INTERFERENCE PROBLEMS ASSOCIATED WITH RISERS IN FLOATING PRODUCTION SYSTEMS

PHASE I SUMMARY REPORT

SEPTEMBER 1989

UNITED STATES DEPARTMENT OF THE INTERIOR

MINERALS MANAGEMENT SERVICE

TECHNICAL ASSESSMENT AND RESEARCH PROGRAM

PARKWAY ATRIUM BUILDING

MAIL STOP 647

381 ELDEN STREET

HERNDON, VIRGINIA 22070-4817

Brown&Root Development, Inc.

DISCLAIMER

INTERFERENCE PROBLEMS ASSOCIATED WITH RISERS IN FLOATING PRODUCTION SYSTEMS

TABLE OF CONTENTS

INTERFERENCE PROBLEMS ASSOCIATED WITH RISERS IN FLOATING PRODUCTION SYSTEMS

TABLE OF CONTENTS, CONT.

FOREWORD

This project constitutes Phase I of the Contract No. 14-12-0001-30444 entitled "Interference Problems Associated with Risers in Floating Production Systems". It was performed under Brown & Root U.S.A. Job Number EF-0405.

Phase I of this project which is reported here was mainly concerned with understanding of the problem through a review and survey of various existing floating production systems and their riser arrangement. As a result, the areas of riser interference potential were identified which led to the selection of a base case platform for detailed analysis in future work on this subject. Additionally, recommendation for future work, detailed plan for carrying out this work, and respective cost estimate were provided in this phase of the study.

The performance of the project spanned over a period of seven months starting in November of 1988.

1.0 EXECUTIVE SUMMARY

A limited study was carried out to investigate the interference problem associated with the Floating Production Systems (FPS). Interference, as intended here, occurs when a riser comes into close contact with another riser or with other components of a FPS.

It was recognized that the most suitable venue to acquire an understanding of this problem would be through an indepth survey and review of the existing floating production systems and their riser arrangements. The Phase I of the project, which is reported here, was mainly concerned with understanding of the problem, identifying most critical areas, and recommendations for future work.

The general conclusions reached during this study indicated that:

1) The design and operation of FPS for deepwater application is still in its infancy. A great deal of challenging engineering problems need to be solved before stretching the limits of FPS beyond today's analytical and technological capabilities.

2) The risers are one of the most delicate components of a FPS and need particular attention in design and deployment from a FPS.

3) Riser interference in a FPS may occur and the riser system in a tension leg platform based FPS (TLP-FPS) manifests greater potential to be involved in an interference event than other FPS's. This is mainly because of the way the risers are deployed in a TLP-FPS. This does not necessarily rule out possibility of riser interference in other FPS's.

4) The potential for riser interference problem may be increased with increasing water depth.

5) Study of the consequences of riser interference problems were beyond the scope of this project but a cursory review indicated that the consequences may range from a tolerable contact of risers with each other or other components of a FPS to severe damage conducive to a failure.

   Investigation on the operational and environmental impact of a failure are recommended for future studies.

6) Because of the fundamental design difference in FPS's, it is difficult to generalize and access the severity of riser interference. Therefore, each FPS should be investigated individually in light of its design premise and intended service.

7) To this date the riser interference potential has been minimized in the existing FPS by proper spacing of risers. However, riser interference potential may increase with increasing water depth and farther spacing of risers may not be practical. Therefore riser system for FPS's destined for deployment in ultra deep waters deserve careful consideration in their design, analysis, deployment and operation.

8) Since riser system in a TLP-FPS shows greater potential to be involved in an interference event, therefore, it is recommended that future work on this subject be focused on a TLP-FPS. Attempts should be made to generalize the methodology for analyzing and assessing riser interference problems in FPS's.

9) The impact of vortex shedding on the riser interference was not addressed in this study. Therefore, this subject is recommended for future work on this project.

10) Because of the common interest of operators on this subject the future works on this study may be carried out as a Joint Industry Project.

1.1 Introduction

As the search for energy moves into progressively deeper water, Floating Production Systems (FPS) such as Tension Leg Platform-based FPS (TLP-FPS), Semisubmersible-based FPS (SEMI-FPS) and Monohull FPS (Mono-FPS) become increasingly attractive concepts for offshore operators.

Risers are critical and delicate components of an offshore FPS and connect the surface facilities to the subsea equipment while suspended beneath the FPS. Economic and operational considerations may dictate that drilling production, and transfer of production occur simultaneously through various closely spaced riser types. Several riser arrangements can be considered including individual riser arrangement, riser bundles, or hybrid systems consisting of rigid and flexible risers. Regardless of the FPS deployed and the riser system configuration used, at any time an array of risers having distinctly different physical properties and tension requirements are bound to work simultaneously. Relative motion among various components of a FPS may cause interference between risers, between risers and platform or between risers and mooring lines. Interference, as intended here, occurs when a riser comes into close contact with other risers or with other components of a floating production system. The main cause of interference can be traced to the environmental loads which induce relative motion among various components of a FPS. The consequences of interference may range from a simple and tolerable contact of risers with each other, hull or mooring to severe damage conducive to a failure. Because of fundamental differences in the design of various FPS's it is difficult to generalize and assess the severity of the interference problem. Therefore, each FPS should be evaluated in light of its design premise and intended mission in order to assess the existence or lack of riser interference.

To reduce the floating production platform size and cost, the usual approach is to minimize the space between risers and structure. However, this spacing cannot be specified arbitrarily and special considerations must be given to this problem.

To avert riser interference, the temptation is to increase the riser top tension. It is important to note that the spacing between risers, risers and hull, or risers and mooring system or risers top tension may not be changed arbitrarily without causing new problems. A wide riser spacing will result in a large fire-restricted platform area. Furthermore, it may impose restrictions on hull design such as not permitting any primary bracing members in a large central area of the platform structure. The riser top tension is a weight burden as far as the FPS is concerned and top tension cannot be increased indiscriminately without careful consideration. Another important factor, which must be considered, is the effect of water depth on spacing requirements.

1.2 Scope of Work

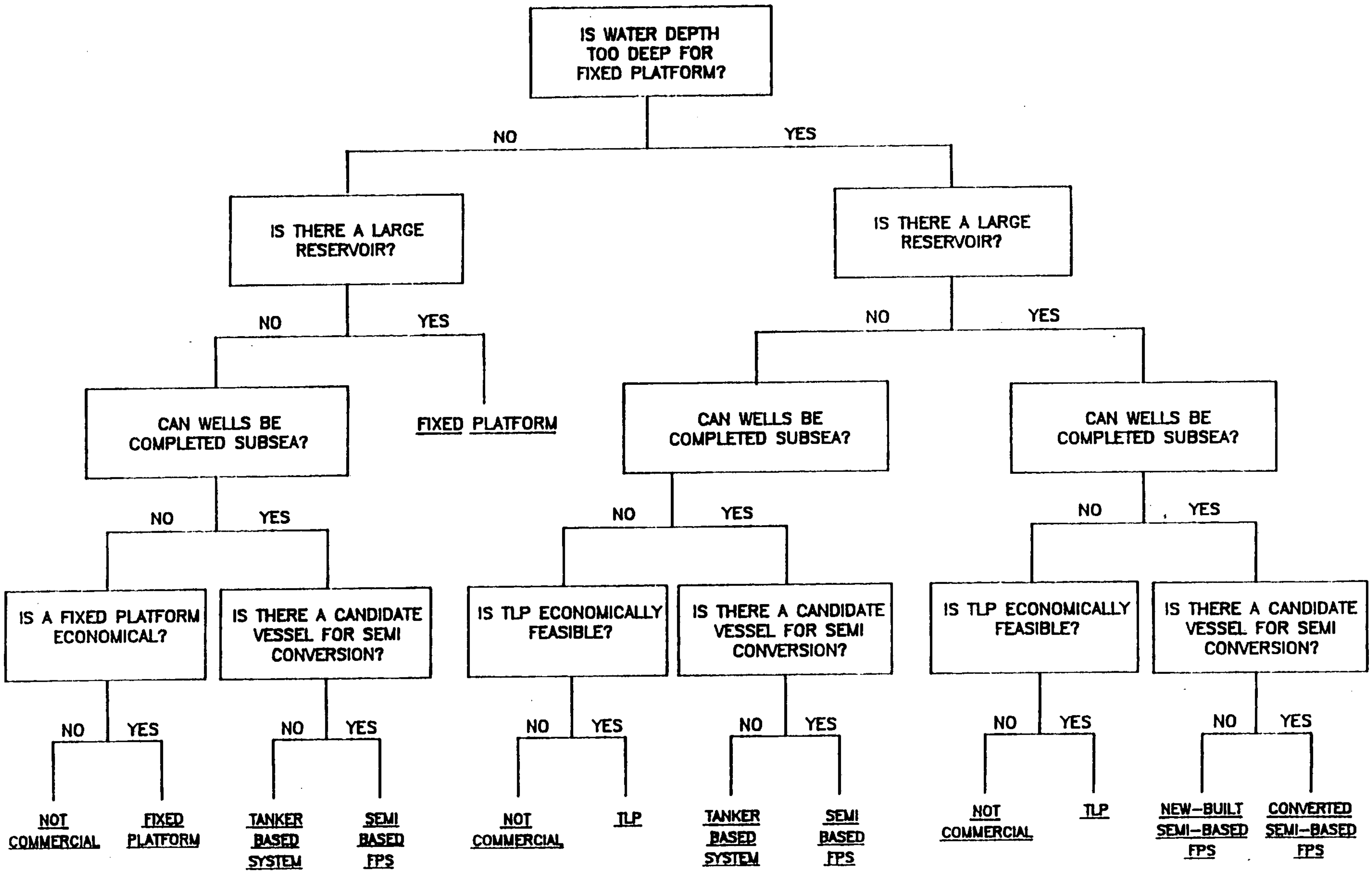
The objective of this project was a critical study of the interference problem involving risers, production platform structure and mooring system. To this end, the project was divided into two distinct phases. The Phase I of the project which is reported here was mainly concerned with understanding of the problem of riser interference. To accomplish this, the following tasks were identified and carried out:

- Review of Floating Production Systems
- Review of Floating Production System Risers
- Identification of Riser Interference problems in Floating Production Systems
- Identification of a base case platforms to be the subject of detailed analysis
- Recommendation for future works and development of a plan for carrying out these works

The content of this report represents the results of the Phase I of this project and provides an understanding of riser interference problem through an in-depth review of existing floating production platforms and their riser systems. The areas where riser interference are of critical concern were identified. Based on these findings, recommendations for future work is presented which suggests to focus the attention on these critical areas of riser interference so that a comprehensive analytical methodology can be developed. The following sections summarize the review conducted during Phase I and present a plan for carrying out the recommended future works.

1.3 Floating Production System Review

A general review of floating production systems was performed. The review addressed semisubmersible based FPS and tension leg platform (TLP) FPS. Other types of FPS, such as tanker or barge supported systems, were not included in the review due to budget constraints and the perceived lower risk of riser interference. The topics addressed in the FPS review include field development scenarios, alternative completion methods, and subsea template



FIELD DEVELOPMENT LOGIC DIAGRAM

FIGURE 1.3-1

configurations. Throughout the review of the FPS, the role of the production riser was addressed.

The simplified flow chart shown in Figure 1.3-1 summarizes the various field development scenarios. This flow chart identifies some of the key decisions which influence the final selection of the platform to produce the reservoir.

The three alternative completion methods which were reviewed are surface trees, subsea trees with individual flowlines to the surface, and subsea trees with commingled production. The completion method is a prime factor in the selection of a riser system for a FPS. Figure 1.3-2 schematically illustrates the three completion methods reviewed in this report. The review of the subsea template configurations presented typical arrangements which are used with the three different completion methods.

A brief synopsis of nine floating production systems was presented. The review ranged from the Argyll Field, which was the first FPS, to the Jolliet TLP, which was installed in 1989 in 1,760 ft. of water and represents the state of the art in FPS technology. The following FPS were reviewed:

<u>Semisubmersible FPS</u>

Argyll
Buchan
Casablanca
Dorada
Enchova
Balmoral
Placid

<u>Tension Leg Platform FPS</u>

SCHEMATIC OF ALTERNATE CONFIGURATIONS FOR RISER/WELL SYSTEMS

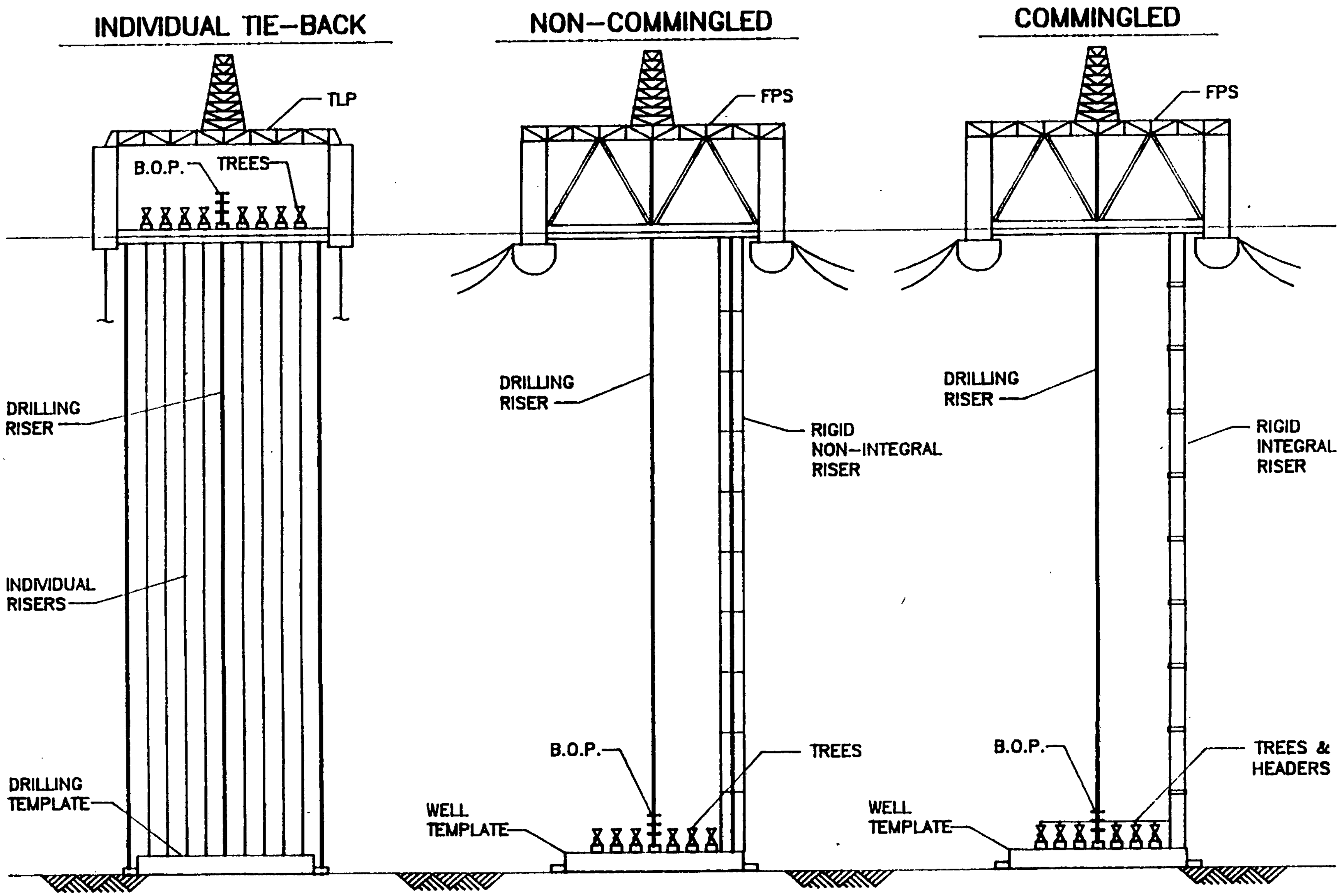


FIGURE 1.3-2

Hutton
Jolliet

1.4 Review of Production Risers

A separate section of the report was dedicated to the review of FPS riser systems. For semisubmersible FPS, two types of risers are used; rigid steel, and flexible. The rigid riser systems can be either integral or non integral. Integral risers are typically selected for subsea commingled production, whereas non integral risers are generally applicable for non commingled production subsea production systems. Flexible risers have been used in a variety of configurations and applications. Their use may range from a simple satellite well extension to a full fledged flexible riser system, including production riser, injection risers, and export risers.

The review of the TLP riser systems was limited to existing tieback production riser technology, where all trees are located on the platform. Locating the trees on the platform requires an individual flowpath, in the form of a tieback riser, for every well. For large fields, there may be as many as 60 wells, each requiring a separate tieback riser. The well spacing and riser top tension has a significant impact on the platform size.

1.5 Riser Interference

The areas where riser interference are of concern were identified. The possible types of riser interference were divided into three categories; riser to riser, riser to hull, and riser to mooring line or TLP tendon. Two of the principle modes of operation which were considered are the installation mode (running/retrieval) and inplace during an extreme event storm.

The potential for the various types of riser interference were assessed for each riser system reviewed. The assessment was based on a coarse qualitative review and was performed so that the critical areas could be identified for further investigation. The potentials are summarized in Tables 1.5-1 and 1.5-2. Even though the ratings are relative nevertheless the results point to the higher interference potential associated with TLP riser systems. While riser interference in a SEMI-FPS is a design consideration, the solutions to overcome interference are more straightforward. The solutions for riser to riser interference in a TLP based system are not well defined, especially for increased water depths. A total system design effort is required to ensure riser clearance.

Riser interference in a TLP is not an isolated problem. Because of the highly interactive nature of various TLP parameters, the well bay system and riser top tension cannot be increased indiscriminately until sufficient clearance is obtained. Increasing these two critical parameters, however, has a significant impact on the total system design.

1.6 Recommendations for Future Work

The results of the study in the Phase I of the project clearly indicated that the potential for riser interference is of greater importance in a TLP-FPS than in a SEMI-FPS. Therefore, the recommendations for future work is to focus the attention to assessment of riser interference/clearance in a tension leg platform. A detailed plan for carrying out this recommended future work is presented in this report. The Scope of Work can be summarized in the following tasks:

1) Establish a base case TLP.

RIGID RISER SYSTEMS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO MOORING
RUNNING/ RETRIEVAL	LOW	LOW	N/A
IN-PLACE MAX. STORM	N/A	N/A	N/A

FLEXIBLE RISER SYSTEMS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO MOORING
RUNNING/ RETRIEVAL	LOW	LOW	LOW
IN-PLACE MAX. STORM	MEDIUM	MEDIUM	LOW

RISER INTERFERENCE POTENTIAL

SEMI-SUBMERSIBLE BASED RISER SYSTEMS

TABLE 1.5-1

RIGID EXPORT RISERS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO TENDON
RUNNING/ RETRIEVAL	HIGH	LOW	N/A
IN-PLACE MAX. STORM	HIGH	LOW	N/A

FLEXIBLE EXPORT RISERS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO TENDON
RUNNING/ RETRIEVAL	HIGH	LOW	LOW
IN-PLACE MAX. STORM	HIGH	MEDIUM	MEDIUM

RISER INTERFERENCE POTENTIAL

TLP BASED RISER SYSTEMS

TABLE 1.5-2

2) Develop a methodology for the detailed analysis and assessment of the interference/clearance of risers for the base case TLP.

3) Apply the methodology to the base case TLP and report the results.

4) Expand and generalize the methodology to be applicable to other TLP configurations.

2.0 INTRODUCTION

A successful offshore hydrocarbon field can be only one which generates both an acceptable level of recovery from the resource, determined with certainty, using current reservoir assessment techniques, and a satisfactory real rate of return of the developer's capital outlay.

In looking at future engineering pertaining to offshore oil and gas development, the world oil picture has to be considered. Predicting future oil and gas demands is difficult, but highly regarded views show the demand continuing to be fairly flat until the end of the century. Even the most optimistic views do not see it rising dramatically. Despite this, to meet the forward demand for oil and gas, production will be necessary from many fields yet to be discovered. It is expected that production from existing fields will drop significantly by the end of the century, and even to meet the fairly flat demand perceived, this drop in production will have to be produced from new fields. It is forecast [1] that a substantial portion of this oil will come from offshore developments. A relatively small contribution is expected to come from enhanced recovery methods.

The pattern of new oil field discoveries, in terms of size, and offshore, in water depth is of substantial significance. Fifty-one percent of the world's known oil demand is contained in only 21 fields though over 30,000 fields are known. The chances of finding super giants in the future appear small. Due to the associated increased development costs as the water depth increases the term "small" or "marginal" takes on a varying parameter. Figure 2.1-1 graphically illustrates the relationship of reservoir size and water depth for marginal fields. These and other factors point towards developing solutions to address smaller fields that have to be produced more economically to justify a commercially viable venture [2]. Floating production systems present one economic and technically viable alternative.

They are becoming increasingly attractive as ways of exploiting offshore fields [3], [4].

Relative motion among various components of a FPS may cause interference between risers, between risers and platform or between risers and mooring lines. The interference, as intended here, is when a riser comes in close contact with other risers or other components of a FPS. The degree of severity and the consequences of riser interference is not well known. Therefore, the present study was undertaken to grasp an understanding of this problem through an in-depth review of the existing floating production systems.

The contents of this report represents the results of this review and provides recommendations for further work in order to enable a critical assessment of the interference problem associated with risers in FPS's.

The report consists of eight sections and an appendix.
A brief outline of the report is given below:

The Executive Summary, presented in Section 1.0, contains an overall outline of the most meaningful conclusions reached during this Phase of the study.

Section 3.0 is concerned with a general review of the Floating Production Systems (FPS). This review introduces the reader to the philosophy involved in deployment of the floating production systems. Various field development scenarios and factors governing the selection of a FPS along with alternative completion systems are discussed briefly. Then the attention is focused on the semisubmersible based and TLP based floating production systems since they represent the greatest potential for a riser interference problem.

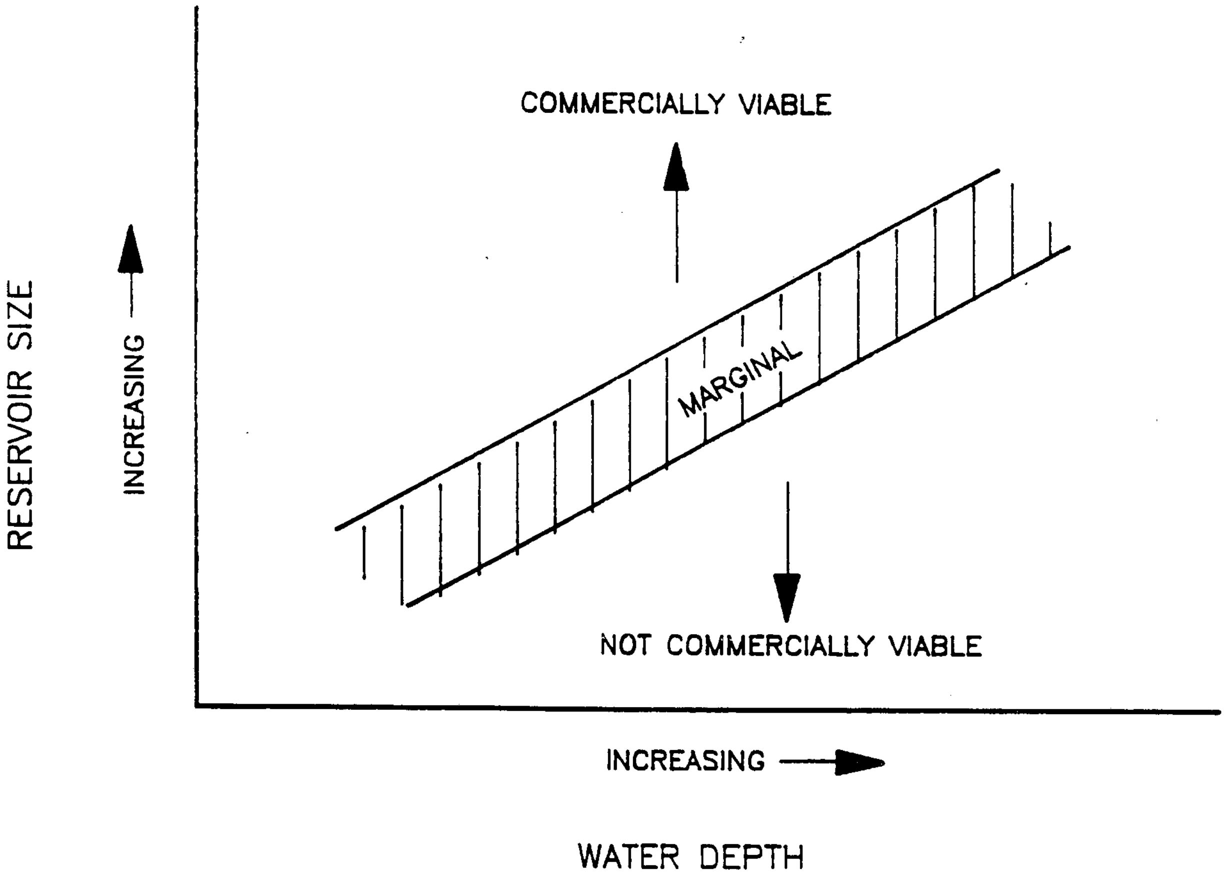
Section 4.0 deals with the riser systems used in the floating production systems. It starts with a literature survey and subsequently details various types and components of the customary riser systems used in the floating production systems.

Section 5.0 is the backbone of the report and deals in substantial detail with risers. It outlines major areas of concern, assesses the riser interference potential for semisubmersible and TLP based floating production systems, defines system designs consideration, illustrates an interference analysis methodology, and finally introduces new concepts that have been developed to avert interference problems.

Section 6.0 describes in detail the proposed Phase II study. A scope of work is presented which includes specific tasks along with required manhour and cost estimates to carry out the Phase II of this project.

Section 7.0 outlines some concluding remarks regarding present work and the proposed Phase II of the project. Section 8.0 is the reference list.

The Appendix contains abstracts from the literature search which was performed as part of this study.



MARGINAL FIELD EVALUATION

FIGURE 2.1-1

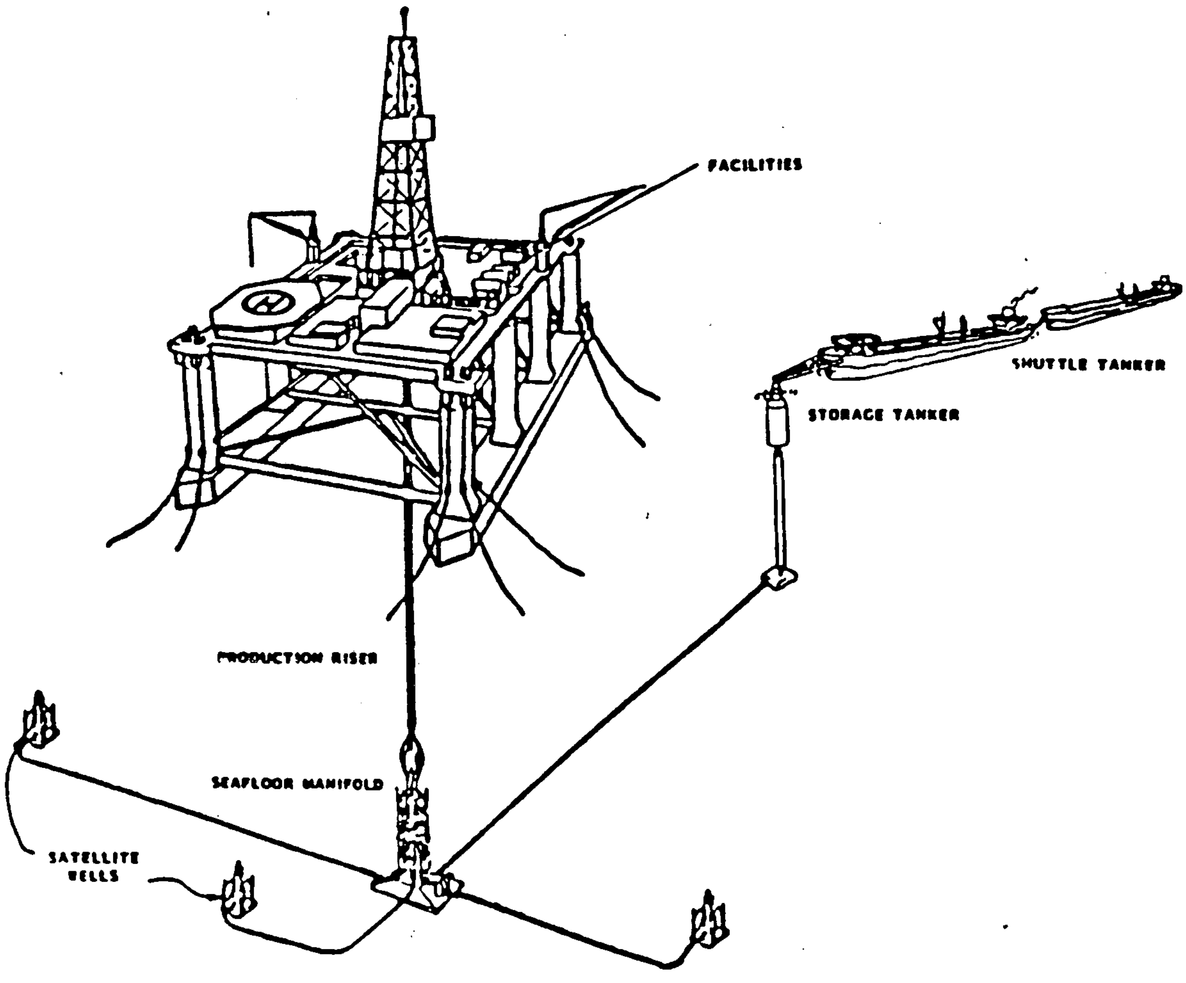
3.0 GENERAL REVIEW OF FPS

The generic term "floating production system" covers a variety of concepts. The basic "floating production system" as intended here consists of a floating vessel, either moored or dynamically positioned, with production facilities included on or in the vessel, subsea wellheads, production risers, and a storage or transportation system. Not all floating production systems always include each of these primary components. Therefore, with this definition the term "floating production system" can be applied to tension leg platform (TLP), semisubmersible (SEMI), or mono hull (MONO) barge or tanker based system.

For the purpose of this study, the review of the floating production system is restricted to (SEMI-FPS) and (TLP-FPS).

3.1 SEMI-FPS

Drilling rigs are most commonly considered for conversion to a production vessel, as shown in Figure 3.1-1. Surplus or stacked drilling or offshore construction semis can be converted to production platforms. When offshore activity is high, or when high storage or production rates are required, purpose-built vessels are necessary. Steel vessels are normally prepared, though concrete vessels represents an additional design option. The vessel may be dynamically positioned (DP) and kept on location by computer-controlled thrusters. In most situations economic considerations dictate that the vessel be held on station by a catenary wire rope/chain mooring system that employs pile anchors for a long-term installation. DP/mooring combinations can also be considered where the DP system could be used to offset the mean environmental forces.



SEMI SUBMERSIBLE PRODUCTION SYSTEM (CONVERSION)

FIGURE 3.1-1

To accommodate the relatively large motion of a catenary moored vessel, without requiring complex riser systems between the sea floor and the vessel, wells are completed on the sea floor either as individual satellite wells, or through a drilling template in clusters. Generally, clustered wells minimize the flowlines required. Satellite wells are used for developing shallow or irregularly shaped reservoirs. Unless only a few wells are involved, a manifold on the sea floor directly below the vessel is often used to limit the number of risers.

Oil flows from the wells to processing facilities on the floating vessel either directly up the production riser, or to a manifold and then up a commingled riser. Oil from satellite wells flows through flowlines to the riser or to the manifold base and then up the riser.

A conventional semisubmersible drilling rig has tankage onboard that is normally used for operating supplies. Several companies have suggested that this storage capacity be utilized to smooth production operations. Using normal marine operating procedures, that tankage can store about 25,000 barrels of oil. In addition, part of the ballast tanks for the vessel can also be used for oil storage, providing an additional 5,000 to 10,000 barrels of capacity. Using these tanks requires installation of dirty water handling equipment and use of special precautions to assure vessel safety.

For a high production rate field (as opposed to a marginal one), using onboard storage does not appear worthwhile unless a very large purpose-built semisubmersible is used. Onboard storage holds only a few hours of production. Substantial storage is a requirement when the method of product export does not utilize pipelines. A larger storage capacity on semisubmersible hulls contradicts the small water plane area principle utilized in developing the hull configuration. This frequently becomes cost ineffective when compared to other means of storage available. A separate storage system often becomes more desirable to avoid shut-ins during periods of bad weather.

Wells completed beneath the FPS are maintained from the vessel. In some cases production from the field has to be shut-in during major well workovers because of the difficulty of installing a workover riser with the production riser in place. Wells completed on the sea floor away from the FPS are maintained by TFL from the FPS or from a separate floating drilling rig.

A converted drilling semisubmersible system can be used in water depths from about 200 ft. to 1,500 ft. The lower limit is set by the mooring system which must be rigid enough to hold the vessel to within an acceptable excursion and have sufficient elasticity for the design storm. Economic considerations control the upper depth limit. The deeper the water, the heavier the production riser and mooring system become. Thus, as water depth increases the process facilities and storage that can be provided on a specific vessel decrease. A medium to large semisubmersible drilling rig can support facilities to process about 75,000 BPD of oil in water depths of 1,000 ft. in a rough weather area. A larger drilling rig could probably support facilities for 100,000 BPD. A large purpose-designed semisubmersible could handle larger production rates. One such design, for harsh environments and 3,000 ft. water depths application has been developed by Brown & Root is shown in Figures 3.1-2 and 3.1-3. The topside facilities weight is about 14,000 long tons and there is a 200,000 bbl crude storage capacity.

Another Brown & Root design for the North Sea, with a unique construction concept is shown in Figure 3.1-4. This permits separate cost-effective exploitation of shipbuilding and offshore

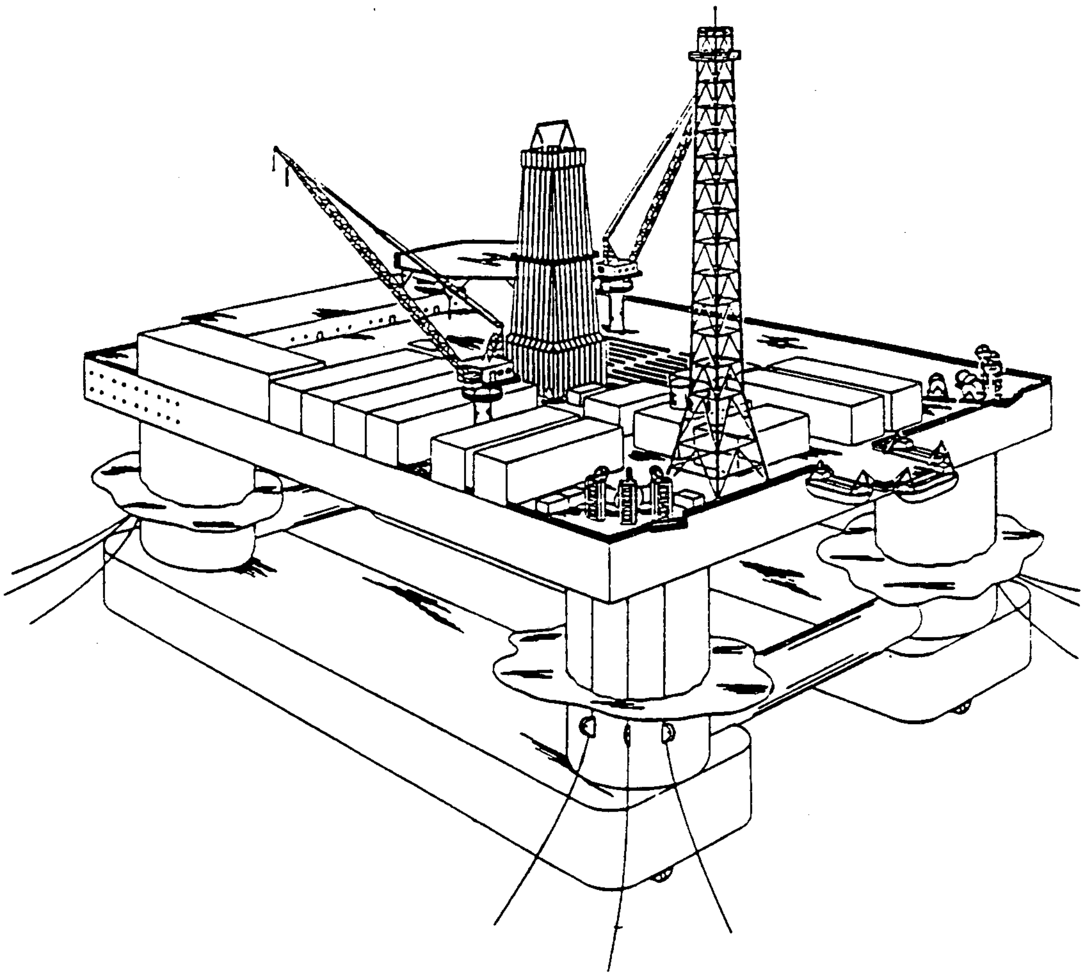
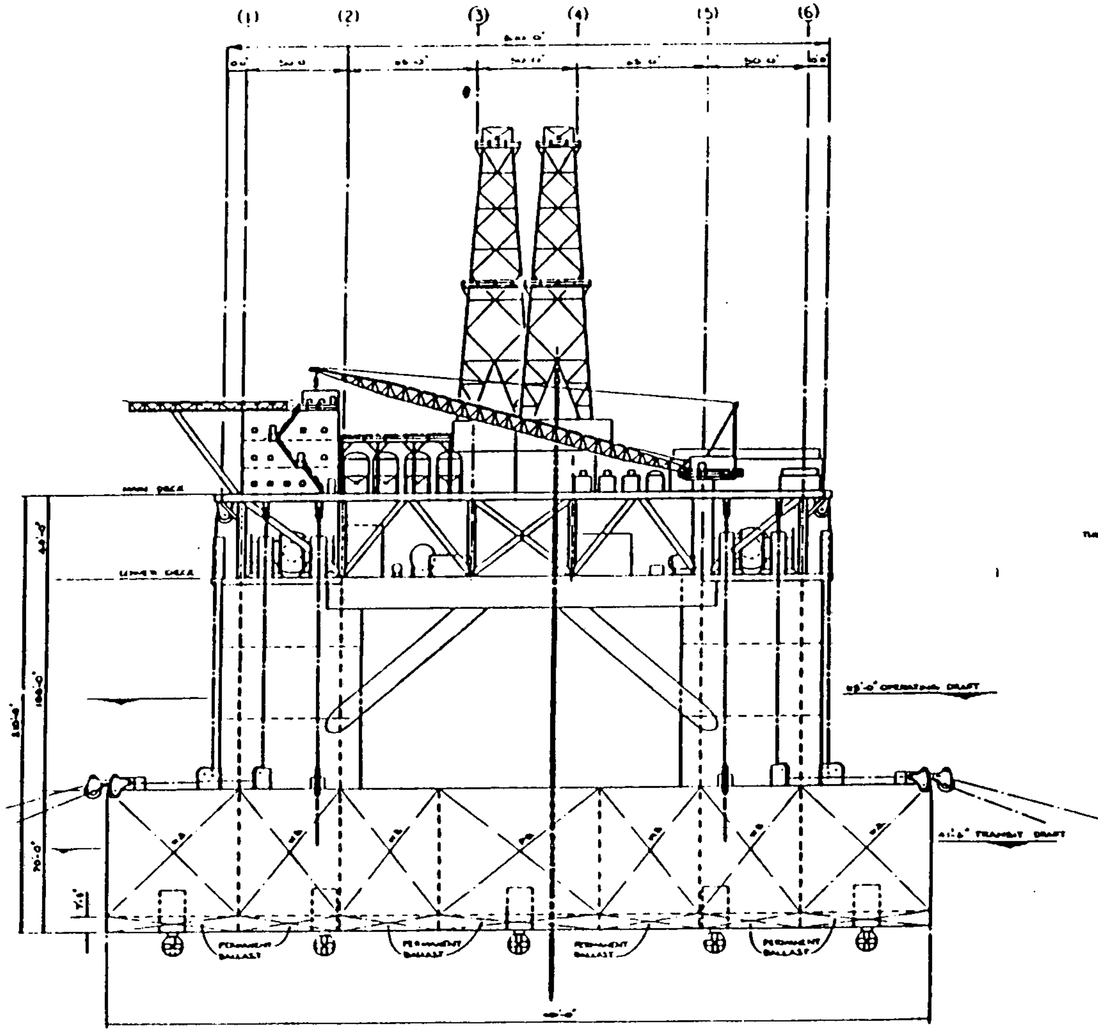
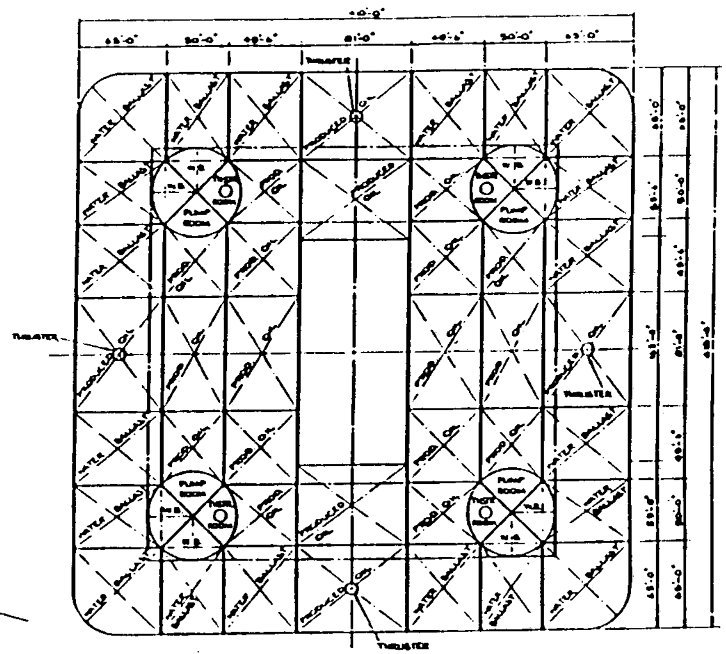


FIGURE 3.1-2



OUTBOARD PROFILE



PLAN OF PONTOON TANKS

FIGURE 3.1–3

HIGHLANDER 6000

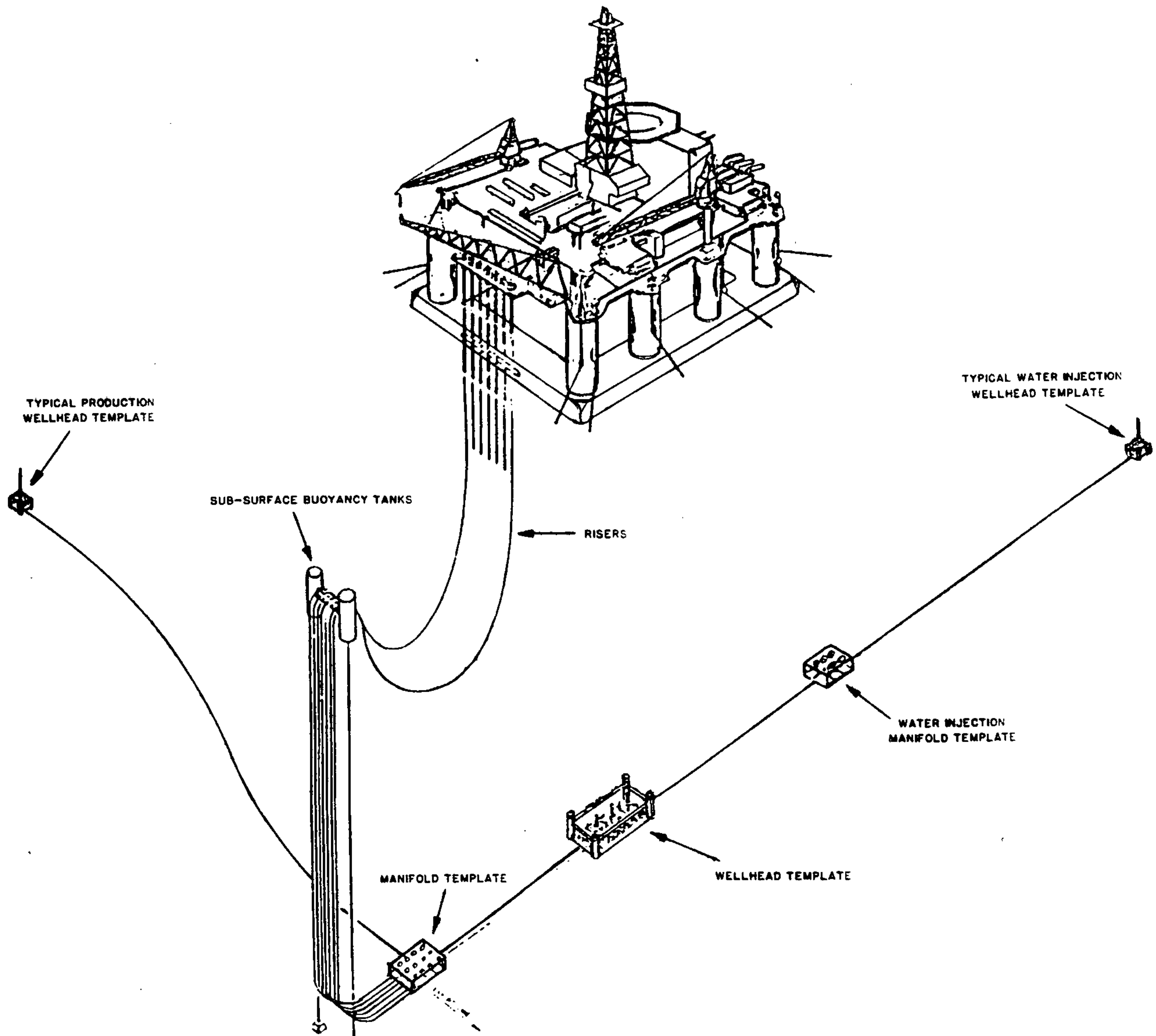


FIGURE 3.1-4

oil and gas construction expertise and mating the two towards final completion in a relatively short schedule.

Weather downtime is a consideration in the design of a semisubmersible system. Unlike a tension leg platform, a spread moored semisubmersible will pitch, roll, and heave in short-period motion almost as if it were free floating. Process facilities and production risers must, therefore, be designed to operate with a maximum of vessel motion to minimize downtime during rough weather.

Process facilities can be designed to be relatively insensitive to motion. "Fluid packed" vessels (those that operate full of fluid) can be used where possible. Separator vessels can be equipped with internal baffling to reduce internal fluid motion, and preferably be placed near midships. These features permit the process operations to continue in more severe weather than other parts of the system such as the shuttle tanker berthing.

The production riser is designed to operate in as severe weather as is practical. The exact weather limits will depend heavily on the motion behavior of the specific vessel and riser system used. In severe weather the riser can be disconnected at the seafloor and hung off. Should the weather continue to intensify, the riser can be pulled onboard and, therefore, it must be designed to be safely pulled in rough weather. This permits the decision to pull the riser to be delayed until accurate forecasts indicate that the weather will be severe enough to warrant pulling. Hence, operating risks and weather downtime, due to unnecessary pulling of the riser, are reduced. Because operations personnel traditionally shut-in production and secure the facilities for extreme weather, riser equipment limitations may not cause weather downtime in future installations.

Various riser systems for FPS's are discussed in detail in Section 4.0 of this report. Several figures of various riser types are also included in this section. However, in the following paragraphs a brief description of various riser types for FPS's is given for the sake of establishing the terminology used in the review.

Two types of riser system have been developed for use with floating production systems. The first is a rigid riser which consists primarily of bundled drill pipe joints. This system has been used successfully in the North Sea. A flexible joint at the base accommodates horizontal motion, while tensioners at the top allow for heave motion and hold up the riser to control buckling. The tensioners must have enough stroke to accommodate the maximum vessel heave. This system requires a dedicated drill derrick to handle it.

The alternative is a flexible catenary riser system which has been used successfully for applications in Brazil and the Mediterranean. This system does not require a drill rig or tensioners.

For multi-well applications in deep water and harsh environments, a combination of these technologies has been used wherein a rigid riser system would extend from the subsea template to a subsurface buoy. Flexible catenary risers connect the buoy to the floating production vessel. Attachment points are either at the pontoons or at the deck level. The lower section of these risers is intended to remain in place should the vessel leave location. This type of system does not appear applicable in iceberg prone areas, since special provisions have to be made to detach or otherwise protect the lower riser section form iceberg impact.

Risers operating in iceberg infested waters normally are designed to detach at the sea floor when moving the rig off to avoid damage by icebergs.

Because of their similarity to drilling rig operations, semisubmersible production systems are considered proven (but not necessarily economical) for water depths where drilling can be conducted from a moored vessel. Moored drilling rigs have been operated in water depths of 1,200 ft. in the North Sea and at depths of 3,400 ft. in mild weather areas.

3.2 TLP-FPS

Mercier et al. [5] describe the tension leg platform (TLP) as a floating structure connected to anchors fixed in the seabed by vertical mooring lines (tension legs) at each corner of the platform (Figure 3.2-1). These vertical mooring lines virtually eliminate the vertical plane motions of heave, pitch and roll, while the lateral movements in surge, sway, and yaw are compliantly restrained. Buoyancy is provided by the vertical columns and the horizontal pontoons connecting the bottoms of these columns. An excess of buoyancy greater than the platform weight keeps the mooring lines in tension for all weather and all loading conditions. Column height is sufficient to support the deck above the wave crest elevations for all tide and wave conditions when the TLP is fixed to the seabed foundations by the tension legs.

