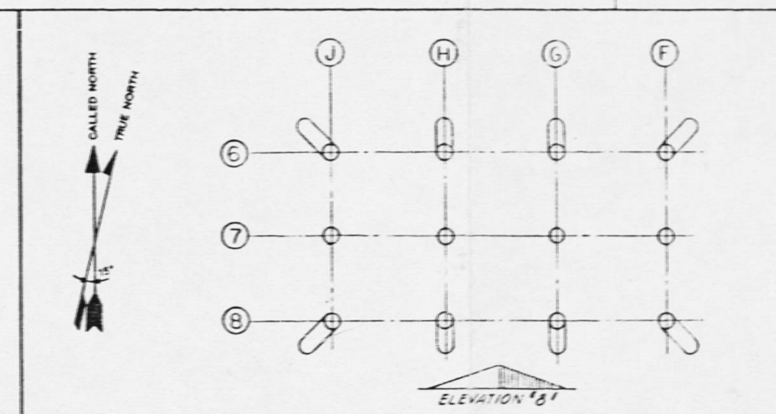
MAY 19 1977

INSTRUMENT PIPING DETAILS CONTROL VALVES NO.

JOB ORDER NO.	INDEX	PLANT NO.	DRAWING NO.	SHT. NO.	REV. NO.
				1 OF 1	0



ELEVATION "8"



KEY PLAN

N.T.S.

NOTES:

1. FOR MATERIAL SPECIFICATIONS REFER TO SPECIFICATION NUMBER
2. FOR SURFACE PREPARATION AND COATING SPECIFICATIONS REFER TO SPECIFICATION NUMBER
3. ALL MONEL SHEATING SHALL BEGIN AT ELEVATION (-)1'-0" AND EXTEND APPROXIMATELY TO ELEVATION (+)14'-0". ACTUAL SHEATING LENGTH SHALL BE ROUNDED OFF TO NEAREST ONE-HALF (1/2") INCH.

FIGURE 20

JACKET ELEVATION DRAWING

REFERENCE DRAWINGS	
JACKET ELEVATION "6"	XA879782
JACKET ELEVATION "7"	XA879783
JACKET ELEVATION "8"	XA879785
JACKET ELEVATION "G"	XA879786
JACKET ELEVATION "H"	XA879787
JACKET ELEVATION "J"	XA879788
JACKET PLAN AND WALKWAY AT EL-20'-0"	XA879792
JACKET PLAN AT EL (-)20'-0"	XA879793
JACKET PLAN AT EL (-)60'-0"	XA879794
JACKET PLAN AT EL (-)99'-0"	XA879795
JACKET FRAMING DETAILS	XA879800

DRAWN BY E.ROSAS CHECKED BY SCALE 3/32"=1'-0"

DATE STARTED 10-05-76 DATE COMPLETED

JACKET ELEVATION "8"

PRODUCTION PLATFORM

3

show details of wiring connections. Figure 21 gives an example of an Electrical Distribution Plan.

o Post Production Phase

This phase begins after all office engineering has been completed except for minor revisions. It includes activities associated with final preparation of equipment for start-up and concludes with the finish of the job.

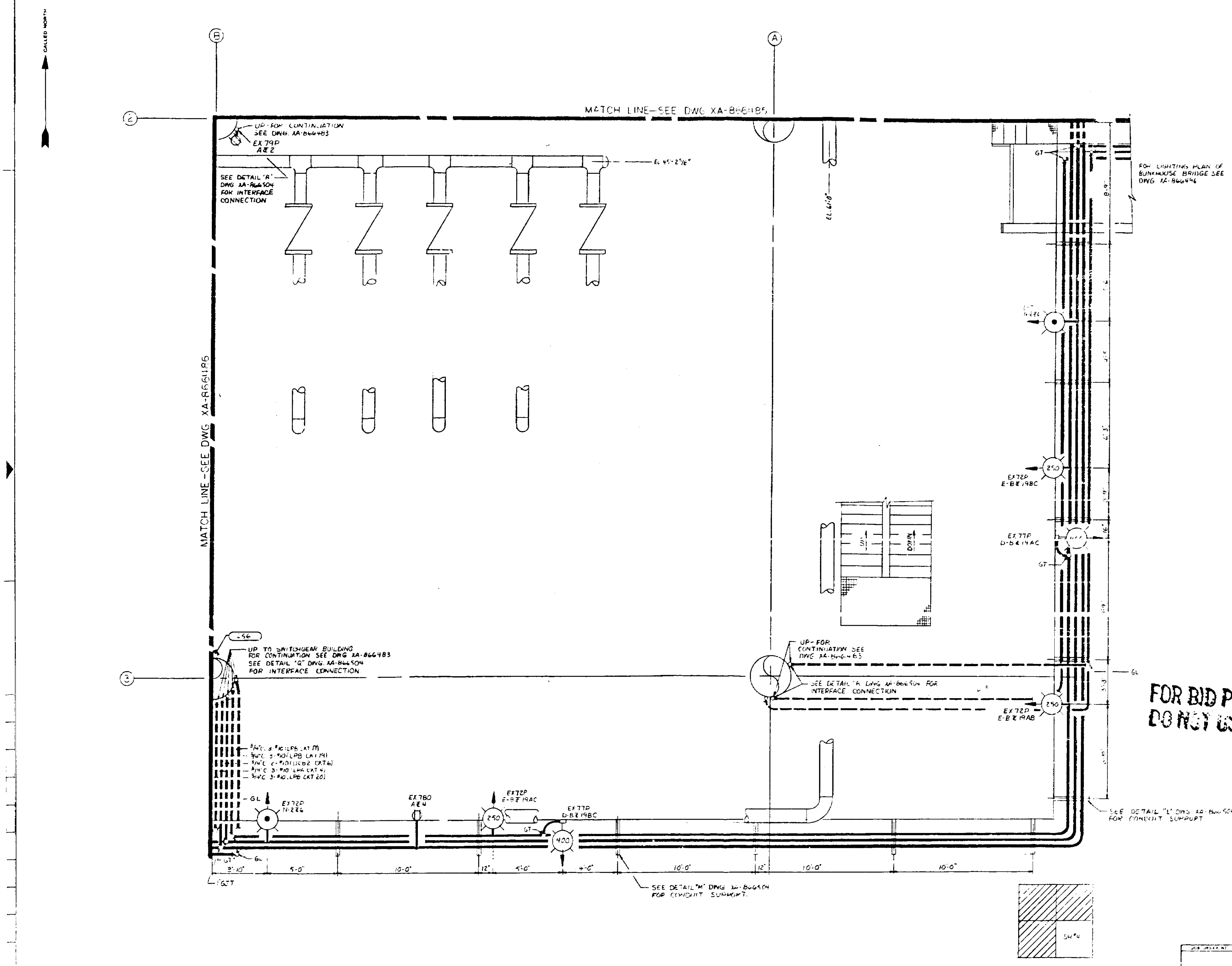
3.2.2.3 CONSTRUCTION PHASE

The Construction Phase is considered here to consist of Fabrication, Installation and Commissioning. During the Construction Phase, the plans and specifications developed during the Engineering Phase are converted to an operative facility. At this time, there is sometimes the need to adjust some small design details and engineering support is needed. This support is provided by field construction engineers and some of the task force engineering personnel as part of their Post Production activities. Task force engineering support is also needed during the Commissioning Phase for start-up preparations.

3.2.2.3.1

FABRICATION

Fabrication is the activity of assembling the vessels, piping and other equipment into the modules that are transported offshore, lifted onto the platform and connected with other modules. To reduce costs, as much fabrication as possible



NOTE

FOR GENERAL NOTES, SYMBOLS & FIXTURE SCHEDULES SEE DWG XA-866484

FIGURE 21

ELECTRICAL DISTRIBUTION LAYOUT DRAWING

REFERENCE DRAWINGS		
ELECTRICAL - POWER, INST. & FIRE PLAN DECK EL 43'-6" - AUXILIARY PLATFORM	[illegible]	XA-866[illegible]
ELECTRICAL - GROUNDING PLAN DECK EL 43'-6" AUXILIARY PLATFORM - SH 4	[illegible]	XA-866523
ELECTRICAL - STD LIGHTING DETAILS STANCHION MOUNTED - EX72P	P	[illegible]
ELECTRICAL - STD LIGHTING DETAILS FLOODLIGHT - EX77P	P	[illegible]
ELECTRICAL - STD LIGHTING DETAILS RECEPTACLE COLUMN MTD - EX79P	P	[illegible]
ELECTRICAL - STD LIGHTING DETAILS RECEPTACLE RAIL MOUNTED - EX78O	P	[illegible]

FOR BID PURPOSES ONLY
DO NOT USE FOR CONSTRUCTION

MAY 19 1977

ELECTRICAL - LIGHTING & COMM. PLAN DECK EL 43'-6" - AUXILIARY PLATF. - SH 4 is done onshore because it is expensive to maintain manpower and equipment offshore. The production equipment which was specified and ordered during the Production Engineering Phase is delivered to the fabrication site, fastened to the module structure, piped-up, insulated and painted. Some of the labor crafts needed for these activities are welders, millwrights, crane operators, electricians, instrument technicians, insulators and painters. It is important that the efforts of these craftsmen be planned and controlled in order to complete the modules on schedule because a delay in the completion of a module could make its installation offshore difficult due to the seasonal weather factor.

Occasionally an item of equipment can not be delivered on schedule and could delay the load-out date for the module. In such cases the module may be shipped to the offshore site without the late equipment. This will cause an increase in the cost of fabrication because the equipment must then be installed offshore. However, waiting for the equipment to be delivered so that fabrication can be completed onshore may have a catastrophic effect on the installation schedule in that offshore installation may be seriously delayed because of bad weather. Weather-windows are of paramount importance in the scheduling of offshore installation.

3.2.2.3.2

INSTALLATION

Installation is the process of assembling and connecting the componenets which were fabricated onshore at the final offshore locations. Installation therefore includes such activities as fixing the supporting jacket to the ocean floor, lifting the modules onto the jacket and fastening them in place, interconnecting the modules and laying subsea pipelines. As mentioned in the discussion of fabrication, weather has a great impact on the installation process due to the difficulties caused by heavy seas.

As compared with engineering and fabrication, relatively few companies possess the installation capabilities of Brown & Root. Necessary equipment such as derrick barges and pipe laying barges are specialized and very expensive.

3.2.2.3.3

COMMISSIONING

This is the final preparation of the facilities for operation and includes such activities as pressure testing the piping and vessels, check-out of instrumentation, check-out of electrical systems and check-out of all of the subsystems that were bought already packaged. Also included in commissioning is filling the production equipment with lube oil, glycol and diesel fuel. It is often desirable to "pre-commission" systems, i.e. make these systems operational onshore before they are transported to the offshore site. The incentive for pre-commissioning lies in the high cost of performing work offshore.

3.2.3 TASK FORCE APPROACH

This approach differs fundamentally from the classical bureaucratic approach in that the task force is created with the knowledge that it will soon disintegrate; to the contrary, a bureaucracy tends to maintain the status quo. The designated engineering project manager leads the engineering task force until the engineering design has been completed. Other key personnel are assigned to the task force for the duration of the job, but many personnel are assigned only on a part time basis. The task force grows and diminishes in number according to the demands of the job. A typical organization chart for a task force dedicated to performing engineering design, procurement and construction supervision services is shown in Figure 22.

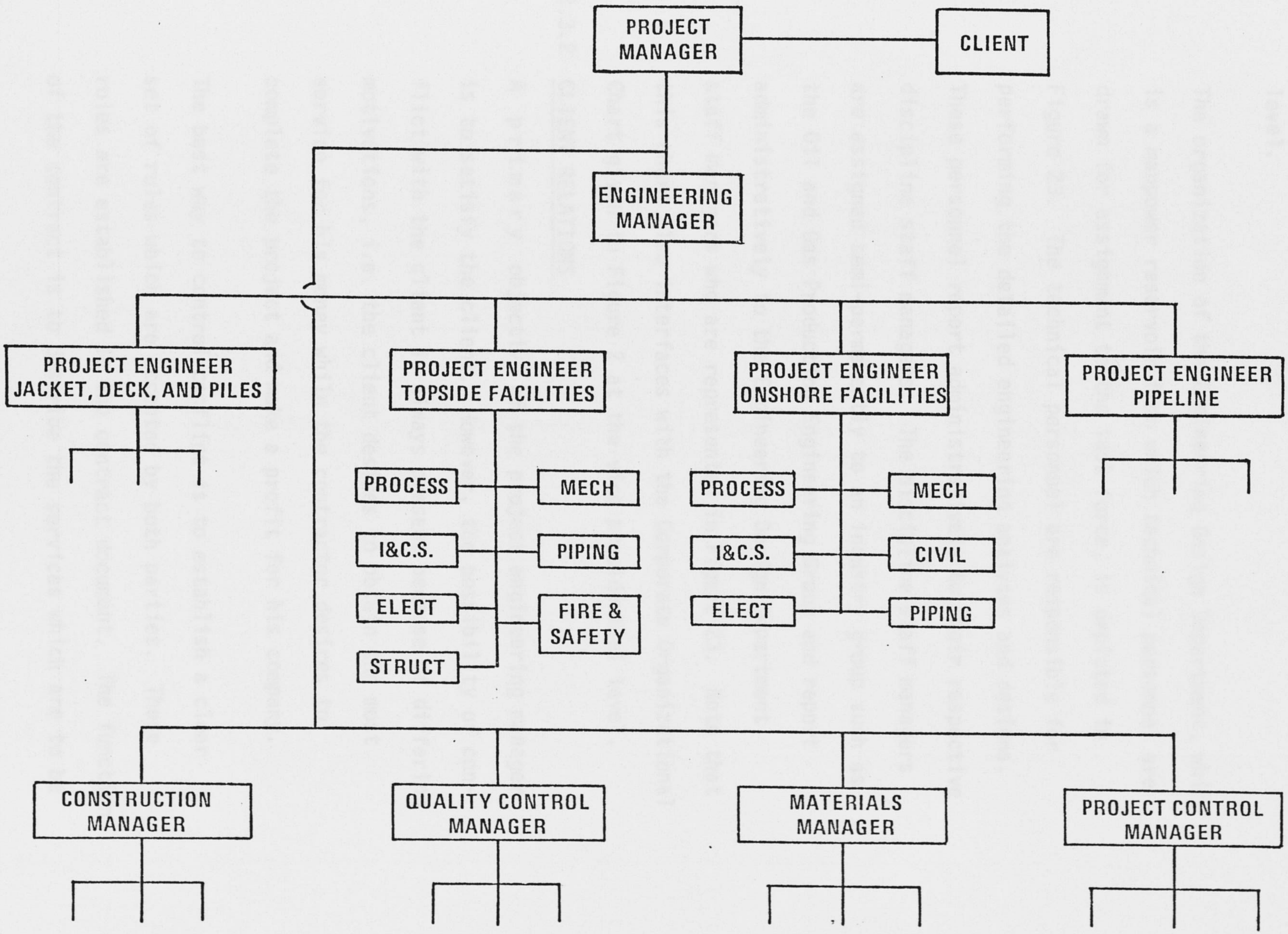
In an engineering and construction contract the engineering task force is part of a larger task force organization. However, the following discussion will be primarily directed toward the engineering task force.

3.2.3.1 THE TASK FORCE/CORPORATE ORGANIZATIONAL RELATIONSHIP

The task force is a combination of two groups of personnel - a management group and a technical group. Project engineering managers, project engineers and assistants are drawn from the management group and provide coordinative and administrative services. The management group's structure was shown in Figure 3. Note that this chart interfaces with the corporate organization chart given in Figure 2 at the vice presidential

FIGURE 22

TASK FORCE STRUCTURE



level.

The organization of the Engineering Design Department, which is a manpower reservoir from which technical personnel are drawn for assignment to the task force, is depicted in Figure 23. The technical personnel are responsible for performing the detailed engineering analyses and designs. These personnel report administratively to their respective discipline staff managers. The discipline staff managers are assigned semi-permanently to an industry group such as the Oil and Gas Production Engineering Group and report administratively to the Engineering Design Department staff managers who are represented in Figure 23. Note that this chart also interfaces with the Corporate Organizational Chart given in Figure 2 at the vice presidential level.

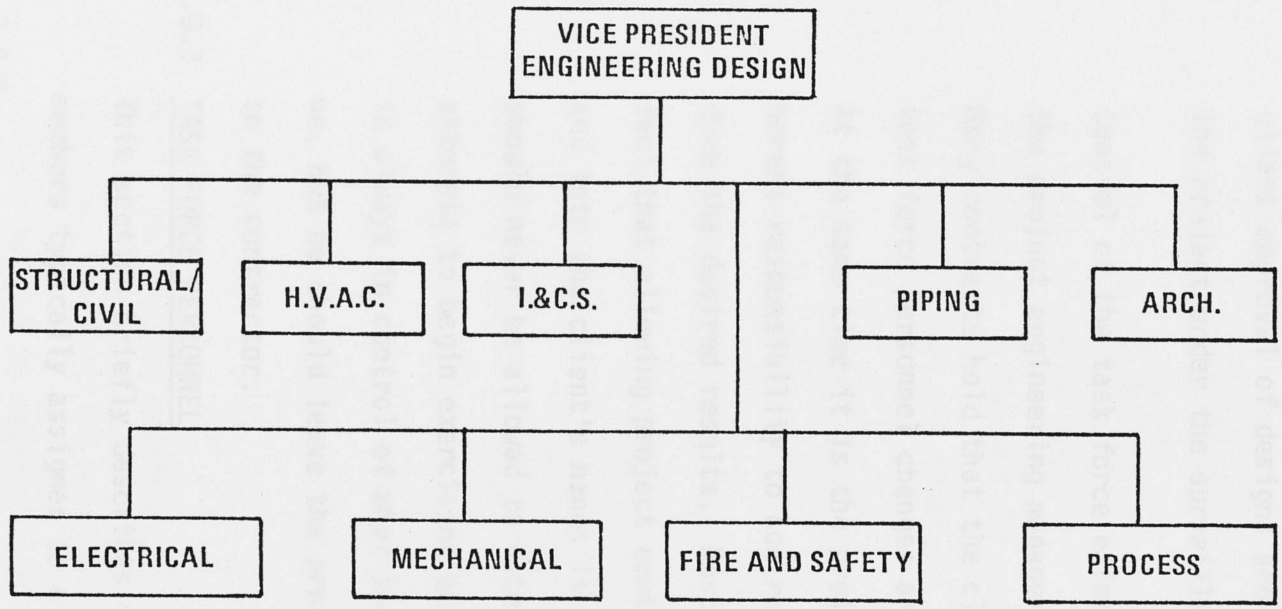
3.2.3.2 CLIENT RELATIONS

A primary objective of the project engineering manager is to satisfy the client. However, the possibility of conflict with the client is always present because of differing motivations, i.e. the client desires to obtain the most service for his money while the contractor desires to complete the project and make a profit for his company.

The best way to control conflict is to establish a clear set of rules which are accepted by both parties. These rules are established in the contract document. The function of the contract is to describe the services which are to be

FIGURE 23

ENGINEERING DESIGN DEPARTMENT STRUCTURE



provided to the client and the remuneration to the contractor. Various procedures are defined in the contract concerning reports to be submitted to the client, procedures for obtaining client approval of designs and other procedures for executing the project under the surveillance of the client.

Control of the task force effort is an issue which requires the project engineering manager to sometimes "walk a tightrope". Many contracts hold that the client has the right to request task force personnel changes and make other project decisions. At the same time it is the project engineering manager's inherent responsibility to control the task force so as to produce the desired results. Most project engineering managers feel that allowing project control to slip out of his hands and into the client's hands is a grave problem. Matters should never be allowed to deteriorate so much that the client attempts to begin exercising excessive control. The client is always in control of what the features of his facility will be, but he should leave the process of developing the designs to the contractor.

3.2.3.3 TASK FORCE PERSONNEL

This section briefly describes the function of the task force members typically assigned to a design and procurement project.

3.2.3.3.1

PROJECT ENGINEERING MANAGER

This member is reponsible for the successful completion of engineering and procurement. Although it is necessary for this person to have the technical background needed for communicating on technical problems, his job is primarily management. He interacts with the client, plans and organizes the execution of the project, monitors its progress and takes corrective action to insure that the work is completed in accord with the governing contract. His job is not to delve into the technical details of all areas of the project, but to establish guidelines for performance and see to it that these guidelines are observed.

His involvement in the project begins as early as the pre-contract, business development phase. He is typically responsible for writing the proposal and his involvement can extend through construction to the start-up of the facility.

3.2.3.3.2

PROJECT ENGINEER

This position is similar to that of the project engineering manager except that the scope of his assignment is smaller. This reduction in scope allows more attention to administrative and technical detail.

While the project engineer is not deeply involved in technical details, his position as an information center enables him to detect and act on major design coordination problems. During the course of the work, those engaged in the details of their specialty are responsible for interfacing with the other specialties to maintain the compatibility of designs. The project engineer double checks the main design interfaces and his position as a supervisor allows him to take corrective action if necessary.

The project engineer handles more administrative detail than the project engineering manager. For example, he approves or modifies the weekly time cards which show manhour expenditures charged against his area of the project. His familiarity with the engineering activities in his area provide a basis for making these decisions. It would be difficult for the project engineering manager to keep abreast of these activities in sufficient detail to make all such judgements for a large project with many task force members.

3.2.3.3.3

DISCIPLINE ENGINEERS

These personnel supply the specialized engineering knoweldge required to design the facilities. Their efforts are supplemental by designers, draftsmen and other technicians. The following discussion outlines the functions of the discipline engineers who produce offshore platform and facility designs.

o Process Engineers - These engineers are responsible for the process design of the oil and gas processing facilities. The process design affects the direction of all other disciplines activities. Process design and process data are therefore developed early in the project. Process engineering activities include:

- Producing and revising flow diagrams to document the system design of process and utility (cooling water, hot oil, etc.) systems.

- Performing the heat and material balance calculations required for subsequent sizing of equipment and pipes.

- Providing pressure, temperature and other process data to other disciplines as required for their calculations.

- Identifying hazardous areas of the plant which impact electrical equipment specifications and personnel protection systems.

- Working with the instrumentation discipline to establish control systems philosophy.

o <u>Mechanical Engineers</u> - These engineers are responsible for material and equipment analysis and specification. Their activities include:

- Performing calculations, based on the heat and material flows established by process engineering, needed to complete the sizing and specification of major equipment (e.g. heat exchanger tube sizing and pump specification).

- Determining flow rates of steam, refrigerant, fuel and other utilities based on exchanger duties and power requirements.

- Performing stress analysis on piping and piping supports.

- Specifying hot and cold insulation.

- Specifying welding materials and procedures.

- Designing corrosion control systems.

o <u>Electrical Engineers</u> - These engineers are responsible for electrical system design as well as analysis and specification of electrical equipment and materials. Their acitivities include:

- Determining voltage and load requirements for instrumentation, electric heating and other electrical devices.

- Producing the electrical one-line diagrams which document the electrical distribution system design.

- Producing electrical location drawings showing the distribution system layout.

- Assessing power generation alternatives in view of present and future electrical load requirements.

- Interfacing with the instrumentation discipline in communications and control systems design.

o **Instrumentation Engineers** - These engineers are responsible for designing the systems which control the process and utility operations. It is necessary for instrumentation engineers to work closely with the process engineers to establish the control systems because the latter can provide insight on the relationships among the operating variables. It is necessary for the instrumentation engineer to interface with the electrical engineers because much of the newer instrumentation is electronic. Activities include:

- Providing input during the development of process and utility flowsheets to document control system philosophy.

- Performing design calculations for control valves, relief valves and flow instrumentation.

- Producing drawings documenting instrument air distribution systems and locations of control elements on the platform.

- Preparing procurement specifications for instrumentation.

o <u>Safety and Fire Protection</u> - These engineers specialize in designing fire protection and safety stystems. Activities include:

- Reviewing process and utility flow diagrams to identify flammable, reactive or toxic substances.

- Providing input in the determination of equipment arrangement to insure compliance with applicable safety codes.

- Specifying fire protection requirements for packaged equipment such as gas turbines and fired heaters.

- Preparing fire protection system flow diagrams.

- Writing specifications and preparing technical evaluations of equipment.

o <u>Piping</u> - These personnel are primarily draftsmen and technicians rather than degreed engineers. A characteristic of a good piping draftsman is the ability to visualize piping and equipment configurations in three dimensions. Activities include:

- Producing finished process and utility flow diagrams from conceptual sketches made by engineers.

- Conducting equipment arrangement studies and making equipment arrangement drawings.
- Making piping plan drawings which show pipe size and routing between equipment.
- Making piping isometric drawings which clarify routing and material quantities for individual pipelines.
- Compiling lists of piping materials.

o <u>Structures</u> - These engineers specialize in the design and analysis of the structures which are immersed in the water and elevate the production facilities above the water level. Activities include:

- Designing the "jacket" which supports the production facilities and is fastened to the ocean floor.
- Analyzing the jacket's integrity with respect to equipment weight, waves, wind, earthquake and boat collisions.
- Designing and analyzing decks and modules which support the production equipment during installation and operation. Often the stresses caused by lifting the modules off of the transport barge control the structural design of the module.

3.2.3.3.4

PROJECT CONTROL PERSONNEL

These personnel provide the administrative and technical assistance needed by the project manager to detect variations from project plans in time to allow any necessary corrective action to be taken.

- Planning and Scheduling - These personnel assist in the management of the project in two basic ways. Firstly, they assist in the planning of the project by documenting the division of responsibilities of task force personnel, planning manpower requirements and planning the sequence and timing of events that must occur to complete the project in accordance with the client's timetable. Secondly, these personnel operate management information systems which allow the project management to assess the completion status of the project in relation to manhour expenditures.
- Cost Estimating - These personnel become important in projects which include responsibility for equipment procurement, fabrication, and installation. Costs are controlled by making a cost estimate based on the existing design philosophy, tracking actual costs, comparing the actual costs to estimated costs to identify deviations and then taking corrective action as necessary. During the engineering of a job, the cost estimator establishes estimates to reflect current

design refinements as well as the increasingly precise information available for estimating. The improved accuracy of cost estimates in turn allow more precise control of costs.

On "engineering-only" contracts, cost is essentially controlled by controlling engineering mahour expenditures and this is monitored by the planning and scheduling function. On contracts involving responsibility for construction, cost also includes equipment costs and construction labor costs. These additional components of cost necessitate the cost estimating function to assist in controlling total cost of the project.

3.2.3.3.5

MATERIALS MANAGEMENT PERSONNEL

The systems which Brown & Root engineer and construct are composed of materials and equipment obtained from vendors. The materials management function monitors and coordinates the procurement process from the point at which material requirements are specified by engineering until the material is issued to field craft personnel for use.

o Material Control - These personnel perform coordination activities during the Engineering Phase. Activities include:

- Providing information on equipment deliveries to scheduling.

