

INTERN EXPERIENCE AT  
BROWN & ROOT, INCORPORATED

AN INTERNSHIP REPORT

by

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Submitted to the College of Engineering  
of Texas A&M University  
in partial fulfillment of the requirement for the degree of  
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May 1979

Major Subject: Civil Engineering

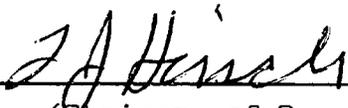
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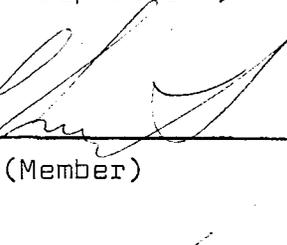
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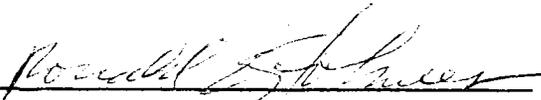
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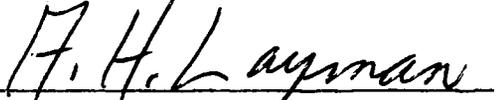
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May 1979

## ABSTRACT

Industrial Experience at the Offshore Structures Department,

Brown & Root, Incorporated. (May, 1979)

Roengnarong Ratanaprichavej,

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Chairman of Advisory Committee: Dr. T. J. Hirsch

This internship report describes the major activities and accomplishments during the author's one-year internship at Brown & Root in Houston, Texas. The report discusses his engineering assignments, and the necessary functions of a project engineer. The author's assignments covered essentially the technical nature and procedures of his work in several areas of fixed offshore platform design. The author presents and discusses the managerial functions of a project engineer whom he observed working in an offshore engineering company. At the end of this report, the author's accomplishments are summarized, and recommendations concerning the internship are presented.

## ACKNOWLEDGEMENTS

The author would like to express his gratitude to Dr. Teddy J. Hirsch for providing help and advice throughout his time at Texas A&M University, and to the Academic Committee members, Dr. Charles M. Hix, Dr. Andy H. Layman, and Mr. John L. Sandstedt for their time. Thanks also go to Dr. Donald McDonald, Dr. Richard E. Thomas, and Dr. Charles A. Rodenberger for their attention and assistance. He is grateful to Mr. Stanley J. Hruska, his internship supervisor, for serving in that capacity, and for his kind and warm attention during the internship period at Brown & Root. His appreciation also extends to Dr. Ronald E. Holmes, the College of Engineering Representative, and Dr. Jimmie D. Dodd, the Graduate College Representative, for their participation on his committee.

TO MOM

Without her love and support,  
there would never be a day like this for me.

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## INTRODUCTION

The purpose of this report is to establish that the two objectives of the internship have been met. These objectives are (1) to work and gain experience as a structural engineer, and (2) to learn the organization and the managerial functions.

For the first objective, the report covers all assignments in the fixed offshore platform design in general, and discusses some of them in detail. It also presents a general explanation of the projects and the design criteria. In fulfilling the second objective, the report discusses the necessary functions and the responsibilities of an engineering manager in an offshore company.

The report briefly explains Brown & Root's operation and organization, and the information pertinent to the assignments such as the names and positions of the supervisors, and the project scopes. Then, the report discusses the assignments during the internship, and the functions of a technical manager.

## I. THE COMPANY AND THE ORGANIZATION

## The Company

Brown & Root, Inc. (hereafter will be called Brown & Root), one of the largest engineering and construction companies in the world, has its headquarters in Houston, Texas, and its offices in San Francisco, Chicago, Bahrain, London, Singapore, and Tehran. The company was founded in 1919 and was incorporated in 1929. In 1962, the company was purchased by Halliburton Company and has become a subsidiary company of Halliburton since then.

Brown & Root has participated in a wide variety of projects, such as offshore platforms and submarine pipelines, industrial plants, power plants, chemical and petrochemical plants, pulp and paper mills, steel mills, highways, dams, bridges, and tunnels and mining operations. However, this report covers only the author's experience with Brown & Root in the design of fixed offshore platforms in the Offshore Structures Department in Houston, Texas.

## The Organization

Figure 1 through Figure 5 are the organization charts of Brown & Root--starting from Halliburton Company, the parent company, to the Offshore Structures Department.

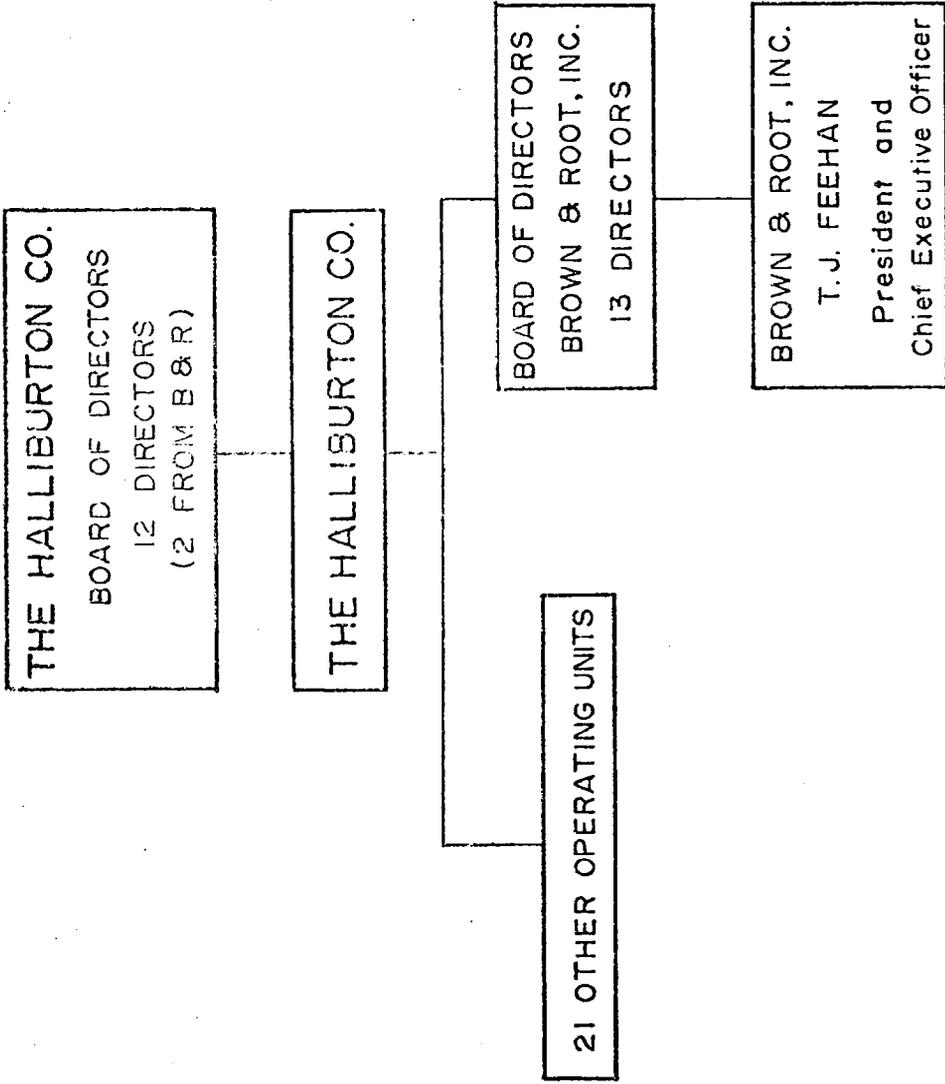


FIGURE 1  
BROWN & ROOT'S PARTIAL ORGANIZATION CHART

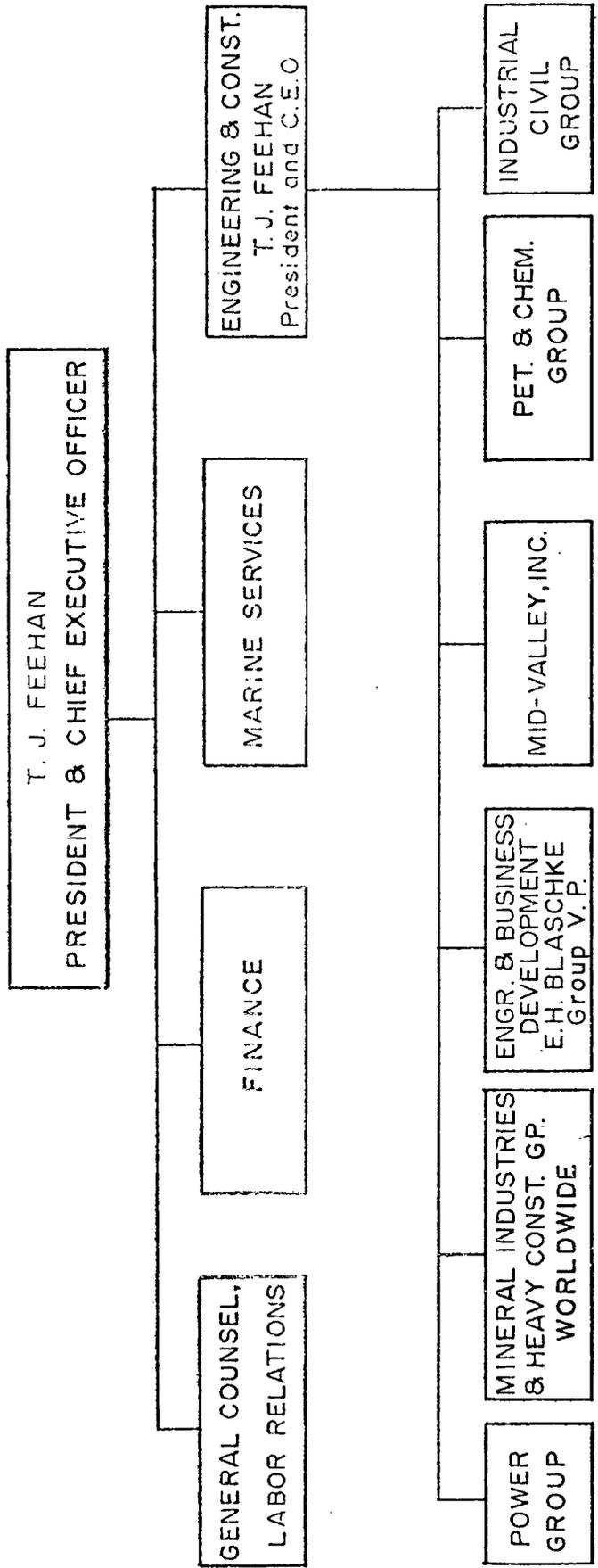


FIGURE 2  
BROWN & ROOT'S PARTIAL ORGANIZATION CHART

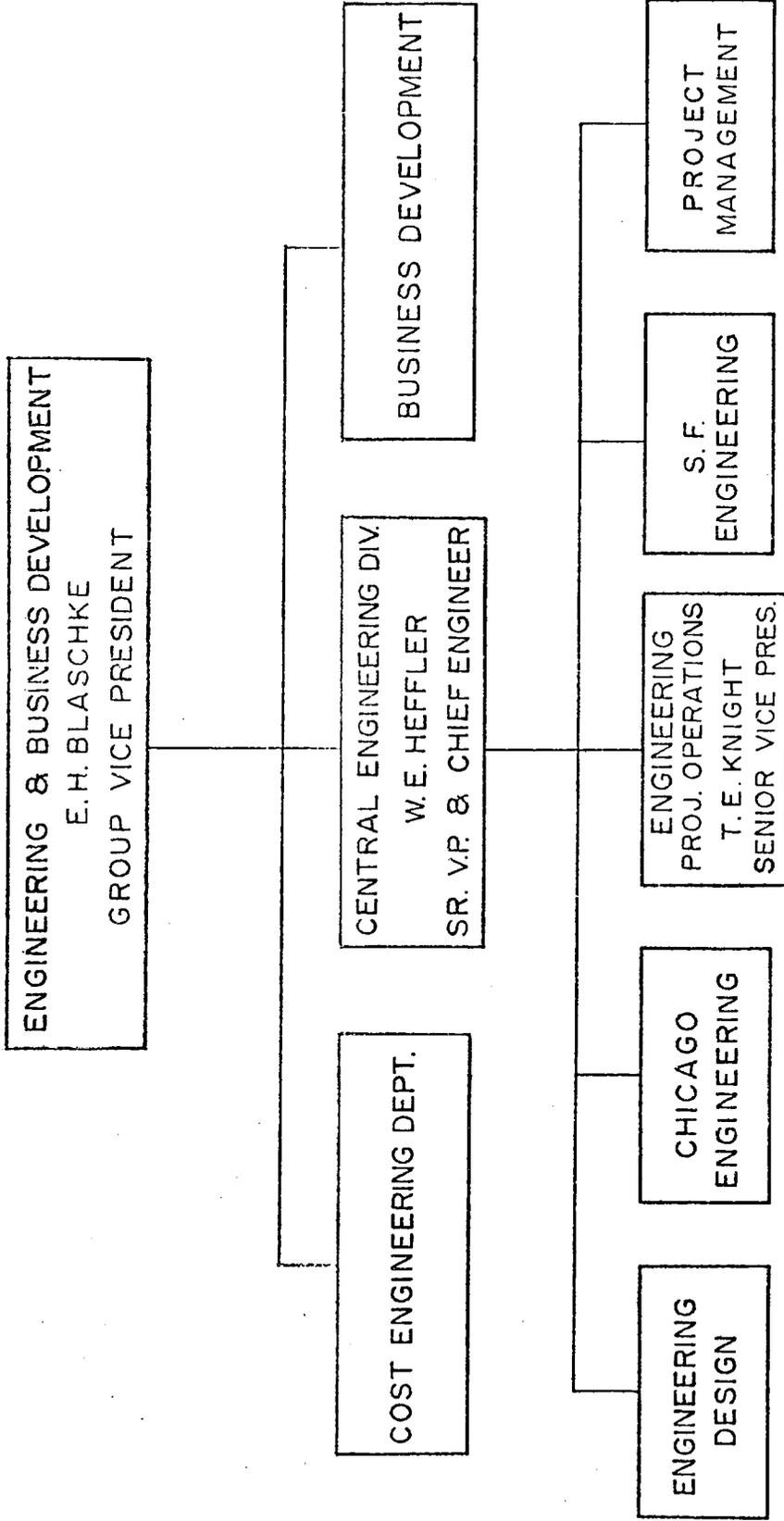


FIGURE 3  
BROWN & ROOT'S PARTIAL ORGANIZATION CHART

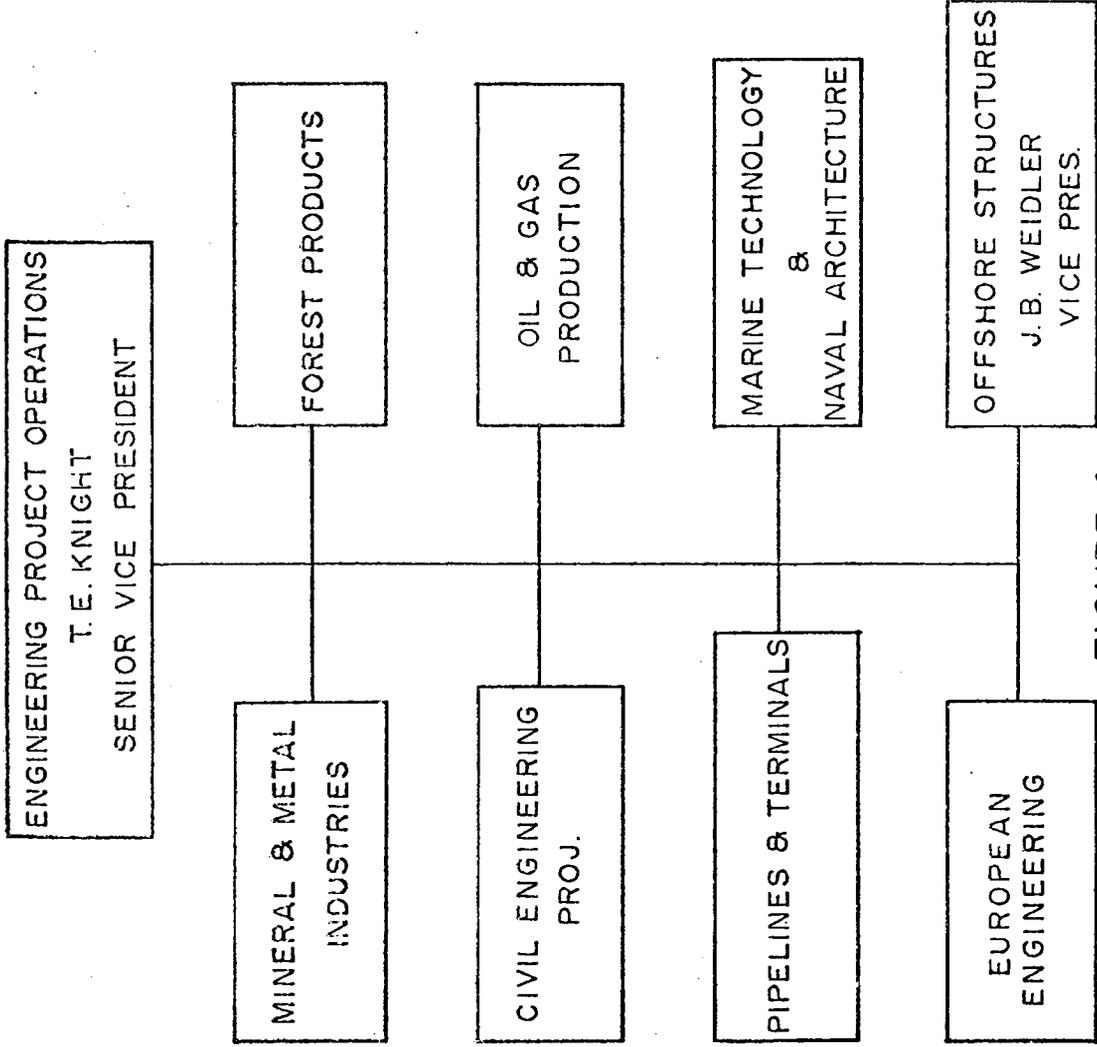


FIGURE 4  
BROWN & ROOT'S PARTIAL ORGANIZATION CHART

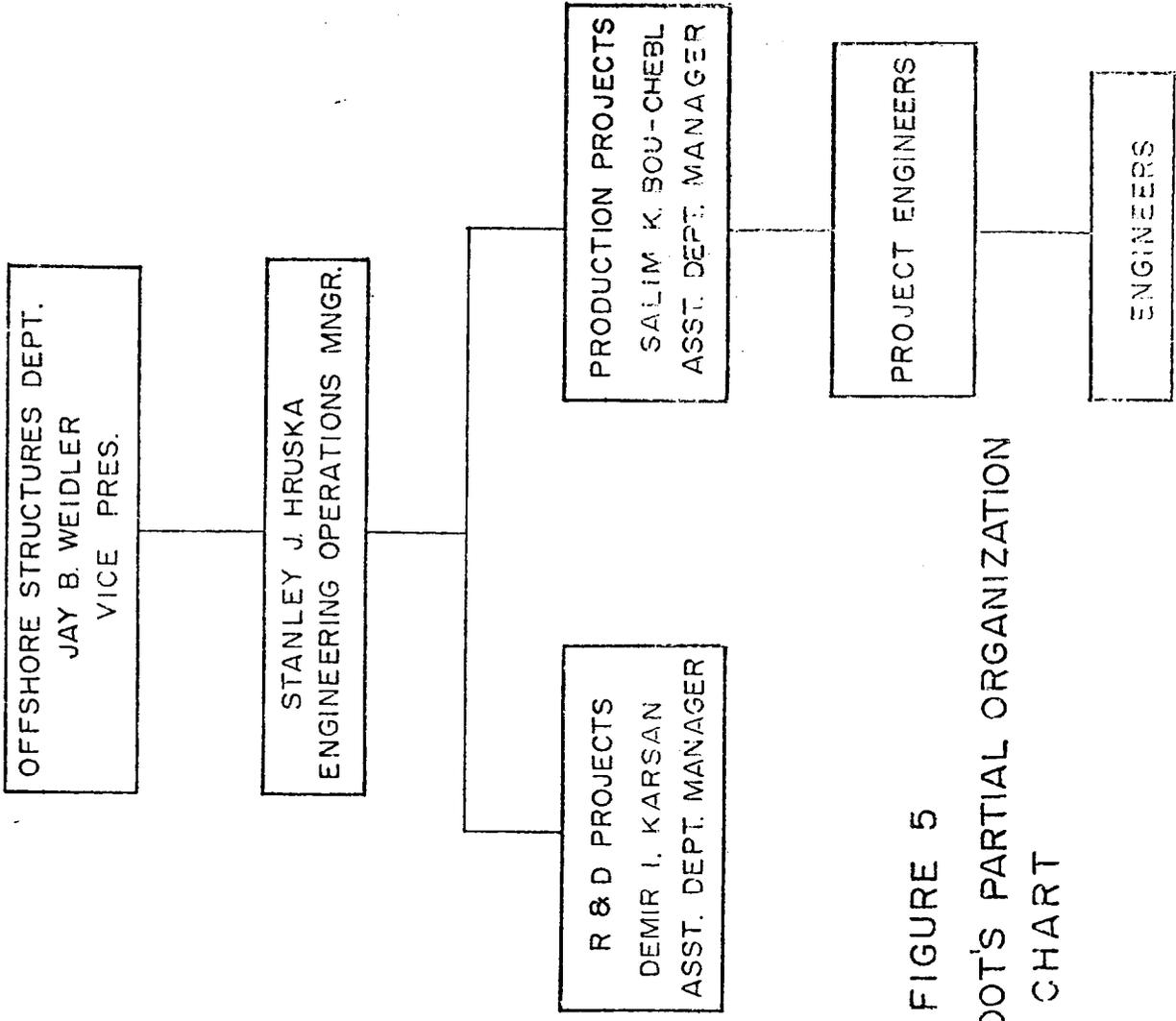


FIGURE 5

BROWN & ROOT'S PARTIAL ORGANIZATION CHART

II. THE AUTHOR'S INTERNSHIP OBJECTIVES, WORK  
POSITION, SUPERVISORS, AND PROJECTS

## The Internship Objectives

The author's internship objectives as submitted to Dr. Teddy J. Hirsch on April 20, 1978 were:

1. To work and gain experience as a structural engineer.
2. To learn the organization of Brown & Root and the functions of some of the managerial positions.

Besides the two primary objectives, eight secondary objectives were set up to specify particular areas of professional development that the author would like to achieve during his internship. They were concentrated on the following work areas:

1. Design
2. Analyses
3. Team work
4. Drawing and checking
5. Scheduling, budgeting, and cost-estimating
6. Study of Brown & Root system
7. Study of the role of a Project Manager
8. Study of the role of a Project Engineer.

In general, the secondary objectives in the professional areas of Design, Analyses, Team Work, and Drawing and Checking would fulfill primary objective 1, while the rest of them would satisfy primary objective 2.

A copy of the author's internship objectives is presented in Appendix A.