In the early days of the TLP conceptual development most drillers and oil and gas production engineers considered the TLP as a logical extension of semisubmersible rigs. Accordingly, conceptual systems were developed on the basis of the existing semisubmersible design technology. However, while a TLP is indeed highly compliant in the surge, sway, and yaw directions

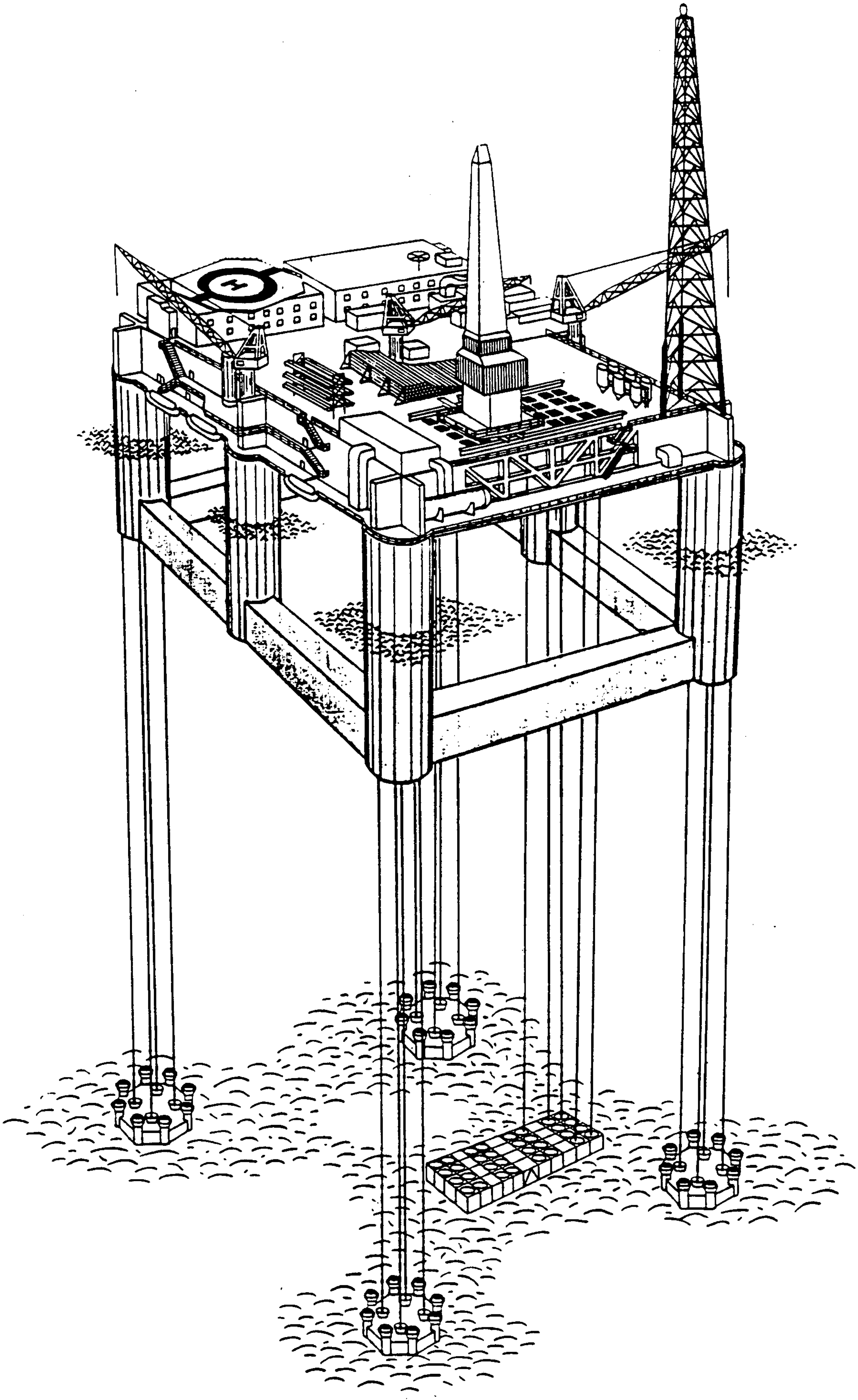


FIGURE 3.2-1

(periods over 100 seconds), it is virtually fixed against pitch, roll and heave motions (periods less than 5 seconds). These motion restrictions result in fundamental differences between a TLP and a semisubmersible platform.

The tension leg platform family encompasses several different designs, e.g. vertically moored platform (VMP), tethered production platform (TPP), and tethered buoyant platform (TBP), etc. Various designs include numerous alternative solutions. For example, the TLP could be anchored by a gravity base, driven piles, or drilled and grouted piles. However, all TLP designs have been developed on the basis of a vertical mooring system under pretension due to excess buoyancy. The term TLP is used in this review in a general sense without reference to any specific design.

Today the TLP concept is a technological reality and appears to be one of the most promising platform configurations for deeper waters.

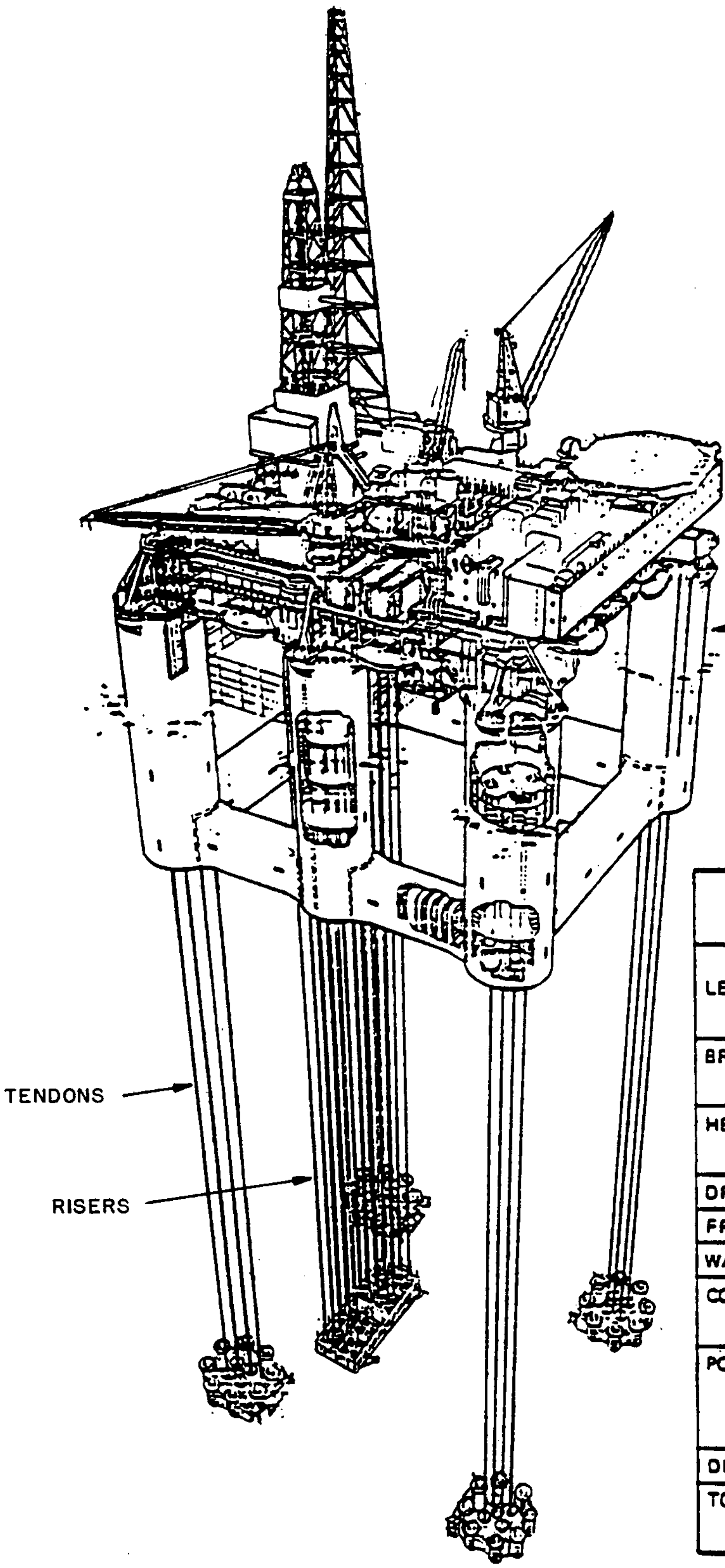
The first tension leg platform was installed in the summer of 1984 for CONOCO's Hutton Field, in 490 feet of water. (See Figure 3.2-2.)

The Conoco's Tension Leg Wellhead Platform (TLWP) was installed in 1,760 feet of water in the Gulf of Mexico in 1989.

3.3 Field Development Scenarios

The specifics of a particular offshore field greatly influence it's development. The type of field development scenarios for floating production systems are governed by the following factors:

HUTTON FIELD
TENSION LEG PLATFORM



GEOMETRY (All dimension to moulded lines)		
LENGTH	· Between column centres	78.00 M
	· Overall	95.70 M
BREADTH	· Between column centres	74.00 M
	· Overall	91.70 M
HEIGHT	· Keel to main deck	57.70 M
	· Main deck to weather deck	11.25 M
DRAUGHT	· Operating	32.00 M at L.A.T.
FREEBOARD	· To underside of main deck	24.50 M at L.A.T.
WATER PLANE	· Area	1324.00 M^2
COLUMNS	· 4 Corners	17.70 M Dia.
	· 2 Centre	14.50 M Dia.
PONTOONS	· Height	10.80 M
	· Width	8.00 M
	· Corner radius	1.50 M
DISPLACEMENT	· Approx.	61500 Tonnes
TOTAL WEIGHT	· Including riser tension (Approx)	48500 Tonnes

FIGURE 3.2-2

- o Reservoir Size and Conditions

  The reservoir characteristics affect a field development scheme by requiring the candidate production scheme to provide the reach to the extent of the reservoir and the capability to provide any secondary recovery services that might be required to produce the specific reservoir. The boundaries and drive mechanisms of the reservoir will determine whether development can be accomplished from one location or multiple locations. The requirement for gas lift, water or gas injection will define the type of facilities that may be involved in the field development.

- o Crude Characteristics

  The crude produced from the reservoir affect the size, number and type of production facilities. Flow rate defines the size of facilities. Gas/Oil Ratio (GOR) dictates the gas handling requirements. Special characteristics such as hydrogen sulfide may impose special process and/or material requirements.

- o Field Economics

  Short term cash considerations and long term production considerations influence the tendency to adopt a production scheme more temporary in concept or of a more permanent nature.

- o Environmental Conditions

  Ability to produce in the environmental conditions encountered offshore is one of the main factors in the decision of the type of field development scheme to select.

Although sometimes downtime may be allowed in floating production systems generally a candidate system must operate in the most severe conditions to be encountered at the site.

- Water Depth

  The preference for a fixed platform makes water depth a main factor in the selection of a production system. For the particular situation under consideration the economics may favor using a floating system.

- Existing Potential Production Vessels

  The availability of an existing floating platform (e.g. - a semisubmersible drilling rig) verses a new - build platform (e.g. - a tension leg platform) may influence the production system development.

- Existing Export Infrastructure

  The proximity of existing platforms and pipelines greatly affects the selected production system. The distance and capacity of these systems may greatly contribute to the decision concerning production systems.

- Drilling and Maintenance

  If the drilling program for a field is accelerated the plans for development will be made around the drilling activities. As drilling is a major cost activity, the emphasis is on the provision for this item. Pre-drilling of the wells while the floating production system is being designed and fabricated is one of the first major decision points in field development.

Usually one of the last considerations in the field development process is maintenance. However, this becomes one of the driving factors in the field development process for floating production systems. Well access and maintenance may be the basis for selecting the final configuration.

Floating production are becoming increasingly attractive as ways of exploiting offshore fields due to the following factors:

- Overall economics for selected applications when compared to conventional facilities.

- Mobility and reusability of the systems, from a risk viewpoint, as applied to:

  - Reservoirs with high risk expectations
  - Early/Interim (temporary) production
  - Extended well testing
  - Politically unstable geographic areas
  - Reservoirs with marginal reserves
  - Deepwater developments

- Offshore tracts that do not have an existing pipeline infrastructure in the vicinity.

- Depressed maritime markets offering relatively low cost constructed or converted floating platforms due to:

  - A depressed ship building industry worldwide
  - A large over supply of tankers and to some extent drilling rigs

- Reduced early capital investment, with available leasing options.

- Reduced lag time from discovery to first production.

- Relative insensitivity of capital cost to water depths.

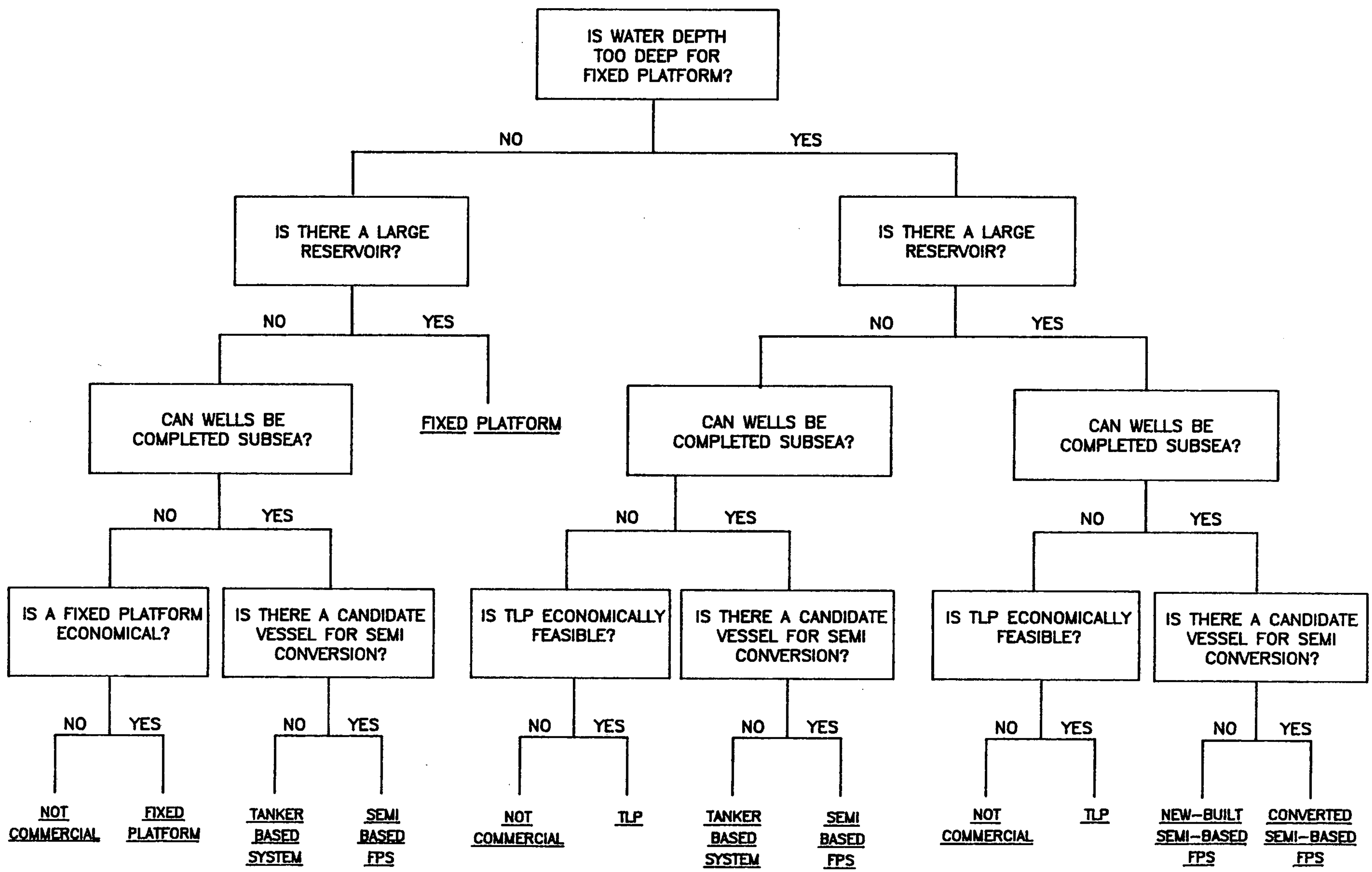
Figure 3.3-1 demonstrates a simplified logic diagram of the considerations that would be involved in the selection of a field development scheme. A consideration of all of these factors usually leads to a floating production system of one of the following types:

- Mono-hull (MONO) barge or tanker based Floating Production, Storage, and Offloading (FPSO)

  A (MONO-FPS) system usually consist of some subsea wells, a tanker loading buoy or mooring, and a tanker for storage. Some provision is made for offloading and gas handling. In any environmental conditions other than extremely mild, the tanker must be allowed to "weather-vane" around the mooring. This requires a production swivel. The necessity for a high pressure multi-path production swivel restricts the number of wells that can be accommodated by the tanker-based system. Tanker-based systems are usually employed for remote small-reservoir locations.

- SEMI-FPS

  In order to accommodate more severe weather conditions, semisubmersible drilling vessels have been used to support production operations. The system usually consist of subsea wells, vessel, and export capabilities (riser/pipeline to loading buoy or other production facility). The limits of



FIELD DEVELOPMENT LOGIC DIAGRAM

FIGURE 3.3-1

the production capacity of the system are the risers and the weight carrying capability of the vessel. Existing vessels can be converted to production use or "new-build" semisubmersibles specially designed for production applications have also been used. The stability and deepwater capability of the semisubmersible make it an attractive option for development.

- TLP-FPS

  The Tension Leg Platform (TLP) is a special designed semisubmersible vessel that utilizes vertically tensioned elements for it's mooring. It usually finds it's application in large fields and deeper waters.

3.4 Alternative Completion Systems

The development of the subsea completion is the primary reason for the evolution of floating production. The installation of the production wellhead on the seabed allows motion of the floating vessel to be isolated from the high pressure production wellhead. The differences in motion due to environmental conditions can be accommodated by special designed components (i.e. risers).

The subsea completions are divided into two general categories; non-commingled and commingled. Non-commingled completions are configured for a single flow path from the wellhead to the point of first separation. For a floating production application this means a separate riser pipe for each well. Commingled production involves manifolding the production from each well on the seabed. This allows one riser to carry the flow to the surface for treatment.

In the non-commingled arrangement the wells are completed at the seabed using subsea trees. Production would be routed through the wing valve of the subsea tree and into dedicated piping on the template. In this case each well would have an individual production flowline plus an annulus line which would be connected to a bundled production riser through the piping on the template. These systems are demonstrated schematically in Figure 3.4-1.

The wells for commingled production are completed on the seabed with subsea trees. However, this involves a different subsea tree arrangement. The tree for commingled production service will be equipped with a retrievable subsea remotely operated choke. The production from this tree will flow into a common production header rather than having its own individual flowline.

Each subsea tree on the template will be fitted with a remotely operated choke to regulate the flow from the well into the production header. The tree will also have an annulus access line and a test and kill line. These lines will be connected to the manifold piping on the subsea template. The header along with an annulus access header and test and kill header are routed to a riser base located on each end of the template.

The exception to this arrangement involves a TLP. The TLP allows the completion to be brought to surface due to it's limited motions. The wellheads are on the deck on the TLP via it's own individual riser. The risers are tensioned in order to maintain acceptable stresses. Having on-the-surface access to the well needs to be traded-off against the multiplicity of risers.

One significant advantage to the individual riser tieback completion is the ability to pre-drill some or all of the wells. This allows for some production soon after the complete subsea template and the TLP have been installed.

SCHEMATIC OF ALTERNATE CONFIGURATIONS FOR RISER/WELL SYSTEMS

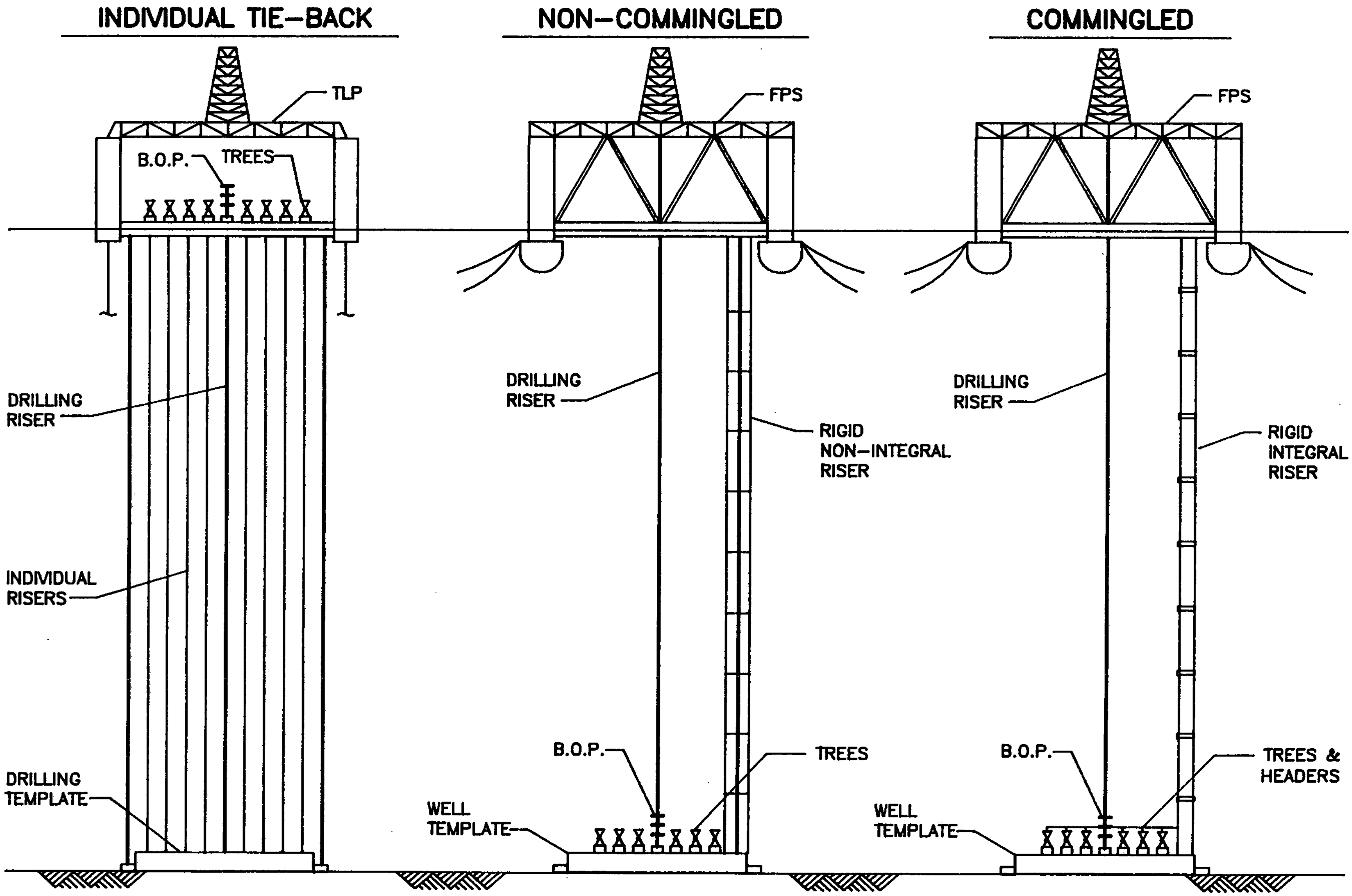


FIGURE 3.4-1

3.5 <u>Subsea Template Configurations</u>

The subsea template structure serves as a collection point for the flow from all the subsea wells and as a base for the connection of the riser to the surface vessel. Existing systems generally consist of a tubular structure piled to the seabed.

The subsea template serves three functions:

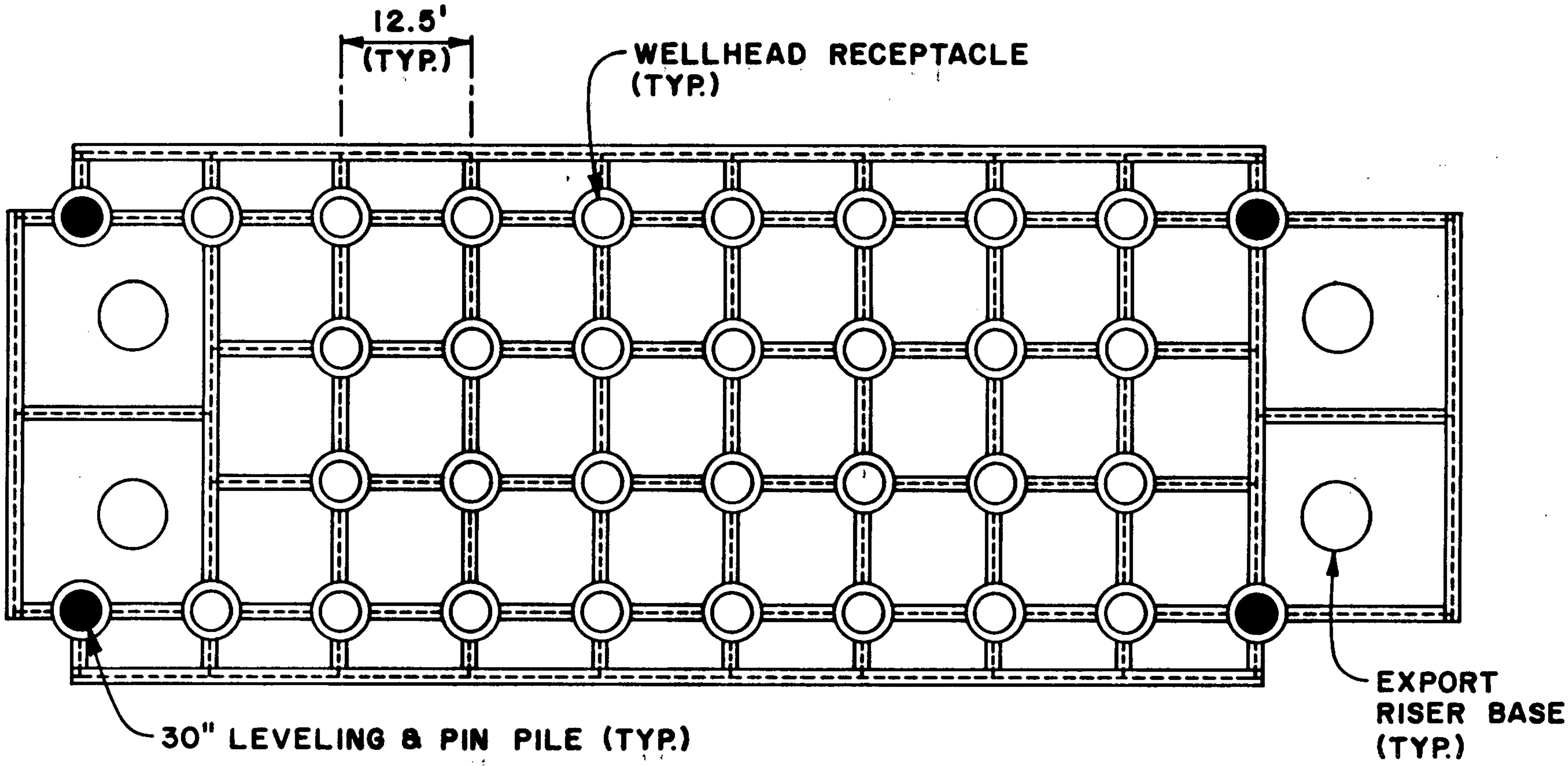
- Guide/support for drilling/completion activities
- Pipeline/riser interface and support
- Foundation for TLP-FPS Mooring Tendons

The template will therefore be configured to the degree it is required to incorporate these three functions.

The template contains well slots for the production wells. These well slots must contain the receptacles and structure to receive and support the wellheads in the case of a subsea well or the tieback hardware in the case of a TLP with surface wellheads. A typical layout is shown in Figure 3.5-1.

The size of the template is primarily dictated by the minimum spacing requirements between wells. The considerations for well spacing are clearance between adjacent wells when landing a lower marine riser package and recognizing the potential for interference between the individual tieback risers and the drilling or workover riser.

For floating production systems with vertically tensioned risers and pipeline connections, the template will contain the structure and the mechanical hardware to support and accommodate these connections. The template must, therefore, be designed for the



30 WELL SLOT SUBSEA TEMPLATE

FIGURE 3.5–1

loads and clearance that these items require. Figure 3.5-2 shows a template for a non-commingled completion system and Figure 3.5-3 show a commingled system template.

The multi-well template will be used as a drilling guide to pre-drill some of the wells prior to installing the TLP. Once the TLP is in place, the pre-drilled wells will be tied back to the surface through an individual riser for each well and completed. The remaining wells will then be drilled from the TLP and tied back to the surface.

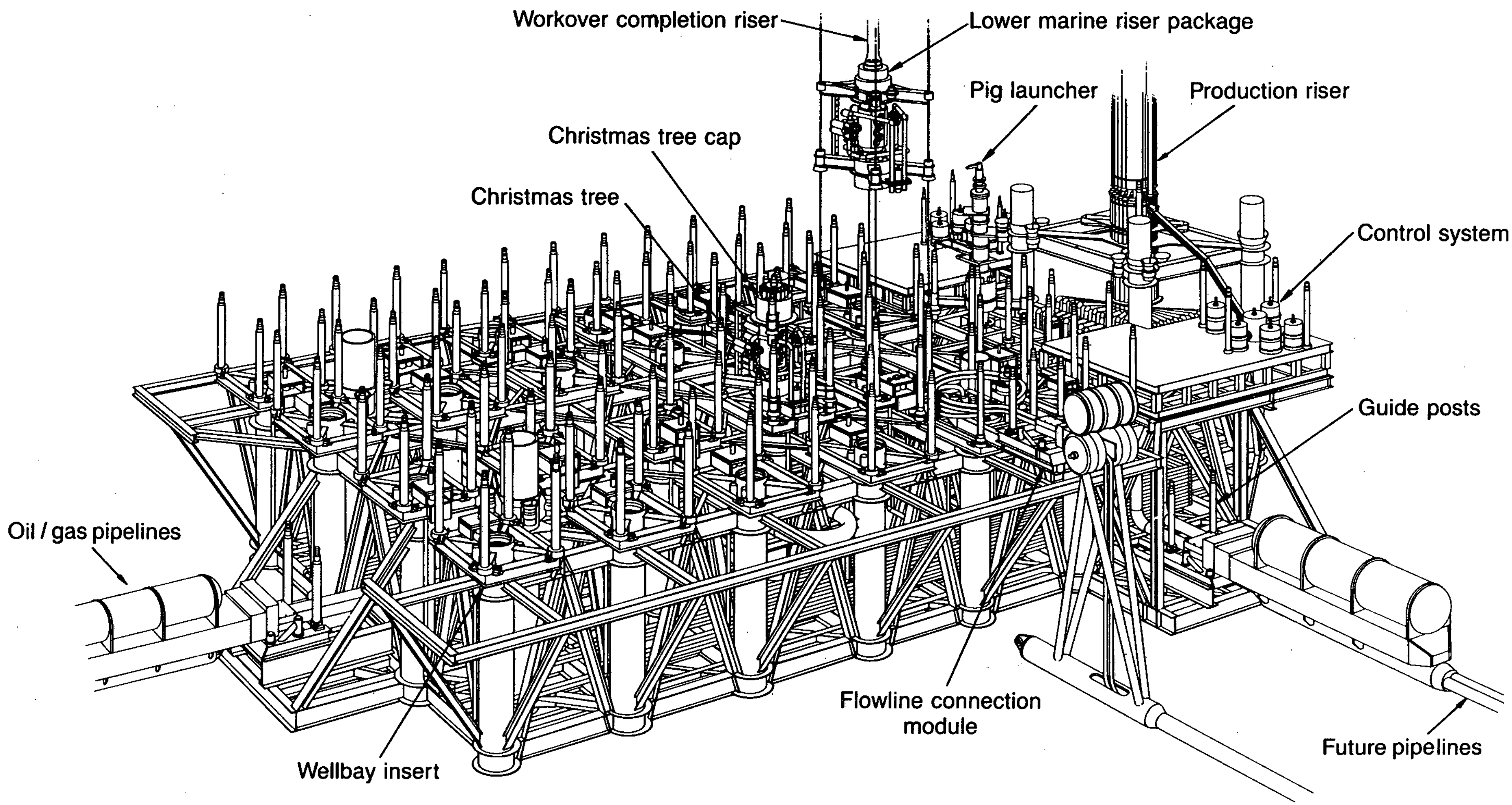
The template will also contain pile bays to guide and support the piling necessary to secure the template to the seabed and to act as an anchor for the TLP tendons. The piling will more than likely be large diameter and require a large space within the configurations of a template.

3.6 Existing (SEMI-FPS) Review

Eight existing semisubmersible floating production systems (SEMI-FPS) have been reviewed and are listed in Table 3.6-1. All are vessel conversions except the Sun's Balmoral field which is a purpose - designed G.V.A. 5000 rig.

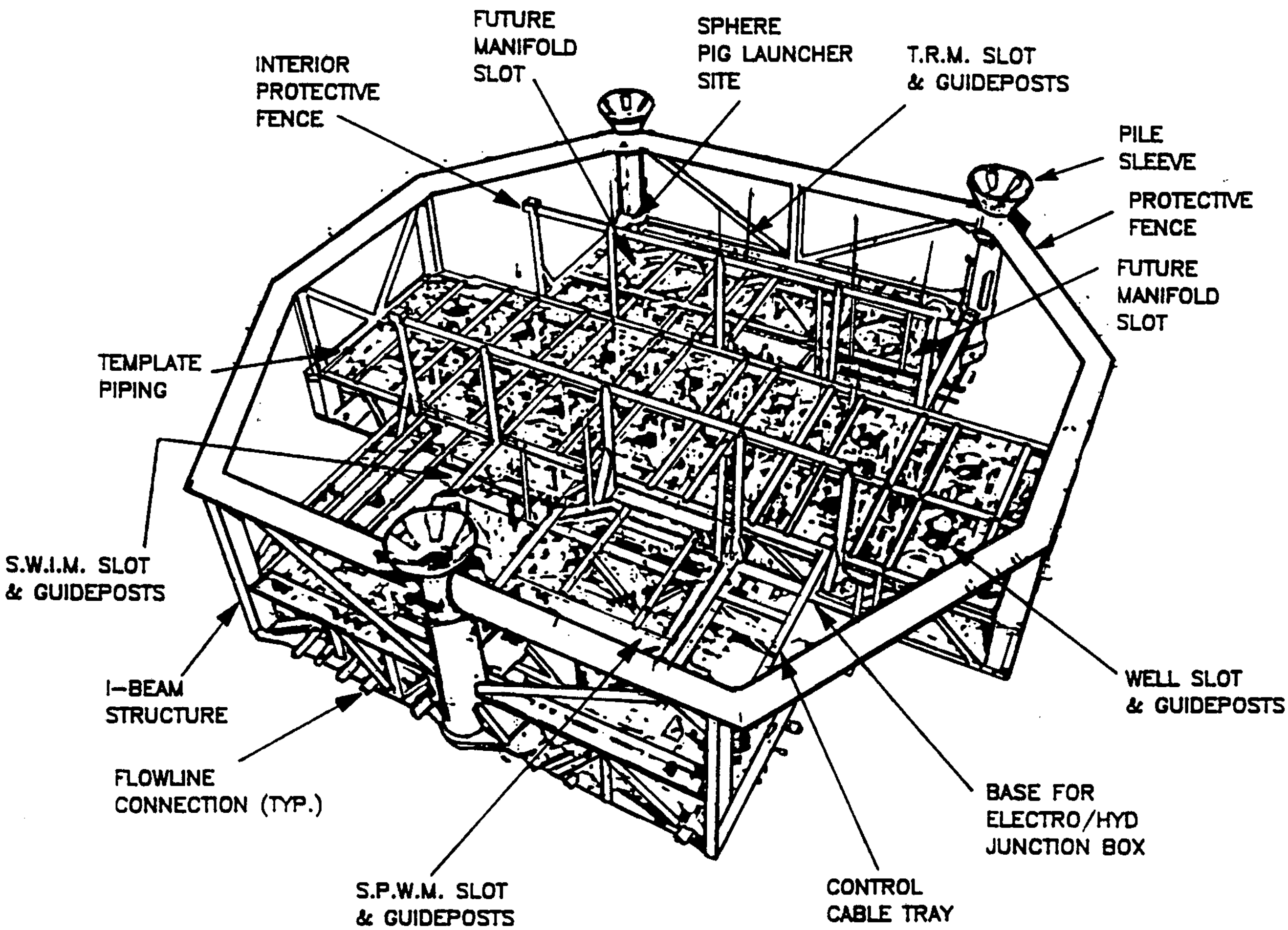
3.6.1 Argyll

The Argyll system (Figure 3.6-1) was the first floating production system installed in the North Sea when production started in June, 1975 [6]. As such it represents a first generation floating production system using a semisubmersible and is therefore of a fairly crude, simple design.



NON–COMMINGLED SUBSEA TEMPLATE

FIGURE 3.5–2



COMMINGLED SUBSEA TEMPLATE

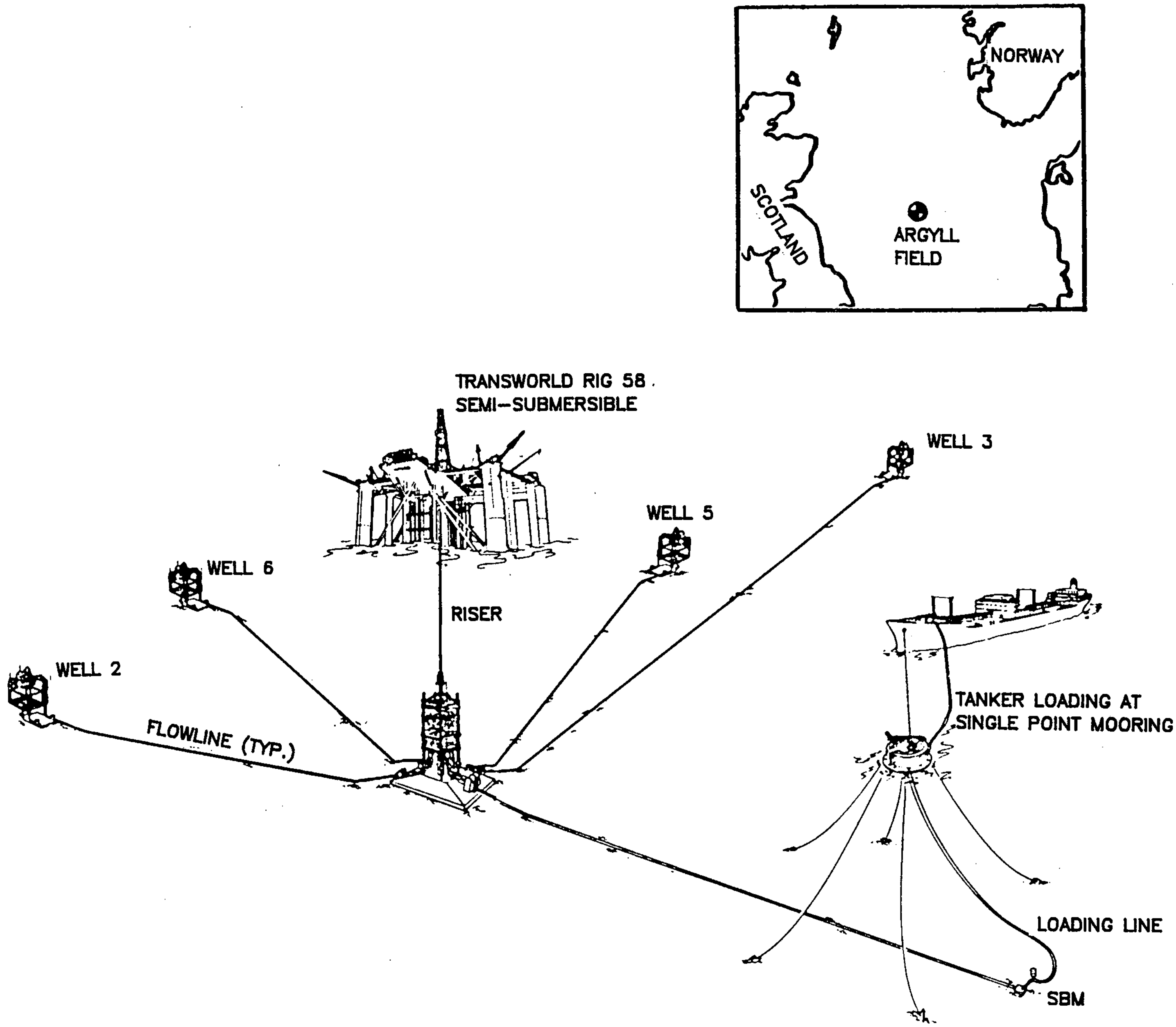
FIGURE 3.5-3

SEMI-SUBMERSIBLE FLOATING PRODUCTION SYSTEMS

PRODUCTION SUMMARIES

FIELD NAME	ARGYLL	BUCHAN	CASABLANCA	DORADA	ENCHOVA	BALMORAL	PLACID
DEVELOPMENT TYPE	Marginal	Marginal	Early Production	Marginal	Early Production	Marginal	Marginal
LOCATION	North Sea	North Sea	Spain	Spain	Brazil	North Sea	Gulf of Mexico
WATER DEPTH (FT)	260	400	400	310	620	460	1522
DESIGN PRODUCTION CAPACITY (1000 BOPD)	70	72	25	20	60	60	
G.O.R. (SCF/BBL)	150–300	310	60–70	315	N.A.	368	
WATER PRODUCED (BBLS/D)	N.A.	None so far	N.A.	2000	None so far	N.A.	N.A.
SULPHUR	0.2%	N.A.	0.2%	N.A.	N.A.	0.31%	
H_2S (PPM)	N.A.	N.A.	N.A.	700	N.A.	N.A.	
WAX	6%	5%	N.A.	N.A.	N.A.	N.A.	
SEPARATION STAGES	2	3	2	2		2	
GAS DISPOSITION	Flared	Flared	Flared	Flared	Flared Provisions for Export to Platform	Flared	
GAS LIFT	N.A.	Yes	None	N.A.	N.A.	N.A.	
PRODUCED WATER DISPOSITION	N.A.	Treat & Dump	Dumped	Treat & Dump	N.A.	Treat & Dump	
RESERVOIR PRESSURE MAINTENANCE	N.A.	Provisions for Water Injection	N.A.	N.A.	Provisions for Water Injection	Provisions for Water Injection	
OIL STORAGE (BBLS)	None	3500	None	None	None	None	None
OIL EXPORT	CALM	CALM	Pipeline	Pipeline	CALM	Pipeline	Pipeline
WORK-OVER	Separate Semi	From FPS Production Shut In	From FPS Production Continued	From FPS During Production	From FPS During Production	From FPS During Production	From FPS During Production
CONFIGURATION	Anchored over Template	Anchored over Manifold	Anchored over Individual Wells	Anchored over Individual Wells	Anchored over Template	Anchored over Template	Anchored over Template
RISERS	Rigid Non-Integral	Rigid Non-Integral	Catenary	Individually Tensioned	Flexible w/Loop on Sea Floor	Flexible w/Midwater Arches & Buoys	Buoyant Non-Integral
NUMBER/TYPE OF WELLS	7 Satellites	4 Satellite 4 Template	2 2	3–4 3–4	4 Satellite 6 Template	9 Satellite 10 Template	4 Satellite 20 Template
EXPORT BY	Shuttle Tanker via S.P.M.	Shuttle Tanker via S.P.M.	Pipeline	Pipeline	Shuttle Tanker via S.P.M.	Pipeline	Pipeline
DATES OF PRODUCTION	1976 to Present	1981 to Present	1977–1982 (Replaced by Permanent Structure)	1978–1983	1978 to Present	1986 to Present	1988 to Present

TABLE 3.6–1



ARGYLL

FIGURE 3.6–1

The decision to use this system was taken when construction of the steel jacket initially selected for Argyll ran into large cost overruns and schedule delays. It later became the means for developing the complete field.

The field reserves have proved to be larger than expected and the operator has maintained an extensive drilling program so that new wells are put on stream as others are depleted.

The floating production vessel was converted from the drilling rig Transworld 58 into a floating production facility. Some of the drilling equipment remained but drilling capability no longer exists. All available deck space is used for production equipment.

The system currently consists of six satellite wells tied into a central manifold on a mass anchor, pinned to the seafloor by a single pin pile. The original manifold has been replaced by a new version following the appearance of a crack in the export line. Some modifications were incorporated into the new manifold including a ring main to enable switching of individual wells to various service risers and other refinements mainly aimed at making work easier for the divers.

The nonintegral rigid riser system [7] [8] consists of eight 4-inch flowlines around the 10-inch export line. However, only seven risers are used for production, as the eighth is needed to purge the lines with seawater prior to pulling the riser. It has proved necessary to pull the riser 2-3 times per year on account of weather, an operation that now takes 6-8 hours.

The riser is supported at the surface by constant tension. Riser tensioners tension both the 10-inch central riser column and the individual 4-inch flowline risers. Tensioners were selected to run continuously at about 50% design rating with a 10-ft. maximum rig heave when the riser is connected. Individual rotary hoses are used to connect the moving riser head and fixed flanges of the pipe work on deck.

Much data has been published on the system downtime, particularly in the early years of production. It would appear that the primary cause of weather downtime is due to the loading buoy and not the production riser, as the tanker must usually leave the buoy long before the riser is pulled.

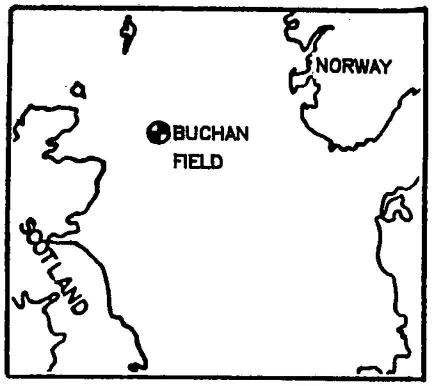
3.6.2 Buchan

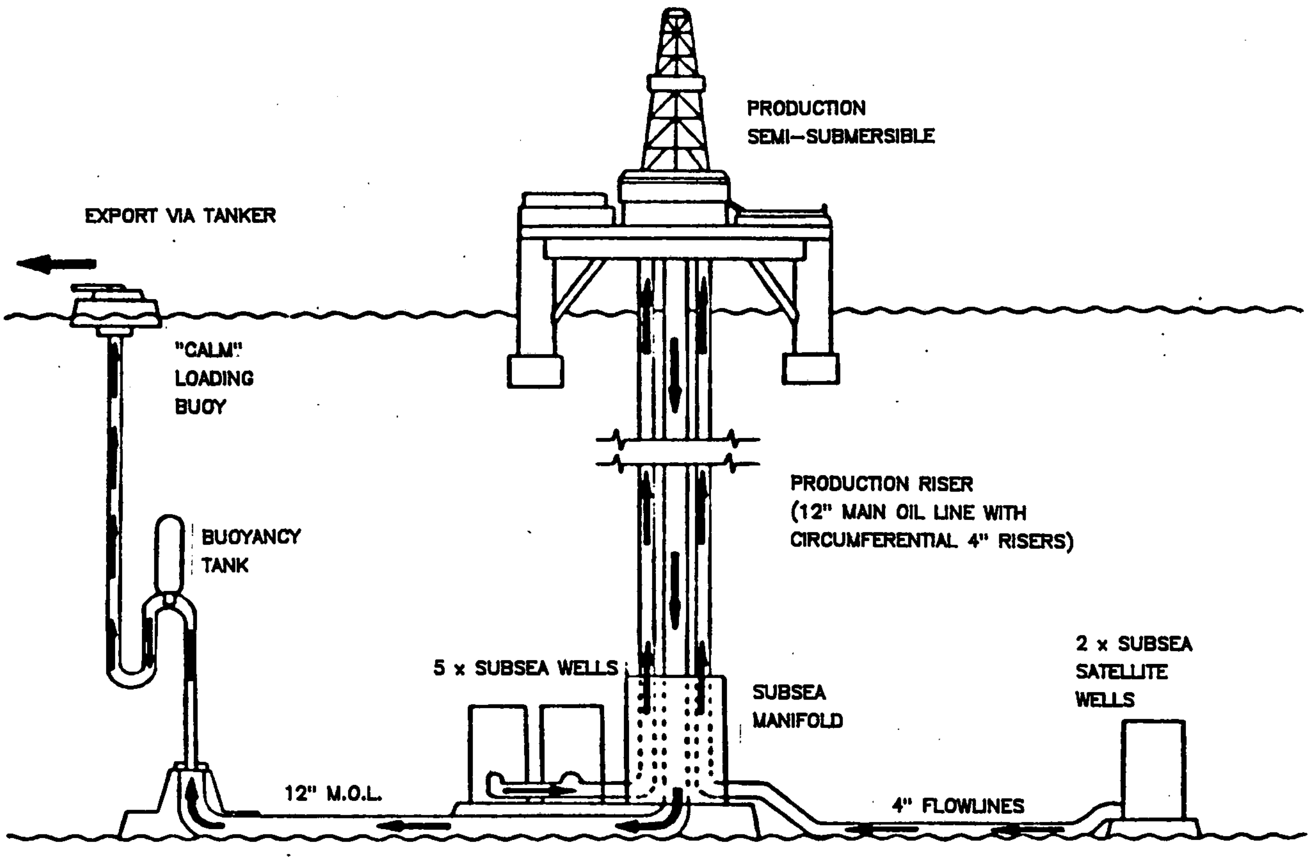
The Buchan Field (Figure 3.6-2) is an example of the development of a marginal field using a floating system to achieve a lower capital investment and earlier cash flow.

In comparison to Argyll, Buchan is a considerably more complex system. In its design and construction it has drawn heavily on the experience gained in the Argyll field.

Considerable delays in the project occurred in the drilling and, most significantly, in the conversion of the semisubmersible. B.P. has commented that, were they to repeat the project, they would opt for a purpose built vessel rather than a conversion. Nevertheless, the development has been pronounced an economic success despite a production delay of 20 months.

The rig is owned by the Buchan consortium, a joint venture set up for the project, and operated by B.P. Petroleum Development (UK). It should be noted that there is a rather different operational philosophy between BP and Hamilton Brothers in the Argyll field. For instance, BP maintains a production crew of some 78 people, whereas Hamilton Brother require only 30-40.