- Coordinating the movement of vendor equipment drawings and specifications among engineering disciplines.

- Coordinating the assembly of equipment specification packages for forwarding to Brown & Root's purchasing agents who interact with the equipment vendors.

- Serving as liason between engineering and purchasing by providing the technical information developed by engineering to purchasing agents in a convenient form.

o Purchasing - These personnel are agents of Brown & Root and have authority to bind the Company in an agreement with others without incurring personal liability for committments. Purchasing agents stay abreast of market conditions and use the marketplace to negotiate favorable bargains for equipment and materials.

o Expediting - These personnel are responsible for monitoring the progress of fabrication in vendor's shops. When it appears that the vendor may not be able to deliver the goods on the promised delivery date, the expeditor brings this fact to project management's attention early enough to allow corrective action to be taken to minimize disruption of the project schedule.

- o Traffic - These personnel are responsible for arranging safe, timely and economical transport of materials and equipment by water, air, or land.

- o Quality Control - These personnel inspect purchased equipment and materials, usually at the vendor's shop, to insure that the goods comply with the procurement specifications issued by Brown & Root. It is not prudent to blindly assume that vendors will strictly comply with these specifications on critical items of equipment because errors, if not detected early, could disrupt the project schedule severely.

3.2.3.4 TASK FORCE MANAGEMENT

This section further discusses the function of the project engineering manager. Included are discussions of the functions of management, the tools of management and management problems.

3.2.3.4.1

FUNCTIONS OF MANAGEMENT

The management process is customarily divided into five functions: planning, organizing, staffing, directing and control.

- o Planning

  The project engineering manager reviews the goals of the project as stated by the client and then, with staff assistance, establishes the sequence and timing of events and the amount and timing of resources needed to meet the goals. This plan represents a baseline from which performance can be measured and project execution controlled.

o Organizing

The project engineering manager evaluates the alternatives for the organizational structure through which the work will be executed. He would consider here, for example, whether project engineers should be assigned by functional subgroups, e.g. a project engineer to coordinate the design of all jackets in complex of several platforms; or by subproject, e.g. a project engineer to coordinate the design of a complete platform - topworks and jacket. He also determines which disciplines will be required under each project engineer. Finally he outlines the structure of other groups as dictated by the scope of work.

o Staffing

The project engineering manager chooses from among those individuals who are available for assignment and have the skill and training necessary for the positions in the task force. This function also involves providing for the training of individuals as necessary and evaluating their performance.

o Directing

The project engineering manager activates and guides the project by directing those who report to him.

Using the established plan as a guide and considering new circumstances, he defines what is to be done and initiates action. The methods used to execute his directives are largely left to subordinates, who operate within guidelines.

o Control

When the project is underway, the project engineering manager monitors progress and compares this to the existing plan. If important variations exist, then he takes corrective action such as increasing or decreasing resources, making personnel changes, modifying procedures, or whatever is necessary to bring the project back toward the plan. In some cases, as when the scope of the project has been changed, it is necessary to modify the overall plan, thus establishing a new baseline for control.

3.2.3.4.2

TOOLS OF MANAGEMENT

The project engineering manager requires several sets of tools for carrying out his management functions.

o Communication Skills

It is necessary to be a polished communicator. As stated above, a prime function of the project engineering manager is to direct others on what is to be done - this requires clear communications. Additionally, he is continuously interacting with the client and it is important that these communications remain clear and effective in spite of the inevitable conflicts and pressures which arise in the client-contractor relationship.

o Engineering Skills

Although the project engineering manager is not actively engaged in solving technical problems, he must be aware of the main technical issues. In order to stay abreast of issues, such as discipline interfaces and the schedule and cost impact of design decisions, he must have sufficient technical knowledge to communicate effectively with the personnel directly involved with the technicalities.

o Management Information Systems

These systems produce reports which should make problem areas apparent and allow indepth review of pertinent data when requested. These Management Information Systems are maintained and operated by staff members.

o Standardized Procedures

At the beginning of the job, a project procedures manual is written which establishes guidelines for checking drawings, filling out time cards and other routine matters. This manual is published and distributed to supervisory personnel in the task force. In addition to standardizing such administrative procedures, it is advantageous to standardize calculation procedures insofar as possible. The strongest argument for selecting an experienced engineering contractor is that experience allows just such standardization and minimizes the risk associated with new approaches.

3.2.3.4.3

MANAGEMENT PROBLEMS

The following is a brief and general discussion of management problems faced by the project engineering manager.

o Communications

Communications problems arise for many reasons - haste, pressure, emotions, distance and language differences within the task force itself. Some engineering design projects are joint efforts with companies based in foreign countries and technical translation becomes a significant problem.

o Personalities

Personality conflicts can occur because of status or pay differences among workers among other reasons.

o Scope Definition

Textbook procedures call for firm scope definition before initiation of detailed engineering work. In practice, some elements of scope definition are unresolved after detailed engineering begins. This is often troublesome because some client-initiated changes are made after considerable detailed engineering has been completed and necessitate some work being done over. This in turn causes budget and schedule problems which must be justified to the client. The challenge for the project engineering manager is to integrate conceptual and detailed engineering work such that wasted effort is minimized while completing the project as soon as possible.

o Manpower Assignment

The execution of engineering design involves a network of ordered steps, certain tasks of which must be completed before succeeding steps can be initiated. Consequently, it is nearly impossible to maintain a uniform workload on all assigned personnel - sometimes personnel will be temporarily idle awaiting completion of work by others. A common manpower loading problem occurs at the outset of a job when several personnel are immediately assigned to the project and not enough information is available to allow each individual to proceed with his work. In these cases the challenge for the project engineering manager is to find productive work for assigned personnel when they would otherwise be idle awaiting the completion of work by others.

3.3 ASSIGNMENTS

This section summarizes several of my work assignments at Brown & Root to demonstrate that I did make an "identifiable contribution" to the company during my internship. The preponderance of these assignments was a part of what I have previously defined to be the Commerical Phase of Brown & Root's activity because this was the area which was receiving much of our department's and my internship supervisor's attention during this time period. In all of the assignments except 3.3.5, a construction proposal, I worked with my internship supervisor. In 3.3.5, I worked with Ron Rabon, who is also a member of the Oil and Gas Production Engineering Department.

Although one of the following assignments involves providing assistance during the preparation for a construction proposal, my acitivites were within an Engineering Department and the following narrative tends to reflect that viewpoint.

Each of these assignment reports has been written to a standard format.

3.3.1 QUALIFICATIONS BROCHURES

3.3.1.1 OBJECTIVE

The objective of this assignment was to prepare qualifications brochures and transmit these to prospective clients. Each brochure issued was specifically prepared to describe Brown & Root's qualifications for performing particular engineering services which would be required in connection with a particular project that a client had in the offing.

3.3.1.2 TASK DESCRIPTION

3.3.1.2.1

BACKGROUND

When Brown & Root learns that a client will require engineering services for studies or engineering design, the Company takes steps to obtain an invitation to bid, i.e. to receive a tender document for the project. One important step in this direction is the preparation of a qualification brochure which presents Brown & Root's experience and capabilities to the client and demonstrates that the Company is qualified to perform these services.

Since the activity level of our department was decreasing, with the expiration of several large projects, business development activity was given a high priority. It was foreseen that qualifications brochures would be issued to several different clients regarding various projects. In order to streamline the preparation of these brochures, a standard format was developed and adopted so that the books could be produced in a minimum amount of time after recognizing the need for a brochure. Simultaneously, it is necessary to maximize the impact of the information presented by excluding information not relevant to the potential project in question, thus making the brochure appear to be tailor-made for each project.

The following is a listing of the brochures issued under our standard format during my internship:

o IIAPCO - gas processing and injection facilities in Indonesia

o UNION OF CALIFORNIA - gas processing and transmission facilities in the Gulf of Thailand

o TEXAS PACIFIC - gas processing and transmission facilities in the Gulf of Thailand

- o CITIES SERVICE - gas processing facilities in the Gulf of Mexico
- o SHELL - oil production, pipeline and storage facilities offshore Nigeria
- o GULF - natural gas liquids extraction and gas compression facilities offshore West Africa.

3.3.1.2.2

SCOPE OF ASSIGNMENT

The first step was to determine the nature of the project under consideration; e.g. waterflood, gas injection or gas production; so that the contents of the brochure may be pointed toward the client's interests. In the simplest case, this could be determined by the correspondence from the client to Brown & Root. In some cases, however, there was no direct correspondence from the client and it became necessary to determine the characteristics of the project from other sources such as trade journals, personal contacts, etc.

The content and organizational structure of the brochure was then selected. Those sections of paramount interest to the client would appear first in the brochure. The Table of Contents in Figure 24 illustrates the organization of a typical brochure.

Using the Table of Contents as a guide, the following information was summarized for inclusion.

FIGURE 24

TABLE OF CONTENTS FOR QUALIFICATIONS BROCHURE

CONTENTS

COVER LETTER

SECTION 1.0 INTRODUCTION

SECTION 2.0 BROWN & ROOT INC. ORGANIZATION

- 2.1 General
- 2.2 Chart

SECTION 3.0 PROJECT PERSONNEL

- 3.1 General
- 3.2 Resumes

SECTION 4.0 FEASIBILITY AND CONCEPTUAL STUDY EXPERIENCE

- 4.1 General
- 4.2 Feasibility Studies
- 4.3 Conceptual Studies

SECTION 5.0 ENGINEERING AND CONSTRUCTION EXPERIENCE

- 5.1 General
- 5.2 Experience Summaries

SECTION 6.0 BROWN & ROOT (SINGAPORE) PTE. LTD.

- 6.1 General
- 6.2 Volume of Business
- 6.3 Staffing
- 6.4 Technical Facilities

SECTION 7.0 COMPUTER SERVICES

- 7.1 General
- 7.2 Computer Programs (Applicable)

SECTION 8.0 PHOTOGRAPHS

SECTION 9.0 JOURNAL ARTICLES

- o Available computer programs
- o Previous experience on studies
- o Previous experience on detailed engineering design
- o Capabilities of Brown & Root branch offices

Relevant photographs of completed facilities were also selected and included in the brochure.

The standard text was written and entered on a computerized word processing system. This system allowed changes to be made to the standard text in a minimum of time.

3.3.1.2.3

NATURE OF MY FUNCTION

I was responsible for developing the standard text for the brochures. Thereafter, I was called on to adjust the standard brochure by emphasizing certain Brown & Root capabilities relevant to the project at hand. I coordinated certain administrative tasks which were necessary in the production of these books such as ordering covers, dividers and arranging for clerical manpower to physically assemble the brochures.

3.3.1.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.1.3.1

ENGINEERING KNOWLEDGE

In order to present a description of Brown & Root's computer capabilities, some knowledge of the calculations necessary in the various phases of design was necessary. A knowledge of the basics of oil and gas production facilities was needed to write a concise and attractive description of the feasibility studies which Brown & Root had completed. This understanding facilitated the selection of the essential issues dealt with in these studies.

3.3.1.3.2

NON-ENGINEERING KNOWLEDGE

Salesmanship was a key factor in composing a qualifications brochure. The descriptions, pictures and articles were all selected and arranged to have the maximum favorable impact on the client. Of course written communications skills were important in preparation of the text.

3.3.1.3.3

SOURCES OF INFORMATION

Information on potential projects was available through U. S. embassies in foreign countries, articles in trade journals and newspapers, and personal contact with clients who were known by Brown & Root from previous projects. This business development information is accumulated in files and these were made available to us for background information when necessary. Other information such as lists of experience on various types of projects, descriptions of the engineering capabilities of foreign affiliates and photographs of offshore facilities engineered by Brown & Root were also available from internal records.

3.3.1.3.4

ESTIMATES

It was necessary to take the available information on the nature and scope of the project under consideration by the client and fill the gaps with subjective estimates. For example, one of the projects was to be a rather small scale feasibility study and we believed that Brown & Root's size would make the client apprehensive that their small project would get "lost in a large organization". Accordingly, in our cover letter, we emphasized that Brown & Root had completed numerous similar small scale studies previously and that the project engineer responsible for the execution of the project would maintain constant contact with the client.

3.3.1.4 ADMINISTRATIVE DUTIES

Since I was responsible for providing a finished product by a certain deadline, it was very important that the right components come together in a timely manner. For example, the book covers and photographs required a one week lead-time, xeroxing the text required one day and it took the secretary a certain amount of time to physically bind the books.

3.3.1.5 INTERDISCIPLINARY INTERACTION

In addition to administrative personnel, it was necessary to interact with two technical disciplines. I discussed some available computer programs with personnel from both the mechanical engineering and scheduling disciplines in order to determine whether some particular programs were used frequently in their departments.

3.3.1.6 RESULTS OF WORK

The brochures were completed, approved by our vice-president, and sent to the clients. At the date of this writing, no tender documents have been received as a direct result of these brochures, but we remain optimistic. Business development activity is a long-term process and results are only evident over the long run.

3.3.1.7 EDUCATIONAL VALUE OF ASSIGNMENT

This assignment demonstrated the techniques of salesmanship in the engineering and construction business. Effective salesmanship involves clear and orderly expression of ideas, the ability to anticipate the concerns that the client has in his mind, and the importance of timing in the presentation of a "sales pitch".

3.3.2 CONCRETE PLATFORM DEVELOPMENT - SALES PRESENTATION

3.3.2.1 OBJECTIVE

The objective of this assignment was to prepare drawings and slides to be used in the presentation of a new concept in offshore platforms to prospective clients. The thrust of the overall project was to sell the concrete platform concept. Our particular assignment was to prepare slides showing how facilities could be arranged on the platform deck space.

3.3.2.2 TASK DESCRIPTION

3.3.2.2.1

BACKGROUND

The Marine Structures Department of Brown & Root was approached by a French contractor having considerable expertise in concrete design and experience in North Sea concrete platform installations. There resulted a joint venture of the two firms for the development of a concept for concrete production platforms for use in the Gulf of Mexico. These platforms would be fabricated in a future graving dock on the Gulf Coast. The platform and facilities would be essentially complete when leaving the graving dock to be towed to the final location offshore. The only offshore work required after the platform was in place would be to make connection with pipelines. This feature would allow earlier production and reduced overall cost by minimizing offshore installation labor.

A project engineer in the Marine Structures group was assigned to prepare the presentation to be given to several potential clients. The purpose of the presentation was three-fold:

- To make the client aware of the new concept
- To hear client comments on how the concept, at its current stage of development, may be made more attractive
- To estimate the likelihood of selling such platforms.

In order to complete the presentation, the structural project eningeer requested assistance from the Oil and Gas Production Engineering Department to produce equipment arrangement drawings for a "typical" Gulf of Mexico oil production facility.

3.3.2.2.2

SCOPE OF ASSIGNMENT

The first problem was to identify which, if any, of the engineering design projects in the department were "typical" Gulf of Mexico projects. The facility which was selected included several features which were deemed "typical". These features included:

- Oil/gas/water separation
- Oil treating, measurement and shipping
- Gas dehydration, measurement and compression
- Saltwater treating and disposal
- Power generation
- Crew quarters

After the project was selected, it was necessary to find information on the process used, equipment cost and equipment weight. It was also helpful to discuss the overall design philosophy with the project engineering manager who had been assigned to the "typical" project selected. The process flow sheets for the selected facility were redrawn and simplified by omitting some equipment.

After selecting the process equipment (i.e. separators, pumps, gas compressors) and the utility equipment (i.e. generators, instrument air driers and compressors, watermaker) that would be included in the facility, we obtained the services of a piping-layout designer. The designer started with the equipment list, process flowsheets, and deck drawings showing floor space and column locations. With this information the designer arranged the equipment on the decks to facilitate piping connection of the equipment with minimum pipe cost. The piping designer cut equipment silhouettes out of paper and then arranged these scaled equipment outlines on drawings of the deck. This technique facilitated the trail and error process involved in selecting a satisfactory equipment arrangement.

The feasibility of the concrete structure itself was the focus of this study and subsequent presentation. To assist the structural engineers in their analysis of concrete structure's suitability for supporting production facilities, we furnished equipment weights along with equipment locations.

3.3.2.2.3

NATURE OF MY FUNCTION

My function was to obtain drafting manpower and supervise preparation of the flowsheets and layout drawings. After completion and checking of the layout drawings, I arranged for the production of a three-dimensional, color artists' rendering of the facilities. In addition, I was called on to prepare estimates of equipment weights.

3.3.2.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.2.3.1

ENGINEERING KNOWLEDGE

Simple calculations were needed to determine the operating weights of the equipment (operating weight=dry equipment weight + fluid weight). Engineering experience related to production facilities was necessary to identify the elements of a typical facility.

In order to communicate with the designer who was arranging the equipment and making the layout drawings, it was necessary to understand something of the factors that the designer considers when arranging the equipment. These factors include pipe cost minimization, safety, accessability of equipment for maintenance, equipment performance and convenience. This technical knowledge was also needed to assess the design produced by the layout designer. In this particular case, the designer had located an aerial cooler on a lower deck to facilitate piping. However, the exhaust air from the cooler would have impinged on the floor of the above deck and recirculated, degrading the performance of the cooler. It was necessary to suggest that the cooler be located on the upper deck and that the other equipment be rearranged to accommodate this.

3.3.2.3.2

NON-ENGINEERING KNOWLEDGE

Since the main objective was to prepare a sales presentation, it was necessary to present the concept clearly to the client and in an attractive manner. We judged that the client first needed an overview of the platform and facilities and later would be interested in the specifics of the layout of each deck. The overview was provided by a strikingly colored artist rendering of the platform on site. The details of the equipment layout would be shown, if necessary, by means of slides of equipment layouts of each deck.

3.3.2.3.3 SOURCES OF INFORMATION

The main source of information was data obtained from the files of the previous project selected as "typical". Another valuable source of information was the piping designer himself who had considerable experience in making equipment layouts.

3.3.2.3.4 ESTIMATES

Actually, the arrangement of equipment of the decks is an approximation of the optimum or minimum cost solution.

3.3.2.4 ADMINISTRATIVE DUTIES

To obtain the services of the piping designer, it was necessary to meet with the piping supervisor and explain the objectives and timing of our assignment. Based on this information and manpower availability, the piping supervisor chose a piping designer to work with us.

To obtain the artists' rendering of the platform, it was necessary to determine where the artists were, which artists were available, and which artists were experienced in producing drawings for color slides.

3.3.2.5 INTERDISCIPLINARY INTERACTION

In the course of this assignment I interacted with flowsheet draftsmen, the Piping Department Staff Manager, a piping designer, the structural project engineer and an artist.

3.3.2.6 RESULTS OF WORK

The slides were provided in a timely manner to the structural project engineer for incorporation into the presentation to several prospective clients.

3.3.2.7 EDUCATIONAL VALUE OF ASSIGNMENT

Several useful lessons were learned in the course of this assignment:

- o The factors important in equipment arrangement
- o Aspects of supervision of technical work
- o The importance of clarity and appearance in sales presentations.

3.3.3 GAS PROCESSING MODULES - ENGINEERING PROPOSAL

3.3.3.1 OBJECTIVE

The objective of this assignment was to prepare a proposal for the engineering design of gas production modules to be located on existing platforms in the Gulf of Mexico.

3.3.3.2 TASK DESCRIPTION

3.3.3.2.1

BACKGROUND

The proposal was prepared in response to a tender document issued by Cities Service Oil Company (CITGO) and received by Brown & Root among other engineering contractors. The tender document contained a general one-page description of the work to be done on this project. This document also included a flow diagram depicting CITGO's preliminary ideas on process design.

In general, the information contained in the tender document was very sketchy. It was necessary for Brown & Root to redraw the flow diagram using standard drafting symbols so that the proposal team could have a firm and clear understanding of CITGO's intentions.

3.3.3.2.2

SCOPE OF ASSIGNMENT

After the tender document was studied by the proposal team, a meeting was scheduled and attended by a representative from each technical discipline. At this meeting the proposal coordinator asked that the following information be prepared and submitted to him.

- o An estimate of the engineering manhours required to complete each discipline's portion of the project.
- o The names of personnel who were qualified and available for assignment to the job if the proposal were successful.
- o Additional information required from CITGO to

clarify the scope or work.

While the discipline engineers were generating the above information, the proposal coordinator and assistant organized and wrote the proposal text. The Table of Contents for this proposal was given in Figure 10. A brief description of the purpose of each item of the contents is given below.

- o Cover Letter - summarizes the contents of the proposal and includes an abbreviated scope of work description along with a cost estimate. In this proposal, a breakdown by month and discipline of manhour estimates was presented as an attachment to the cover letter.

- o Introduction - summarizes the function of the new facilities.

- o Scope of Work - spells out in some detail the design philosophy and the documents to be produced by Brown & Root as end products of the design effort. This section also included the flow diagram shown in Figure 25.

- o Personnel - includes resumes of personnel presently available for assignment to this project if awarded to Brown & Root. However, the commitment of personnel to this project is not definite at this stage. The personnel specified here are usually intended to be

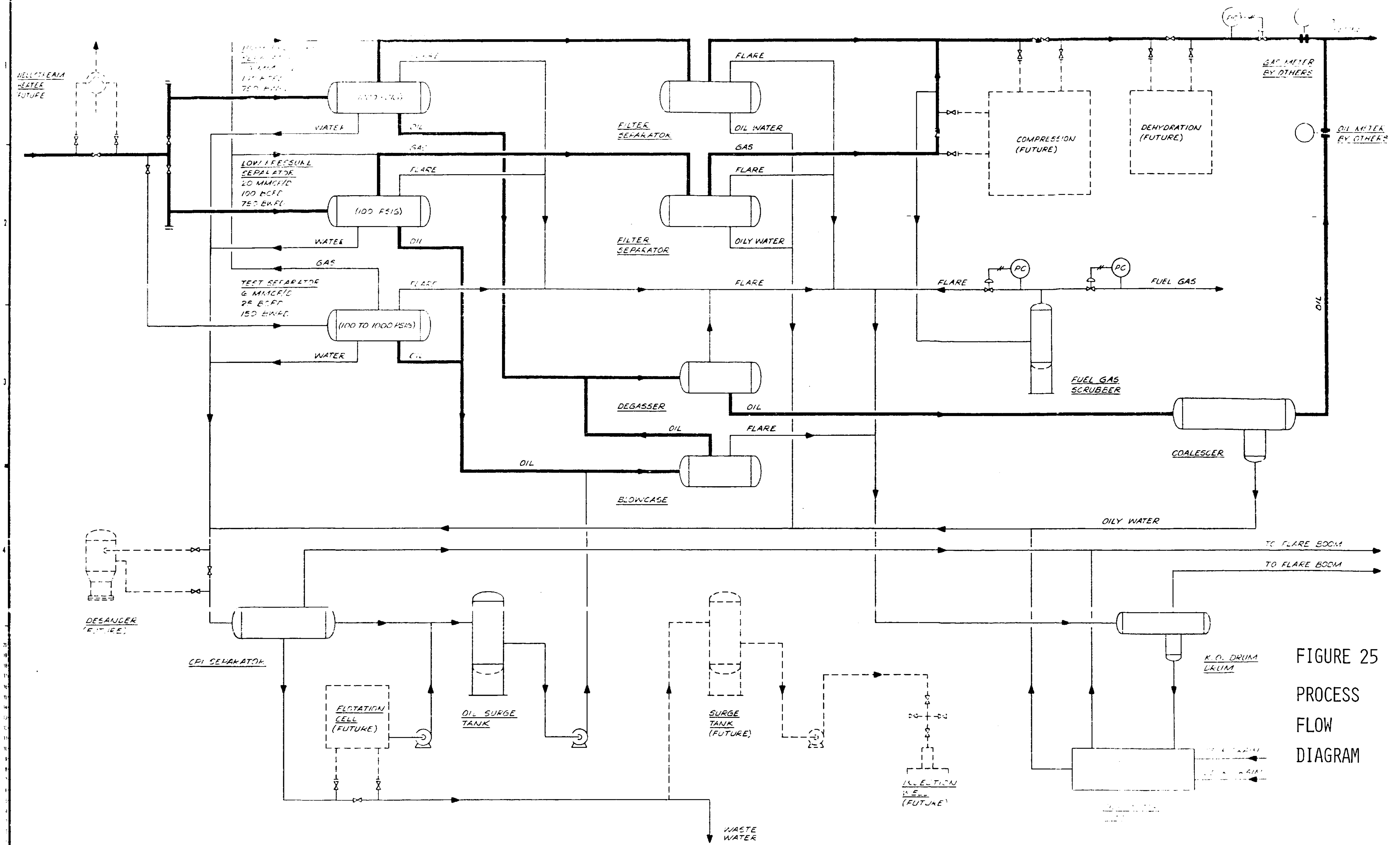


FIGURE 25

PROCESS FLOW DIAGRAM

NOTES

REVISIONS	BY	DATE	REVISIONS	BY	DATE

Brown & Root, Inc.

HOUSTON, TEXAS

DRAWN BY
DATE
CHK'D BY
DATE
SCALE NONE

APPROVED

APPROVED

SEAL

TITLE OF DRAWING PROCESS FLOW DIAGRAM

NAME OF OWNER

LOCATION OF PROJECT

CONTRACT NO

DRAWING NO

SHEET

"typical".

o Terms and Conditions - shows the client the form of contract that Brown & Root wishes to apply to this project. This section also includes a list of manhour rates and rates for auxiliary services such as reproduction and computing. This information was necessary because the proposal contract was the cost-plus type, in which the client would pay Brown & Root's costs plus a percentage of cost for overhead and profit.

Accompanying the proposal document was a qualification brochure, of the type discussed in 3.3.1, showing Brown & Root's experience on similar projects.

After the proposal coordinator received the requested information from the disciplines, he has the perogative to adjust their input as necessary before incorporation into the proposal.

3.3.3.2.3

NATURE OF MY FUNCTION

In this assignment I was the assistant to the proposal coordinator and served in a predominantly administrative capacity. Although the proposal coordinator had the ultimate responsibility for the proposal contents, I was involved in many of the same tasks and was aware of most of the issues. In addition to providing this general assistance, I was specifically responsible for coordinating the physical assembly of the books. I was also responsible for supervising the preparation of the process flowsheet which was included in the proposal.

3.3.3.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.3.3.1 ENGINEERING KNOWLEDGE

In the preparation of this proposal, the proposal coordinator's technical knowledge was required to understand the process design philosophy represented by CITGO on the flowsheet included in the tender documents. Some aspects of the process design were unclear because of the format of this document, but the proposal coordinator's experience on similar facilities helped to fill the gaps. Additionally, the proposal coordinator's technical knowledge was helpful in judging the engineering manhour estimates submitted to him by the discipline engineers. For this, he needed a general understanding of type and complexity of the engineering work which must be carried out by each discipline to produce a finished engineering design.