### The Work Position

The author worked in Brown & Root's Offshore Structures Department as an engineer, a position which he maintained throughout his twelve-month internship period. The position requires an acceptable degree with six or more years of experience. However, with his bachelor's and master's degrees, two years experience as a structural engineer, and four semesters into the Doctor of Engineering Degree Program, the author was certain that he was qualified for the position. A detailed description of the position is included in Appendix B.

As an engineer in the Offshore Structures Department, the author reported to the project engineer, the assistant manager, and the manager while he supervised associate designers, technicians, and draftsmen. The word "supervised" is implied and indirect, because all engineers do not have the authority over the drafting personnel. The author provided technical support to the design engineers, the senior engineers, and the project engineers that he worked with. He helped them in designing and analyzing minor offshore structures, preparing specifications and drawings, reviewing and checking detailed drawings, and preparing input data for computer-assisted structural analysis programs.

Although there was a need for the author to participate in some non-engineering, administrative assignments to satisfy the second internship objective, the need for an engineer and the tight schedule of his projects always prevented him and Mr.

Stanley J. Hruska, the manager and internship supervisor, from arranging such an assignment. As the result, the author finished his internship with tremendous technical exposure and a small amount of administrative experience. However, the author had been aware of this situation from the beginning, and, during his internship, made the observation of the organization and the administration of the department and studied the Project Engineering Management Program and the Project Engineering Management Manual which are the indispensable management handbooks for the project engineers. In Chapter IV of this final report, the author explains the functions of a technical manager basing them on the information he gathered at Brown & Root, his own judgement, and the management books of his interest. Chapter IV presents the administrative and managerial procedures of Brown & Root that he observed during his internship.

## The Supervisors

The author's internship supervisor was Mr. Stanley J. Hruska who was the Engineering Operation Manager of Brown & Root's Offshore Structures Department from January 15, 1978 to January 5, 1979, the author performed his work under the supervision of the following project engineers who were also his immediate supervisors:

1. Mr. Thomas C. Wozniak. From January 15, 1978 to September 10, 1978, Mr. Wozniak served as his immediate supervisor when the author worked for him in the Chevron project.
2. Mr. Mohamed I. El-Hitamy, who was the project engineer for three projects - the CNG twin-platform projects, the Mesa project, and the Natomas project. The author worked under his supervision from September 11, 1978 to January 5, 1979.

## The Projects

Only two projects--the Chevron project and the CNG projects--are explained to illustrate the required engineering activities for two types of fixed offshore platform projects in the Gulf of Mexico. The Chevron project was an example of a large project while the CNG project was a typical medium-size project. The Mesa and Natomas projects were small projects which usually have the same scope of work as the medium size project, thus they are not discussed here. It should be noted that the size of the projects is usually classified by the water depth of the platform. Therefore, the Chevron project with 685 ft of water depth was a large project, and the CNG project with 337 ft of water depth was a medium-size project, while the Mesa and Natomas in 35 and 95 ft of water, respectively, were classified as small projects.

## The Chevron Project

Chevron U.S.A., Inc. requested that Brown & Root design, fabricate, loadout, transport, and install a drilling and production platform in 685 ft of water in the Gulf of Mexico.

The scope of work was as follows:

1. The deck was to be an eight leg, two level, trussed structure, and would be designed and fabricated to be installed as a single lift.
2. The jacket was a conventional, template type structure with eight main legs and twelve skirt sleeves.

The jacket would be designed for launch in a single piece from a launch barge.

3. The piles consisted of eight skirt piles and eight main piles. The estimated ultimate capacity was 7,200 kip for the skirt pile and 4,800 kip for the main pile. The piles would be driven by conventional stream hammer with 500,000 ft-lb energy rating.

Since this project involves engineering, fabricating and installing activities, the following coordination was set up:

(Figure 6)

1. Project Management. The project manager was assigned from Brown & Root's Western Hemisphere Marine Construction Division. He was the designated representative of Brown & Root's management for the accomplishment of the project, and had the authority to draw on Brown & Root's resource to complete the assignment.
2. Engineering. A structural project engineer and two senior engineers were assigned from the Offshore Structures Department to co-ordinate and be responsible for the analysis and design effort for the project. This design effort included the in-place analyses of the jacket and deck, the foundation design, the fatigue analysis, the transportation and installation analyses, and grouting and flooding system. The structural project engineer was Mr. Thomas C. Wozniak and the two senior engineers were Mr. Ernest Teague, and Mr. Wayne

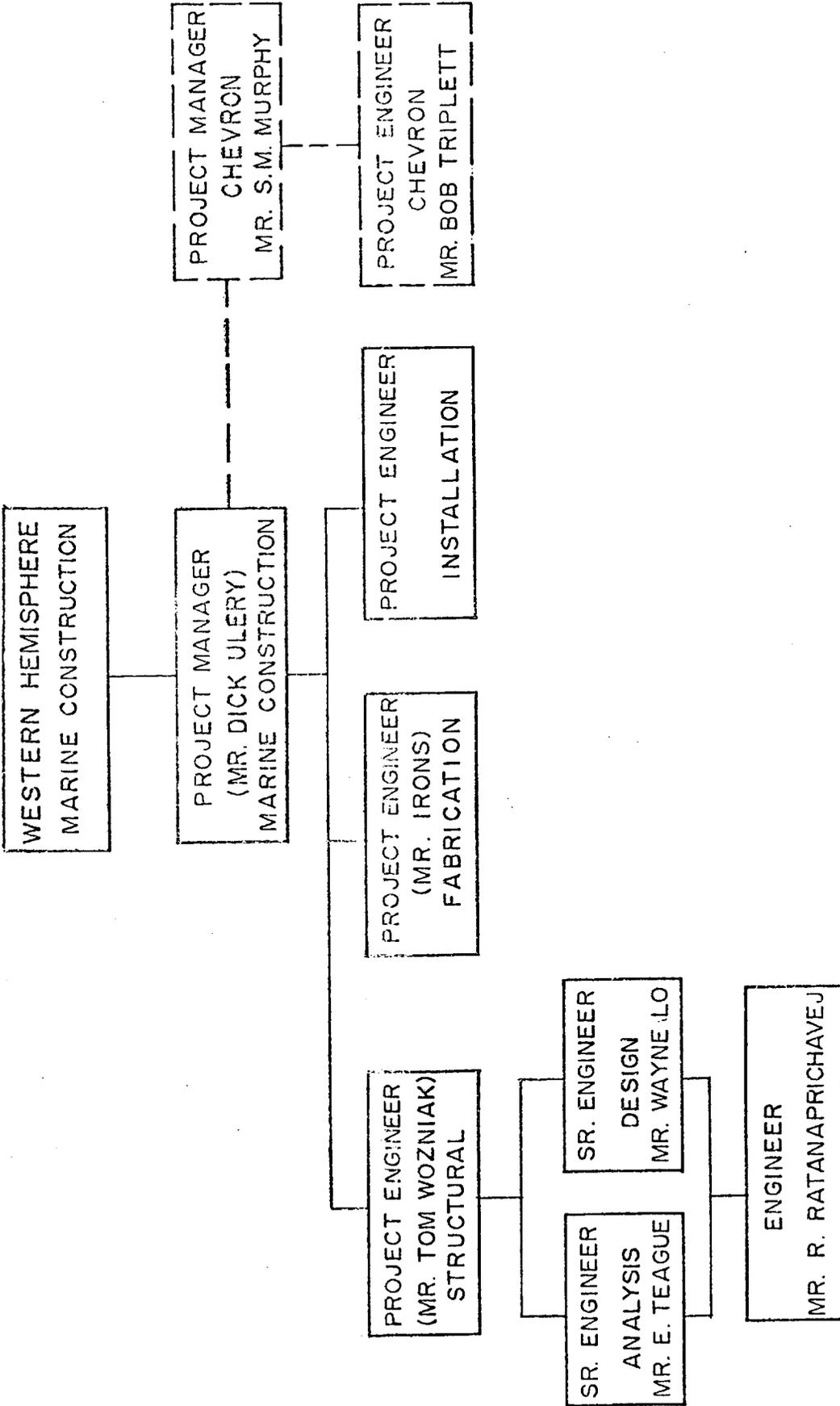


FIGURE 6  
PROJECT ORGANIZATION CHART  
 CHEVRON PROJECT

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3. Fabrication. Two fabrication project engineers from the Western Hemisphere Marine Construction Division co-ordinated the fabrication effort. One was located at the Harbor Island fabrication site and the other located at the Greens Bayou fabrication site. The Greens Bayou project engineer was responsible for all scheduling, material ordering, pre-fabrication work, and transporting pre-assembled jacket components to Harbor Island. He was also responsible for the fabrication of the deck. The Harbor Island project engineer was responsible for the assembly of the jacket and the loadout of the jacket.
4. Installation. An installation project engineer to coordinate the installation effort was assigned from the Western Hemisphere Marine Construction Division. He was responsible for the installation effort and developed the installation procedures, schedule installation equipments, and solved any installation problems that arose.

### The CNG Project

Brown & Root designed two 337 ft steel template type platforms for CNG Production Company. Each platform was designed to support itself safely under installation, drilling, and production loads. The required engineering designs were the

in-place analysis, the launch and floatation analysis, the pile driving analysis, and the dynamic analysis. It should be noted that a platform in medium depth of water such as the CNG platforms would not encounter the slenderness problem that would require the fatigue analysis as in deep-water platforms. Moreover, stresses in the medium-size platform during transportation would not be critical, and the transportation analysis was omitted.

The design criteria for the CNG project were as follows:

1. The deck would have three levels and be supported by four main piles. The deck components would be designed for the most critical of the three cases--the in-place loading condition, the deck lift condition, and the percentage of uniform live load condition. In each case, the derrick would be assumed to be located at the most critical drilling position that would produce the maximum overturning moment on the platform.
2. The jacket would be designed for the more critical of either the in-place loading combinations or the installation conditions. In either the in-place or installation analyses, the interaction ratio, which is the summation of the computed stresses over the allowable stresses, must be less than 1.0 for every primary member. The punching shear stress at each major joint in both analyses must be checked according to API RP 2A. Hydrostatic collapses would be calculated for all

tubular members for both installation and in-place conditions.

3. The pile design above the mudline would be based on the space frame analysis while those below the mudline would be designed by the laterally loaded pile analysis. The length of the pile add-on sections would depend on the type of hammer used. Nevertheless, all piles were analyzed by the wave equation theory to verify their drivability.

The senior engineer whom the author worked with in the CNG project was Mr. Richard W. Mudd.

### III. THE AUTHOR'S ENGINEERING WORKS

## Introduction

Under the supervision of Mr. Thomas C. Wozniak, the project engineer of the Chevron project, the author participated in the following assignments:

1. Boat landing design
2. Curved conductor design
3. Jacket design
4. Fatigue analysis
5. Transportation design
6. Joint analysis of the conductor guides by the manual calculation
7. Structure-soil interaction analysis.

During the last four months of the author's internship at Brown & Root, he worked for Mr. Mohamed I. El-Hitamy, the project engineer, in the CNG project, the Mesa project, and the Natomas project. All of his engineering works were:

1. Foundation design
2. Joint analysis of the jacket by JAMS program
3. Pile driving analysis for curved conductors.

Only the boat landing and curved conductor designs from the Chevron project, and the foundation design from the CNG project are explained and discussed in detail, since they are the assignments on which the author had sole responsibility and control. By working on the assignments by himself from the beginning to the end, the author had the opportunity to develop his engineering knowledge and his judgement. In solving the problems

concerning the assignments, the author, with some advice from his senior and project engineers, has gained experience in working and has realized the importance of performance and time. On one hand, he had to get the job done right; on the other hand, he had to consider the time allocation which is always limited. In making a decision, the author has learned to define the problem, analyze the problem, find the alternative ways, and select the best solution to the problem. As a result, the author always finished his assignments before the deadline and with the satisfaction of himself and his superior.

The rest of the assignments were those where the author worked with other engineers on a team basis. They were explained only briefly because their contribution was rather limited in terms of knowledge, but significant in increasing the author's awareness and appreciation of the team effort. The author learned how to interact and communicate with his colleagues.

All Brown & Root's computer program names are abbreviated names. To find more detailed explanation on any computer programs, the readers are suggested to turn to Appendix C.

## A. Information Pertinent to Offshore Structure Design

Prior to the discussion and explanation of the author's engineering assignments, some pertinent information related to his task are presented. They are the results of his effort to study various aspects of offshore platform design in order to get an in-depth understanding of the industry. They are condensed from Griff C. Lee's lecture notes on fixed offshore platform design for the University of Texas Short Course\* (14).

They are as follows:

### 1. General Information

An offshore platform can be defined as a manmade "island" constructed to allow drilling and production activities to be carried on using conventional above-water techniques. Since platforms have to be installed in the marine environment, a specialized structure has been developed which is particularly adapted to its use. The platform is further specialized in that the concept and design are based almost entirely on installation procedures and not on architectural or operational consideration.

The general requirements of an offshore platform are similar to any other industrial structure in that it must fulfill its intended purpose. It must be structurally adequate for both operational and environmental loading, and must be practical to construct. As part of the overall system, the platform must be cost effective and provide a satisfactory return on the investment. The design of an offshore platform involves consideration of all of these factors.

Before the design of an offshore platform can be started, it is necessary to determine the foundation conditions at the site and to predict the environmental conditions--wind, wave, ice, earthquake, etc., which are to be used as the design criteria. In some areas of the world, such as the North Sea, the environmental loading criteria is established by the

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\*Numbers in parentheses thus (14) refer to corresponding item in References.

governmental "decree" and must be used by designers as a "minimum" on the same basis as building codes are applied in other industries. In other areas, however, the design criteria for environmental loads is established by the owner on the basis of risk evaluation. This evaluation must take into account protection of life, environment, projected useful life of the facility, and economic aspects.

In addition to establishing the environmental design criteria, the basis of the design must also be established. The Division of Standardization of the American Petroleum Institute under the API Offshore Committee has developed the API RP 2A Code [2] which provides recommendations and guidance to designers to supplement existing design aids. The American Welding Society also made a substantial contribution with the publishing of Structural Welding Code D 1.1 [3]. Other institutes such as the AISC, ACI also provide recommendations practices for engineering design for the type of structure that can be applied to.

Within the U. S. waters in 1953, Congress, under the Outer Continental Shelf Lands Act, gave to the Bureau of Land Management, USGS, the responsibility for proper development and conservation of natural resources, and to the Coast Guard the responsibility for safety and the protection of life. The USGS implemented its responsibility through the issuance of OCS Orders. Order No. 8 [19] which applied to the platform, required that the structure be designed under the direction of registered profession engineers. The owner was responsible for proper design and operation, subject to approval of the USGS. Only a minimum of reporting information was required to be submitted to the USGS for permitting purposes.

In other areas of the world, such as the North Sea, more direct government regulations of offshore structures have been in effect. Regulations or specifications such as DnV Code [10] have been developed which must be followed by the designer. In addition, the design must be reviewed by a verifying authority before governmental approval can be obtained.

The design of the platform is not the beginning of the operation but actually the end of a long chain of events which must progress through leasing, exploration and evaluation. These stages are necessary to determine if the oil and gas in commercial quality has been allocated. Platform-related engineering can begin with a field development to assist in determining what type of structures

will be required to most economically and efficiently develop the field after the type of platforms has been selected, the operational requirements and loadings can be determined and the platform design can be started.

## 2. Concepts of Fixed Offshore Platform Design

The first step in the actual design of an offshore platform is to develop the concept of the structure based on the method of installation. Following this, the layout is selected which will satisfy the operational requirements. A preliminary design for the operational and environmental loading can then be made. After the preliminary structural design has been completed, it is then necessary to make a review of the construction procedure, taking into account the stresses which will be encountered for lifting, launching, floating, etc. Generally, this "installation analysis" will change the preliminary concept sufficiently that several operations may be necessary. This is not unusual since an increase in member diameter will cause a corresponding increase in wave loading, and a change in wall thickness will cause a change in the floatation characteristics.

The design of platforms for "deep" water is not correlated to that for shallow water. The same problems such as determination of environmental loading and the design of foundations and of tubular joints are encountered. However, these problems may be somewhat more severe due to the increased loading. Deep water platform designs, however, are dominated by factors that are of less importance in shallow water structures. The deep water platform is more slender and therefore more susceptible to stress amplification due to wave dynamics which could be safely ignored in shallow water. This also increases the significance of fatigue assessment.

Figure 7 is a pictorial example of a typical fixed offshore platform whose platform-related terminology is shown in Figure 8. Figure 9 represents the design loadings that would occur during the life of the platform.

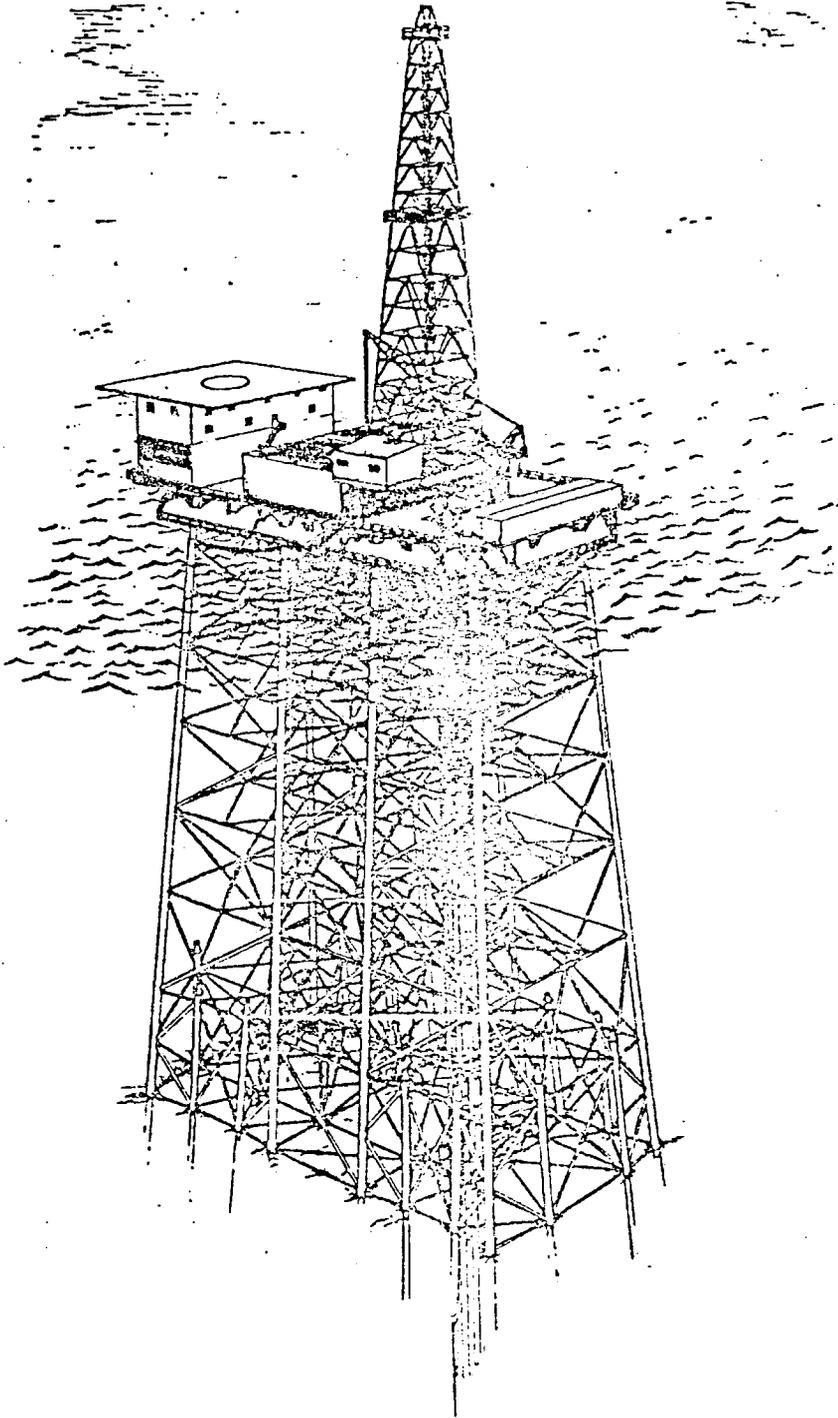


FIGURE 7  
PERSPECTIVE VIEW OF A TYPICAL FIXED OFFSHORE  
PLATFORM (AFTER B & R'S TRAINING MANUAL)

LECTURE General Design of Offshore Structures	PLATE G.1.3.a
SECTION Introduction	REV. 1
SUBTOPIC Principle Platform Elements	DATE Oct. - 1976

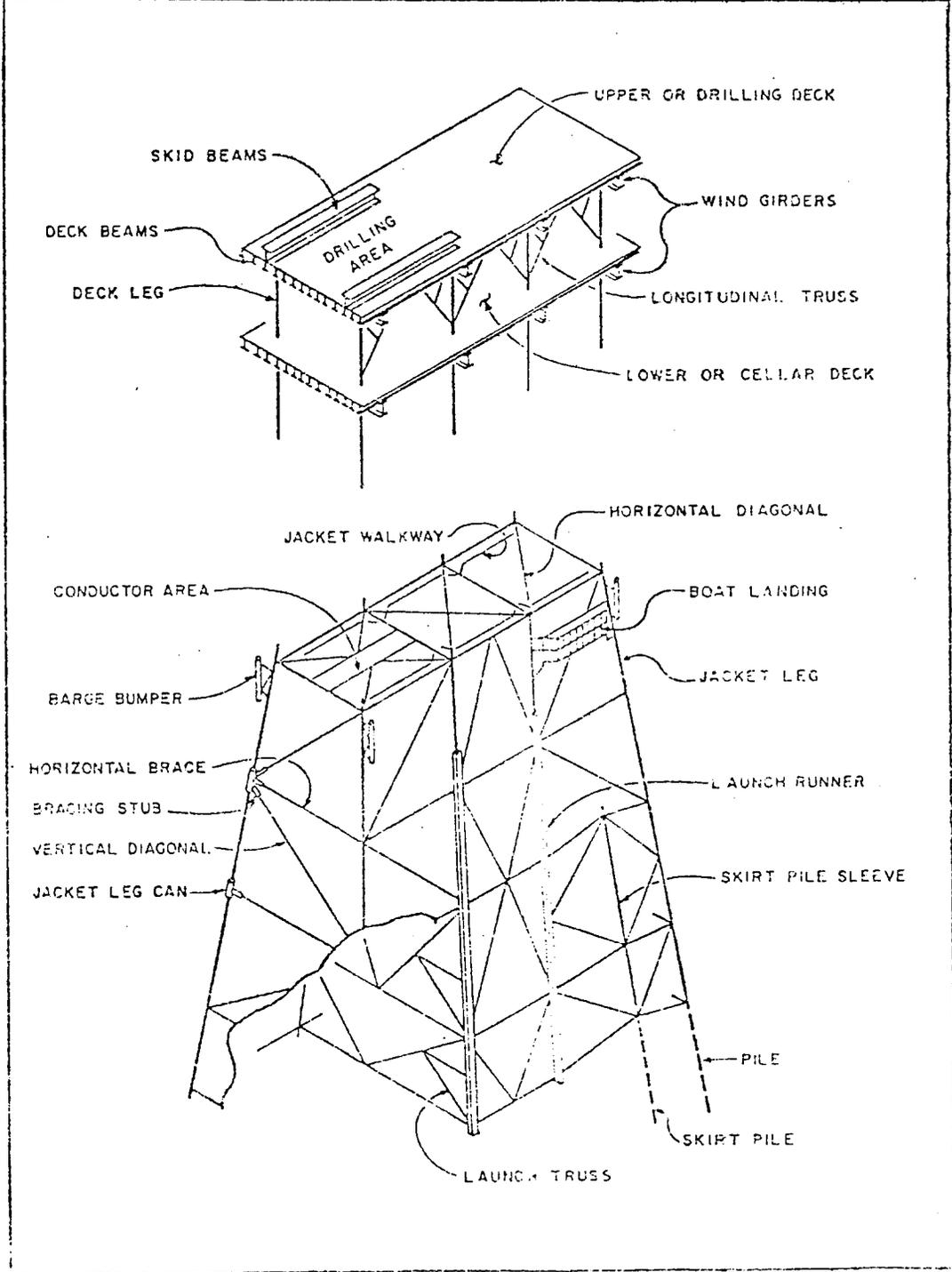


FIGURE 8  
PLATFORM TERMINOLOGY  
(AFTER B & R'S TRAINING MANUAL)