BUCHAN

FIGURE 3.6–2

The floating production vessel was converted from a Drillmaster semisubmersible. The conversion was performed in a remote location in the Shetland Islands and as a result labor costs for the actual conversions were probably higher than normal rates.

New crew accommodation had to be added to the vessel plus provisions for gas lift and storage for some 4,000 bbls of oil. In practice, this storage has not been used, as it cannot support production, even during the 3-4 hours required to change tankers at the loading buoy. The vessel uses its original diesel generators for power, and all gas produced is flared.

The vessel is certified by Lloyds and has undergone rigorous structural checks as a result of the failure of the Alexander Kielland, which was a similar design.

The system consists of the following components:

- Four (4) satellite subsea trees.
- Four (4) steel flowlines connecting the satellite trees to subsea template.
- One (1) subsea template with four (4) subsea wells.
- One (1) non-integral riser to semisubmersible with tensioning system.
- Semisubmersible with process equipment for 72,000 barrels per day.
- Export line to CALM loading buoy PLEM.
- One (1) CALM loading buoy with six point mooring system.

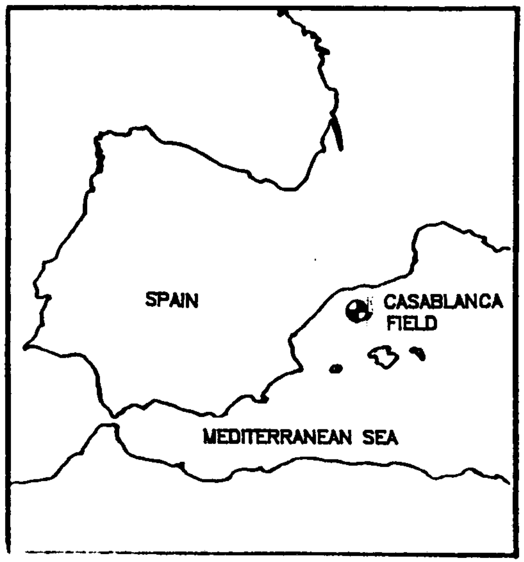
The riser is one of the most sophisticated yet constructed and has resulted in a very cluttered moonpool. As a result, a shutdown of the template wells is required during workovers, although it was originally intended to continue production when the system was designed. The outer production risers are normally pulled when the vessel heave is 3 m, an operation that has taken about 12 hours. Disconnection of the export risers at 5 m heave takes a further 16 hours. The inability to reconnect until the vessel heave has reduced to 0.5 m has resulted in considerable downtime.

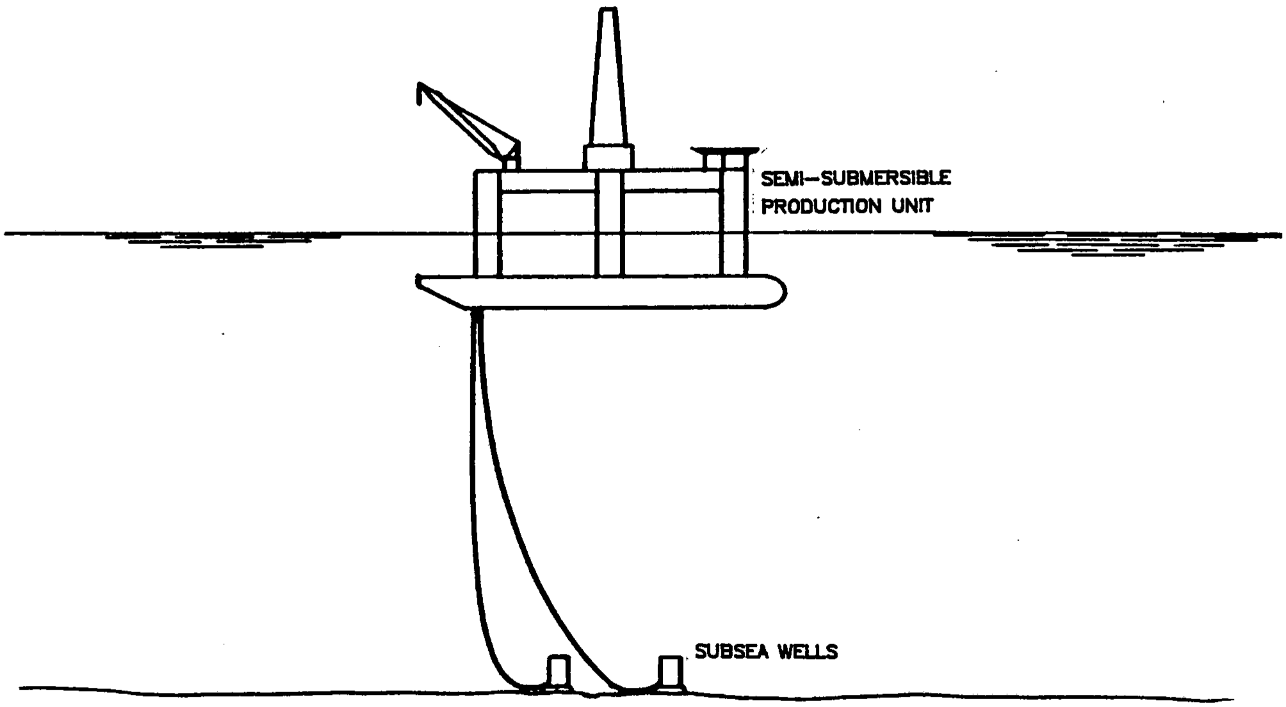
Another major source of downtime is the loading buoy. Production is stopped at a hawser tension of 75 tonnes, the hose is disconnected at 80-85 tonnes and the tanker leaves at 100 tonnes. it should be noted that the loading operation at the SPM is often the limiting production factor, and production is therefore stopped before other factors, such as vessel motions, become a problem.

Performance for the Buchan buoy has been 60-65% of the time when the system was operational. Studies have indicated that these figures were typical of what might be expected and that a tower might achieve 71% compared to 65% for a CALM buoy. BP has also investigated upgrading the buoy to accept a mooring load of 180 tonnes, compared to the 120 tonne design criteria, which represents a major design change. It has been concluded that this would only increase productivity by two to three percent.

3.6.3 Casablanca

The floating production system used on the Casablanca development (Figure 3.6-3) by the operator ENIEPSA consisted of an early production system from two wells which were eventually to become satellites to a fixed platform. These satellites were required since, even with the highly deviated wells used, it was not possible to develop the entire field from one location.





CASABLANCA

FIGURE 3.6-3

The original wells were drilled by the semisubmersible, "Bideford Dolphin". This rig was equipped with limited process facilities rented from Flopetrol and carried out the initial testing of the wells. It was then replaced by the Afortunada rig, owned by the Casablanca group, and the rented equipment was transferred.

The two wells CA1A and CA6, are currently producing 16,000 bbls/day to a fixed platform installed in 1982. The Afortunada was demobilized and was put up for sale.

It should be noted that the floating system was used as a temporary measure only, to generate revenue during the main development construction. As a result, the system was kept as simple as possible and made use of some facilities provided for the main development such as the pipeline to shore, which could probably not have been justified for the floating production wells alone.

The subsea system consists of Regan, diverless trees which incorporates a heat exchanger to cool the oil from 300^{o}F to 200^{o}F to prevent damage to the Coflexip risers. The risers are free-hanging without pretension with enough slack to allow the rig to position over either well with the other still in production.

The process equipment consists of a simple two stage, three phase separation system at 80 psi and 8 psi respectively. Water is passed through a skimmer and dumped overboard with a target oil content of 20-30 ppm. All gas is flared at the rate of 1 mcfpd as it was not considered practical to use it for power generation for the short life of the early production. The control lines consists of hydraulic line bundles, two for well CA6 and one for well CA1A.

In contrast to a number of developments no problem was experienced with deck space on the Afortunada with ample room available for the equipment required.

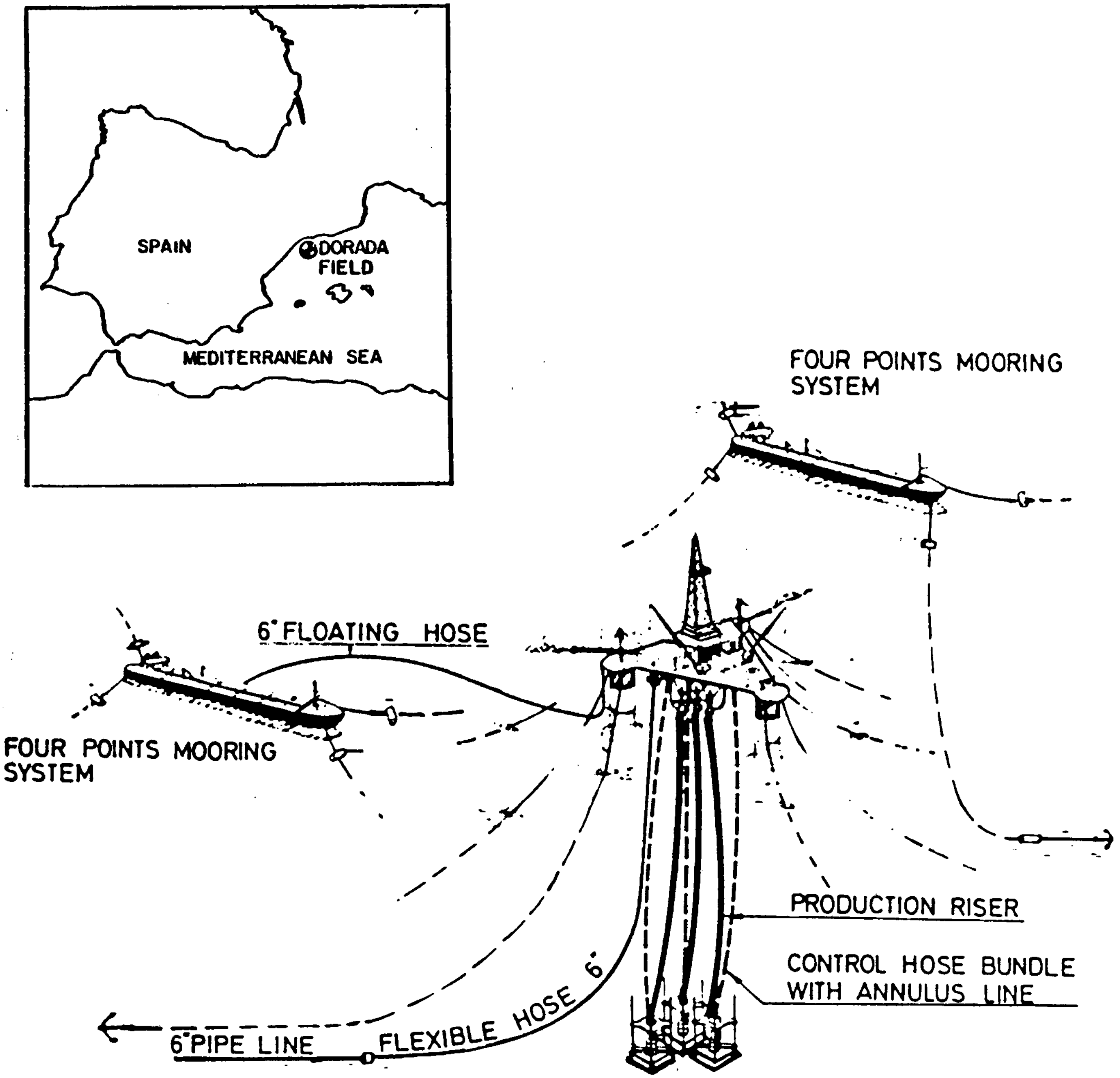
The support operation is run by the same base as for the Dorada field and shares the same supply boat. A standby vessel is used with capabilities for pollution control.

3.6.4 Dorada

The Dorada field (Figure 3.6-4) is a small reservoir that has been developed by conversion of the original Sedco drilling rig. Due to the reservoir size and geology a fixed platform was not justified and it was decided by the operator ENIEPSA to use a floating production system. A semisubmersible was chosen to provide access to the wells for workover during production.

The original production took the form of an extended well test and the minimum equipment necessary was installed on the semi in approximately 45 days. One year later the system was revamped to increase the production capacity to 20,000 bbl/day, an operation that took approximately two months. In view of the field life, it was decided to rent the process equipment. However, the operators indicated that had the field reserves been better known at the start of the development it would have been preferable to purchase the equipment.

The subsea trees are Regan, 5000 psi units which produce through the steel risers via a flex joint up to the mezzanine deck level. Here they are manifolded and passed through a heater to raise the temperature from 40^o to 70^o. Emulsifier, bactericide and an anti-foamer are also added at this stage. The oil is first heated and then passed through two, three phase separators, one at 120 psi and the other at near atmospheric



DORADA FIELD PHASE II – PRODUCTION SYSTEM

FIGURE 3.6–4

pressure. It is then metered and pumped to shore. Water is passed through a skimmer and then dumped overboard with a target oil level of 20-30 ppm. Gas is passed through a condenser and then mostly flared with some supplying the heater. All the equipment is designed for use with H_2S. The H_2S content at the second separator is 30,000 ppm.

One problem associated with the conversion was the lack of deck space available for the equipment. The equipment installed is the maximum possible without major modifications to the semi.

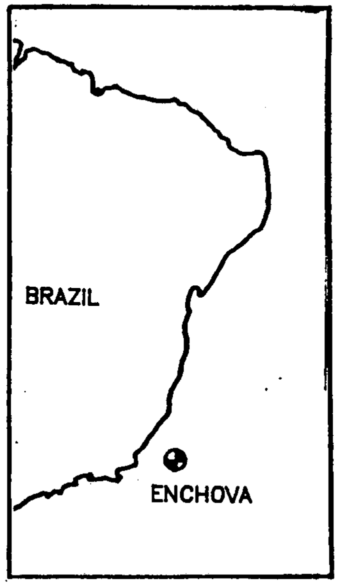
The subsea production system has run virtually without interruption since start-up except from the drilling of the additional wells.

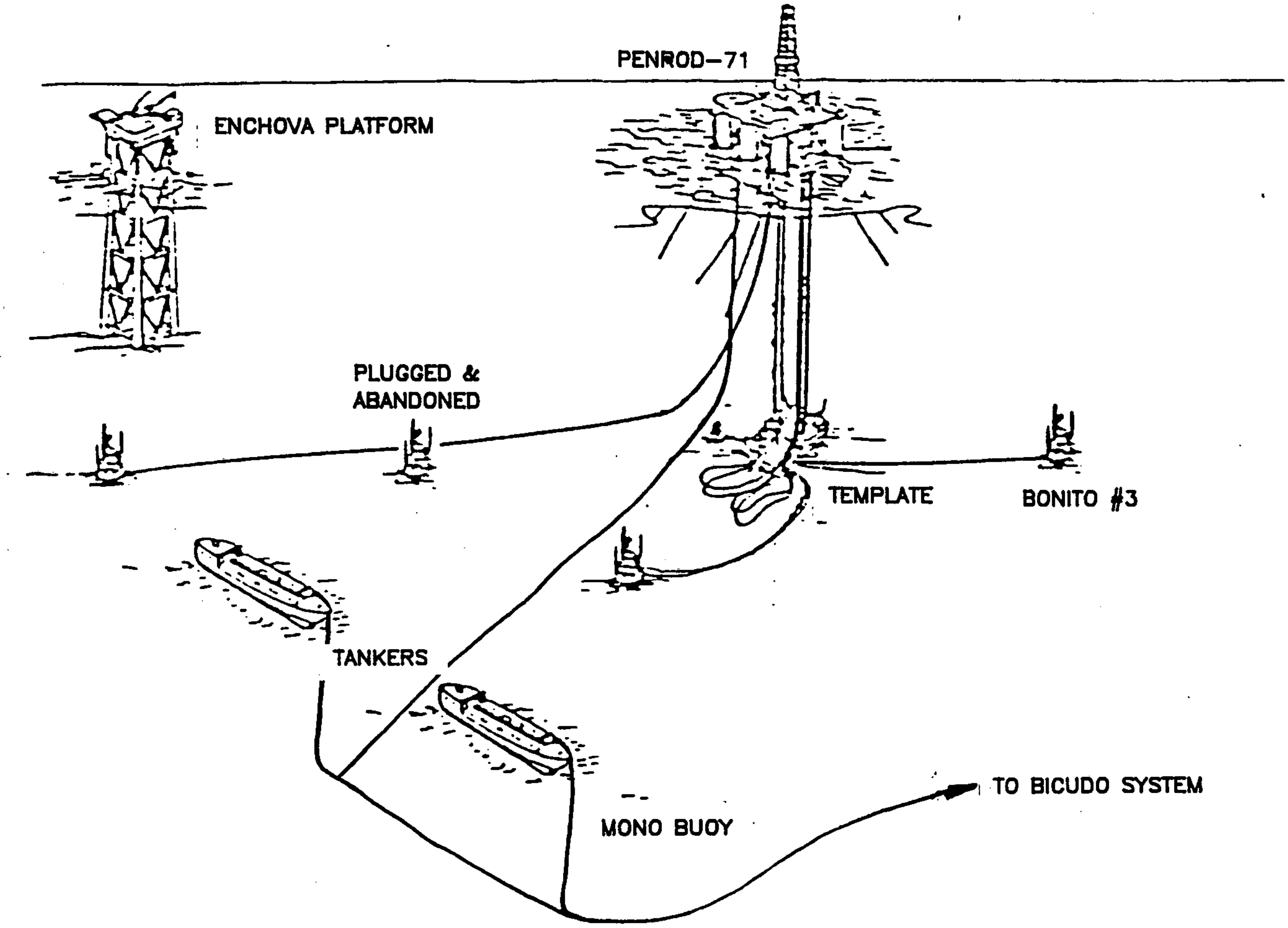
A very small amount of downtime has resulted from shutdowns caused by the H_2S detector alarm sounding. It has never been necessary to disconnect the riser due to weather. Strain gauges and angle indicators are provided to monitor the riser loads but they are mainly used to check rig position.

The vessel and system is classified by ABS to API specifications. It is inspected every year with a major inspection every 4 years. A tug is supplied as a standby boat for rescue with some limited pollution control capability.

3.6.5 Enchova Phase IV (Bonito)

The development of the Enchova field in the Campos Basin, offshore Brazil (Figure 3.6-5), by Petrobras followed closely behind that of the Garoupa field a few miles away. At this time the Garoupa system, which was to use a relatively sophisticated one atmosphere wellhead system, was late in going into production for a variety of reasons. As a result, it was decided to develop





BONITO (ENCHOVA PHASE IV)

FIGURE 3.6-5

Enchova using the simplest possible system and the first production was from a semisubmersible over a single well, Enchova #1, with a hose to a tanker in a four point mooring system. This well produced 10,000 barrels per day, making it the best producing well in the Campos Basin, and production was achieved in the very short lead time of 5 months. As a result, this development system gave a very successful, quick solution to the requirement for early production for revenue (foreign exchange) and also to establish the reservoir characteristics which were not very well known at that time.

Later phases of the development incorporated the use of one and two semisubmersibles, a loading buoy, and finally a subsea template and manifold system. This last arrangement (Phase IV) was not completed until March 1983, although the template was already installed and has been producing since December 1982. The system was called the Bonito system. A jacket has been installed for the Enchova field. The design capacity of the Bonito system is 60,000 bbl/day, although only 45,000 bbl/day is expected.

The system shares two SPM loading buoys with the nearby Bicudo system. This system uses the Sedco 135D semisubmersible to produce from three wells below the rig plus two satellite wells. As with most fields in the Campos Basin, the Bonito system will continue to be modified to take advantage of new developments in the area.

The main feature of the design is the subsea template and the manifold which used subsea chokes. These chokes are a very simple fixed bean type and can be changed out by divers. The original proposal by the designers (Vetco) was for a rigid, non-intergral riser, but Petrobras preferred to choose a subsea manifold and free hanging risers. Petrobras also investigated the use of a hydraulically operated variable subsea choke but could not find one that was reliable.

Commingled product from the template flows via an 8-inch Coflexip flexible riser which is attached to a quick-disconnect fitting on the lower hull of the semisubmersible. Originally two of the template wells had been planned as water injection wells although this idea was later abandoned. As a result two wells now produce to the semi via individual 4 inch Coflexip hoses. An additional 4 inch line from the manifold is used for well testing or to monitor the annulus pressure of any well. Three of the satellite wells connect to the manifold via pull-in connections on the side of the template. The fourth satellite well flows directly to the semisubmersible. Two future wells are planned which will also produce directly to the surface vessel.

System performance has been good to date. Some problems have been experienced with the vessel process equipment and also with some subsea electrical equipment. In contrast to some systems there is no problem with space on the vessel with adequate area for the process equipment and also the future gas compression equipment.

The system consists of the following components:

- Four (4) satellite subsea trees.
- Four (4) single Coflexip flexible flowlines from the wellheads to a subsea template.
- One (1) subsea template with six (6) wellheads, a manifold base and associated piping.
- One (1) subsea manifold with four Coflexip flexible risers to the surface vessel.
- Semisubmersible vessel with process equipment for 60,000 bbl/day and subsea equipment control units.

- Coflexip flexible pipeline to CALM export buoy PLEM.
- CALM loading buoy with 6 point mooring system.

3.6.6 Balmoral

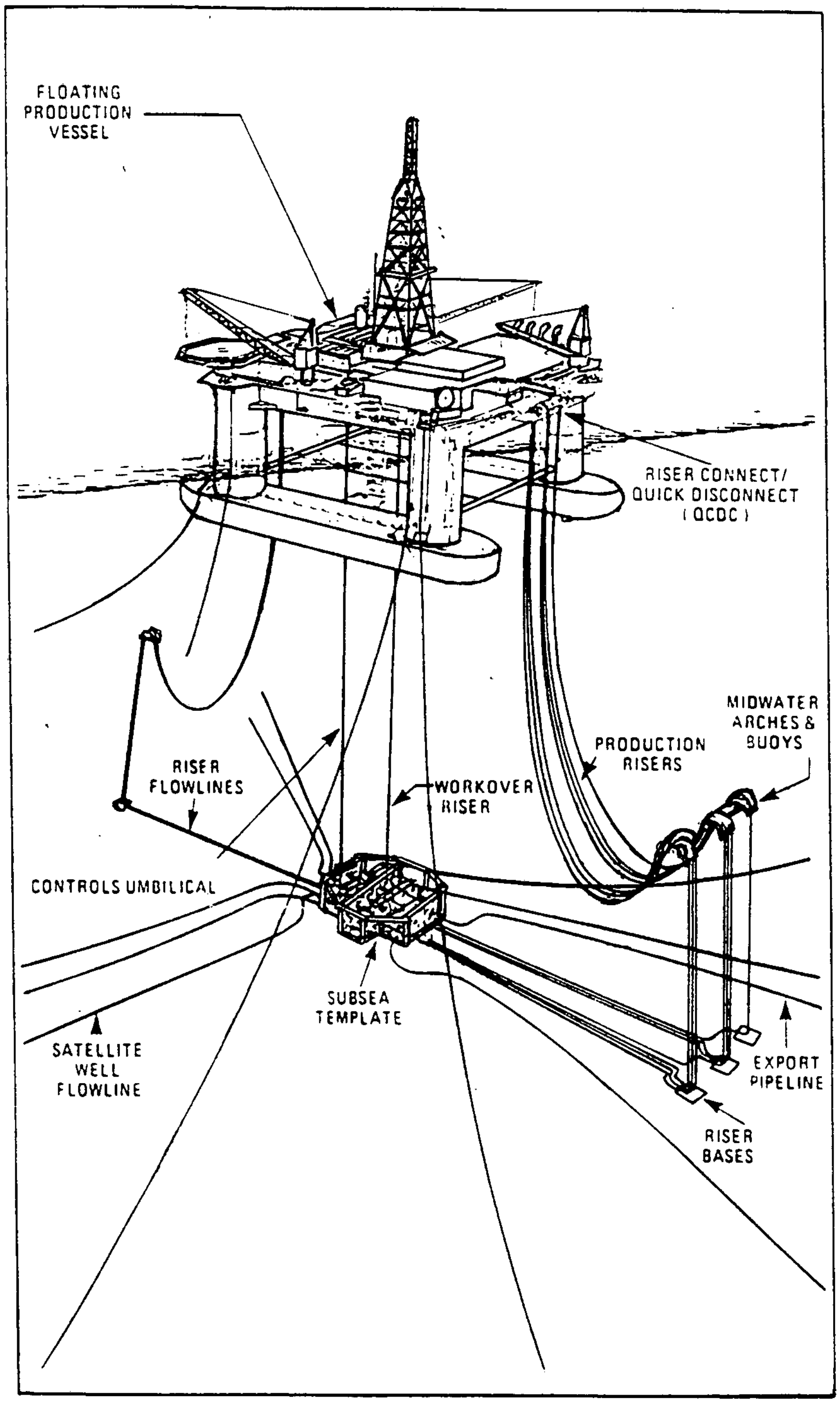
Sun Oil Balmoral field is a small reservoir located in 460 ft. water depth on the UK sector of the North Sea (Figure 3.6-6). After reviewing all the options Sun decided on a subsea development with a SEMI-FPS. Crude oil was to be collected from 13 subsea production wells and processed on the world's first propose built SEMI-FPS before being exported through a 14-inch pipeline to the Brae/Forties pipeline.

This field was expected to produce at a peak production rate of 35,000 BOPD for approximately three years before commencing its decline.

The results of cost studies indicated that a platform would be 40 percent more costly than a floater. Further technical studies confirmed this conclusion and compared monohulls, semisubmersibles and conversion versus purpose built. The final conclusion of these studies suggested that a purpose built semisubmersible represents the best option for the field development [9].

The selected semisubmersible was a GVA 5000 series with the final deck load carrying capability of 6,800 tonnes. The vessel has been designed for a life of 20 years in accordance with the Department of Energy's guidelines. It includes a permanent 12 man diving spread.

Four dedicated moonpools are sited midship. The primary one is used for workover and the others are provided for the subsea control umbilical, the ROV and the diving bell.



BALMORAL FIELD DEVELOPMENT

FIGURE 3.6–6

The vessel is moored by an 8 point mooring system connected to 1.5 m diameter preinstalled piles. Four dedicated thrusters are used to maintain the vessel within its watch circle.

The risers are flexible lines supported at the upper deck level and suspended in a steep-S configuration. The risers are supported at midwater by a pipe arch and buoys.

The system consists of the following components:

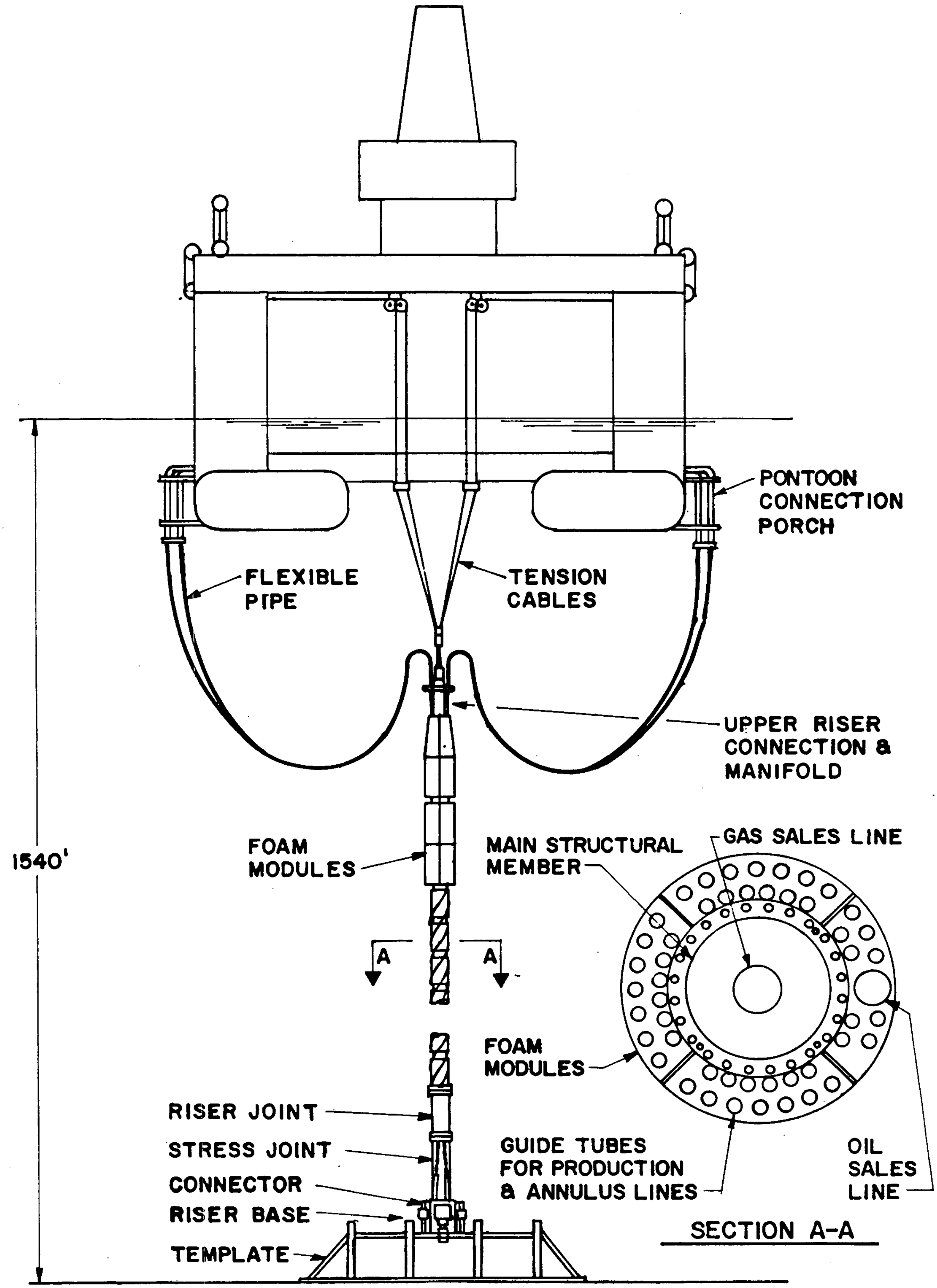
- Nine (9) satellite wells
- Ten (10) template wells
- One subsea template with three manifolds; one for commingling flow from satellite production wells, another for metering the water to the satellite injection wells, and the third provides for riser flushing.
- Purpose built semisubmersible with process equipment for up to 60,000 barrels.
- Flexible production risers
- Flexible export riser

Detailed description of this system is provided in references [10], [11], and [12].

3.6.7 Placid

Placid is the first floating production system installed in the Gulf of Mexico. The SEMI-FPS was installed in 1,522 feet of water on Placid's Green Canyon Block 29 in 1988 after lengthy bankruptcy battles that frequently threatened the realization of this project [13] [14]. (Figure 3.6-7).

The production system consist of the following:



PLACID RISER

FIGURE 3.6–7

- The seabed template containing its own wells drilled and completed through template slots, plus tie-ins from satellite wells.

- The world's largest riser to transport individual well production to surface and separated oil/gas back to seafloor.

- Floating vessel which is the converted Penrod 72.

The subsea template weighed 1,250 tons [15] [16]. There are 24 well bays. Twenty well bays have inserts which interface with the BOP during drilling. After well completions, template trees will be stabbed vertically into landing receptacles, simultaneously making flow line, annulus line and hydraulic control line connections.

The most innovative part of the system is the self-supporting rigid riser. It is designed for a 20-year life that includes remaining connected during a Gulf of Mexico 100-year storm. The riser was installed from the semisubmersible production vessel in the same way as a drilling riser.

The rigid riser extends from the riser base at the seafloor to 150 ft. below mean sea level [17]. From top to bottom, the rigid riser is composed of an upper riser connector package (URCP) twenty-five 50 ft. and one 34-ft. riser joints, and a titanium tapered stress joint and bottom connector assembly. At the top, flexible flow-line jumpers connect the upper riser connector package with the permanently moored semisubmersible. Six tensioners on the rig apply load to the riser's top to minimize the horizontal displacement of the riser. This reduces the possibility of damaging the flexible flow lines.

Both fixed and variable buoyancy make the riser self-supporting. The fixed or synthetic foam modules give each joint slightly negative buoyancy in water and allow for a simplified installation procedure. After riser installation, the individual nonintegral production and annulus lines for 24 wells and a single oil sales line are installed through fiber glass guide tubes within the foam modules.

Inside each riser joint is an air can that when filled will support the wet weight of the two nonintegral export lines, and the nonintegral production and annulus lines.

To provide clearance for a drilling or workover riser without interrupting production, the location of the production riser will be 80 ft. aft of the moonpool, midway between the port and starboard pontoons.

Because the rigid riser is beneath the rig, the flexible flow lines hang in catenaries from each side of the rig to the riser's top, applying a symmetrical load to the riser's upper end.

The floating vessel is the Penrod 72 which entered the Marathon Le Tourneau shipyard in August 1986 to undergo modifications which allow it to moor for a 15 year period for production purposes [18]. The Penrod 72 is a twin pontoon, 6 column unit completed in 1975. Because of its size and configuration, it was considered an ideal vessel for this service.

The vessel, along with two sister rigs (Penrod 71 and Penrod 75), were among the first to feature a two deck, hull type superstructure. Consequently, most of the original equipment, quarters and storage is below decks, leaving an exceptionally clear, flush upper deck. A net 3,800 tons of new equipment, structure and outfit were added. Also, 700 tons of production variable deck load was added to the existing 2,000 tons variable load for drilling. This was achieved by the addition of sponsons to each of the corner columns to provide adequate stability.

The mooring systems is an eight point wire, chain and buoy, pre-installed system [19]. The existing self deploying mooring system and the thrusters have been removed entirely. The converted Penrod 72 is designed to operate for a 15-year period without return to port or draft change during storms or inspections.

3.7 Existing TLP-FPS Review

Two TLP-FPS have been previously mentioned; the Hutton TLP and the Jolliett Green Canyon TLWP. Both of these TLP's belong to Conoco and represent two different school of thoughts in the use and application of tension leg platforms.

Invariably every major oil company has performed some kind of study to assess the feasibility of TLP for their prospects. Some of these operators have advanced their design beyond preliminary stages. Therefore, it should be expected to witness other tension leg platforms in the future.

3.7.1 Hutton TLP

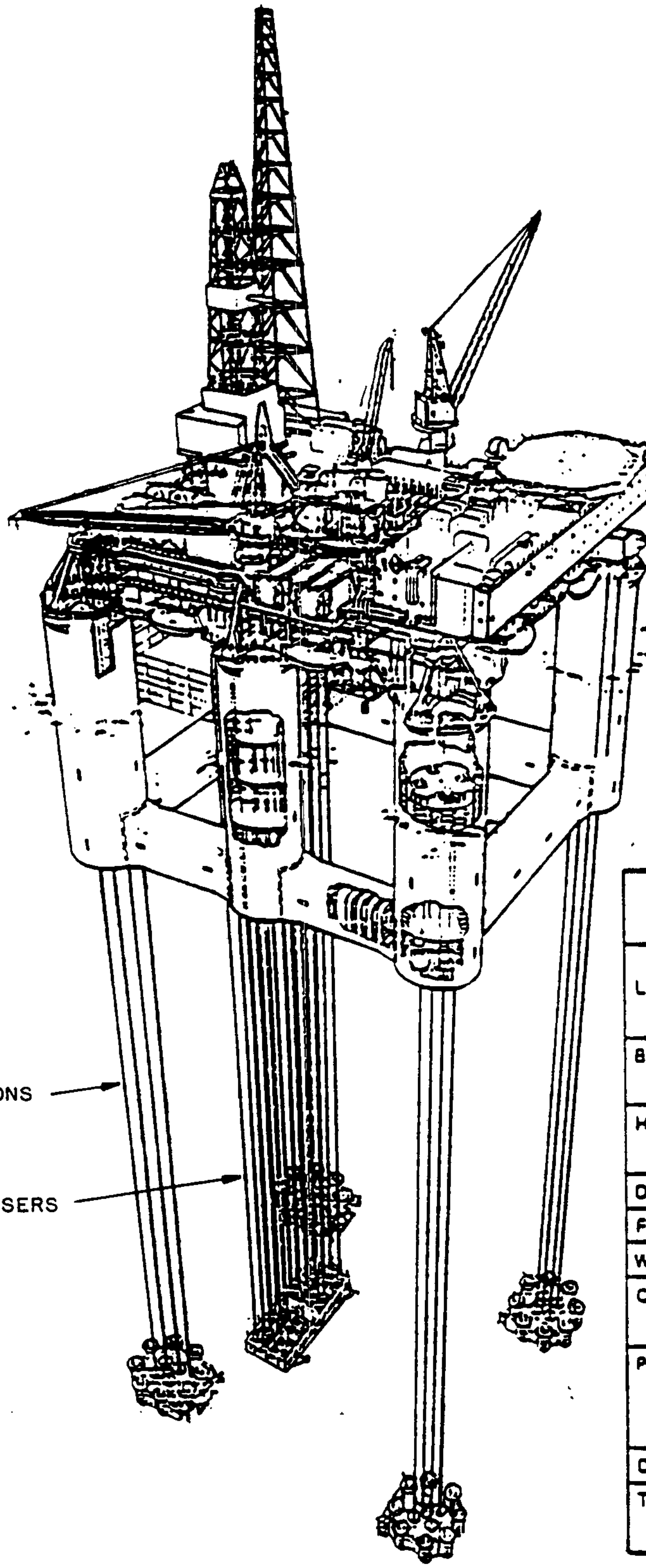
The Hutton TLP was the first tension leg platform ever installed. It was designed and fabricated for Conoco's Hutton field, British North Sea in 490 feet of water.

The detailed design of the Hutton TLP was one of the largest design contracts ever awarded for a floating production system. Brown & Root in association with Vickers Offshore Ltd were responsible for design and fabrication of the platform. The realization of this first of a kind concept required more than 10,000 fabrication drawings, 675 procurement packages and used thousands of hours of computer time for design calculations. The structure displaces 61,500 tonnes and more than 40,000 components had to be monitored to meet the sensitive weight requirements (see Figure 3.7-1).

Major characteristics of the field and TLP are as described below:

Location:	Northern North Sea - U.K. Blocks 211/27 and 211/28
Water depth:	490 feet
Recoverable Reserve:	245 million barrels of oil, 5 million barrels of NGL
Quality:	Medium crude, gravity 30.5^0 API, low GOR of 100-125 SCF/bbl
Process Capability:	110,000 barrels of oil per day
Production Aids:	Water injection
Hull Type:	Compartmental floating hull with 6" thick wall tendons
Deck Type:	Single integrated deck with a mezzanine level carrying all the process and utility equipment plus external modules for the drilling rig, power generations, accommodation, helideck and flare structure
Deck Dimension:	244′ x 257′
Number of wells:	24, ten drilled prior to TLP installation. Fourteen more were drilled from TLP after installation

HUTTON FIELD
TENSION LEG PLATFORM



GEOMETRY (All dimension to moulded lines)		
LENGTH	· Between column centres	78.00 M
	· Overall	95.70 M
BREADTH	· Between column centres	74.00 M.
	· Overall	91.70 M
HEIGHT	· Keel to main deck	57.70 M
	· Main deck to weather deck	11.25 M
DRAUGHT	· Operating	32.00 M at L.A.T.
FREEBOARD	· To underside of main deck	24.50 M at L.A.T.
WATER PLANE	· Area	1324.00 M^2
COLUMNS	· 4 Corners	17.70 M Dia.
	· 2 Centre	14.50 M Dia.
PONTOONS	· Height	10.80 M
	· Width	8.00 M
	· Corner radius	1.50 M
DISPLACEMENT	· Approx.	61500 Tonnes
TOTAL WEIGHT	· Including riser tension (Approx)	48500 Tonnes

FIGURE 3.7-1

Riser Type:	Individual steel drilling, production and export risers
Platform Weight:	48,500 tonnes
Platform Displacement:	61,500 tonnes
Accommodation:	239 personnel

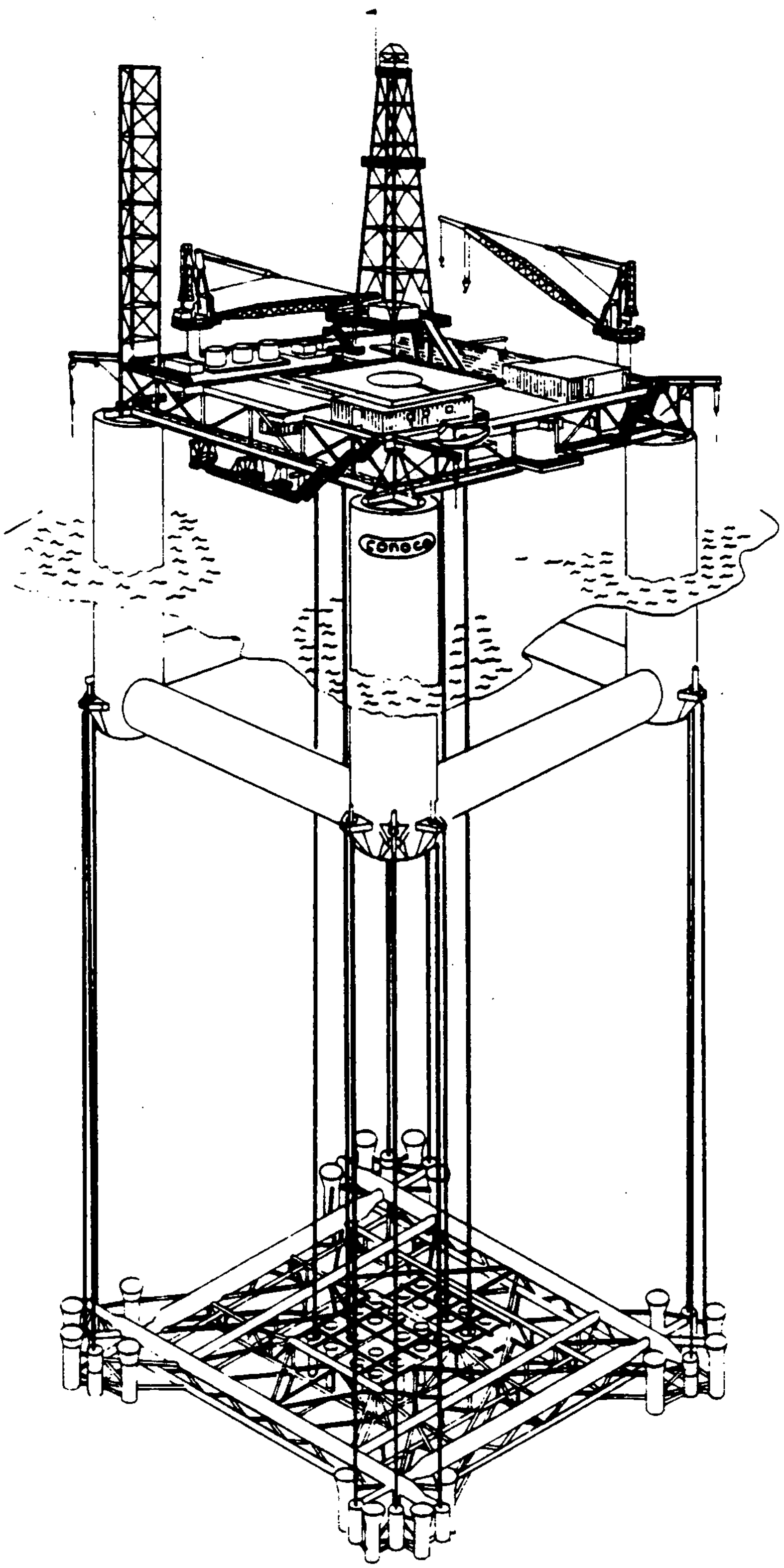
3.7.2 Jolliet TLWP

The innovative Green Canyon tension leg technology is a reflection of today's tight economic environment and efforts to reduce the high cost of building fixed-position platforms for deep water.

After Conoco completed its main in-house work on Hutton in 1986, it went on to start a four year program in 1984 which at first was neither site specific nor for TLPs alone, being aimed at taking production capabilities to the water depths of 4,000 ft. and more in which Conoco holds leases. Tankers, semis (and even fixed platforms to 1,500 ft.) were also considered before the scheme for block 184 (now named the Jolliet field) hardened up as a TLP in mid-84.

Unlike the Hutton TLP, which contains all production and drilling equipment, the Gulf of the Mexico platform holds only the wellheads, the productions separator, the well test system, a completion rig, a gas compression system and accommodation for 40 workers (see Figure 3.7-2).

In order to achieve the maximum cost efficiency, the equipment on the Jolliet TLWP were minimized. This allowed the Gulf unit to be about one-quarter the size of its North Sea counterpart.



JOLLIET FIELD

TENSION LEG WELLHEAD PLATFORM

FIGURE 3.7–2

About a quarter of the $400 million price tag on the overall Jolliet project will go to the TLWP itself. When installed in mid 1989, the platform will raise the world record water depth for offshore production to 1,760 ft.

The rest of the money goes to development drilling, pipelines, and to the shallow water jacket (sited 10 miles north in around 490 ft. of water) which carries oil and water treating equipment, and to the process equipment on both that jacket and the TLWP.

The major structural steel saving was achieved in the hull and tendons. The redesign of the TLWP hull has reduced structural steel weight by 40 percent compared with the Hutton approach. Instead of ring-stiffened columns with steel shell up to 40 mm thick which were used in Hutton, the Green Canyon unit will adopt thinner shells with orthogonal, egg-box stiffening. The result is a structural steel weight in the Jolliet platform of only 9 pounds per cubic foot of hull volume compared with 15 pounds in Hutton.

Another drastic design change is concerned with the tendon. The Jolliet tendons are large diameter, thin walled tubulars which are externally attached to the columns.

The individual riser arrangement is also adopted here. However, the export risers are catenary flexible risers.

The process facility has a capacity of 35,000 barrels of oil per day and 50 MM cfd of gas. A total number of 24 well slots are provided on the preinstalled drilling template. However, only 16 wells will be producing. Preinstallation of the drilling template and drilling of all wells before TLWP installation will allow the field to come on stream about two years sooner than if another approach was undertaken.

Major characteristics of the field and the TLWP are presented below:

Location:	Block 184, Jolliet field, Green Canyon, Gulf of Mexico
Water depth:	1,760 ft.
Quality:	Medium Crude Gravity (NA) GOR (NA)
Processing Capability:	35,000 barrels of oil per day 50 mmcfpd
Hull Type:	Compartmental floating hull with 12 thin wall, large diameter tendons
Deck Type:	Single integrated deck
Deck Dimension:	140′ x 140′
Number of Wells:	16 (all predrilled)
Riser Type:	Individual steel workover and production risers. Flexible export risers.
Platform Weight:	Hull 4600 tons Deck 2200 tons
Platform Displacement:	16,700 tons
Accommodation:	40 workers

Table 3.7-1 shows a comparison between the Hutton TLP and Jolliet TLWP.

FIELD	HUTTON	JOLLIET
Recoverable Reserves		
Oil	190 mn bbls	40 mn bbls
Gas		2.1 bn m^3
Peak Capacity		
Oil	110,000 b/d	35,000 b/d
Gas		1.4 mn m^3/D
No. of Wells	21	16
Onstream Date	August 84	September 89
LOCATION		
Water Depth	147m	536m
Design Wave Height	30m	22m
PLATFORM		
Operating Displacement	61,500t	16,700t
Operating Draft	32m	24m
Mooring Tendons, Number	16	12
Total Mooring Pre–tension	13,200t	4900t
Total Riser Pre–tension	1350t	1100t
TENDONS		
Tendon Outside Diameter	260mm	600mm
Tendon Wall Thickness	92.5mm	20mm

COMPARISON BETWEEN HUTTON TLP AND JOLLIET TLWP

TABLE 3.7–1

4.0 REVIEW OF RISER SYSTEMS FOR FLOATING PRODUCTION SYSTEMS

This section presents a review of the riser systems which have been used with floating production systems (FPS). A literature search was conducted into the area of production risers. Following a discussion of the results of the literature search, the various types of riser systems compatible with FPS are described and reviewed. The review addresses both semisubmersible based systems and TLP riser systems.

4.1 Literature Search

A literature search was conducted to obtain a listing of technical papers written on the subject of production risers. The literature search was conducted by Brown & Root's technical library staff. The following three data basis were surveyed:

1) Oceanic Abstracts (papers from 1964 to February, 1989)

2) Compendex Plus (papers from 1970 to December, 1988)

3) Fluidex (papers from 1973 to March, 1988)

The search is performed by searching all the titles and abstracts contained in the data basis for key words or phrases. When a key word or phrase appears in the title or abstract of one of the papers, that paper is selected for further review. The following key words and phrases were used in the literature search for production risers:

1) Riser interference
2) Riser Clearance
3) Production Riser
4) Flexible Riser

5) Nonintegral Riser

A total of 139 papers were selected from the three data basis relating to production, flexible, or nonintegral risers. Some duplication of papers within the three data bases was noticed. An abstract of each paper is included in the Appendix.

4.2 SEMI- FPS Riser Systems

There are two common types of riser systems which are used with semisubmersible based FPS; rigid and flexible. The two systems will be described in the following section. The discussion will address the application, installation, operation, and maintenance of each system. Figure 4.2-1 summarizes the riser types which are used with semisubmersible based FPS.

4.2.1 Rigid Riser Systems

Rigid riser systems were the first type to be developed for use in a semisubmersible based FPS. The rigid production riser was developed using drilling riser technology. Rigid production risers can be divided into two categories; integral and nonintegral. The distinguishing difference between the two types is that all the individual risers (flow paths) for an integral riser is contained within a single joint. When an integral riser is installed, all the flowpaths are established at the same time. An integral riser may consist of a structural member with all the individual risers located within the structural member. The risers would be shielded from the environmental forces. Another form of an integral riser is very similar to an integral drilling riser with exterior choke and kill lines. This type of riser would use the main member as an export riser, with additional integral riser mounted on the exterior. Figure 4.2-2 illustrates the typical integral rigid risers described above.