3.3.3.3.2 NON-ENGINEERING KNOWLEDGE

An important factor at the time that this proposal was prepared was the low engineering work backlog existing in our department. Some sizeable engineering projects were being completed and engineering personnel were becoming available. As stated above, the proposal coordinator has the perogative of adjusting the manpower estimates before publishing these in the proposal. The need for additional work gave us an incentive to submit realistically low manhour estimates.

It was crucial that the proposal coordinator understand the terms and conditions offered to CITGO for the performance of the work. We submitted a cost-plus-a-percentage-fee type contract wherein Brown & Root would be reimbursed for all expenses plus a percentage to cover overhead and profit. The cost estimate given to the client is only a guide - payment to Brown & Root is based on actual expenses, not the estimate. This factor would appear to give the proposal coordinator freedom to decrease the estimates to increase the proposal's attractiveness to the client. However, if Brown & Root is awarded the contract, the proposal coordinator who would probably become the project engineer, would be called on by CITGO to explain the variance from the estimate.

3.3.3.3.3

SOURCES OF INFORMATION

The most important source of information in proposal preparation is the tender document which describes the scope of the work. Another primary source of information is the discipline engineers, who provide the proposal coordinator with manpower estimates and personnel information. Manpower expenditures on previous similar jobs are useful as a guide in preparing the final manhour estimate.

3.3.3.3.4

ESTIMATES

The key estimate made is that for manhour requirements. This estimate is made by the discipline representatives by means of a review of historical data as well as judgements on the number of drawings required and manhours required per drawing.

3.3.3.4 ADMINISTRATIVE DUTIES

These duties included the following:

- o Arranging meetings of the proposal team
- o Coordinating the preparation of a flow diagram
- o Proofreading the text
- o Assembling the proposal books .

3.3.3.5 INTERDISCIPLINARY INTERACTION

In arranging the above mentioned proposal meetings, it was necessary to meet each discipline representative individually and briefly discuss the contents of the tender document and background of the project.

3.3.3.6 RESULTS OF THE WORK

The proposal was completed and submitted to CITGO on time. However, the proposal was not successful.

3.3.3.7 EDUCATIONAL VALUE OF ASSIGNMENT

The assignment illustrated the nature of the interaction between the proposal coordinator and the proposal team members. The proposal coordinator relies on the team members to provide him with information and uses this information, tempered by his knowledge and experience, to produce the proposal document.

3.3.4 GAS COMPRESSION FACILITIES - ENGINEERING PROPOSAL

3.3.4.1 OBJECTIVE

The objective of this assignment was to prepare a proposal for engineering services necessary for the design of gas compression facilities to be located offshore Brunei in Southeast Asia.

3.3.4.2 TASK DESCRIPTION

3.3.4.2.1

BACKGROUND

This proposal was prepared in response to a tender document issued by Brunei Shell Petroleum Company Limited to Brown & Root as well as several other contractors.

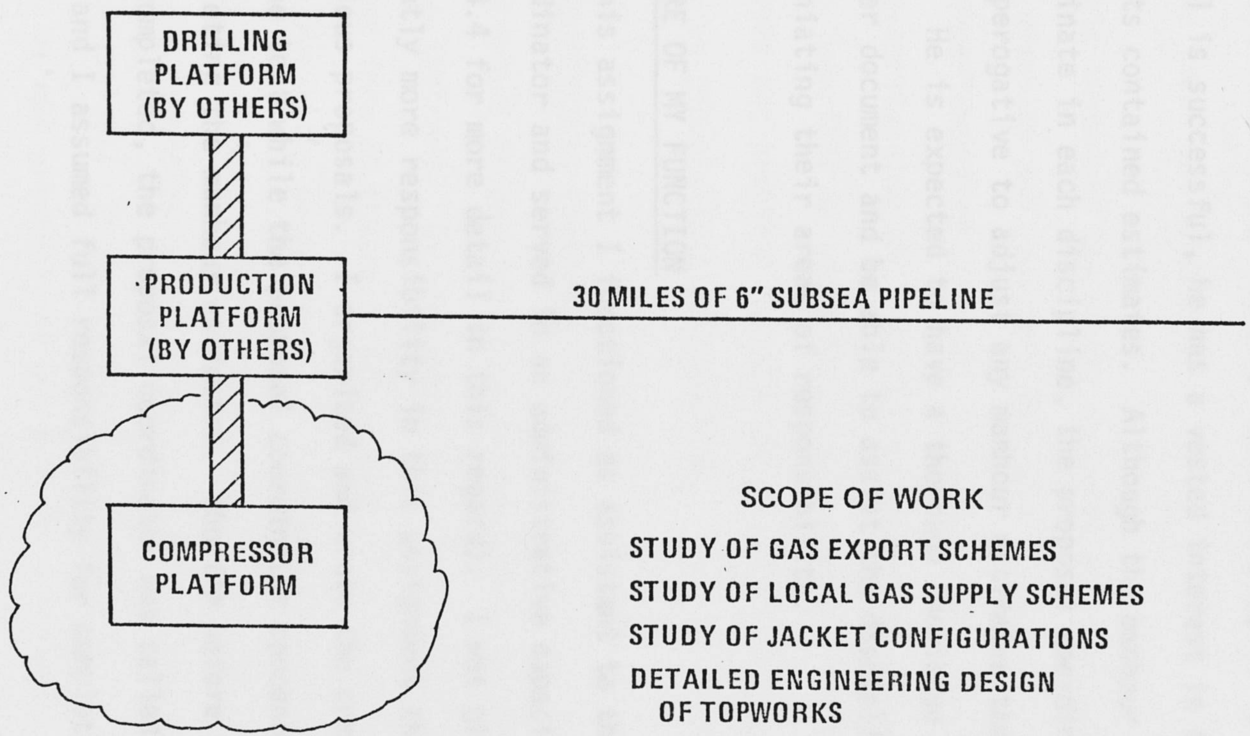
Brunei Shell intended to bring a new oil field onstream towards the end of 1978. Drilling and production platforms were being installed by others at the time that the tender document for the gas compression facilities was received by Brown & Root. Brunei Shell anticipated that gas compression facilities for providing gas lift gas would be necessary shortly after initial production began in order to maintain oil production capacity at desired levels. Initially this gas lift gas would be supplied from a nearby field via a small diameter pipeline. However, Brunei Shell considered the local compression of gas from production separators to be the most economical scheme long-term. All other facilities, including the jacket which supported the gas compression facilities, would be designed by others. A schematic of this arrangement is shown in Figure 26.

The successful bidder would first conduct three brief studies of the facilities to identify optimum designs. After these designs were identified, a detailed design would follow which would produce all documents necessary for construction of the facilities. As part of the first study, Brown & Root would provide equipment sizes, arrangements and costs for a scheme which would provide the requisite gas lift gas as well as facilities to allow excess gas to be conditioned and sold. In the second study, Brown & Root would develop equipment sizes, arrangements and costs for a scheme which would provide the necessary gas lift gas and allow the excess gas to be distributed for in-field use rather than sales. In the third study, Brown & Root would assess the impact of the facilities arrangement on jacket design and recommend a jacket configuration compatible with topside facilities.

At the conclusion of the studies, and after Brunei Shell decided which basic design scheme to use, Brown & Root would complete all of the necessary specifications and construction drawings. Brown & Root would also assist Brunei Shell in purchasing all equipment and materials. The detailed deisgn phase of the project would account for about 90% of the total engineering manhours.

FIGURE 26

SCHEMATIC OF PLATFORMS



3.3.4.2.2

SCOPE OF ASSIGNMENT

The proposal coordinator is ultimately responsible for the contents and timely submission of the proposal. Because the proposal coordinator usually heads the project if the proposal is successful, he has a vested interest in the accuracy of its contained estimates. Although the manhour estimates originate in each discipline, the proposal coordinator has the perogative to adjust any manhour estimates that he sees fit. He is expected to have a thorough knowledge of the tender document and be able to assist the disciplines in deliniating their areas of responsibility.

3.3.4.2.3

NATURE OF MY FUNCTION

In this assignment I functioned as assistant to the proposal coordinator and served in an administrative capacity (see 3.3.4.4 for more detail in this regard). I was given significantly more responsibility in this assignment than on previous proposals. I organized and wrote the preponderance of the text while the proposal coordinator concentrated on completing the manhour estimates. Shortly before the proposal was completed, the proposal coordinator was called out of town and I assumed full responsibility for completing the work.

3.3.4.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.4.3.1

ENGINEERING KNOWLEDGE

Although the assistant does not become involved with engineering computations, engineering knowledge is essential to communication with the engineering disciplines who are involved in the technical problems.

In this instance, the tender document included a set of flow diagrams and equipment layouts. Technical knowledge and experience were important in interpreting these diagrams and understanding the interrelationships of the equipment. It is important to understand basic process engineering concepts and problems because the entire facility design turns on process-related decisions.

3.3.4.3.2

NON-ENGINEERING KNOWLEDGE

The proposal is an offer made to the client for entering into a contract. In this case, the client specified the desired form of contract rather than allowing Brown & Root to indicate its preference. It was therefore important that Brown & Root's legal department review the form of contract requested by the client and make comments and qualifications. To successfully coordinate their contribution to the proposal, it was helpful to understand some of the legal department's concerns such as currency movement and penalties for design mistake.

Schedulers not only play an important role during the execution of a project, but also contribute to the preparation of the proposal. This tender document called for the inclusion of scheduling information in the proposal to assist Brunei Shell in its evaluation of Brown & Root's bid. With guidelines from the proposal coordinator, the scheduler prepared a Manpower Forecast (See Figure 27) as well as a pseudo-CPM Logic Diagram (See Figure 28). In order to communicate efficiently with the scheduler, it was necessary to understand the his point of view.

3.3.4.3.3

SOURCES OF INFORMATION

The most important source of information for the entire team was the tender documents. This document described bidding instructions, scope of work, desired Form of Contract, and contained drawings and other information necessary for proposal preparation.

Historical data on projects similar to the one under consideration provided useful guidelines for manhour estimates. We examined manhour data on two jobs which Brown & Root had completed and which were similar to the job in question. Although there was considerable difference in the magnitudes of these three jobs, the proportionate weight of each discipline's manhour estimate should be approximately similar (e.g. 3% process, 15% piping, etc.)

NUMBER OF PERSONNEL ASSIGNED

FIGURE 27
MANPOWER FORECAST

	JULY '78			AUGUST '78				SEPTEMBER '78					OCTOBER '78				NOVEMBER '78				DECEMBER '78				TOTAL
ACTIVITY																									MANHOURS
PROJECT ENGINEER	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	964
PROCESS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.5	.5									600
PROCESS FLOWSHEETS	.5	1	1	1	1	1	1	1																	300
ELECTRICAL ENGINEER	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1.5	2140
ELECTRICAL DRAFTING	1	1	1	1	2	3	3	3	3	3	3	3	3	3	4	4	3	3	3	3	2	2	2	1	2400
INSTRUMENT ENGINEERING	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.5	1700
INSTRUMENT DRAFTING										2	2	3	3	3	4	4	4	4	4	4	4	3	2	1.5	1900
PIPING & LAYOUT	2	2	3	3	3	5	5	5	5	5	9	9	9	10	10	10	10	10	10	10	10	10	6	6	6670
STRUCTURAL ENGINEERING	2	2	2	2	2	3	3	3	3	3	3	3	3	3	2	2	2	2							1800
STRUCTURAL DRAFTING	1	1	2	2	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2						1800
MECHANICAL ENGINEERING	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	.5	1500
FIRE & SAFETY										.5		.5			.5		.5		.5						100
PLANNING & SCHEDULING	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.5	.5	.5	.5	.5	1	.5		796
MATERIAL CONTROL						.5	.5	.5	.5																80
COST ESTIMATING					.5				.5					.5				.5				1			120
SECRETARIAL	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5			440
TOTAL MANHOURS																									23310
WEEKLY TOTAL PERSONNEL	13	13.5	16.5	16.5	18	24	25	25	25.5	27	30.5	32	31.5	33	32.5	32	29.5	29.5	27.5	24.5	23.5	23.5	16.5	13	

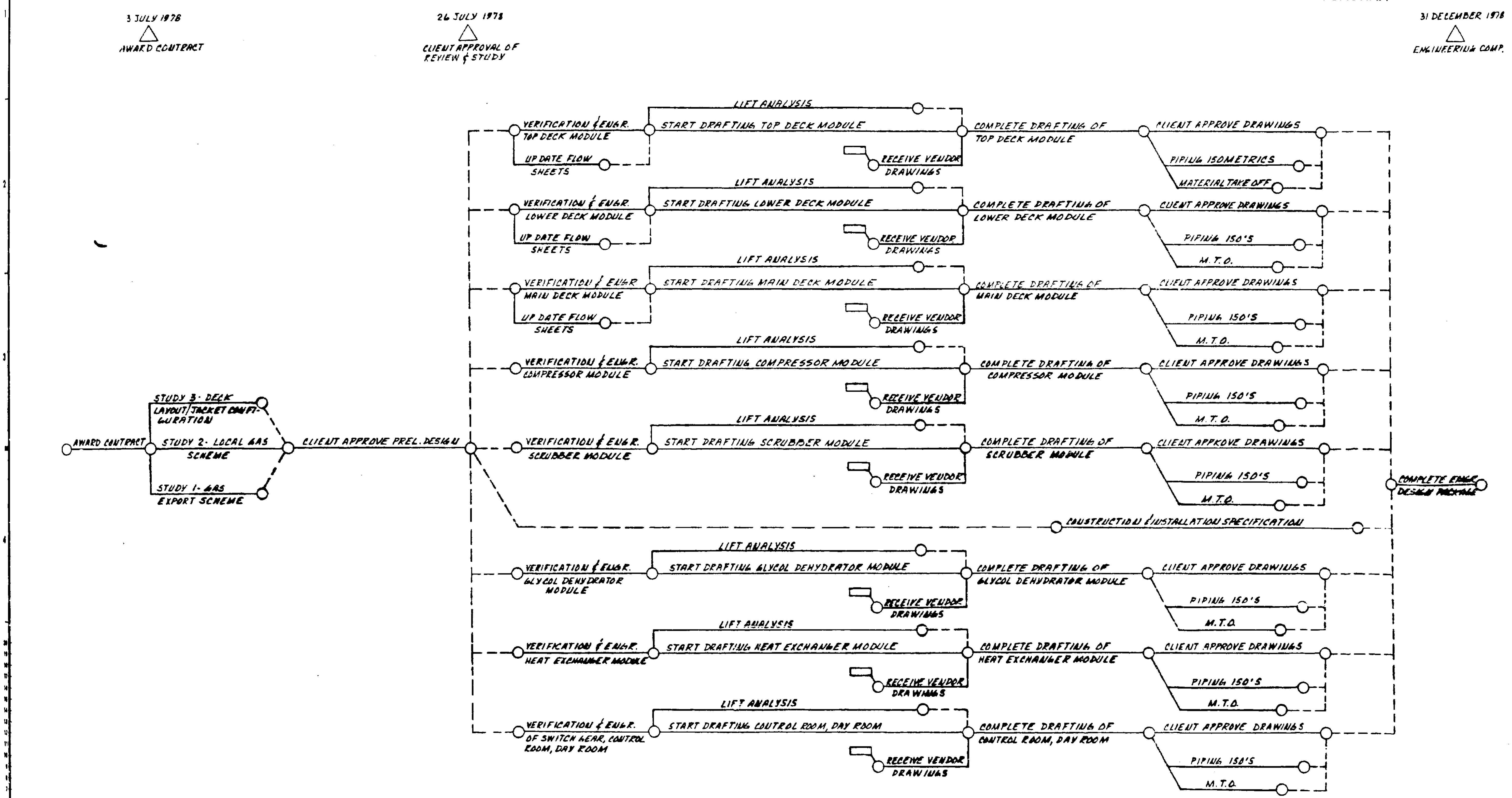
NOTE:
BASED ON 40 HOUR WEEKS

Brown & Root, S. A. HOUSTON, TEXAS

MANPOWER FORECAST
GAS COMPRESSION FACILITIES

DRAWN BY APPROVED DATE

FIGURE 28
CPM LOGIC DIAGRAM



NOTES

INTERFACE FROM PROCUREMENT

REVISIONS • BY • DATE

Brown & Root, S.A.
HOUSTON TEXAS

DRAWN BY G.M. SMITH
DATE 6-13-78
CHK'D BY W. KIDD
DATE 6-12-78
SCALE NONE

APPROVED

SEAL

TITLE OF DRAWING: C.P.M. LOGIC DIAGRAM
CONSULTIVE DESIGN SERVICES FOR GAS COMPRESSION PLATFORM

CONTRACT NO
DRAWING NO
SHEET

3.3.4.3.4

ESTIMATES

The primary estimate in this exercise was the previously mentioned engineering manhour estimate which was broken down by month and discipline.

3.3.4.4 ADMINISTRATIVE DUTIES

The first step for both the proposal coordinator and his assistant is to study the tender document in its entirety. The individual disciplines are concerned with becoming intimately familiar with only those sections of the tender document that affect their work. It is therefore critical that the proposal coordinator have a broad understanding of all the client's requirements so that the efforts of the individual disciplines fit together without leaving any gaps.

The assistant should flag any unusual concepts or requirements appearing in the tender document and make sure that the proposal coordinator is aware of these. This serves two purposes: first, two sets of eyes are better than one and the assistant may alert the proposal coordinator to an unseen problem that deserves attention; secondly, the coordinator's time can be conserved by answering the question once and leaving it to the assistant to explain the answer to others should the question be raised again.

After studying the tender document and discussing it with the proposal coordinator, the assistant is capable of answering many of the more routine questions of the other team members. Of course there will always be some critical questions that must be referred to the proposal coordinator.

The assistant is in a position to organize the contents of the proposal so that it is responsive to the requirements of the client. This organization is subject to the review and approval of the proposal coordinator. Quite often the proposal coordinator alters the recommended plan somewhat but this is less time-consuming, from the proposal coordinator's standpoint, than organizing the proposal from scratch.

Early in the process, the proposal coordinator publishes a proposal schedule which sets forth deadlines for inputs from each discipline. However, it is sometimes necessary for the assistant to follow-up these instructions to insure that information on manhour estimates, available personnel, or legal comments, are received in a timely manner.

The language used in the proposal is critical. Poor spelling, improper grammar, or sloppy format reflects poorly on Brown & Root's competence to perform. There is even the temptation on the part of the client to extrapolate the careless appearance of the proposal to indicate some lack of technical competence by Brown & Root.

In case the proposal coordinator is called away at the last minute, as was the case here, the assistant should be capable of presenting the proposal for signature by the appropriate

Brown & Root officer as well as seeing that copies of the proposal are sent to the right places at the right time.

3.3.4.5 INTERDISCIPLINARY INTERACTION

From time to time it was necessary to answer questions from discipline engineers regarding the contents of the tender document. The proposal coordinator and I incorporated some last minute changes into the schedule with the help of the scheduler. The legal department reviewed the Form of the Contract submitted in the tender document and took exception to several points. This information had to be incorporated into the proposal.

3.3.4.6 RESULTS OF WORK

The proposal was submitted and was considered by Shell Brunei. However, the proposal was not successful.

3.3.4.7 EDUCATIONAL VALUE OF ASSIGNMENT

In this proposal I was responsible for organizing and writing most of the text. The proposal coordinator was called out of town during the last two days of proposal preparation. I was responsible for handling all of the last minute details and gained an appreciation of the sense of urgency which descends on the proposal coordinator as the submission deadline nears.

3.3.5 GAS PRODUCTION COMPLEX - CONSTRUCTION PROPOSAL

3.3.5.1 OBJECTIVE

The objective of this assignment was to assist in the preparation of a lump-sum proposal for engineering, procurement, fabrication, transportation and installation of gas production facilities in the Persian Gulf for the Oil Service Company of Iran (OSCO).

3.3.5.2 TASK DESCRIPTION

3.3.5.2.1

BACKGROUND

This proposal was prepared for submission to OSCO in response to a tender document received by Brown & Root along with other contractors. The tender document consisted of drawings, specifications, contract and other documents defining the scope of services to be provided to OSCO. The tender document received by Brown & Root was the finished product of an engineering design project executed by Spence Landes Engineers for OSCO. However, the drawings produced by Spence Landes were not intended to be sufficient for constructing the facilities - it would be necessary for the successful bidder to provide final engineering. Final engineering would include preparation of piping isometrics, piping spool drawings, and detailed electrical and instrumentation drawings. In the course of their project, Spence Landes prepared specifications and ordered most of the major equipment.

The tender document was initially received for Brown & Root by its Foreign Marine Construction Department. The total proposal effort was coordinated by a proposal coordinator from Foreign Marine. However, input from the Oil and Gas Production Engineering Department was required in the form of manhour and material estimates.

The project would consist of six offshore gas production and dehydration complexes in shallow water offshore Iran. Each complex would contain three wellhead platforms, one main production platform, one heater platform and one flare platform. Additionally, two of these complexes would also contain a manifold platform which would receive gas and condensate from the two-phase, twenty-inch pipelines coming from surrounding complexes and would combine the flow in a two-phase, thirty-six inch pipeline to shore.

The total field flow from the 6 complexes is 3.6 BCF/D. This gas is intended for injection into oil fields in Southern Iran for enhanced recovery. The processing facilities on the platforms consist of gas dehydration, condensate sweetening, and salt water treating and disposal. The facilities to be supplied include equipment-containing modules, decks and bridges. The jacket and subsea pipelines were furnished by others. The successful bidder would provide final engineering, procurement services, fabrication of equipment into modules (Brown & Root maintains a fabrication yard in Bahrain), transportation of facilities to the installation site and installation of the facilities with derrick barges.

3.3.5.2.2

SCOPE OF ASSIGNMENT

The task of the coordinator assigned to this proposal team from the Oil and Gas Production Engineering Department was to estimate the number of engineering and drafting manhours required to complete final engineering, estimate material requirements (pipe, welding rods, etc.), estimate the number of craft manhours (welders, electricians, instrument technicians, etc.) required to fabricate the facilities, and estimate the cost of shipping the equipment and material from point of origin to fabrication yard. After this information was assembled, it was submitted to the overall proposal coordinator in Foreign Marine who incorporated this information into the total proposal.

3.3.5.2.3

NATURE OF MY FUNCTION

I served as an assistant to the proposal coordinator assigned from the Oil and Gas Production Engineering Department. I was given the assignment of estimating the freight, insurance and crating costs for the equipment ordered for OSCO. In addition, I was to estimate the cost of the technical manpower supplied by equipment vendors which would be required for start-up of their respective equipment. My work was done, for the most part, independently of the proposal coordinator.

Crating, insurance and freight costs are functions of equipment cost, equipment volume and equipment weight. Equipment weight estimates were included in the tender document and I called equipment vendors to obtain estimates for the remaining information.

3.3.5.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.5.3.1

ENGINEERING KNOWLEDGE

The ability to read and understand equipment specifications was important in my assignment. This required a knowledge of technical terminology as well as an understanding of the purpose of various types of equipment. A key factor in the success of communications with equipment vendors was the ability to identify the parameters which heavily influence the size and cost of each type of equipment. The specification provided with the tender document gave an exhaustive description of the equipment - however when conversing with equipment vendors over the phone, there is time only for a quick description of key characteristics of the equipment before the vendor's attention is lost.

The estimation of costs for technical assistance during start-up requires some judgement on the operational complexity of the equipment. For example the start-up of a turbine-generator set would require a vendor representative to be present in order to protect the equipment guarantee. On the other hand, putting a new pump or separator into service is relatively simple and would require no vendor representative.

Some of the equipment included in the facilities which required discussion with vendors are listed below.

o Turbine-generator sets

- o Pumps
- o Filters
- o Cranes
- o Storage tanks
- o Pressure vessels
- o Heaters
- o Coolers
- o Escape craft
- o Electrical equipment
- o Hydraulic supply systems
- o Fire protection equipment
- o Instrumentation panels

To present the crating, freight, insurance and technical assitance costs in convenient form, the equipment was listed by modules. This required examination of equipment arrangement drawings to determine which module contained each piece of equipment.

After obtaining equipment price, equipment volume and equipment weight data, the relatively simple calculations to determine crating, insurance, and freight were made. Standard Brown & Root estimating formulae were used.

3.3.5.3.2

NON-ENGINEERING KNOWLEDGE

It was necessary to know which vendors to contact regarding each type of equipment. Although the tender document gave an exhaustive description of each piece of equipment, it did not specify the vendor that would supply the equipment. Knowing the supplier would have considerably simplified the information gathering process. These circumstances made it necessary to choose a vendor who sells the type of equipment in question and discuss with him the characteristics of the equipment.

3.3.5.3.3

SOURCES OF INFORMATION

As pointed out above, a great deal of information was obtained from the drawings and specifications which accompanied the tender document. Some information was available in-house from engineers who regularly dealt with certain types of equipment such as fire and safety systems and some electrical equipment. The techniques used for actually calculating the cost of crating, insurance and freight were learned from cost estimators within the Foreign Marine Department.

3.3.5.3.4

ESTIMATES

The entire process of obtaining costs, weights and dimensions was an estimating process. These figures could be refined considerably if more time were available. However, the preparation of this proposal was on a tight time budget - as is the case in most proposal efforts. In general the less time permitted for developing an estimate, the more conservative the estimate tends to be.

3.3.5.4 ADMINISTRATIVE DUTIES

I was called on from time to time to research questions on the contents of the tender document.

3.3.5.5 INTERDISCIPLINARY INTERACTION

Since the equipment in question ranged from pumps to instrumentation, interaction with several technical disciplines was necessary. In most cases vendor contacts were engineers of various backgrounds. Fire and safety engineers and electrical engineers were consulted regarding estimates on equipment in their areas of expertise.

3.3.5.6 RESULTS OF WORK

My estimates were submitted to the proposal coordinator on schedule. The overall proposal was submitted but it is not known at this time whether or not the proposal was successful.

3.3.5.7 EDUCATIONAL VALUE OF ASSIGNMENT

This assignment gave me the opportunity to see the engineering design phase from a different viewpoint. Our work on the construction proposal began where the Spence Landes engineering effort finished. The interface between engineering and construction became visible and was seen to be flexible, i.e. the services provided by the engineering contractor(s), construction constractor(s) and client can be fitted together in different ways.

The assignment also brought out the fact that vendors can provide valuable information to contractors such as Brown & Root. At the same time, vendors are very interested in active projects at the contractors offices. This information interchange is useful to both parties and lubricates the relationship between the two.