LECTURE General Design of Offshore Structures  
 SECTION Introduction  
 SUBTOPIC Platform Loads

PLATE G.1.4.a  
 REV. 1  
 DATE Oct. - 1976

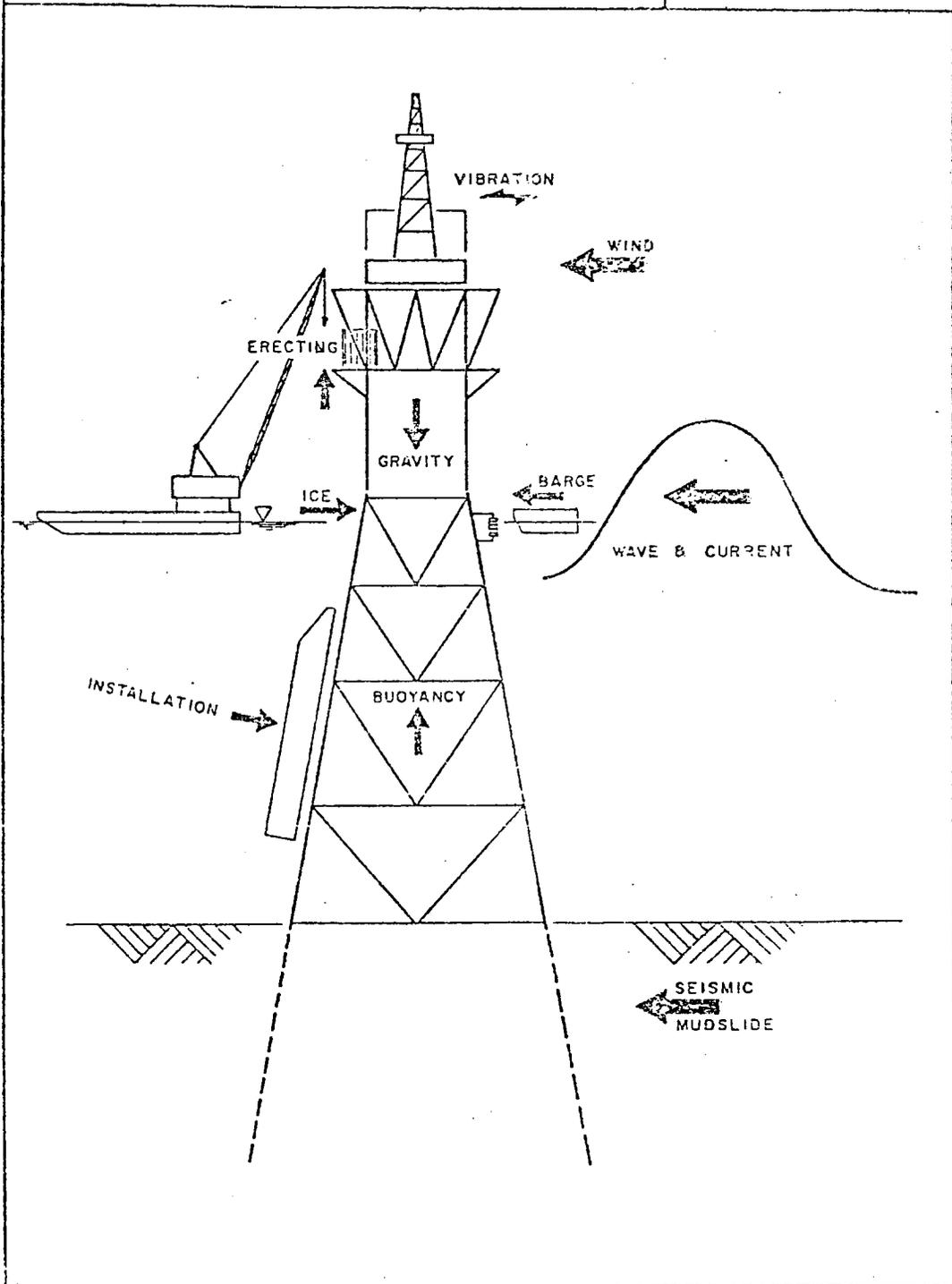


FIGURE 9  
 PLATFORM LOADS  
 (AFTER B & R'S TRAINING MANUAL)

## B. Assignments in the Chevron Project

### 1. The Boat Loading Design

Objective: To design two 60 ft span boat landings based on the preliminary drawing provided by Chevron.

Description: Each boat landing was to be located along the longitudinal side of the platform between the 60 ft span interior legs and would be supported by four shock cells connected to the legs at elevation + 12 and - 10 ft. The geometry of the boat landing is shown in Figures 10 and 11. The front view and the profile of the boat landing (Figure 10) show the configuration, and the connection to the jacket leg, respectively. Figure 11 shows the detailed plan view at each elevation, and the cross-sections of the boat landing.

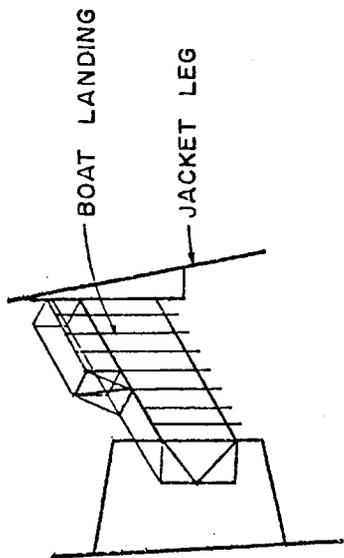
Technical knowledge required: Structural steel design, analysis of structures under static and dynamic loadings, and knowledge of Brown & Root's Offshore and Civil Engineering Analysis System (OCEANS).

Administrative assignments: None

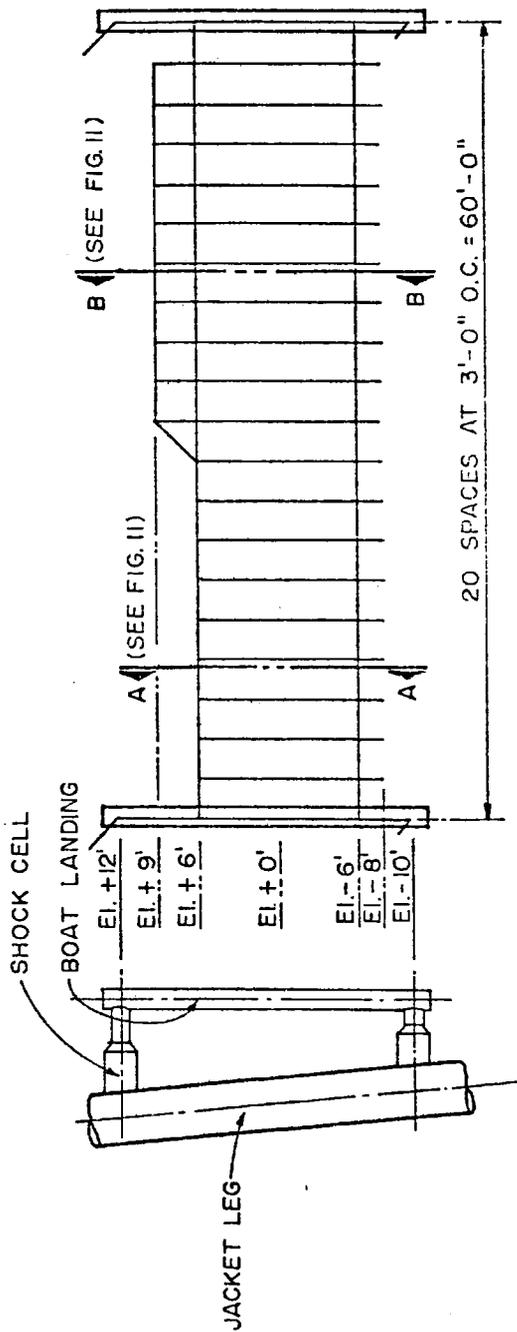
Non-technical problems: The boat landing was designed to be replaced partially and totally with an economical amount of expense.

Sources of information:

1. Theodore T. Lee's "Design Criteria Recommended for Marine Fender Systems (15)."



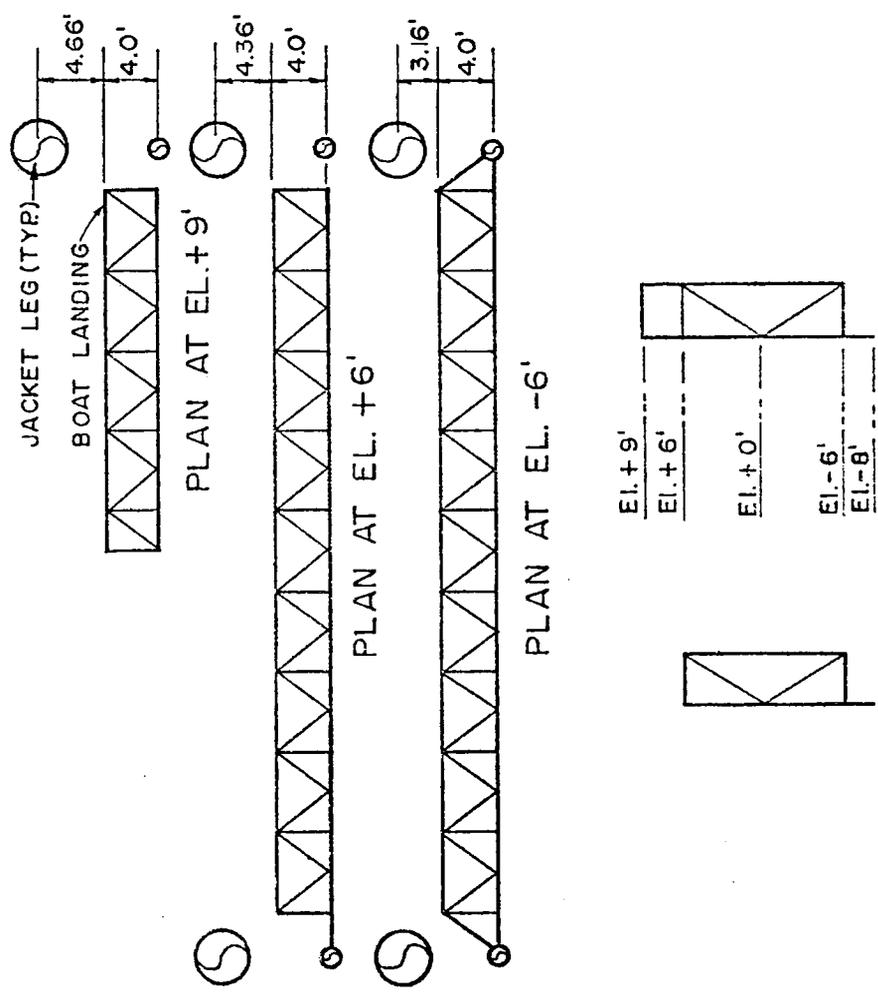
PERSPECTIVE OF BOAT LANDING  
(NOT TO SCALE)



SIDE ELEVATION

FRONT ELEVATION

FIGURE 10  
GEOMETRY OF THE BOAT LANDING



SECTION A-A SECTION B-B  
 (FROM FIG. 10) (FROM FIG. 10)

FIGURE II  
 GEOMETRY OF THE BOAT LANDING

2. Richard W. Mudd's Boat Landing Design on Amoco Project (18).
3. G. Dortmerssen's "The Berthing of a Large Tanker to a Jetty (20)."
4. Regal Catalogue on Barge and Boat Bumpers for Offshore Platforms (22).
5. Carl A. Thoresen and Odd P. Torset's "Fenders for Offshore Structures (25)."

Information pertinent to task: Boat landing, together with barge bumper, form a fender system for the platform. The system was designed to prevent direct contact between ships and structure so that mechanical damage caused by impact and abrasion can be minimized. A boat landing must absorb high energy with low load transmission and, at the same time, be constructed and maintained at an economic and reasonable price. Therefore, it was impractical and unreasonably expensive to select a fender system that can protect the structure against any kind of impact load. A good design should be the trade-off between the price and the degree of protection it can provide. The boat landing in the Chevron project was designed in such a manner as to be safe against the normal condition loading only.

According to C. A. Thoresen and D. P. Torset (25), three different loading conditions that may occur during the lifetime of an offshore platform are--normal, accidental, and catastrophic.

In normal ship berthing conditions, impact is inevitable. No matter how careful the berthing procedure is, the platform

will always be hit by the ship berthing. The impact load, though not a substantial one, must be absorbed by the fender system. It is possible to eliminate the fender system by making the platform strong enough to withstand any operational impact load without permanent damages, but the berthing ship will probably be wrecked because the impact energy which must be absorbed somewhere, will be transmitted to the ship.

Accidental condition is the condition when the ship is out of control and hits the platform. The impact energy will be so large that it is impractical to fender against. Thus some damage to the platform may occur.

Catastrophic condition covers the situation where a large ship hits the platform and causes a collapse of the structure. It is impractical to protect the platform from such impact. Decreasing the probability that it will happen is usually the preferred action.

Design procedures:

1. The kinetic energy from the impact of a berthing ship in sway motion and under wave actions is calculated by using Theodore T. Lee's dynamic equation for open-type structure (15) which is also the equation suggested by Regal Catalogue (22).
2. An equivalent static load was found by equating half of the kinetic energy absorbed by the structure (boat landing, shock cell, and platform) to the work done by the spring of the structure. The other half of the kinetic energy was

assumed to be dispersed in the rotation of the center of mass of the boat around the point of contact.

3. The equivalent static load was applied to various regions of the boat landing to determine the most critical loading conditions on which the design was based.
4. After the boat loading had satisfied AISC steel design specifications (1), its punching shear stresses at the joints where the boat landing was connected to the jacket legs were checked against the available values specified by API RP 2A (2). If the punching shear stresses from all loading conditions were less than the allowable shearing stress while the interaction ratios of their members did not exceed 1.0, the boat landing was considered to be safe in its normal loading and unloading conditions.

Results: From the structural analysis of the boat landing using the DAMS program (see Appendix C for more details on the explanation of the program). The most critical punching shear stress calculating by API criteria was found to be 53% of its allowable value.

Conclusions: Boat landing facilities are required for every offshore platform as a "fender" against the impact caused by ship berthing. It is considered both practical and economical to design a boat landing that can be safe only in the loading and unloading conditions. Moreover, in case of an accident when the berthing velocity is much greater than the design velocity, the boat landing should collapse and break away from the jacket

without causing any damage to the platform. Therefore, it must not only be structurally strong to adequately resist small impact but also be weak enough, in case of accident, to break away.

In the Chevron's boat landing, the jacket leg is capable of resisting almost twice as much punching shear from the most critical loading condition, while the primary members of the boat landing connected to it have been stressed to their ultimate capacity. Thus, the boat landing is weaker and will fail before the support. Therefore, in case of an accident impact the boat landing will fail by combined stresses before the connections at the jacket legs fail by punching shear.

## 2. The Curved Conductor Design

Objectives: To design a curved conductor 900 ft long with 5 degrees per 100 ft curvature.

Description: The conductor was straight for the first 362 ft from the upper deck to the platform then was curved until it reached the mudline and became straight again for the last 150 ft (Figure 12).

Technical knowledge required: The theory of a beam-column, and the knowledge of Brown & Root's OCEANS system.

Administrative assignments: None

### Sources of Information:

1. D. Bogard and H. Matlock's "A Computer Program for the Analysis of Beam-Columns Under Static Axial and Lateral Loads (7)."
2. Brown & Root's DAMS (Design and Analysis of Marine Structures) Manual (see Appendix C).
3. J. S. Cobbet's "Conductor Installation on Deepwater Platforms (8)."
4. B. E. Cox and W. A. Bruha's "Curved Well Conductors and Offshore Platform Hydrocarbon Development (9)."
5. F. J. Fisher's "Driving Analysis of Initially Curved Marine Conductors (11)."
6. H. Matlock's "Applications of Numerical Methods to Some Structural Problems in Offshore Operations (17)."

Information pertinent to task: The straight, conventional conductors are effective only for the hydrocarbon field relatively

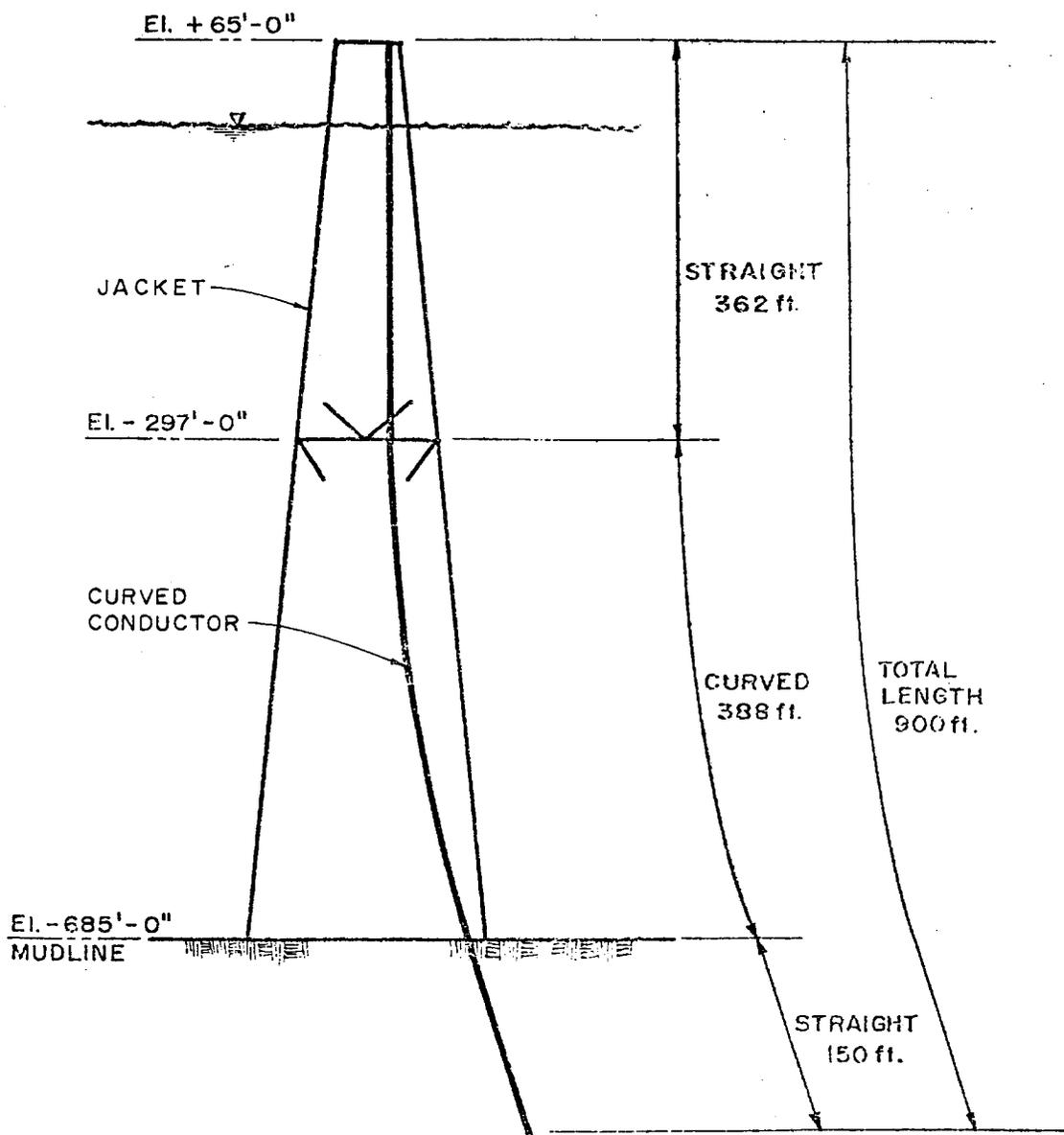


FIGURE 12

## CURVED CONDUCTOR GEOMETRY

far away from the mudline. If the field is near the mudline, straight conductors alone are not adequate. By using a combination of straight and curved conductors, the field's production of hydrocarbon can be increased substantially.

Design procedures: It is evident that a general solution of this problem is complex, both conceptually and computationally. In fact, there is no good method available for analyzing and designing a curved conductor. However, after all related articles from the journals, and Brown & Root's computer-aided structural analysis program had been reviewed, it was concluded that there is no particular program theoretically fit for analyzing the curved conductor. To analyze this problem, four distinct problems must be considered. First, the curved conductor involves soil-pile-structure interaction. Although the Research and Development section in the Offshore Structures Department has developed the PLANS version of the DAMS program (see Appendix C for explanation of program names), it was not in a reliable working condition. Second, the curved conductor is a long pipe unsupported between the top of the jacket and the mudline until it deflects under loading and reacts against the conductor guides at each jacket bracing level. Third, the curved conductor is also basically a curved beam-column; it combines the effect of the buckling of a long column and the combined stresses of the beam column. Finally, the axial loads on the conductor which come from the weight of various sizes of casing hanging inside the conductor present further complication.

The axial loads would act as a tensile force for the casings at the position where they are connected to the conductors, and would be transferred upward to the top of the conductor where they become a compressive force on the conductors.

The curved conductor was analyzed by two computer models. The first model utilized the BMCOL 73 program (Figure 13) while the second model was set up for the DAMS program (Figure 14). Since BMCOL 73 cannot handle permanent deflection of the curved portion of the conductor, one model with deflections only was run and its stresses subtracted from the model with deflections and axial loads. This simplification was assumed without considering the inside casings as co-axial members and the axial deformations of the conductors since both are out of the application limit of BMCOL 73. In the DAMS model, the permanent deflections were represented by the appropriate off-set at every 5 ft increment while the inside casings were input as co-axial members which occupied the same space as the conductors. The connection between the casings and the conductor was such that only lateral forces were transferred at each bracing level, and the axial tension forces from the casings became the compressive forces in the conductor.