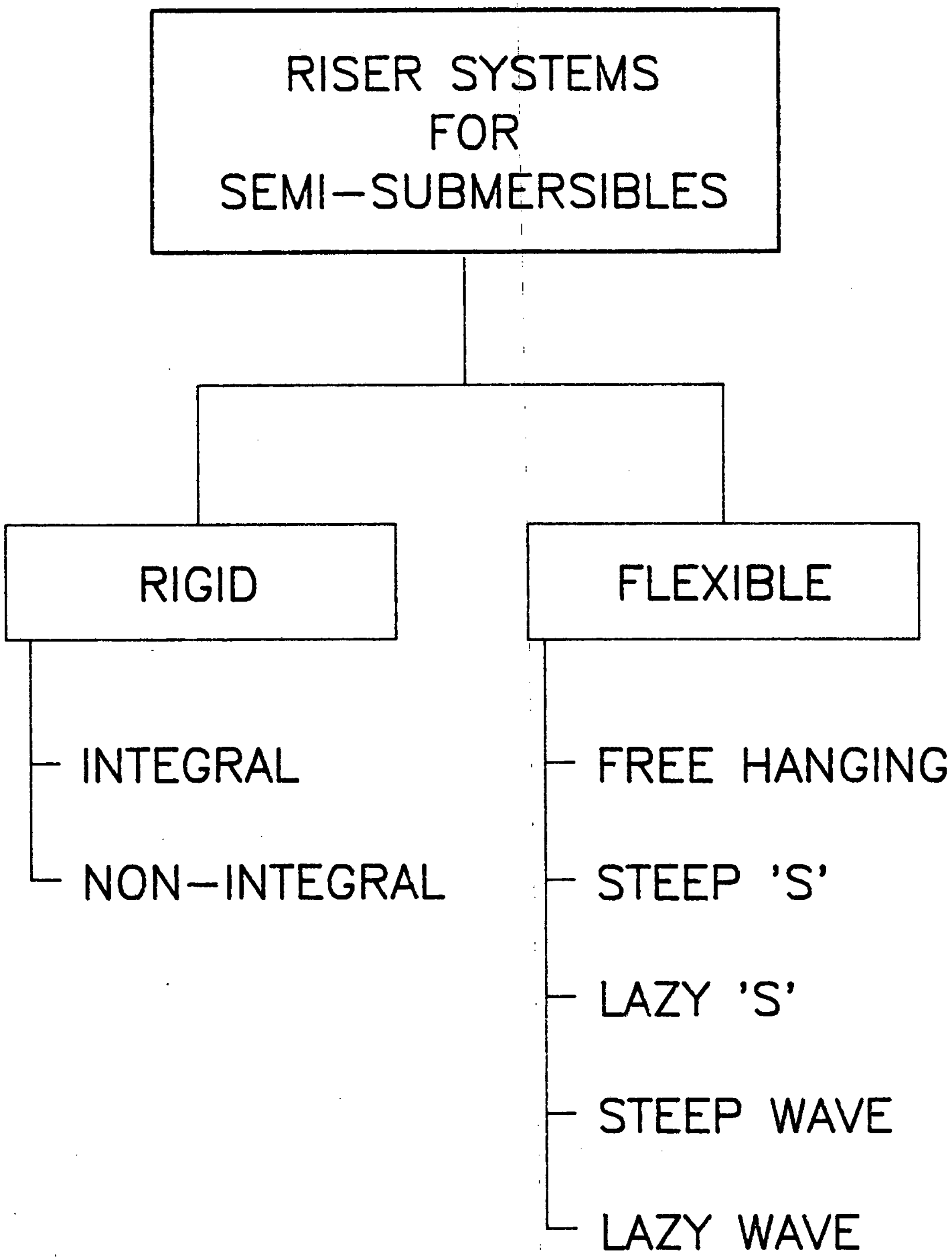
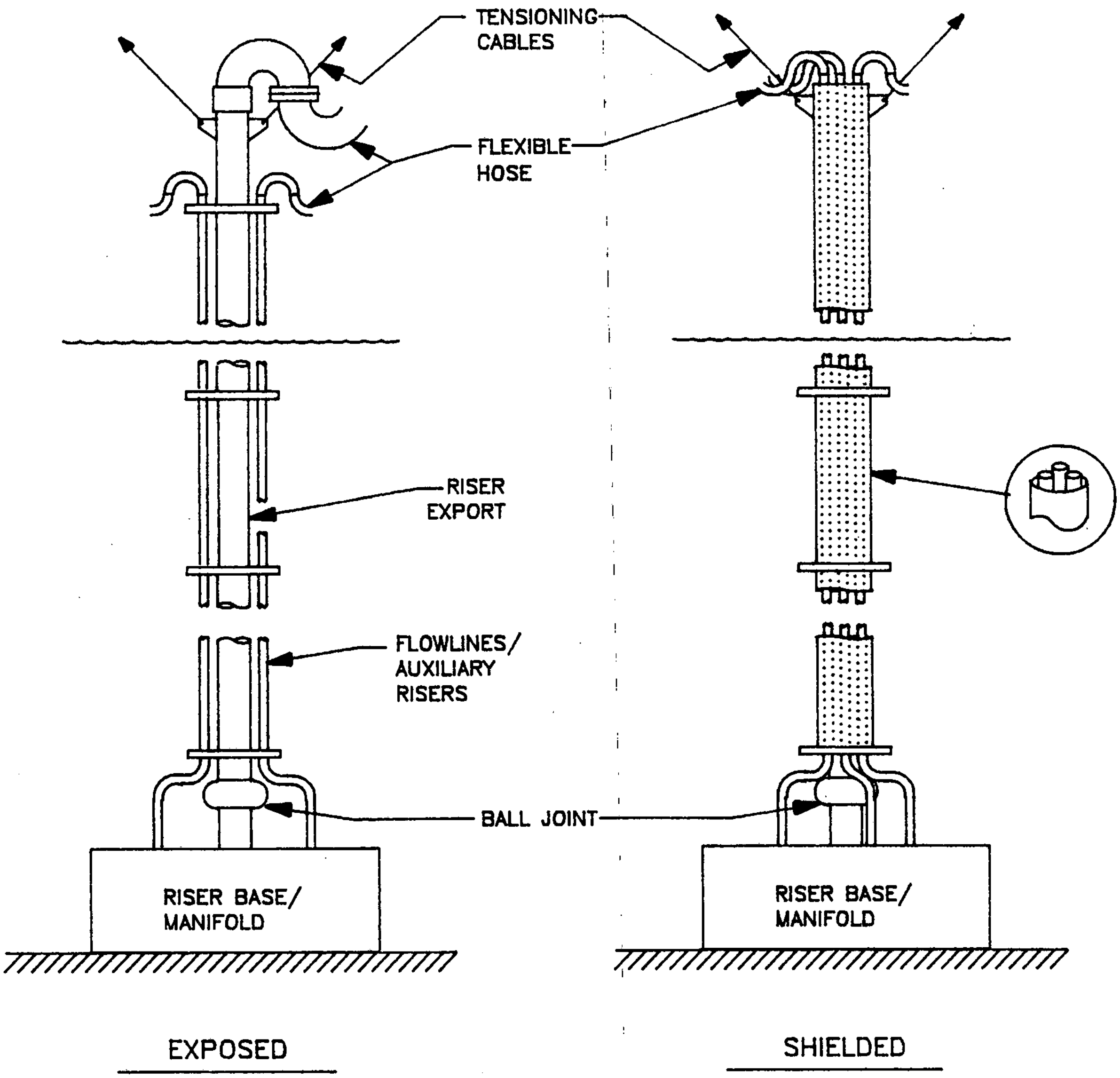

RISER SYSTEMS FOR SEMI-SUBMERSIBLES
RIGID
FLEXIBLE
INTEGRAL
NON-INTEGRAL
FREE HANGING
STEEP 'S'
LAZY 'S'
STEEP WAVE
LAZY WAVE

FIGURE 4.2-1



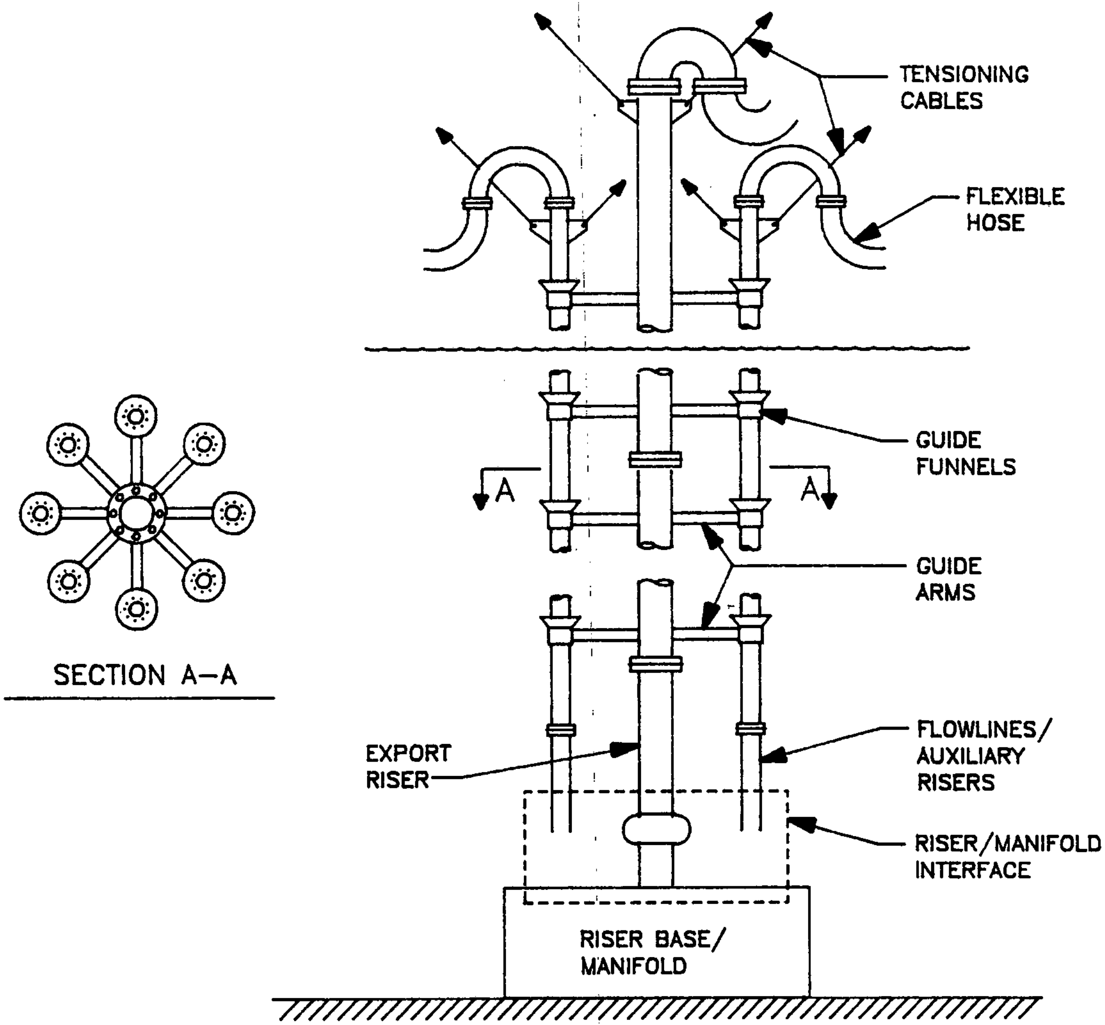
INTEGRAL PRODUCTION RISERS

FIGURE 4.2–2

A nonintegral riser is comprised of a main structural member, which is typically used as an export riser, and independently run flowline risers. The flowline riser are supported at regular intervals with guide arms mounted on the main member. A nonintegral riser was used in the Argyll Field Development, which was the first floating production system to be installed. Figure 4.2-3 illustrates a typical nonintegral rigid riser.

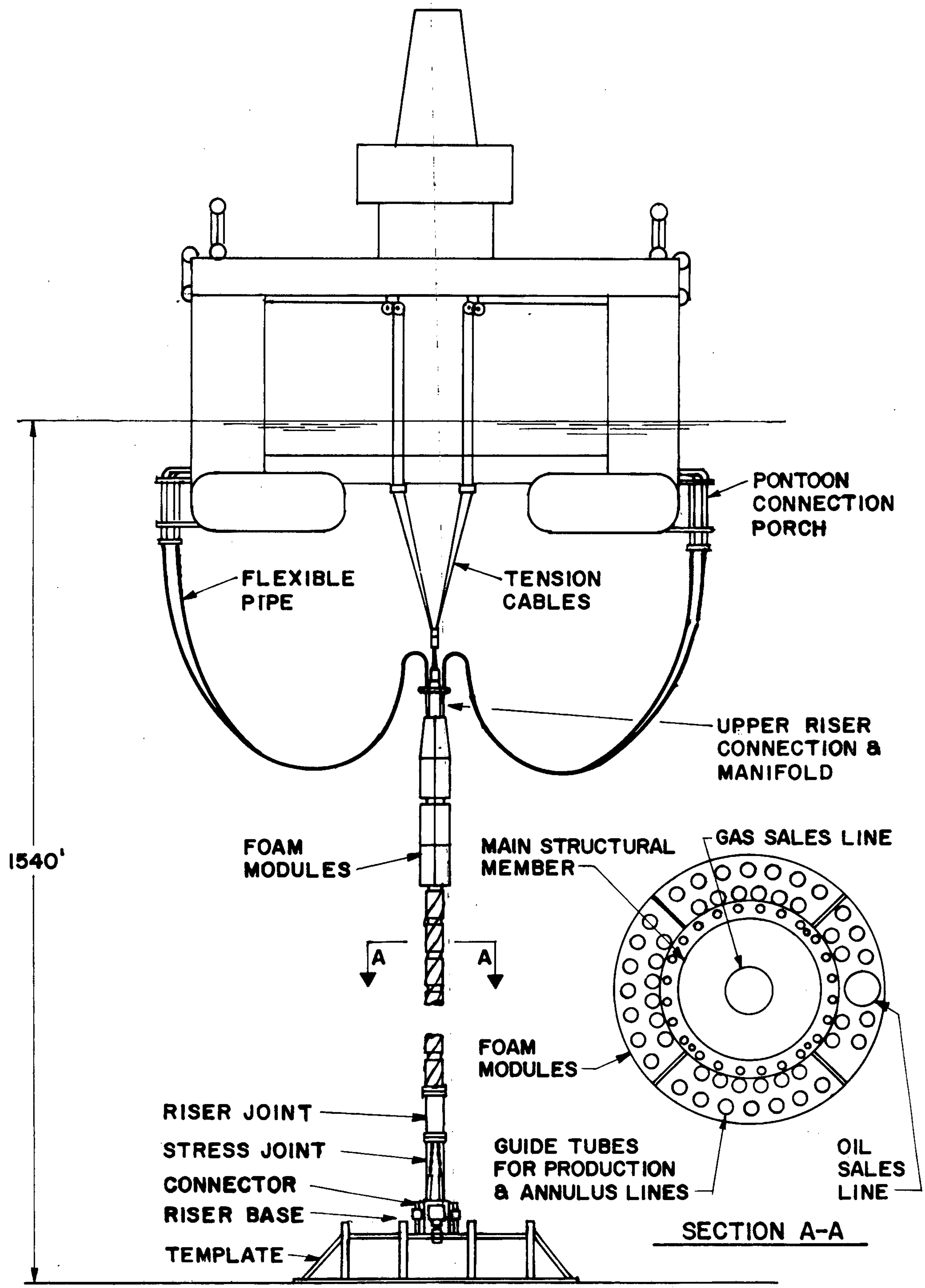
Another nonintegral riser system has recently been installed for the Placid Green Canyon Development in 1,524 ft. water depth. This riser has several unique features (see Figure 4.2-4). The riser is self supporting with both fixed and variable buoyancy methods. The self standing riser will be capable of remaining in place during a 100 year hurricane. A small tensioner is used only to provide a nominal 100 kip top tension to control the displacement envelope. The top of the rigid riser section terminates 139 ft. below water. An array of flexible risers are used at the top of the riser to complete the flowpath to the semisubmersible. A titanium tapered stress joint is used at the riser base to control the stresses. A total of 24 individual flowlines, 24 individual annulus access lines, two export flowlines, and a control umbilical are supported by the riser. This riser incorporates the latest technology in rigid nonintegral deepwater risers.

The installation of an integral rigid riser is very similar to that of a drilling riser. The riser is installed a joint at a time. The connections of each riser are integral to each joint. Once the riser has been run, all flowpaths are established concurrently. A nonintegral riser is installed by first running the main member. The exterior flowlines are then installed individually through guide funnels attached to the main member. The weight of the flowline risers must be carried by individual tensioners at the top of the riser. The guide funnels do not carry any weight of the flowline riser.



NON–INTEGRAL PRODUCTION RISER

FIGURE 4.2–3



PLACID RISER

FIGURE 4.2-4

Associated with the installation of each riser system is a riser base located on the subsea template. The riser base section of the template transfers the loads of riser through the template and into the seabed. There is also considerable amount of flowline tubing contained within the riser base which links the riser flowpaths to subsea trees or manifold.

The rigid riser systems described above could not be used to workover the subsea wells. A separate workover riser would be required to gain access to the well. The use of pumpdown techniques, however, could be used on non-commingled production systems to perform limited downhole functions. The tools would be pumped down the individual riser, through the template piping and subsea tree and into the well.

The maintenance of an integral riser would require the shutting-in of all production and the retrieval of the entire riser. The individual risers of a nonintegral riser system, on the other hand, can be retrieved separately and maintained without total interruption of production.

4.2.2 Flexible Riser Systems

Flexible riser systems have been used on several floating production facilities. Flexible riser systems are very adaptable to various field development scenarios. Their use may range from a simple satellite well extension to a full fledged flexible riser system, including production risers, injection risers, and export risers.

There is a wide range of configurations used for flexible risers. The environment plays a significant role in selecting the appropriate riser configuration. Some of the configurations which have been used include:

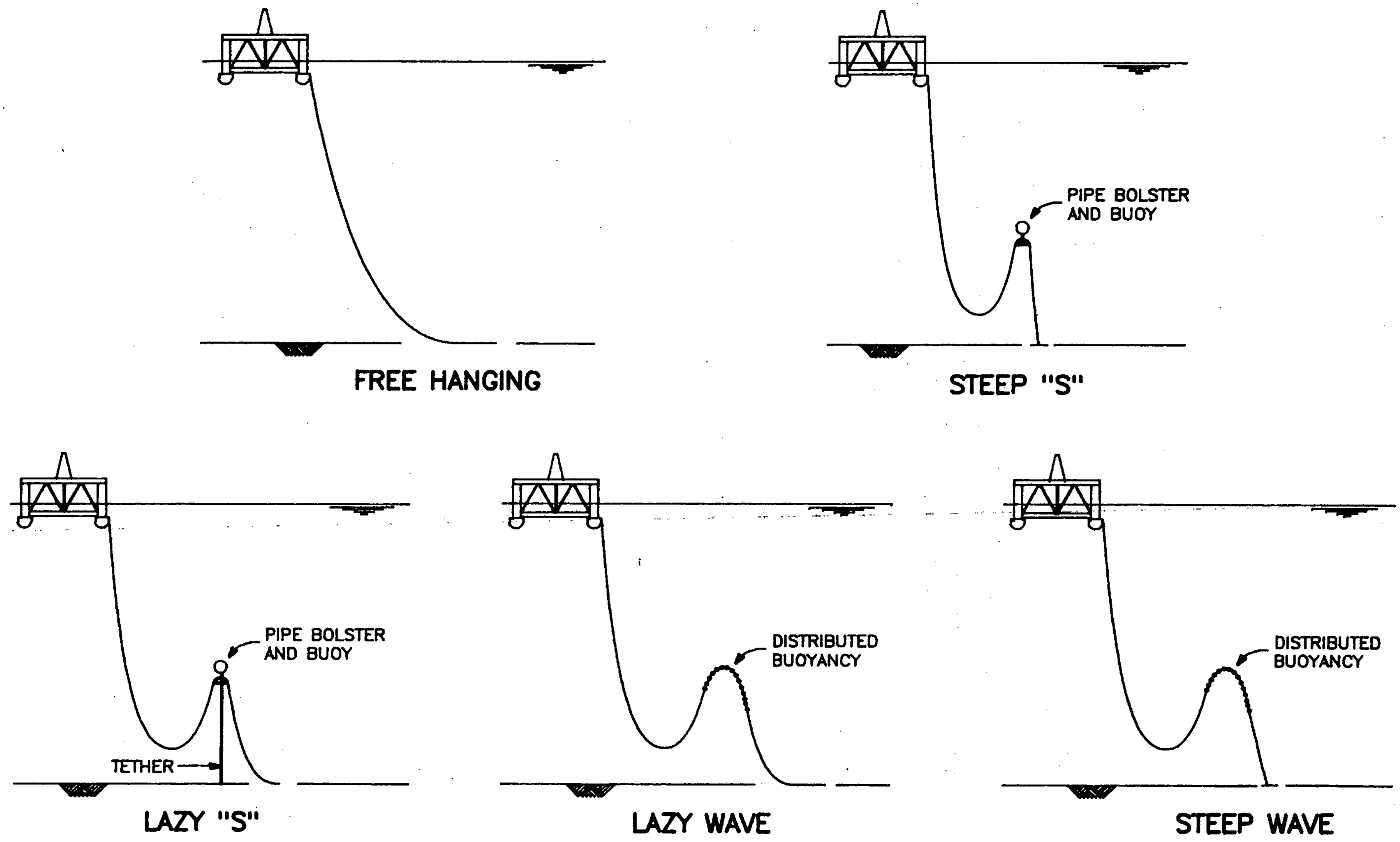
1) Free Hanging
2) Lazy Wave
3) Steep Wave
4) Lazy "S"
5) Steep "S"

The configurations mentioned above are illustrated in Figure 4.2-5. The catenary is frequently used for single satellite well or export riser applications. The riser and flowline/pipeline can be continuous from the surface to the well. The catenary riser configuration, however, is generally not suitable for extreme environmental conditions due to excessive bending of the riser at the seabed touchdown point.

The lazy wave and steep wave configurations use distributed buoyancy along the riser to decouple the vessel motion from the lower riser region. This type of configuration is more suitable for an extreme environment than the standard catenary.

The steep "s" and lazy "s" utilize a mid-arch pipe bolster and buoy. The pipe bolster limits the radius of the flexible pipe, while the buoy supports the weight of the free span and provides a restoring force. The steep "s" riser is usually used with a riser base, separate from the wellhead template. Both of these configurations perform very well in extreme environments.

Unlike rigid riser systems, the installation of flexible risers usually requires a dynamically positioned (DP) vessel. The flexible pipe is either carried on reels, or for short lengths, simply laid on the deck. The riser installation is sometimes performed with the flowline installation, particularly in the case of a satellite well or export pipelines. The retrieval of flexible risers for periodic repair or maintenance is usually not a part of the design criteria. The risers typically remain in place through the life of the facility.



FLEXIBLE RISER CONFIGURATIONS

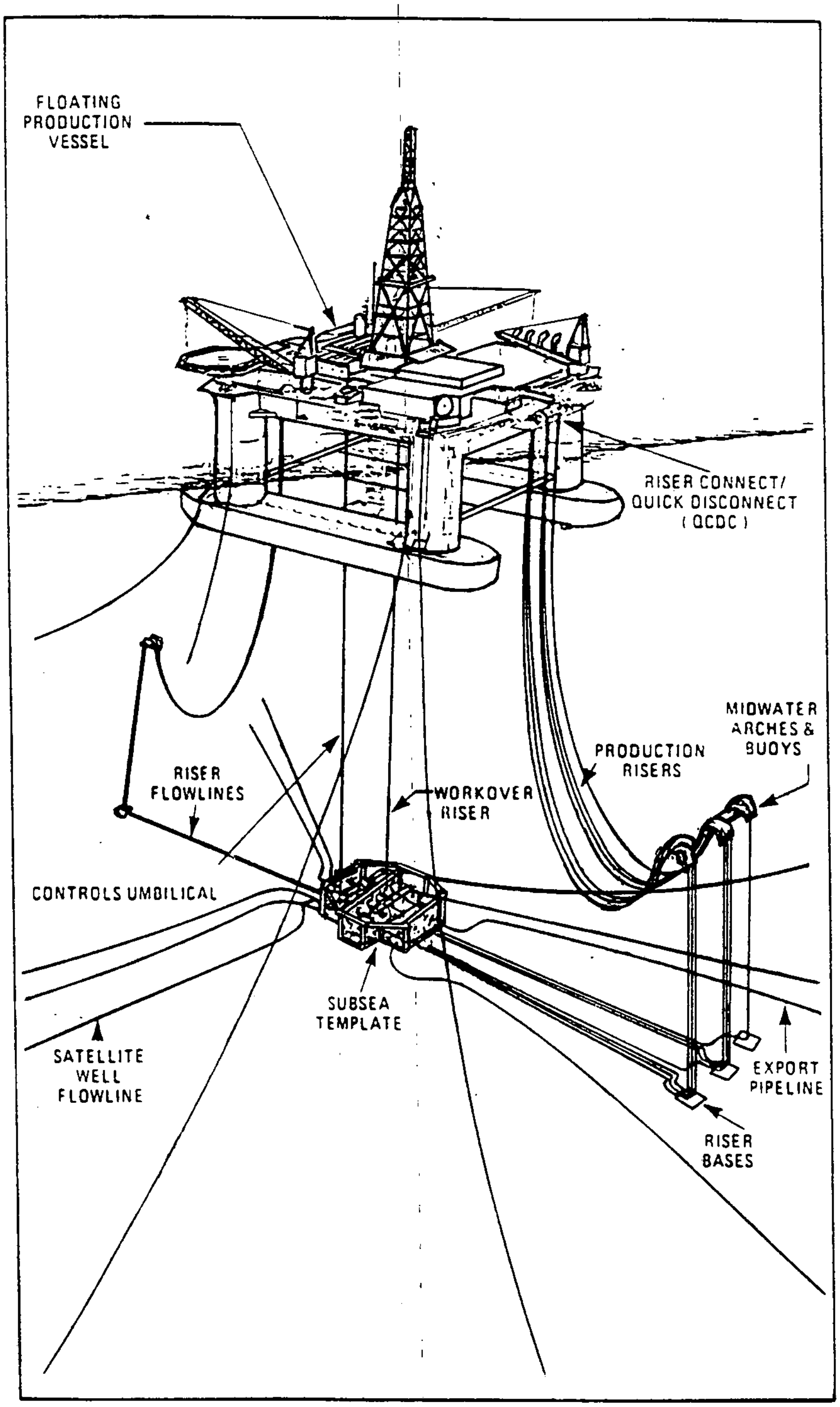
FIGURE 4.2–5

A feature which has been included in some flexible riser systems is a quick connect/disconnect at the surface. This top connection allows the riser to be temporarily disconnected from the semisubmersible in the event of an accident or severe environment. The riser would fall to the seabed with a retrieval line and buoy for later reconnection. As with integral and nonintegral rigid riser systems, flexible risers are not designed for well workovers. Pumpdown tools could be used for some applications. However, a workover riser is normally used to perform maintenance functions on the template subsea wells located beneath the semisubmersible.

The Balmoral field development project is a good example of a complete flexible riser system. Figure 4.2-6 illustrates the Balmoral riser system. The Steep S configuration was selected based, among other reasons, on the severe North Sea environment. The risers are designed to remain connected during severe weather. However, a quick disconnect feature was incorporated to allow the risers to be disconnected from the vessel during an emergency situation. A total of nine flexible risers comprise the system. The riser types and sizes are as follows:

1) 2 - 8" Water Injection
2) 2 - 8" Flowline Production
3) 1 - 4" Annulus Access
4) 1 - 4" Test & Kill
5) 1 - 4" Gas Lift
6) 1 - 8" Oil Sales
7) 1 - 4" Gas Sales

There are several factors which must be considered when selecting a riser system. The selection process is performed using specific requirements and constraints for the particular development project. There are some comparisons, however, which



BALMORAL FLEXIBLE RISER SYSTEM

FIGURE 4.2-6

have been made between the various riser systems which may assist the preselection process. Table 4.2-1 summarizes some of the advantages and disadvantages of each riser system.

4.3 TLP-FPS Riser Systems

This section describes the various types of risers which are used for a Tension Leg Platform (TLP), including production tieback riser, export riser, drilling riser, and risers for satellite wells. The discussion will be limited to existing riser systems, which utilize tieback production risers with surface trees. Figure 4.3-1 illustrates an individual riser tieback system for a TLP. There have been other types of riser systems proposed for TLPs which would use subsea production techniques. These other riser systems will be addressed in Section 5.5, New Concepts.

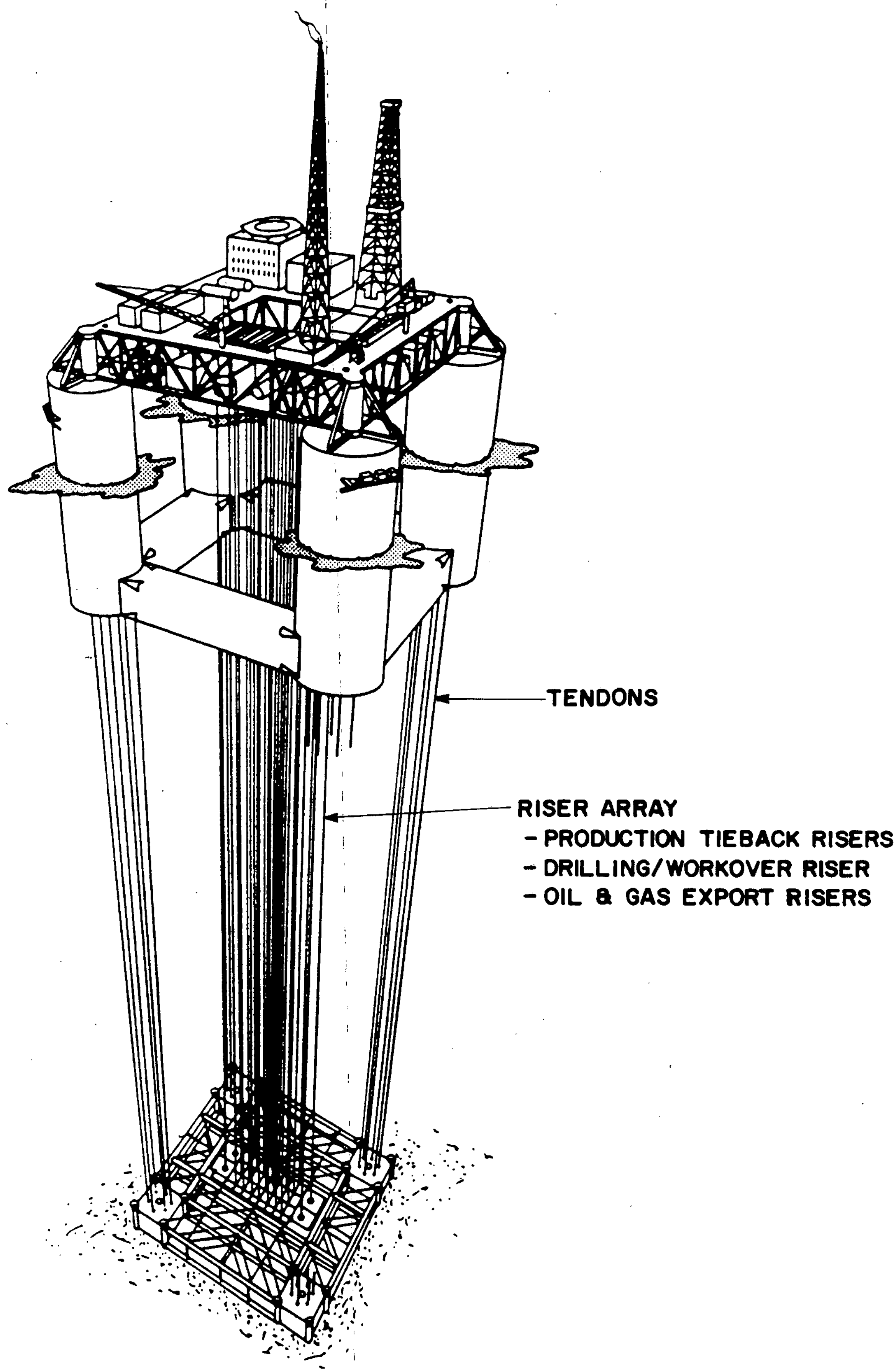
The only TLP to be installed, to date, is Conoco's Hutton in the North Sea. This TLP was installed in 490 ft. water depth in 1984. Conoco is nearing the completion of a second TLP project in the Jolliet Field, Gulf of Mexico. This TLP is planned to be installed in 1,760 ft. water depth in late 1989. The riser systems described in the following section will be based on these two TLP designs.

A principle design constraint on a TLP design is the platform payload. Because the performance of the TLP depends largely on the restoring buoyant force, every effort is made to minimize the load which the deck is required to carry. The riser top tension is a significant component of the total deck payload. Another principle design feature of a TLP which has a significant impact on the riser design is the limited heave motion. The TLP heave is almost negligible, when compared to that of a semisubmersible. The small amount of heave is easily accommodated in short slip joints and flexible jumper lines.

NON-INTEGRAL RISER	INTEGRAL RISER	FLEXIBLE RISER
• Simple construction	• Successful experience in deep water production tests by drilling vessels	• Remains connected in all weather conditions
• Ready availability of construction material (normally drill pipe)	• Deepwater application due to one tensioning system	• Higher cost
• Risers can be installed/retrieved individually	• Higher cost	• Limited technology for large diameters
• Each riser individually tensioned	• Rapid disconnect capability	• Requires subsea buoys to maintain tension in deepwater applications
• Complicated for deep water applications where large number of risers required	• Proven performance in harsh environments	• Rapid disconnect at surface capability
		• Relatively easier installation
		• Concern for dynamic loads in high currents
		• Limited workover capability

ADVANTAGES/DISADVANTAGES OF SEMI-SUBMERSIBLE BASED RISER SYSTEMS

TABLE 4.2-1



TLP RISER SYSTEM

FIGURE 4.3-1

4.3.1 Production Tieback Risers

The production tieback risers are very similar to conventional fixed jacket wellhead conductors. In both structures, a conductor is used to provide a direct vertical access from the platform deck to the well. The trees are located on the platform deck and conventional land based production techniques are employed. The tieback risers for a TLP, however, are only supported at the top and bottom of the riser. The riser must be tensioned to limit the bending stress.

A typical production tieback riser is shown in Figure 4.3-2. The main components, starting from the top, include; tree, tensioner, riser joints, the lower tapered stress joint, and the tieback connector. The riser joint is constructed from conventional threaded conductors. The diameter of the tieback risers for the Hutton TLP and Jolliet TLP is 9-5/8 inch. The production tubing is run within the tieback riser. The annulus between the tubing and tieback riser is filled with inhibited seawater.

4.3.2 Export Risers

The export risers used for the Hutton TLP are conventional vertical steel risers. The riser joints and connectors are very similar to a drilling riser. A riser base is used to connect the riser to the export pipelines. Figure 4.3-3 shows the main components of the Hutton export riser.

Flexible catenary risers are used as export risers for the Jolliet Field TLP. The flexible pipe is routed through "pull tubes" down to the pontoon of the hull. The top tension required for a flexible export riser is much lower than for a steel rigid riser.

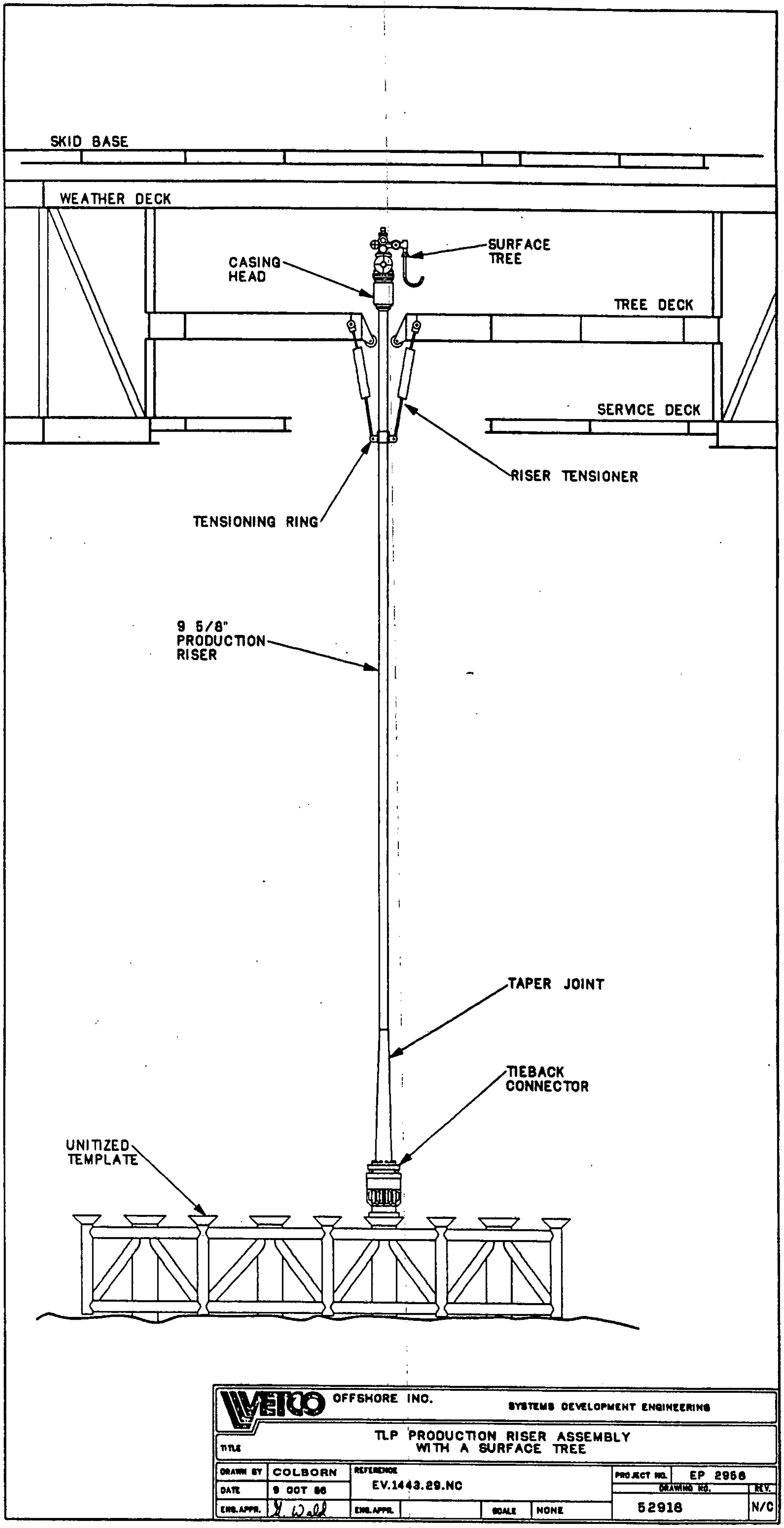
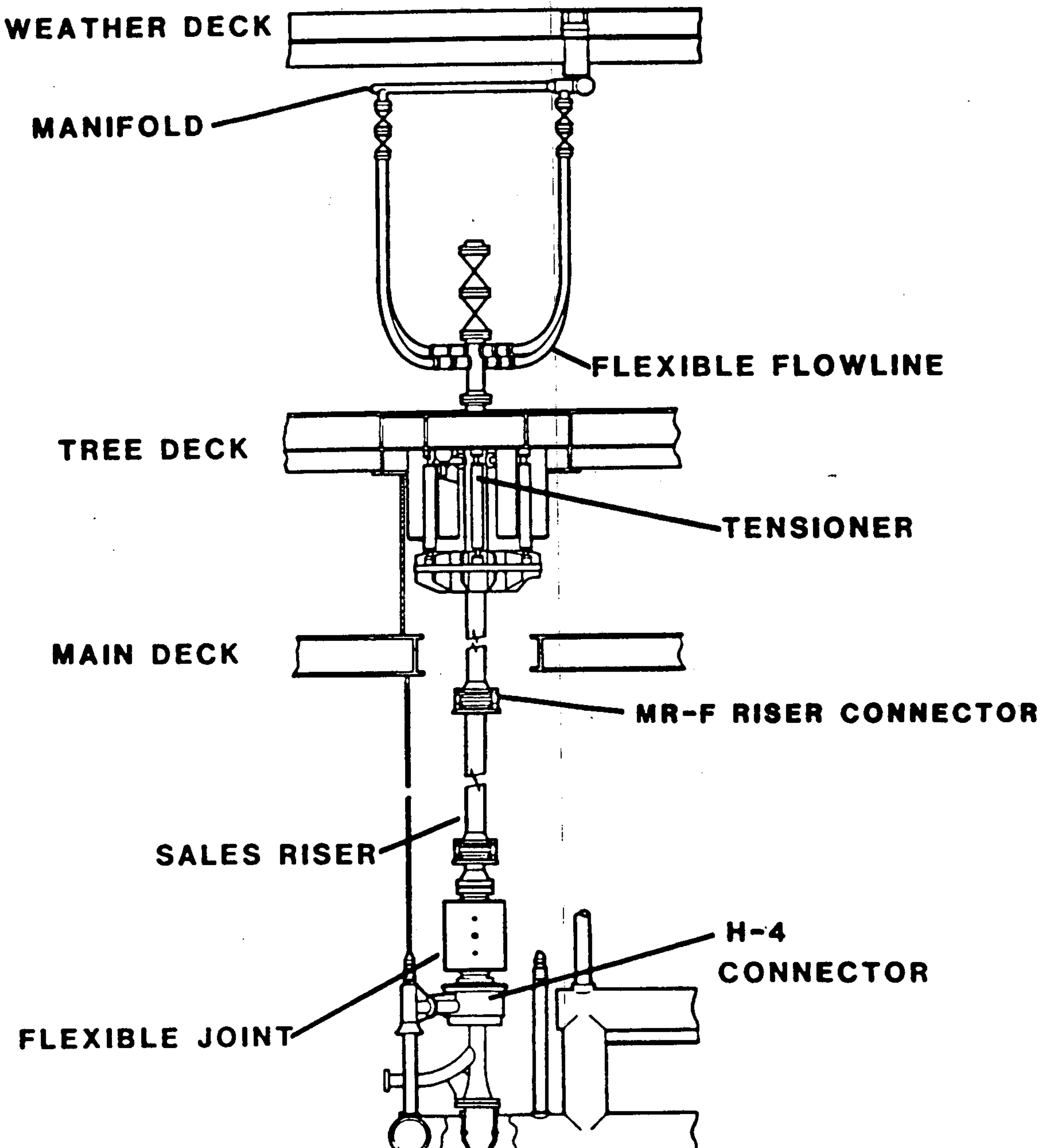

SKID BASE
WEATHER DECK
SURFACE TREE
CASING HEAD
TREE DECK
SERVICE DECK
RISER TENSIONER
TENSIONING RING
9 5/8" PRODUCTION RISER
TAPER JOINT
TIEBACK CONNECTOR
UNITIZED TEMPLATE
VETCO OFFSHORE INC.
SYSTEMS DEVELOPMENT ENGINEERING
TITLE
TLP PRODUCTION RISER ASSEMBLY WITH A SURFACE TREE
DRAWN BY COLBORN
DATE 9 OCT 86
ENG. APPR.
REFERENCE EV.1443.29.NC
ENG. APPR.
SCALE NONE
PROJECT NO. EP 2958
DRAWING NO. 52918
REV. N/C

FIGURE 4.3–2

SALES RISER ASSEMBLY



50938A

VETCO

FIGURE 4.3-3

4.3.3 Drilling Risers

The drilling riser system used on the Conoco Hutton TLP was a surface BOP stack and a high pressure drilling riser, as shown in Figure 4.3-4. The major components of this system include the lower riser package, high pressure drilling riser, drilling riser tensioner, tensioning spool, surface BOP stack, and slip joint. All wells were drilled from the TLP. The drilling riser can also be used to workover the wells for major workovers.

The Jolliet Field TLWP, on the other hand, does not have a drilling riser. All the wells will be pre-drilled using a semisubmersible drill rig. The TLWP will complete the wells with the tieback risers and production tubing. A small workover riser will be provided for workovers which cannot be performed through the tieback riser.

4.3.4 Risers for Satellite Wells

The risers for satellite wells can be rigid steel, with flowlines connecting the well to the riser base template, or flexible. Early designs of the Jolliet Field TLWP included several satellite wells. Flexible catenary risers were designed to connect the satellite well to the platform production facilities. As with the flexible export risers, the flexible satellite risers were routed to the lower pontoons and columns via steel pull tubes.

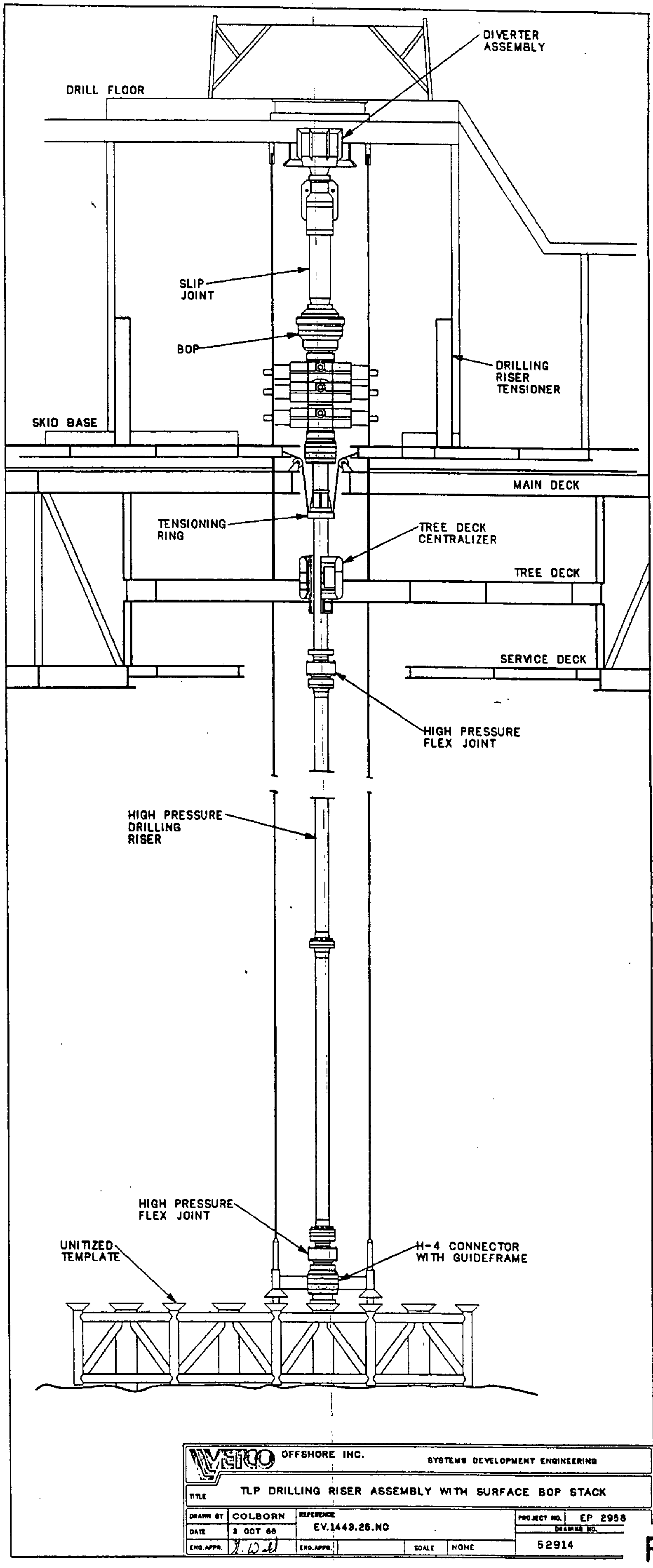

DIVERTER ASSEMBLY
DRILL FLOOR
SLIP JOINT
BOP
DRILLING RISER TENSIONER
SKID BASE
MAIN DECK
TENSIONING RING
TREE DECK CENTRALIZER
TREE DECK
SERVICE DECK
HIGH PRESSURE FLEX JOINT
HIGH PRESSURE DRILLING RISER
HIGH PRESSURE FLEX JOINT
UNITIZED TEMPLATE
H-4 CONNECTOR WITH GUIDEFRAME
OFFSHORE INC.
SYSTEMS DEVELOPMENT ENGINEERING
TITLE
TLP DRILLING RISER ASSEMBLY WITH SURFACE BOP STACK
DRAWN BY
COLBORN
DATE
3 OCT 86
ENG. APPR.
REFERENCE
EV.1443.25.NC
ENG. APPR.
SCALE
NONE
PROJECT NO.
EP 2958
DRAWING NO.
52914

FIGURE 4.3–4

5.0 RISER INTERFERENCE

The subject of riser interference is addressed in this section. The areas where riser interference are of concern are identified. The various types of potential riser interference are described. Methods of calculating riser interference are discussed. Some possible solutions to eliminate interference are mentioned, as well as their impact on the floating production system design. This section concludes with a discussion of new concepts that will likely play a roll in future deepwater riser designs.

5.1 Areas of Concern

Riser interference is a concern which must be addressed, in some form, for most every deepwater floating production system. The collision of a riser, whether it be a drilling, production, or sales riser, with any object, such as another riser or platform hull, is a condition which should be avoided. The consequences of such a collision could vary from minor structural damage to a complete riser failure. The failure of a riser would certainly lead to a catastrophic situation.

There are several possible types of riser interference, which include the following:

1) Riser to riser
2) Riser to hull
3) Riser to TLP tendon or mooring line

The interference potential varies with the operating mode. The two principle modes of operation which must be considered include:

1) Installation (running/retrieval)
2) In-place during extreme event storm

The various types of riser interference will be briefly considered for all common types of riser systems, for both TLP and semisubmersible based production systems. The potential for the various type of interference will be assessed, so that the more critical areas of interference may be identified. These critical areas will serve as the focal point in the subsequent sections.