3.3.6 OIL PRODUCTION FACILITIES - ENGINEERING PROPOSAL

3.2.6.1 OBJECTIVE

The objective of this assignment was to assist in the preparation of a proposal for the engineering design, procurement and fabrication supervision for Chevron of Spain's Casablanca Field Development Project.

3.3.6.2 TASK DESCRIPTION

3.3.6.2.1

BACKGROUND

This proposal was prepared in response to a tender document issued by Chevron and received by Brown & Root along with other contractors. It was decided that Brown & Root would submit this proposal in partnership with a Spanish engineering firm, Empresa Nacional de Ingenieria y Technologia, S.A. (INITEC). INITEC is a mature engineering and construction firm with experience in power and petrochemical plants, but with no experience in the area of offshore production facilities. If the bid were successful, Brown & Root would provide its expertise in the critical early stages of the engineering design and INITEC would participate more heavily later during the detailed engineering. The successful completion of detailed engineering is not so reliant on offshore experience, because it is similar to the detailed engineering executed on onshore petrochemical facilities.

The facilities to be designed include one production platform, a thirty-one mile, twelve-inch subsea crude carrying pipeline and an onshore terminal for crude dehydration, storage and pumping. Figure 29 presents a schematic plan of these facilities. The facilities will be designed to handle 60,000 barrels of oil per day. The small amounts of gas produced will be used for fuel with the excess flared.

Two consulting engineering firms conducted preliminary studies for Chevron: one firm studied topworks and jacket, the other firm studied pipeline and onshore terminal. These studies, documented in design reports, recommended configurations for the facilities along with budget-type cost estimates. However, it would be the successful engineering design contractor's responsibility to verify the workability of the recommended configuration and suggest changes where necessary.

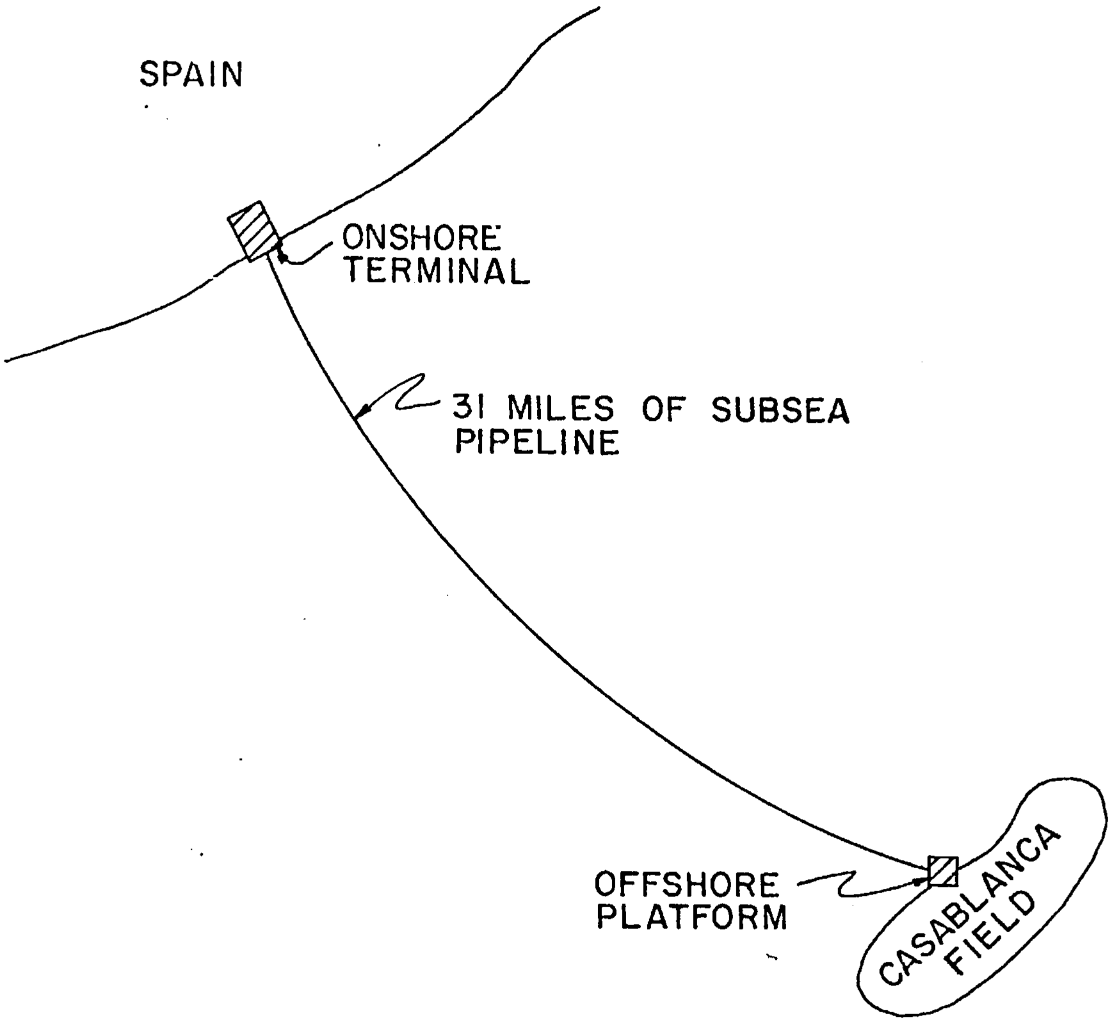
3.3.6.2.2

SCOPE OF ASSIGNMENT

The proposal coordinator is reponsible for the timely assembly and submittal of the proposal. He is responsible for the

FIGURE 29

SCHEMATIC LAYOUT OF FACILITIES



SCOPE OF WORK

- DETAILED ENGINEERING DESIGN OF TOPWORKS, JACKET, PIPELINE, AND ONSHORE TERMINAL
- SUPERVISION OF FABRICATION

engineering manhour estimates which are originally generated by the engineering disciplines. The preparation of this proposal was complicated by two factors:

- The design would be executed by 2 different engineering firms with differing modus operandi.
- The tender document required that the proposal be submitted in separable parts (i.e. onshore terminal - submarine pipeline - jacket - topside facilities) so that conceivably, each of the four parts could be awarded to different contractors.

3.3.6.2.3

NATURE OF MY FUNCTION

I served as the assistant to the proposal coordinator. It is difficult to make a clear distinction between my assignment and the proposal coordinator's assignment. In general, I was called on to gather information for the coordinator, arrange meetings and perform other administrative functions.

3.3.6.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.6.3.1

ENGINEERING KNOWLEDGE

Technical knowledge was needed to understand the terminology and design parameters discussed in the tender document.

3.3.6.3.2

NON-ENGINEERING KNOWLEDGE

I was involved in preparing a schedule which was to be included in our proposal to assist Chevron in their evaluation of our offer. This called for a general knowledge of the sequence of job events and the usual trend of manpower build-up during the execution of a job.

3.3.6.3.3.

SOURCES OF INFORMATION

The primary source of information was the tender document and the discipline engineers who provided manpower estimates.

3.3.6.3.4

ESTIMATES

The primary estimate involved in this assignment was the manpower estimate.

3.3.6.4 ADMINISTRATIVE DUTIES

These duties included reading the tender document, raising and answering questions, arranging meetings and gathering information.

3.3.6.5 INTERDISCIPLINARY INTERACTION

During the preparation of the proposal, I interacted with all of the engineering disciplines and the scheduler.

3.3.6.6 RESULTS OF WORK

The proposal was submitted on time and was accepted by Chevron.

3.3.6.7. EDUCATIONAL VALUE OF ASSIGNMENT

This assignment highlighted some of the special arrangements which are necessary when submitted a joint proposal. Some of the problems which must be dealt with in this situation include: The management control systems to be used, the productivity of Brown & Root manpower working within another organization, the split of profits between the two engineering contractors and the division of responsibility for design mistakes.

3.3.7. PROCEDURES MANUAL

3.3.7.1. OBJECTIVE

The objective of this assignment was to produce a procedures manual for the Chevron Casablanca Project which would serve as an administrative guide for Brown & Root and its partner INITEC in the execution of the project.

3.3.7.2. TASK DESCRIPTION

3.3.7.2.1.

BACKGROUND

The proposal for the Casablance Field Development Project (see 3.3.7.2) was successful. The proposal had been submitted to Chevron jointly by Brown & Root and INITEC, a Spanish engineering firm. The partnership of two firms, with differing modus operandi, to produce an engineering design poses certain coordination problems. It is therefore important to establish procedural standards early in the execution of the job. The procedures manual would serve this purpose and would be drafted by Brown & Root and then modified by Brown & Root and INITEC to establish procedures acceptable to both parties.

3.3.7.2.2

SCOPE OF ASSIGNMENT

Rather than writing this voluminous manual from scratch, several previously used procedures manuals were examined and an appropriate model chosen. The model selected for our procedures manual had been used on a project in which Brown & Root was in partnership with a foreign, Spanish-speaking engineering company.

In spite of the basic similarities between the Casablanca project and the project for which the model procedures manual was written, extensive revision of the model procedures manual was necessary. Firstly, the contract between the engineering firms and the client differed from the previous case. It was necessary to study the contract between Brown & Root, INITEC, and Chevron to identify the provisions for reporting, purchasing, approval of drawings, etc. which were in force. The model procedures manual had to be modified to incorporate these requirements. Secondly, we wished to reorganize and edit the model procedures manual to enhance its clarity. Since the procedures manual would be used routinely by secretaries as well as engineers, it should be easy to understand.

A draft of the procedures manual was prepared and submitted to INITEC for review and comment. INITEC marked up the draft and sent it back to Brown & Root. INITEC's comments were reviewed and incorporated as appropriate. Another draft of the procedures manual will be prepared and submitted to the project manager for approval. The manual will then be submitted to Chevron for final approval.

3.3.7.2.3

NATURE OF MY FUNCTION

It was my responsibility to produce a completed draft of the manual for the project manager. I functioned fairly independently in this capacity.

3.3.7.3 KNOWLEDGE AND INFORMATION NECESSARY

3.3.7.3.1

ENGINEERING KNOWLEDGE

No engineering computations were required. However, familiarity with technical terminology was necessary to communicate clearly on procedures.

3.3.7.3.2

NON-ENGINEERING KNOWLEDGE

Written communications skills were crucial to this assignment. Some general knowledge of procedures used on other jobs was useful. This helps to identify unusual circumstances where special procedures would be necessary.

3.3.7.3.3

SOURCES OF INFORMATION

The most important sources of information were previous procedures manuals and the current contract between the contractor and client.

3.3.7.3.4

ESTIMATES

No significant estimates were made as part of this assignment.

3.3.7.4 ADMINISTRATIVE DUTIES

The entire assignment was administrative in nature.

3.3.7.5 INTERDISCIPLINARY INTERACTION

No direct interdisciplinary interaction was necessary.

3.3.7.6 RESULTS OF WORK

The first draft of the manual was completed in time for the project manager to carry it to Madrid for a meeting with INITEC.

3.3.7.7 EDUCATIONAL VALUE OF ASSIGNMENT

This assignment forced an appreciation of the importance of the documentation of administrative procedures and its role in controlling the execution of a project according to a plan. The assignment also caused me to become aware of the procedures themselves - this familiarity will be useful during the course of the execution of a project.

3.3.8 MISCELLANEOUS ASSIGNMENTS

This section presents a brief description of several miscellaneous assignments.

3.3.8.1 PRODUCTION PLATFORM - JOINT ENGINEERING PROPOSAL

I was called on to provide administrative assistance during the preparation of an engineering proposal to Petrobras for a large oil production platform offshore Brazil. The proposal provided that Brown & Root and Pronon would jointly supply engineering design and procurement services. Pronon is a mature, Brazilian engineering firm with experience in petrochemical and power projects but little experience in the area of offshore oil production facilities. Under this arrangement, Brown & Root personnel in Houston would contribute primarily during the conceptual engineering phase. After conceptual engineering is substantially complete, the work would move to Brazil where Promon personnel would contribute heavily to the detailed engineering effort. Offshore experience is important during conceptual engineering - this specific expertise is less critical during detailed engineering.

I sat in on a two-day meeting between Brown & Root management and Promon management in which proposal strategy was discussed. My function was to summarize the conclusions that were reached by the two parties. I later became involved in the preparation of a manual for Petrobras which documented Brown & Root financial stability.

3.3.8.2 STANDARDIZED SPECIFICATIONS

To speed up the process of preparing specifications for procurement of equipment, Brown & Root developed a set of standardized specifications which can be applied to most situations with a minimum of modification. Equipment variables such as flow rate, pressures, dimensions and temperatures change from case to case. These parameters would appear on a data sheet which would be attached to the specification text. The text itself can be quite lengthy but need not change significantly from application to application.

A strong set of such specifications had been prepared for a previous job and the departmental management suggested that these be established, with minor modifications, as a standard. I was charged with making some modification to these standard specifications, having the changes made to the text on the computerized typing system, and producing a set of the specifications for review by members of the Oil and Gas Production Engineering Department.

3.3.8.3 BARGE MOUNTED PRODUCTION FACILITIES

Brown & Root was considering the development of standardized barge mounted production facilities. This scheme would minimize the amount of labor and equipment required to install the facilities on site because the barges would be essentailly complete and ready for pipeline hookup.

I was charged with studying some equipment layout schemes to optimize space usage with respect to safety and convenience. I also estimated equipment cost for a given configuration.

3.3.8.4 JOINT VENTURE DISCUSSIONS

I sat in on other meetings with management personnel in which joint venture possibilities were discussed. These included:

o Meetings with IHI, a Japanese firm, who had approached Brown & Root in connection with development of a large sour gas field in Russia.

- Meetings with NKK, a Japanese firm, in connection with production facilities in the Indian Ocean.

SECTION 4.0 EXXON CO., USA

SECTION 4.0 EXXON CO., USA

4.1 GENERAL

This section briefly discusses my experience at Exxon Co., USA - an operating company. Although the experience at Exxon was not an internship experience, it has been included in this report because it complements the viewpoint of a contractor. The discussion of this experience is organized along the same lines as that of Brown & Root in the previous section.

4.2 ORGANIZATIONAL APPROACH

This section briefly discusses the Exxon organization and how it functions to produce oil and gas. The discussion is limited to its production operations.

4.2.1 CORPORATE DESCRIPTION

This section presents a brief discussion of Exxon Co., USA, in terms of its activities, history and organizational structure.

4.2.1.1 SCOPE OF OPERATIONS

Exxon Co., USA, is the domestic branch of the world-wide Exxon Corporation. Exxon Co., USA, is a fully integrated oil company, i.e. it participates in exploration, production, transportation, refining and marketing.

The Production Department is responsible for development drilling, reserves management, well maintenance, field gathering of petroleum and gas plant operations. It employs geologists for describing the reservoirs, accountants for assistance in the control of assets, engineers for advising on operating problems, operating and maintenance personnel for running the machinery, and managers to direct the efforts of all personnel and allocate the company's resources to maximize profit. Production operations are carried on by Exxon Co. USA, in locations ranging from the hospitable environment of East Texas which contains some of the Company's oldest reserves, to the hostile climate of the North Slope of Alaska which contains some of the company's newest reserves.

4.2.1.2 BRIEF HISTORY

The present Exxon Corporation was formerly the Standard Oil Company (New Jersey). The organizers of the Humble Company were small Texas-based producers who joined their interests in 1917 to develop a stable market for their crude. Complementary needs brought the Humble Company and Jersey Standard together in 1919 when Humble sole 50 percent of its stock to Jersey. Response to opportunities and changing business climates brought the Corporation to its present form.

4.2.1.3 ORGANIZATION

This section presents an overall discussion of the organization of one division of the Production Department. Organization charts of the East Texas Division are given in Figure 5 and 6 and show this division; which is typical of the other geographical divisions of Exxon Co. USA; to be organized along the lines of a bureaucracy.

4.2.1.3.1

LINE AND STAFF POSITIONS

A line position is directly involved with making the Company's product, in this case the product is oil and gas. In Exxon there are line positions in the field - i.e. the personnel who are present to operate and maintain the facilities; line positions in the field offices - i.e. the field supervisors; line positions in the District Offices - i.e. the managers who coordinate the activities over a wide geographical area and can authorize a given level of expenditures; and line positions in the Division Office - i.e. the managers who coordinate the activities of the districts and authorize the expenditures of larger amounts of money. In order to effectively perform their jobs, line managers rely on the advice of staff who possess more specialized knowledge.

A staff function performs in an advisory capacity and generally possesses little authority to direct personnel or allocate resources. A staff member typically confines his activity and study to a smaller sphere, allowing him to become an expert in that area. While staff positions do not directly impact production, their recommendations to line managers heavily influence the directives issued by line management.

Moving from the bottom of Exxon's organization upward, staff positions first appear in the District Office. These positions include engineers, geologists and accountants, all of whom assist district management by monitoring operations and formulating recommendations to adapt operations to changing conditions.

Staff positions in the division office are analogous to those at the district level except that these members assist and answer to division management. Staff at this level of the organization generally address problems which involve more money and have a larger impact on the division's operations than problems handled by district level staff. These division staff positions can direct that certain information be collected by district staff personnel and be submitted to the division staff for use. Division staff have the disadvantage of being further away from field operations and therefore usually see field problems less clearly than district staff. Thus there is a trade-off between familiarity with details, and comprehension of the larger problem.

4.2.1.3.2

ORGANIZATION BY GEOGRAPHICAL AREAS

The existence of district offices on the partial organization chart (Figure 6) shows that the East Texas Division and the Production Department are organized by geographical location. An alternative to this arrangement is centralization with no local offices. The centralized approach possesses the advantage of shortening the lines of communication between the district and division office, but this would be at the expense of more difficult communications between the field operations and the district offices. The degree of decentralization varies over time with changing field conditions and administrative philosophy.

4.2.1.3.3

ORGANIZATION BY FUNCTION

A company organized strictly by function would locate all engineers in one hierarchy, all accountants in another hierarchy, and so on. At the district level, there is a degree of organization by function. Figure 5 shows that the engineering personnel are placed in a separate hierarchy. The advantage of organization by function is that the placement of like professions together results in an environment in which new technologies are discussed and skills can be kept up to date. If carried too far, this style of organization causes personnel to lose sight of the company's objectives.

4.2.2 TYLER DISTRICT ENGINEERING

The Tyler District is a geographical subdivision of the East Texas Division. It is in a sense, a self-sufficient business which includes an accounting group, administrative services group, operations group, engineering group and district management. This district is also one of Exxon's most profitable districts, because it includes two of the most prolific oil fields in Texas - the Hawkins Field and the East Texas Field. Since engineering is strictly a staff function, engineers influence production only by obtaining management approval of their recommendations.

4.2.2.1 RESERVOIR ENGINEERING

These engineers are concerned with the description and analysis of reservoir performance as well as planning for exploitation of reserves. The reservoir engineer's job includes contributing to well maintenance procedures, production forecasting by means of mathematical reservoir simulation and economic evaluation of producing properties. Each reservoir engineer is typically assigned particular producing fields.

4.2.2.2 SUBSURFACE ENGINEERING

These engineers work closely with the reservoir engineers but are more deeply involved with the mechanical details of the subsurface equipment. While the reservoir engineers provide valuable input to the well maintenance procedures by identifying problem wells and desirable producing zones along the wellbore, it is the subsurface engineer who actually spells out the detailed procedures involved with well repair.

4.2.2.3 SURFACE FACILITIES ENGINEERING

These engineers are responsible for maintenance of field surface facilities and gas plants, design of small scope projects, surveillance of surface equipment performance, as well as long and short term facilities planning and budgeting. Typically, each engineer monitors several surface facilities installations within the district and becomes familiar with the personnel and operating characteristics associated with these facilities. The ability to communicate with field operations personnel is very important because these personnel have an intimate knowledge of many operating problems and can sometimes alert the facilities engineer to serious problems that are developing.

Besides the line operations personnel, the surface facilities engineer must interact with other staff to be effective in his work. For example, he must interact with reservoir engineers to get a forecast of production from new wells so that equipment can be properly sized, he must interact with accountants to get historical cost data for making cost estimates, he must interact with the legal department to secure pipeline right-of-way, and he must interact with the civil engineering group to arrange for installation of facilities. Additionally, he works with Exxon personnel outside of the district office. Division surface facilities staff provide support by generating some reports on facilities performance, identifying new gagetry which may find application in the district, providing assistance on major repairs, and procuring contracted engineering and construction services for installation of new major facilities.

Finally, the district surface facilities engineer interacts with agencies outside of Exxon. He works with the Environmental Protection Agency on matters pertaining to waste discharges from facilities, the Occupational Safety and Health Administration on matters of safety precautions, and vendors on a variety of questions regarding equipment maintenance and performance.

The following is a discussion of the duties of a surface facilities engineer.

4.2.2.3.1

PROJECT ENGINEERING

Relatively small scope capital projects ranging from installation of a new surge tank to installation of facilities for a new, small oil field can be handled at the district level. In these cases, the surface facilities engineer is responsible for gathering necessary data, creating flowsheets and plot plans, performing cost estimates and economic analysis, obtaining management approval, and interacting with the civil engineering group throughout the installation process. The facilities engineer is of course on location during start-up. Throughout the design and installation process the facilities engineer receives input from the local field superintendant. The facilities engineer should make an effort to accommodate the field superintendant because the latter must operate the installation. This relationship is somewhat analogous to the client-contractor relationship found on larger projects. After start-up of the facilities, the facilities engineer is expected to follow-up on any operating problems encountered on these facilities.

4.2.2.3.2

SURVEILLANCE

The facilities engineer is responsible for monitoring equipment performance; e.g. fuel gas consumption, horsepower utilization, flared gas volumes, and equipment downtime; and making recommendations for the correction of abnormalities. Some equipment performance is tracked via reports generated in the Division Office, but much information comes from first-hand observation of operations supplemented by discussion with operating personnel.

4.2.2.3.3

MAINTENANCE

In addition to monitoring equipment failures, the facilities engineer assists in maintenance activities by coordinating scheduled maintenance programs. He also assists in major repairs by locating major components or specialized services.

4.2.2.3.4

BUDGETING

The facilities engineers are more heavily involved in the budgeting process than any other discipline because a large part of the capital budget is associated with surface facilities installations. In this process, the engineers are first asked to identify all substantial equipment additions for the coming year. This again calls for heavy input from field personnel. Next the engineer estimates the cost of each of these facilities and projects incremental cash flows due to the resultant improved operating conditions. This data is then entered into the computer and rate of return is calculated. The computer program automatically arranges each project by rate of return. A given amount of money is earmarked for capital spending. Those projects at the top of the rate of return list are chosen for inclusion in the budget and projects are added until the total budget amount is exhausted.

The budget serves as a guideline for capital spending and also as a device for controlling expenditures, i.e. the cost estimate helps to detect over-expenditures.

4.3 ASSIGNMENTS

This sections summarizes three work assignments at Exxon. Although I was active in all phases of surface facilities engineering discussed in 4.2.2.3, all of the assignments presented here are of the project engineering variety. The three assignments have been written to a standard format.

4.3.1 WASTE HEAT STEAM GENERATOR INSTALLATION

4.3.1.1 OBJECTIVE

The objective of this assignment was to replace fuel gas consuming boilers by a heat exchanger which would generate steam from waste heat.

4.3.1.2 TASK DESCRIPTION

4.3.1.2.1

BACKGROUND

When the East Texas Gas Plant was built, boilers were installed to provide steam for powering pumps, steam for stripping LNG from absorption oil, and steam for utility such as cleaning, thawing, heating and snuffing. Through the years the use of stripping steam was discontinued and the small steam turbines which drove many pumps throughout the plant were replaced by electric motors. However, steam for general plant use was still required and this necessitated the operation of one of the boilers at much less than full capacity.

Fuel gas consumption was monitored and it was known that fuel consumption by the boilers represented a large opportunity cost because this gas could be sold for a premium price. This provided an incentive to find alternate means of generating utility steam.

I was aware that a surplus heat exchanger was available in the plant and that the existing hot oil system which recovered waste heat from gas turbine exhaust had excess capacity. After discussing the idea of using the surplus exchanger and excess hot oil capacity to generate plant utility steam with several parties including my supervisor, I was asked to evaluate this idea and present a recommendation.

4.3.1.2.2

SCOPE OF ASSIGNMENT

In order to perform the engineering study, design and economic analysis it was necessary to procure the following data:

- Price forecast for this gas over the life of the project
- Historical data on boiler fuel gas consumption
- Descriptions of the surplus heat exchangers available in the plant
- Flow diagram and plot plan describing the existing hot oil system
- Flow diagram and plot plan describing the existing steam distribution and condensate return system
- Exxon specifications pertinent to heat exchanger

materials requirements

- o Plant personnel's philosophy on location and operation of the proposed steam generator

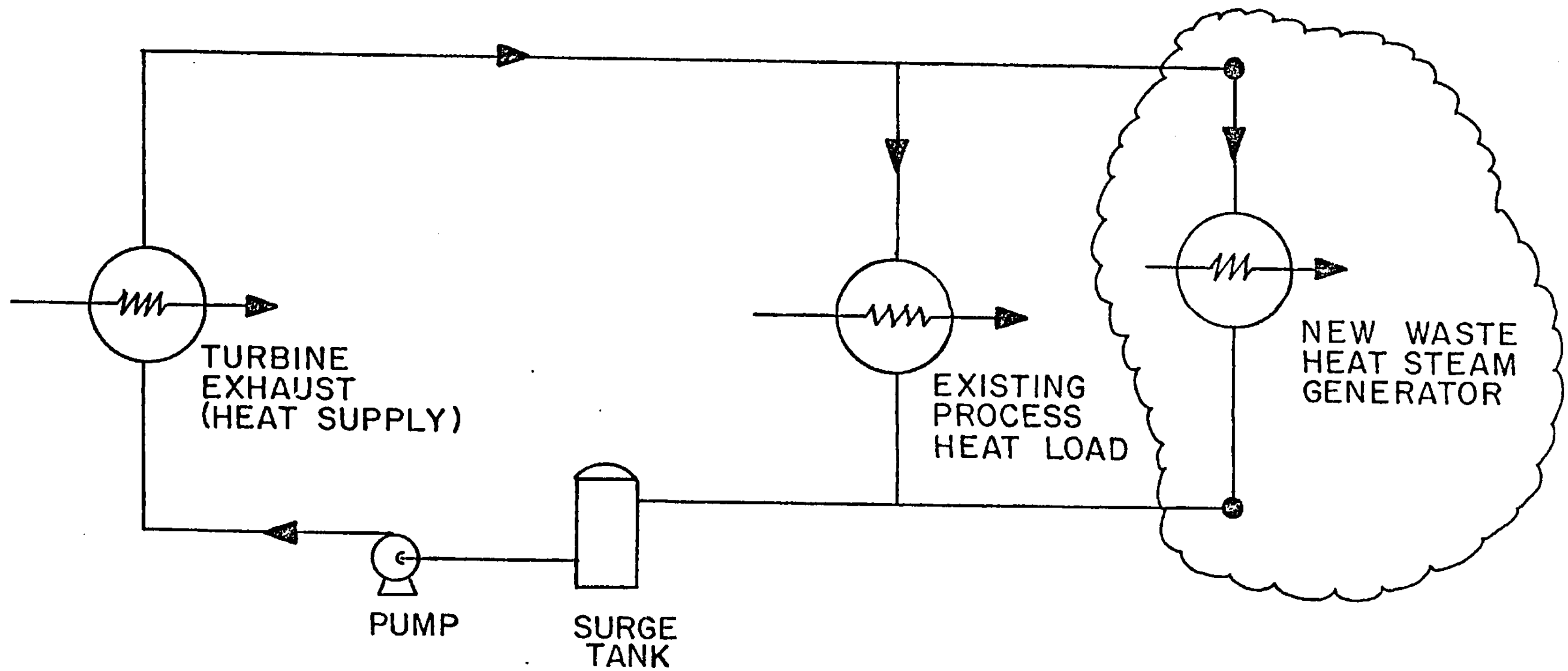
- o Advice from various district and division engineering personnel on configuration and operation of the proposed steam generator.