The following loading conditions are assumed for both models:

1. Axial forces from the weights of the casings and the conductors are the only forces applied in the analysis.
2. No environmental forces from current, wave, or wind are applied.

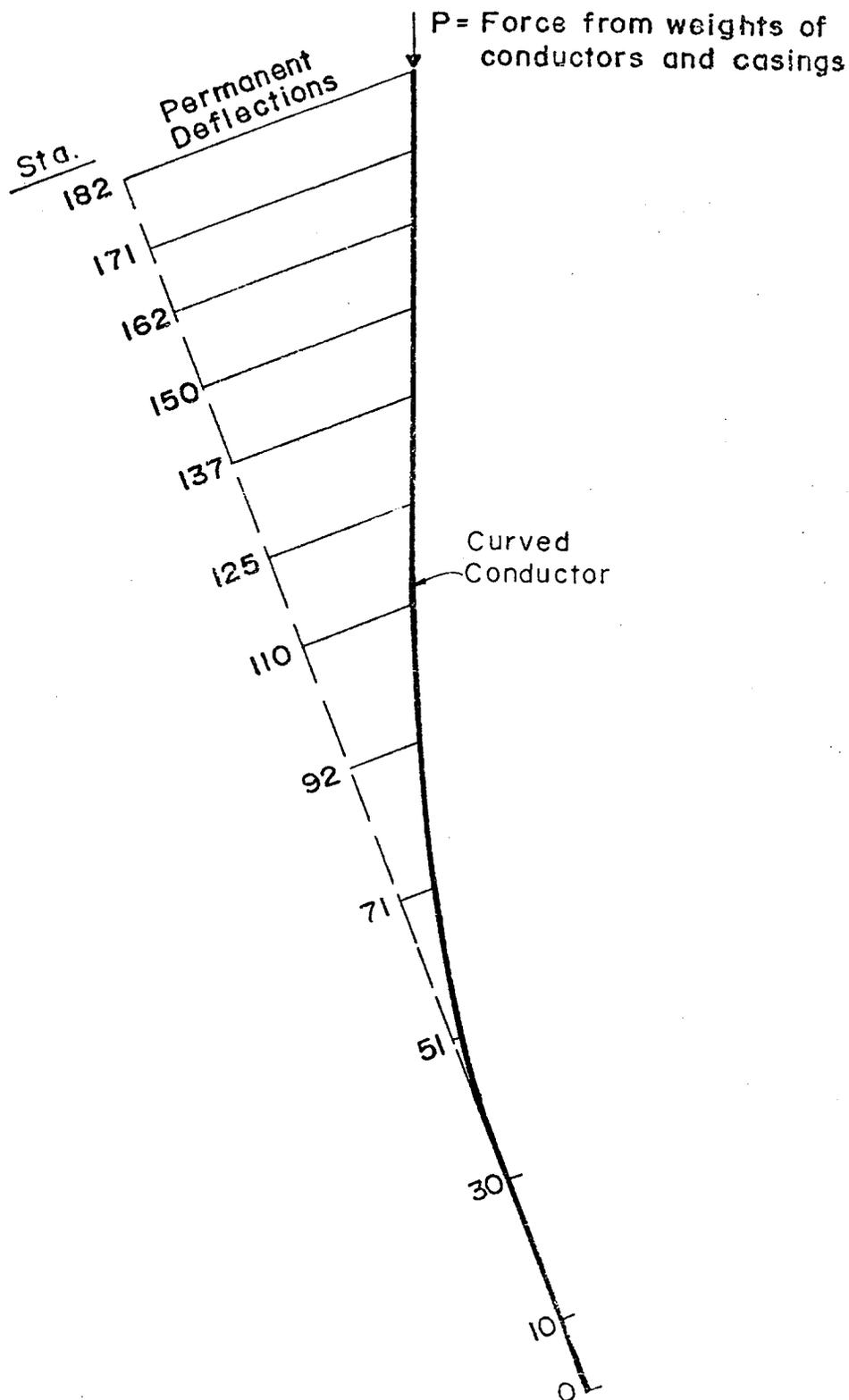


FIGURE 13  
BMCOL MODEL

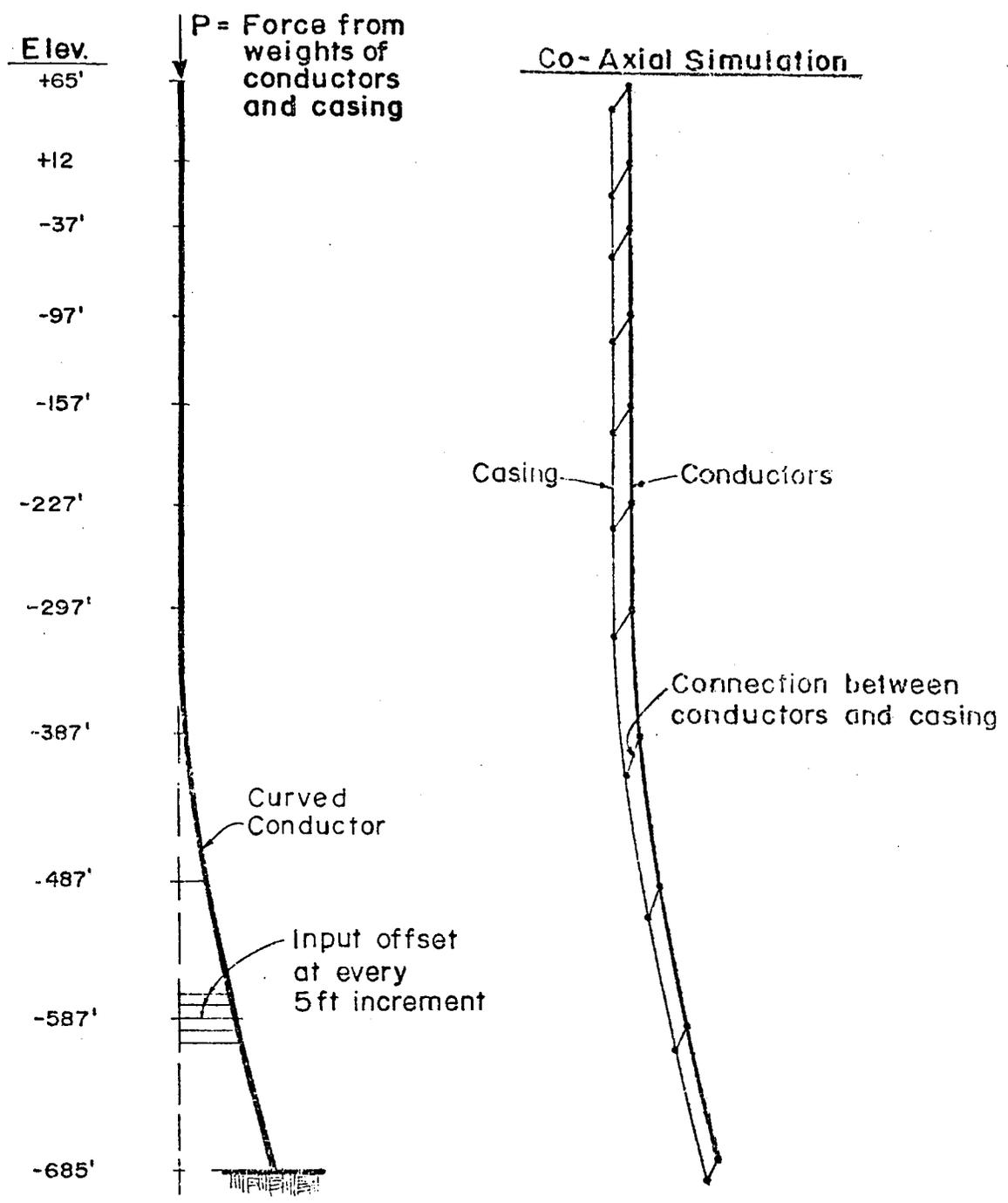


FIGURE 14  
DAMS MODEL

3. No driving forces due to hammer weight and impacts are used.
4. The forces induced by driving a straight section through the guide preset for curved section, and vice versa, are neglected.

Results: The BMCOL 73 model yielded unrealistic and questionable results. The maximum moments did not occur at mudline and they were greater than the plastic moments of the sections. Besides, the reaction was maximum at the top, not at the mudline as it might be expected, and its magnitude was extremely high. All of these unexpectations led to the question of whether the concept is theoretically sound or not.

The DAMS model was run for three different axial forces; each of them represented the weights of the casings hanging from the top of the jacket. The model that would be accepted must have the interaction ratio, which is the summation of the ratios of computed stresses over allowable stresses, less than or equal to 1.0 as required by AISC (1). From the computer output, it is evident that the conductor could withstand only the minimum axial force since the maximum interaction ratio is 0.79 at the mudline. With the axial forces greater than the minimum force, the interaction ratios exceed 1.0 considerably in critical members.

Conclusions: The BMCOL 73 model has many disadvantages. It cannot handle curved beam-column, axial deformation, and co-axial member orientation. Therefore, its results are doubtful. Compared to BMCOL 73 model, the DAMS model gives a rational but yet conservative enough solution to the design of the curved conductor. The reactions and interaction ratios from the

minimum force seem to be reasonable and their maximum values appear at the expected location. The internal casings are also simulated as co-axial members, thus, presenting a more realistic model. Overall, the DAMS results were satisfactory and acceptable.

Recommendations: The DAMS program should be used to design curved conductors unless a better, more rational model for curved beam-column can be found. DAMS's PLANS version which can simulate the soil-pile-structure relationship should be tried to get a more accurate solution. As for the BMCOL 73 program, its unsatisfactory results should not be interpreted as being unacceptable. The BMCOL 73 model can be easily set up and costs little to run. Some adaptations, such as adding the stiffness of the guides to the conductors at the bracing levels to reduce the stress, and changing to BMCOL 76 model (17) are recommended.

3. The Jacket Design. The author's assignment was to calculate the wind load on the platform in the drilling and production phases. He had to calculate the windward and leeward forces on the drilling and production packages, and the deck structure. The directions and magnitudes of the wind were according to API RP 2A and Chevron's specifications.

4. The Fatigue Analysis. The purpose of the analysis was to find the fatigue lives of the tubular joints which will represent the fatigue life of the platform. Most fatigue damage in offshore structures is caused by the occurrence of many cycles of small stress ranges. Severe storms, with return periods in

excess of one year, are unimportant in fatigue damage considerations. Only small waves of relatively low wave height and short mean period are of prime concern.

Fatigue life can be found by two methods--the punching shear method, and the brace end methods. The punching shear method is designed to assess fatigue in the chord wall, that is, in the wall of the through-members framed into by the brace. The brace end method deals with fatigue in the wall of the brace and adjacent to the weld.

The punching shear method determines the fatigue damage due to cyclic punching shear. Punching shear was calculated by API procedure and its ranges were established as functions of wave height and direction. Each range had an allowable number of cycles to failure as described by empirical S-N (stress range versus number of occurrence) curves. The actual number of cycles for each range was computed by using the exceedance data for various wave heights. The ratios of actual cycles to allowable cycles for each stress range were accumulated into a total damage fraction. When the fraction becomes unity, that is, actual cycles equal allowable cycles, the time over that period was the expected fatigue life of the platform.

The brace end method is similar to the punching shear method except that the stress ranges are ranges of cyclic combined stresses at each of several locations around the circumference of the member end. Moreover, the S-N curves are those established for combined stresses in member ends.

The results from the FATIG program indicated that the weakest point has a 5,300 year fatigue life from the punching shear method. Thus the fatigue life of the platform was assumed to be 5,300 years. Manual calculations were performed on the same joint to verify the computer prediction, and yielded a 5,702 year fatigue life. Therefore, the problem of fatigue due to cyclic loadings appears to be of no consequence.

5. The Transportation Analysis. The author was called to assist in calculating the overturning moments due to different wave position for the platform sitting on the barge during transportation. The platform was analyzed on various barge positions--roll, yaw, pitch, and heave.

6. The Joint Analysis of the Conductor Guides. Although Brown & Root has a computer program called JAMS (Joint Analysis for Marine Structures) to analyze the joints, JAMS is usually set up for primary members such as jacket components. Conductor guides are considered to be secondary members and cannot be checked by the JAMS program. They were simulated in the DAMS program to save computer time, and had to be checked by hand to be assured that the requirements from API RP 2A were met. As the results of the manual checking, several members had to be resized when their initial sizes did not provide adequate resistance to punching shear.

7. Structure-Soil Interaction Analysis. This analysis utilized a highly developed computer program called PLANS (Platform

Analysis with Nonlinear Supports) which is another version of the DAMS program, to verify previous platform design. Usually fixed platform analysis is done in two parts--the structural analysis with simulated foundation, and the foundation analysis with simulated superstructure. With the PLANS program, both analyses can be combined together and only one analysis is needed, resulting in the saving of the engineer's input preparation time and the computer's execution time. In the near future, the two-part conventional fixed platform design will be replaced by the PLANS version of the DAMS program.

## C. Assignments in the CNG Project

### 1. The Foundation Design

Objective: To design the piling support for the 337 ft fixed offshore platform for CNG Production Company.

Description: The foundation analysis and design must be done in the following sequence:

- a. Calculating the wave forces using WAVPLT 73 program
- b. Determining the axial spring and the pile's load-settlement curves by AXCOL 1 program
- c. Distributing the platform loadings to the supporting piles using TD Bent program
- d. Simulating the nonlinear foundation, and preliminary designing of pile sections by DUMYPILE program
- e. Analyzing the laterally and axially loaded pile by LATPILE program
- f. Predicting the pile drivability by AMPILE program.

Technical knowledge required: Offshore foundation design, analysis of structures under static and dynamic loadings, and knowledge of Brown & Root's OCEANS system.

Administrative assignments: None

Non-technical problems: None

Sources of information:

1. Brown & Root's OCEANS Manuals (4).
2. A. H. Glenn & Associates' Environmental Report (12).

3. McClelland Engineers' Geotechnical Report (16).
4. Texas Transportation Institute's "Pile Driving Analysis-- Wave Equation Users Manual (24)."
5. V. N. Vijayvergiya's "Load-Movement Characteristics of Piles (6)."

Information pertinent to task: Foundations for fixed offshore platforms are designed at the time the engineering assignment gets started. While the engineer comes up with the preliminary jacket framing, he will also estimate the sizes and number of piles to support the platform and the pile penetration that will provide adequate pile capacity.

An offshore platform is generally composed of a highly redundant space frame and a multiple nonlinear supporting system. Its analysis is also split into two separate models. They are a detailed superstructure with simplified foundations, and a foundation with simulated superstructure restraints. The procedure of simplifying a foundation system is termed "Foundation Simulation." The results of a foundation simulation is a set of supporting constraints or linear elastic spring for each pile attached to the bottom of the jacket.

Since the pile-soil system behaves nonlinearly, the simulation is dependent on the structural analysis of the platform. When the loads change, the simulated properties of the foundation change accordingly. Therefore, the foundation and superstructure analyses are done repeatedly until the latest foundation analysis loaded with the reactions from the previous superstructure

analysis yields the properties that are compatible with the input properties for that superstructure analysis.

When the foundation simulation is completed, the supporting foundation will be designed by the vertically and laterally loaded pile analysis to obtain the make-up of each pile. Finally, the drivability of the pile is predicted using the one dimensional wave equation theory.

Design procedures: The design procedures will be explained according to the sequence of the analysis as follows:

a. WAVPLT 73 program

The environmental data concerning wave characteristics was input in the WAVPLT 73 program to find the hydrodynamic forces for a specific size of a tubular member. This force is determined by one of the six methods. Five of them are programmed wave theories: Cnoidal, Stokes Fifth Order, Airy, Solitary, and Stream Function theories; the sixth method utilizes a set of either velocity/acceleration, or force, or pressure profiles. The WAVPLT 73 program calculates the vertical and horizontal distribution of the pressure within a wave as well as the total base shear and overturning moment of a single member. When the forces on all members that form the platform are summed up, the horizontal forces and overturning moments at the base of the jacket are found. These forces, together with the forces from the operation and wind loadings of the jacket, the deck, and the

substructures, represent the total forces and moments in the X, Y, and Z directions. When the nonlinear soil-pile-structure analysis is performed using these forces as input, the reaction on each pile will be found.

b. AXCOL 1 program

AXCOL 1 is the computer program for the analysis of axially loaded foundation piles with nonlinear support. The program utilizes a discrete-elements method as a basis in formulating a set of simultaneous finite-difference equations which are solved to produce a prediction of a pile under specified static loads and restraints. In the foundation design, the AXCOL 1 is run with the T-Z data as its input to obtain the load-settlement curve. Usually the T-Z data are provided by the geotechnical consultant. However, in the absence of any T-Z data, the P-Y data (which is always provided) can be used to calculate the T-Z data using the method by V. N. Vijayvergiya (26). When the T-Z data are obtained, they are input with other soil properties in the TD BENT program to find the reaction on each pile.

c. TD BENT program

TD BENT or Three-Dimensional Bent program is a computer program written for the purpose of simultaneously analyzing the soil-pile interaction of all members in a platform foundation subjected to both lateral and axial

loads. The output of the program will comprise the deflection, lateral load, settlement, bearing, and stresses of each pile. Its bearing will be checked against the ultimate capacity of the soil at design penetration to ensure that its factor of safety is greater than 1.50 which is recommended by API RP 2A.

d. DUMYPILE program

The purpose of utilizing the DUMYPILE program is to determine a set of simulated springs to be used in dummy piles in the superstructure analysis, and to check the combined stresses and lateral deflections of the laterally and axially loaded piles.

Fixed offshore platforms are normally installed with support piles that are driven into the soil foundation for the purpose of resisting the lateral and axial movements of the platform induced by winds, waves, and vertical loads on the structure. The interactions between the piles and the surrounding soil are known to be nonlinear and cannot be evaluated by any linear space frame program such as the STRAN in the DAMS program. Therefore, a set of dummy piles that reacts linearly with the superstructure has been used to simulate the nonlinear behavior between the soil and the piles. The simulation is considered to be acceptable when the STRAN output, using the dummy pile springs, and the DUMYPILE output satisfy the compatibilities of the

deflections and rotations at the pile heads. Therefore, many sequential runs of the STRAN and the DUMYPILE programs may be needed before the deflections and rotations from the STRAN program match those from the DUMYPILE program.

The DUMYPILE program can also be used in the preliminary design of foundation piling. If the combined stresses in the preliminary sections from all loading conditions are less than the allowable value specified by AISC or API RP 2A, such pile make-ups are safe against the lateral and axial loads.

e. LATPILE program

LATPILE is a subroutine program in the DUMYPILE program. It is capable of analyzing laterally and axially loaded piles with the additional features such as calculating the stresses without considering the skin frictions of the soil, and generating the printer plots of lateral deflections, bending moments, and soil reactions along the pile axis.

After the superstructure analysis and the foundation simulation have been finalized, the LATPILE program will be run to verify the design of the piles. Two outputs from the LATPILE program--the combined stresses, and the bending moments from the design penetration and the 20 ft underdrive will be compared with the allowable values. The combined stresses will be compared with

AISC's allowable combined stress to determine whether the initial make-up of the pile is adequately strong or not. If the combined stress in one section exceeds the allowable limit, the thickness or the yield strength of that section must be increased. In case of the bending moment comparison, graphic presentations must be obtained to insure that the allowable bending moment of the section is greater than the maximum bending moment from the full penetration or the 20 ft underdrive from the critical loadings. Usually, these loadings are selected from the maximum of the reactions of all piles under all drilling and production loads in the DAMS program. They are the maximum axial (compression), the maximum shear, the high axial and high shear, and the maximum pull-out load (tension).

f. The AMPILE program

Normally the single most time consuming, and frequently the most costly, operation in the installation of an offshore platform is to achieve design pile penetration. A pile installation procedure, which requires jetting and driving, or driving and grouting, can significantly increase the installation cost of an offshore platform. A most desirable and less costly procedure for installing the piling should be based on the promise that the pile can be installed by driving only. Therefore, a pile drivability study that can accommodate such

promise is very useful and is considered an indispensable practice in the design of offshore foundation.

The AMPILE program has been Brown & Root's standard procedure in predicting the pile drivability in all fixed offshore platform projects. The program utilizes the one dimensional wave equation in finite difference form and also models the pile-hammer-soil interaction during the driving operation. The drivability of each type of pile will be analyzed with at least two different hammers and two soil set-up factors. The set-up factor is the percentage of the maximum soil resistance over the resistance at the time of driving. It indicates how many times the final soil resistance will be, in terms of its remolded driving resistance when the soil has ample time to regain its ultimate strength after being disturbed by the pile driving.