5.1.1 Riser Interference Potential: Semisubmersible Riser Systems

The two basic riser systems for a semisubmersible floating production systems are rigid and flexible. In a rigid riser system, weather it be integral or nonintegral, the production riser is typically located at one end of the subsea template. A riser-to-riser interference could occur between the production riser and the drilling or workover riser. Figure 5.1-1 illustrates a potential interference situation between a rigid production riser and a drilling/workover riser. This situation is typically eliminated by locating the riser base a sufficient distance from the nearest well bay or applying sufficient tension to the guidelines on the drilling/workover riser. Since rigid risers are typically retrieved during extreme events for semisubmersible systems, the clearance is usually based on environmental conditions less than the extreme design event. Therefore, eliminating riser to riser interference in a semisubmersible based rigid riser system can usually be achieved without imposing on other system design constraints.

The riser to hull interference potential for a rigid riser system depends largely on the configuration of the semisubmersible. The potential problem area is the structural bracing. The problem

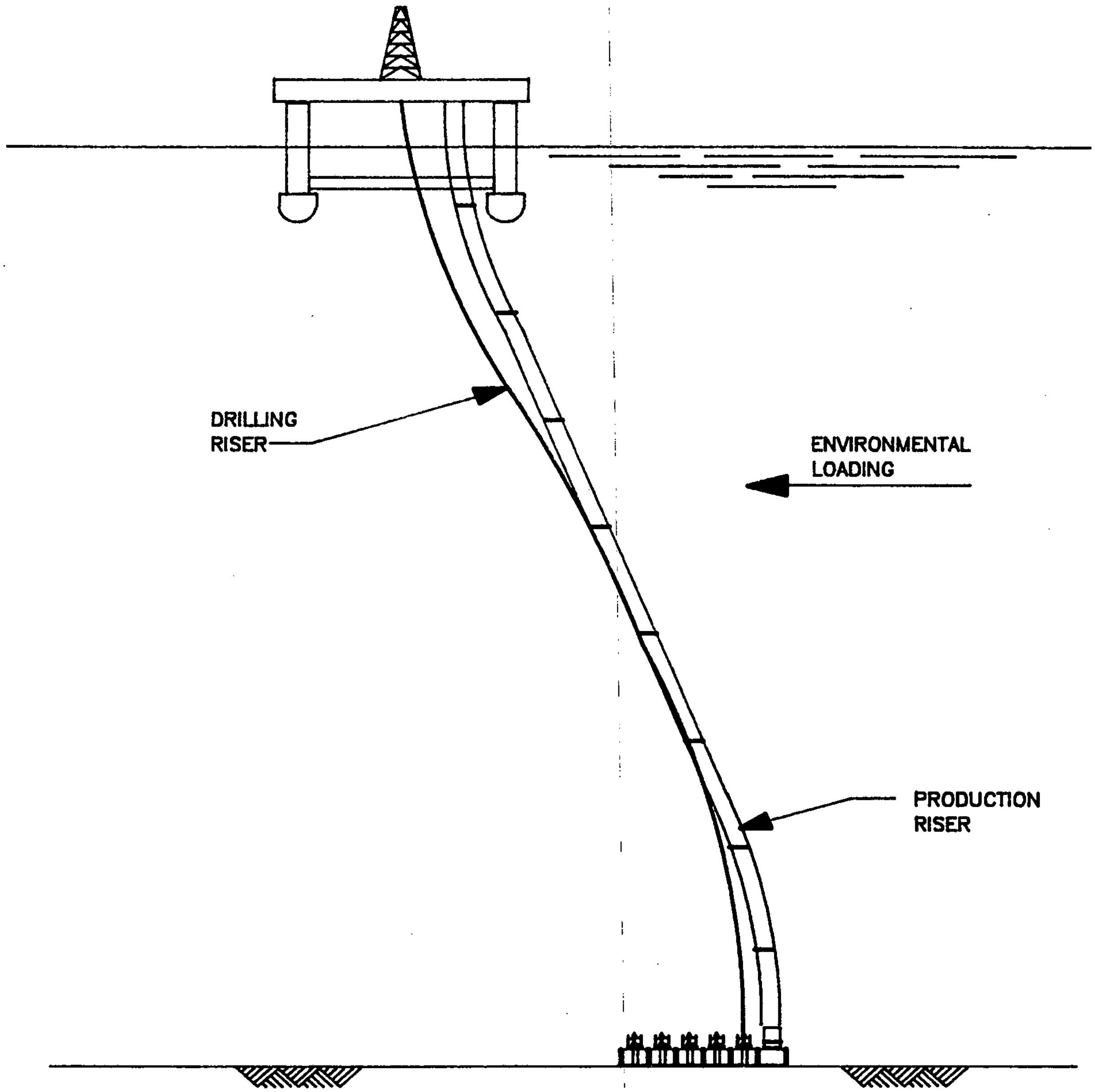
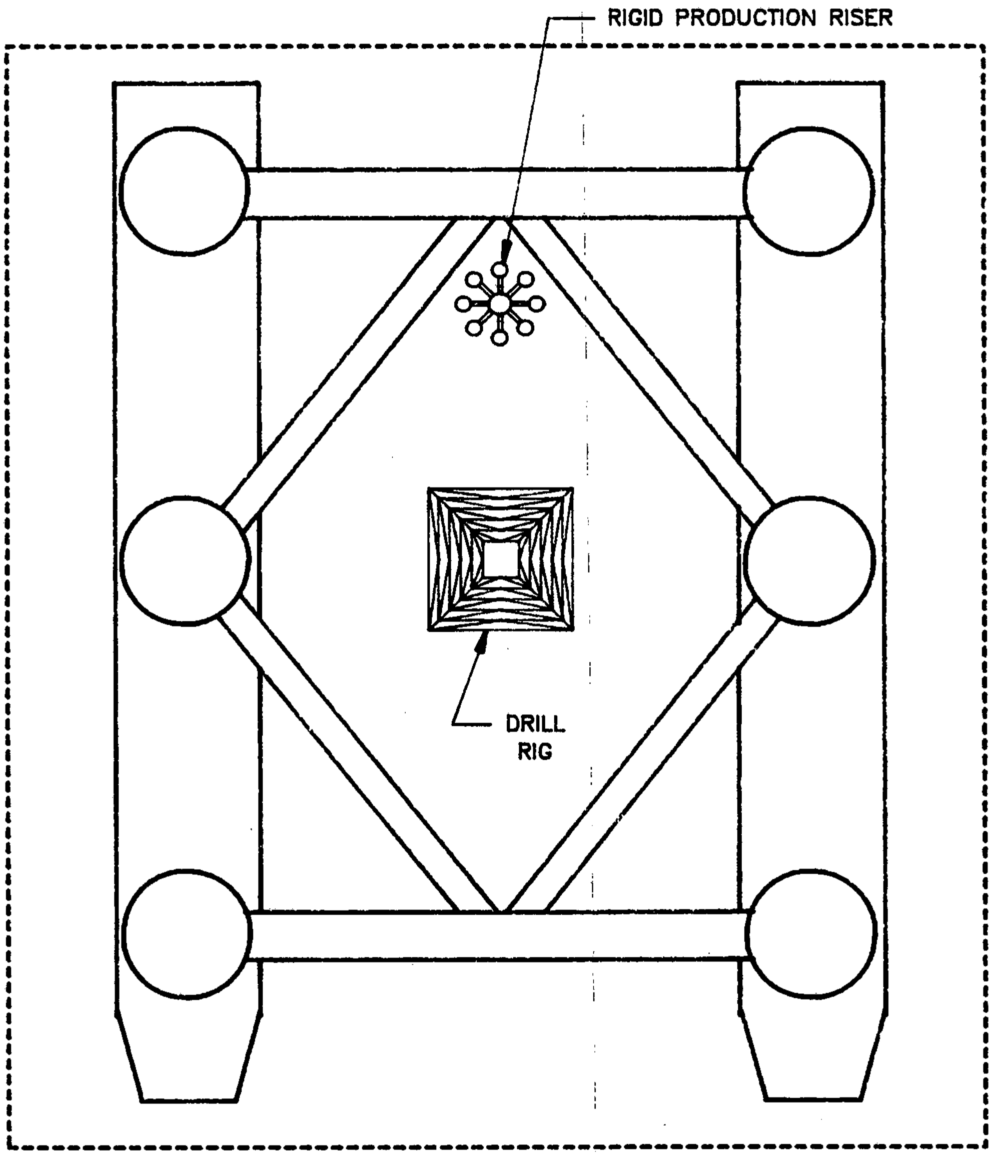


FIGURE 5.1-1

can be made more difficult in semisubmersible conversions, where the structural design was performed without regard to future clearance requirements. Figure 5.1-2 is a plan view of a semisubmersible with a large diameter rigid production riser located near one end. The center area remains open for access with the drilling/workover riser. Providing clearance between rigid production risers and semisubmersible hulls is generally a structural design issue. For purpose built semis, the bracing is often eliminated to provide open areas for production risers. Converted semis could require structural modification to provide the necessary clearance. In either case, the solution is typically achieved without a significant impact to the overall system design.

The interference between a rigid production riser and a mooring line for a semisubmersible is usually not applicable. The mooring lines generally depart the semi outboard from the column. Therefore, the vertical rigid riser would contact the hull long before interfering with the mooring lines.

The interference potential for a flexible riser system for a semisubmersible is far different than that of a rigid riser system. The concern with a riser to riser interference lies not with the drilling/workover riser, but with the various flexible risers. In many flexible riser systems, the risers are closely spaced as they depart the vessel. Due to the high degree of flexibility, the risers can experience large deflections from current loadings. The deflections have been found to be dependent on the diameter to weight ratio of the riser. If adjacent risers have different diameter to weight ratios and are closely spaced, then interference must be considered. However, there are several solutions which have been used to eliminate the interference potential. One possible solution is to alter the configuration and departure from the vessel so that there is



TYPICAL SEMI-SUBMERSIBLE BRACING

FIGURE 5.1-2

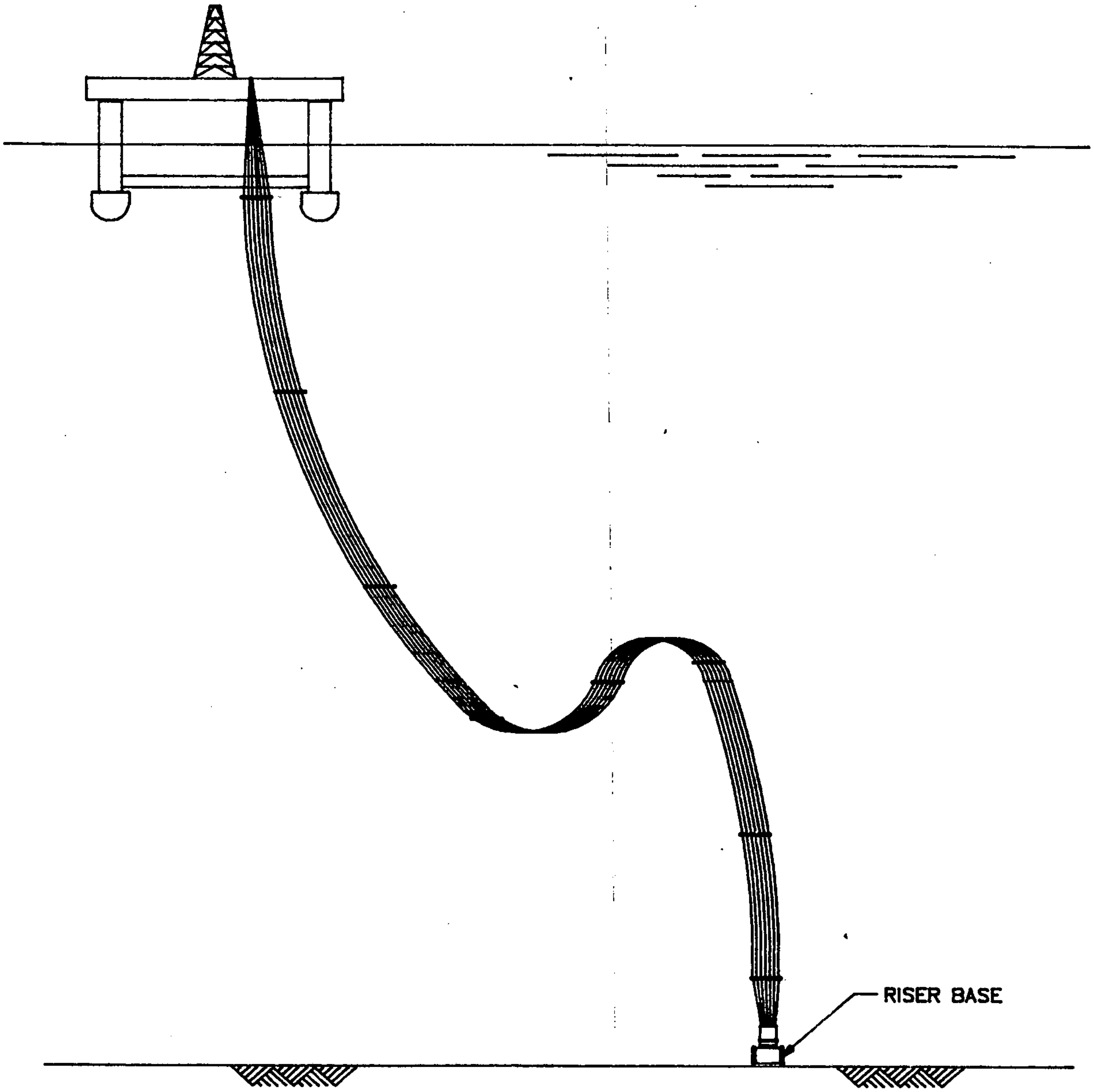
sufficient clearance between risers. Another method is to use a ribbon-type connection to tie the risers together. Figure 5.1-3 illustrates this type of connection, which controls the spacing between risers.

The potential for a flexible riser to interfere with the hull or mooring line depends upon the placement of the attachment point of the riser to the vessel and the response of the flexible riser. To avoid the interference potential, the flexible riser attachment point to the vessel is often located at the outer edge of the lower deck. In general, lowering the attachment point will reduce the interference potential. In the extreme, the flexible pipe could be attached to the vessel at the pontoon level, which would effectively eliminate all risk of interference with the hull.

Table 5.1-1 summarizes the interference potential for semisubmersible based riser systems. The assessment of the potential has been generalized and should not be considered valid for all cases. It should also be noted that the rating reflects the interference potential and the ability to eliminate the interference. For example, the interference potential between two flexible risers could be extremely high for the initial design, but could be easily eliminated by relocating the risers or using a mechanical device to connect the risers. Therefore, the riser to riser type interference for a flexible riser systems is given a low rating.

5.1.2 Riser Interference Potential: TLP Riser Systems

The riser to riser interference is of particular concern in the TLP riser systems. Figure 5.1-4 shows schematically interference of two adjacent risers in a TLP. The potential for this type of interference is greatest between risers of differing size, mass,



RIBBONED FLEXIBLE RISER

FIGURE 5.1–3

RIGID RISER SYSTEMS

TYPE / MODE	RISER TO RISER	RISER TO HULL	RISER TO MOORING
RUNNING/ RETRIEVAL	LOW	LOW	N/A
IN-PLACE MAX. STORM	N/A	N/A	N/A

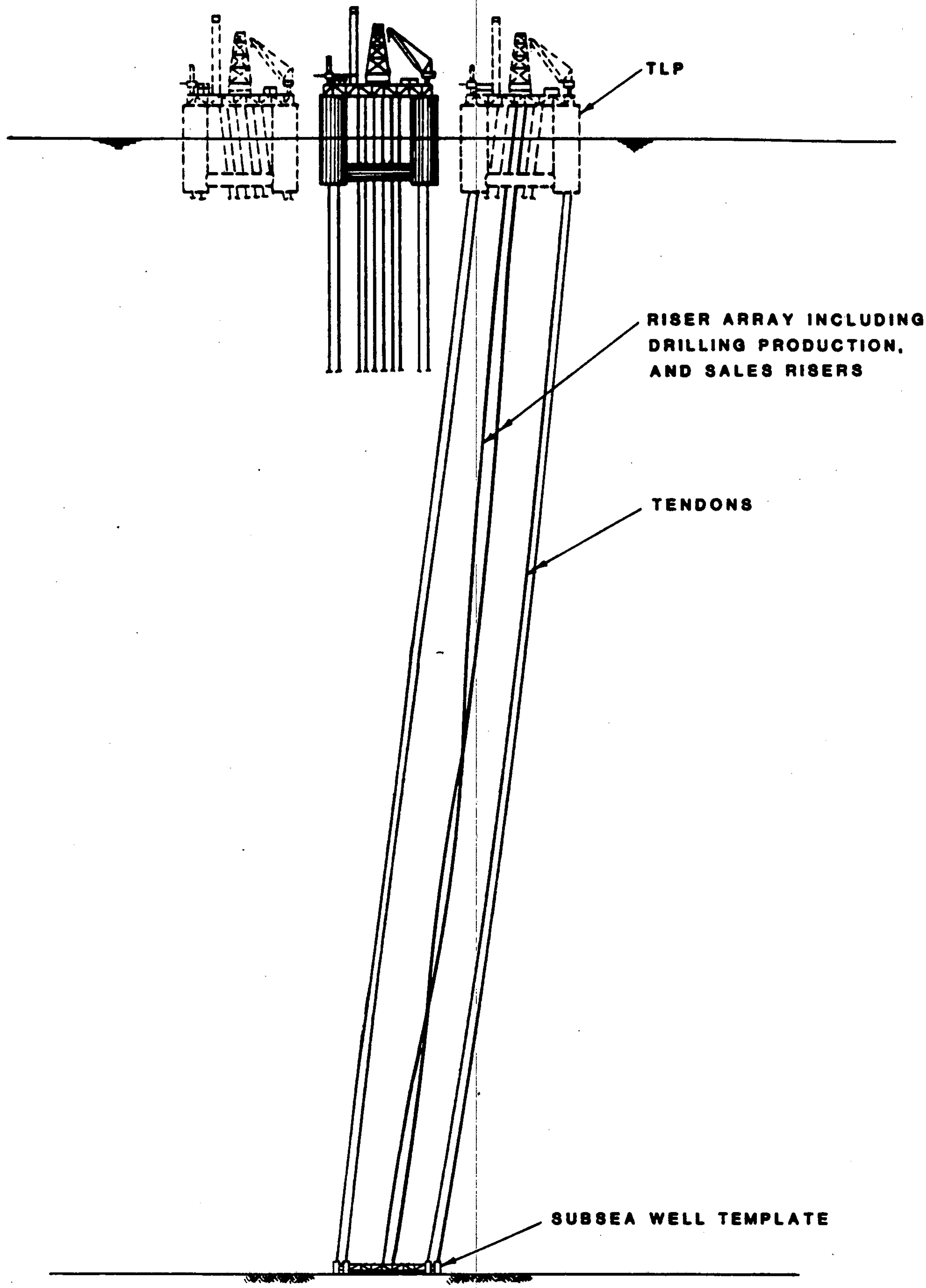
FLEXIBLE RISER SYSTEMS

TYPE / MODE	RISER TO RISER	RISER TO HULL	RISER TO MOORING
RUNNING/ RETRIEVAL	LOW	LOW	LOW
IN-PLACE MAX. STORM	MEDIUM	MEDIUM	LOW

RISER INTERFERENCE POTENTIAL

SEMI-SUBMERSIBLE BASED RISER SYSTEMS

TABLE 5.1-1



RISER—TO—RISER INTERFERENCE PROBLEM

FIGURE 5.1—4

and top tension (eg. drilling and production). The two different risers will have different response envelopes. The response envelopes may overlap, which would indicate contact between the risers.

The risk of interference varies for different operating modes. One of the most critical times during which riser to riser interference may occur is when the risers are being run or retrieved. Some form of guidance system is required in order to position the riser being run within the existing riser array. The most common example of this operating mode is the drilling of a well next to previously completed wells with the tieback risers in place. If a subsea BOP stack is used, the size and exposed drag area compounds the clearance problem. A current loading displaces the drilling riser downstream. The tension in the drilling riser guide line system must be increased with increasing water depth and current loading to prevent interference.

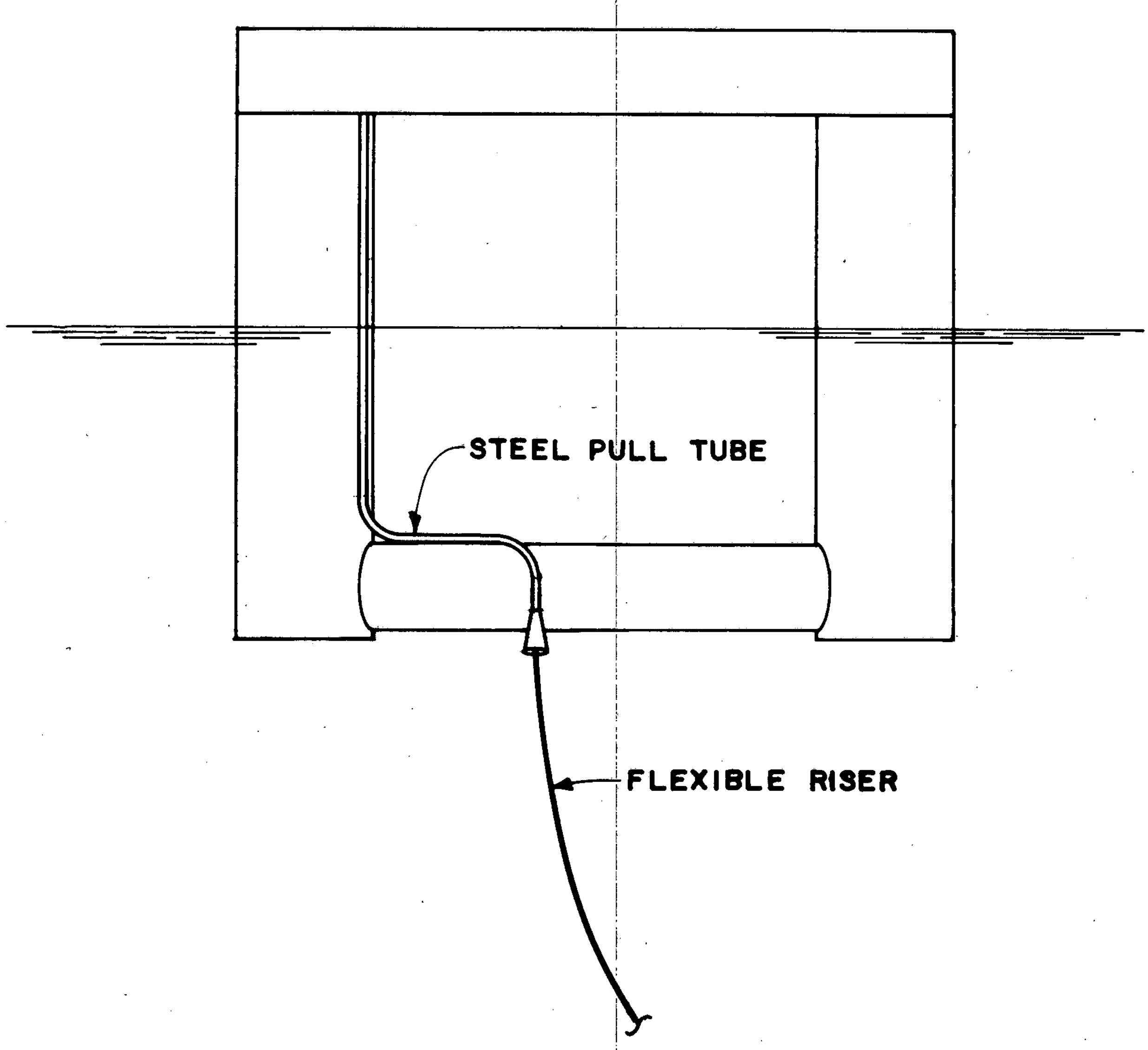
The potential for a rigid production, sales, or drilling riser to contact the TLP hull is much lower than the previously discussed riser to riser interference. As with semisubmersibles, the problem is very dependent on the configuration of the hull design. If the hull is designed with diagonal braces between pontoons, the distance between the tieback risers and hull bracing may be reduced considerably.

The potential for a flexible export or satellite well riser to contact the hull can vary greatly. If the flexible risers are simply hung from the lower deck, near the production risers, the potential for interference is extremely high. Because flexible risers can experience very large lateral deflections, it is desirable to design the system so that the flexible risers depart the TLP away from the tieback risers. One possible solution to eliminate contact between flexible risers and the hull is to use rigid "pull tubes" to guide the flexible pipe from the deck, through the wave zone, past the hull. The pull tubes are continuous steel pipe which are preinstalled to the TLP hull and routed in such a way to provide an exit outbound from the hull and production risers.

Figure 5.1-5 illustrates a typical pull tube with a flexible riser in place. There are alternatives to the pull tube concept, but the primary objective in a flexible riser system is to locate the riser exit point well away and below the hull and production tieback risers.

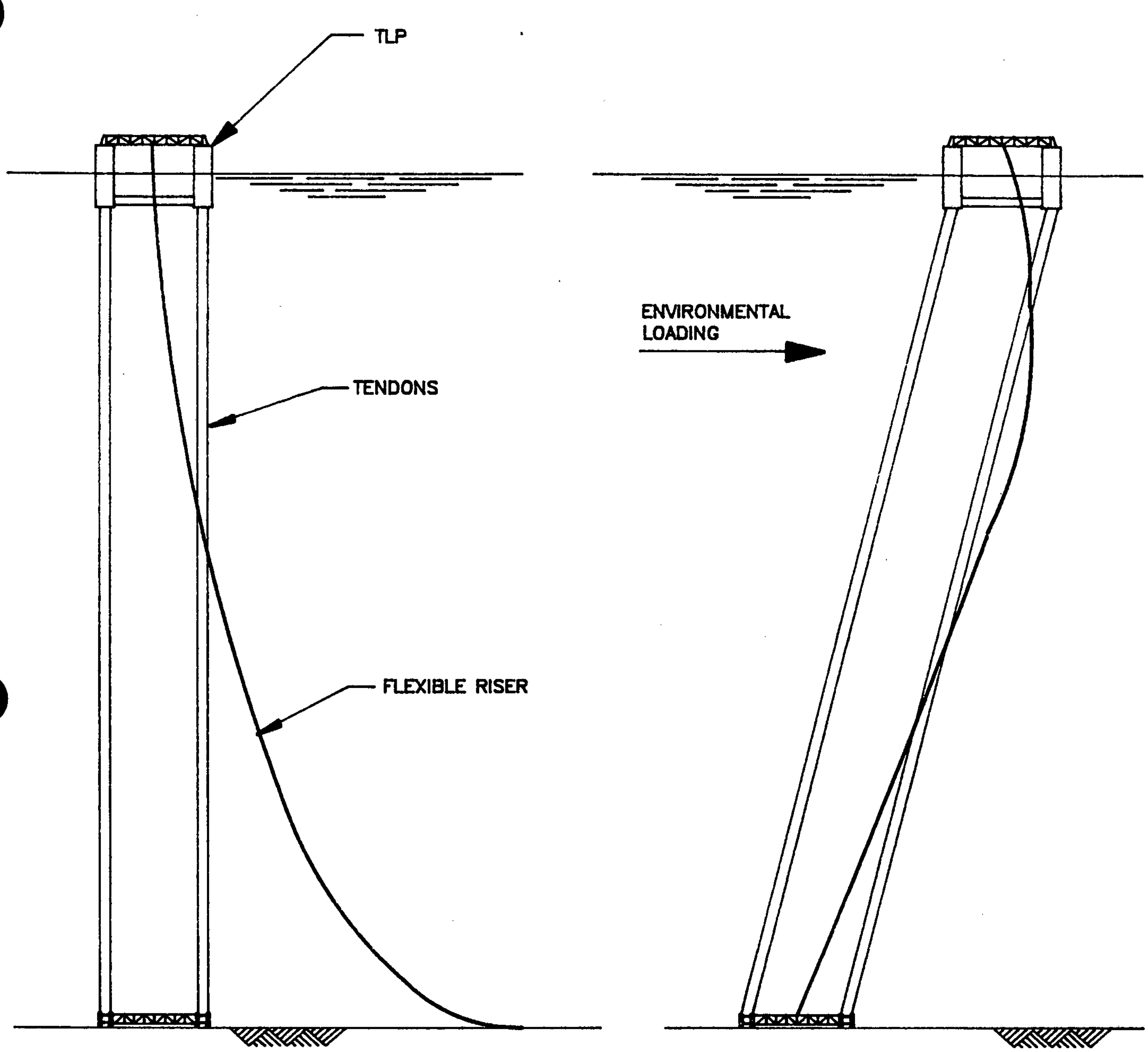
As with riser to hull interference, the potential for a rigid tieback riser to interfere with a TLP tendon is extremely low. The more likely area of concern is with a flexible riser and tendon interference. In deep water TLP projects, the probable configuration of a flexible riser is a simple catenary, or free hanging. The shape of the catenary must be designed so that when the TLP horizontal excursion (surge) is at a maximum, the flexible riser does not experience either excessive tensions or excessive bending radii. The resulting shape then needs to be evaluated with regard to interference with the TLP tendons. Eliminating this type of interference is a matter of adjusting the departure location and orientation from the TLP. Figure 5.1-6 illustrates this type of interference.

The interference potential for TLP riser systems is assessed and summarized in Table 5.1-2. Again, the ratings are relative and are for illustrative purposes only. A significant point to be made, however, is the higher interference potential associated with TLP riser systems. While riser interference in a semisubmersible based production system is a design consideration, the solutions to overcome interference are more



TYPICAL FLEXIBLE RISER PULL TUBE

FIGURE 5.1–5



RISER TO TENDON MOORING SYSTEM INTERFERENCE

FIGURE 5.1–6

RIGID EXPORT RISERS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO TENDON
RUNNING/ RETRIEVAL	HIGH	LOW	N/A
IN-PLACE MAX. STORM	HIGH	LOW	N/A

FLEXIBLE EXPORT RISERS

MODE \ TYPE	RISER TO RISER	RISER TO HULL	RISER TO TENDON
RUNNING/ RETRIEVAL	HIGH	LOW	LOW
IN-PLACE MAX. STORM	HIGH	MEDIUM	MEDIUM

RISER INTERFERENCE POTENTIAL

TLP BASED RISER SYSTEMS

TABLE 5.1-2

straightforward. The solutions for riser to riser clearance in a TLP based system are not well defined, especially for increased water depths. A total system design effort is required to ensure riser clearance in a conventional TLP riser system. There are also economical implications due to increased riser top tension or wellbay spacing which must be considered. For the abovementioned reasons, the remainder of this section will be dedicated to the problem of riser to riser interference in a TLP.

5.2 System Design Considerations

Eliminating riser interference in a TLP is not an isolated problem. If it were, the well system and riser top tension could be increased indiscriminately until sufficient clearance is obtained. Increasing these two critical parameters, however, has a significant impact on the total system design.

The most important factor used in controlling the riser response envelope is the riser top tension. Increasing the top tension will reduce the response envelope, while decreasing the tension will have the opposite effect. Given a response envelope, the well spacing could then be adjusted until the desired amount of clearance between risers was obtained. This simplistic approach can be applied with success to TLPs in mild environments, or relative shallow water. However, the impact of increased top tension and well spacing escalates as the water depth increases and the environment becomes more severe. Therefore, a total system design effort must be considered in evaluating the riser interference problem and obtaining alternative solutions.

The fundamental principle behind a TLP is the reliance on platform buoyancy. A penalty must be paid when any weight is added to the platform, which reduces the available buoyancy The penalty is an increase in platform size and cost. Increasing the riser top tension, therefore, reduces the riser response envelope to the detriment of the platform buoyancy.

Eliminating the riser interference by increasing the well spacing also opposes the goal of minimizing the size of a TLP. At some upper limit, the well spacing or riser top tension could render the TLP concept uneconomical for a given field development project.

5.3 Interference Analysis

This section presents the techniques which have been used to assess riser interference. The primary area of concern is the riser interference between two tensioned risers. The analysis procedure for a riser to hull or riser to tendon clearance problem is very similar, and will be discussed. This section concludes with a summary of critical factors which should be considered in performing interference analysis.

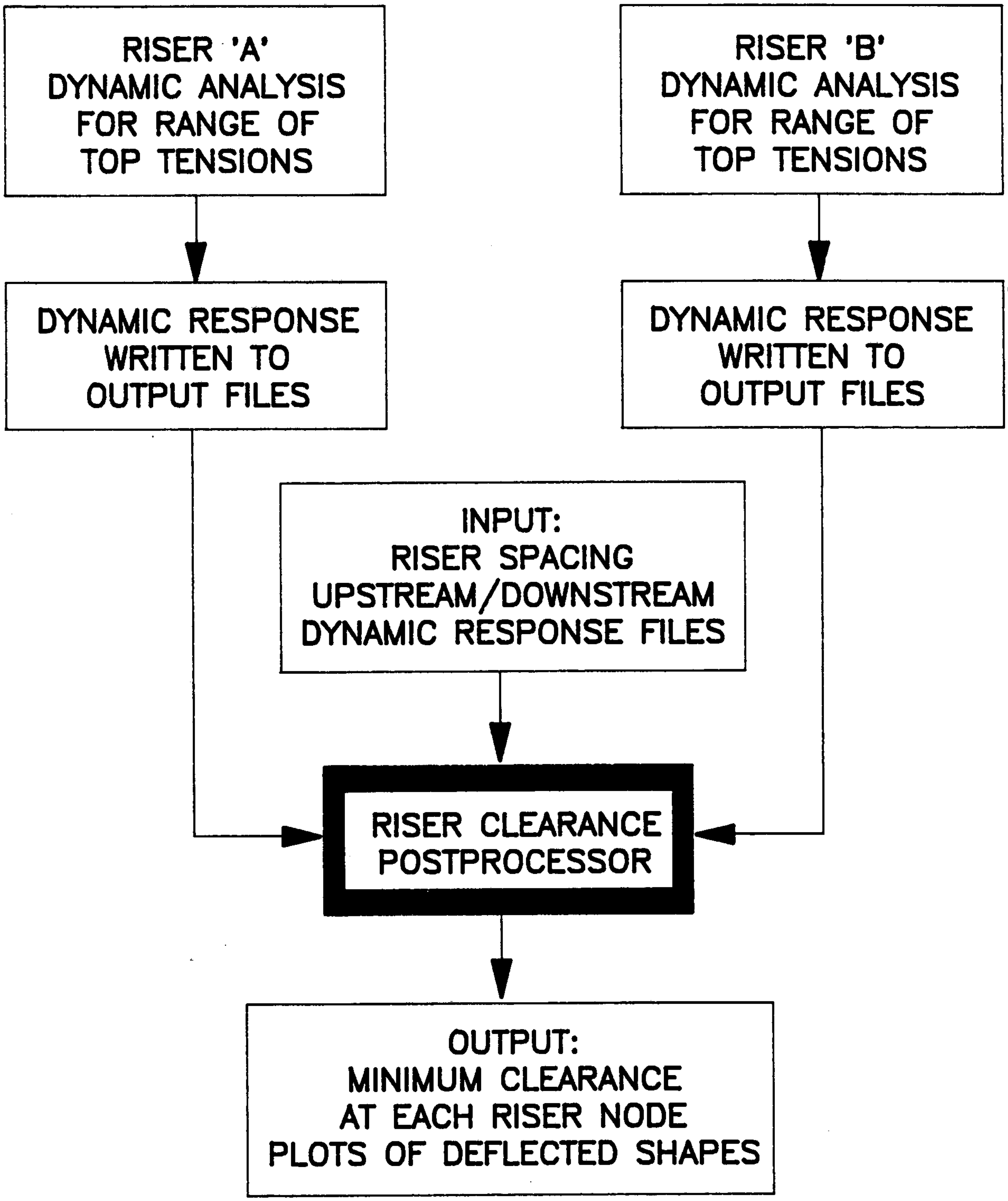
5.3.1 Riser to Riser: In-Place

The typical approach used in analyzing riser clearance between two adjacent tensioned risers involves a sequence of steps. First, a separate analysis is performed for each riser. The results of these analyses are written to output files for further processing. The analysis is performed for a range of top tensions. Next, the postprocessing program is used to compute the clearance between the risers. The spacing between the top of the risers is input. The wave propagation direction is also input, which in effect places one riser upstream and the other downstream. The program accounts for the appropriate phase angle shift due to the input top spacing. The analysis is performed for two wave propagation directions, so that the clearance between upstream and downstream risers can be determined. The program typically will step through the wave in small slices of time. The clearance between the risers will be calculated at each time step and at each response point (node) along the riser. The diameters of the risers can also be considered to obtain an actual clearance, versus a centerline to centerline spacing.

The results of this analysis can be reported in several fashions. A plot of the deflected shapes at the most critical time step can be produced, or the minimum clearances for each node can be printed. Figure 5.3-1 summarizes the above steps in flowchart form.

The results of the riser clearance analysis provides the spacing between two different risers for a specific set of conditions, (ie top tension, water depth, etc.). A positive spacing distance would indicate clearance between the two risers, while a negative distance signifies interference. The minimum clearance between the two risers for a specific set of top tensions can be plotted. Figure 5.3-2 is a typical clearance plot for a production tieback riser and a drilling riser.

The clearance analysis results are ultimately used to select a set of top tensions for all the various risers. This task is accomplished by organizing the clearance analysis results into a matrix array graph. Figure 5.3-3 illustrates a typical matrix array graph for a drilling riser, production riser, and sales riser. For three risers, nine sets of clearance analyses is performed. The clearance is analyzed between each riser for both upstream and downstream conditions. The cases are summarized below.



TYPICAL RISER
INTERFERENCE ANALYSIS
PROCEDURE

FIGURE 5.3–1

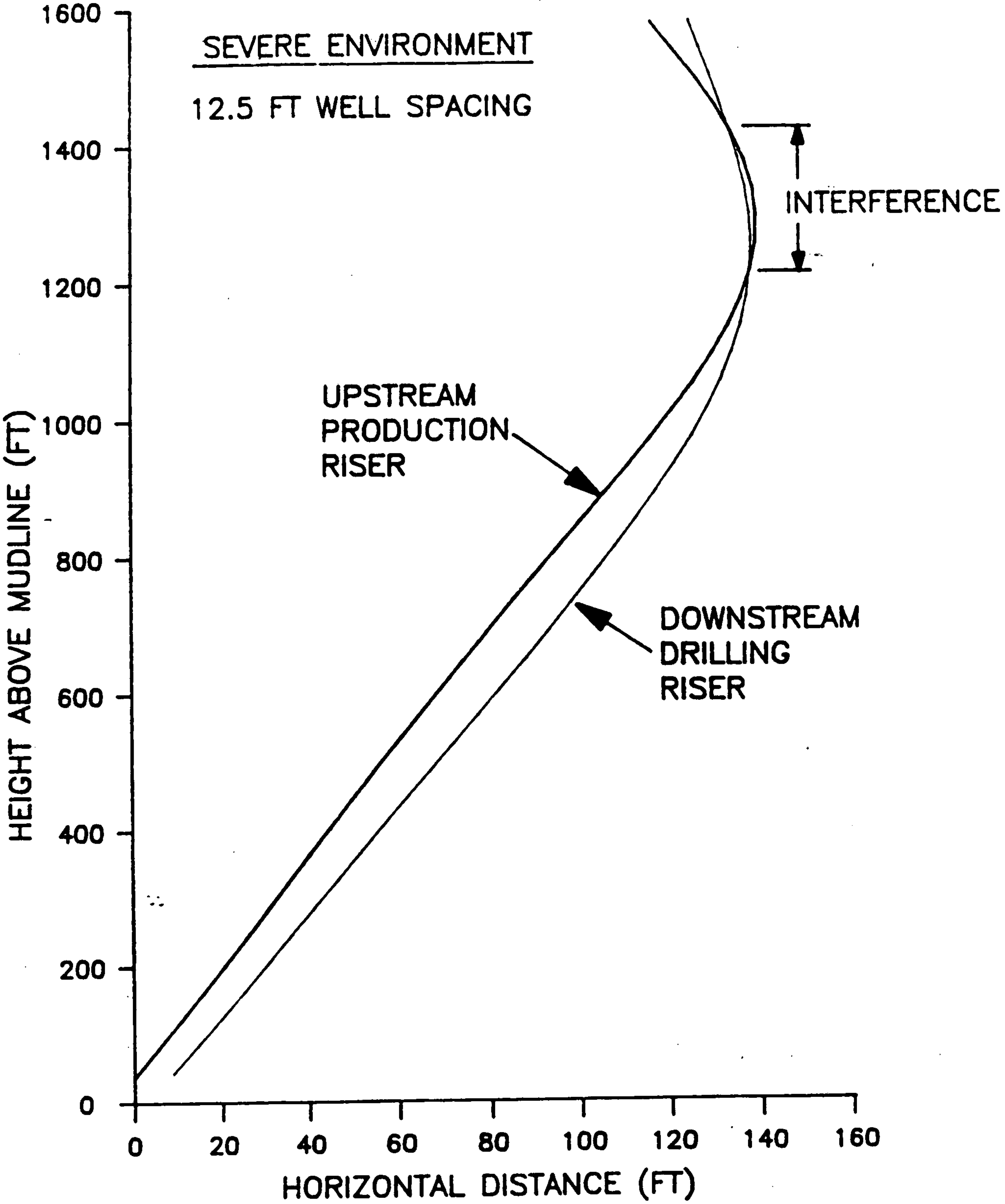
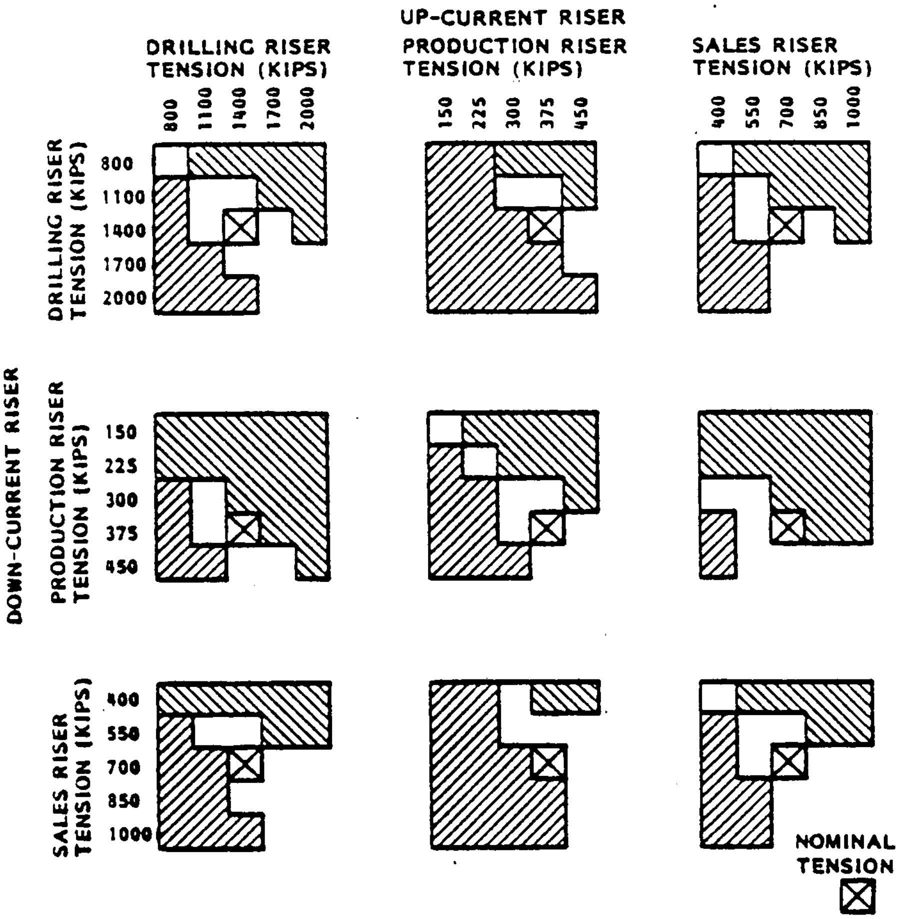

SEVERE ENVIRONMENT
12.5 FT WELL SPACING
INTERFERENCE
UPSTREAM PRODUCTION RISER
DOWNSTREAM DRILLING RISER
HEIGHT ABOVE MUDLINE (FT)
HORIZONTAL DISTANCE (FT)
0
200
400
600
800
1000
1200
1400
1600
0
20
40
60
80
100
120
140
160

FIGURE 5.3-2



ACCEPTABLE TENSIONS FOR TLP RISER ARRAY

FIGURE 5.3–3

UPSTREAM	DOWNSTREAM
Drilling	Drilling
Drilling	Production
Drilling	Sales
Production	Drilling
Production	Production
Production	Sales
Sales	Drilling
Sales	Production
Sales	Sales

The combinations of tension which result in riser interference are partitioned. The minimum tensions which can be used without resulting in riser interference are selected as the nominal tension. It should be noted that some of the cases which should be considered depend greatly on the specific TLP riser system. The previous example, for instance, considers interference between two adjacent drilling risers. Only the larger fields would require two drilling risers. The number of cases could also increase, for example the sales risers could include both a gas export and oil export. Each riser would have to be considered as a separate riser with a unique response envelope.

5.3.2 Riser to Riser (Running/Retrieval)

The interference analysis between risers during running/retrieval is performed in a similar manner to the in-place analysis. The tension in the guidelines for the riser being run becomes the critical parameter. The size of the lower riser package must be modeled to obtain an accurate solution. The running of the production tieback risers and sales risers should also be considered, but will likely pose much less of a problem.

5.3.3 Riser to Hull/Tendon

The analysis for a riser to hull and riser to tendon type interference is performed in a similar fashion to a riser to riser clearance problem. The difference is that the postprocessor only requires the dynamic response envelope for a single riser. The innermost boundaries of the hull and bracing or tendon is modeled and coupled to the riser motion by fixed displacement conditions at the top of the riser. The procedure is the same weather the riser is rigid or flexible.

5.3.4 Critical Factors

In performing the riser interference analysis, several factors must be considered. The factors can be grouped into the following general categories:

1) Riser properties
2) Platform parameters
3) Environmental conditions
4) Modeling technique

Nikkel, et al., [20] studied these critical factors in predicting TLP riser clearance. The modeling techniques compared time history and frequency domain solutions, regular and irregular wave analysis, and hydrodynamic coefficient modeling techniques. The riser properties which were evaluated included riser top tension, riser buoyancy, riser diameter, riser wall thickness, and riser contents. The well spacing and platform offset were varied to study the effect of platform parameters. The environmental parameters studied included wave height, wave period, and current profile.

The following conclusions were drawn from their study:

1) Frequency domain and time domain analysis techniques show good agreement in predicting riser response. (See Figure 5.3-4.)

2) Some discrepancies were found between frequency domain and time domain methods for calculating riser to riser clearance. (See Figure 5.3-5.)

3) Irregular wave analysis predicted less clearance than regular wave analysis. (Figure 5.3-6.)

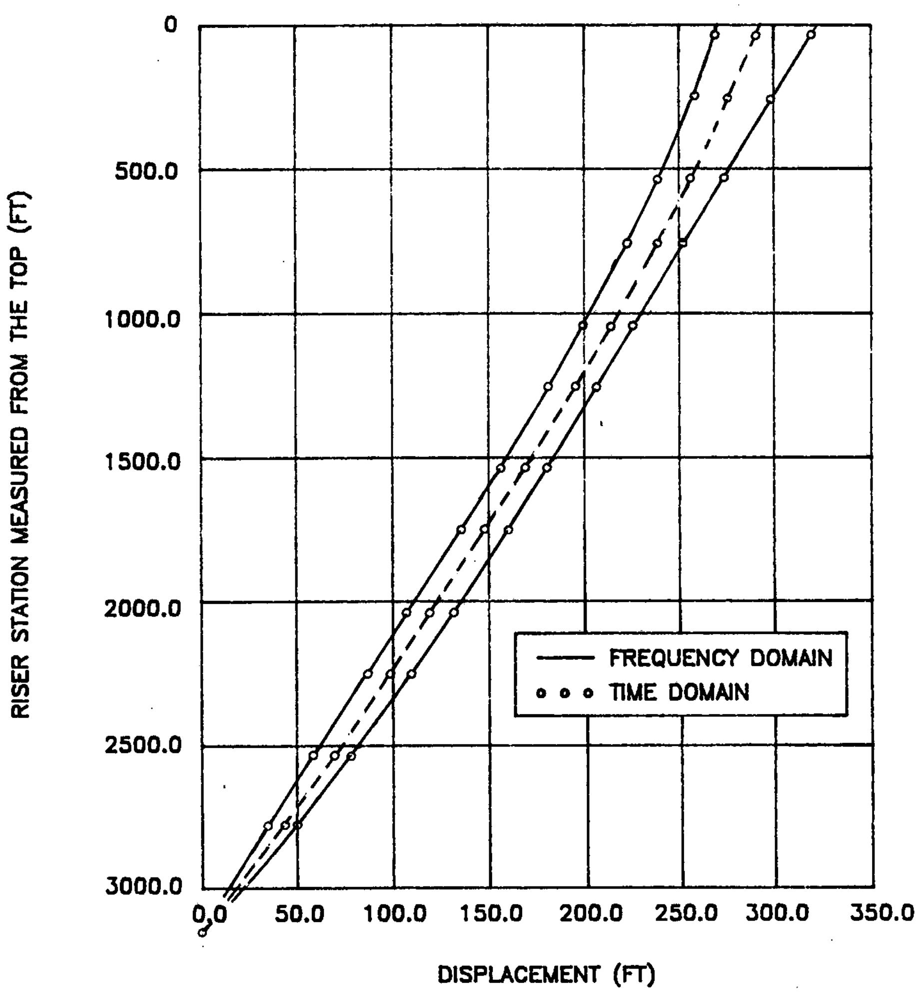
4) The clearance predicted using constant hydrodynamic coefficients is in good agreement with using Reynolds number and Keulegan-Carpenter dependent coefficients (Figure 5.3-7).

5) The effect of wave height on riser clearance decreases as the water depth increases (Figure 5.3-8)

5.4 Solutions to Riser Interference

The principle solutions to eliminate riser interference are increased riser top tension and increased well spacing, or a combination of the two.