After obtaining the necessary data, heat exchanger surface area requirements were determined and specifications were written for a new tube bundle to replace the old, corroded existing tube bundle. The point at which the refurbished exchanger was tied-in to the existing system was suggested by the overall system configuration as well as the preference of the plant superintendant. After decisions were made regarding tie-in location, equipment placement, and controls, new drawings were prepared to document the modified system. A simplified flow diagram showing the configuration of the system is given in Figure 30.

The completion of the basic design allowed an economic analysis of the proposed installation. The main component of the investment was the purchase of a new tube bundle for the old heat exchanger. Other components of investment are the value of the surplus heat exchanger, and the price of pipe,valves, fittings and controls. The direct labor required for the installation was a

FIGURE 30

SCHEMATIC OF WASTE HEAT STEAM GENERATOR



major component of the investment.

Incremental revenues were estimated from gas price and the volume of gas freed for sale by elimination of boiler fuel gas consumption. Incremental operating and maintenance costs were estimated by considering the expenses eliminated by shutting down the boilers together with new expenses caused by the new facilities. The incremental revenue, expense and investment figures were used to calculate economic yardsticks for judging the attractiveness of the investment.

The required investment, a brief outline of the work, and the results of the economic analysis are formally presented to management for approval. After management approval, purchase and installation begin.

4.3.1.2.3

NATURE OF MY FUNCTION

Although I was free to obtain advice from anywhere within the company, I was responsible for the engineering design and economic justification for this project.

4.3.1.3 KNOWLEDGE AND INFORMATION NECESSARY

4.3.1.3.1

ENGINEERING KNOWLEDGE

- Heat transfer calculations

- Control systems design

- o Safety standards
- o Pressure drop calculations

4.3.1.3.2

NON-ENGINEERING KNOWLEDGE

- o Communications
- o Economic analysis

4.3.1.3.3

SOURCES OF INFORMATION

- o Field personnel
- o District and division engineers
- o Exxon standards
- o Vendors
- o Heat transfer text

4.3.1.4 ADMINISTRATIVE DUTIES

No additional administrative duties.

4.3.1.5 INTERDISCIPLINARY INTERACTION

- o Interaction with field personnel
- o Interaction with accounting in connection with historical cost

4.3.1.6 RESULTS OF WORK

The facilities are operational.

4.3.1.7 EDUCATIONAL VALUE OF ASSIGNMENT

This assignment gave me the opportunity to begin with the seed of an idea and carry it through to a point just prior to construction. This process pointed out the importance of communications with various levels of personnel in selling a new idea.

4.3.2 COMPRESSOR INSTALLATION

4.3.2.1 OBJECTIVE

The objective of this assignment was to increase the gas production from the Reklaw gas field by installing compression.

4.3.2.2 TASK DESCRIPTION

4.3.2.2.1

BACKGROUND

Gas produced from this small gas field was delivered into the Exxon Gas System's pipeline at about 600 psi. As the gas field was depleted, reservoir pressure decreased and caused reduced gas flow rates from the reservoir to the pipeline. The flow rate from one of the wells was so low that Exxon was in danger of losing its rights to the lease due to substandard production.

The installation of a small engine driven gas compressor can increase the flow rate from the reservoir by lowering the pressure that the well must produce against. Such an installation is economical if the extra gas produced justifies the capital outlay for the compressor and increased operating and maintenance costs.

4.3.2.2.2

SCOPE OF ASSIGNMENT

In order to perform the engineering design and economic analysis for the installation of compression, the following was necessary:

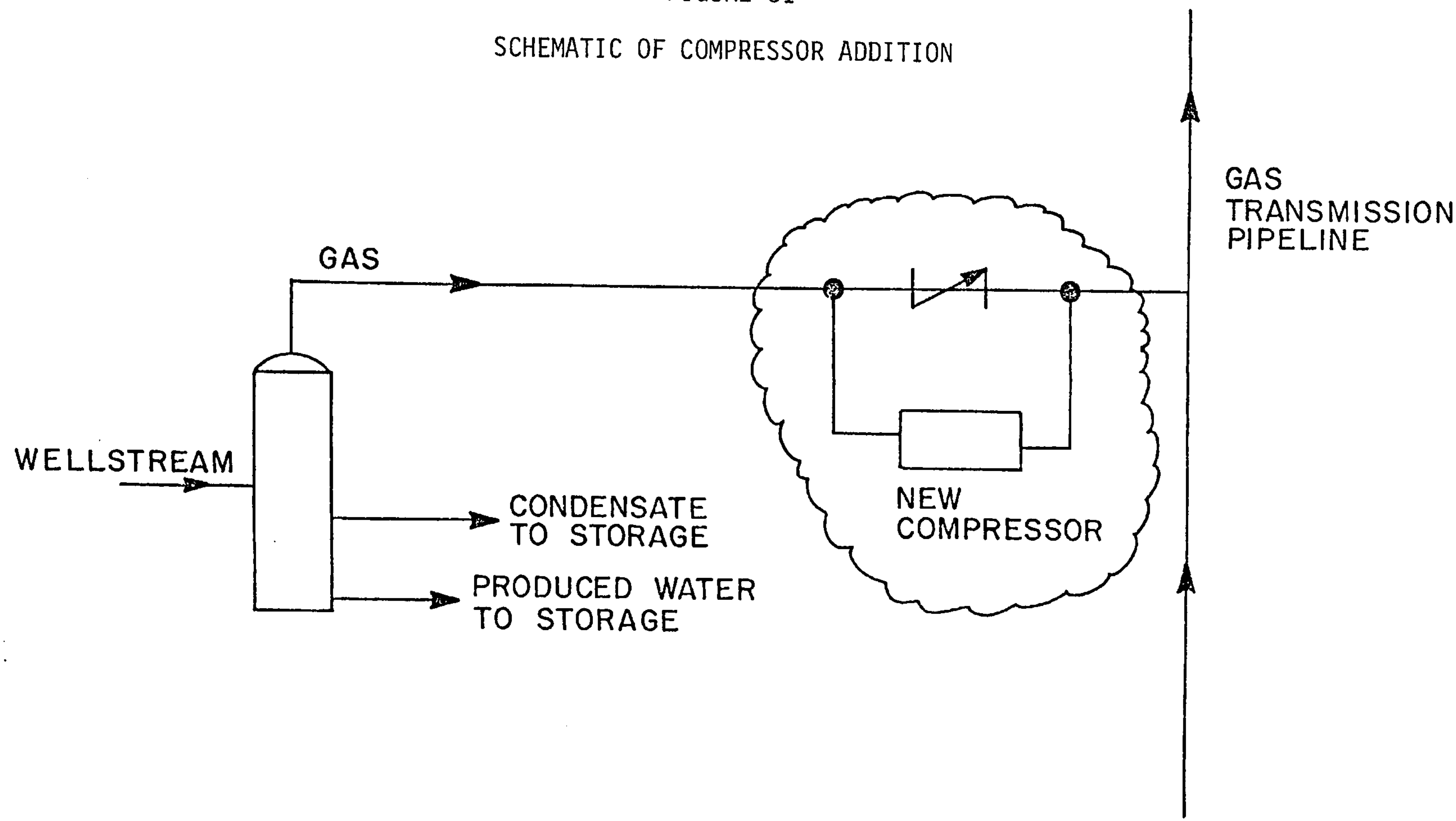
- o Site visit and discussion with the field superintendant to document the existing production system
- o Price forecast for gas produced
- o Field superintendant's general philosophy of operation for new production system.

After obtaining the necessary data, the horsepower and cylinder size requirements were determined by routine compressor calculations. The point at which the compressor is tied-in to the existing system is suggested by logic of the existing system as well as the preference of the field superintendant. After decisions are made regarding 'tie-in' locations, equipment placement and controls, new drawings were made to describe the new system. A simplified flow diagram showing the modified production system is given in Figure 31.

The completion of the basic design allowed an economic analysis of the proposed installation. The main com-

FIGURE 31

SCHEMATIC OF COMPRESSOR ADDITION



ponent of the investment required is the purchase and installation of a suitable compressor. Other components of the investment were the purchase and installation of pipe, valves, fittings and controls. Incremental operating and maintenance costs were approximated from historical data. Incremental revenues were determined from gas price and incremental gas flow rate. The incremental revenue, expense and investment figures are used to calculate economic yardsticks, to judge the attractiveness of the investment.

The required investment, a brief outline of the work and the results of the economic analysis were formally presented to management for approval. After management approval, purchase and installation begin.

Although field operations personnel are usually familiar with such oil field equipment, I was responsible for answering questions on operation of the facilities. Additionally, I was present when the new facilities were put into operation.

4.3.2.2.3

NATURE OF MY FUNCTION

Although I was free to obtain advice from anywhere within the company, I was responsible for the engineering design and economic justification for this project.

4.3.2.3 KNOWLEDGE AND INFORMATION NECESSARY

4.3.2.3.1

ENGINEERING KNOWLEDGE

- Dynamics of interaction between compressor and well in determining the new operating conditions of the well
- Compressor sizing calculations
- Control systems design
- Safety standards.

4.3.2.3.2

NON-ENGINEERING KNOWLEDGE

- Communications
- Economic analysis.

4.3.2.3.3

SOURCES OF INFORMATION

- Field personnel
- Other district engineers
- District reservoir engineers
- Vendors
- Natural Gas Processor Suppliers Association databook.

4.3.2.4 ADMINISTRATIVE DUTIES

- Equipment procurement (in conjunction with purchasing)

- o Informal status reporting to management.

4.3.2.5 INTERDISCIPLINARY INTERACTION

- o Interaction with reservoir engineering in connection with well performance

- o Interaction with field personnel

- o Interaction with accounting personnel in connection with historical costs.

4.3.2.6 RESULTS OF WORK

The installation and start-up of the compressor proceeded smoothly. Gas production increased in line with predictions.

4.3.2.7 EDUCATIONAL VALUE OF ASSIGNMENT

This assignment demonstrated that the installation and start-up of a facility can be smooth when engineering and operations are successfully coordinated.

4.3.3 FIELD PRODUCTION FACILITIES INSTALLATION

4.3.3.1 OBJECTIVE

The objective of this assignment was to provide facilities for producing a small, newly discovered oil field.

4.3.3.2 TASK DESCRIPTION

4.3.3.2.1

BACKGROUND

A small oil field was discovered in an area of the Tyler District which had previously produced only gas. After the initial wells confirmed the existence of commerical quantities of oil, step-out wells were planned to determine the extent of the field. At the time that this drilling program was being carried out, District Management asked engineering to begin work on designing production facilitites. The incentive to install producing facilities as soon as possible was to obtain revenue from those wells which were completed and could be produced as soon as facilities were available. However, since the field was not yet completely defined, it was difficult to determine the optimum design for the producing facilities. For example, if it were assumed that all of the planned step-out wells would be commercial producers, then central treating facilities would be located at a certain point in the field. If it turned out that none of the future wells were successful, then this chosen site for central treating facilities may not be optimum and as a result, investment and operating costs could be greater than necessary. In this situation then, it was necessary to compromise and design flexibility into the producing system.

4.3.3.2.2

SCOPE OF ASSIGNMENT

In order to perform engineering design and economic analysis of the facilities, it was necessary to procure the following information:

- o Well test data on completed wells, e.g. flow rates of oil, gas and water together with flowing and shut-in pressures
- o Production forecast for wells over life of the field
- o Best estimates of characteristics of wells to be drilled in the step-out program
- o Surface terrain
- o Location of wells on a map
- o Final disposition of oil, gas, and water
- o Sales price of oil and gas
- o Historical data on operating costs
- o Surplus equipment availability
- o Field superintendant's operating philosophy
- o Existing facilities in the area which could influence design
- o Advice from various district engineering personnel.

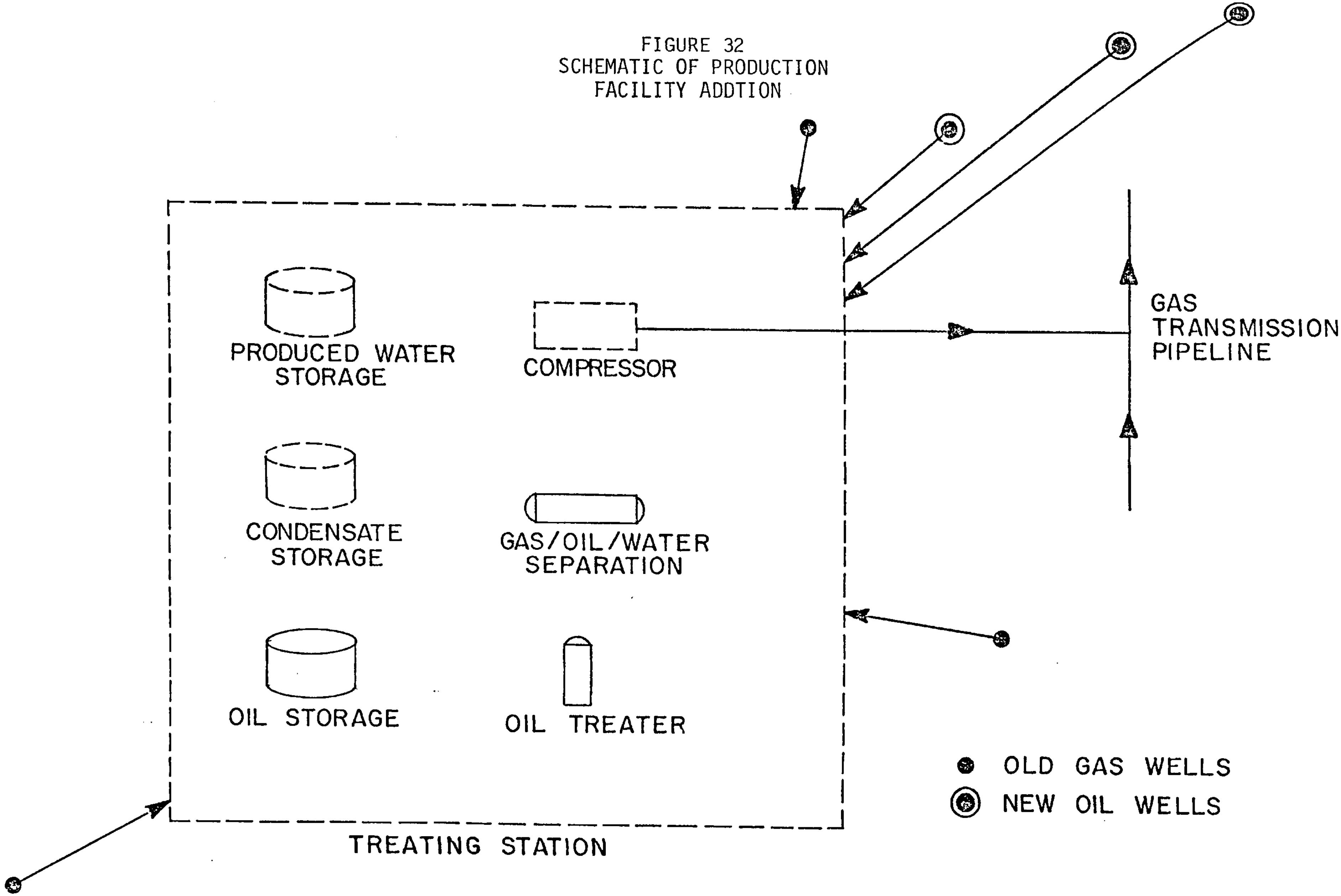
After obtaining the necessary data, preliminary flow diagrams and equipment arrangements were made and studied. For the most promising schemes, preliminary sizing calculations were made and equipment lists compiled. Due to the length and cost of the flowlines (e.g. the pipe which carried produced fluids from the well to the separators), two-phase pressure drop calculations were important.

At this point, more input from experienced district engineering and operations personnel was obtained regarding the best alternative for further refinement. Flow diagrams, equipment arrangements and equipment lists were created and refined accordingly. Figure 32 shows as schematic diagram of the recommended configuration.

The completion of the basic design allowed an economic analysis of the proposed installation. As mentioned above, a large component of the total investment was the purchase and installation of flowline. Other major items were compression, oil/water/gas separators, storage tanks, and a heater treater. Revenues were estimated from gas and oil prices together with forecast volumes over the life of the field. Operating and maintenance costs were estimated from historical data as well as discussion with operations personnel. Revenue, expense and investment figures were then used to calculate economic yardsticks.

The required investment, a brief outline of the work,

FIGURE 32
SCHEMATIC OF PRODUCTION
FACILITY ADDTION



and the results of the economic analysis are formally presented to management for approval. After management approval, purchase and installation began.

4.3.3.2.3

NATURE OF MY FUNCTION

Although I was free to obtain advice from anywhere within the company, I was responsible for the engineering design and economic justification for this project.

4.3.3.3 KNOWLEDGE AND INFORMATION NECESSARY

4.3.3.3.1

ENGINEERING KNOWLEDGE

- o Two phase flow pressure drop calculations
- o Compressor calculations
- o Control systems design
- o Safety standards.

4.3.3.3.2

NON-ENGINEERING KNOWLEDGE

- o Communications
- o Economic analysis.

4.3.3.3.3

SOURCES OF INFORMATION

- o Field personnel
- o District and division engineers

- District and division accountants

- Vendors.

4.3.3.4 ADMINISTRATIVE DUTIES

No additional administrative duties.

4.3.3.5 INTERDISCIPLINARY INTERACTION

- Interaction with field personnel in connection with operating philosophy

- Interaction with accounting in connection with historical costs and surplus equipment availability

- Interaction with the legal department in connection with purchasing right-of-way for flowline.

4.3.3.6 RESULTS OF WORK

At the time that I left Exxon, installation of the facilities were in progress.

4.3.3.7 EDUCATIONAL VALUE OF EXPERIENCE

This assignment provided me with the opportunity of performing the entire system design for a small but representative oil field. It also caused an appreciation for the importance of the basic design decisions which are made early in the design process, e.g. the decision to provide a centralized facility rather than a satellite concept.

SECTION 5.0 EVALUATION

SECTION 5.0 EVALUATION

5.1 GENERAL

This section contains discussion of the extent to which the Internship Objectives were achieved as well as discussion of the value of the combination of job experiences at Brown & Root and Exxon.

5.2 ACHIEVEMENT OF OBJECTIVES

As stated in Section 1.0 of this report the FIRST OBJECTIVE of my Internship at Brown & Root was "to make an identifiable engineering or administrative contribution to the activities in the life cycle of projects at Brown & Root." I believe that this objective has been met. As documented in the assignment write-ups of Section 3.3 of this report, I directly contributed to several types of activities including business development, proposal writing and project administration. Due to the time limitation on my Internship, I was not able to directly contribute to other activities such as feasibility studies, conceptual studies, detailed engineering construction and commissioning. However, several of my assignments did indirectly involve me in some of these activities.

- Two of my assignments, namely the development of a concrete platform for the Gulf of Mexico (see 3.3.2) and the development of barge mounted production facilities (see 3.3.8.3), did share some of the characteristics of a feasibility study.

- After Brown & Root was awarded the Casablanca Field Project, I was present during several conceptual engineering discussion between the project manager and key discipline engineers.

- I edited many sets of procurement specifications which play an important role in detailed engineering activities (see 3.3.8.2).

The SECOND OBJECTIVE of my Internship at Brown & Root was "To become aware of the Task Force Approach used by Brown & Root." I believe that this objective has also been achieved. Brown & Root maintains several sets of manuals on project execution and the task force approach and these were an excellent source of information on this topic. However, the most valuable source of information were the project managers themselves who shared their time and philosophy generously. My understanding of Brown & Root's organizational approach, including the task force approach, is documented in section 3.2 of this report.

Over and above the achievement of the Internship Objectives, this experience provided me with another benefit - perhaps the most important benefit of all. As a result of keeping constant contact with engineering managers, and with my Intern Supervisor in particular, I began to see how engineering managers think and act. Although this benefit is somewhat nebulous, I feel it to be important.

5.3 COMPLEMENTARY EXPERIENCE

I feel that the experience at Brown & Root was an excellent complement to my experience at Exxon. Both job positions were concerned with oil and gas production facilities, so many of the same engineering concepts were needed in both positions. However, there were fundamental differences in viewpoint.

There was the difference between line and staff:

- At Exxon I was in a staff position which provided engineering support to the company's petroleum production operations

- At Brown & Root I was in something which approached a line position because our department's "product" was engineering services.

There was the operator-contractor difference:

- Exxon was an operating company whose revenues resulted from producing petroleum products

- Brown & Root was a contractor whose revenues resulted from designing and constructing facilities.

And finally, there was the engineering-administrative difference:

- o At Exxon my involvement was of a technical nature requiring familiarity with the details of equipment operation, maintenance and erection.

- o At Brown & Root my involvement was more of an administrative nature requiring coordination of the efforts of others.

I believe that these differing viewpoints have been most helpful in developing my perception of an engineering manager's role in industry.

5.4 CONCLUSIONS

Although I had substantial industrial experience prior to my Internship, I feel that the Internship experience was highly beneficial - in fact its value was increased by my previous experience. Because of my familiarity with some of the equipment and concepts associated with petroleum production, I could profitably study questions of management and commerce from the beginning of the Internship period.

SECTION 6.0 APPENDIX

6.1 INTERNSHIP PROGRESS REPORTS

6.2 ORAL PRESENTATION

6.3 REFERENCES

SECTION 6.0 APPENDIX

6.1 INTERNSHIP PROGRESS REPORTS

The following section contains the Internship progress reports issued to describe my activities at Brown & Root.

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

January 31, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

Dear Dr. Jenkins,

This letter represents the first of twelve monthly status reports which will inform you of my Doctor of Engineering internship activities in the Oil and Gas Production Department at Brown & Root. Next month's report will contain my objectives for the internship as a whole. The objectives will reflect inputs from you as well as management at Brown & Root. According to "Guidelines for Industry Participation in the Doctor of Engineering Internship", my supervisor here at Brown & Root should submit performance evaluations to you at three month intervals.

Since my arrival here on January 9, I have been "learning the system". This has involved reading, question - and-answer sessions, a seminar on a new offshore installation technique, a meeting between Brown & Root and the management of a Japanese company, and general discussion. I have had frequent contact with Mr. John Doak, Vice President of the Oil and Gas Production Department, as well as many other management and technical personnel. My internship supervisor, Mr. Frank Redus, is currently on assignment in London, but will be in these offices shortly.

The following is a summary of the general topics that I have been studying.

1. Technical Concepts and Terminology. Although I am familiar with some concepts and terminology involved with onshore oil and gas production facilities, there are many ideas and terms associated with offshore facilities which are new to me and require some familiarization.

2. Project Organization and Execution. Brown & Root executes engineering projects by means of a task force approach. These task forces include various technical disciplines and are directed by an engineering manager. I have been looking into how these teams are organized as well as the sequence of events necessary for project execution.

3. Commercial Aspects of Engineering and Construction. A good deal of Brown & Root's new business comes as a result of having satisfied clients, i.e. "repeat business". However, Brown & Root is also establishing itself in new areas. I am learning about the events that preceed the signing of a contract for Brown & Root's services.

4. Optimization Study and Engineering Design. It is anticipated that Brown & Root will conduct an optimization study and engineering design of facilities for producing gas and condensate from three gas fields located offshore Sarawak. I will be assigned to this project if Brown & Root secures the contract for this work. I have been reading and discussing the background of this project.

Any committee members who have questions should call me at 713-671-5009 and I will be glad to discuss any aspects of my internship with them.

Yours truly,

Stephen Kibbee

Stephen Kibbee

cc: J. H. Doak
F. W. Holm
C. A. Phillips
D. T. Phillips
F. R. Redus
C. A. Rodenberger
R. E. Thomas
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

March 2, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

RE: February Status Report

Dear Dr. Jenkins,

Although Brown & Root has not yet been awarded the contract for the offshore Sarawak field development study, we are optimistic about our prospects. Our work on this project may start as early as April 1.

My internship supervisor arrives in Houston this week and I will begin my association with him. Up to this point I have been working with several other technical and managerial personnel.

Next month's status report will contain my objectives for the internship as a whole.

The following is a summary of my main activities during February.

1. Feasibility Studies. I reviewed several studies completed by Brown & Root which are somewhat similar to the Sarawak study. The study documents provide clear explanation of some basic concepts related to offshore work. Another purpose of this reading is to see how the overall problem treated by a study can be broken down into smaller components.

2. Planning and Scheduling Tools. In order to gain some understanding of how Brown & Root uses these tools to guide the task force toward its objectives, I reviewed related articles and manuals as well as discussed applications with several people. Among other uses, Brown & Root uses these tools to monitor and control manhour expenditures and the delivery - status of purchased equipment. As an aide in identifying future activities crucial to the timely completion of the total project, Brown & Root uses Critical Path Methods (CPM).

3. Field Trips. In order to get a better "feel" for offshore operations, I attempted two trips to a recently completed platform. Unfortunately neither trip was completed due to poor visibility. (During the second trip our helicopter had almost reached the platform when we encountered fog and had to turn back.)

4. Internship Objectives. In order to establish a starting point for discussion of objectives with my supervisor, I have identified some objectives which may be compatible with Brown & Root's business as well as the general objectives of the Doctor of Engineering Internship Program. Of course, the final objectives must also take into account my supervisor's work objectives and responsibilities.

Any committee members who have questions should call me at 713-671-5009 and I will be glad to discuss any aspects of my internship with them.