Results: The results of the foundation design are as follows:

- a. The wave shear and overturning moment from the WAVPLT 73 program in the longitudinal and transverse directions of the platform were 1,463 kip and 520,000 kip-ft, respectively. These forces, together with the vertical force of 7,200 kip were the loadings in the TD BENT program.
- b. The load-settlement curve from the AXCOL 1 run using McClelland Engineers' T-Z data is shown in Figure 15. If the estimated T-Z data from Vijayvergiya's method

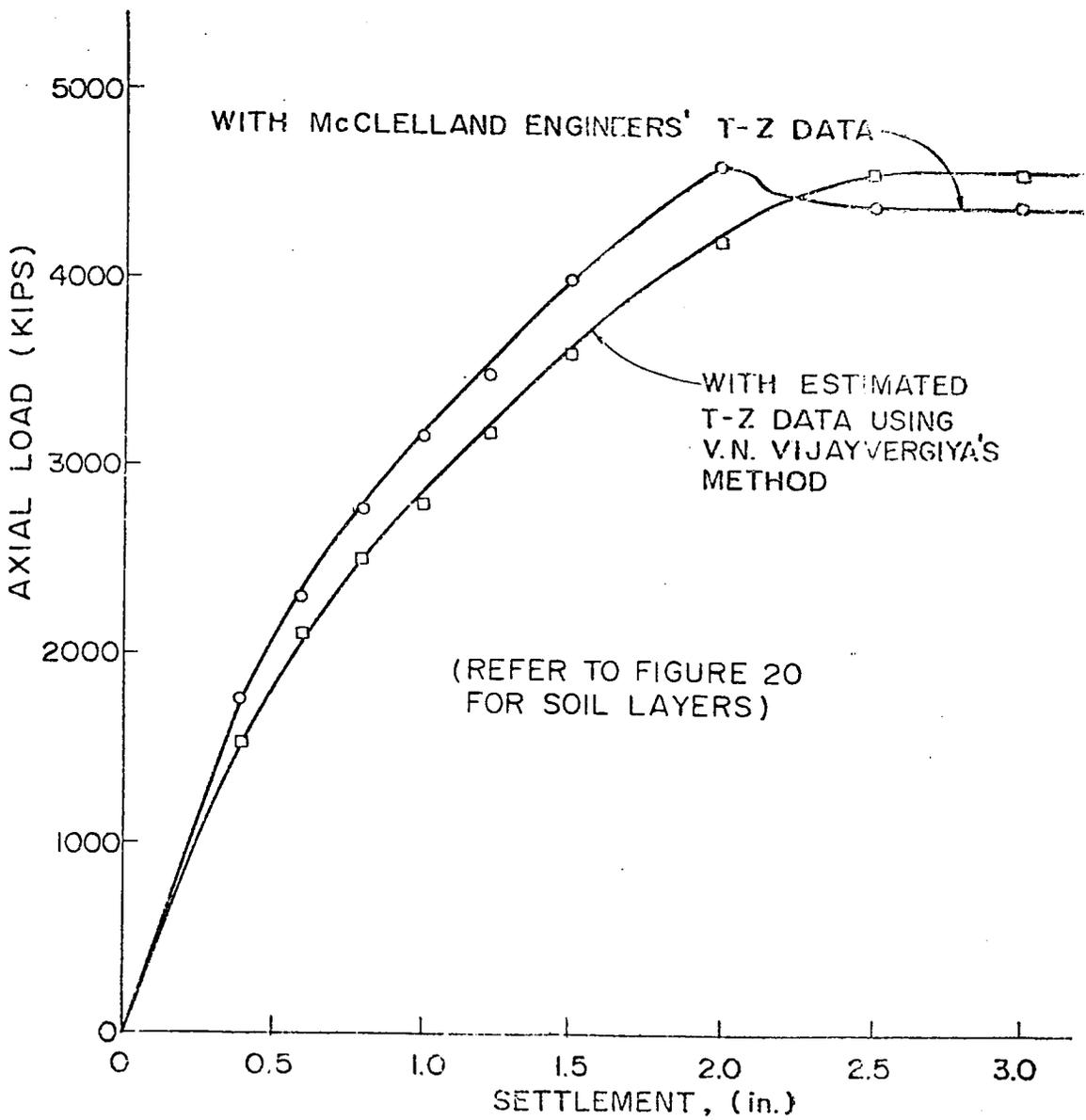
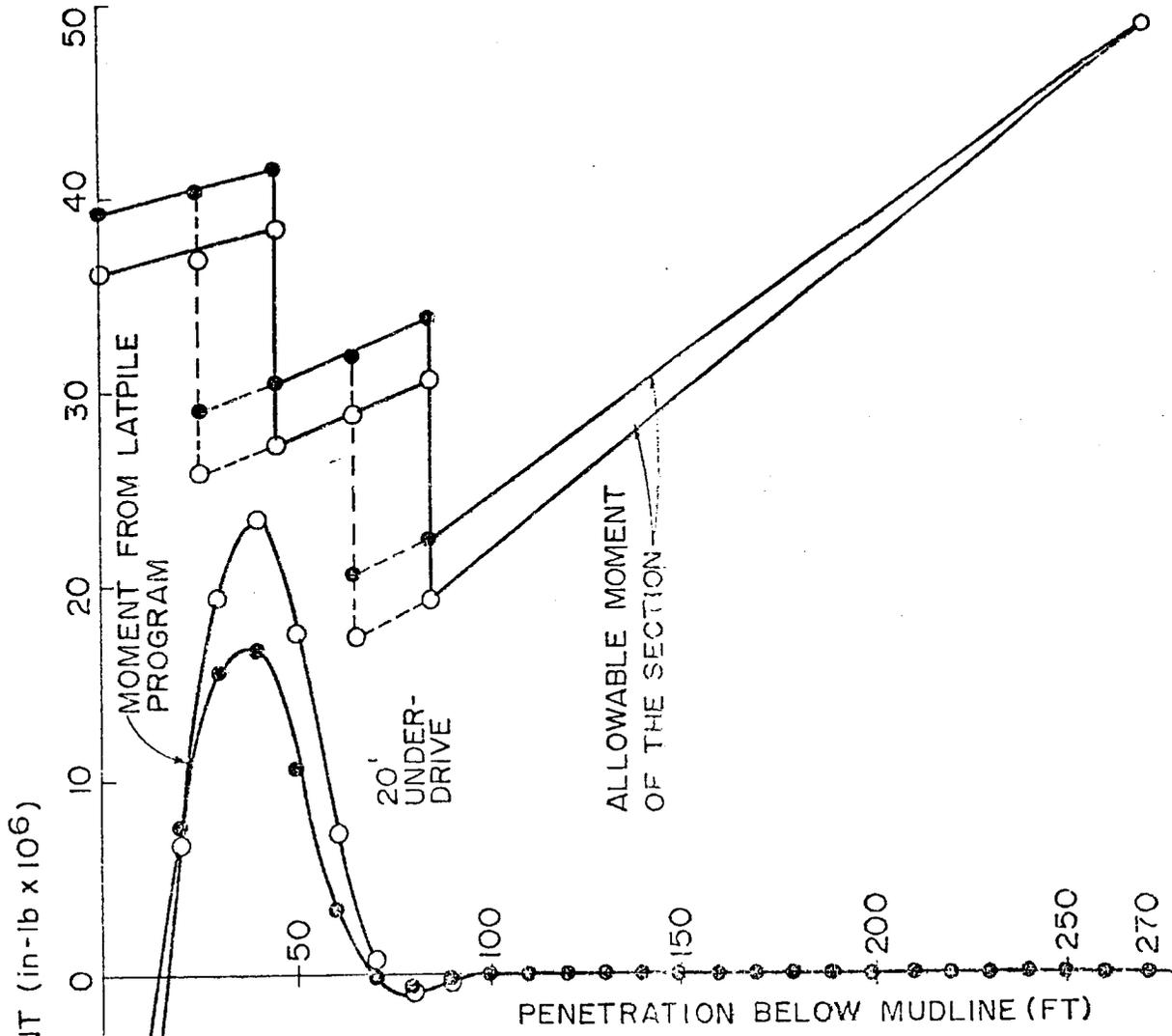


FIGURE 15

AXIAL LOAD vs. SETTLEMENT

were used instead, the result would be another load-settlement curve as shown in Figure 15. However, in the preliminary analysis of the platform the actual load-settlement curve using McClelland Engineers' soil data was used.

- c. From the TD BENT program, the maximum reactions in the skirt and main piles were 4,550 kip and 5,352 kip for the axial loads, and 120 kip and 140 kip for the lateral loads, respectively.
- d. After the STRAN and the DUMYPILE programs were run sequentially for three times, their deflections, in the lateral and axial directions, were found to be compatible with each other.
- e. Figures 16 and 17 show the maximum bending moment and their allowable values for the skirt and main piles for the maximum tension and maximum compression, respectively. The LATPILE program was run for both penetrations--the 270 ft design penetration and the 250 ft penetration with 20 ft underdrive. The allowable bending moments for the 20 ft underdrive which represents the weaker pile models, exceed the maximum bending moments in every critical loading condition.
- f. The AMPILE program was run for the skirt and main piles using two different steam hammers--Vulcan 360, and Vulcan 3100. From McClelland Engineers' geotechnical report, a set-up factor of 1.45 was chosen to represent



CNG - WC  
48" Ø MAIN and SKIRT PILES

MAX. COMPRESSION

- MAIN PILE
- SKIRT PILE

FIGURE 16  
PENETRATION vs. MOMENT

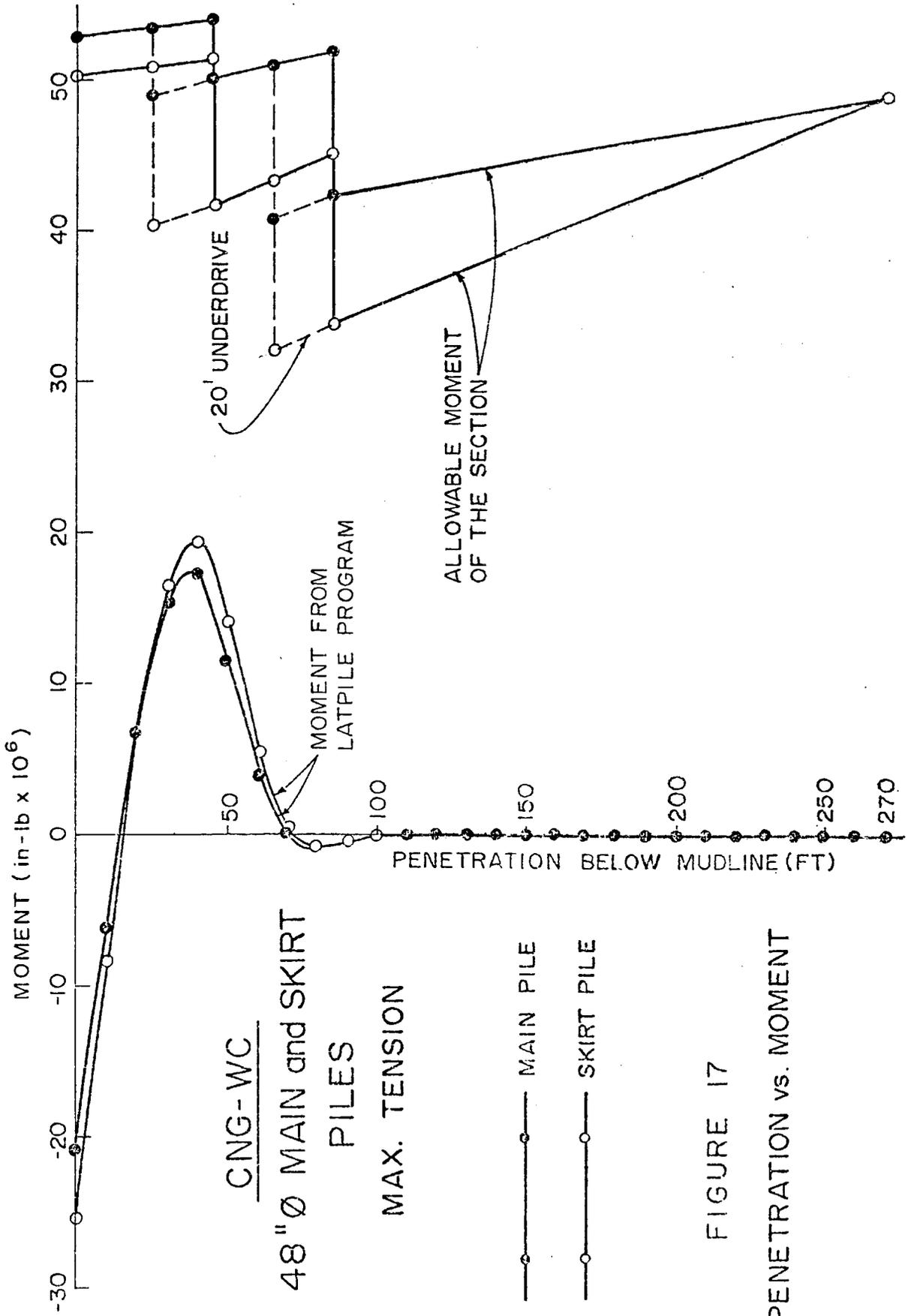


FIGURE 17  
PENETRATION vs. MOMENT

the soil resistance under remolded state, while the ultimate soil capacity whose set-up factor of 1.0 was assumed to be the maximum soil resistance. The output of the AMPILE program is the curves between soil resistance at time of driving versus rate of penetration (see Figures 18 and 19). These curves indicated the number of blows for a given driving resistance that a specific hammer will generate to drive the pile one foot. When the driving resistance is entered into the pile capacity curve (Figure 20), the corresponding depth of penetration can be found. Figures 21 through 24 are the curves of penetration below mudline versus rate of penetration. It can be determined from each curve whether or not the pile can be driven to grade by the specified hammer during continuous driving (anticipated resistance) or non-continuous driving (maximum resistance).

#### Conclusions and Recommendations:

##### Pile Installation:

1. It was recommended that Vulcan 360 be used to drive both skirt and main piles until they reach elevation - 220 ft from the mudline or until some delays such as those caused by splicing occur. Then Vulcan 3100 would be used to break the soil set-up and continue the driving.

CNG WC  
48"Ø SKIRT PILE

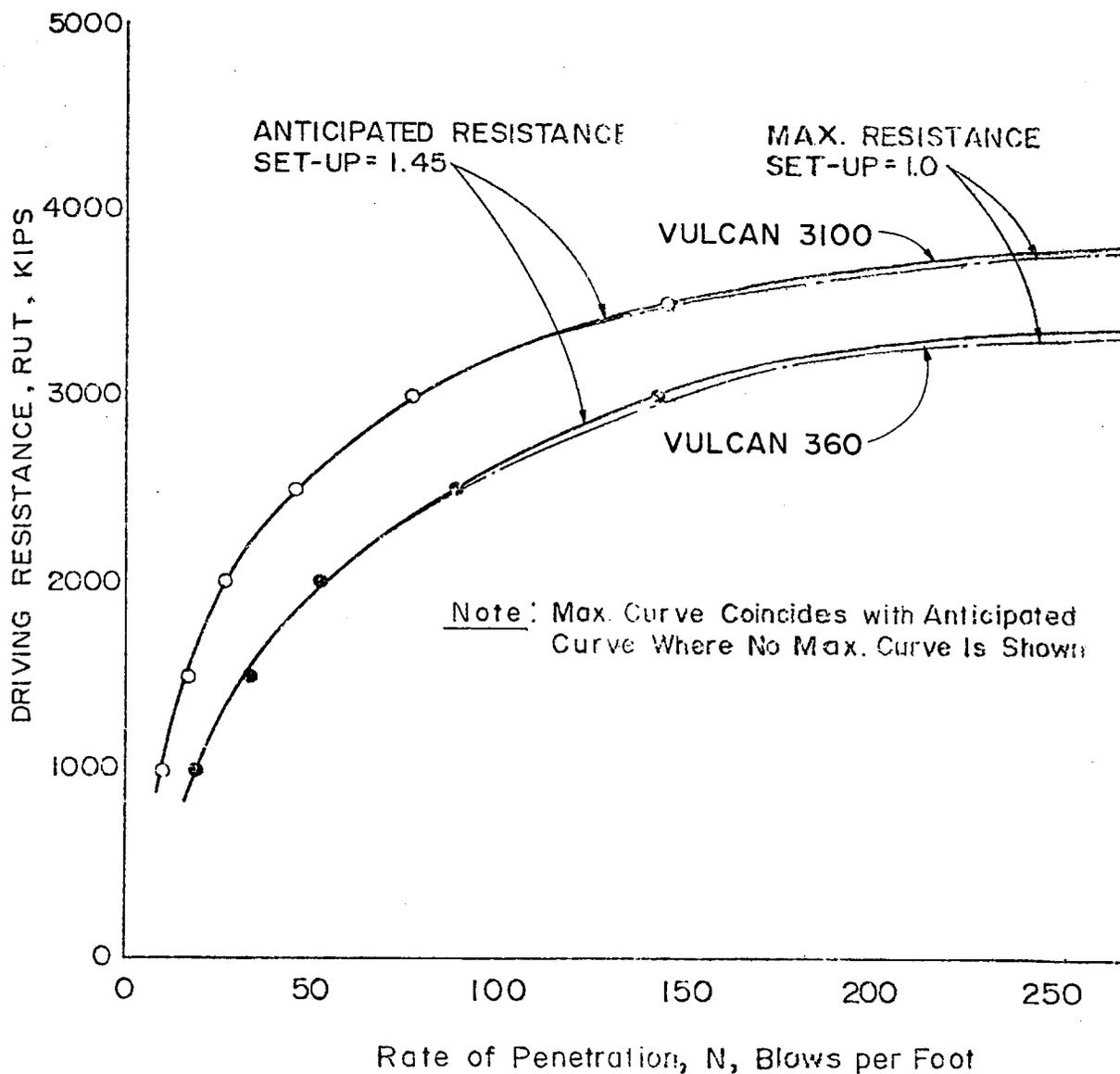


FIGURE 18

DRIVING RESISTANCE vs. RATE OF PENETRATION

CNG WC  
48" Ø MAIN PILE

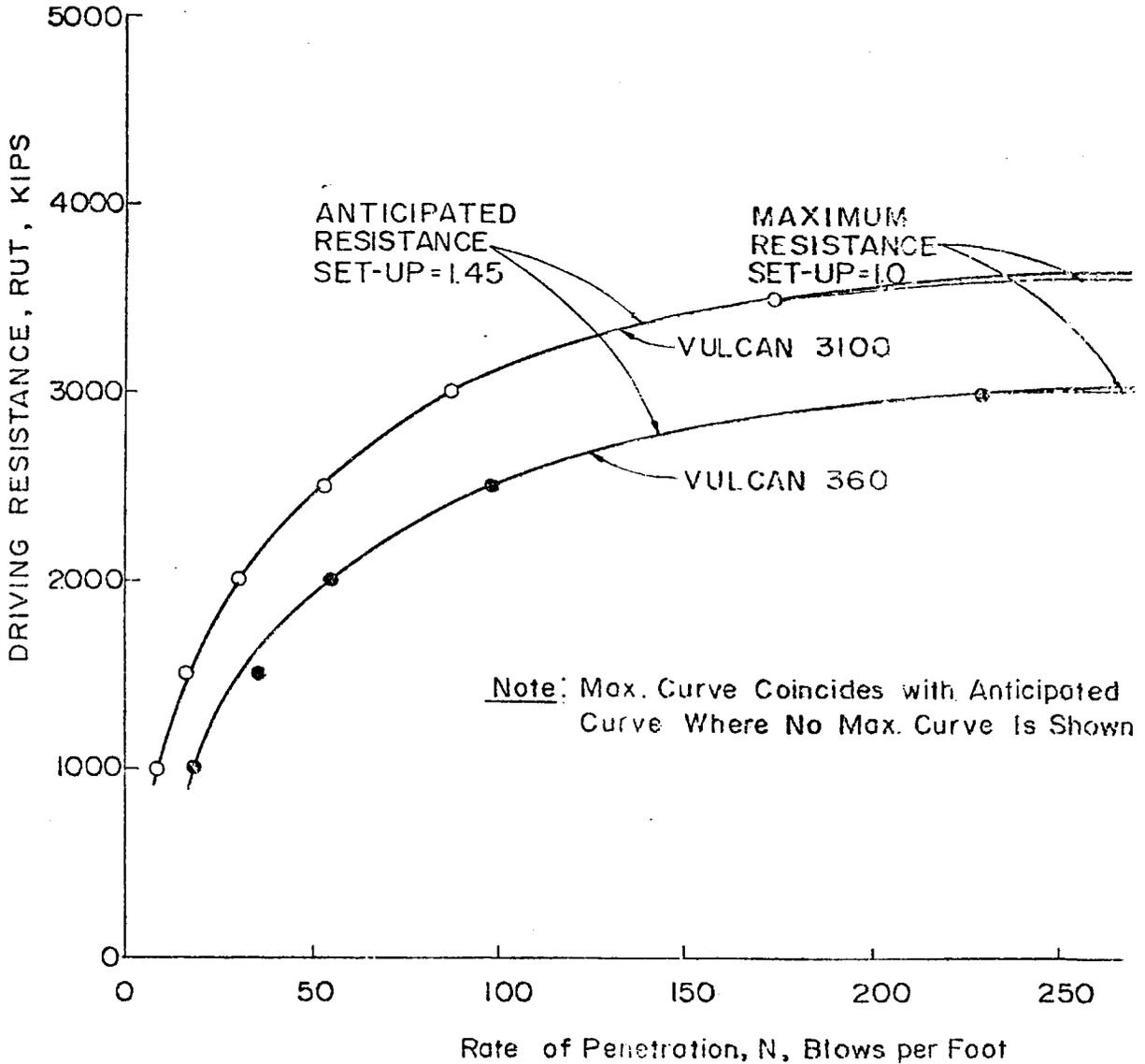
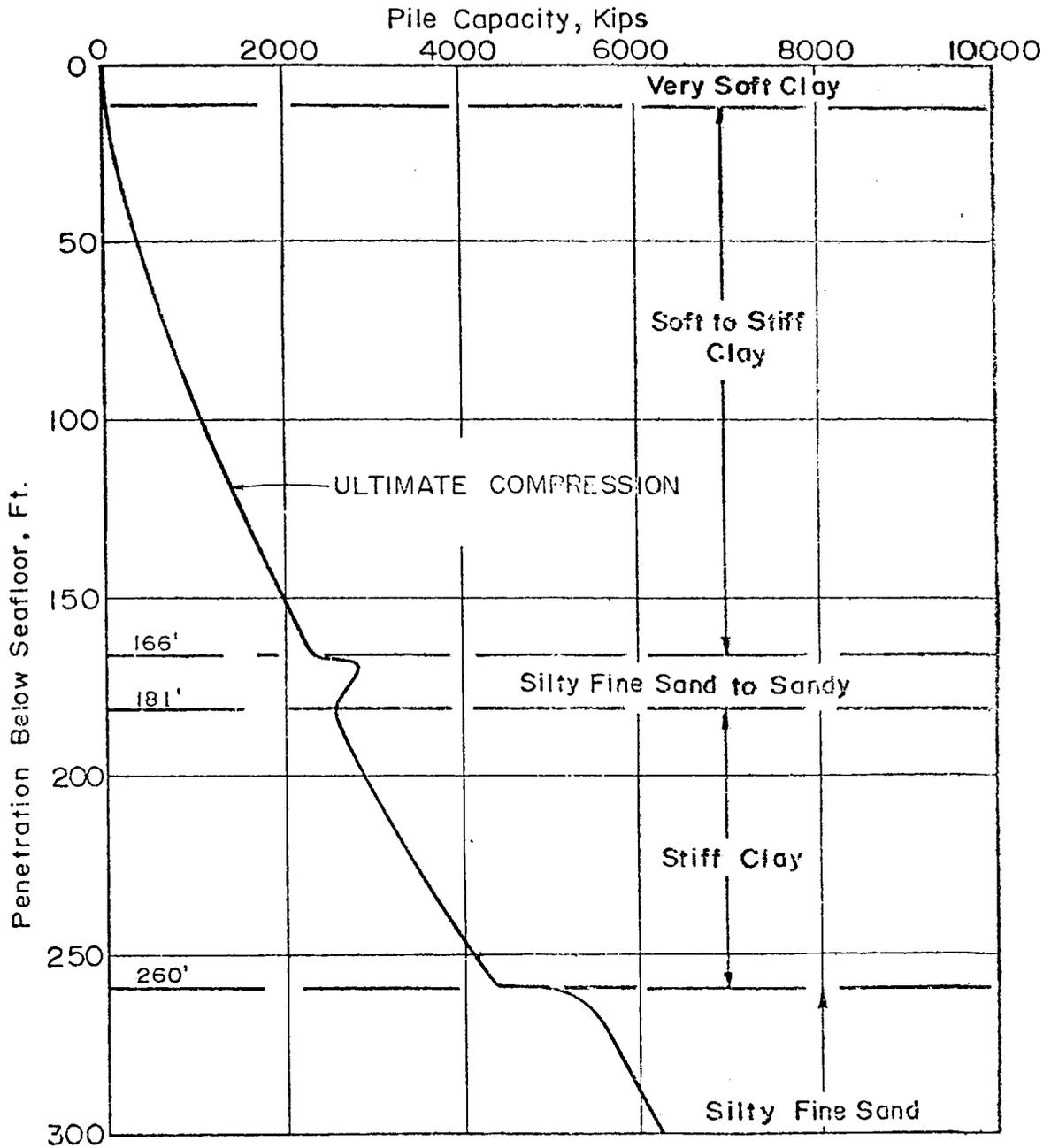