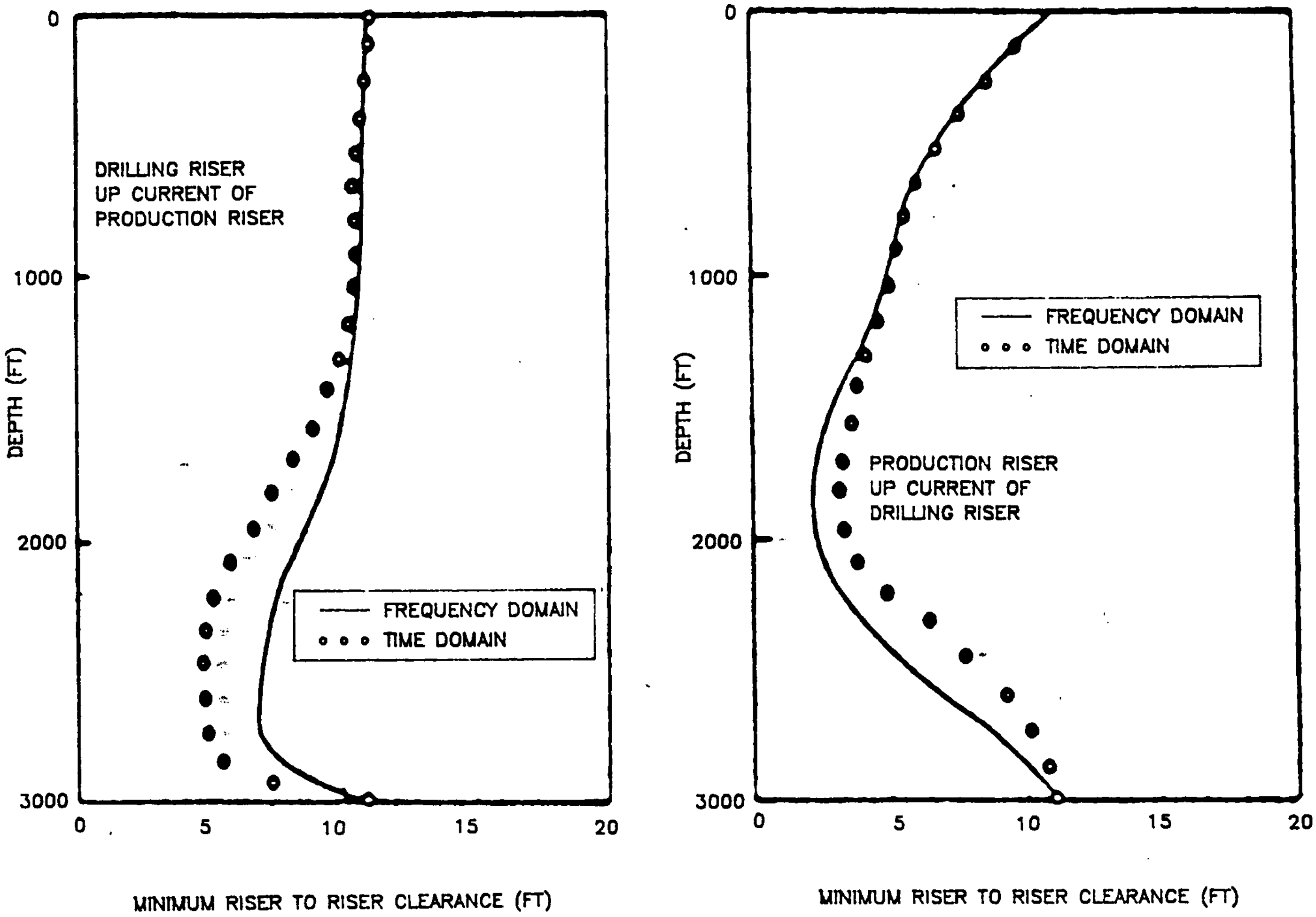
For deep water TLPs, there may not be a practical combination of well spacing and top tension. Therefore, additional solutions should be considered. These solutions will likely have a significant impact on the field development philosophy, but are worth consideration. Some possible secondary considerations are discussed below.



RISER RESPONSE COMPARISON

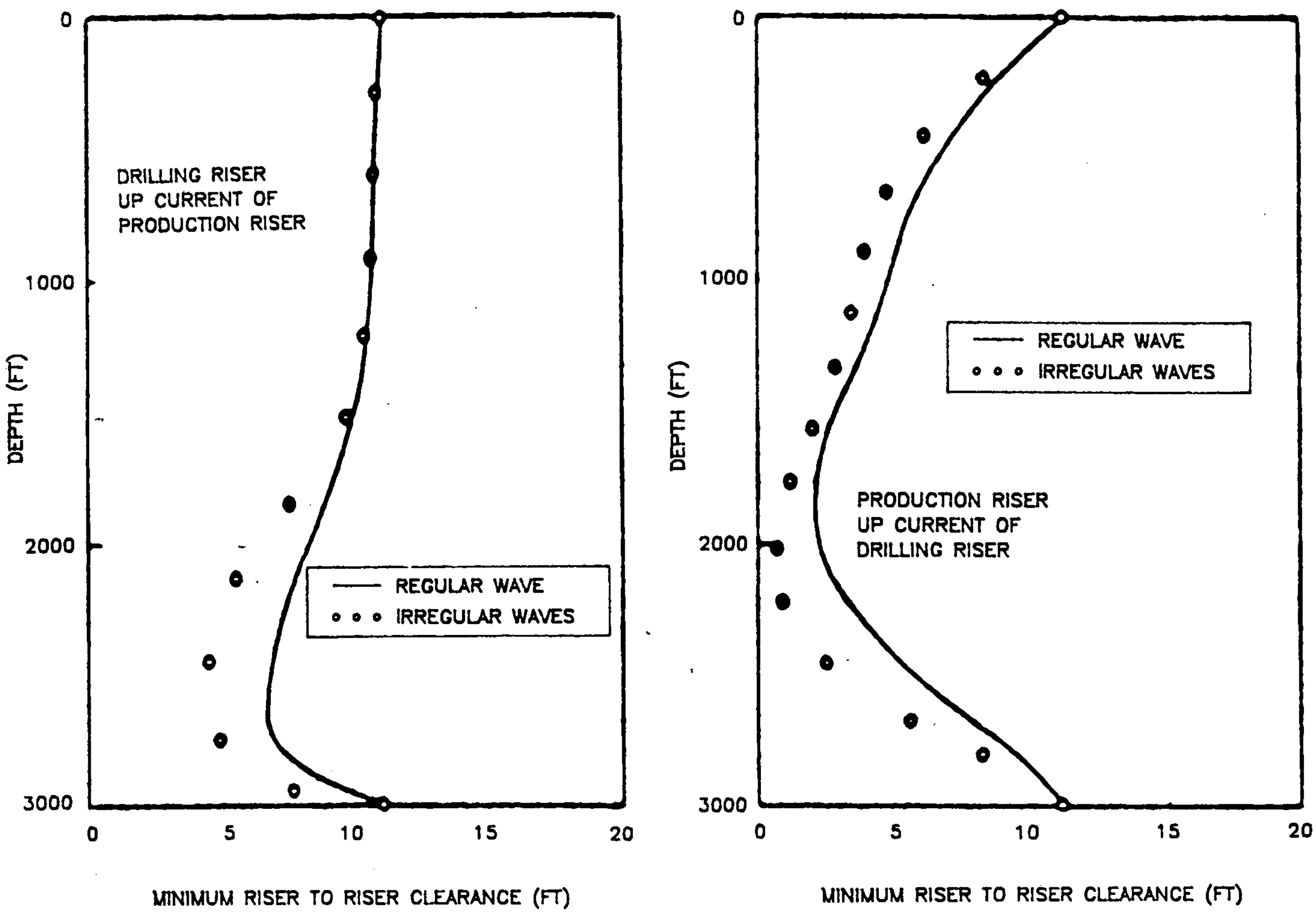
USING TIME & FREQUENCY DOMAIN TECHNIQUES

FIGURE 5.3–4



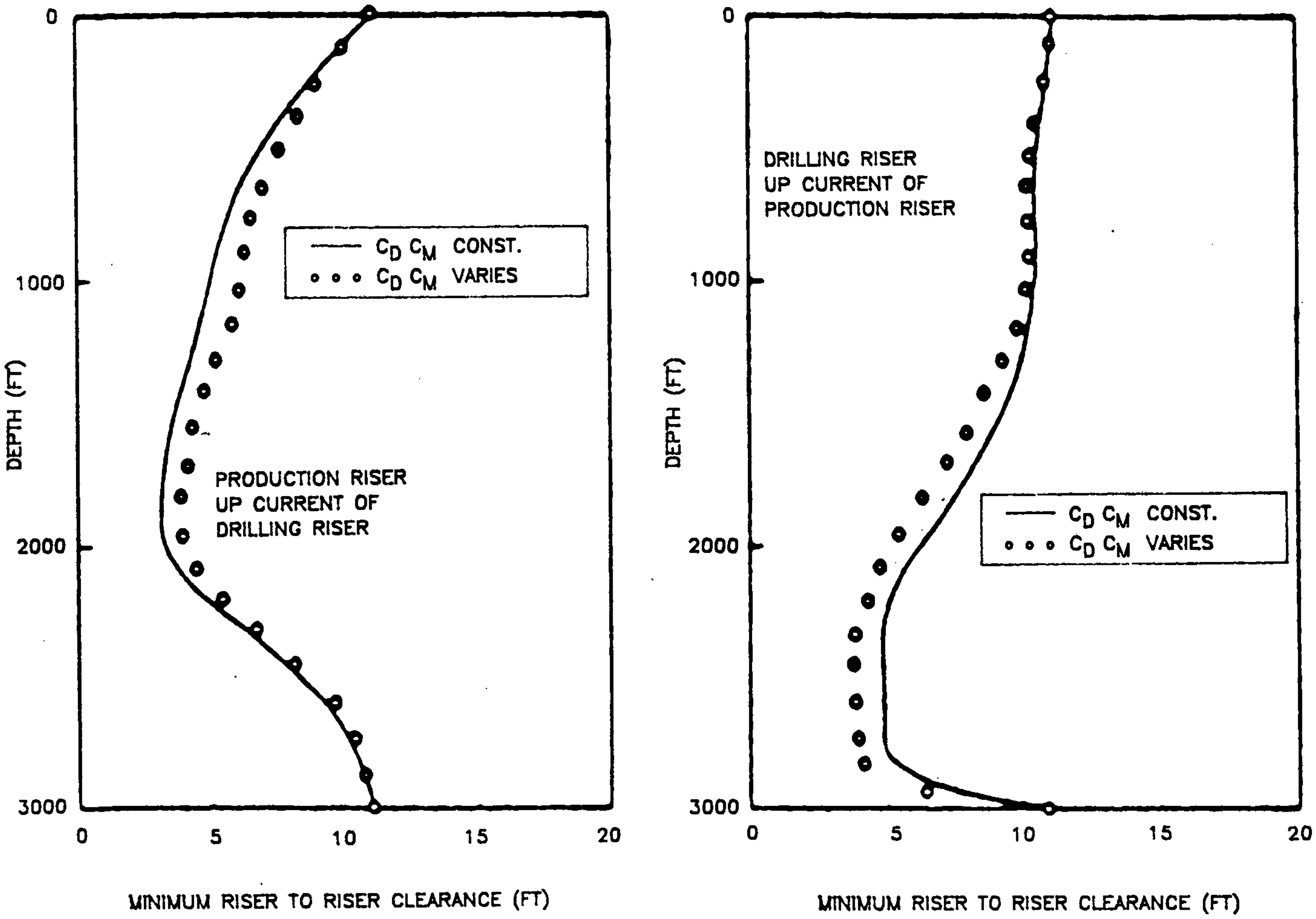
COMPARISON OF MINIMUM RISER CLEARANCE
USING TIME & FREQUENCY DOMAIN TECHNIQUES

FIGURE 5.3–5



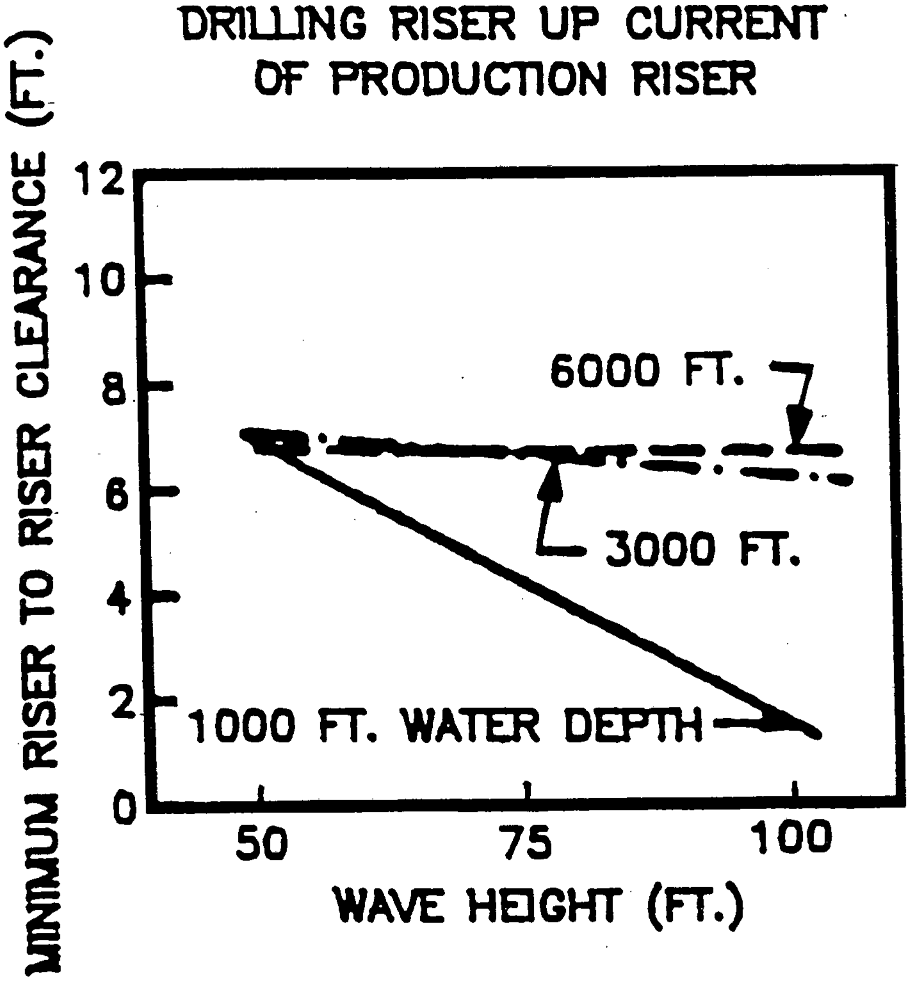
COMPARISON OF MINIMUM RISER CLEARANCE
CALCULATED USING REGULAR WAVE AND
SPECTRAL ANALYSIS TECHNIQUES

FIGURE 5.3–6



COMPARISON OF MINIMUM RISER CLEARANCE
CALCULATED USING CONSTANT AND
VARYING HYDRODYNAMIC COEFFICIENTS

FIGURE 5.3–7



EFFECT OF WAVE HEIGHT

ON MINIMUM RISER CLEARANCE

FIGURE 5.3-8

Two types of drilling risers are presently being considered for TLPs. One type is a conventional fixed platform type drilling riser with the BOP located at the surface. The other uses a subsea BOP, which is common for drilling risers in FPS. Locating the BOP at the surface will tend to decrease the interference potential by decreasing the size of the lower marine package.

The drilling riser may be eliminated altogether by predrilling the wells from a semisubmersible prior to installation of the TLP. This could have a significant impact on the field development scheme. Even if the wells are predrilled, a workover riser would be required. The workover riser could be smaller than the drilling riser and designed to minimize the size of the lower riser package.

One possible consideration is to establish limiting sea states for the running/retrieval of drilling/workover risers. A limiting sea state would restrict the time available for workover or drilling operations, but should be considered as a method of reducing the interference potential.

In extreme cases, the wells adjacent to the drilling/workover riser could be shut-in and the production tieback risers retrieved. This would be very undesirable from an operation view point. A more palatable solution may involve the varying of the riser top tensions in the vicinity of the drilling riser. A schedule of top tensions could be produced which could be implemented during drilling/workover operations.

Another consideration is the use of an anti-fouling coating on the production risers to prohibit marine growth. Controlling marine growth would decrease the exposed area subject to current loadings and reduce the overall diameter of the riser. For a given top tension, the response envelope for a riser without marine growth should be smaller than one with marine growth.

5.5 New Concepts

There have been some recent developments in the area of TLP designs which could play a role in eliminating riser interference. Some of the work has only been carried out to the conceptual level, while other developments involve the development and testing of new materials. The following section addresses some of the new concepts which are under consideration for future deepwater TLPs.

Several studies have been conducted which study the advantages and disadvantages of using a semisubmersible rigid riser system. This concept places the trees subsea in order to eliminate the individual tieback risers. The subsea wells could either be non-commingled, with individual flowpaths to a large non-integral type riser, or commingled with fewer individual risers. Figure 5.5-1 illustrates both of these concepts. In either case, the riser to riser interference potential is greatly reduced.

Another new TLP concept for deepwater uses non-vertical production tieback risers. The riser spacing at the surface is similar to conventional TLPs. However, the subsea wellheads are spaced out significantly so that the spacing of the tieback risers increases as the water depth increases. A conventional wellhead template would not be used. The subsea wells would be located on individual, separate wellbases.

Considerable work has been performed to develop new material for tieback risers. Titanium has been considered which would save weight, reduce the riser top tension, and improve flexibility and corrosion resistance properties. A composite material made of carbon fiber and fiberglass/epoxy is also being considered, which would further reduce the top tension and weight. By reducing the

SCHEMATIC OF ALTERNATE CONFIGURATIONS FOR RISER/WELL SYSTEMS

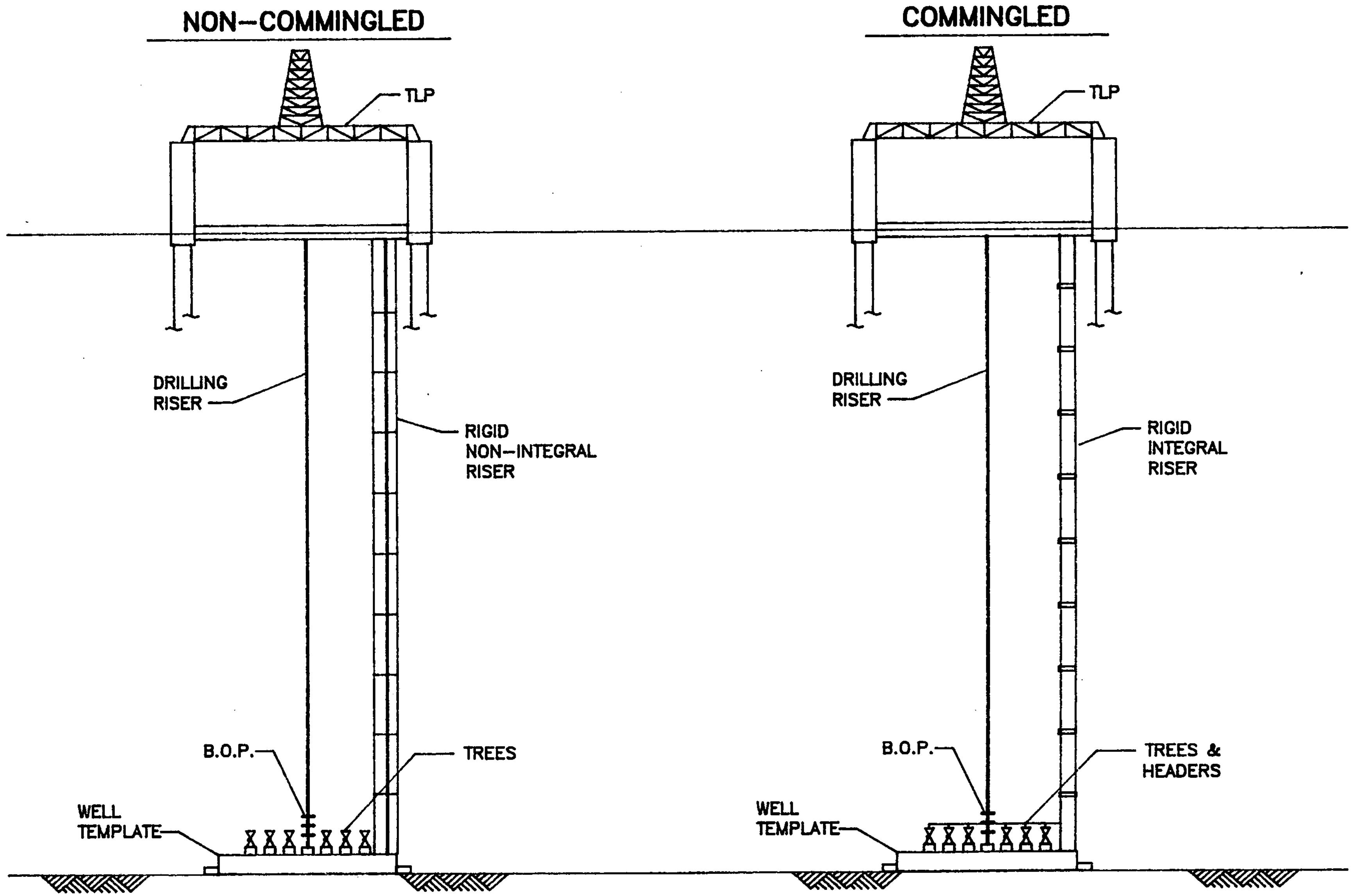
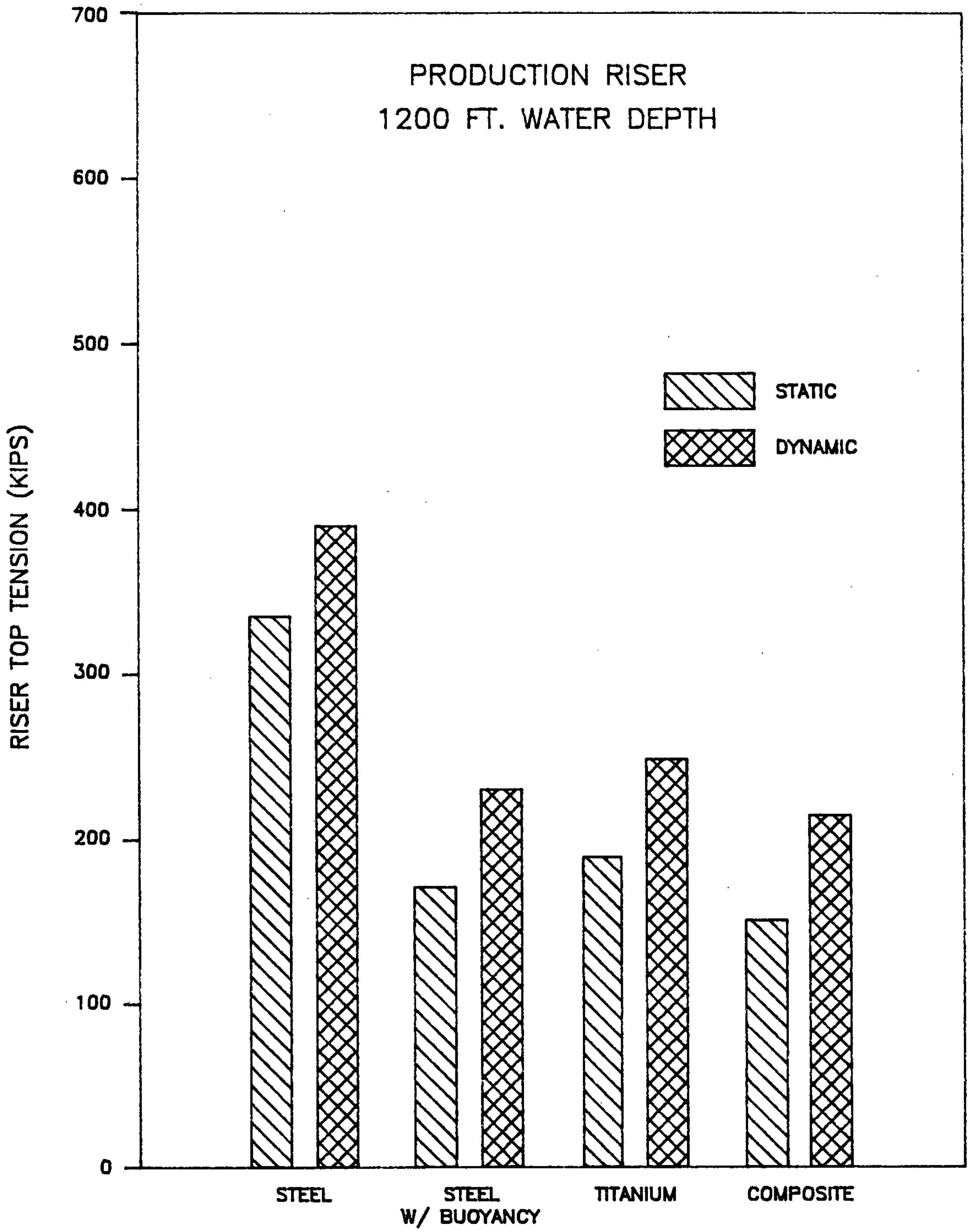


FIGURE 5.5-1

weight of the riser material, the tension required to support the riser and limit the stresses is reduced. Additional top tension is then available for controlling the dynamic response of the riser. The use of foam buoyancy modules would also reduce the tension, but is at a disadvantage because of the increased diameter of the riser. Delgado, et al. [21], studied the various riser material options for a 1200 meter water depth TLP. The new material resulted in significantly reduced top tensions. Figure 5.5-2 shows the predicted top tensions for the various materials considered.



RISER TOP TENSIONS FOR
DIFFERENT RISER MATERIALS

FIGURE 5.5–2

6.0 RECOMMENDATION FOR FUTURE WORK

The results of the study in the Phase I of the project clearly indicated that the potential for riser interference is of greater importance in a (TLP-FPS) than in a (SEMI-FPS). Therefore, it is recommended that the main thrust of the future work be directed towards the assessment of riser interference/clearance in a tension leg platform.

The recommended future work can be carried out as a joint industry project. Two distinct stages of activity can be identified in the project. Stage one is concerned with the preparation of the proposal, identification of potential participant, organizing a meeting with potential participant, and finalization of the Base Case which would be the subject of the study for the Joint Industry Project (JIP).

The stage two is the performance of JIP itself. The need for this distinction stems from the fact that a certain funding is necessary to carry out the first stage. JIP participants historically have been reluctant to provide or compensate expenses that are incurred to organize the JIP itself. Therefore, these two stages of activity are clearly distinguished in the work breakdown structure presented in this section.

A scope of work and an analysis methodology for assessing the riser interference/clearance problem in a TLP is presented in the following sections. The detailed plan for carrying out these analyses is presented in Section 6.4. It is important to mention that the analysis methodology presented here is not the only possible approach that can be undertaken. However, it represents a reasonable approach for studying this problem.

6.1 Scope of Work

The Scope of Work can be summarized in the following tasks:

1) Establish the base case TLP in concordance with the potential participants.

2) Develop a methodology, in agreement with the participants, for the detailed analysis and assessment of the interference/clearance of risers for the base case TLP.

3) Apply the methodology to the base case TLP and report the results.

4) Expand and generalize the methodology to be applicable to other TLP configurations.

6.2 Description of TLP

The recommended base case TLP for further work is the TLP configuration used in the MCAP (Methodology for Comparison of Alternative Production Systems) Joint Industry Project. Some of the important parameters for this TLP are presented in Table 6.2-1.

6.3 Analysis Methodology

The parametric analysis, which is needed for this study, requires many computer runs. A frequency domain riser program is best suited for this purpose. A suitable candidate is the FDRISER program. This frequency domain riser analysis computer program incorporates a linearization method based on energy considerations. Its output include displacements, angle, combined stress, bending stress, local forces, and local moments. It contains a plot subroutine that generates graphs of

TABLE 6.2-1

BASE CASE TLP PARAMETERS

Water Depth:		2500 ft
Platform:	Displacement	77,500 kip
	Weight	
	Operating	47,940 kip
	Extreme	46,660 kip
	Mass Moments of Inertia	
	Pitch and Roll	1.2×10^{10} slug-ft^2
	Yaw	1.8×10^{10} slug-ft^2
	Draft	95 ft
	Deck Clearance (MWL to Main Deck)	65 ft
	Vertical Center of Gravity (KG)	
	Operating	112 ft
	Extreme	112 ft
Column:	Spacing (Centerline)	202 ft x 202 ft
	Size	46 ft x 46 ft
	Corner Radius	6 ft
	Displacement	48,130 kip
Pontoon:	Size	26 ft x 26 ft
	Corner Radius	2 ft
	Displacement	29,370 kip
Tendon:	Size	24" Ø x 1.00"
	Pretension (Operating)	
	Total of 16	24,180 kip
	Each Tendon	1,510 kip
	Pretension (Extreme)	
	Total of 16	25,470 kip
	Each Tendon	1,590 kip
	Axial Stiffness (per Tendon)	820 kip/ft
	Flex Joint Rotational Stiffness	15,000 ft-lbs/degree
Riser:	Size	11.0" Ø x 0.625"
	Pretension	
	Total of 24	5380 kip
	Each Riser	224 kip
	Axial Stiffness (per riser)	232 kip/ft
	Buoyancy Material	22" Ø (-500′ to -2350′)

RISER

envelopes of all major response parameters. Furthermore, the FDRISER program can investigate hydroelastic oscillation of a riser due to vortex shedding and its susceptibility to undergo such oscillations up to the 10th natural mode. The FDRISER program assumes planar deflection and constant top tension.

Furthermore, the "CLEARANCE" program, which is a postprocessor of the FDRISER, can be used to study riser interference/clearance problems. This program has been developed specifically to investigate interference/clearance problems with vertically tensioned risers.

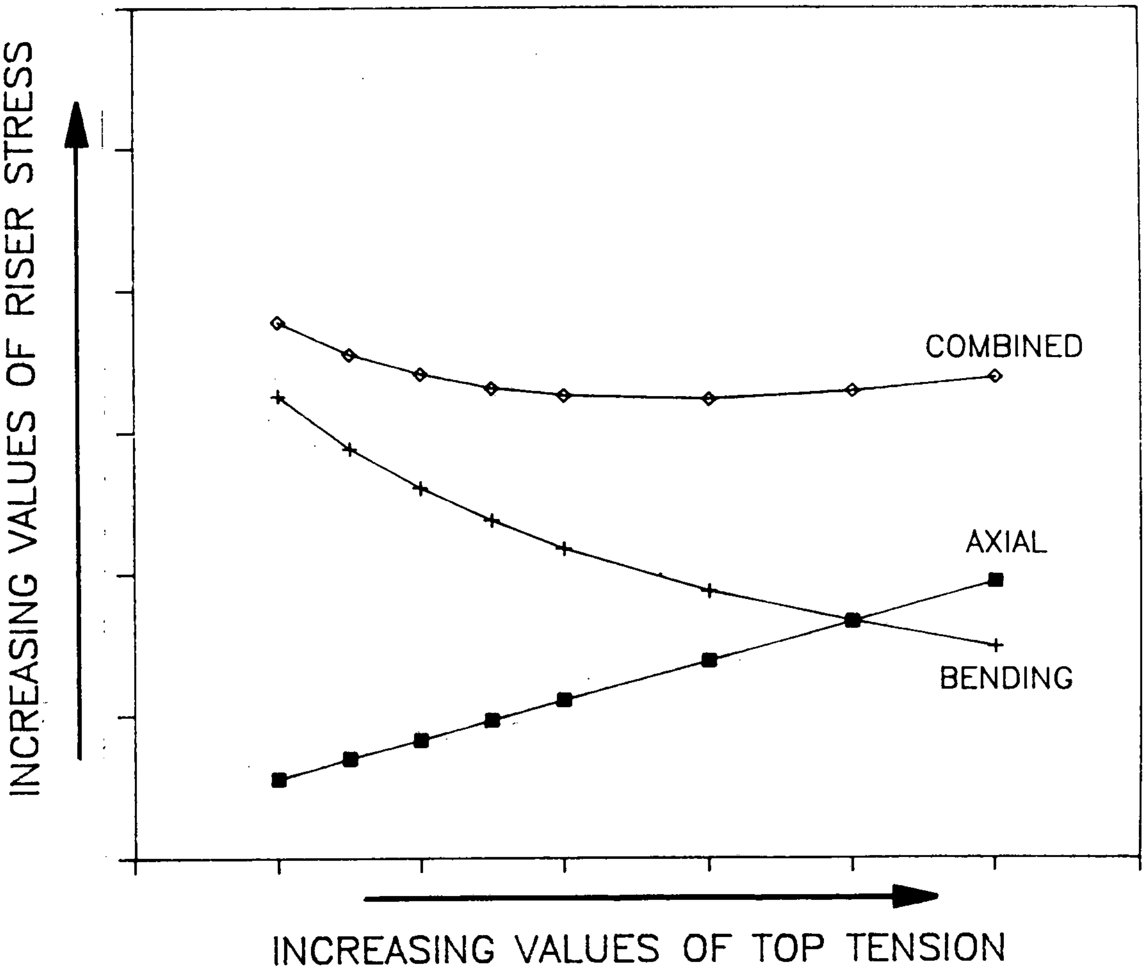
6.3.1 Preliminary Analysis

1) Top Tension Range

The goal of this task is to establish a reasonable top tension range based on stress minimization for each riser.

The lowest allowable top tension (which corresponds to zero tension at the bottom) does not necessarily imply minimum combined stress level in the riser. As seen from Figure 6.3-1, the combined stress becomes minimum for a certain combination of bending moment and axial tension which can be identified by a parametric study comparing the results of computer runs corresponding to different axial tension levels.

It is estimated that a total number of eight or nine computer runs will be sufficient to generate stress curves similar to those shown in Figure 6.3-1 for each riser type. These curves will lead to the identification of the near-optimum top tension range for the particular riser designs under consideration.



SELECTION OF A NEAR–OPTIMUM RANGE

FOR TOP TENSION IN RISER SYSTEMS

FIGURE 6.3–1

2) Sensitivity Analysis

A sensitivity test, with respect to variation of wave height/period, will be carried out to define extreme sea states. Accordingly, several sea states will be considered. However, in an effort to minimize computer costs, sensitivity studies for each riser type will be limited to the range of near optimum top tension previously established. It is anticipated that a total number of three top tension values per riser per sea state will be sufficient to assess sensitivity.

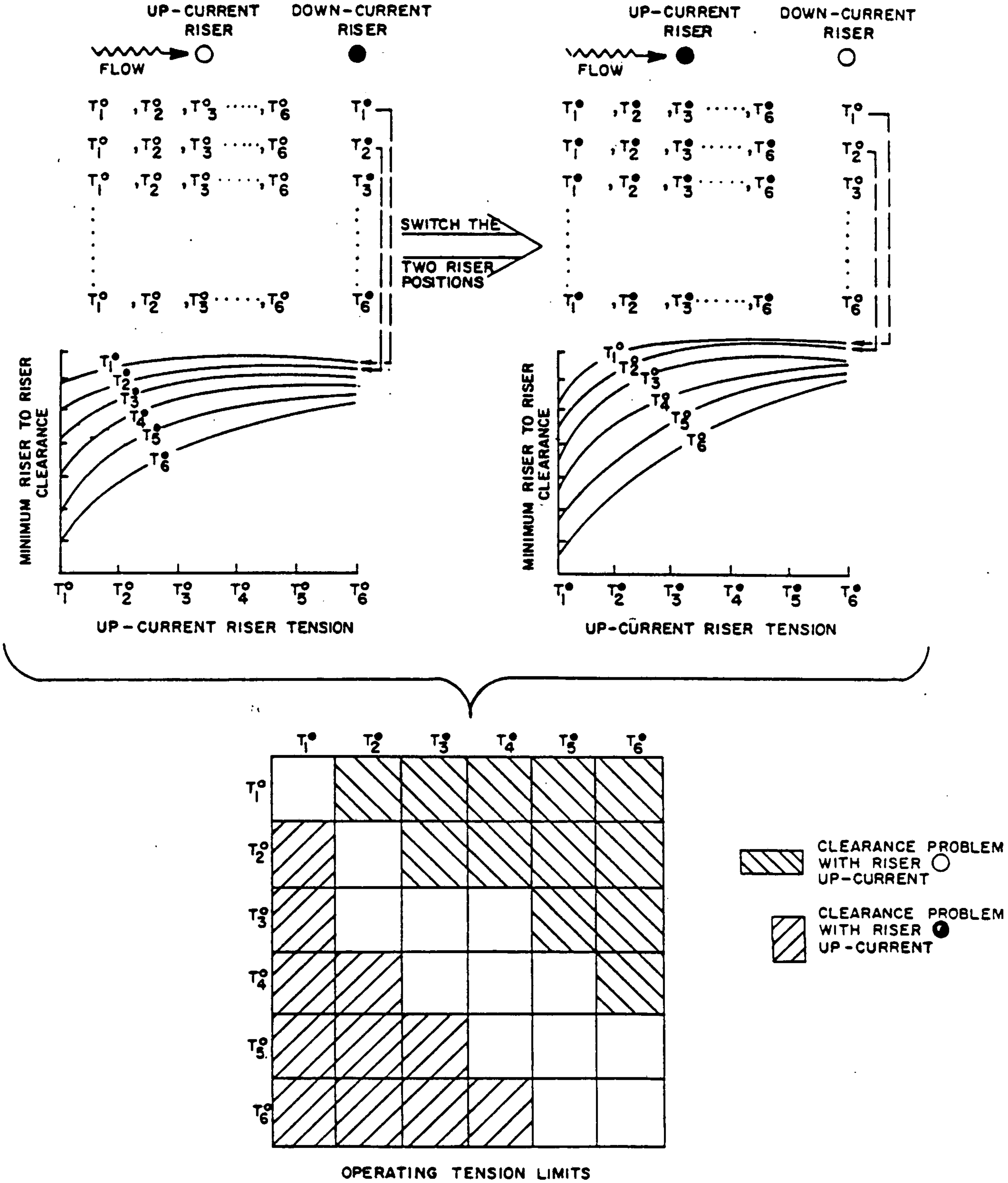
6.3.2 Analysis of Clearance Between Risers

Clearance studies will be performed to assess the possibility of adjacent risers coming in contact as they oscillate in response to the platform motions, waves, and currents. The FDRISER program or another computer program with similar capabilities can be used for this purpose. Clearance analysis will be performed on extreme sea states defined in Paragraph 6.3.1 and with all risers in place.

A variety of parametric simulations will be run for each type of riser by varying both the top tension and the riser configuration. In the FDRISER program, the amplitude of motion at each node, along with the motion phase lag relative to the wave, is evaluated. Since for this type of solution the motions of all points of the system are assumed to be harmonic and of the same period, knowing the amplitude and phase angle of each node allows a pseudo-time history of the motion of the entire riser to be calculated by stepping through the wave. Breaking the wave cycle into many small increments and making the calculations simultaneously for two adjacent risers will give a pseudo-time history of their relative motions. The CLEARANCE computer program will accept the output of the FDRISER program to carry out this analysis.

Figure 6.3-2 represents schematically the methodology adopted in clearance analysis of two adjacent risers. One riser will be placed up-current and another riser will be positioned in an adjacent slot down-current with respect to the first one. Each wave cycle will be broken into 72 increments (5 deg) for the stepping-through process. The relative position of the outside diameters of each riser pair being considered will be calculated for these increments. The results will be scanned to locate the minimum clearance. Then the top tension value of the up-current riser will be changed, while tension on the down-current riser is kept fixed. The stepping-through process will be repeated and the minimum clearance will be found. Six different tensions for the up-current riser will be tested against a fixed tension value of a down-current riser. The minimum clearance results will be plotted against top tension of the up-current riser. A family of such curves for various top tensions of down-current risers will be generated. Six different tensions for the down-current riser will be used for generating this family of curves.

Next, the position of up-current and down-current risers will be exchanged. The same parametric study mentioned above will be performed and another family of curves will be generated. The results of these two families of curves will be combined to establish the conditions under which a riser can be located next to another riser regardless of the current direction. Using a bar chart format, all combinations of riser tensions which result in interference are blocked out. The unshaded region in the figure then represents the acceptable operating tension for the two risers considered.



METHODOLOGY IN CLEARANCE ANALYSIS OF TWO ADJACENT RISERS

FIGURE 6.3-2

The ability to identify tension settings to preclude interference will be a direct function of the riser spacing on the TLP and template and their outer diameters. Evidently, the analysis starts with maximum allowable tension settings of both adjacent risers. If for such a favorable condition an interference is detected, then spacing on TLP and template will be deemed not acceptable, and TLP and template design have to be modified to provide a larger spacing between risers.

Various combinations of adjacent risers of different configurations will be considered. The number of computer runs is different for each combination because some of the results obtained in previous runs will be used for following combinations.

6.3.4 Analysis of Clearance Between Risers and TLP Hull/Tendons

It is important to note that the spacing between adjacent risers may not always be increased arbitrarily without causing new problems. A wide riser spacing will result in a large fire-restricted platform area. Furthermore, it may impose restrictions on the design of the hull, not permitting any bracing members in a large central area of the platform substructure. In view of this, the possibility of contact between the risers and the platform at lower hull diagonal braces, wellbay levels, and pontoons will be investigated. It is anticipated that no new riser analysis will be necessary and the results of activities described in previous sections will be sufficient to assess potential contact problems between hull and risers. However, a post processing activity for monitoring minimum spacing between risers and bracing or tendons will be needed by using the CLEARANCE program.

A riser located at the least favorable position will be investigated. The maximum excursion at lower hull diagonal braces and wellbay levels will be checked against structural data for possible contact. Production, drilling, and sales risers at six different tension settings will be studied.

6.3.3 Installation and Retrieval Analysis

One of the most critical times during which riser-to-riser, riser-to-hull or riser-to-mooring interference may occur is when the risers are being run or retrieved. When a current is present, it causes the TLP to move down-current from the template. With the TLP in this position, a riser being run without guidelines would trail off down-current even more than the platform and would surely contact any downstream risers, hull, or mooring lines. Using a guideline system to run the risers will help to position them within the existing array and will help minimize the possibility of interference. Whether interference occurs will depend on the severity of the environmental conditions, the tension in the guidelines and the configuration of the risers, along with the weight and size of any equipment at the base of the riser.

The objective of this analysis is to address:

a. Clearance problems during running and retrieval of risers.

b. Guidelines tensions.

c. Estimate the maximum sea state in which installation and retrieval is possible.

The following conditions will be considered:

1) Running the drilling riser with and without BOP stack.
2) Running 30" surface casing.
3) Running the production risers.

An accurate assessment of the degree of importance of each of the parameters affecting installation and retrieval of risers would require a large number of computer runs. However, it might be possible to undertake a somewhat limited study by confining the attention to those cases that could establish significant trends and provide other useful information. With this in mind, the following methodology is proposed to develop recommendations for installing and retrieving various risers.

The dynamic response of a running riser at four different running lengths will be analyzed. The dynamic separation distance between running riser and adjacent riser, hull and mooring lines will be determined using the CLEARANCE program. The method of minimum clearance computation is similar to that employed for clearance analysis of two adjacent risers.

6.4 Study Approach

Two distinct stages of activities can be identified to organize and perform recommended future work for this project. The first stage represents the work required to initiate a Joint Industry Project (JIP). A substantial amount of work is required to prepare a JIP proposal, develop a scope of work which is compatible with all prospective participants, organize meetings with prospective participants, and manage the contractual and financial arrangements. The second stage represents the work carried out after the JIP kickoff meeting. The activities corresponding to each stage are summarized in the following sections. Figure 6.4-1 shows the schedule and cost estimates required for carrying out the recommended future work for the project.

ACTIVITY	ACTIVITY MANHOURS	SUBTOTAL	$
PREPARATION OF PHASE II PROPOSAL	80		
ISSUE PROPOSAL	---		
SOLICITE PARTICIPATION	40		
1st MEETING: PRESENTATION OF PROPOSAL	50		
ISSUE REVISIONS TO THE PROPOSAL	40		
RECEIVE LETTERS OF INTENT	40		
TASK 1 – DEVELOP BASE CASE	70		
2nd MEETING: PROJECT KICKOFF	40	360	19,800
TASK 2 – DEVELOP DETAILED ANALYSIS METHODOLOGY	200		
TASK 3 – APPLY METHODOLOGY TO BASE CASE	560		
ISSUE DRAFT RESULTS	---		
3rd MEETING: PRESENT RESULTS	60		
TASK 4 – GENERALIZE METHODOLOGY	300		
ISSUE RESULTS & DRAFT REPORT	60		
4th MEETING: FINAL PRESENTATION	120		
INCORPORATE COMMENTS & PREPARE FINAL REPORT	80		
ISSUE FINAL REPORT	---	1,380	82,800

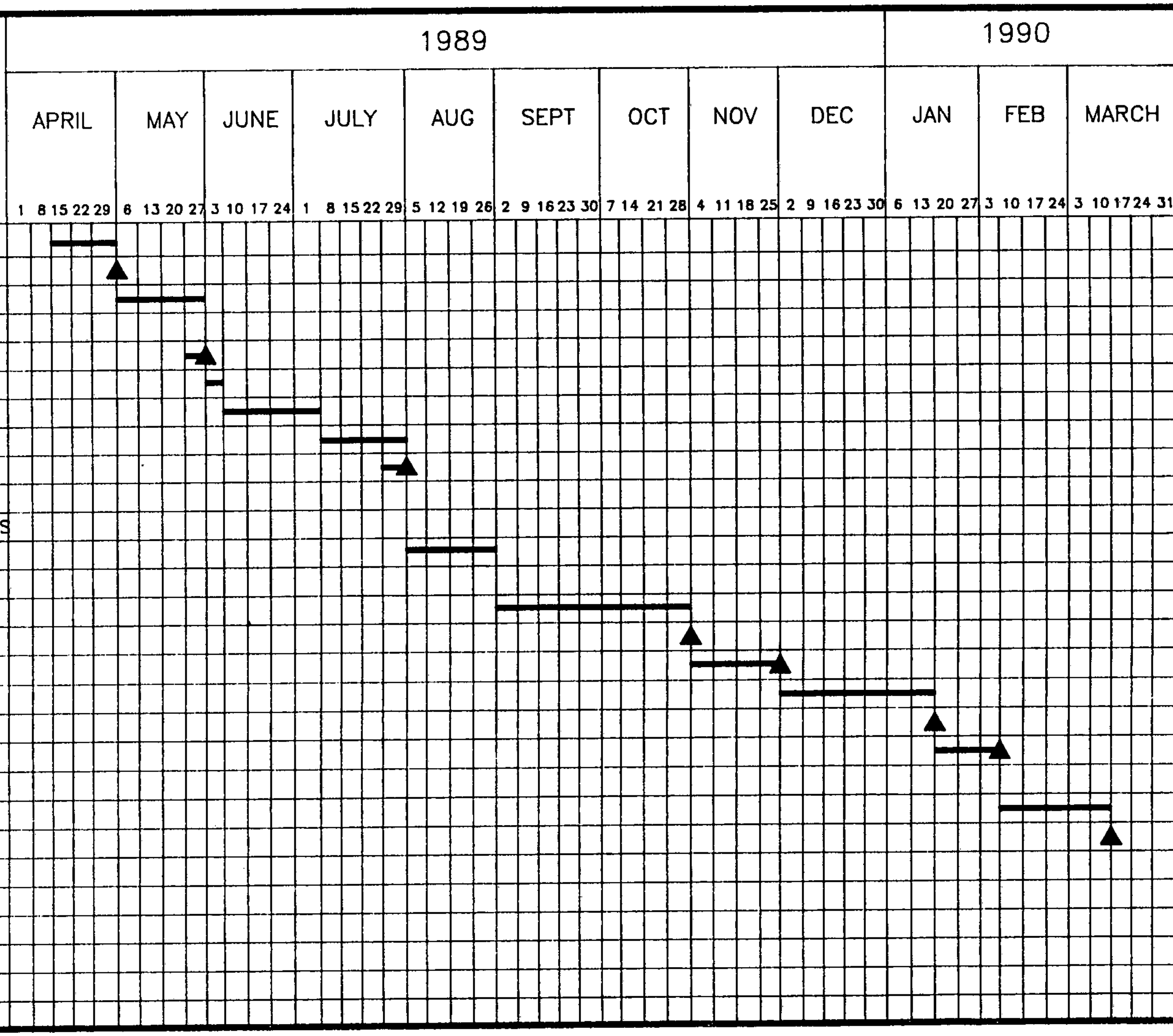


FIGURE 6.4–1

6.4.1 STAGE 1

- o Prepare a Proposal for Phase II

  In this activity a comprehensive proposal will be prepared which includes the detailed Scope of Work, deliverables, and costs. Furthermore, a mailing list of potential participants will be prepared as part of this activity.

- o Issue the Proposal to potential participants

  In this activity, the potential participant will be advised to indicate their intention to participant in a meeting to discuss the scope and the possibility of a JIP.

- o Organize the first meeting with potential participants

  In this meeting, the following major activities will be carried out:

  i) Presentation of the proposal
  ii) Presentation of the prospective base case
  iii) Presentation of the proposed analysis and assessment approach
  iv) Open discussion on the base case and analysis approach
  v) Poll prospective participants to investigate the degree of interest for the JIP.

- o Issue revisions of the proposal to the prospective participants

As a result of the first meeting, revisions to the proposal will be made and a revised proposal will be prepared. Furthermore, in issuing the revisions, the prospective participants will be advised to indicate their willingness to participate in the JIP with a letter of intent.

- Receive the letters of intent

  A predetermined number of participants must reply positively in order for the JIP to proceed.

- Task 1 - Develop the prospective Base Case

  The reason for carrying out this task in Stage 1 is based on the fact that some of the participants may not agree with the selection of the MCAPS TLP as the base case and the subject of the study. Therefore, it is necessary to develop and establish a new base case TLP on the basis of the comments received during the first meeting or follow-up contacts with the participants. In other words, the base case TLP must be unanimously approved by all the participants.

  If the MCAPS TLP is approved by the participants as the base case TLP, then this activity will focus on the refinement and gathering of additional data necessary for performance of the JIP.

  Additional work that will be carried out as part of this activity consists of follow-up correspondence with committed participants, search for additional participants, and preparation of an outline for the analysis methodology to be presented at the project kick-off meeting.