Yours truly,

Stephen Kibbee

Stephen Kibbee

SK:mc

cc: J. H. Doak
F. W. Holm
C. A. Phillips
D. T. Phillips
F. R. Redus
C. A. Rodenberger
R. E. Thomas
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

April 27, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

RE: March and April Status Reports

Dear Dr. Jenkins:

I have worked closely with my internship supervisor since his arrival here on March 6. We have had extensive discussions on a wide range of subjects--from technical aspects of gas processing to personnel considerations.

Brown & Root was not awarded the contract for the offshore Sarawak field development study. My objectives for the internship, which are attached, reflect this change.

The following is a summary of my main activities during March and April.

1. Field Trip. I visited a gas and condensate separation platform offshore Louisiana. This visit made me aware of general aspects of size, arrangement, weight, and space limitations on offshore platforms.

2. Product Development. Brown & Root is considering the development of a new concept in offshore facilities. A task force was established to formulate preliminary designs and assess the marketability of the product. I participated in several task force meetings and made a preliminary literature search on the subject.

3. Qualifications Brochures. In order to inform a prospective client of the range of services that Brown & Root offers, a qualifications brochure is assembled and sent to the prospective client at an appropriate time. I was assigned to help organize, write and assemble brochures on engineering services for three prospective clients in Southeast Asia.

4. Proposal. I assisted in the preparation of a proposal for water injection facilities to be located offshore Brunei.

5. Business Development Meetings. The Russian government is considering the development of a large onshore sour gas field. A Japanese firm, which has been in contact with the Soviet government, has approached Brown & Root with a cooperative venture in mind. I have sat in on two meetings with representatives of the Japanese Company in which preliminary ideas were discussed.

6. Drawings and Specifications. I am studying the elements and sequence of the various drawings and specifications which are produced in the course of engineering design.

Yours truly,

Stephen Kibbee

Stephen Kibbee

SK/sr

cc: J.H. Doak
C.A. Phillips
F.W. Holm
F.R. Redus
C.A. Rodenberger
R.E. Thomas
File

FIRST OBJECTIVE OF THE DOCTOR OF ENGINEERING INTERNSHIP PROGRAM:

"to enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable engineering contribution in an area of practical concern to the organization or industry in which the internship is served."

CORRESPONDING OBJECTIVES OF THIS INTERNSHIP:

1.0 To make an identifiable engineering or administrative contribution in some of the following activities in the life cycle of projects at Brown & Root.

1.1 Business Development

1.2 Proposals

1.3 Feasibility Studies

1.4 Conceptual Studies

1.5 Detailed Engineering

1.6 Construction Proposals

1.7 Construction

1.8 Commissioning

SECOND OBJECTIVE OF THE DOCTOR OF ENGINEERING INTERNSHIP PROGRAM:

"to enable the student to function in a non-academic environment in a position where he will become aware of the organizational approach to problems in addition to traditional engineering design or analysis. These may include, but are not limited to: problems of management, labor relations, public relations, environmental protection, and economics."

CORRESPONDING OBJECTIVES OF THIS INTERNSHIP:

2.0 To become aware of the Task Force Approach used by Brown & Root.

2.1 Organizational structure of the task force

2.2 Management of task force

2.2.1 Interpersonal considerations

2.2.2 Information systems

2.3 External interfaces

2.3.1 Client-task force interface

2.3.2 Upper management - task force interface

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

June 5, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

RE: May Status Report

Dear Dr. Jenkins,

I enjoyed the visit that you, Frank and I had in these offices on May 9th. This provided a timely opportunity for me to go over some of my objectives for the internship as well as the general organization of my internship report.

The proposal for the offshore Brunei waterflooding facilities which I had referred to in my last status report (item #4) was not successful.

The following is a summary of my main activities during May.

1. Proposal-Gulf of Mexico. I assisted in the preparation of a proposal for gas and condensate production facilities to be located on existing platforms in the Gulf of Mexico. I accompanied my internship supervisor to the client's offices to present the proposal. A few days later, Brown & Root prepared a revised proposal based on a better understanding of the client's intended scope of work. I delivered written confirmation of these changes to the client's offices and briefly discussed these with the client. Unfortunately, Brown & Root has not been successful in winning this contract and we are currently analyzing the question to ascertain why we were not successful.

2. Proposal-Southeast Asia. Brown & Root is preparing a proposal for the design of gas compression facilities to serve a field offshore Brunei. We are in the process of making the necessary manhour estimates, schedules, and writing the proposal.

3. 'Product' Development. Brown & Root is currently contemplating the development of a new method for installing oil and gas producing facilities in the Gulf of Mexico. I have been involved in gathering data on 'typical' equipment arrangement, sizes, and weights used on facilities in the Gulf. This data will be needed to evaluate the feasibility of the new method.

4. Project Engineering Management. I am currently reading a set of Brown & Root manuals dealing with elements of Engineering Management.

5. <u>Offshore Technology Conference</u>. I spent one day touring the exhibits at the OTC.

Any committee members who have questions should call me at 713-671-5009 and I will be glad to discuss any aspects of my internship with them.

Yours truly,

Stephen Kibbee

Stephen Kibbee

SK:es

cc: J. H. Doak
C. A. Phillips
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F. R. Redus
C. A. Rodenberger
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D. T. Phillips
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

June 30, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

RE: June Status Report

Dear Dr. Jenkins,

Under separate cover I am sending you some discussion on the paper that you left with me entitled "Solar Assisted Secondary and Tertiary Recovery of Low Viscosity Crudes".

This month Frank and I completed and submitted a proposal for compression facilities to serve a field offshore Brunei (see item #2 in May Status Report and item #1 below). If our proposal is successful, and we will know this in early July, there is a good chance that I will be assigned to the project.

The following is a summary of my main activities during June.

1. Proposal - Southeast Asia. I was given more responsibility in the preparation of this proposal than any of the previous ones. I had an active part in several phases of the proposal including organization and composition of the text, preparation of schedules, and receiving input to the proposal from the legal department. Frank was called out of town the day before the proposal had to be posted to Southeast Asia and I was charged with winding up the last minute details.

2. 'Product' Development. Brown & Root is currently engaged in a joint venture to develop a new method for installing oil and gas producing facilities in the Gulf of Mexico. I helped coordinate the preparation of necessary flow diagrams, equipment arrangements, and artist renderings.

3. Project Engineering Management. I am reading a set of Brown & Root Manuals on this subject.

Any committee members who have questions should call me at 713-671-5009 and I will be glad to discuss any aspects of my internship with them.

Yours truly,

BROWN & ROOT, INC.

Steve Kibbee

Steve Kibbee

SK:es

cc: J. H. Doak
C. A. Phillips
F. W. Holm
F. R. Redus
C. A. Rodenberger
R. E. Thomas
D. T. Phillips
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

August 9, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A&M University
College Station, Texas 77843

RE: July Status Report

Dear Dr. Jenkins,

The proposal for the offshore Brunei compression facilities (item #1) in June status report) was not successful - we came in second place. The last three proposals that Frank and I have submitted were relatively small engineering jobs. The competition for this size job is fierce because of the number of domestic and foreign competitors.

The following is a summary of my main activities during July.

1. Standardized Specifications - In order to speed up the process of preparing specifications for procurement of equipment, we are developing a set of standard specifications which can be used in most applications with a minimum of modification. Such parameters as horsepower, capacities, dimensions, temperatures, and pressures which change from application to application would appear on a data sheet attached to one of the standard specifications. These data sheets would of course be prepared especially for each application. However, the specifications which denote applicable codes and describe materials, coatings, surface finish, and certain other aspects of manufacturing methods change only slightly from application to application and can be standardized.

   I have been involved in proofreading these standardized procurement specifications. This exercise has been valuable in that it has acquainted me with the organization, contents, and function of specifications - an important part of Brown & Root's business.

2. Proposal - Offshore Spain - This project would involve engineering design of a platform complete with oil production facilities, a 30 mile submarine pipeline, and onshore oil storage and treating facilities. Brown & Root formed a joint venture with a Spanish engineering contractor for purposes of bidding and executing the job. The bid was further complicated by the fact that each phase of the engineering; i.e. the jacket, the production facilities, the submarine pipeline, and the onshore terminal; could be awarded separately. The contracts are due to be awarded in mid-September.

3. 'Product Department' - Brown & Root is considering development of a new concept for production facilities in sheltered waters (see item #2 in March status report). I have been assigned to make equipment layouts and gather cost data. This exercise is valuable in that it forces attention on factors important in optimizing equipment locations.

4. Qualifications Brochure - Offshore Nigeria - This assignment involved assembling a 'sales' brochure hilighting Brown & Root's capabilities in offshore platforms, submarine pipelines, and marine loading terminals as they applied to a potential bidding opportunity.

Any committee members who have questions should call me at 713-671-5009 and I will be glad to discuss any aspects of my internship with them.

Very truly yours,

BROWN & ROOT, INC.

Stephen Kibbee

Stephen Kibbee

SK/do

cc: J. H. Doak
C. A. Phillips
F. W. Holm
F. R. Redus
C. A. Rodenberger
R. E. Thomas
D. T. Phillips
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

September 27, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A&M University
College Station, Texas 77843

RE: August and September Status Report

Dear Dr. Jenkins,

We are optimistic concerning our chances of winning the contract for the design of oil producing facilities to be located offshore Spain. (See Item 2, July Status Report.) Frank is currently involved with the final contract negociations. If we win the contract, I will probably be able to participate in the first phases of the work, prior to my return to campus.

The Fall 1978 Meeting of the Industrial Representatives occurs on 26-27 October on campus. This is about the same time that we will be busy with our Spanish job, however I will make every effort to attend the meeting. I hope to see you then.

The following is a summary of my main activities during August and September.

1. Construction Proposal - Persian Gulf - We are bidding on the fabrication, transportation, and installation of gas producing facilities in the Persian Gulf. The Tender Document that all bidders have received includes all drawings and specifications necessary to define the scope of work. Our task involves estimating construction labor costs, material costs, and all other costs necessary to complete the facility.

   This assignment has been beneficial in that it has afforded another view of the Engineering and Construction business. The Construction Proposal activity begins where the Engineering Design activity leaves off. The subject Persian Gulf producing facilities were designed by another Engineering firm and it was of course necessary for us to study this design in the process of preparing our estimates.

   My part in this activity was to study the equipment specifications and contact vendors regarding equipment start-up assistance, as well as equipment shipping and handling costs.

2. Literature Search - We received a gas analysis relevant to a project which is in the "business development" stage. I conducted a brief literature search on processes suitable for removing carbon dioxide from gas streams. I then performed some calculations to approximate the size and weight of a large process vessel because there was some concern over the feasibility of locating such a vessel on a platform.

3. Tour of Fabrication Yard - Together with our vice-president, department manager, Frank and another project manager, I toured the Green's Bayou Fabrication Yard. The production facilities that we inspected were practically ready for load-out onto barges for transport to a site offshore Louisiana.

4. Procurement Specifications - I made final preparations for an office check of some standardized procurement specifications. (See Item 1, July Status Report.)

Anyone who has questions should call me at (713) 671-5009 and I will be glad to discuss any aspect of my internship with them.

Very truly yours,

BROWN & ROOT, INC.

Stephen Kibbee

Stephen Kibbee

SK:rlm

cc: J. H. Doak
C. A. Phillips
F. W. Holm
F. R. Redus
C. A. Rodenberger
R. E. Thomas
D. T. Phillips
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

November 2, 1978

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A&M University
College Station, Texas 77843

RE: October Status Report

Dear Dr. Jenkins,

Our proposal for the Casablanca Field Project was successful and I will be involved in this project until my return to campus in January.

The following is a summary of my main activities during October.

1. Project Procedures Manual

   I was responsible for preparing a draft of the manual which documents the administrative routines to be followed during project execution. These procedures pertain to reporting, checking of drawings, specification preparation, travel, and others.

2. Engineering Proposal - Brazil

   Brown & Root and a Brazilian engineering firm prepared a joint proposal for the engineering design of a large offshore platform in Brazil. I observed a two-day meeting between Brown & Root management and the Brazilian firm's management regarding preparation of the joint proposal. Topics of discussion included the split of engineering work, assignment of personnel, and liability questions.

Anyone who has questions should call me at (713) 671-5009 and I will be glad to discuss any aspect of my internship with them.

Very truly yours,

Stephen E. Kibbee

Stephen E. Kibbee

SEK/do

cc: J. H. Doak
C. A. Phillips
F. W. Holm
F. R. Redus
C. A. Rodenberger
R. E. Thomas
D. T. Phillips
File

Brown & Root, Inc. Post Office Box Three, Houston, Texas 77001

January 8, 1979

Dr. Peter E. Jenkins
Department of Mechanical Engineering
Texas A & M University
College Station, Texas 77843

RE: November and December Status Report

Dear Dr. Jenkins,

After Chevron awarded the Casablanca Field Development Project to the Brown & Root joint venture, we learned that it was necessary for the Spanish government to publish its approval of an Exploitation Concession in a Spanish document similar to the U.S. Federal Register before our design activities could begin. This condition was satisfied in late December, and at that point Brown & Root began expending reimbursable engineering manhours. From this time until I left Brown & Root on January 10 to return to school, I was cognizant of much of the conceptual engineering activity that was in progress.

The following is a summary of my main activities during November and December.

1. Conceptual Engineering - I read the report prepared by Chevron's previous consultants on the Casablanca Field Project concerning the installation of the submarine pipeline from the offshore platform to the onshore terminal. I participated in most of the meetings between the project manager and the various discipline staff personnel during conceptual discussion of the facilities.

2. Paper for Project Management Institute - I submitted an abstract of a paper to be entered in the 1979 Student Paper Award sponsored by the Project Management Institute. The paper will be entitled "Integrated Academic and Industrial Training for Project Engineering Managers".

3. Qualifications Brochure, Arabian Gulf - In order to be included on the bidders list for a large water injection project in the Arabian Gulf, Brown & Root completed an exhaustive questionnaire concerning our modus operandi, experience, and capabilities. This effort required inputs from several engineering and administrative disciplines. I played a part in coordinating these inputs and assembling the text.

4. Qualifications Brochure, Offshore Western Africa - A major oil company was interested in installing gas production, dehydration, compression, and liquids removal facilities on a platform in waters offshore of a politically unsettled country in Western Africa. The operator not only required information on Brown & Root's technical expertise but also asked for information on our capabilities in connection with the arrangement of the financial backing for the large investment required for the facilities.

5. Specifications - I collected some previously used equipment procurement specifications which could serve as patterns for the specifications to be written for the Casablanca Project.

This is the final status report on my internship activities at Brown & Root. I would like to take this opportunity to thank the many people at Brown & Root for their contribution to what I feel was a very successful internship experience.

Yours truly,

BROWN & ROOT, INC.

Stephen Kibbee

Stephen Kibbee

SK:do

cc: J. H. Doak
C. A. Phillips
F. W. Holm
F. R. Redus
C. A. Rodenberger
R. E. Thomas
D. T. Phillips
File

6.2 DOCUMENTATION OF ORAL PRESENTATION

This section contains hard copy of slides prepared specifically for oral presentations of my industrial experience. Some of these figures have been used in the body of this report where appropriate.

PRESENTATION

OF

INTERNSHIP EXPERIENCE

- Steve Kibbee

INTRODUCTION

SUMMARY OF WORK EXPERIENCE

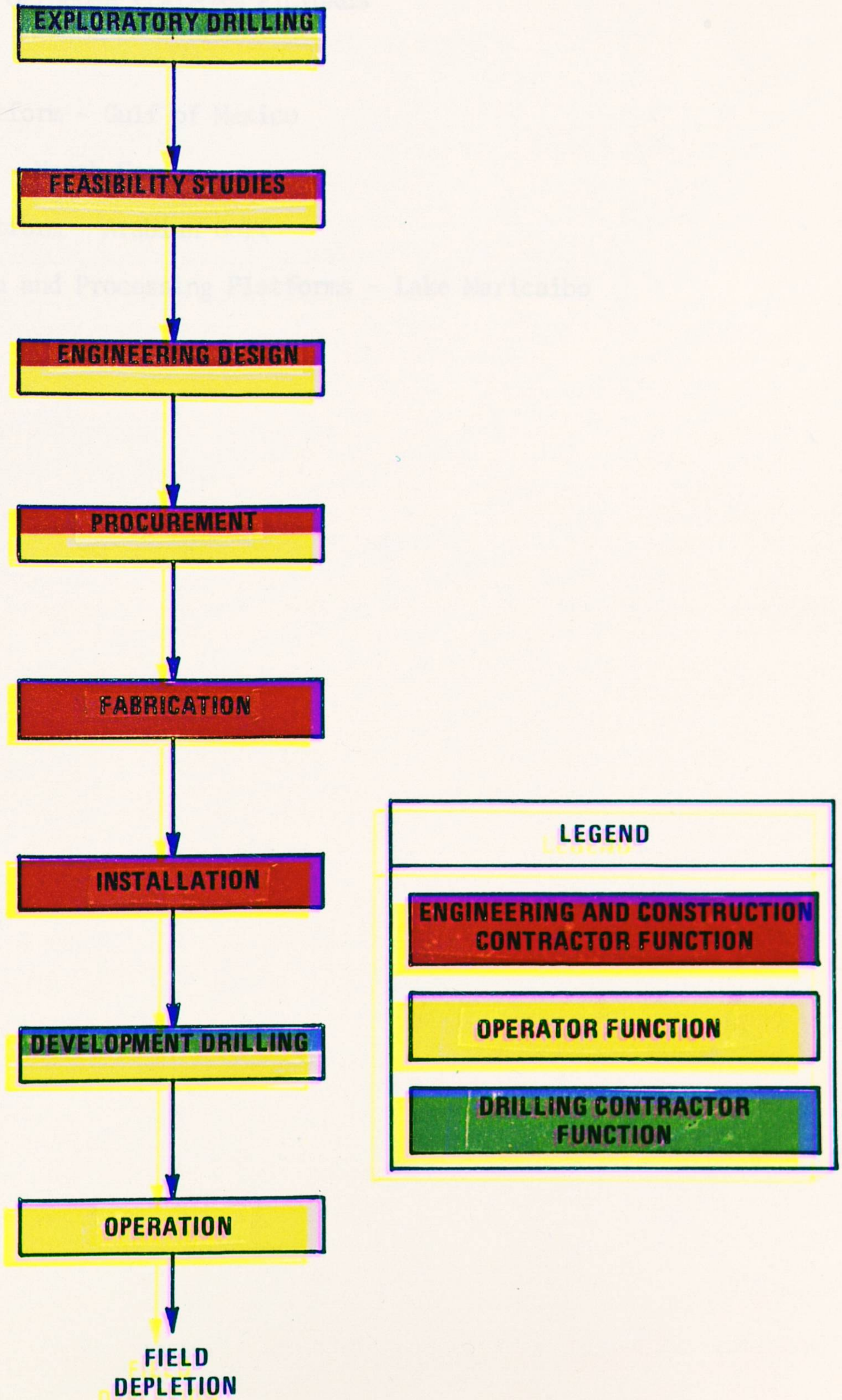
FUNCTIONS OF CONTRACTORS AND OPERATORS
IN FIELD DEVELOPMENT

OFFSHORE PLATFORMS

SUMMARY OF WORK EXPERIENCE

	INTERNSHIP	PREVIOUS EXPERIENCE
COMPANY	BROWN & ROOT, INC.	EXXON CO., USA
DEPARTMENTAL ACTIVITY	DESIGN OF OFFSHORE OIL AND GAS PRODUCTION FACILITIES	OPERATION OF ONSHORE OIL AND GAS PRODUCTION FACILITIES
POSITION	ASSISTANT PROJECT ENGINEER	PRODUCTION ENGINEER
DURATION	1 YEAR	2.5 YEARS
ACTIVITY	BUSINESS DEVELOPMENT AND PROJECT ADMINISTRATION	ENGINEERING SUPPORT OF OPERATIONS

FUNCTIONS OF CONTRACTORS AND OPERATORS IN FIELD DEVELOPMENT



OFFSHORE PLATFORM PICTURES

Compressor Platform - Gulf of Mexico

Super Platform - North Sea

Separation Platform - Arabian Gulf

Gas Compression and Processing Platforms - Lake Maricaibo

ENGINEERING AND CONSTRUCTION EXPERIENCE

POSITION WITHIN E&C INDUSTRY

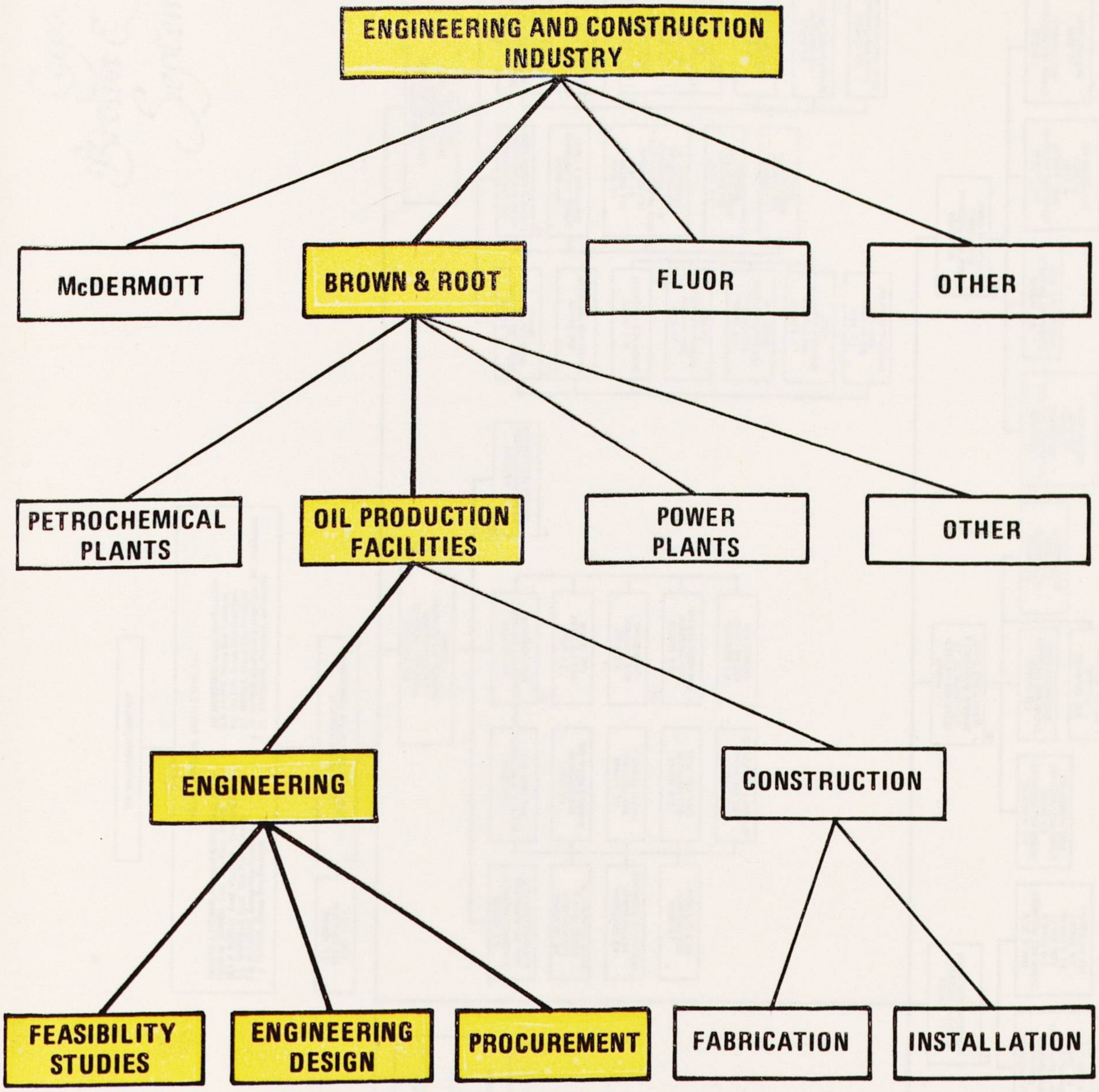
BROWN & ROOT'S ORGANIZATIONAL APPROACH

- CORPORATE STRUCTURE
- OIL & GAS DEPARTMENT STRUCTURE
- ENGINEERING DESIGN DEPARTMENT STRUCTURE
- TASK FORCE STRUCTURE
- LIFE CYCLE OF A PROJECT