FIGURE 19

DRIVING RESISTANCE vs. RATE OF PENETRATION



(After McClelland Engineers' Geotechnical Report)

48-in. Diameter Pipe Piles

API RP 2A (November, 1977)

FIGURE 20  
PILE CAPACITY CURVE

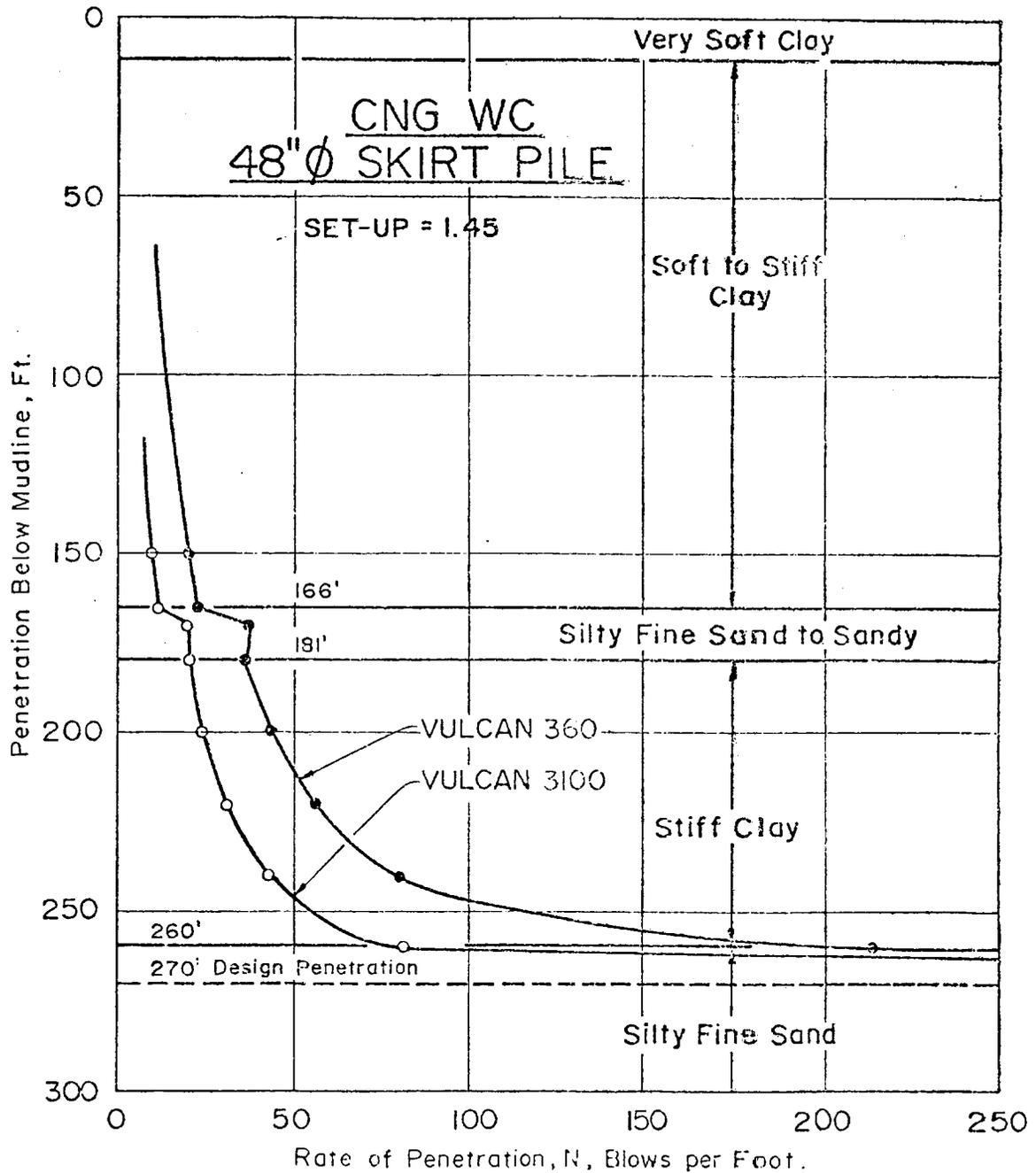


FIGURE 21  
PENETRATION vs. RATE OF PENETRATION

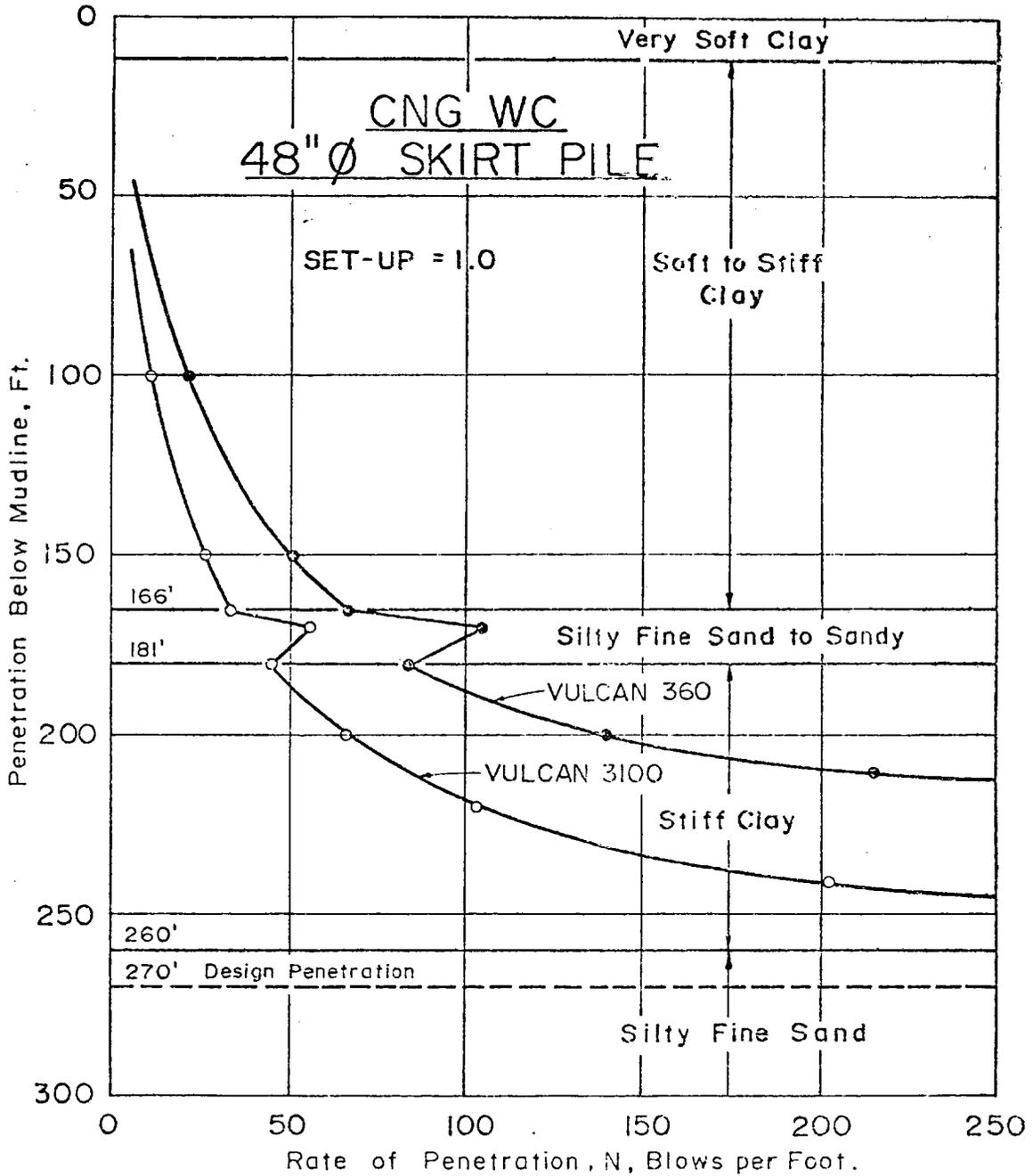


FIGURE 22

PENETRATION vs. RATE OF PENETRATION

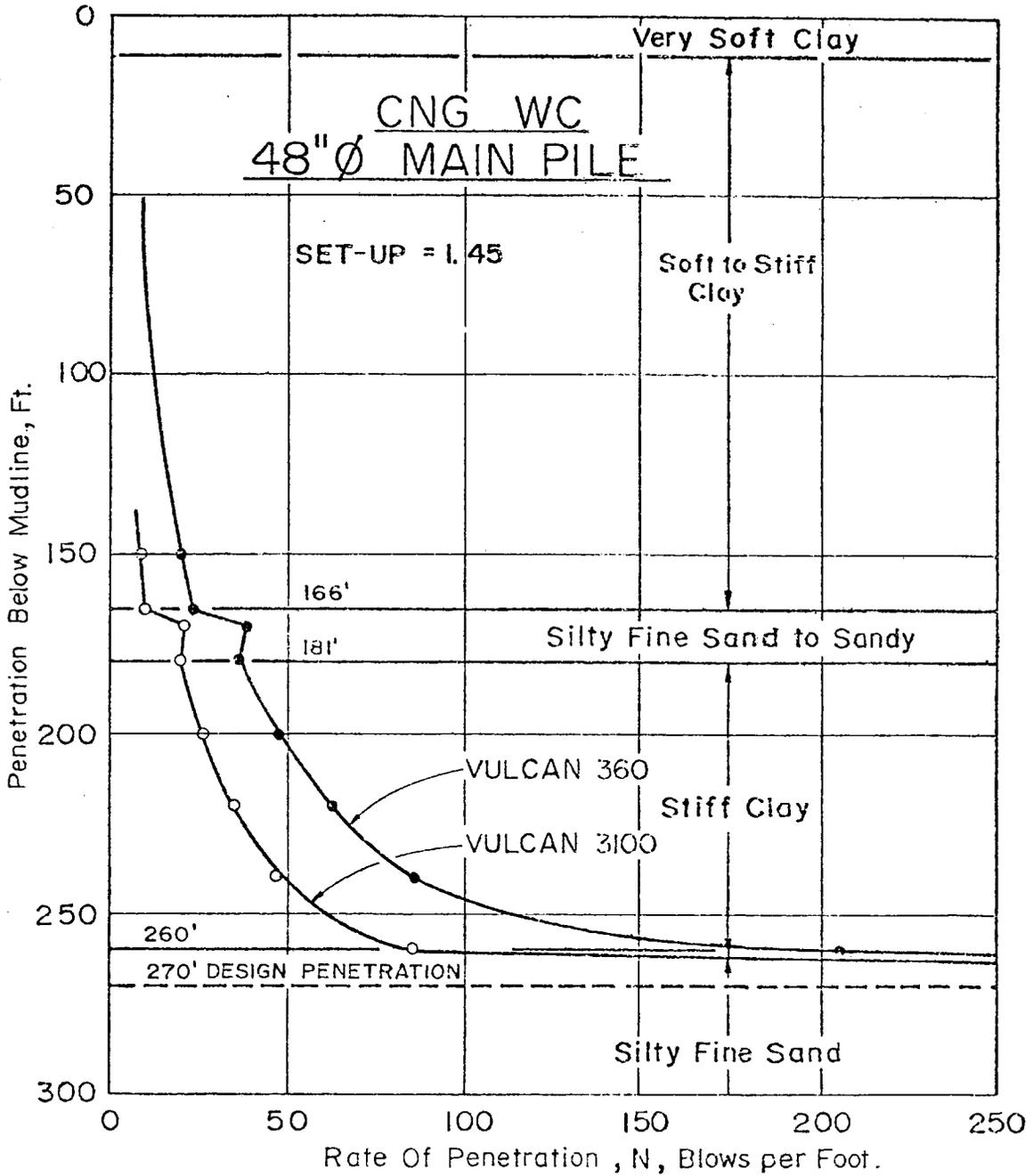


FIGURE 23

PENETRATION vs RATE OF PENETRATION

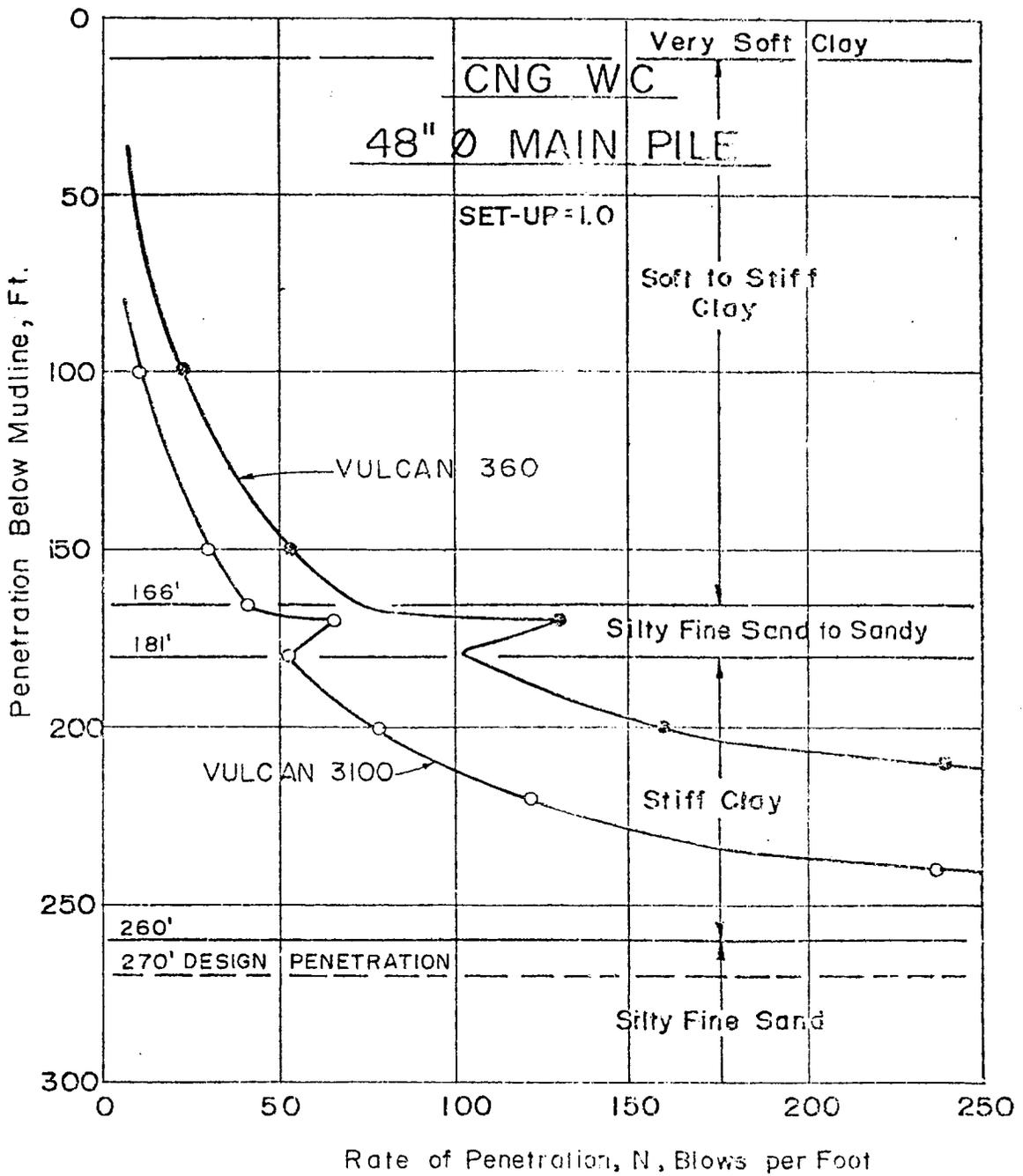


FIGURE 24

PENETRATION vs. RATE OF PENETRATION

2. The Vulcan 3100 may not have enough energy to drive the pile beyond elevation - 260 ft from the mudline; therefore, some underdrive could be expected.
3. The last 50 ft of each pile should be driven continuously by the Vulcan 3100 until design penetration is reached or pile refusal occurs.
4. Piles may be assumed to refuse when the blow count is greater than 200 blows per foot.

## 2. Punching Shear Analysis by JAMS Program

JAMS (Joint Analysis for Marine Structures) is the joint analysis program in the OCEANS system which provides for the analysis of specified joints according to API RP 2A and DnV's punching shear criteria (2; 10). The JAMS program is run to determine whether a can (sleeve) is needed at a specific joint or not. Usually a can of the same size as the joint is input in the program and it will automatically be increased until its allowable shearing stress is greater than the actual value from the punching shear at the joint.

## 3. File Driving Analysis for Curved Conductor

The AMPILE program has been used to predict the drivability of the curved conductor. It was found that some underdrive might happen unless the conductor is open-ended and equipped with a special driving shoe to eliminate the internal frictions and end bearings of the soil.

IV. THE AUTHOR'S SELF-STUDY ON THE FUNCTIONS  
OF A TECHNICAL MANAGER

## INTRODUCTION

Functions of a technical manager are the basic duties and responsibilities of an engineer that the author thinks he should be able to assume when he becomes a manager. They are the kinds of tools and helping devices for managers that calculators (or slide rules) and handbooks are for engineers. A novice engineering manager, no matter how well prepared he is in engineering, will need those basic tools and techniques before he can develop and progress. Therefore, it is the purpose of this chapter to discuss those tools and techniques in management. The method of demonstration will be mainly the comparison of the author's concepts of management and his internship experience at Brown & Root. The concepts of management will be based upon his experience and several relevant management books. The internship experience will include the tools and techniques that he or other engineers have used, and Brown & Root's standard procedures of project engineering in the Offshore Structures Department. By comparing the two sources of information, the author hopes to come up with a comprehensive study of the management functions that will satisfy the non-engineering objective of the internship.

### Definition

A technical manager, in the author's opinion, is the person who utilizes men, materials, methods, machines, money, and time

in an effective way to reach his objectives. He is not the manager who has a brilliant idea but never accomplishes anything, nor the one who gets the job done but, along the way, wastes human and natural resources. He must get the job done efficiently and, more importantly, effectively. He will be as close as possible to being an ideal manager who demands that his project be the fastest, the cheapest, and the best that has ever been. He must be dedicated to his job and his company and be willing to accept commitments and responsibilities. He should also be proficient in his management as well as in his engineering skills.

Now, let us consider Brown & Root's philosophy of Project Engineering in the Central Engineering Division (5, section 2.1.c)\*:

Brown & Root's philosophy of project engineering is to execute a project in a professional manner, on time, within the budget, with the requisite degree of efficiency, reliability and safety, to the client's satisfaction, and at a profit to the company.

### Two Important Functions

To be a good technical manager or a good project engineer (the words "project engineer" will be used interchangeably with the words "technical manager"), the engineer must perform the following functions:

1. Engineering and organizational functions

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\* Numbers in parentheses, thus (5, section 2.1.c), refer to the corresponding item and its location in References.

## 2. Management functions.

### I. Engineering and Organizational Functions

Engineering and organizational functions mean engineering-related and company-related work of a technical manager. At Brown & Root, a project engineer/manager has to supervise the designing and drafting of his project, and routine paper work such as the time sheet and overtime authorization, budget work, job procurement (including proposal writing and client soliciting), and personnel work consisting of selecting, training, and evaluating personnel. All of these non-management functions are related to the following:

- a. Production
- b. Finance
- c. Sales
- d. Personnel

#### a. Production

Production is the technical manager's bread and butter. It is his main objective as a manager, since without production he cannot build and maintain a profitable organization. In offshore platform design projects, the manager must get the production from engineers and draftsmen. Engineers have to design the platform and draftsmen have to represent the design in technical drawings. So the technical manager must interact with his disciplines in a manner that he can get the optimum output from them.

To his engineers he must be technically competent and be able to help them in technical areas. Brown & Root's Project Engineering Management (PEM) Program (6, section 1.1.d) gives the explanation of the engineering function of a project engineer as follows:

It almost goes without saying that the Project Engineer must be a skilled engineer. He is responsible that his project is technically sound, which means it must be operational and in full compliance with the design criteria, specifications, safety codes and regulations. Although the Project Engineer cannot be an expert in all technical areas of the project, he should probe engineering problems outside of his own discipline or area of knowledge and familiarize himself with all the technical aspects of his project.

He must not use the large amount of paper work as an excuse to divorce himself from the technical matters of his project and be merely a paper shuffler. He must try to understand the language, responsibilities, and get involved in the problems of each of the many disciplines on his project team.

If the technical manager thinks he needs help in some technical areas, he should study the subjects by himself or enroll in a nearby college that offers courses in those areas.

To his draftsmen, the technical manager can increase the level of production by providing them with necessary details and giving them adequate time to finish the drawings. At Brown & Root, by letting them work overtime (which will increase their incomes substantially), the project engineer has enjoyed more productivity and has been able to meet the deadlines of several activities.

b. Finance

The technical manager must be aware of the financial aspect of his project. He must try to keep the cost of his project down while maintaining the quality and schedule of the project. He must prepare his budget carefully and keep all expenses under control. At Brown & Root, the Engineering Labor Accounting System (ENLAB) is designed to help the project engineer keep track of the manhours and other expenses in a weekly or monthly period. The ENLAB System (5, section 17.5.3) is a basic computerized data processing system and can be used to:

- a. provide a historical record of cost and manhour expenditures,
- b. provide basic information of labor costs and manhours in each project,
- c. provide data for client billing,
- d. provide data for accounting department.