- o Organize Kick-Off Meeting

  In this meeting, the following major activities will be carried out:

  i) A steering committee will be established
  ii) The proposed base case TLP will be presented and finalized
  iii) Agreement will be sought on the proposed outline of the analysis methodology
  iv) Agenda will be set-up for future meetings, schedules, etc.

6.4.2 STAGE 2

- o Start Task 2 - Develop Analysis Methodology

  In this activity the detailed analysis methodology will be developed.

- o Start Task 3 - Apply the Methodology

  The methodology developed in task 2 will be applied to the base case TLP. The results will be presented in a draft report and issued to the participants for comments and discussion at the third meeting.

- o The third meeting will be held four weeks after the issuance of the draft report. In this meeting the following major activities will be undertaken:

  i) Presentation of the results included in the draft report
  ii) Open discussion on the results

iii) Recording of comments to be included in the final report

iv) Presentation and finalization of the approach for Task 4

o Start Task 4 - Generalize Methodology

This task is basically concerned with the expansion and generalization of the methodology applied to the base case so it can be applied to other TLP configurations. Additionally, a draft report on the results of the Task 4 will be prepared.

o Draft report on the results of Task 4 will be issued to the participants. Participants will be advised to provide their comments and will be invited to the fourth and final project meeting.

o The fourth project meeting will be held four weeks after issuance of the draft report. In this meeting the following major activities will be carried out:

i) Presentation of the results of Task 4

ii) Presentation of the summary results of JIP

iii) Discussion on the final draft report

iv) Recording of the comments to be included in the final report.

o Incorporate comments in the final report

o Issue the final report

o Conclude the project

7.0 CONCLUDING REMARKS

In concluding this report, it is worthwhile to mention that the design and operation of Floating Production Systems (FPS) for deepwater application is still in its infancy. A great deal of challenging engineering problems need to be solved before stretching the limits of FPS beyond today's analytical and technological capabilities.

The results of this limited study clearly indicate that the risers are one of the most delicate components of a FPS and need particular attention in design and deployment from a FPS. Furthermore, the study shows that the riser system in a tension leg platform based floating production systems (TLP-FPS) manifest a greater potential to be involved in an interference event than other Floating Production Systems. This is mainly because of the way the risers are deployed in a TLP-FPS. This does not necessarily rule out the possibility of riser interference in a semisubmersible-based Floating Production System (SEMI-FPS). However, in order to contain the scope of project within time and budgetary constraints, the recommendation for future work suggests that the main thrust of work should be directed to studying the riser interference problem in a tension leg platform.

In the report a methodology for analysis of interference is presented. It is important to mention that this methodology is not the only procedure to analyze this problem but merely represents a viable approach. In the second phase of the study several other options for analyzing the riser interference will be sought and will be presented to the project sponsors and the most appropriate method will be used to study the base case platform.

Another important factor which was not dealt with in the course of this phase of study was the impact of hydroelastic oscillation and vortex shedding on the interference problem. This subject will be addressed in the future work for this project.

Probably the most important conclusion that can be drawn from this phase of study is that the riser interference problem does exists and TLP-FPS show a greater potential to be involved in a riser interference situation. Furthermore, the results of the study indicated that this problem will be compounded with increasing water depth.

The consequences of the riser interference either from operational or environmental stand points were beyond the scope of this phase of study and were not discussed explicitly. However, these important issues will be addressed in the second phase of the study.

8.0 REFERENCES

1. Arnold, K., and Stewart Jr., M., "Designing Oil and Gas Production Systems", World Oil, November 1984.

2. Clayton, D. A., "Simplification in Offshore Engineering is Required as Small Field Costs Rise", Petroleum Review, October 1984.

3. Draw III, W. J., Raj, A., and Rawstron, P. J. "Technical and Economics Consideration in Developing Offshore Oil and Gas Prospects Using Floating Production Systems", SNAME, Texas Section, February 1985.

4. Dudfield, C. F. O., "Evaluating Options in Field Development Planning", Offshore, November 1988.

5. Mercier, J. A., Goldsmith, R. G., and Curtis, L. B., "The Hutton TLP: A Preliminary Design", Journal of Petroleum Technology, January 1982.

6. Hammett, D. S., and Johnson, J. S. "First Floating Production Facility - Argyll", Offshore Technology Conference, OTC Paper No. 2821, Houston, Texas, 1977.

7. Gordy, T., "Hamilton's Argyll Semisubmersible/Production Riser Concept", SPE Paper 5281, 1975.

8. Kirkland, J., "The Production Riser System for the Argyll Field", Offshore Technology Conference, OTC Paper No. 2327, Houston, Texas, 1975.

9. Mahoney, R. T., "Balmoral: Conception to Production", Offshore Technology Conference, OTC Paper No. 5430, Houston, Texas, 1987.

10. Donovan, J. F., Beran, W. T., and Nark N. W., "The Balmoral Subsea Production Template", Offshore Technology Conference, OTC Paper No. 5431, Houston, Texas, 1987.

11. "Subsea Completion in The Balmoral Field", Offshore Technology Conference, OTC Paper No. 5433, Houston, Texas, 1987.

12. "Flexible Production Riser System for Floating Production Application in the North Sea", Offshore Technology Conference, OTC Paper No. 5163, Houston, Texas, 1986.

13. Littleton, J., L., "Placid Pioneers Deepwater Subsea Production", Petroleum Engineering International, May 1986.

14. Crager, B., "Green Canyon FPS to Set World Waterdepth Record", World Oil, May 1986.

15. Crager, B., "Placid's Subsea Systems for 1,540-ft. U.S. Gulf Waters", Ocean Industry April, 1986.

16. Ocean Industry, "Placid Installs Template for Deepwater Project", Ocean Industry, April 1987.

17. Berner, P. C., "First-of-a-kind Deepwater Production Riser Installed", Oil & Gas Journal, May 2, 1988.

18. Filson, J. J., "Penrod 72 Ideal for Conversion", Offshore, January 1987.

19. Dove, P., "New System for Deeqwater Mooring", Offshore, January 1987.

20. Nikkel, K. G., Wang, E, Labbe, J. R., "Critical Factors in Predicting the Clearance Between TLP Risers", Ocean Structural Dynamics Symposium Proceedings, September 1982.

21. Delgado, J. H., Erb, P. R., Moe, G., "TLP Production Risers for 1200M Water Depth", Society of Petroleum Engineers Production Engineering, November 1988.

The following is a list of reference for figures contained within this report:

Figure 3.5-2	Crager, B., "Placid's Subsea System for 1,540 ft. U.S. Gulf Waters", Ocean Industry, April 1986.
Figures 3.5-3 3.6-6 4.2-6	Donovan, J. F., Beran, W. T., Nash, N. W., "The Balmoral Subsea Production Template", OTC 5431, 1987.
Figure 3.6-1	Hammett, D. S., Johnson, J. S., White, J. L., "First Floating Production Facility - Argyll", OTC 2821, 1977.
Figure 3.6-4	Montoya, L. S., Lopez-Fanjul, G. M., "Dorada Field Production System: A Solution to Individual Permanent Vertical Access to Several Wells From a Semisubmersible", OTC 4041, 1981.
Figures 4.2-2 4.2-3	Bennett, B. E., Wilhelm G. P., "Analysis of Production Risers", OTC 3536, 1979.
Figures 5.3-3 5.3-4 5.3-5 5.3-6 5.3-7 5.3-8	Nikkel, K. G., Wang, E., Labbe J. R., "Critical Factors in Predicting the Clearance Between TLP Risers" Ocean Structural Dynamics Symposium Proceeding, September 1982.

11/7/1
89-01581
Dynamic aspects of offshore riser and mooring concepts
van den Boom, H.J.J.; Dekker, J.N.; van Elsaecker, A.W.
Maritime Research Inst., Netherlands
Offshore Technology Conf., Houston, TX (USA)
19. Annual Offshore Technology Conference Houston, TX (USA) 27-30 Apr 1987
NINETEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1987 PROCEEDINGS pp. 405-416, 1987
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC-5531.
Languages: ENGLISH
Journal Announcement: V26N1
Until recently the design of mooring systems and flexible risers was unable to account for dynamic effects in the extreme load assessment. Latest research has shown that the dynamic modification of the tensions in the lines and risers can as large as the installed quasi static values. It has also been shown that dynamic effects in the mooring lines can affect the low frequency motions of the structure by the increase of virtual stiffness. Newly developed 3D computational procedures are presented describing the motion and bending moment along a flexible pipe or line, and correlations with model test results are discussed.

11/7/2
89-01551
Laying flexible pipelines over coral reefs in the Geisum Field, Gulf of Suez, Egypt
Tillinghast, W.S.; Shah, B.C.; Sturdevant, L.A.
Conoco Inc., USA
Offshore Technology Conf., Houston, TX (USA)
19. Annual Offshore Technology Conference Houston, TX (USA) 27-30 Apr 1987
NINETEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1987 PROCEEDINGS pp. 297-306, 1987
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC-5585.
Languages: ENGLISH
Journal Announcement: V26N1
The Geisum Oil Co. designed, manufactured, and installed a flexible pipeline system in 10 months which connects a well platform and several satellite well caissons to a permanently moored production tanker in the Geisum Field, Gulf of Suez, offshore Egypt. The pipeline system traversed an area covered with coral reefs with pinnacles and severe undulations along coral ridges resulting in widely varying water depths. A steep dropoff from 45 ft to 90 ft water depths occurred over 75 ft of horizontal distance and another dropoff from 90 ft to 220 ft occurred over 575 ft of distance. This paper discusses the installation problems and how they were minimized by the use of flexible pipe for the entire pipeline system. This project was the first application of the "lazy wave" configuration of the dynamic flexible riser to a tanker. The composite structure of the flexible pipe and riser, and their manufacturing and installation are presented.

11/7/3
89-01396

Improving wellhead performance with programmed cement shortfall
Britton, J.S.; Henderson, G.
Stress Engineering Services, USA
Offshore Technology Conf., Houston, TX (USA)
19. Annual Offshore Technology Conference Houston, TX (USA) 27-30 Apr 1987
NINETEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1987 PROCEEDINGS pp. 223-228, 1987
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC-5508.
Languages: ENGLISH
Journal Announcement: V26N1

Subsea wellheads can be subjected to extreme external loads when a drilling or production riser remains connected during storm or vessel drive off conditions. In addition, vortex shedding from high currents and wave action on drilling and production risers can subject the wellhead to high cycle fatigue loads. These extreme loads and high cycle fatigue loads can cause failure of the wellhead system when a fully cemented annulus between the 30 inch conductor and 20 inch surface casing is not achieved. This effect of cement shortfall is most damaging when the cement level is just below the wellhead body/conductor housing region. Purposefully setting the cement level far below the mudline can be a cost effective solution to the unintentional cement shortfall problem.

11/7/4
89-01322
Nonlinear dynamic analysis of hybrid riser system for deepwater application
Chaudhuri, J.; McNamara, J.F.; O'Brien, P.J.
John Brown Engineers and Constructors Ltd., UK
Offshore Technology Conf., Houston, TX (USA)
19. Annual Offshore Technology Conference Houston, TX (USA) 27-30 Apr 1987
NINETEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1987 PROCEEDINGS pp. 405-416, 1987
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC-5466.
Languages: ENGLISH
Journal Announcement: V26N1

This paper describes the analytical process adopted for the preliminary design of a deepwater hybrid riser system. The proposed system consists of a rigid riser system spanning from articulated joint on the sea bed manifold to a large diameter buoyancy chamber at a depth of 80m below mean sea level. A flexible riser system is used for connection between the subsea swivel at the top end of rigid riser and a quick connect/disconnect coupling on the floating facility. It is considered that this type of hybrid riser system is capable of providing a low cost solution for loading and production/storage requirements for deepwater hostile environment operations. A mixed finite element formulation analysis tool is employed for time domain analysis of the hybrid riser system subject to irregular wave, current and surface vessel motions.

11/7/5
89-01052
Nonlinear analysis of flexible risers using hybrid finite elements
McNamara, J.F.; O'Brien, P.J.; Gilroy, S.G.
Dep. Mech. Eng., University Coll., Galway, Eire
5. International Symposium and Exhibit on Offshore Mechanics and Arctic

Engineering Tokyo (Japan) 13-22 Apr 1986
J. OFFSHORE MECH. ARCT. ENG VOL. 110, NO. 3, pp. 197-204, 1988
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V26N1

A method is developed for the static and dynamic analysis of flexible risers and pipelines in the offshore environment under conditions of arbitrarily large motions due to wave loading and vessel movements. A mixed finite element formulation is adopted where the axial force is independently interpolated and only combined with the corresponding axial displacements via a Lagrangian constraint. An advantage of the resulting hybrid beam element is that it may be applied to offshore components varying from mooring lines or cables to pipelines with finite bending stiffnesses. Results are presented for the motions and forces on a flexible riser connecting a tanker to a subsea tower and also on a combined flexible riser and subsea support buoy structure which is part of a floating offshore production system.

11/7/6
88-03940
Deepwater multiwell subsea production system
Lim, J.S.; Barker, G.L.
Offshore Technology Conf., Houston, TX (USA)
18. Annual Offshore Technology Conference Houston, TX (USA) 5-8 May 1986
EIGHTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1986 PROCEEDINGS pp. 87-96, 1986
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC 5092.
Languages: ENGLISH
Journal Announcement: V25N3

Subsea production system designs and field developments have sometimes been restricted to a limited number of wells, due to a lack of confidence in manifold systems, flowline connections, production riser capacities, and difficulty with downhole and equipment maintenance. These problems are magnified in deepwater. Because Gulf of Mexico deepwater fields will probably require a large number of wells to develop, ARCO decided to acquire a better understanding of these critical areas. Consequently, Vetco Gray and ARCO examined subsea production alternatives, and developed solutions to the problem areas, described herein. This study provides a reference for future field development, and illustrates the versatility and flexibility of subsea technology.

11/7/7
88-03757
Flexible production riser system for floating production application in the North Sea
Mahoney, T.R.; Bouvard, M.J.
Offshore Technology Conf., Houston, TX (USA)
18. Annual Offshore Technology Conference Houston, TX (USA) 5-8 May 1986
EIGHTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1986 PROCEEDINGS pp. 111-120, 1986
OTC, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH; OTC 5163.
Languages: ENGLISH
Journal Announcement: V25N3

This paper describes the Flexible Production Riser system for use in

North Sea conditions on the Balmoral Field. This paper first recalls the project requirements and how these requirements have been implemented into the design through the various steps of the engineering phase, i.e. model basin test, static and dynamic analyses, service life evaluation and interface with the floating production vessel. A description of the components of the riser system follows. The installation, operation and maintenance procedures are also discussed.

11/7/8
86-06993
Hydrodynamic forces on multitube production risers exposed to currents and waves
Demirbilek, Z.; Halvorsen, T.
Conoco Inc., Res. and Dev. Dep., Ponca City, OK 74603, USA
J. ENERGY RESOUR. TECHNOL VOL. 107, NO. 2, pp. 226-234, 1985
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N5
This paper presents the experimental results of a joint industry riser test program. Over a five-year period, an extensive experimental investigation of hydrodynamic loads acting on various production risers was carried out. The program included the laboratory testing of many multitube riser configurations as well as a single cylinder.

11/7/9
86-06165
Stress analysis of marine risers under lock-in condition
Larsen, C.M.; Bech, A.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Div. Mar. Struct., Norwegian Inst. Technol., Trondheim, Norway
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 450-457, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4
A procedure for static and dynamic analysis of marine risers under lock-in condition in constant current has been developed. The method is based upon results from experiments with flexible supported riser sections and calculation of natural frequencies and modeshapes for the full-length riser. The procedure is implemented in a computer program where test results are built-in as a data base for several types of cross sections and current velocity parameters. A finite element model of the riser is used for computation of static response, modeshapes, natural frequencies and stresses. Results from the computer program indicate that static response in current can be dramatically increased during lock-in, and that bending stresses caused by lock-in can have a significant impact on fatigue life. Another observation is that difficulties can occur during marine operations such as docking of subsea modules due to large oscillation amplitudes at the lower riser end.

11/7/10
86-06152
Design, testing and operation of the production riser connectors for the Hutton Field
Chapman, J.C.; Dier, A.F.; Dowling, P.J.; Hobbs, R.E.; Myers, R.J.; Penfold, B.L.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)

Imperial Coll. Sci. and Technol., London SW7 2AZ, UK
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 434-441, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

The background to the main design decisions and the method of analysis are described. Tests were designed to verifiy the static strength and fatigue life of the connector and to establish a torquing procedure which would ensure the required preload. The connector sustained the specified proof loading and an overload without damage. Torque/rotation/preload relations are given. The specified service fatigue spectrum was applied to each of three specimens for the equivalent of 60 years without any cracking being detected. Increasing levels of constant amplitude loading were then applied to one specimen to establish the approximate life and the mode of cracking. The torquing trials led to an operational procedure in which torque and rotation are measured. Operational torque/rotation measurements are reviewed and suggestions are made whereby the control system might be improved. Hutton Field is in the UK Sector of the North Sea.

11/7/11
86-06123
Nonlinear analysis of flexible risers using hybrid finite elements
McNamara, J.F.; O'Brien, P.J.; Gilroy, S.G.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Mech. Eng., University Coll., Galway, Eire
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 371-377, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

A method is developed for the two-dimensional static and dynamic analysis of flexible risers and pipelines in the offshore environment under conditions of arbitrarily large motions due to wave loading and vessel movements. A mixed finite element formulation is adopted where the axial force is independently interpolated and only combined with the correponding axial displacements via a Lagrangian constraint. An advantage of the resulting hybrid beam element is that it may be applied to offshore components varying from mooring lines or cables to pipelines with finite bending stiffnesses. Results are presented for the motions and forces on a flexible riser connecting a tanker to a subsea tower and also on a combined flexible riser and subsea support buoy structure which is part of a floating offshore production system.

11/7/12
86-06116
Model tests and analysis of flexible riser systems
Owen, D.G.; Qin, K.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Dep. Offshore Eng., Heriot-Watt Univ., Edinburgh EH1 1HX, UK
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 354-362, 1986

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

In this paper a catenary flexible riser system is studied in relation to a typical field development in the North Sea. Such systems exhibit behaviour which is more complex and difficult to determine than for a rigid vertical riser. The paper first presents simple and approximate formulae developed by catenary theory. Catenary solutions accurately describe the shape, tensions and inclinations of a riser if its flexural stiffness is low. A formal asymptotic expansion is then presented and this method is applied to the non-linear behaviour of a long, flexible riser. The paper develops the governing equations for the non-linear dynamic analysis of a flexible riser system and outlines one method of solution based on a finite element approach. A series of model tank tests were carriet out in a wave flume in order to observe the non-linear response of the flexible riser system. The system consisted of a flexible pipe suspended in a catenary between a subsurface buoy and a surface buoy. These tests were designed to cover different waves including both operating and severe environmental conditions.

11/7/13
86-06090

Nonlinear dynamic analysis of flexible risers during environmental loading

Hansen, H.T.; Bergan, P.G.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Inst. Stat., Trondheim, Norway

5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 346-353, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

A method for computation of forces from waved and current on bar and beam type structures during large displacement and large rotational motion is presented. Two types of stationary waves are considered: Airy wave theory and Stokes "5th order theory". Short term sea states are also generated from wave spectra using linear wave theory and stochastic processing. From this particle velocity and acceleration histories are generated in a three-dimensional grid that encompasses the entire structure. The forces on the structure are then derived from the relative motion between the water particles and the dynamically responding structure using the socalled Morison equation. The paper presents the simulation in time of the dynamic response of a flexible riser during loading from waves and current. Graphical display of the large amplitude response as well as some statistical treatment of the results are given.

11/7/14
86-06085

Nonlinear static analysis of flexible risers

Mathisen, K.M.; Bergan, P.G.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Div. Struct. Mech., Norwegian Inst. Technol., Trondheim, Norway

5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 337-345, 1986

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

A method for computation of buoyancy forces on cable and bean type structures is presented. A general large displacement formulation which allows for displacements and rotations of unlimited size is assumed. The finite deformation bending of flexible risers may be very large. Second order hydrostatic pressure effects due to the curvature may therefore be of particular importance for flexible risers. Alternative ways of introducing hydrostatic nodal forces are discussed. Equilibrating forces for nodal points as well as incremental force-displacement relationships are given. Alternative ways of making the geometric load correlation matrix symmetric for incremental analysis is discussed. Different solution strategies for finding the resting position of a riser by starting with stratight sections are discussed. The paper presents some examples of static flexible riser analysis.

11/7/15
86-06063
Unique triple tubing riser developed for completion and production testing subsea wells
Bates, J.B.; Saunders, D.N.
Address not stated
17. Annual Offshore Technology Conference Houston, TX (USA) 6-9 May 1985
SEVENTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1985 PROCEEDINGS VOL. 3, pp. 445-452, 1985
- OFFSHORE TECHNOLOGY CONFERENCE, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

This paper describes the design, manufacture and operation of a simple, tubin-based, triple bore riser used for the initial completion of the Shell-Esso Underwater Manifold Centre (UMC) wells. The design demonstrates the use of standard well tubular goods and couplings in a completion riser system requiring special end terminations only. The novel design of these riser end terminations permitted timely manufacture of the components required to complete the riser system. The installation technique and operation of the riser in service is reviewed and solutions to the several problems encountered are presented. The paper concludes that a relatively simple and low cost alternative to a multibore integral riser system has been proved by its successful operation.

11/7/16
86-05857
The design and analysis of a TLP 9 5/8-in. threaded connection
Valka, W.A.; Fox, S.A.
Address not stated
17. Annual Offshore Technology Conference Houston, TX (USA) 6-9 May 1985
SEVENTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1985 PROCEEDINGS VOL. 3, pp. 231-240, 1985
OFFSHORE TECHNOLOGY CONFERENCE, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4

The design of a 9-5/8 inch threaded connection for long-term production applications is presented. The threaded connection was designed for joining sections of 9-5/8 inch production riser for a tension leg platform in 1,600

feet of water for the Santa Barbara Channel. The connection utilizes a tapered thread profile, a preloaded external shoulder and a primary metal-to-metal pressure seal at the nose of the pin. The following items were evaluated for the threaded connection using finite element analysis and the results are presented: the ability to transmit the applied static loads, the ability to survive the applied cyclic loads and the ability to maintain a seal under all load conditions.

11/7/17
86-05849
The design and analysis of a TLP subsea wellhead
Valka, W.A.; Fowler, J.R.
Address not stated
17. Annual Offshore Technology Conference Houston, TX (USA) 6-9 May 1985
SEVENTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1985 PROCEEDINGS VOL. 3, pp. 223-230, 1985
OFFSHORE TECHNOLOGY CONFERENCE, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4
The subsea wellhead for a tension leg platform application may be subjected to large external loads when the drilling riser remains connected during the 100 year storm. In addition, because the subsea wellhead is tied back to the platform for production, it must withstand a large number of smaller loads induced by the production riser. Therefore, the design of the wellhead requires the consideration of both large external and cyclic fatigue loadings. This paper will discuss the mechanism of load transfer, analytical techniques, and component design considerations.

11/7/18
86-05841
Prototype development of a TLP production riser tieback connector
Crotwell, G.W.; Knerr, E.R.; Valka, W.A.; Miller, C.A.
Address not stated
17. Annual Offshore Technology Conference Houston, TX (USA) 6-9 May 1985
SEVENTEENTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE. 1985 PROCEEDINGS VOL. 3, pp. 213-222, 1985
OFFSHORE TECHNOLOGY CONFERENCE, HOUSTON, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4
A remotely operated mechanical tieback connector and retrievable hydraulic tool, for tying back subsea wellheads to a tension leg platform, have been developed and prototype tested. The connector transmits riser loads to the wellhead and seals inside the 9-5/8" casing hanger. The connector is rated for 10,000 psi and has a 30 year service life and a 100 year fatigue life. The retrievable hydraulic tool provides the operating force to lock and unlock the connector. The development of the tieback connector and tool is presented with a description of the method of analysis, the metal-to-metal seal utilized in the connector and the prototype test results.

11/7/19
86-05794
A consistent, large-amplitude analysis of the coupled response of a TLP and tendon system
Paulling, J.R.; Webster, W.C.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)

Univ. California, Berkeley, CA 94720, USA
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 126-133, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4
The tension leg platform, together with its mooring tendons and drilling or production risers, forms a dynamic system with an infinity of degrees of freedom. In the deep water applications for which it is anticipated that TLP's will be the most attractive, the mass of the moorings and risers may be appreciable in comparison with the platform mass, and there will probably be considerable dynamic interaction between the two systems. The present paper presents a consistent, nonlinear procedure for the prediction of the large-amplitude coupled motions which result from the action of wind, waves and currents on the platform and risers.

11/7/20
86-05708
Lightweight composite production risers for a deep water tension leg platform
Sparks, C.P.; Chung, J.S.; Yoshida, K.; Sparks, C.P.; Tsahalis, D.T. (eds.)
Inst. Francais du Petrole, Paris, France
5. International Offshore Mechanics and Arctic Engineering (OMAE) Symposium Tokyo (Japan) 13-18 Apr 1986
PROCEEDINGS OF THE FIFTH INTERNATIONAL OFFSHORE MECHANICS AND ARCTIC ENGINEERING (OMAE) SYMPOSIUM. VOLUME 3 pp. 86-93, 1986
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V23N4
This paper describes the architecture of the individual composite production risers of the PLTB 1000 concrete tension leg platform, designed for 500-1000m water depths, and presents the design procedure that determines their dimensions. It emphasises the important influence of riser apparent weight on platform payload. It shows that TPLs are more sensitive to such weight than they are to structural deadload. Methods of calculating the equivalent elastic characteristics of composite tubes are presented. These characteristics allow wellheads to be fixed at deck level without continual compensation of vertical relative movements. Each wellhead has to be installed on passive jacks to allow periodic adjustment of mean riser tension. The paper describes ways of designing the tubes so as to limit the required stroke of the jacks. The principal factors leading to differential profiles between adjacent risers are identified and their relative influence discussed. It is shown that individual production risers are valid proposition in 1000 m of water, if they are fabricated from lightweight, high strength composite materials.

11/7/21
86-01209
Large deformation three-dimensional static analysis of deep water marine risers
Bernitsas, M.M.; Kokarakis, J.E.; Imron, A.
Dep. Nav. Archit. and Mar. Eng., Univ. Michigan, Ann Arbor, MI 48109-2145, USA
APPL. OCEAN RES VOL. 7, NO. 8, pp. 178-187, 1985
SUMMARY LANGUAGE - ENGLISH

Languages: ENGLISH
Journal Announcement: V23N1
The problem of static three-dimensional, nonlinear, large deformation response of a marine riser is formulated within small strain theory and solved numerically. This type of analysis is necessary, for the new generation of drilling and production risers. The mathematical model takes into account the effects of internal and external pressure and the complete nonlinear boundary conditions, without linearizing the follower forces. The extensibility or inextensibility condition is used as the constitutive relation in the tangential direction. Torsion and bending are coupled. The external load and the boundary conditions are deformation dependent.

11/7/22
84-09988
Theoretical and experimental prediction of the response of marine riser model subjected to sinusoid excitation of its top end with amplitude of two diameters orthogonal to a uniform stream of speed equal to 240 mm/s
Patrikalakis, N.M.; Chryssostomidis, C.
Massachusetts Inst. of Technology, Cambridge (USA). Sea Grant Coll. Program
REP. MASS. INST. TECHNOL. SEA GRANT PROGRAM 1983
SUMMARY LANGUAGE - ENGLISH; NTIS Order No.: PB83-210583; NOAA-83052509, Grant NA81AA-D-00069.
Languages: ENGLISH
Journal Announcement: V21N6
The objective of this report is to provide an analysis of the experimental results obtained from a 3 m flexible riser model with its top end oscillated harmonically with an amplitude of two diameters orthogonal to a uniform stream which is constant with depth and of speed equal to 240 mm/s, and a comparison of the experimental results from the flexible model with theoretical predictions of the response based on rigid cylinder experimental results.

11/7/23
84-09971
Theoretical and experimental prediction of the response of a marine riser model subjected to sinusoid excitation of its top and with amplitude of two diameters parallel to a uniform stream of speed equal to 120 mm/s
Chryssostomidis, C.; Patrikalakis, N.M.
Massachusetts Inst. of Technology, Cambridge (USA). Sea Grant Coll. Program
REP. MASS. INST. TECHNOL. SEA GRANT PROGRAM 1983
SUMMARY LANGUAGE - ENGLISH; NTIS Order No.: PB83-210328. Grant NA81AA-D-00069.
Languages: ENGLISH
Journal Announcement: V21N6
The objective of this report is to provide an analysis of the experimental results obtained from a 3 m flexible riser model with its top end oscillated hamonically with an amplitude of two diameters parallel to a uniform stream which is constant with depth and of speed equal to 120 mm/s, and a comparison of the experimental results from the flexible model with theoretical predictions of the response based on rigid cylinder experimental results.

11/7/24
84-09969
Theoretical and experimental prediction of the response of a marine riser model subjected to sinusoid excitation of its top end with amplitude of two diameters parallel to a uniform stream of speed equal to 240 mm/s
Chryssostomidis, C.; Patrikalakis, N.M.

Massachusetts Inst. of Technology, Canbridge (USA). Sea Grant Coll. Program
REP. MASS. INST. TECHNOL. SEA GRANT PROGRAM 1983
SUMMARY LANGUAGE - ENGLISH; NTIS Order No.: PB83-210567.; NOAA-83052507; Grant NA81AA-D-00069.
Languages: ENGLISH
Journal Announcement: V21N6
The objective of this report is to provide an analysis of the experimental results obtained from a 3 m flexible riser model with its top end oscillated harmorically with an amplitude of two diameters parallel to a uniform stream which is constant with depth and of speed equal to 240 mm/s, and a comparison of the experimental results from the flexible model with theoretical predictions of the response based on rigid cylinder experimental results.

11/7/25
84-09957
Theoretical and experimental prediction of the response of a marine riser model subjected to sinusoid excitation of its top end with amplitude of two diameters orthogonal to a uniform stream of speed equal to 120 mm/s
Patrikalakis, N.M.; Chryssostomidis, C.
Massachusetts Inst. of Technology, Cambridge (USA). Sea Grant Coll. Program
REP. MASS. INST. TECHNOL. SEA GRANT PROGRAM 1983
SUMMARY LANGUAGE - ENGLISH; NTIS Order No.: PB83-210559; NOAA-83052508; Grant NA81AA-D-00069.
Languages: ENGLISH
Journal Announcement: V21N6
The objective of this report is to provide an analysis of the experimental results obtained from a 3 m flexible riser model with its top end oscillated harmonically with an amplitude of two diameters orthogonal to a uniform stream which is constant with depth and of speed equal to 120 mm/s, and a comparison of the experimental results from the flexible model with theoretical predictions of the response based on rigid cylinder experimental results.

11/7/26
84-09955
Theoretical and experimental prediction of the response of a marine riser model subjected to sinusoid excitation of its top end with amplitude equal to two diameters
Chryssostomidis, C.; Patrikalakis, N.M.; Vrakas, E.A.
Massachusetts Inst. of Technology, Cambridge (USA). Sea Grant Coll. Program
REP. MASS. INST. TECHNOL. SEA GRANT PROGRAM 1983
SUMMARY LANGUAGE - ENGLISH; NTIS Order No.: PB83-210575; NOAA-83052505; Grant NA81AA-D-00069.
Languages: ENGLISH
Journal Announcement: V21N6
The objective of this report is to provide an analysis of the experimental results obtained from a 3 m flexible riser model with its top end oscillated harmonically with an amplitude equal to two diameters, and a comparison of the experimental results from the flexible model with theoretical predictions of the response based on rigid and flexibly mounted rigid cylinder experimental results.

11/7/27
84-01262
Modern production risers. Part 1
Cowan, R.; Horton, E.E.

Global Marine Development Inc.
PET. ENG. INT VOL. 55, NO. 2, pp. 36-59, 1983
Languages: ENGLISH
Journal Announcement: V21N1
Designed for drilling and producing in water depths of 1,500 to 10,000 ft, buoyant towers promise to open up the deep ocean basins for development.

11/7/28
83-08989
Arbitrarily large static and dynamic motions of drilling and production risers
McNamara, J.F.; Joyce, P.J.; Gilroy, J.P.
University Coll. Galway, Ireland
Norwegian Inst. Technology, Trondheim (Norway); Norwegian Hydrodynamic Lab
Int. Symp. on Hydrodynamics in Ocean Engineering Trondheim (Norway) 24 Aug 1981
HYDRODYNAMICS IN OCEAN ENGINEERING pp. 865-885, (1982)
NORWEGIAN HYDRODYNAMIC LABORATORIES, TRONDHEIM (NORWAY)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V20N6
A general approach for computing finite dynamic motions and associated stresses in drilling and production risers under wave loading and vessel motions is described. The method is based on convected coordinates for modelling the large motions and all terms due to hydrodynamic, buoyancy, and gravity forces are readily accommodated using this formulation within the context of a finite element structural discretization. The time integration scheme is selected on the basis of its efficiency and stability, and the solution scheme is further optimized by the manner in which the large rigid body motion effects are included as a load term in the nonlinear equilibrium equations. The method is further extended to the simulation of the behaviour of multi-line production riser bundles where each line is considered as a separate structural component and only tied at intervals to its adjoining lines.

11/7/29
83-08414
Review of alternative production risers
Mason, J.P.; Parlas, S.C.
Address not stated
Deep Offshore Technology Conference Palma de Mallorca (Spain) 19 Oct 1981
DEEP OFFSHORE TECHNOLOGY CONFERENCE. PROCEEDINGS. VOLUME 2 -- DEEPWATER PRODUCTION pp. 35-50, 1981
DOT, PARIS (FRANCE)
Languages: ENGLISH
Journal Announcement: V20N6
A production riser, for this presentation, is a means of connecting wells on the seafloor with production treatment facilities on a floating vessel. The production riser transmits produced fluids, injection water or gas, TFL tools, chemicals and hydraulic control fluids, and in some instances, moors the production vessel. The intent of the present paper is to describe the alternative systems in use or proposed, and review the "state-of-the-art" in design and equipment. For classification purposes, three broad categories of production risers will be presented: vertical tensioned risers, buoyant structural risers, and catenary riser systems. The advantages, disadvantages and ranges of applicability of each will be discussed.

11/7/30
83-08352
Titanium stress joint for marine risers
Fisher, E.A.; Schnitzer, E.
Cameron Iron Works, Inc., USA
Deep Offshore Technology Conference Palma de Mallorca (Spain) 19 Oct 1981
DEEP OFFSHORE TECHNOLOGY CONFERENCE. PROCEEDINGS. VOLUME 1 -- DEEPWATER EXPLORATION pp. 152-166, 1981
DOT, PARIS (FRANCE)
Languages: ENGLISH
Journal Announcement: V20N6

In the offshore oil and gas industry, although some of its properties are attractive for and compatible with long term, severe subsea structural applications, the use of titanium has been limited primarily to withstanding corrosive environments. In this paper, such a much needed structural application is discussed which has been exhaustively studied, analyzed and tested over the past four years. The incorporation of the proposed design into working production riser systems whose hardware requirements are beyond the capabilities of current structural steel components, would pave the way for the introduction of titanium into other offshore structural equipment.

11/7/31
83-08274
Application of filament-wound composite tubes to production risers
Falcimaigne, J.; Sparks, C.; Phan, A.
I.F.P., S.N.I.A.S.
Deep Offshore Technology Conference Palma de Mallorca (Spain) 19 Oct 1981
DEEP OFFSHORE TECHNOLOGY CONFERENCE. PROCEEDINGS. VOLUME 2 -- DEEPWATER PRODUCTION pp. 221-227, 1981
DOT, PARIS (FRANCE)
Languages: ENGLISH
Journal Announcement: V20N6

With the development of fields in very deep water, foreseen for the near future, the weight of the riser will become a significant parameter in its design. The mechanical strength of certain materials composed of high-performance fibers embedded in a resin matrix can be as high as that of steel; their weight is lower, and they are less sensitive to corrosion by many chemical agents. For deep offshore applications, the lightness of composite materials constitutes a further and essential advantage. A research program has been developed by IFP, in association with SNIAS, which has acquired a 20-year expertise in filament-wound components in order to design, manufacture and test tubes capable of supporting high internal pressure and axial tension. These composite tubes and their principal properties are described in this paper. Their mechanical behavior has been verified by many tests, carried out under various loadings. The influence of their properties on production-riser design is then discussed. Last, some applications of this new technology to other components of a production riser are considered, but further research is needed to be completely sure of their feasibility. These applications are expected to lead to significant improvements in the performance of production risers.

11/7/32
83-08269
Sea bed to surface connections in very deep water: Dynamic production riser
Dumay, J.-M.

COFLEXIP SA
Deep Offshore Technology Conference Palma de Mallorca (Spain) 19 Oct 1981
DEEP OFFSHORE TECHNOLOGY CONFERENCE. PROCEEDINGS. VOLUME 2 -- DEEPWATER PRODUCTION pp. 208-220, 1981
DOT, PARIS (FRANCE)
Languages: ENGLISH
Journal Announcement: V20N6
The most viable solution for developing deep water fields would seem, at the present time, to be a system whereby the crude is produced via a number of sub sea satellite wells, transported through flowline networks to be processed on semi-submersible production platforms and then transferred to loading facilities. Crucial factors of this type of development program are the dynamic type of liaisons necessary to flow the production between the sea bed and surface installations, and the difficulty in installing pipes and in carrying out sub sea works in deep water. For these important functions, Coflexip risers are now used worldwide in water depths of up to 200 meters. This paper describes the main problems encountered, and some possible solutions, with regard to pipe structures and pipe installation in deep waters.

11/7/33
83-08183
Random dynamic response of a tethered buoyant platform production riser
Etok, E.U.; Kirk, C.L.; Kirk, C.L. (ed.)
Offshore Struct. Group, Cranfield Inst. Technol., Cranfield, Bedford, MK43 0AL, UK
DYNAMIC ANALYSIS OF OFFSHORE STRUCTURES: RECENT DEVELOPMENTS pp. 81-94, 1982
CML PUBLICATIONS, SOUTHAMPTON (UK)
PROGRESS IN ENGINEERING SCIENCES, VOL. 1, , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V20N6
A new normal mode spectral analysis method is presented for calculating r.m.s. riser deflections, bending stresses and lower ball joint angles. Forces on the riser consist of: (a) non-linear fluid drag taking account of the relative velocity due to tethered buoyant platform (TBP) motion, riser elastic deflection and wave induced fluid velocity, (b) wave induced fluid acceleration, (c) inertia forces due to TBP acceleration, and (d) buoyancy. The non-linear fluid drag forces are linearized using Tung and Wu's approximation based on the r.m.s. relative fluid velocity and current. A wide range of results is presented for risers in water depths up to 1000 m and to 1000 m and it is observed that 6 normal modes are sufficient for calculating bending stresses. A static analysis is also presented for bending stresses due to wave and current induced drag forces and riser offset.

11/7/34
83-04286
On the dynamics of production risers
Patel, M.H.; Sarohia, S.; Chryssostomidis, C.; Connor, J.J. (eds.)
Univ. Coll. London, London, UK
3. International Conference on the Behaviour of Off-shore Structures Cambridge, MA (USA) 2 Aug 1982
BEHAVIOUR OF OFF-SHORE STRUCTURES. VOLUMES 1 and 2 pp. 599-617, 1983
HEMISPHERE/MCGRAW-HILL, WASHINGTON, DC (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V20N3
This paper presents some results from an investigation into the

structural and fluid loading aspects of single and multi-tube production risers. Two methods of structural analysis are outlined; the first is an extension of conventional drilling riser practice and employs an equivalencing technique for transforming the physical properties of a riser of complex cross-section to that of an equivalent single tube drilling riser. A second method, based on a fuller finite element structural analysis of the riser is also described. The paper presents results of large scale tests for a marine riser of circular cross-section. These large scale tests were performed for 1:23 scale risers in 7.6m water depth with a model semisubmersible surface platform. Measurements of wave elevation, surface platform surge together with in line (to the wave direction) and transverse displacements and bending stresses at several stations along the riser length are compared with a two dimensional finite element computation.

11/7/35
82-03957
Multiple String Production Riser Analyses - A Comparison of Methods
Olson, R.J.; McIver, D.B.; Kozik, T.J.; Mann, R.J.; Shelton, J.E. (eds.)
Battelle Houston Operations, Houston, TX, USA
37. Petroleum Mechanical Engineering Workshop and Conference Dallas, TX (USA) 13-15 Sep 1981
RISERS, ARCTIC DESIGN CRITERIA, EQUIPMENT RELIABILITY IN HYDROCARBON PROCESSING: A WORKBOOK FOR ENGINEERS pp. 119-126, 1981
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N3

A comparison is made between two techniques for computer modeling of multi-tube marine riser production systems. One technique models the multi-tube system as a single equivalent riser, while the other technique simultaneously models the individual risers in the system and their structural ties. The riser equations of motion, multi-tube riser modeling considerations, and sample comparison results are presented. Results demonstrate that both riser system modeling techniques have limitations and that the ultimate choice of technique will depend upon accuracy and economic constraints.

11/7/36
82-03956
A High Pressure Swivel for Natural Gas Service and Oscillating Motion in a Marine Environment
Herbert, J.T.; Ortloff, J.E.; Kozik, T.J.; Mann, R.J.; Shelton, J.E. (eds.)
Corporate Eng., Aeroquip Corp., Jackson, MI, USA
37. Petroleum Mechanical Engineering Workshop and Conference Dallas, TX (USA) 13-15 Sep 1981
RISERS, ARCTIC DESIGN CRITERIA, EQUIPMENT RELIABILITY IN HYDROCARBON PROCESSING: A WORKBOOK FOR ENGINEERS pp. 111-118, 1981
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N3

A joint development program by Exxon Production Research Company and Aeroquip Corporation produced a unique flowline swivel for high pressure (6,000 psig (41,370 kPa)) natural gas service under continuous, small degree rotation, oscillating service. The swivel uses an elastomeric bearing element made up of alternate, frustro-conical shaped rings of metal and rubber (elastomer) to absorb continuous small degree (plus or minus 5 degree to plus or minus 6 degree) rotary oscillations or flexures of the swivel. A 6-in (152.4 mm), 6,000 psig (41,370 kPa) prototype successfully passed a rigorous qualification test program which included one million cycles of flexure (from 0 degree to + 4 1/2 degree to - 4 1/2 degree and back to 0 degree) at a rate of five cycles per minute. The test program also included a pressurized "soak" test with methane containing 10 per cent (by volume) hydrogen sulfide. The swivel should be useful in offshore marine production riser systems and loading terminals or any application involving continuous small degree motions.

11/7/37
82-03955
An Articulated Multiline Production Riser for Deepwater Application
Ortloff, J.E.; Caldwell, J.B.; Teers, M.L.; Kozik, T.J.; Mann, R.T.; Shelton, J.E. (eds.)
Exxon Prod. Res. Co., Houston, TX, USA
37. Petroleum Mechanical Engineering Workshop and Conference Dallas, TX (USA) 13-15 Sep 1981
RISERS, ARCTIC DESIGN CRITERIA, EQUIPMENT RELIABILITY IN HYDROCARBON PROCESSING: A WORKBOOK FOR ENGINEERS pp. 105-110, 1981
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N3
The need to produce oil and gas in water depths beyond the physical and economical limits of fixed platforms and pipelines has led to the development of a feasible concept for an articulated multiline flexible marine production riser system. This paper covers the history of the concept development from inception to readiness for engineering design and fabrication of a prototype test model.

11/7/38
82-03954
Design, Fabrication, and Installation of a Prototype Multiline Marine Production Riser System
Gammage, W.F.; Ortloff, J.E.; Teers, M.L.; Caldwell, J.B.; Kozik, T.J.; Mann, R.J.; Shelton, J.E. (eds.)
Exxon Co., New Orleans, LA, USA
37. Petroleum Mechanical Engineering Workshop and Conference Dallas, TX (USA) 13-15 Sep 1981
RISERS, ARCTIC DESIGN CRITERIA, EQUIPMENT RELIABILITY IN HYDROCARBON PROCESSING: A WORKBOOK FOR ENGINEERS pp. 99-104, 1981
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N3
A multiline marine production riser and floating production, storage, and terminal facility may be required for economic development of oil and gas reserves in remote, deep water locations. A deep water production riser design has evolved through study, analyses, and model testing. In order to gain experience, development confidence, and improve the riser design prior to commercial application, a prototype has been built for testing as part of Exxon's Submerged Production System offshore test in the Gulf of Mexico. This paper treats the design, manufacture, and installation of the prototype multiline marine production riser system.

11/7/39
82-03951
Stress Balanced Tapered Columns in Marine Risers
Dareing, D.W.; Kozik, T.J.; Mann, R.J.; Shelton, J.E. (eds.)
Maurer Eng., Inc., Houston, TX, USA

37. Petroleum Mechanical Engineering Workshop and Conference Dallas, TX (USA) 13-15 Sep 1981
RISERS, ARCTIC DESIGN CRITERIA, EQUIPMENT RELIABILITY IN HYDROCARBON PROCESSING: A WORKBOOK FOR ENGINEERS pp. 75-80, 1981
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK, NY (USA)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N3
Tapered columns are widely accepted as a preferred method of controlling bending stresses at the lower end of production risers. In addition, they eliminate doglegs, which develop in flexible joints, and produce a smooth curvature between marine risers and well leads. This paper gives a calculation method for determining dimensions of tapered columns. Example calculations show how this method is used to produce a stress balanced design.

11/7/40
82-02968
A System for Surveillance of Deflection and Stress in Flexible Risers for Use on Floating Production Platforms
Otteren, A.
Chr. Michelsen Inst., Dept. Sci. Technol., Bergen, Norway
Conference on the Automation for Safety in Shipping and Offshore Operations Trondheim (Norway) 16 Jun 1980
COMPUTER APPLICATIONS IN SHIPPING AND SHIPBUILDING. VOLUME 8: AUTOMATION FOR SAFETY IN SHIPPING AND OFFSHORE PETROLEUM OPERATIONS pp. 139-144, 1980
NORTH-HOLLAND, AMSTERDAM (NETHERLANDS)
SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N2
This paper presents a proposed system for monitoring the deflection and stesses in a marine riser. A mathematical model suitable for on line estimation of riser profile (riser angle) using a Kalman filter technique has been developed. Wave forces are considered as process noise and the parameters in a wave model (wave spectrum) are estimated if a wave height measurement is available. Input to the system can be riser angle or riser velocity at the top of the riser and at some position along the riser profile. Based on these measurements, the instantaneous riser profile is estimated on line. Output from the system can be: Instantaneous deflection and the load conditions (stress) along the riser profile; Maximum and minimum deflection and stress along the riser profile (envelope) within a preset time period; Accumulated fatigue along the riser profile.

11/7/41
82-01450
The Dorada Field Production Risers
Wybro, P.G.; Davies, K.B.
Getty Oil Company
Thirteenth Annual Offshore Technology Conference Houston, TX (USA) 4 May 1981
Proceedings of Thirteenth Annual Offshore Technology Conference VOL. 2, pp. 335-351, 1981
Offshore Technology Conference, Dallas, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N1
The Dorada Field floating production system, located offshore Spain in 310 ft of water in the Mediterranean Sea, utilizes three individual production risers. This paper outlines the riser analysis methodology,

identifies several new aspects of production riser design analysis, describes some pertinent results, and discusses the riser instrumentation system developed to verify these results. The riser analysis utilized a time-domain finite element program to predict survival state conditions and develop stress transfer functions. The fatigue analysis assessed both the familiar wave-frequency fatigue damage and damage due to wind-gust induced low-frequency vessel motion. A riser instrumentation system was designed and installed to assist in production riser operations and to provide data for validating riser analysis models. Local riser stresses, flex-joint angle, vessel motions, and environmental factors are measured by the system. The results of a preliminary comparison between predicted and measured results are presented.

11/7/42
82-01448
Dorada Field Production System: A Solution to Individual Permanent Vertical Access to Several Wells From a Semi-Submersible
Montoya, L.S.; Lopez-Fanjul, G.M.
G.M. (ENIEPSA)
Thirteenth Annual Offshore Technology Conference Houston, TX (USA) 4 May 1981
Proceedings of Thirteenth Annual Offshore Technology Conference VOL. 2, pp. 319-334, 1981
Offshore Technology Conference, Dallas, TX (USA)
PROC. OFFSHORE TECHNOL. CONF., , , ; SUMMARY LANGUAGE - ENGLISH
Languages: ENGLISH
Journal Announcement: V19N1
Water drive reservoirs of small size, such as the Dorada Field, require frequent wire-line and stimulation operations. Individual permanent vertical access to each well from the semi must be provided to carry out the frequent down-hole operations required, without affecting the production of the wells not being worked-over. This paper describes the first functional installation of individual production risers from a three-well cluster to a semi-submersible. It outlines the alternatives considered, the design criteria, the computer analysis developed, the equipment used and the instrumentation system for monitoring critical riser and rig parameters. Three innovations which are prototype for production risers have been introduced for each well in the Dorada Project: a flex joint installed between the sub-sea tree and the riser, a threaded riser, and the tensioning system devised for it.

11/7/43
81-08309
Modern Production Risers Part 6 - Buoys, Swivels, and Emergency Disconnects
Morgan, G.W.
Eng. Consult., San Jose, CA
PETRO. ENG. INT VOL. 53, NO. 3, pp. 62,66,68+, 1981
Languages: ENGLISH
Journal Announcement: V18N6
As production risers become longer, and as their support buoys become larger, it is increasingly important to determine the appropriate characteristics of the net vertical support forces associated with various buoy configurations. The engineer must develop an appreciation for force contributions related to the geometries of typical buoy shapes. Some buoy configurations impart large fluctuations in support force with the passing of high-amplitude waves, while other designs may maintain a more evenly distributed uplift throughout the wave cycle. From the standpoint of fatigue degradation, for long periods of production service, studies of force fluctuations in riser structures should not be overlooked. Also, from

the viewpoint of riser analysis input, dynamic variations in support tension which result from a particular buoy configuration (assuming, of course, that major support for the given riser is by means of buoy flotation) must be specified properly.