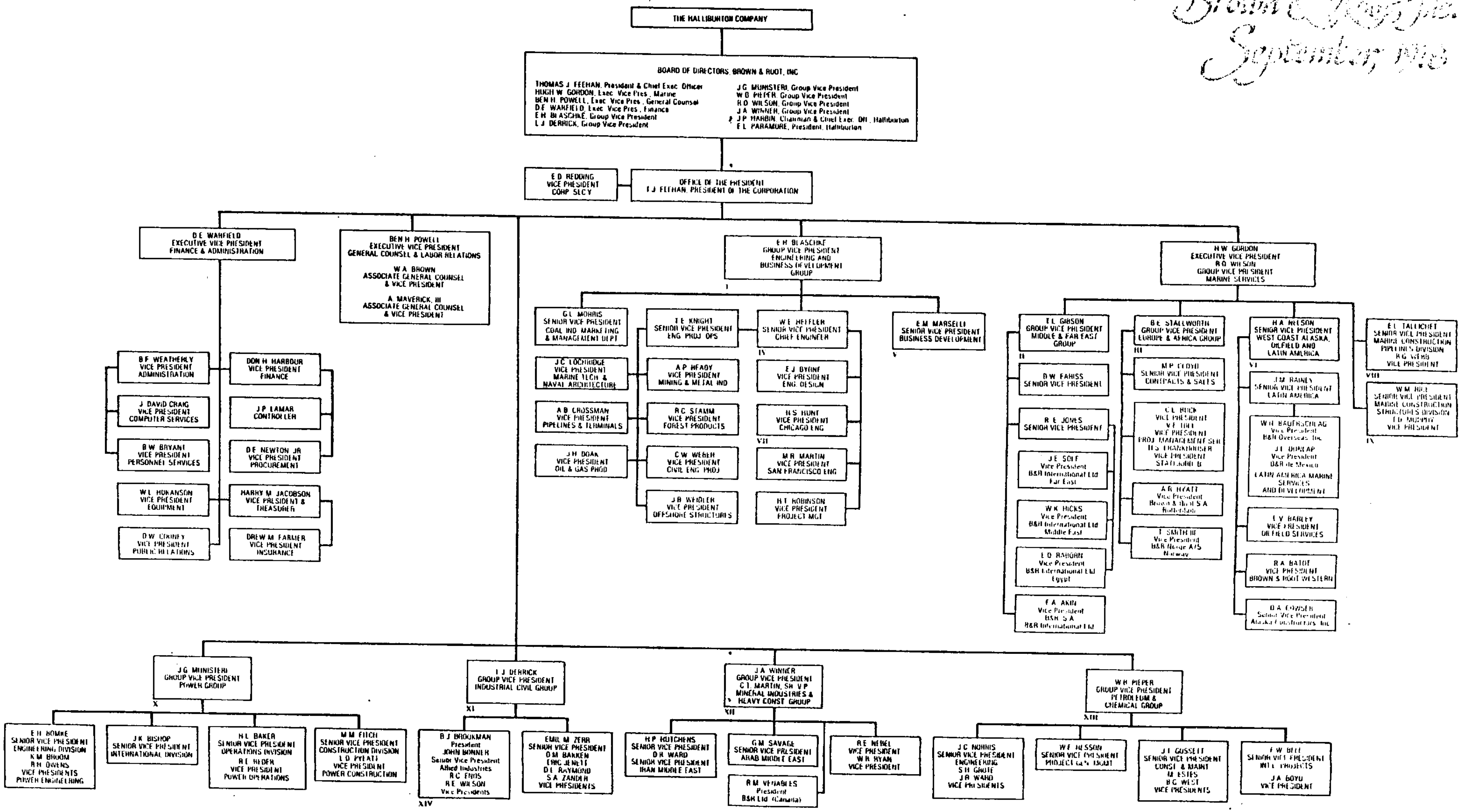
INTERNSHIP ACTIVITIES

- BUSINESS DEVELOPMENT
- PROPOSAL WRITING
- MOBILIZATION AND CONCEPTUAL ENGINEERING

POSITION WITHIN THE
ENGINEERING AND CONSTRUCTION INDUSTRY

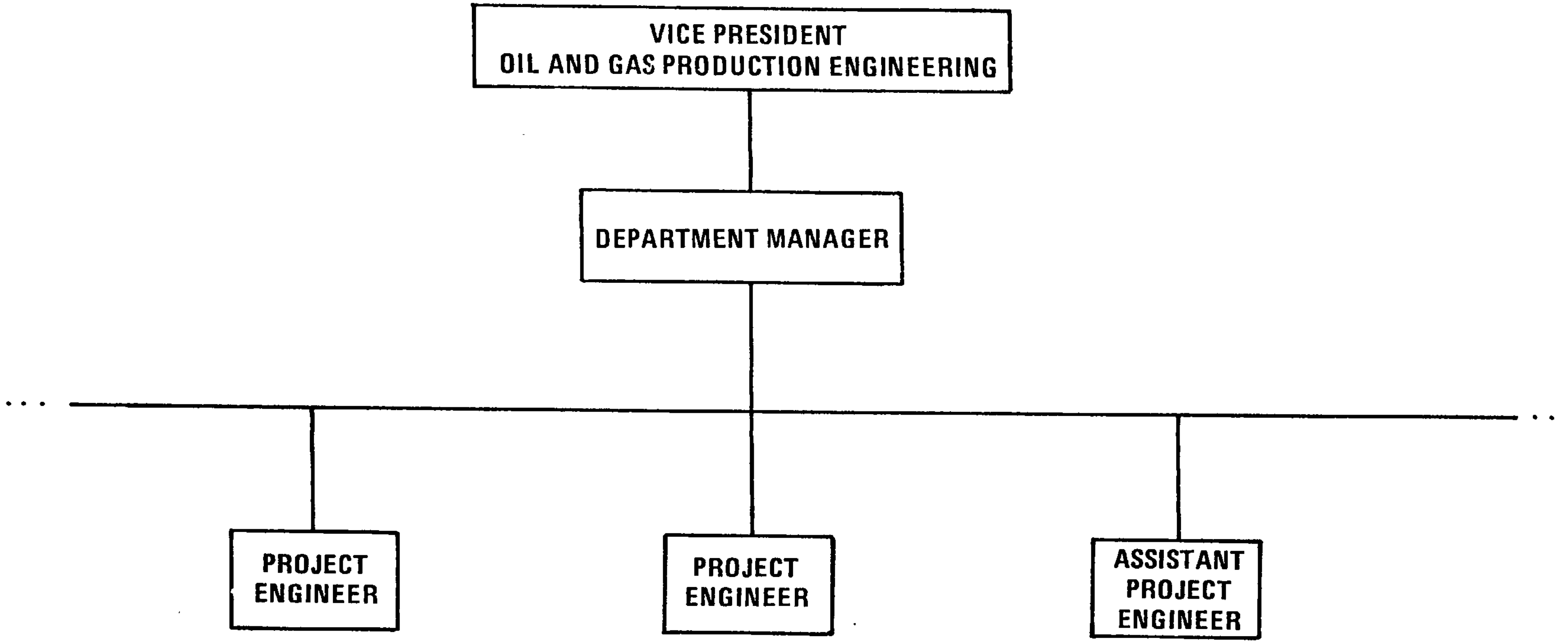


Corporate Officers
Brown & Root Inc.
September

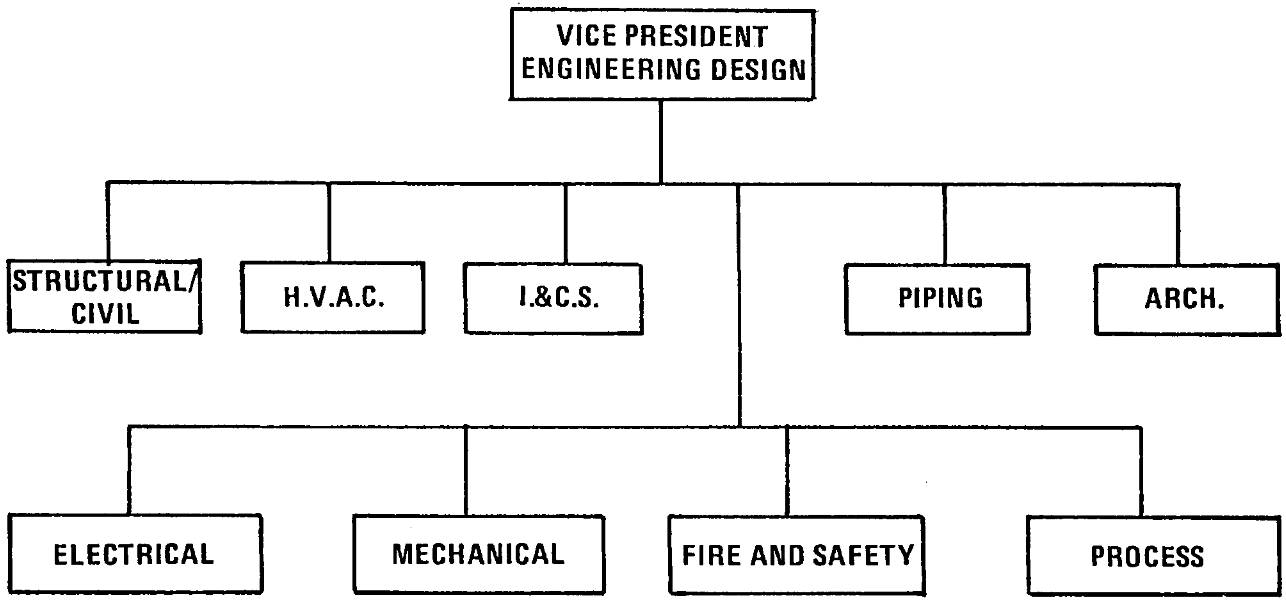


BROWN & ROOT'S ORGANIZATIONAL APPROACH

OIL AND GAS DEPARTMENT STRUCTURE

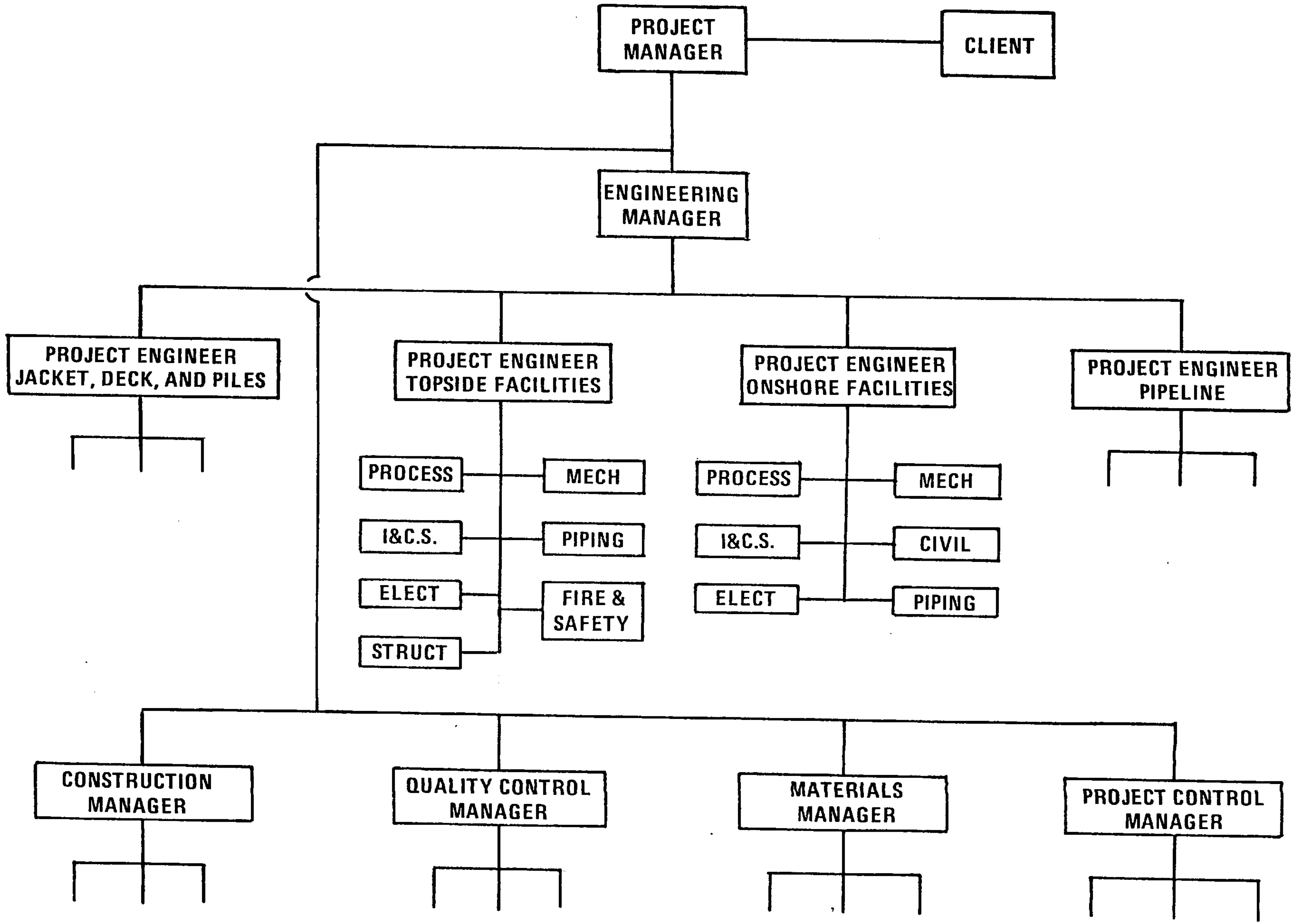


BROWN & ROOT'S ORGANIZATIONAL APPROACH
ENGINEERING DESIGN DEPARTMENT STRUCTURE



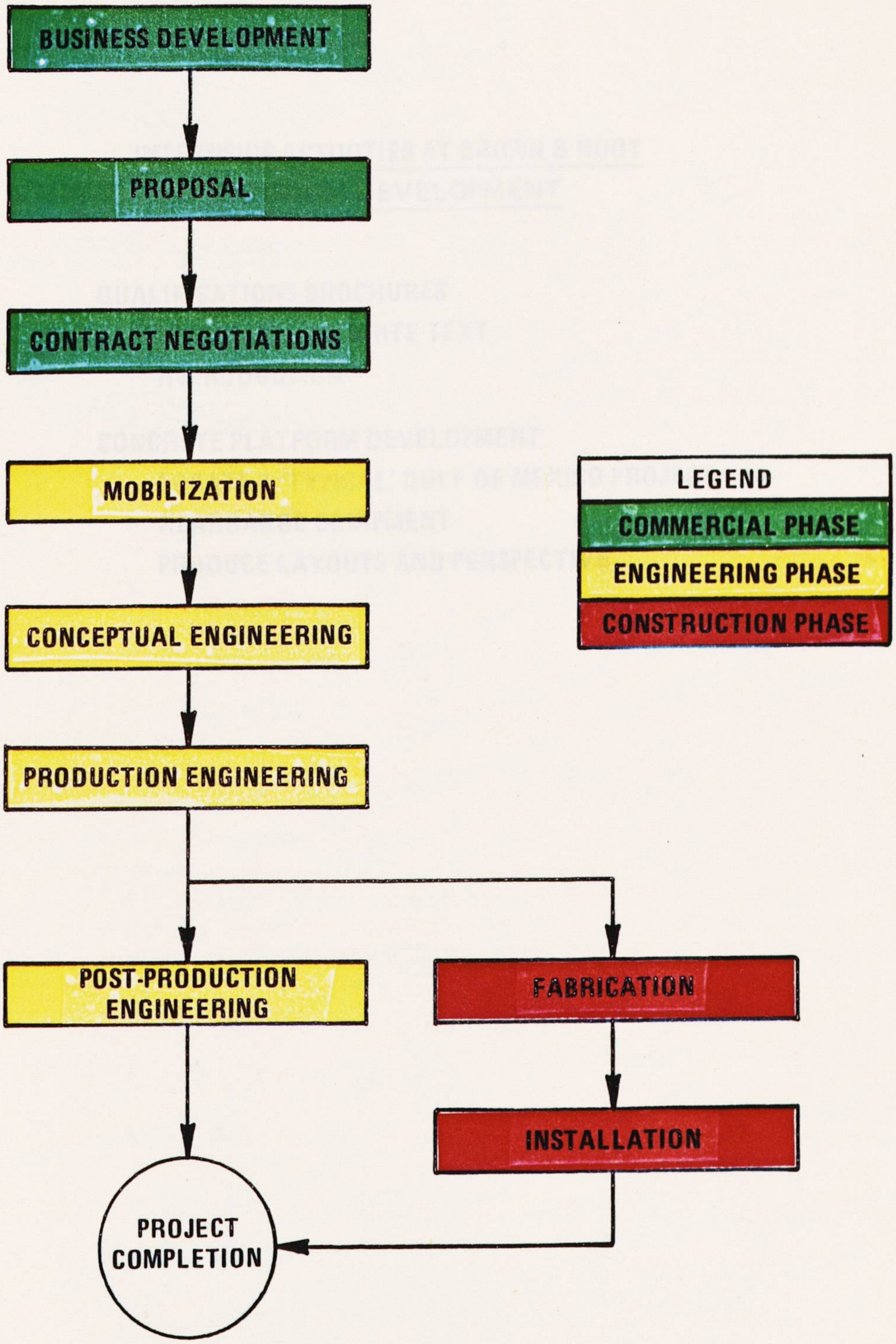
BROWN & ROOT'S ORGANIZATIONAL APPROACH

TASK FORCE STRUCTURE



BROWN & ROOT'S ORGANIZATIONAL APPROACH

LIFE CYCLE OF PROJECT



INTERNSHIP ACTIVITIES AT BROWN & ROOT
BUSINESS DEVELOPMENT

QUALIFICATIONS BROCHURES
- ORGANIZE AND WRITE TEXT
- REPRODUCTION

CONCRETE PLATFORM DEVELOPMENT
- LOCATE A 'TYPICAL' GULF OF MEXICO PROJECT
- REARRANGE EQUIPMENT
- PRODUCE LAYOUTS AND PERSPECTIVE

CONTENTS

ARTIST'S RENDITION OF CONCRETE PLATFORM

INTERNSHIP ACTIVITIES AT BROWN & ROOT
PROPOSAL WRITING

ENGINEERING DESIGN OF GAS/CONDENSATE/WATER SEPARATION FACILITIES

- STUDY TENDER DOCUMENT
- REVISE FLOW DIAGRAM
- PRODUCE AND DELIVER TEXT

ENGINEERING DESIGN OF GAS COMPRESSION FACILITIES

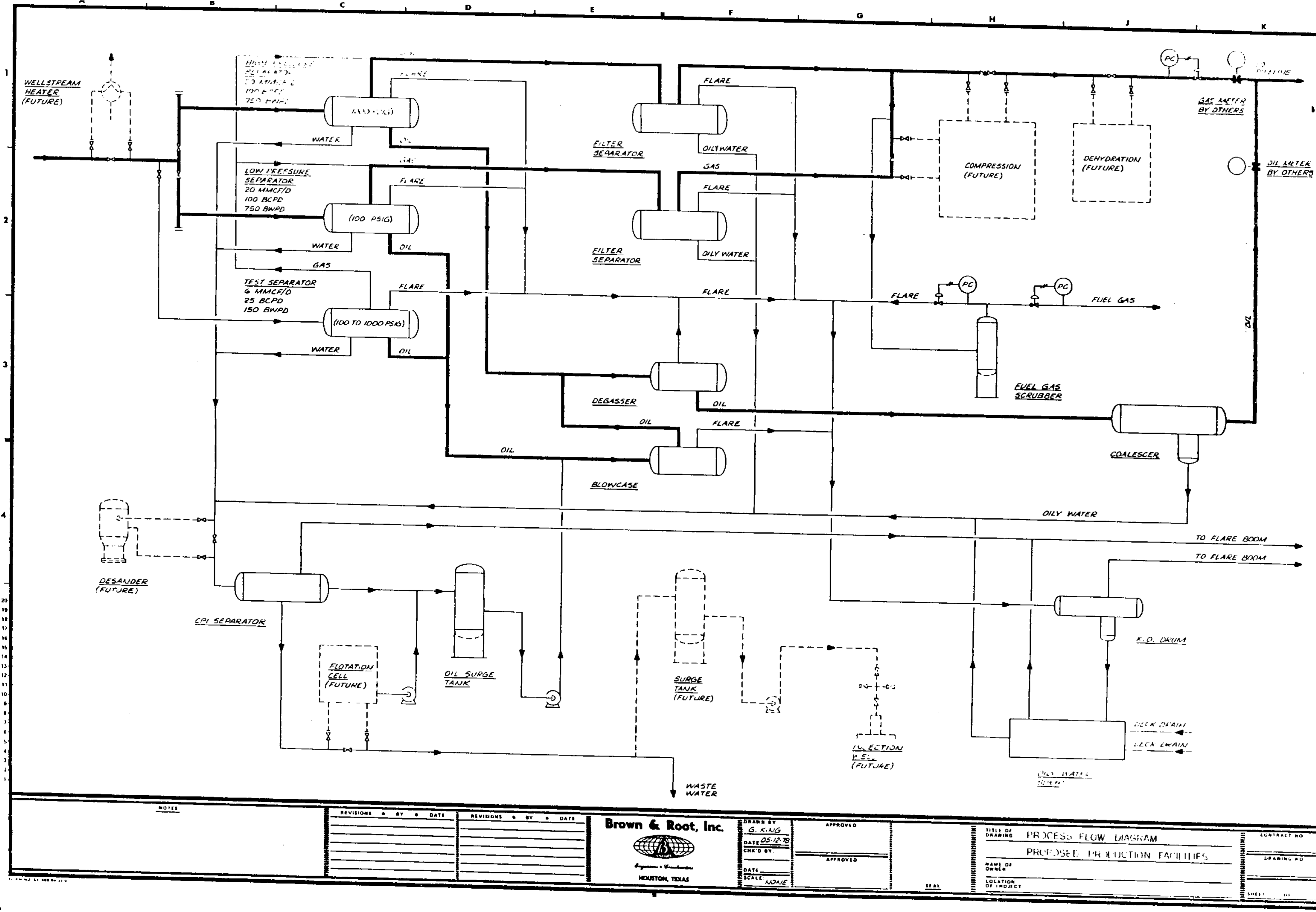
- STUDY TENDER DOCUMENT
- ORGANIZE AND WRITE TEXT
- INCORPORATE LEGAL INPUT

ENGINEERING DESIGN OF PLATFORM, PIPELINE, AND TERMINAL

- STUDY TENDER DOCUMENT
- ASSIST IN SCHEDULE PREPARATION

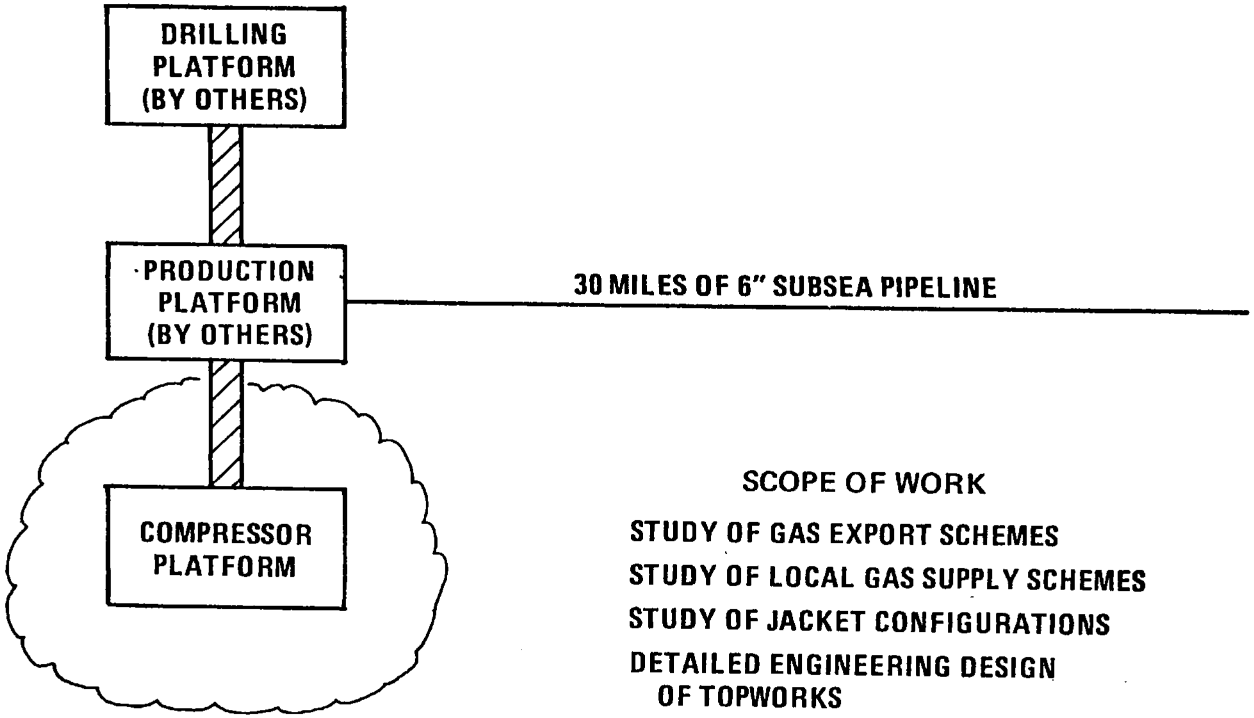
JOINT VENTURE ENGINEERING DESIGN OF LARGE PLATFORM

- SUMMARIZE MEETING NOTES
- EDIT FINANCIAL PRESENTATION



WELLSTREAM HEATER (FUTURE)
LOW PRESSURE SEPARATOR
20 MMCF/D
100 BCPD
750 BWPD
(100 PSIG)
TEST SEPARATOR
6 MMCF/D
25 BCPD
150 BWPD
(100 TO 1000 PSIG)
WATER
OIL
GAS
FLARE
FILTER SEPARATOR
OILY WATER
DEGASSER
BLOWCASE
COMPRESSION (FUTURE)
DEHYDRATION (FUTURE)
FUEL GAS
FUEL GAS SCRUBBER
PC
GAS METER BY OTHERS
OIL METER BY OTHERS
COALESCER
TO FLARE BOOM
TO FLARE BOOM
K.O. DRUM
DESANDER (FUTURE)
CPI SEPARATOR
FLOTATION CELL (FUTURE)
OIL SURGE TANK
SURGE TANK (FUTURE)
WASTE WATER
NOTES
REVISIONS BY DATE
Brown & Root, Inc.
HOUSTON, TEXAS
DRAWN BY G. KING
DATE 05-12-78
CHK'D BY
SCALE NONE
APPROVED
SEAL
TITLE OF DRAWING PROCESS FLOW DIAGRAM
PROPOSED PRODUCTION FACILITIES
NAME OF OWNER
LOCATION OF PROJECT
CONTRACT NO
DRAWING NO
SHEET OF