An example of ENLAB report is shown in Figure 25.

c. Sales

In an offshore platform design, sales is better known as project procurement. The technical manager can procure a project by the use of bids and proposals. Both types of documents require high skills and effective techniques in oral and written communications. In bidding, especially lump-sum bids, some strategies such as constructing bid models (21; 27) based on past bidding statistics to come

PART 17

5.0 ENLAB REPORTS

BROWN & ROOT, INC. REGULAR REPORT 12 - COMBINED OFFICES WEEKLY PROJECT ENGINEERS MAN HOURS										PAGE	1
JOB CR-0900 PINE CONCRETE CO. LOCATION LAF 34 ROLM 708 EXT 4101										WEEKLY PERIOD ENDING	06/12/78
CHARGED**	DW	NAME	EMPLOYEE	SOCIAL SECURITY	SEQ	THIS PERIOD	MANHOURS	TO DATE	MANHOURS	CHANGED PERIOD	PERIOD
S#	ACT	SEC			NUM	TOTAL	TOTAL	TOTAL	UVERTIME	FROM/7U	ADJUSTED
005 411	000	34	281	BARNES, DOUGLAS LEE	443-64-7350	001	45.0	45.0			
005 011	000	34	291	KINNY, PAUL MICHAEL	452-68-6811	001	45.0	45.0			
005 011	000	34	281	MASON, ROBERT ALLEN	383-44-4168	001	36.0	36.0			
005 011	000			GENERAL			182.0	182.0			
005 021	401	34	020	MILLAR, GILBERT	085-16-9-22	001	19.0	19.0			
005 021	401			DESIGN			19.0	19.0			
005 021	402	34	020	DUJ, CHEOL, SABA SALIM	450-02-0241	001	36.0	36.0			
005 021	402	34	020	KIMBLE, WILLIAM L	297-44-7612	001	37.0	37.0			
005 021	402	34	020	TRAYLOR, STEVEN S	426-62-2212	001	36.0	36.0			
005 021	402			CONCEPTUAL DESIGN			129.0	129.0			
005 112	000	34	112	SIMONE, PHILLIP	276-30-7421	001	23.0	23.0			
005 112	000			GENERAL			23.0	23.0			
005 155	401	02	050	FULLER, ROBERT MARY	406-20-7733	001	5.0	5.0			
005 155	401			DESIGN			5.0	5.0			
005 175	000	34	112	KRAN, KENNETH JAMES	459-68-4263	001	3.0	3.0			
005 175	000			GENERAL			3.0	3.0			
005 232	000	02	232	JIMMINS, JAMES BARILEY	447-02-3347	001	15.0	15.0			
005 232	000			GENERAL			15.0	15.0			
005 410	121	34	410	TRIFRY, GALETT W	030-37-8095	001	5.0	5.0			
005 410	121			COST CONTROL			5.0	5.0			
(A)											
JOB RECAP BY SECTIONS											
PROJECT ENGINEERING	011						126.0	126.0			
PROJECT	021						148.0	148.0			
PLANNING & SCHEDULING	112						23.0	23.0			
MATERIALS ENGR. WELDING	155						5.0	5.0			
GRAPHICS & COMPUTER TYPING	175						3.0	3.0			
PIPELINE	232						15.0	15.0			
COST CONTROL	410						5.0	5.0			
-JOB TOTAL							325.0	325.0			

FIGURE 25

EXAMPLE OF THE ENLAB REPORT  
(AFTER B & R'S PEM MANUAL)

up with an optimum bid that is low enough to win the contract and yet high enough to gain profit have been proved to be successful. In preparing and writing proposals, Hicks (13, p. 82) suggested that two important areas to be organized are personnel and procedures. He said:

To organize your personnel, assign full responsibility for economic, on-time preparation of proposals to one person. Choose for this assignment an engineer who understands the purpose of proposals and who has written enough proposals himself to understand the difference between clear and unclear writing. Have this man--be his title 'proposals engineer,' 'project engineer,' 'project leader,' or some similar title--report to you. With this arrangement you will have ultimate control of each proposal and you can guide it any way you wish.

. . . Once your proposal personnel are organized, you can turn to organization of proposal-writing procedures. Effective procedures are important because they assist your group in obtaining consistently high quality in every proposal. Well-planned procedures allow the group to concentrate on the proposal itself instead of worrying about the width of margins, sequence of sections, and like details which can be standardized by adopting organized procedures.

In Brown & Root's PEM Program (6, section 2.2.1.b), project procurement and proposal preparation are explained as follows:

Project procurement is frequently a fill-in assignment for many Project Managers/Engineers. Let us briefly mention the many facets that proposal preparation may involve.

It will include determining whether it is a new or an old client, a verbal or written inquiry, and a solicited or unsolicited inquiry. Proposal analysis will include such items as the type of facility, the size, its location and the client dictated completion dates. The scope of the project may include process involvement, site selection, sources of electrical power, sources of all other utilities,

material and equipment procurement and who will be responsible for field construction.

. . . Proposal content will include items as pricing schedule, drawings, manpower availability, experience of Brown & Root in similar or identical plants, organization charts for project management, engineering and construction, procurement procedure, cost of the facility, and preliminary engineering and construction schedules. All copies of documents included in the proposal must be top quality. A section is devoted to detailing the exceptions and/or omissions relative to the inquiry documents.

The proposal letter may be written by the Project Manager/Engineer and will include all the 'ifs,' 'ands,' and 'buts' as well as the price, commercial terms, location of engineering services, schedule, procedure for payment, statements relative to secrecy agreements, duration of proposal and how the proposal may be accepted by the client. The letter will be signed by an officer of Brown & Root. The proposal and the proposed contract must be reviewed by Brown & Root's legal department.

On some large facilities and complex proposal preparations, management may ask the Project Manager/Engineer to prepare an estimated cost for proposal preparation.

#### d. Personnel

The technical manager is involved in the personnel function by selecting, training, and evaluating his subordinates. He will have to rely on his communication skill to implement those functions effectively. In training new engineers, he will need his teaching skills to make them understand the engineering and organizational procedures of the company. When he has to select personnel for an assignment, he must rely on his knowledge of such personnel. Finally, to be able to critically evaluate his subordinates' performance, he must be fair and honest. In an end-of-the-

year, face-to-face type of job evaluation, he must try to point out each individual's weak and strong points. The best suggestion for the technical manager concerning personnel function is that he should be a "diplomat." Brown & Root's PEM Program (6, section 2.2.1) gives a good definition of a "diplomat" as follows:

By definition, a diplomat is skilled in handling affairs without arousing hostility; he is flexible, tactful, and judicious in dealing with others, or in new and trying situations.

## 2. Management Functions

If there is a question of the most important deed a manager must achieve, the answer will be the "implementation" of his work, that is--a manager must get his job done regardless of the difficulties that might have been encountered. To implement, the technical manager must know how to manage. Management is the action the technical manager takes to lead his group to the objectives he sets up. Howard Sargent (23, p. 26) defines management in the following way:

Management. The actions and activities (management functions) a manager performs or coordinates, using available resources, to attain self-established objectives while observing self-imposed policies (rules and procedures), in an environment that includes constraints (policies and objectives) announced by higher authorities and others.

Brown & Root's PEM Program (6, section 2.2.1) defines "a project engineer" as follows:

. . . He is the focal point of the project and the quarterback of the project team calling

signals. He is the only one directly responsible for and in complete charge of the organization, direction, coordination, and control of all engineering functions. He coordinates these with the Project General Manager on a single responsibility project, Construction Manager, Client, and other departments as needed.

There are several different opinions among management theorists about the management functions, which are what a technical manager does in his day-to-day work. They all come up with different names for the activities of a manager. However, Howard Sargent's five functions of management will be adopted here and explained throughout the rest of the chapter. They are as follows:

- a. Decision making
- b. Communication of decision
- c. Follow-up on decision
- d. Organization
- e. Motivation.

The first three functions are cyclic functions. The technical manager will perform the three functions repeatedly in a cyclic way. He will make a decision and communicate it to his subordinate. When he follows up on that decision and finds out that there are some obstacles, he will use that feedback in re-considering his objective to come up with the best decision, and this cycle goes on and on until the objective has been reached. Organization and motivation, the last two functions, will be performed continuously to support the manager's implementation of his objective.

a. Decision Making

Decision making, or planning, as it is better known, is the identification of a set of objectives of the company (or the project). Once the objective(s) has been determined, appropriate policies, procedures, and methods can then be adopted to help the manager reaching his objective(s).

Steps involved in the process of decision making are:

1. Studying the situation to find where the company (project) stands and what is its weakness and strength.
2. Identifying the objective(s), that is, studying the scope of the objective(s).
3. Allocating the resources. This will include the selection of subordinates and the approximation of manhours needed.
4. Making the assumptions concerning the objective(s).
5. Developing alternative plans for the same objective(s).
6. Selecting the best plan to be utilized.

Scientific management techniques such as system analysis and operation research have been developed to help a manager making decisions. System analysis is a study of alternative systems to determine the best system for implementing a specific organizational objective. Operation research is a system analysis in which mathematical models are used to represent alternatives and conditions. Other techniques,

such as CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique) have proved to be helpful in decision making process, especially in planning and scheduling.

In an offshore platform project, identifying the objective is equivalent to determining the scope of the project. Brown & Root's PEM Program (6, section 2.2.1.b) describes project scope as follows:

A good project description must define what is to be done by engineering, procurement and construction as specifically as possible for all facets of the project. The client may or may not approve the document. However, it is issued to all interested parties within and outside the task force, including the client. Revisions are issued, as required, to document major changes. Minor changes can be handled by the variance system. Scope detail is dependent upon the size and nature of the job.

Poor definition in scope may cause false starts, over-looked items and misunderstandings within the task force as well as with the client. On the other hand, a good scope definition provides a sound basis for defining extra work, presents a goal of accomplishments to the task force and is a prerequisite for the preparation of an estimate . . . .

For example, if the project is a mega project--multi-million, multi-company project--what kind of scope defining tool should the technical manager adopt? The answer is-- he should utilize the Responsibilities Matrix. The following paragraphs are quoted from Brown & Root's PEM Program (6, section 3.2.b) to illustrate the significance of the Assignment of the Responsibilities Matrix:

The Assignment of Responsibilities Matrix defines the managerial, administrative, technical and construction responsibilities for a project. Why do we need it? We need it because the projects that we are involved in now are generally so big and complicated, mega projects, which often have one or more engineering or construction companies involved, are frequently in the five-hundred million dollar plus range, and often have a job site that may well be halfway around the world. Under these conditions it is difficult to determine what the scope of the project is and one group's individual responsibilities. First let's examine what is meant by "Scope of Project." There is usually some piece of paper--a contract, letter of intent, notice to proceed, or other document, authorizing Brown & Root to proceed. This document, in whatever form, will have a section which outlines the nature of the work to be undertaken, and may or may not accurately describe what has to be done by Brown & Root to provide the client with the engineering and/or construction facility he desires. Normally it does not define project scope well enough to be considered definitive. Due to the omissions, or lack of information many questions must be answered in order to allow work to proceed. It is up to the Project Engineer to get answers to questions like: What information can he expect from the client? What progress has the client made in developing general criteria? Who is providing what equipment? Are there environmental considerations? If other engineering and construction companies are involved, what portions of the work will they execute? etc., in order to satisfy the client's desires. Answers to the above questions, some of which will lead to more questions, are necessary to define the scope of the project. When the answers to these questions are not obtained at the proper time, or if the questions are not asked, the seeds of future problems have been planted. Two examples of the types of problems the Assignment of Responsibilities Matrix attempts to resolve are illustrated by the following incidents from two different jobs.

The first problem relates to a Material Control problem. On one Petrochemical job no one had determined who was coordinating overall Material Control. The client had four engineering companies and two construction companies working on the project. The other engineering

companies made drawings and submitted them to Brown & Root. Brown & Root assumed that they had done the takeoff and had bought the material on those drawings. The other engineering companies assumed that we were doing the takeoff when we got the drawings. We made a number of drawings and took off our material and bought it. The shortages showed up pretty quickly after construction began. All of the companies involved made a simple, but fatal assumption: The other guy is taking care of that. The results were a delay in the project and an unhappy client. Could the problem be prevented? Yes, if the companies involved had determined early in the project who was in charge of coordinating Material Control, and who was responsible for takeoffs and purchasing.

The second example relates to the problem of what data the client will supply the contractor at award time. In this case the client was to supply Brown & Root with the general criteria for the project. The general criteria was to represent their corporate philosophy as to certain characteristics the plant should have when completed. It would answer questions like, Do we have lighting in parking lots? Do we pave the roads? Do we have toilet facilities for 10 men or for 200 men? On that particular job, we (Brown & Root) put that material together for the client. One day, when the lack of the general criteria finally became critical because it was holding up our design effort the client's personnel went running around to a number of their company standards, and pulled all the material necessary. Then they turned that material over to Brown & Root for completion. There was a large stack of paper, with a bunch of hand written notes, modified pages from their standards, and other data that was peculiar to that job that wasn't in their normal plant standards. It was up to Brown & Root to get that material assembled. The content was the client's responsibility. They were to give it to us and they were responsible for what it said, but they made Brown & Root responsible for getting it typed up, put in some kind of reasonable order, reproduced, bound and distributed. It would have been preferable not to struggle along for about four or five months without knowing who was going to put such a document together or when it would be available. Initially no manhours or dollars had been allocated by Brown & Root for such an effort. Could this

problem be prevented? Yes, had the client and Brown & Root determined from the outset who was to perform that function.

This example illustrates another point. There can be a difference between the organization responsible, in a decision making sense, for a particular function and the organization that executes or inputs to that particular function.

One example of such a problem would be the cost report on a project with multiple company involvement. The organization responsible for the content and timeliness of the cost report may itself generate only a portion of the data but must correlate the balance of the data supplied by others. The other parties must be made aware of their responsibilities and instructed as to the content, format, and timing of their inputs.

Because these types of problems occur again and again it appeared that a formal uniform approach to the solution of these problems was necessary. The solution will be in the form of the Assignment of Responsibilities Matrix. Even in the simplest case where Brown & Root is the sole contractor it would still be useful to determine what the General Manager is responsible for, what the Engineering Manager is responsible for, and what the Construction Manager is responsible for.

An example of the Assignment of the Responsibilities Matrix is shown in Figure 26.

#### b. Communication of Decision

Communication of decisions, and follow-up on decisions, represents the most neglected and overlooked activities. Managers seem to think that once the objectives have been set up they will flow smoothly to the subordinates and will be implemented accordingly. Unfortunately, most of the time they are not. Either the objectives themselves are unclear or the subordinates will misinterpret or misunderstand them. In both cases, even the well prepared plan will be

**MEGA PROJECT 'X'**  
**ASSIGNMENT OF RESPONSIBILITY MATRIX**  
**Total Project**

**LEVEL I**  
R- RESPONSIBLE FOR  
A- APPROVAL OF

ACTIVITY		RESPONSIBILITY	BROWN & ROOT	"X" COMPANY	"Y" COMPANY	"Z" COMPANY	CLIENT	CONSTRUCTION
=TOTAL PROJECT =	MOBILIZATION PHASE		R	R	R		A	
	BASIC DESIGN ENGINEERING PHASE		R	R	R		A	
	PRODUCTION ENGINEERING PHASE		R	R	R	R	A	
	POST PRODUCTION ENGINEERING PHASE		R	R	R	R	A	
	PROCUREMENT		R				A	
	CONSTRUCTION		R			R	A	
	PROJECT MANAGEMENT		R				A	

FIGURE 26

EXAMPLE OF THE RESPONSIBILITY MATRIX  
(AFTER B & R'S PEM PROGRAM)

executed poorly. To avoid such ambiguities, the technical manager should communicate his decision by:

1. Selecting a clear, well-defined objective. The alternatives in the decision making process must be described precisely so that when the best plan is reached, its objectives will be defined clearly. Nevertheless, the objectives of the subordinates should be recognized and included in the manager's objectives because the subordinates, not the manager, are the ones who actually carry out the plan. This concept may lead to the idea of sharing objectives with the subordinates. Once the objectives are shared, the manager will be released of the burden of objectives communication and will have more time to perform other management functions.
2. Directing or, as Howard Sargent (23, p. 141) points out,

. . . maintaining a basic policies directive containing the most important policies to be observed by the people in the manager's organization. The directive would be a companion document to the manager's personal objectives plan .  
. . .

Basic policies that should be developed first by the manager are the management system policies such as decentralization policy, communication policy, inhibition policy, promotion policy, and operational policy, in other words, the manager

should set up the "rules of the house" for the subordinates who must comply with them.

At Brown & Root, the project engineer will consult his PEM Manual (5) if he has any questions about the policies and procedures of the company.

3. Training. Training by the manager is usually conducted on the job and falls into two categories: operational, or technical, and management training. Howard Sargent (23, p. 158) recommends the ways that Monsanto Chemical Company and Lyndall Urwick use to train and develop employess as follows:

- Joint activities in which the 'students' see you conducting management processes properly.
- Special assignments and investigations critiqued by you.
- Temporary replacement of supervisors by subordinates.
- Job rotation.
- Community activities.
- Teaching.
- Public speaking.
- Leadership of conferences and committees.
- Students in classroom.
- Observational visits.
- Reading.
- Learning from more experienced people-- pairing trained and untrained people.
- Meetings and seminars.

At Brown & Root's Offshore Structures Department, technical training is done by 'staff' training groups from the Research and Development section while management training is done on a selected group of employees by the Personnel Department.

c. Follow-up on Decision

When the objectives have been identified and communicated, it is the technical manager's final responsibility to ensure that the plans being executed follow the policies that have been established. Follow-up, or control function, requires that the technical manager must monitor the change of events and adapt his organization accordingly so that future activities will be consistent with the existing plans and objectives. The adaptation implies that the technical manager must treat follow-up function as a continuous event. He must frequently, preferably daily, make contact with his subordinates about the current status of the operation. If some problems occur and the operation is not obtaining the desired results, the technical manager must make necessary changes to achieve them. He may have to go back to the first management function, the decision making, again and find the best alternative that will solve the problem and communicate the new decisions and, again, follow them up carefully and closely.

Follow-up methods as suggested by Howard Sargent (23) are:

1. Periodic narrative written progress reports. Progress reports are usually written in the way that they show the current situation of the operation by expressing it in the ratios of performance over objective. These ratios are crucial data in budget

analysis and schedule control. However, there are several weaknesses in periodic written progress report. Among them are the omittance of self-incrimination information by the reporter, and the absence of easy resolution of questions. Therefore, this type of progress report does not provide adequate management information for the control function.

2. Visits to subordinates. According to Howard Sargent (23, p. 167, 168), management visits can be categorized as follows:

- Visits in reaction to a problem. A problem becomes evident, and the manager or a staff representative reacts by visiting lower echelons to discuss the matter. A memorandum listing actions to be taken is often issued, but has no connection with an existing objective plan. . . .

- Compliance audits or inspections. An annual visit to detect violations of destablished directives is usually involved. The people on these inspection teams often have little intellectual curiosity. They accept the directives as gospel, and restrict their role to checking system output (performance) against established policies and procedures. In a typical case, a list of deficiencies ("noncompliances") several pages long is published. Two weeks later the visited activity replies, saying all deficiencies have been corrected--an untruth since the underlying system faults remain uncorrected. . . .

- "Showing the flag" command visits. . . . To instill discipline, the senior manager personally visits the field briefly to check on obedience to orders. Of necessity, an easy-to-check area is selected. This type of ego visit has

resulted in much grass cutting, rock white washing and similar nonsense. Serious problems are not confronted by the senior manager. . . .

- Management analyses (random sample analyses). This method of follow-up requires the design of a spotcheck procedure. It involves repeated short visits to lower echelons to compare randomly selected samples of system performance with a limited number of standards. . . .

- Assistance visits and in-depth reviews. This type of follow-up action is usually accomplished by a staff member or a staff team visiting lower echelons for several days or weeks to probe a system or project in depth, to discover faulty design or performance and what needs to be done. Advice and assistance is also provided. . . .

3. Periodic face-to-face progress interviews. If properly conducted, periodic face-to-face progress interviews will be very useful to the technical manager in the follow-up decision. They will help reveal hidden operational obstacles. However, there are some rules that the technical manager should consider. They are:
  - a. The face-to-face progress interviews serve as a checkpoint rather than a decision making tool. Their sole purpose is to convey the management information concerning the status of the operation.
  - b. The subordinates being interviewed should have direct responsibility for the operation so that their information will be accurate.

At Brown & Root, the Technical Support Service Department has developed the Project Reviews and Manhour Estimate (PRAME) system to assist the project engineer in monitoring engineering manhour estimates and expenditures and the timely execution of engineering functions. However, in the PEM Program (6, section 2.2.2.d) project control in off-shore project is defined as follows:

Project control is a most important responsibility of the Project Manager/Engineer. Three steps used in project control are: 1. status control, or a determination of the current condition of the project; 2. analysis control which discusses and ascertains the impact of deviations, and 3. the actions required to be made by the Project Manager/Engineer to correct the condition and keep the project within the time/cost schedule.

The four parameters involved in project control are time, resource consumptions, achievement, and specifications. A time unit may be days, or weeks and is applied to schedules, spanned time or to how late the item or activity is in relation to the schedule. Resource consumption is recorded in dollars, manhours, or dates and is applied to budgets, cost estimates, and overruns. Achievement, also known as earned value, is generally nonlinear with time and it is reported in units such as tons of steel, feet of pipe, yards of concrete, or number of milestones accomplished. It is applied to the value of the work accomplished, percent complete, or planned percent complete. Achievement cannot normally be stated in manhours expended. The specifications relate to the physical description or process, equipment item, range, weight, or speed as applied to the product to determine if it meets the specification. One of the newer aids to project engineering control is the use of modern bar charting which shows activities, who is responsible, time span, restraints, as well as the critical path. It replaces the CPM events charts. Brown & Root, however, does not use this method.

d. Organization

Organization is the act of organization of the technical manager and his functions. It is how the technical manager puts his staff together and relates to them in an organized way. Two categories concerning the organization function of the technical manager will be discussed here.

They are:

1. Organization structure. Brown & Root's PEM Program (6, section 6.2) gives the definition of the organization structure as follows:

An organization structure is a framework or pattern of functional relationships, which have been expressed as individual positions, determined to be essential to the achievement of the objectives of the enterprise. It is a plan of action between and among the work and the people deemed necessary to obtain the goals of the group effort. The structure is the product of the process or function of organization. .

. . .

Organization structure can be classified as:

- a. Line structure. This type of structure is simple and usually is used in small companies. Its authority and responsibility comes directly from the top to the bottom, that is, from the president of the company to the lowest employee.
- b. Line and staff structure. Larger companies such as Brown & Root, use this type of structure. Though authority in the line and staff structure

flows directly downward as in line structure, it is limited. All lines are independent of each other. Only in its own line will the staff people have authority over people within their own staff activity.

- c. Line and functional staff structure. This type of structure is identical to the line and staff structure except in its operation. Brown & Root's PEM Program (6, section 6.2) describes the difference as follows:

In this type of structure, the specialized staff units have authority over other staff units and over line units, for matters within their field of specialization. As an example, if a personnel problem arises in the sales area, the personnel manager has authority to settle the matter. It, thus, differs from the line and staff structure in that in the former, the staff merely advises the line and other staff departments; it cannot order or direct them to do anything.

2. Line and staff relationships. Brown & Root's PEM Program (6, section 6.2) explains line and staff activities and their importance as follows:

Line activities are those that make direct contribution to the organizational objective. They make a direct contribution to the values which the organization seeks to produce, distribute, and maintain for their customers. The staff activities are those which make an indirect contribution to the objectives, by aiding the line units to provide greater values.

. . . it is essential in any enterprise that the line and staff work

harmoniously together. One factor important to such harmony is a clear division of authority and responsibility between line and staff. If a pure staff approach is used rather than a functional staff one, it is more likely that harmony will prevail. A good understanding of what the line and staff units do is also important to successful organization. Recognition and utilization of staff by line people is another important element.

e. Motivation

Galileo once said: "You cannot teach a man anything; you can only help him to find it within himself." The same idea is true for motivation. A man has to have such a strong desire within himself that it will motivate his action. Thus, motivation can only come from within. However, outside help may initiate the desire and speed up motivation. In the management field, by knowing motivation theories, a manager can effectively motivate his subordinates to willingly motivate themselves.

Theories on motivation can be summarized as follows:

1. Hierarchy of Needs Theory. In 1943 Abraham Maslow wrote a book on this theory which explains human needs. He grouped them into five sequential steps as follows:
  1. Physiological needs. They are the needs that must be fulfilled first: hunger, thirst, rest, sex, and so on.
  2. Safety. These are the needs to have physical safety and to live in an environment that has

minimum risks.

3. Social. The human being is a social animal and wants to be loved and belong to groups.
  4. Esteem or status. The need for status, both in terms of self-respect and esteem of others, is a strong motivating force.
  5. Self-actualization. Finally, after all other needs have been obtained, people will seek self-fulfillment and will be fully content with life and non-critical of others.
2. Two-Factor Theory. This theory is basically the hierarchy of needs theory, but concentrates more in the area of on-the-job motivation. According to Brown & Root's PEM Program (6, section 6.2) Frederick Herzberg, the founder of the theory, reached the following two conclusions:
1. There are some conditions of the job which operate primarily to dissatisfy employees when they are not present. However, the presence of these conditions does not build strong motivation. Herzberg called these factors maintenance or hygiene factors since they are necessary to maintain a reasonable level of satisfaction. He also noted that many of these factors have often been perceived by managers as motivators, but that they are, in fact, more potent as dissatisfiers when they are absent. He concluded that there were ten maintenance factors, namely:
    - a. Company policy and administration,
    - b. Technical supervision,
    - c. Interpersonal relations with supervisor,

- d. Interpersonal relations with peers,
  - e. Interpersonal relations with subordinates,
  - f. Salary,
  - g. Job security,
  - h. Personal life,
  - i. Work conditions, and
  - j. Status.
2. There are some job conditions which, if present, operate to build high levels of motivation and job satisfaction. However, if these conditions are not present, they do not prove highly dissatisfying. Herzberg described six of these factors as motivational factors or satisfiers:
- a. Achievement,
  - b. Recognition,
  - c. Advancement,
  - d. The work itself,
  - e. The possibility of growth,
  - f. Responsibility.

The maintenance factors cause much dissatisfaction when they are not present, but do not provide strong motivation when they are. On the other hand, the factors in the second group lead to strong motivation and satisfaction when they are present, but do not cause much dissatisfaction when they are absent.

3. Theory X and Theory Y. Every manager will take one of the two different attitudes toward his subordinates in trying to motivate them. He will be positive or negative about them. If a manager has a positive attitude, he will trust his subordinates and believe that they are responsible and like their jobs. On the contrary, a manager with a negative attitude will think that his subordinates cannot be trusted and must be watched closely. Negative attitude or Theory X, and positive attitude

or Theory Y belong to Douglas McGregor who, in 1960, explained two contrasting assumptions being used by managers in motivating their subordinates. Brown & Root's PEM Program (6, section 6.2) summarized Theory X and Theory Y in the following way:

Theory X contained three postulates as follows:

1. The average human being has an inherent dislike of work and will avoid it if he can.
2. Because of this characteristic of dislike of work, most people must be coerced, controlled, directed, or threatened with punishment to get them to put forth adequate effort toward the achievement of organizational objectives.
3. The average human being prefers to be directed, wishes to avoid responsibility, has relatively little ambition, and wants security above all.

McGregor stated that Theory X was the dominant belief in a wide sector of American industry at the time the book was written in 1960. However, he felt this was based on outdated assumptions about people, and he proposed in its place Theory Y:

1. The expenditure of physical and mental effort in work is as natural as play or rest.
2. External control and the threat of punishment are not the only means of bringing about effort toward organizational objectives. Man will exercise self-direction and self-control in the service of objectives to which he is committed.
3. Commitment to objectives is a function of the rewards associated with their achievement. The most significant of such rewards; for example, the satisfaction of ego and self-actualization needs, can be direct

products of effort directed toward organizational objectives.

4. Under proper conditions the average human being learns not only to accept but to seek responsibility. Avoidance of responsibility, lack of ambition, and emphasis on security are generally consequences of experience, not inherent human characteristics.
5. The capacity to exercise a relatively high degree of imagination, ingenuity, and creativity in the solution of organizational problems is widely, not narrowly, distributed in the population.
6. Under the conditions of modern industrial life, the intellectual potentialities of the average human being are only partially used.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions on the Internship

The reason the author selected Brown & Root as the place for his internship was the nature of the fixed offshore platform design that would enable him to work in four interesting areas relating to his first objective of gaining engineering experience. They were the areas in which he could (1) participate in structural design and analysis, (2) familiarize himself with computer analysis system, (3) get experience in geotechnical-oriented design, and (4) work on pile driving analysis using wave equation theory.

After the completion of his internship, the author concludes that he had reached this objective. On the Chevron project, he did some structural designs and analyses on the boat landing and curved conductor designs, and used several computer programs to design various platform components such as deck, jacket, and piles. While he was working with Mr. Mohamed I. El-Hitamy, he had the opportunity to use the geotechnical report in the design of the foundation by inputting the soil data in various computer programs, such as AXCOL 1, DUMYPILE, and LATPILE. Finally, on the pile driving analysis, he used the AMPILE program which is based on the wave equation theory, to predict the drivability of the piles.

As far as his second objective of participating in some administrative assignments is concerned, he had not been

assigned to any of them during his internship. The tight time schedule of his projects had always tied him down to his engineering assignments. However, he has made the attempt to study the subject himself by reading the manuals used in the professional development course that Brown & Root has set up for the project engineers. When he came back to Texas A&M for his last semester, he enrolled in a management course on the survey of management, and has developed his own concepts about management. The result of both studies is a topic in management functions which he explains in Chapter IV.

#### Recommendations for the Future Intern

1. The future intern should consider Brown & Root as a potential place for his internship. Being a large corporation, Brown & Root can provide him with any kind of training in any areas of engineering. Besides, Brown & Root has the flexibility hardly found in small companies; the company can afford to move the intern around to several different levels of work without suffering the loss of manpower.
2. The future intern should try to demonstrate his technical ability as best as he can. He should be willing to take responsibility not only of his assignments, but also of those who work with him.
3. Attention should be paid by the intern to developing the management skills at the place of internship while

the administrative work is assigned. He can do it by either observing his supervisors, or by studying them on his own time. He should also be aware of the transition from an engineer to a manager that he will encounter soon after his graduation, and he should prepare for it.

4. The intern should spend as much time as he can to improve and sharpen his communication techniques--both oral and written. A public speaking club, such as the Toastmaster Club, is a very good social group to join in order to improve his speaking ability. Frequent presentation of the reports is also helpful to oral communication. In developing the written communication skill, frequent memorandum and report writings have proved to be beneficial.
5. He should keep records of the daily assignments in a diary, and document all the computations and assumptions in the design. They will serve as future references and also as legal protection.
6. The intern should attempt to know the company and its organization, in addition to the technical nature and the design procedures of the company.
7. The future intern should try to achieve both the engineering and the non-engineering aspects of the internship. If one of them will be absent, he should try to study the subject by himself. He should also

finish writing his final report and have it in final draft ready to be typed before he comes back to school for his last semester.

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## APPENDIX A

Brown & Root, Inc.

## FINAL INTERNSHIP OBJECTIVES

Submitted To: Dr. Teddy J. Hirsch, Committee Chairman  
By: R. Ratanaprichavej  
Place of Internship: Brown & Root, Inc.  
Houston, Texas  
Internship Supervisor: Mr. Stan Hruska  
Project Manager

April 20, 1978

**Brown & Root, Inc.**

Mr. R. Ratanaprichavej, the intern, intends to inform Dr. T. J. Hirsch, the Chairman, and the Advisory Committee of the final objectives of his internship with Brown & Root, Inc. of Houston, Texas, from January 1978 to January 1979. During this period, Mr. Stan Hruska will be his internship supervisor and serve as a full member of the Committee.

His final internship objectives are as follows:

- (1) To work and gain experience as a structural engineer;
- (2) To learn the organization of Brown & Root and the function of some of the managerial positions in the Marine Industries Department.

To achieve these two primary goals, several secondary goals are set up and included in the report. They come from the job description of his position, the guideline of the internship report, and his own determination to make his internship the most valuable part of his education. They are designed to broaden not only his technical skills but also other managerial and human relation skills. In general, the secondary goals represent what the intern thinks he should get from his short employment with Brown & Root and what he should do to reach these goals.

To better fulfill his objectives, the intern will try to achieve the following goals:

- (1) Design. The intern will get familiarized with appropriate design codes, especially API Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms, AISC Manual of Steel Construction. He will prepare input data for computerized solutions using the OCEANS (Offshore and Civil Engineering Analysis Systems) Program.
- (2) Analyses. He will participate in analyses required to formulate and determine design criteria for minor structures, systems, material and equipment items. Whenever possible, he will try to do library researches and readings to get the updated information.
- (3) Team Work. The intern will take responsibility not only of his assignment, but also of associates and supervisors. He will learn to contribute to the task and, at the same time, gracefully acknowledge the contributions of fellow engineers.
- (4) Drawing and Checking. The intern will prepare drawing and diagrams of special items and prepare sketches for use by drafting personnel. He will also review and check detailed drawings and layouts.

Brown & Root, Inc.

Final Internship Objectives

Page 2

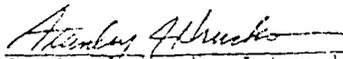
April 20, 1978

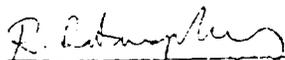
- (5) Scheduling, Budgeting, and Cost-Estimating. The intern will learn how to estimate and schedule engineering manhour and perform quantity take-offs and preliminary cost estimating for client information. He will prepare periodic status report on manhours versus budget.
- (6) Study of Brown & Root System. He will get acquainted with the organization chart and learn the way Brown & Root acquires a client and distributes the project among various divisions.
- (7) Study of the Role of a Project Manager. He will learn what duties a project engineer performs and how he interrelates and delegates authority and responsibility.
- (8) Study of the Role of a Project Engineer. The intern will learn how the project engineer matches work assignments with human resources, measures progress and quality of work, and develops effective communications with his group and his supervisor.

During the internship period, the intern will participate on the Chevron project and others.

The Chevron project is the design of a 685 ft., 8-leg platform in the Gulf of Mexico. When completed it will be the deepest single piece production platform ever built. At the sea bed elevation, the jacket has the dimension of 185.6 ft. by 330 ft., larger than the size of a football field. Besides routine designs, Chevron U.S.A., Inc. requests that Brown & Root does some extra designs and analyses, such as the boat landing design, the transportation analysis and the fatigue and dynamic analyses.

As future is unforeseen and the next project to which the intern will be assigned is unknown, the intern will consider his secondary goals as guideline only. As time goes by, he will do the best he can to follow them, but if there is a better alternative, he will modify and improve them. At the end of the internship period, all the intern's activities will be detailed and summarized in the final report.

  
 Stanley J. Hruska, Internship Supervisor

  
 Ron Patanapichavej, Intern

## APPENDIX B

## JOB DESCRIPTION

**TITLE:** Engineer **SKILL LEVEL: 050**

**REPORTS TO:** Manager, (Discipline) Engineering Department  
 Asst. Manager, (Discipline) Engineering Department  
 (Staff Responsibility)  
 Project Engineer  
 Project Staff Engineer  
 Senior Engineer  
 Design Engineer  
 (Line Responsibility)

**SUPERVISES:** Associate Engineers  
 Associate Designers  
 Technicians  
 Draftsmen

Provides support to more experienced engineering personnel by performing engineering and design assignment of a varied nature requiring reasonable technical understanding of one engineering discipline. Typically, is given assignments relating to a given project of limited complexity. Results are subject to regular review and check. Errors generally are easily detected. From time to time, may function at a lower skill level, but will be utilized at a higher level only at the direction of the Department Manager. The Manager, (Discipline) Engineering Department will expand the definition of this skill level, if required, outlining specific duties and responsibilities which are applicable to a particular discipline.

**PRIMARY RESPONSIBILITIES:**

Typical responsibilities may include, but are not limited to, all or some combination of the following:

1. Participates in analyses required to formulate and determine design criteria for minor structures, systems, material and equipment items and prepares specifications for same in accordance with codes, discipline standards, and client instructions.
2. Prepares drawings and diagrams of special items and prepares sketches for use by drafting personnel. Reviews and checks detailed drawings and layouts.
3. Reviews client's requests for minor engineering change orders and recommends action to supervisor.
4. Participates in economic and operating feasibility studies and studies aimed at evaluating alternative systems, equipment, materials, or engineering methods.
5. Prepares input data for computerized solutions to engineering problems.

**TITLE: Engineer**  
**(Continued)**

**SKILL LEVEL: 050**

- 6. Assists in preparation of contract specifications, evaluation of bid proposals, and preparation of purchase requisitions.**
- 7. Prepares statistics and maintains records on engineering manhours and prepares periodic status report on manhours versus budget.**
- 8. Assists in preparation of client progress reports.**
- 9. Assumes such other duties and responsibilities as may be indicated by experience.**

**KNOWLEDGE AND EXPERIENCE:**

**Acceptable degree with six or more years of experience.**

## APPENDIX C

## THE OCEANS SYSTEM

OCEANS (Offshore and Civil Engineering Analysis System) is a series of computer programs developed by the Offshore Structures Department of the Engineering Division of Brown & Root. It is a comprehensive system which provides state-of-the-art computing power to all areas of marine structural and foundation design.

Basically the OCEANS system is comprised of three major subsystems with several smaller stand-alone programs in general support. Each of the major subsystems consists of a preprocessor, a central problem solver, and several post-processors.

DAMS (Design and Analysis of Marine Structures) is the oldest major subsystem, having been in use for some ten years. DAMS is further subdivided into the following parts: PREP, STRAN, POST, FATIG, and JAMS. PREP is the preprocessor which generates the geometry and load data. PREP includes the following features:

- Extensive automated generation of geometry
- Automatic generation of wave, current, dead and buoyant loads
- Automatic determination of critical location of wave
- Automatic methods to vary direction, amount and combination of loadings
- Resultant forces on structure for preliminary analysis
- Mass and flexibility matrices for a dynamic analysis
- Data check for errors and selective printout for visual checking of data.

STRAN, the problem solver, is a typical matrix structural analysis computer program. It is specifically designed for static analysis

of linear three-dimensional systems composed of an assembly of tubular and prismatic beam elements (members). STRAN accepts the data prepared in PREP and outputs member end displacements/forces and rotations/moment.

POST is a post-processor which converts the basic results from STRAN into stress tabulations suitable for use by the design engineer. POST includes the following features:

- Joint deflections, support reactions and joint equilibrium check
- Tabulation of member forces, stresses, and interaction ratios of ends and intermediate points
- Tabulation of interaction ratios or stresses for members by design groups
- Tables summarizing deflections and rotations at selected levels
- Generation of input file for use in calculating fatigue life in the FATIG program.

FATIG is an optional post processor feature which uses stress results from POST to estimate fatigue lives of tubular joints. FATIG includes the following features:

- Two different analytical methods: punching shear or member end method
- Automatic input of AWS "T" and "K" type S-N curves for punching shear method and six (6) S-N curves for member end method
- Outputs partial damage ratios as a function of wave height and direction
- Outputs a summary of member end lives
- Optionally outputs plots of circumferential stress versus wave crest location and stress range records versus wave height.

JAMS is another extra post processor feature which uses geometry and member end force results from STRAN to analyse tubular joints against API punching shear criteria and/or the det Norske Veritas Code. JAMS includes the following features:

Use of the can group concept for convenience in design.  
Optional variation of safety factor for operating,  
storm or earthquake conditions.  
Optional automatic resizing of over or understressed  
joint cans by can group.

PLANS (Platform Analysis with Nonlinear Supports), the second and latest major subsystem, is an improved variation of DAMS which solves both the linear analysis of the jacket and the nonlinear analysis of the foundation piles in one computer run. PLANS retains all the input and output features, functions, and capabilities of DAMS with added input requirement on piles and soils, plus additional output of pile solutions.

Solution of jacket and piles for each loading condition by PLANS satisfies compatibility and equilibrium at the jacket/piles interface (normally at the mudline) within tolerance specified by the user. With the 1977 version developed jointly by the Offshore Structures and Data Processing Departments of Brown & Root, a one-percent tolerance at the interface can be acquired without any extravagant computer cost. This improved tolerance compliance can eliminate the possibility of both an unbalanced jacket design near the mudline and overconservatism in pile penetration requirement.

In the 1977 version of PLANS, the load-deflection behavior of the foundation piles are approximated by their Tangent Moduli at the mudline. This results in a rapid and stable convergence with regard to the interface compatibility and equilibrium.

In support of these three major subsystems, OCEANS also contains several stand-alone programs. These include MISP,

WAVPLT 73, FLAP, DYAN, TOWER, TD BENT, AXCOL 1, DUMYPILE, LATPILE, AMPILE, BMCOL 73, and other miscellaneous design aid programs which are briefly described below:

MISP is used to generate CALCOMP plots from PREP output or from the FLAP program described below.

WAVPLT 73 generates plots of wave particle velocities, acceleration and/or pressure values exerted by a specified wave on a cylinder of given diameter. Available wave theories include Stokes 5th Order, Airy, Solitary, Cnoidal, and Stream Function. This plot program provides such information as the positions of wave for maximum horizontal force, overturning effect, and crest elevation, plus other general wave data.

FLAP analyzes an offshore structure model to determine its flotation and launching characteristics. Using a coding technique similar to DAMS, separate subroutines compute a three dimensional floating position or launching path for an object which can be described using tubular members, joint or line panels, and triangular or rectangular panels. The launching program follows an iterative procedure which cycles at each time step to obtain a balance between forces acting on the structure and the inertial terms. Initial position, frictional coefficients, drag and virtual-mass coefficients, and time intervals may be adjusted to suit the application. Forces acting on each member at any time can also be obtained for subsequent stress analyses.

DYAN, using the mass and flexibility matrices of structural

system generated from a previous DAMS run, analyzes the system to determine the structure's dynamic characteristics. Using these data, the structure can be analyzed for response using a harmonic function or a one or three dimensional spectrum. The program supplies the periods, accelerations, velocities, displacements, forces and overturning moments of the system.

TOWER performs a non-deterministic dynamic analysis of offshore structures subjected to wave forces. The ocean's waves are described by the wave height spectrum. A two-dimensional model of the structure is analyzed. The required structural input is as follows: 1) flexibility matrix, 2) lumped masses and volumes, and 3) member projected area for wave force calculations. Mode shapes and natural frequencies (or periods) are determined, and thereafter the dynamic response is calculated. The response quantities include root mean square (RMS) values and peak values of transverse displacements, accelerations, shear forces and bending moments.

TD BENT is a specialized three dimensional space frame program for foundation applications which can be utilized to perform a nonlinear soil-pile-structure analysis. The model used in this program simulates the jacket and deck superstructure as a simirigid pile cap supported by a group of piles which are restrained by a set of nonlinear soil springs. These lateral and vertical springs are defined by the characteristics of "P-Y" and "T-Z" input curves.

This program can be used in conjunction with the "DAMS"

system to minimize the number of analysis cycles. Essentially, TD BENT analyzes the foundation system for a given set of input total mudline loads from "DTCK476" by using LSUM cards (i.e., individual pile head reactions, and complete pile solutions of axial and shear forces, and bending moments at each station along the piles are determined). However, additional results (dummy piles with springs or support springs directly at the foundation interface) of the TD BENT analysis can then be used for the foundation simulation which is required for a "DAMS" run, but optional input for "PLANS".

AXCOL 1 (AXially loaded COlUMns, 1st version) is a computer program used primarily for the analysis of axially loaded foundation piles with nonlinear soil support, although other similar structural models may be analyzed by using this program.

The program discretizes the real pile-soil system by a series of linearly elastic segments for the pile and a series of linear or nonlinear support springs in the form of T-Z input curves of the soil. Axial loads or displacements may be specified anywhere along the pile and the corresponding solution given by the program output consists of axial displacements, compression or tension forces in the pile, and external loads (or displacements) acting on the piles.

DUMYPILE is used to generate a set of dummy pile properties with support springs which represents the actual foundation piles within the computer modeled structure for a regular DAMS run. The dummy pile system which reacts linearly with the

superstructure is used to simulate the nonlinear soil-pile behavior by satisfying the compatibilities of computed deflections and rotations at the pile heads between the dummy pile system and the real pile for a particular set of pile head loads.

This program can also be used to approximate the pile head reactions due to the total shear force, overturning moment, and vertical load for a particular loading condition taken from a data check (DTCK476) run. However, this pile load distribution technique of DUMYPILE does not account for pile flexibility which is considered in TD BENT. DUMYPILE also provides a complete pile solution (axial and shear forces, plus bending moment at each station along the pile) which is a useful design aid.

LATPILE (which is a subroutine in DUMYPILE) can also be run separately to solve the indeterminate problem as the behavior of a laterally loaded pile supported by a nonlinear soil system. The pile is an elastic member described in terms of its structural properties and loaded at the mudline with an axial load, a shear force, and a moment. This soil is simulated as an elasto-plastic material whose force-deformation characteristics are described by P-Y curves. By an iterative-processed solution of the fourth order differential equation for the elastic curve of a beam, the program determines the resultant shears, moments, deflections, and soil reactions on the pile resulting from the imposed loads and soil reactions.

AMPILE analyzes dynamic driving of piles using the mechanics of impact and propagation of stress waves in tubular members.

The program takes into account the characteristics and energy of the hammer, pile, driving accessories, and the properties of the soil. This computer program can be useful in any of the following ways: 1) hammer selection, 2) selection of driving accessories, 3) determining required pile sizes, 4) prediction of static pile capacity, 5) determination of driving stress, and 6) providing field control during installation.

BMCOL 73 can be used for the same purposes as the laterally loaded pile program, LATPILE, but BMCOL has general beam-column applications. It uses a discrete-element method to analyze a beam-column resting on linear (elastic) or nonlinear supports with the real beam simulated by a system of mechanical finite element beams. Two finite difference equations are used to develop and solve the fourth-order difference equation of a beam-column. An iterative tangent modulus method (modifying both stiffness and resistance of the support from iteration to iteration) is used to account for nonlinear behavior of the supports. Final settlements of the support stations can also be included as a boundary condition.

## VITA

Name: Roengnarong "Ron Ratana" Ratanaprichavej

Born: June 21, 1949 - Bangkok, Thailand

Parents' Names: Mr. Lim Kim Ho and Mrs. Somchit Ratanaprichavej

Permanent Address: 47 Soi Srisukrinives (89/1), Bangchak Bangkok, Thailand

High School: Assumption College, Bangkok, Thailand (May 1968).

Universities: Chulalongkorn University, Bangkok, Thailand Bachelor of Engineering in Civil Engineering (May 1972).

California State Polytechnic University at Pomona, California Master of Engineering in Civil Engineering (August 1975).

Texas A&M University, College Station, Texas Doctor of Engineering (May 1979)

Work Experience: Structural Engineer in the Offshore Structures Department, Brown & Root, Inc., Houston, Texas (January 1978 to January 1979).

Structural Engineer in Chira Silpakanok & Associates: Office of Environmental Designs, Bangkok, Thailand (February 1972 to January 1974).

The typist for this report was Ms. Josephine Payne.