PROPOSAL FOR STUDY AND DESIGN OF COMPRESSOR MODULES



SCOPE OF WORK

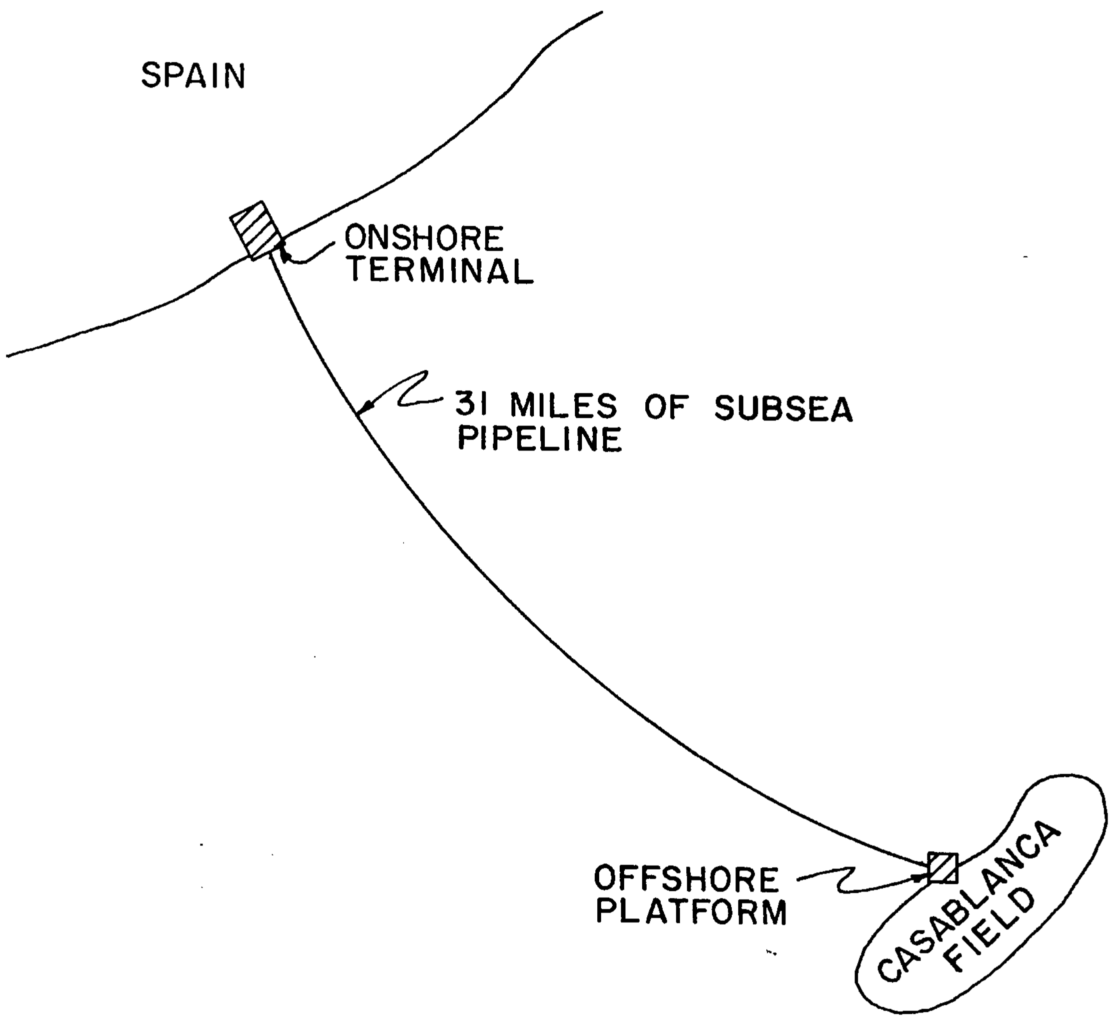
STUDY OF GAS EXPORT SCHEMES

STUDY OF LOCAL GAS SUPPLY SCHEMES

STUDY OF JACKET CONFIGURATIONS

DETAILED ENGINEERING DESIGN OF TOPWORKS

PROPOSAL FOR DESIGN OF PLATFORM, PIPELINE AND TERMINAL



SCOPE OF WORK

- DETAILED ENGINEERING DESIGN OF TOPWORKS, JACKET, PIPELINE, AND ONSHORE TERMINAL
- SUPERVISION OF FABRICATION

INTERNSHIP ACTIVITIES AT BROWN & ROOT
MOBILIZATION AND CONCEPTUAL ENGINEERING

PROCEDURES MANUAL

CONCEPTUAL STUDIES

OPERATING COMPANY EXPERIENCE

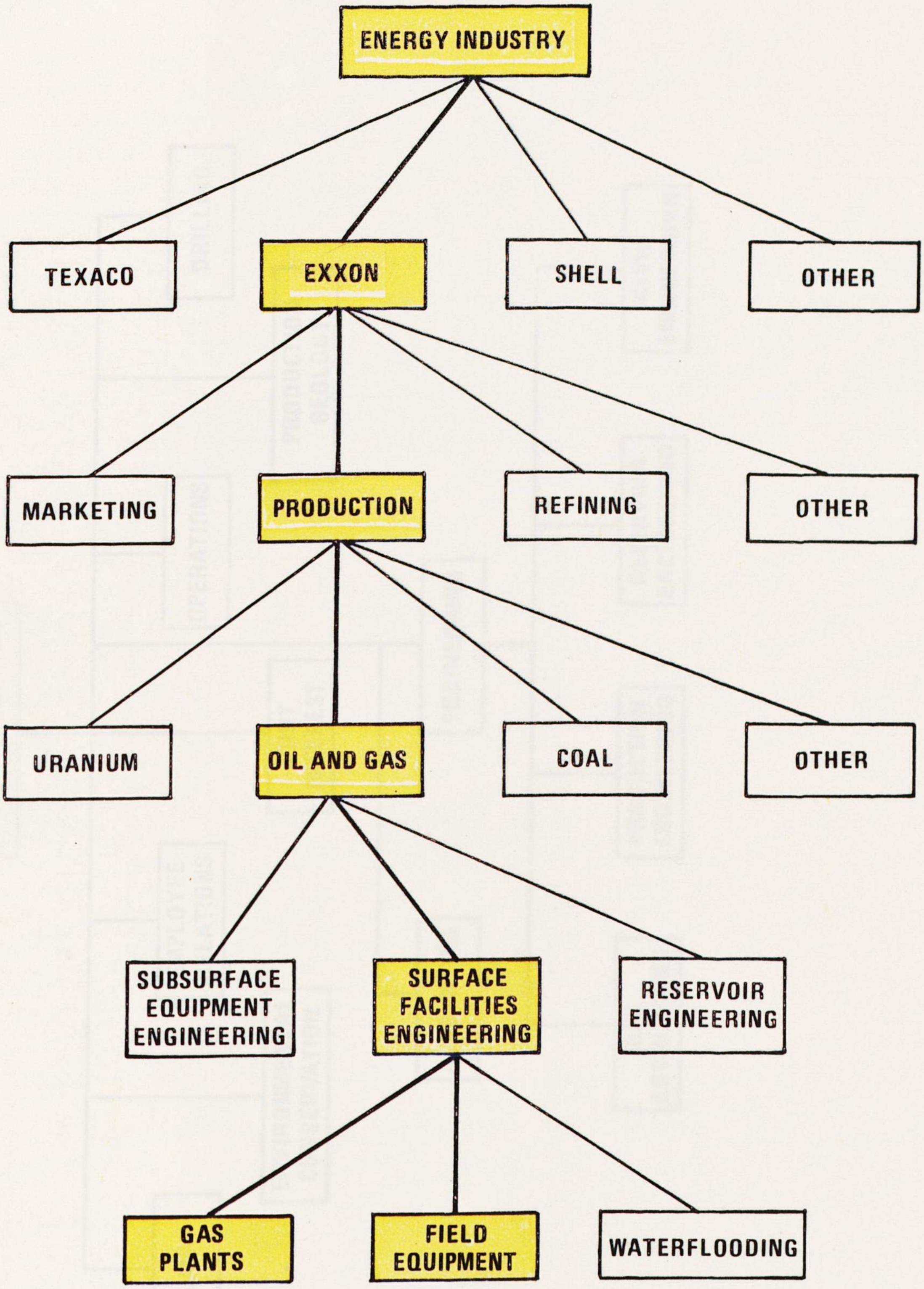
POSITION WITHIN ENERGY INDUSTRY

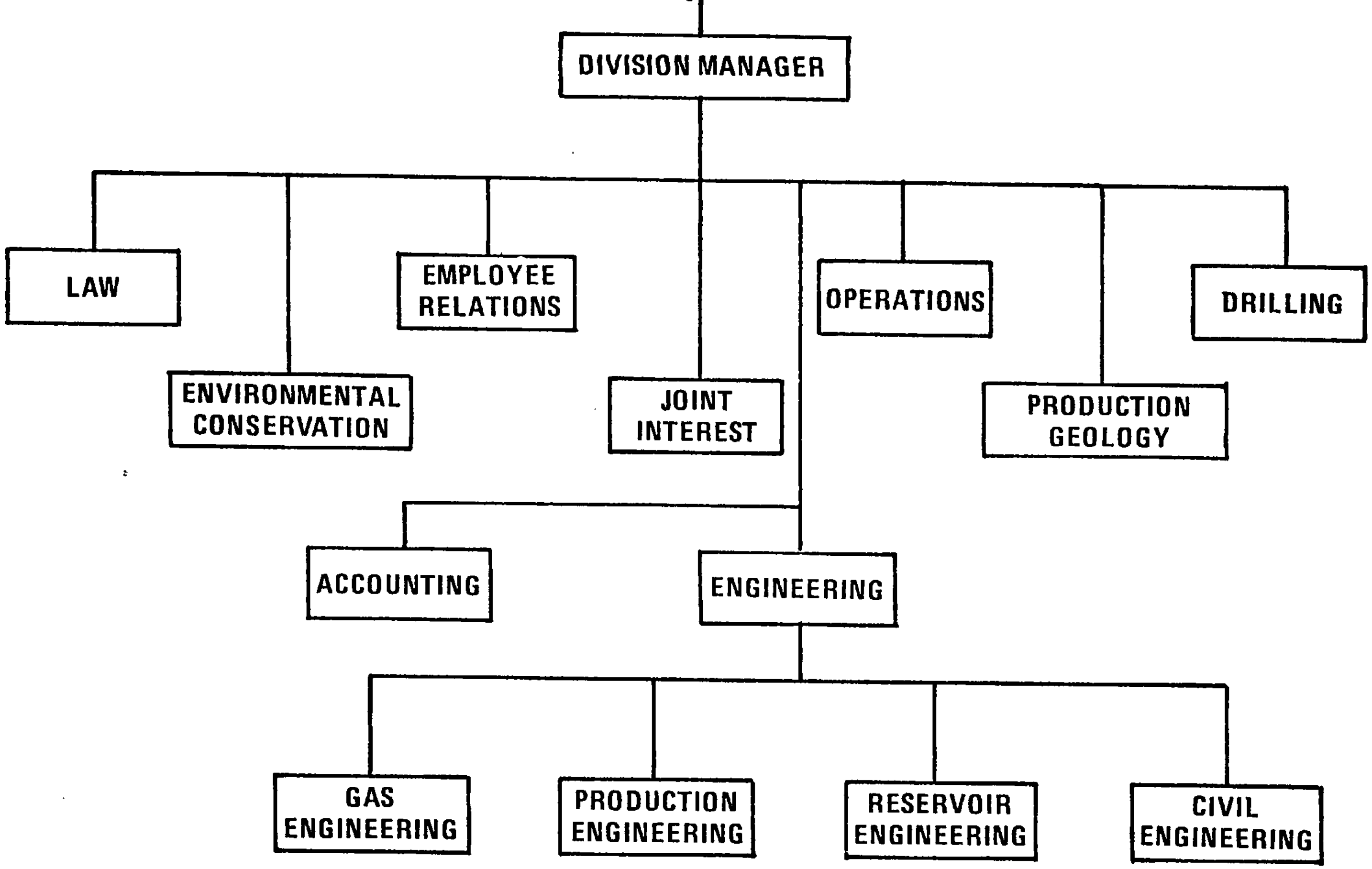
EXXON'S ORGANIZATIONAL STRUCTURE

PROJECTS AT EXXON

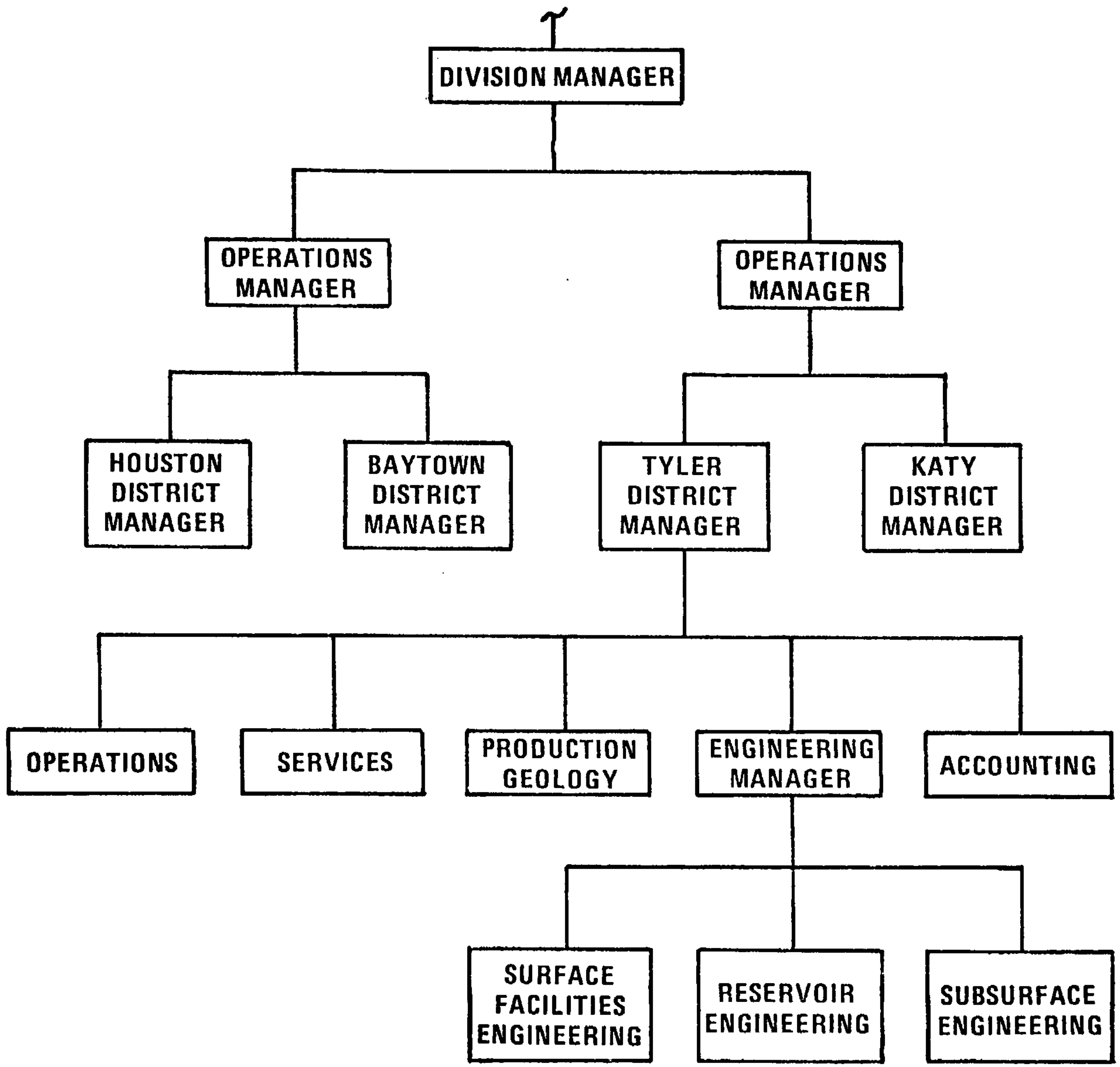
- WASTE HEAT STEAM GENERATOR
- COMPRESSOR INSTALLATION
- OIL PRODUCTION FACILITIES

POSITION WITHIN ENERGY INDUSTRY



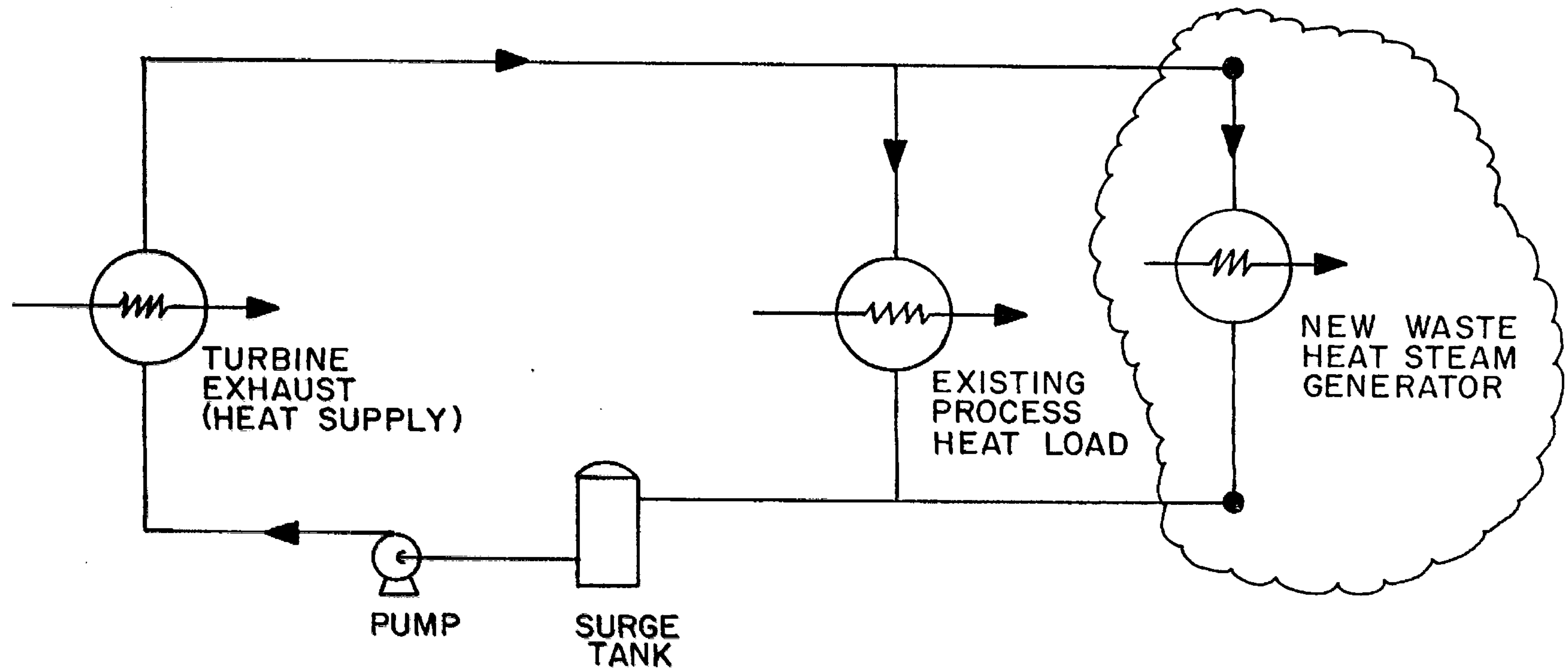

DIVISION MANAGER
LAW
ENVIRONMENTAL CONSERVATION
EMPLOYEE RELATIONS
JOINT INTEREST
OPERATIONS
PRODUCTION GEOLOGY
DRILLING
ACCOUNTING
ENGINEERING
GAS ENGINEERING
PRODUCTION ENGINEERING
RESERVOIR ENGINEERING
CIVIL ENGINEERING

EXXON'S ORGANIZATIONAL STRUCTURE



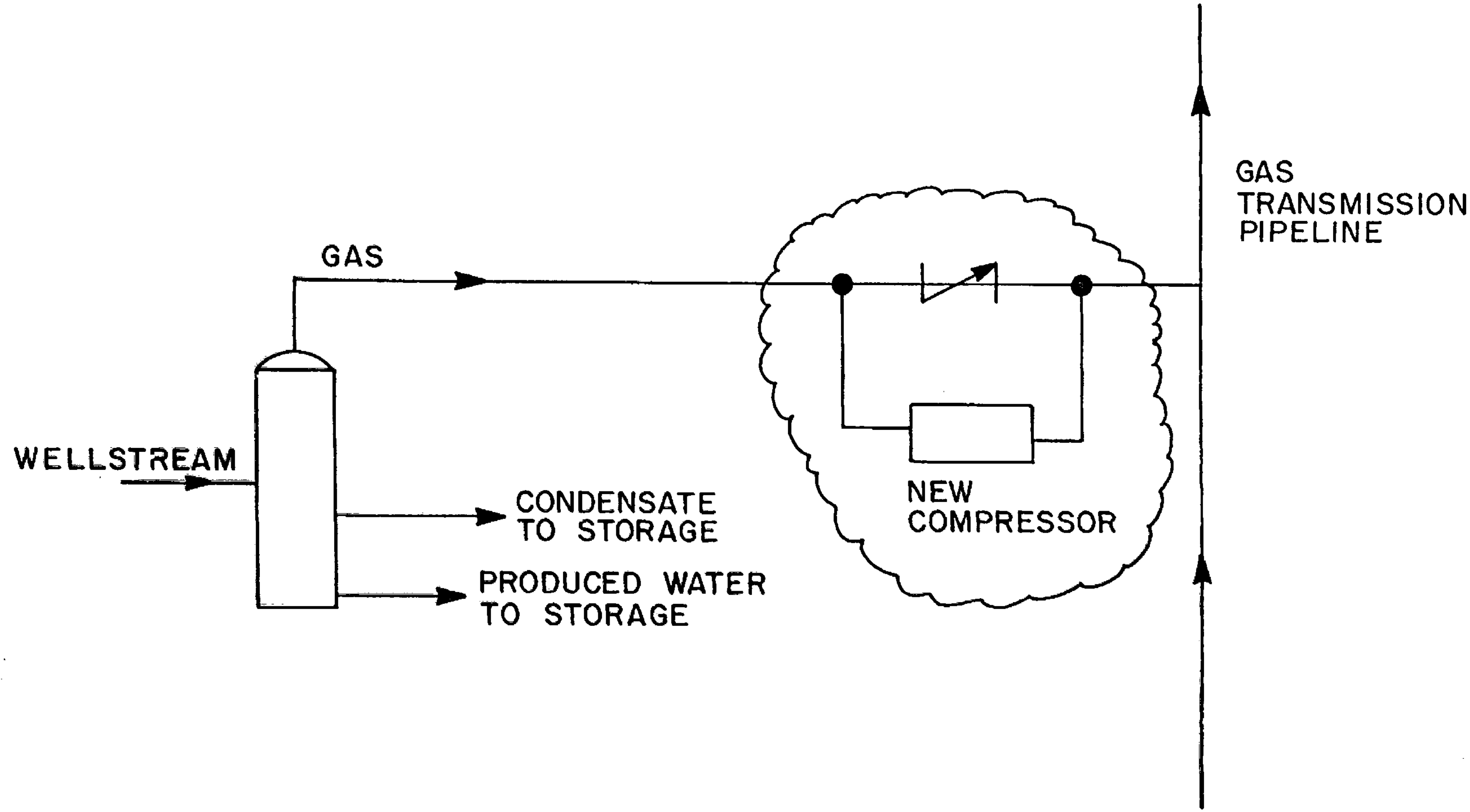
PROJECTS AT EXXON

- WASTE HEAT STEAM GENERATOR INSTALLATION

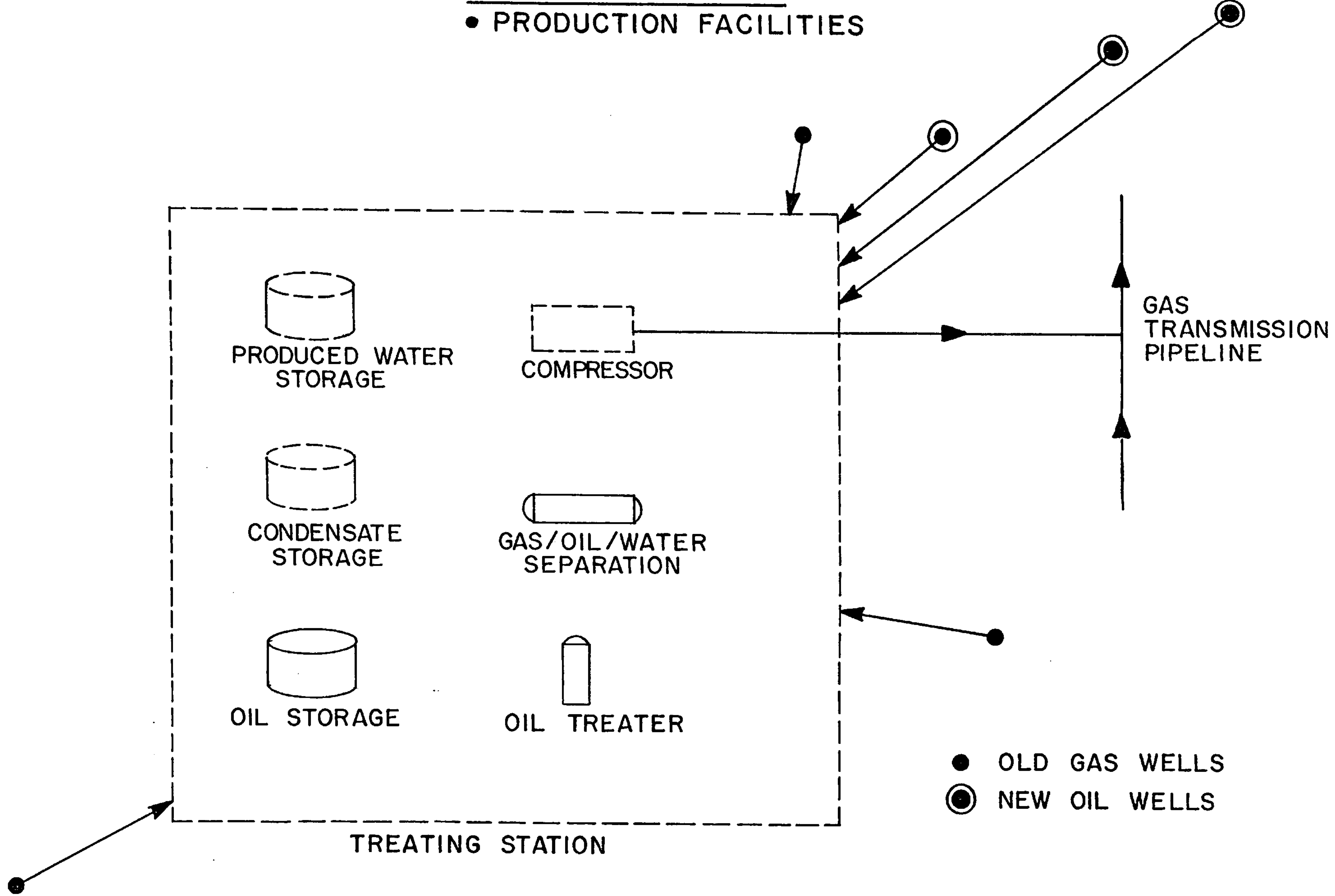


PROJECTS AT EXXON

- COMPRESSOR INSTALLATION



• PRODUCTION FACILITIES



6.3 REFERENCES

The primary references and written learning aids used during the Internship at Brown & Root were the three-volume set of manuals used for the in-house training of engineering managers entitled "Advancements in Project Engineering Management". These manuals were extremely useful in gaining an understanding of the organizational approach at Brown & Root.

VITA

The author was born on July 17, 1951, in Kansas City, Kansas, to Willard and Dorothy Kibbee. He attended Turner High School in Kansas City, Kansas, and graduated as valedictorian in May, 1969. After graduating in May, 1973, with highest distinction from The University of Kansas with a Bachelor of Science Degree in Mechanical Engineering, he went to work for Exxon Co., USA, as a Production Engineer in Houston and Tyler, Texas. In January, 1976, he left Exxon to begin graduate work at Texas A&M University, where he also held teaching and research assistantships. He received a Master of Engineering Degree in Mechanical Engineering in August, 1977. From January, 1978, until January, 1979, he served an Internship at Brown & Root, Inc. in their Oil and Gas Production Engineering Department. The Doctor of Engineering Degree in Mechanical Engineering will be awarded in May, 1979.

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The typist for this report was Ms. Dorothy Edwards.