11/7/44
81-06793
Modern Production Risers; Part 7 - Historical Review of Technological Development
Morgan, G.W.
PETRO. ENG. INT VOL. 53, NO. 4, pp. 26-27, 30+, 1981
Languages: ENGLISH
Journal Announcement: V18N5
It has sometimes been assumed, in recent years, that design techniques and corresponding analytical methods for production risers can be directly extrapolated from those used in the past for drilling risers. Major differences exist, both in the physical attributes of the structures and in their analytical methodologies. If one may judge from the past, hardware designs for offshore exploration and production have developed along two separate lines: (1.) carefully planned experimental programs, followed by detailed design and analysis studies, and (2.) the so-called "expedient" approach, in which design compromises are accepted under the urgency of the moment.

11/7/45
81-05379
Modern Production Risers Part 8 - Analysis of Articulated Production Risers
Cowan, R.
Lockheed Missiles and Space Co., Sunnyvale, CA
PETROLEUM ENGINEER INT. VOL. 53, NO. 6 , 1981
Languages: ENGLISH
Journal Announcement: V18N4
Technological advances have not only occurred in the hardware aspects of offshore oil and gas production systems, but also in the analytical methods to predict the behavior of the production riser. Most modern mathematical solution techniques use computers and numerical analyses. Computers enable the modern engineer to perform analyses in rigorous detail. Computations once considered too expensive and time consuming now are routine and necessary to evaluate modern production riser systems. Most riser computer programs allow for variations in input data to evaluate design parameters of the system in terms of the ability to withstand loading conditions imposed by the environment and operational requirements.

11/7/46
81-03647
Modern Production Risers Part 5-Riser Base Section
Morgan, G.W.
PETROL. ENG. INT. VOL. 53, NO. 2 , pp. 36,38,40+ , Feb. 1981
Languages: ENGLISH
Journal Announcement: V18N3
The type and arrangement of a riser base section is detemined to a great extent by hydraulic, mechanical, structural, and geotechnical parameters.

11/7/47
81-00814
Intervention requirements for seabed oil and gas production systems.
Shotbolt, K.
CJB Subsea Ltd.
Seminar on alternatives to divers in deep waters London, England Nov

27, 1979
Society for Underwater Technology
Society for Underwater Technology. Journal of the Society for Underwater Technology 6(2), 13-16, Jun 1980 Coden: JSUTDD
illus. no refs.
ISSN: 0141-0814
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER CONFERENCE PAPER
TREATMENT CODES: G (GENERAL OR REVIEW)
Journal Announcement: V18N1
Six tables of systems-drilling; well completion; pipelines, flowlines, and control cable; production riser and manifold; tanker loading facility; multi-well manifold centers-identify activities requiring underwater intervention. Information includes the activity, visual capability, degree of manipulation, and other intervention required. The general conclusion is that good visual capability and dextrous manipulation are often required at present. Good design and extensive on-surface inspections and testing are recommended to save dives and possibly lives. (FT)

11/7/48
81-00784
Producing via DP tanker.
Steven, R. R.
Offshore, London Bureau, 12 Caxton St., Alliance House, 6th Floor, Westminster, London SW1H OQS, England
Offshore 40(10), 62-64, Sep 1980 Coden: OFSHAU
illus. no refs.
ISSN: 0030-0608
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
TREATMENT CODES: G (GENERAL OR REVIEW)
Journal Announcement: V18N1
Four new design-research projects by Progressive Production Technology to study the effectiveness of tanker-based marginal and other offshore production operations are reviewed. Three use essentially the same dynamically positioned (DP) tanker concept. Projects shown in schematics and discussed include the DP Bee similar to BPs SWOPS and generally using a flexible riser; the DP North Sea Dragon using a catenary flexible riser with or without a double ''S'' bend; the DP MPT (Marginal Production Tanker) 100 for severe waters and using a flowline support buoy (FSB) concept; and the MPT 50 for moderate waters using a FSB concept and conventional rather than DP anchoring technology. One still unresolved question is the lifespan of flexible risers in dynamic applications. The overall goal is a flexible and economic solution for limited offshore production situations. (FT)

11/7/49
80-06695
Floating production system insures Buchan Field success.
Likwartz, D. J.
SEDCO-Hamilton Production Services, Project Developments, Dallas, TX
PETROLEUM ENGINEER 52(4), 13-18, Mar 15, 1980 Coden: PEEID4
illus. no refs.
ISSN: 0096-4514
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
TREATMENT CODES: G (GENERAL OR REVIEW)

Journal Announcement: VOL. 17, NO. 5
Floating production facility (FPF) will go on stream in the near future in Buchan Field, a small reserve in the North Sea's UK sector. The technological breakthrough making Buchan a viable project came in 1975 when the 1st FPF was commissioned at Argyll Field, =120 mi SE of Buchan. Descriptions are given of the subsea template, subsea trees, production riser, control system, corrosion protection, and project schedule. Although the development scheme features no complex technological breakthrough, it does represent a steady but significant advance in the FPF learning curve. The step-wise evolution from Argyll Field minimizes the possibility of any major problems occurring and should ensure another successful production operation. (FT)

11/7/50
80-00835
(Subsea wellhead equipment).
Anonymous
OFFSHORE SERVICES 12(3), 34-41, Mar 1979 Coden: OFSVA4
illus. no refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
TREATMENT CODES: N (NEW DEVELOPMENTS) ; A (APPLICATIONS)
Journal Announcement: V17N1
A recent subsea manifold and production template and also a wellhead cover in concrete proposed by Norwegian Contractors (NC) and recent designs and trends in marine production risers are described. NC's solutions are novel because of their toroidal shape, the use of gravity anchorages, and the use of concrete. Any size unit can be built. The units are built in a graving dock and floated out normally. Advantages include the promise of early production, usefulness at greater depths, and subsea accommodation for oil-processing equipment in a 1-atm state. No NC structures are yet in use. Four developments in marine risers evaluated include a segmented tension or nonintegral riser from Sedco-Hamilton, SALM, a fully articulated tower, and single anchor leg storage. Drawbacks in each method limiting its applications are discussed. Choice depends on duty and location of the riser, the method of service and maintenance after installation, and the expected service life of the chosen flexible sections and joints of the subsea end of the riser. Experience gained in the field with each method is reported. The development of mechanical joints, mechanical swivels, and instrumentation is described. Maintenance economics of the methods are compared. (FT)

11/7/51
79-08794
An unmanned tethered maintenance vehicle for deepwater production riser maintenance.
Teers, M. L.
Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001
pp. 1905-1912
illus. refs.
79-08606 Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

11/7/52
79-08764
Aspects of hydrodynamic loading in design of production risers.
Loeken, A. E.; Torset, O. P.; Mathiasson, S.; Arnesen, T.
Det norske Veritas, P.O. Box 6060 Etterstad, Oslo, 6, Norway

pp. 1591-1601
illus. refs.
79-08606 Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

11/7/53
79-08763
Analysis of production riser systems.
Bennett, B. E.; Wilhelm, G. P.
Earl and Wright Consulting Engineers, 657 Howard St., San Francisco, CA 94105
pp. 1577-1590
illus. refs.
79-08606 Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

11/7/54
79-08762
Structural design of production risers and offshore production terminals.
Wolfram, W. R., Jr.; Gunderson, R. H.
Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001
pp. 1569-1576
illus. refs.
79-08606 Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

11/7/55
79-08257
Deepwater platform minimizes problems.
Anonymous
OFFSHORE 38(10), 109-114, Sept. 1978 Coden: OFSHAU
illus. no refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

Amoco International Oil Co. and Amoco Production Co. have developed and engineered a new deepwater drilling and production platform called the Vertically Moored Platform (VMP). It allows production of established offshore fields in water depths from 800 to 3,000 ft. A major advantage of the VMP design is the riser assembly system composed of tubular risers, providing the primary structural mooring and the conductors through which the wells are drilled. Essentially conventional offshore platform drilling, completion, production, and workover operations are conducted from the VMP deck. Ready access to wells provides a high degree of safety, reliability and of well maintenance to minimize well problems and downtime. The VMP is a large semisubmersible structure from which drilling and production operations are conducted. The bending flexibility of the long riser system permits the platform to move horizontally with storm waves so that large structural forces are avoided. The VMP is compliant but is designed as a permanent structure. All structural elements have been engineered for strength and protection against fatigue and corrosion. The VMP can be retrieved and used at other locations. VMP costs are relatively insensitive to water depth increases. Selected major engineering contractors are being provided with the Amoco VMP technology and are authorized to perform VMP engineering studies for clients, and VMP designs for licensed operators. (FT)

11/7/56
79-06849
Deepwater production risers.
Gunderson, R. H.; Lunde, P. A.
Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001
ASME Petroleum Division: Energy technology conference Houston, Texas Nov. 5-9, 1978
AMERICAN SOCIETY OF MECHANICAL ENGINEERS. PAPER (1978?) Coden: ASMSA4
8 pp
illus. refs.
Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

Exxon's deepwater production terminal, applicable for use in water depths K5,000 ft and in rough weather environments, consists of a Single Anchor Leg Mooring (SALM) production riser and a floating storage tanker with production facilities on board. The separated gas and water are disposed of by reinjection into the formation. Shuttle tankers offload the crude oil by tandem mooring to the storage tanker. The broad concepts of the riser system are described including the design criteria. Exxon has conducted extensive model tests and analyses on this system to assess its feasibility and has designed several SALM systems for various parts of the world. The design of a new structural system requires establishing design criteria consistent with good engineering practice and safety considerations. The Exxon riser system design criteria has been developed using established codes and emerging code requirements for offshore loading terminals modified to fit the functional and structural characteristics of the Exxon SALM. (AM)

11/7/57
79-05212
"Joint" combination offers flexibility.
Sprague, R. G.
Hydril Co.
OFFSHORE 38(13), 88-95, Dec. 1978 Coden: OFSHAU
illus. refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The Hydril Annu-Flex, an integral elastomeric flexible riser connection available in 163/4-in and 183/4-in sizes, is discussed. Its early developmental history from 1963 by the Lockheed Propulsion Co. is considered. The testing program for the "Lockseal" included the following 4 phases: demonstration of structural capability of the connector and provision of the initial spring rate data of the elastomer element; checking the flex joint's structural integrity; testing the hydrostatic pressure at 2,000 psig for 24 hr with no pressure change, and pressurization to 2,000 psig; and actuation F4deg for 550 cycles. The flex joint has a working tension capacity of 1 million lb at a rated working pressure of 1,500 psi and a maximum pull capability of 1,500,000 lb. It provides for NF10deg of flexure. The self-centering joint has restoring flexure and is unaffected by changes in tension and pressure. Vibration dampening to the stack and marine riser is provided. There are no sliding parts to wear or gall, nor is lubrication or pressure balancing required. Reduction of required top tension in the marine riser where the ball joint angle is the governing factor is provided. The components of the system are a combination BOP and flexible riser connector. The Hydril GL annular BOP, designed and developed for subsea and deep-well applications, contains only 2 movable parts-the piston and the packing unit. Oil States Rubber Company's Flex Joint-as used in the Hydril Annu-Flex is constructed of alternate layers of spherically shaped rubber and metal. Flex Joint applications and the elastomeric bearing principles are discussed. (FT)

11/7/58
79-03837
Exxon's new deepwater production riser.
Gunderson, R. H.; Lunde, P. A.
Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001
OCEAN INDUSTRY 13(11), 67-73, Nov. 1978 Coden: OCIDAF
illus. no refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Exxon's new production terminal features a SALM production riser and a floating storage tanker with production facilities on board. It can operate in rough water depths of K5,000 ft. Separated gas and water are reinjected into the formation, and shuttle tankers offload the crude oil via tandem mooring to the storage tanker. The SALM riser moors the storage vessel, acts as a support for the fluid lines, and serves as a support for communication lines leading to subsea production equipment. Numerous offshore loading terminals have been modified to fit the functional and structural characteristics of Exxon's SALM system. The riser uses an above-water hinged stationary arm to permanently moor a storage tanker to the SALM. Multiline fluid swivels and electrical swivels are situated above water and are reachable for inspection and maintenance via the rigid arm. The arm itself can be conveniently inspected and serviced. The major structural components of the SALM system are the pile-founded or gravity base, the upper and lower universal joints, riser, buoy, mooring turntable and -pitch pin, roll pin, rigid mooring arm, and hinge connector to the tanker. Installation procedures for the SALM riser are discussed. Descriptions and functions of the components are detailed along with an account of a riser dynamic analysis program and a fatigue analysis program used to design the riser. (FT)

11/7/59
79-01192
Santa Barbara SALM-A prototype deepwater production riser and floating production system.
Wolfram, W. R.; Law, T. E.
Exxon Corp., Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001
Vol. 2 pp. 781-788
illus. refs.
79-01104 Abs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER

11/7/60
79-00826
International report: The Netherlands.
Huijskens, J. P. H.; Suyderhoud, J.; Goldan, M.; et al.
Industrial Council for Oceanology
OCEAN INDUSTRY 13(4), 313-335, Apr. 1978 Coden: OCIDAF
illus. no refs.
Sum.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Technical advancements in the offshore industry made by Dutch companies during the past year briefly discussed include the following: the Narwhal, a 144-m semisubmersible derrick and pipe lay barge owned by the Netherlands

Offshore Co. and built by Ishikawajima-Harima Heavy Industries; a diesel-powered offshore crane equipped with a closed hydraulic system driven by a diesel engine, developed by Sanders Co.; a 75-ton Hook anchor for mooring concrete platforms during the building stage; a marine production riser system developed by Marcon, which can be applied to all subsea systems, and may be the link in the production flow bridging the gap between the seabed and a surface floating unit; a 2.3% Ni-type welding stick developed by Arcos Electrolasch; an instrumented riser joint developed by the Netherlands Organization for Applied Scientific Research, which has a proven operating depth of 2,000 ft; salvage of the jackup Orion; and a nondestructive test of pipe welds developed by the Rontgen Technische Dienst, which uses 12 ultrasonic transducers operating jointly from different directions. A discussion of deep water operations, marginal field production, and technical problems facing the offshore industry with 10 representatives of Norwegian industry and government is presented. Although no oil and gas developments are discussed, a list of about 50 research programs subsidized by the Netherlands government is presented. (FT)

11/7/61
78-05371
Deepwater production.
Anonymous.
OFFSHORE 38(1), 61-66, 68, 71, Jan. 1978 Coden: OFSHAU
illus. no refs.
Sum.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

New concepts, equipment, and methods in ultradeep water exploration are presented. Topics discussed include the Aker Motion Compensated Offshore Crane, a heavy lift crane developed by Nylands Versted, Fred Olsen and Co., and Aker Engineering A/S, for use in rough weather on a converted Aker H-3 platform; the Sub-cap system, developed by Havron Engineering Ltd., which encapsulates wellhead equipment in a concrete base and connects to a surface buoy by an umbilical which carries the control and monitoring lines; the tethered production platform, preliminary specifications of which were recently completed by the Aker Group; Eccofloat buoyancy modules made by Emerson & Cuming, Inc.; Exxon's Submerged Production System, designed to produce oil and gas from remotely controlled ocean floor equipment; the Towing Tension Tie-in method of onshore-welded pipelaying, developed by 2 French oil companies; a remotely controlled pipeline trenching system developed by Kvaerner-Myren; remotely controlled lifting and observation systems developed by Myren Versted Sub Sea; 2-yr tests of Exxon's guyed tower; experiments conducted by Elf-Aquitaine from a subsea station offshore Gabon; a water and sand jet spray for cleaning underwater welds developed by Strongwork Diving International Ltd: plans by R. J. Brown and Associates to install 4 flowline bundles in the world's 1st submarine pipeline installation by off-bottom tow at Conoco North Sea Inc.'s Murchison Field; and the Marcon Production Riser System, claimed by Marcon marine consultants to be the missing link in the subsea development chain. (FT)

11/7/62
78-05361
A new trend: Floating production facilities.
Delmas, R.; Grange, A. R.; Chevallier, J.
Schlumberger Ltd.
OCEAN INDUSTRY 12(10), 53-56, Oct. 1977 Coden: OCIDAF
illus. no refs.
No abs.

Languages: ENGLISH
Doc Type: JOURNAL PAPER
Floating production facilities discussed include the extended flow test system, which involves the use of a semisubmersible used in the drilling mode; the multiwell production system, in which a cluster of N6 wells is drilled directionally and connected to semisubmersible through a multiple riser; the permanent multiwell production system, which is basically the same design as the preceeding systems with a production range of N60,000 BPD; the integrated production system, which would service N10 wells on a cluster and some isolated wells for water injection with a specially built floater; and a single well system which involves a moored tanker installed at some distance from the wellhead and a catenary flex pipe as a production riser. Engineering these facilities will require a perfect knowledge of floater design, riser design, wellhead controls, production process, secondary recovery equipment, and other components of the production system. Several groups are now proposing this engineering and service capability to the operators, and several floating facilities are now producing offshore fields. (FT)

11/7/63
78-05357
Subsea developments.
Hayward, T.; Usquin, B.
Comex Seal
OFFSHORE SERVICES 10(11), 28, 30-32, Nov. 1977 Coden: OFSVA4
illus. no refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Oil company reticence to use untried early production methods when familiar equipment is available has stimulated development of floating "packages" which take advantage of down-market equipment. Virtually any combination of semisubmersibles, jack-ups, integrated and export tankers, buoys, small platforms, and small gravity platforms is on offer, but the use of a large tanker as a permanently moored storage and processing base, loading into smaller export tankers, figures prominently. Contractors are offering designs-considered excellent for marginal fields-mostly for the Mediterranean and Middle East. A system proposed by Northern Offshore Production Ltd. involves a tanker with oil separation equipment, single point mooring, and a shuttle tanker. Mesa plans to develop its Beatrice Field in a similar manner. Uses of subsea completions for marginal fields and as extensions of fixed platforms for major fields are discussed. New developments by Comex Seal discussed include a composite completion riser, installation and maintenance systems, and production risers. Sea trials for 1-atmosphere welding to 1,000 ft, a near-bottom tow flowline installation to 1,600 ft, and flowline bundle laying and connection to 1,000 ft using the draw-down method, were planned by Comex Seal for the near future. Subsea completions are now included in early technical/economic studies of North Sea fields, which was not the case several years ago. (FT)

11/7/64
78-05335
Deepwater production system plays effective role in subsea reentry operations.
van Bilderbeek, B. H.
Vetco Offshore Group, Ventura, CA
OFFSHORE 38(2), 94-96, 98, Feb. 1978 Coden: OFSHAU
illus. no refs.
No abs.
Languages: ENGLISH

Doc Type: JOURNAL PAPER

Because building production platforms for water depths K1,000 ft is largely technically and economically impractical, Vetco Offshore Group has developed 3 Early Subsea Production Systems: the multiwell modular template system; the multiwell unitized template system, which involves a fixed template able to accommodate N11 subsea wells; and the multiwell satellite system, in which several individual subsea wells are tied to a production riser base with subsea flowlines and control lines. The systems were designed to use guideline techniques for re-entry operations throughout the drilling, completion, and production phases of the field development. The 5 major subsystems which form the overall deepwater production systems are the single-well drilling and completion system; the drilling and production templates; the production riser manifold template; the deepwater production riser system; and the floating production platform, all of which are discussed. Objectives of the systems include recovery from field beyond platform depths; recovery at a lower overall cost, allowing prior considered marginal fields to become economically attractive; a predetermined rate of capital expenditure; recovery of part of the exploration cost through integration of exploratory wells into the production system; equipment which is installed on a semipermanent basis to facilitate recovery and reuse; and flexibility when considering field size, geometry, location, and water depth. (FT)

11/7/65
77-03684
MARINE PRODUCTION RISER--A SUBSYSTEM OF THE SUBMERGED PRODUCTION SYSTEM.
TEERS, M.L.
EXXON CO.
EIGHTH ANNUAL OFFSHORE TECHNOLOGY CONFERENCE: 1976 PROCEEDINGS: VOL. 2. (N. P.): OFFSHORE TECHNOLOGY CONFERENCE, 1976. PP. 45-56 1976
Languages: ENGLISH

11/7/66
76-01892
THE PRODUCTION RISER SYSTEM FOR THE ARGYLL FIELD.
KIRKLAND, K.
NATIONAL SUPPLY CO.
OFFSHORE TECHNOLOGY CONFERENCE: SEVENTH ANNUAL: PROCEEDINGS: VOL. II. (N.P.): OFFSHORE TECHNOLOGY CONFERENCE, 1975. PP. 813-818 1975
Languages: ENGLISH
?

12/7/1
0207413
FE
Flexible risers for north sea floating production systems.
Pettenati-Auziere, C.
StavangerForum
In: ONS'86, Offshore Northern Seas Conf. & Exhib., (Stavanger, Norway: Aug. 26-29, 1986), vol.4, Stavanger, Norway, Stavanger Forum, 1986, Paper 7, 27p. ,
Languages: English
The state of the art of flexible dynamic riser systems is described. Since the pioneering use of such a system to develop the Balmoral field in 1984, intensive design work has been carried out, and much technological progress has resulted. General design guidelines are proposed. (D.W.T.)

12/7/2
0204427
FE
Flexible risers.
Palmer, A.C.; Chasserot, J.L.
Andrew Palmer & Assocs. Goodfellow Assocs.
IBC Tech. Serv.Ltd.
In: The Way Forward for Floating Production Systems, Proc. Conf., (London, U.K.: Dec. 16-17, 1985), London, U.K., IBC Tech. Serv. Ltd., Apr. 1986, p.103-119. (ISBN 0-907822-77-0) , 0-907822-77-0
Languages: English
Flexible dynamic riser design is discussed. Some alternatives which were examined in detail are considered first and then discussed in relation to installations in the North Sea. Among the alternative configurations are the free hanging riser, the double catenary, the simple catenary and the steep wave and lazy wave riser systems. It is concluded that flexible risers give the designer of a floating production system a freedom in design which rigid risers cannot give. (D.W.T.)

12/7/3
0199228
FE
Flexible risers.
Palmer, A.C.; Chasserot, J.L.
Andrew Palmer & Assocs. Goodfellow Assocs.
IBC Tech. Serv. Ltd.
In: The Way Forward for Floating Production Systems, Proc. Conf., (London, U.K.: Dec. 1985), London, U.K., IBC Tech. Serv. Ltd., 1986, p.103-119. (ISBN 0-907822-77-0) , 0-907822-77-0
Languages: English
Alternative configurations to the dynamic flexible riser are the free hanging riser, the double catenary, the simple catenary, steep wave and lazy wave. The mechanical components are outlined and stages in the design process of such a riser are examined. Examples quoted from the North Sea are the flexible arch North Sea test, an experimental project, the Argyll/Duncan field and the Balmoral field. (A.J.)

12/7/4
0190826
FE
Linear dynamics of flexible risers.
Patrikalakis, N.M.; Kriezis, G.A.

Mass. Inst. Technol.

,

In: Proc. First OMAE Specialty Symp. on Offshore and Arctic Frontiers, Presented at ASME Ninth Annual Energy-Sources Technol. Conf. & Exhib., (New Orleans, U.S.A.: Feb. 23-27, 1986), M.M. Salama (ed.), New York, U.S.A., Am. Soc. Mech. Engrs., 1986, p.327-336. ,

Languages: English

Presented are solutions for the linear dynamics of flexible risers using a novel combination of efficient embedding and asymptotic techniques. Numerical examples for a buoyant flexible riser are included and the effects of the principal parameters are discussed. A numerical scheme employing the linear solutions to develop a solution of the non-linear problem is outlined. (from authors' abstract)

12/7/5

0190825

FE

Flexible production risers.

Laloe, J.L.

Coflexip & Serv. Inc.

,

In: Proc. First OMAE Specialty Symp. on Offshore and Arctic Frontiers, Presented at ASME Ninth Annual Energy-Sources Technol. Conf. & Exhib., (New Orleans, U.S.A.: Feb. 23-27, 1986), M.M. Salama (ed.), New York, U.S.A., Am. Soc. Mech. Engrs., 1986, p.321-325. ,

Languages: English

Flexible risers may be one of the following: configurations, free hanging, lazy S, steep S, lazy wave or steep wave. Lists the typical layers (interlocked stainless steel carcass, inner thermoplastic tubes and sheath etc.) of a flexible production riser. Presents typical results of static and dynamic analyses and discusses briefly the deep water requirements. Design studies for Coflexip pipe are noted. (C.J.U.)

12/7/6

0190778

FE

Model tests and analysis of flexible riser systems.

Owen, D.G.; Qin, J.

Heriot-Watt Univ.

Thomas Telford Ltd.

In: UK Offshore - Maintaining Self-Sufficiency, Proc. Conf., (London, U.K.: Oct. 9-10, 1985), London, U.K., Thomas Telford Ltd., 1986, Session IV, Paper 11, p.133-145. (ISBN 0-7277-0267-X) , 0-7277-0267-X

Languages: English

A catenary flexible riser system was studied in relation to a typical field development in the North Sea. Simple and approximate formulae developed by catenary theory are presented. Catenary solutions accurately describe the shape, tensions and inclinations of a riser if its flexural stiffness is low. A formal asymptotic expansion is then presented and this method is applied to the non-linear behaviour of a long, flexible riser. A series of model tank tests were carried out in a wave flume in order to observe the non-linear response of the flexible riser system. The system consisted of a flexible pipe suspended in a catenary between a subsurface buoy and a surface buoy. These tests were designed to cover different waves including both operating and severe environmental conditions. The test results showed a reasonable agreement with analytical results. (from authors' abstract)

12/7/7

0189065

FE
Predicting the behaviour of flexible riser systems.
Offshore Res. Focus, no.53, Jun. 1986, p.10. , ISSN 0309-4189
Languages: English
A suite of computer simulations has been developed to investigate the use of flexible systems for production risers and for field injection. Details of the two modules SEAFLEX and RISER, that make up the package are presented. SEAFLEX is a static model, found by modelling the riser as a series of straight segments, not necessarily of the same length. When the static solution is obtained, the model can be used to calculate the natural frequencies and model shapes of the resulting profile. The RISER simulation analyzes the dynamic behaviour of flexible risers, and currently the problems are solved in real time using special purpose hardware. The computer models have been validated by known results and model tests. (A.J.)

12/7/8
0184728
FE
Dynamic behavior of flexible riser.
Bratu, C. ; Narzul, P.
Elsevier Sci. Publishers B.V.
In: Behaviour of Offshore Structures, Proc. 4th Int. Conf., BOSS '85, (Delft, The Netherlands,: Jul. 1-5, 1985), J.A. Battjes (ed.), Amsterdam, The Netherlands, Elsevier Sci. Publishers B.V., 1985, Paper B6, p.375-381. (Dev. Mar. Technol. Vol.2) (ISBN 0-444-42513-6) , 0-444-42513-6
Languages: English
A time domain simulation model of flexible riser dynamic behaviour is presented. Various configurations can be analyzed by this computer program: catenary flexible pipe between the surface support vessel, sub-surface intermediate buoy and 'lazy' or 'steep' pipe configuration to the sea bottom. Features of the long finite element of the riser, submitted to water waves, current and surface support movements are described. The numerical model, which allows a short CPU time, simulates the dynamic behaviour of the riser and calculates tensions and motions at various points, i.e. top tension, radius of curvature at the lowest part, etc. Comparison between some results of ten month sea test (Frigg Field, North Sea) of a flexible catenary pipe and computations is presented. (A)

12/7/9
0181746
FE
Flexible riser coupling for deepwater drilling, production, and service applications.
Reinhardt, C.M. ; Sullivan, P.E.
Murdock Mach. & Engng. Co. of Texas
Deep Offshore Technol. B.V.
In: Proc. Deep Offshore Technology, 2nd Int. Conf. & Exhib., (Valletta, Malta: Oct. 17-19, 1983), vol.II, Amsterdam, The Netherlands, Deep Offshore Technol. B.V., 1983, Session III.1, Paper III.1.f, p.83-106. ,
Languages: English
Specific applications for a variety of elastomeric flexible riser couplings and their design criteria are examined. Influence of the working environments, externally applied forces, angles of deflection, transmitted fluids, internal pressures, and temperatures are reviewed as they affect design and material selection. Results of in-service use and special structural, fluid compatibility and fatigue tests are also presented. (from authors' abstract)

12/7/10

0180371
FE
Flexible risers for early production and testing vessels.
Barthelemy, B.; Carrio, P. ; Pettenati-Auziere, C.
Swedish Trade Fair Found.
In: Proc. Offshore Gothenburg 85, Int. Conf. on Offshore & Marine Technology, (Gothenburg, Sweden,: Feb. 25-Mar. 1, 1985), Gothenburg, Sweden, Swedish Trade Fair Found., 1985, Session 4, Paper 4, p.1-16. ,
Languages: English
This paper presents some typical solutions suitable for implementing early development schemes by means of flexible dynamic risers with special emphasis on testing and servicing systems. (A)

12/7/11
0179903
FE
Hydrodynamic forces on multitube production risers exposed to currents and waves.
Demirbilek, Z.; Halvorsen, T.
Conoco Inc.
Am. Soc. Mech. Engrs.
In: Proc. Fourth Int. Offshore Mechanics & Arctic Engineering Symp., (Dallas, U.S.A.: Feb. 17-21, 1985), J.S. Chung; V.J. Lunardini; S.K. Chakrabarti; Y.S. Wang; D.S. Sodhi; K. Karal (eds.), vol.1, New York, U.S.A., Am. Soc. Mech. Engrs., 1985, p.363-370. ,
Languages: English
Discusses results from a joint research programme on multitube risers. DHI performed the steady current and moving model tests, HRS conducted the oscillatory flow tests. Tabulates the test conditions and results (drag, inertia coefficients, lift coefficient, total force coefficient) obtained. For the oscillatory flow tests, drag and inertia coefficients obtained are tabulated. These were calculated from analysis of each force cycle (first harmonic component only). Presents corresponding tables for both sets of tests with coefficients redefined so that test data relates to the actual cross sectional and projected areas of a multitube riser. Discusses how the coefficients vary according to Reynolds number and Keulegan Carpenter number. Interference effects are assessed. (C.J.U.)

12/7/12
0176234
FE
'Hutton' production risers - a novel cleaning problem. An up-to-the -moment case history.
Tyson, J.A.G.
Corr. Prev. & Control, vol.32, no.6, Dec. 1985, p.111-117. , Coden: CRPCAK ISSN 0010-9371
Languages: English
Conoco's innovative tension leg platform in the northern North Sea has presented the industry with a novel cleaning problem. Production risers transport reservoir fluids from seabed to surface on Hutton. The cleaning problem arises beacuse these risers are protected from corrosion by a thin, relatively fragile, coating of flame-sprayed aluminium (FSA). There is a requirement to keep these risers free of marine growth, and the challenge was offered to a wide spectrum of U.K. based companies to come up with a viable, and necessarily innovative, system to remove this marine growth without damaging the FSA. It also details the research work on high pressure water jet cleaning undertaken by BHRA in order to solve this problem. (from author's abstract)

12/7/13

0174778
FE
Prototype development of a TLP production riser tieback connector.
Crotwell, G.W.; Knerr, E.R.; Valka, W.A.; Miller, C.A.
OffshoreTechnol. Conf.
In: OTC '85, Proc. Seventeenth Annual Offshore Technology Conf. (Houston, U.S.A.: May 6-9, 1985), vol.3, Richardson, U.S.A., Offshore Technol. Conf., 1985, Paper OTC 4982, p.213-222. ,
Languages: English
A remotely operated mechanical tieback connector and retrievable hydraulic tool, for tying back subsea wellheads to a tension leg platform, were developed and prototype tested. The connector transmits riser loads to the wellhead and seals inside the 9-5/8 casing hanger. The connector is rated for 10000 psi and has a 30 year service life and a 100 year fatigue life. The retrievable hydraulic tool provides the operating force to lock and unlock the connector. The development of the tieback connector and tool is presented with a description of the method of analysis, the metal to metal seal utilized in the connector and the prototype test results. This work demonstrates the feasibility of designing a tieback connector with no internal hydraulic to meet the environmental and service life requirements of a tension leg platform. Analytical and experimental data are compared. (A)

12/7/14
0173911
PL
Deepwater record for flexible risers.
Oilman, Jun. 1985, p.63. , ISSN 0143-6694
Languages: English
The recent achievements by Coflexip of connecting a flexible flowline between a satellite well in 1270 ft of water and a semi submersible moored in 800 ft of water off Brazil is reported. This sets a deepwater record which is likely to be superceded later this year. (P.J.B.)

12/7/15
0171060
The development of a mobile production system incorporating a compliant production riser.
Pass, H.
Foster Wheeler Pet. Dev. Ltd.
OyezSci. & Tech. Serv. Ltd.
In: Proc. Conf. on Design & Operational Aspects of Floating Production Systems, (London, U.K.: Sep. 26, 1984), London, U.K., Oyez Sci. & Tech. Serv. Ltd., 1984, p.175-199. (ISBN 0-907822-48-7) , 0-907822-48-7
Languages: English
The study details 5 main areas for technical evaluation in the overall development of a mobile production system: the areas analyzed are subsea systems; production and export risers; platform design; topside facilities and process design; storage and export facilities. Operational considerations, economic analysis and cost elements are also included in the study. (A.J.)

12/7/16
0171057
The advantages of flexible risers.
Griffiths, A.D.
Dunlop Ltd.
OyezSci. & Tech. Serv. Ltd.
In: Proc. Conf. on Design & Operational Aspects of Floating Production Systems, (London, U.K.: Sep. 26, 1984), London, U.K., Oyez Sci. & Tech.

Serv. Ltd., 1984, p.113-128. (ISBN 0-907822-48-7) , 0-907822-48-7
Languages: English
Reliable, high pressure flexible pipes are necessary for the development of marginal oilfields where the pipes have to withstand a hostile environment. A test regime was developed, capable of simulating many of the operating conditions encountered. Armalinte and Armaline flowlines are described with reference to their properties for operating in such conditions. (A.J.)

12/7/17
0170966
CH
Hydrodynamic forces on multitube production risers exposed to currents and waves.
Demirbilek, Z.; Halvorsen, T.
Conoco Inc. Kongsberg Vapenfabrik A/S
Trans. ASME J. Energy Resour. Technol., vol.107, no.2, Jun. 1985, p.226-234. , Coden: JERTD2 ISSN 0195-0738
Languages: English
Experimental results of a joint industry riser test programme are reported. Hydrodynamic force coefficients for some marine risers consisting of one or more cylinders interacting either with currents only or oscillatory flow separately, are presented. The coefficients of drag, inertia, and lift are given as a function of the Reynolds and Keulegan-Carpenter number. An analysis and synthesis of the test data is also included. (A.J.)

12/7/18
0170965
Hydrodynamic forces on multitube production risers exposed to currents and waves.
Demirbilek, Z.; Halvorsen, T.
Conoco Inc. Kongsberg Vapenfabrik A/S
Trans. ASME J. Energy Resour. Technol., vol.107, no.2, Jun. 1985, p.226-234. , Coden: JERTD2 ISSN 0195-0738
Languages: English
Experimental results of a joint industry riser test programme are reported. Hydrodynamic force coefficients for some marine risers consisting of one or more cylinders interacting either with currents only or oscillatory flow separately, are presented. The coefficients of drag, inertia, and lift are given as a function of the Reynolds and Keulegan-Carpenter number. An analysis and synthesis of the test data is also included. (A.J.)

12/7/19
0146494
CH
Random dynamic response of a tethered buoyant platform production riser.
Etok, E.U.; Kirk, C.L.
Cranfield Inst. Technol.
C.M.L. Publications Ltd.
In: Dynamic Analysis of Offshore Structures: Recent Developments, C.L. Kirk, Southampton, U.K., C.M.L. Publications Ltd., 1982, p.81-94. (Progress Engng. Sci. Vol. 1) (ISBN 0-905451-07-4) , 0-905451-07-4
Languages: English
A new normal mode spectral analysis method is presented for calculating r.m.s. riser deflections, bending stresses and lower ball joint angles. Forces on the riser consist of (a) non-linear fluid drag taking account of the relative velocity due to tethered buoyant platform (TBP) motion, riser elastic deflection and wave induced fluid velocity, (b) wave induced fluid

acceleration, (c) inertia forces due to TBP acceleration, and (d) buoyancy. The non-linear fluid drag forces are linearized using Tung and Wu's approximation based on the r.m.s. relative fluid velocity and current. A wide range of results is presented for risers in water depths up to 1000 m and it is observed that 6 normal modes are sufficient for calculating bending stresses. A static analysis is also presented for bending stresses due to wave and current induced drag forces and riser offset. (A)

12/7/20
0143051
CH
Deepwater production riser.
Panicker, N.N.; Yancey, I.R.
Offshore Technol.Conf.
In: Proc. Fifteenth Annual Offshore Technol. Conf., (Houston, U.S.A.: May 2-5, 1983), vol.2, Dallas, U.S.A., Offshore Technol. Conf., 1983, Paper OTC 4512, p.9-18. ,
Languages: English
A deepwater production riser design developed by Mobil Research and Development Corporation is presented. The riser consists of a lower rigid section terminated about 200 feet below the sea surface with a tensioning buoy assembly and a flexible upper section made of a bundle of flexible pipes. It is designed to be compliant to waves, currents and vessel motions and applicable to both mild and severe environments. Design, analysis, testing, and installation method are discussed. (A)

12/7/21
0143032
CH
The influence of production-riser design on the configuration and operation of semi-submersible floating production systems.
Shotbolt, K.
Brown & Root (UK) Ltd.
J. Soc. Underwater Technol., vol.9, no.3, Autumn 1983, p.14-21. ,
Coden: JSUTDD ISSN 0141-0814
Languages: English
Considers the types of risers for use with Semi-Submersible Floating Production Systems (SSFPS). The paper examines the choice of a particular type of rise, for its purpose in the overall production system. The alternative types of risers are described and their influence on various aspects of system configuration and operation is compared. Finally, comments are made regarding an SSFPS with optimised configuration and operating characteristics. (from paper)

12/7/22
0142803
CH
On the dynamics of production risers.
Patel, M.H. ; Sarohia, S.
London Univ. Coll.
Hemisphere Publishing Corp.
In: Behaviour of Off-Shore Structures, Proc. Third Int. Conf., (Cambridge, U.S.A.: Aug. 2-5, 1982), C. Chryssostomidis; J. J. Connor (eds.), vol. 1, Washington, U.S.A., Hemisphere Publishing Corp., 1982, Paper H12, p.599-617. (ISBN 0-89116-343-3) , 0-89116-343-3
Languages: English
This paper presents some results from an investigation into the structural and fluid loading aspects of single and multi-tube production risers. Two methods of structural analysis are outlined. The first is an extension of conventional drilling riser practice and employs an

equivalencing technique for transforming the physical properties of a riser of complex cross-section to that of an equivalent single tube drilling riser. A second method, based on a fuller finite element structural analysis of the riser is also described. The paper presents results of large scale tests for a marine riser of circular cross section. These large scale tests were performed at the National Maritime Institute in England for 1:23 scale risers in 7.6 m water depth with a model semisubmersible surface platform. Measurements of wave elevation, surface platform surge together with in line (to the wave direction) and transverse displacements and bending stresses at several stations along the riser length are compared with a two dimensional finite element computation. (from authors' abstract)

12/7/23
0139041
CH
An assessment of vortex suppression devices for production risers and towed deep ocean pipe strings.
Rogers, A.C.
Offshore Technol. Conf.
In: Proc. 1983 Offshore Technol. Conf., (Houston, U.S.A.: May 2-5, 1983), vol. 3, Dallas, U.S.A., Offshore Technol. Conf., 1983, Paper No. OTC-4594, p.119-126. ,
Languages: English
The paper discusses vortex suppression devices as applied to deep ocean production risers and pipe strings. The basic problem of flow induced structural excitation is discussed as well as the present state of the art of vortex suppression devices. One of the most promising devices discussed, the guiding vane principal, is of 1945 vintage and on the average, all the other concepts available for discussion are estimated to be of 1967 vintage. Based on a conclusion that a drag reduction and structural symmetry to flow are considered to be of equal importance to vortex suppression, several basic types of devices are suggested. Configurations and pipe string arrangements are portrayed and the need for an evolution of new concepts is emphasized. (A)

12/7/24
0127725
CH
Flexible riser for a floating storage and offloading system.
Beynet, P.A.; Frase, J.R.
Amoco Prod. Co.
Offshore Technol.Conf.
In: Proc. Fourteenth Annual Offshore Technol. Conf., (Houston, U.S.A.: May 3-6, 1982), vol.3, Dallas, U.S.A., Offshore Technol. Conf., 1982, Paper OTC 4321, p.249-258. ,
Languages: English
In connection with the final design of the riser system, a series of model tank tests were conducted specifically to verify the performance of the risers. These tests were designed to cover the conditions of different wind, wave and current directions. The test results show that the combined tanker, buoy and flexible riser dynamics in three dimensional space must be included in the design evaluation. Some of the critical motions and loading of the flexible risers and the associated fixtures could not be revealed by the conventional design evaluations. The observed dynamic behaviour of the riser system was further confirmed by analysis. Remedial methods were developed to correct the uncovered problems. Additional confirmation model tests were conducted prior to arriving at a final design. (from authors' abstract)

12/7/25
0093374
X
Aspects of hydrodynamic loading in design of production risers.
Lohen, A.E. ; Torset, O.P. ; Mathiassen, S. ; Arnesen, T.
J. Pet. Technol., vol.32, no.5, May 1980, p.881-890. , Coden: JPTJAM
ISSN 0022-3522
Languages: English
Tests results are described, and a generalisation is given for engineering applications. (A)

12/7/26
0092930
X
An unmanned tethered maintenance vehicle for deepwater production riser maintenance.
Teers, M.L.
Exxon Production Res. Co.
Offshore Technol. Conf.
In: Proc. Eleventh Annual Offshore Technology Conf., (Houston, U.S.A.: Apr.30-May 3, 1979), vol.3, Dallas, U.S.A., Offshore Technol. Conf., 1979, Paper OTC 3576, p.1905-1912. ,
Languages: English
A maintenance system is required to inspect and maintain all facilities and equipment associated with a deepwater marine production riser system. Exxon Production Research Company is developing a multi-purpose maintenance system consisting of (i) a submersible unmanned Tethered Maintenance Vehicle (TMV), (ii) interchangeable tool packages to be used in conjunction with the TMV, (iii) a launch and recovery system, (iv) a control van, and (v) auxiliary surface support equipment. The TMV, which is operated from the control van at the surface, will provide the propulsion, guidance, and control necessary to manoeuver the tool package to the work site. Once at the work site, the tool package will attach itself and the vehicle to the riser; it will then accomplish the predetermined maintenance task. The interchangeable tool packages will be specially designed to efficiently perform each specific task. If new tasks are defined, new tool packages can be designed to perform the tasks and the basic vehicle will remain unchanged. This paper presents the design concept of this system and reports on the current status of the system's development. (A)

12/7/27
0090271
CH
- a prototype deepwater production riser and floating production system.
Santa Barbara SALM
Wolfram, W.R. ; Law, T.E.
Exxon Prod. Res. Co.
J. Pet. Technol., vol.32, no.2, Feb. 1980, p.311-318. , Coden: JPTJAM
ISSN 0022-3522
Languages: English
The Hondo offshore storage, oil treating, and off-loading system in the Santa Barbara Channel contains most of the essential features of a deepwater floating production system. This paper discusses the design concept, including dynamic analysis, earthquake design, fatigue analysis, and the high-pressure flow system. A current status report and future plans for the project are given. (A)

12/7/28
0079660
CH

Production riser analysis.
Harper, M.P.
Koninklijke Shell Exploratie en Produktie Laboratorium
BHRA Fluid Engng.
In: Proc. Second Int. Conf. on the Behaviour of Off-shore Structures, (London, U.K.: Aug. 28-31, 1979), vol.2, Cranfield, U.K., BHRA Fluid Engng., 1979, Paper 60, pp.207-212. , 0-906085-36-5
Languages: English
The dynamic analysis of a multibore production riser in a northern North Sea environment is discussed. Results presented concern the bending moment response due to random wave loading and the sensitivity of these results to variations in hydrodynamic coefficients. (A)

12/7/29
0074117
CH
Structural design of production risers and offshore production terminals.
Wolfram, W.R. ; Gunderson, R.H.
Exxon Production Res. Co.
Offshore Technol. Conf.
In: Proc. Eleventh Annual Technology Conf., (Houston, U.S.A.: Apr.30-May 3, 1979), vol.3, Dallas, U.S.A., Offshore Technol. Conf., 1979, Paper OTC 3535, pp.1569-1576. ,
Languages: English
Offshore production terminals and deepwater risers are seeing increasing use by the offshore oil industry. The structural design of these units presents a unique challenge compared to other offshore systems. Development of design loading conditions and fatigue histories is especially interesting due to the complex interaction of non-linear riser and vessel dynamics, the statistical nature of maximum loads and the need to consider directionality as well as the magnitude of environmental loading. This paper presents a complete procedure for predicting design loads and fatigue histories for production risers and offshore terminals. The emphasis will be on systems wherein a dedicated vessel is connected to the riser by a rigi morring arm. A number of structural design configurations will be surveyed. Techniques for preliminary sizing, dynamic analysis, model testing and fatigue analysis will be discussed, The application of this procedure to several specific design cases will be summarized. (A)

12/7/30
0074116
CH
Aspects of hydrodynamic loading in design of production risers.
Lken, A.E. ; Torset, O.P. ; Mathiassen, S. ; Arnesen, T.
Det Norske Veritas Kongsberg Vapenafbrikk
Offshore Technol. Conf.
In: Proc. Eleventh Annual Offshore Technology Conf., (Houston, U.S.A.: Apr.30-May 3, 1979), vol.3, Dallas, U.S.A., Offshore Technol. Conf., 1979, Paper OTC 3538, pp.1591-1601. ,
Languages: English
Selective results of hydrodynamic loads on various production riser concepts derived from large-scale model tests in stationary and oscillatory flow are presented. The investigation which covered altogether 24 riser configurations was joined by several major oil companies. Typical results for 5 basic production riser geometries consisting of a large centre export pipe and varying number of outer pipes of varying distance from the centre pipe are presented. The importance of hydrodynamic coefficients in the design of such multibore production risers are discussed through investigation of the sensivity in riser response due to variation of the hydrodynamic coefficients and other important design parameters.

Application of generalized hydrodynamic coefficients from model experiments to arrive at engineering solutions are discussed. An actual design case for a production riser in deep water is presented. (A)

12/7/31
0071388
CH
Exxon's new deepwater production riser.
Gunderson, R.H. ; Lunde, P.A.
Exxon Production Res. Co. Ocean Res. Engng. Inc.
Ocean Ino., vol.13, no.11, Nov.1978, pp.67-70 and 73. , Coden: OCIDAF
ISSN 0029-8026
Languages: English

Exxon's deepwater production terminal applicable for use in water depths to over 5,000 ft in rough water environments, consists of a SALM (Single Anchor Leg Mooring) production riser and a floating storage tanker with production facilities on board. The separated gas and water are reinjected into the formation, and shuttle tankers offload the crude oil by tandem mooring to the storage tanker. The riser serves three main functions: (i) it moors the storage vessel, (ii) serves as a support for the fluid lines, and (iii) serves as a support for communication lines to subsea production equiPment. Exxon has conducted extensive model tests and analyses on the new riser system to assess its feasibility and has designed several SALM systems for various parts of the world. The Exxon riser system design criteria has been developed using established codes and emerging code requirements for offshore loading terminals modified to fit the functional and structural characteristics of the Exxon SALM. In fact, many of the design features of the deepwater riser are evident in the Santa Ynez SALM that was installed in the Santa Barbara Channel in 490 ft of water during the summer. (A)

12/7/32
0064326
CH
Santa Barbara Salm - a prototype deepwater production riser and floating production system.
Wolfram, W.R.; Law, T.E.
Exxon Prod. Res. Co. Exxon Co.
In: Proc. 1978 Offshore Technology Conf., (Houston, U.S.A.: May 8-10, 1978), vol.2, Dallas, U.S.A., Offshore Technology Conf. 1978, Paper OTC 3143, pp.781-788. ,
Languages: English

The Hondo offshore storage, oil treating, and offloading system in the Santa Barbara Channel contains most of the essential features of a deepwater floating production system. A dedicated 50,000 dwt tanker will be moored to a single anchor leg type production riser using a rigid mooring yoke. The riser unit is designed for 100-yr storm conditions; it also will withstand the maximum expected earth-quake loading with the vessel attached. The use of the rigid yoke with the single anchor leg mooring yields a number of design and operational advantages. This paper presents the design concept of the system. Particular design considerations are discussed including dynamic analysis, earthquake design, fatigue analysis and high pressure flow system. Finally, a current status report and future plans for the project will be given. (A)

12/7/33
0046402
CH
Design, fabrication and installation of a prototype multiline marine production riser system.

Gammage, W.F. ; Caldwell, J.B. ; Ortloff, J.E. ; Teers, M.L.
Exxon Co.
New York, ASME United Engineering Centre, Sep. 1976, 6pp. (ASME Paper 76-Pet-45). ,
Languages: English
A multiline marine production riser and floating production, storage, and terminal facility may be required for economic development of oil and gas reserves in remote, deep water locations. A deep water production riser design has evolved through study, analyses, and model testing. In order to gain experience, development confidence, and improve the riser design prior to commercial application, a prototype has been built for testing as part of Exxon's Submerged Production System offshore test in the Gulf of Mexico. This paper treats the design, manufacture, and installation of the prototype multiline marine production riser system. (A)

12/7/34
0046401
CH
An articulated multiline production riser for deepwater application.
Ortloff, J.E. ; Caldwell, J.B. ; Teers, M.L.
Exxon Co.
New York, ASME United Engineering Centre, Sep. 1976, 6pp. (ASME Paper 76-Pet-44). ,
Languages: English
The need to produce oil and gas in water depths beyond the physical and economical limits of fixed platforms and pipelines has led to the development of a feasible concept for an articulated multiline flexible marine production riser system. This paper covers the history of the concept development from inception to readiness for engineering-design and fabrication of a prototype test model. (A)

12/7/35
0046292
CH
A method for analysis of a prototype articulated multiline marine production riser system.
Caldwell, J.B. ; Gammage, W.E.
Exxon Co.
New York, ASME, United Engineering Centre, Sep. 1976, 6pp. (ASME Paper 76-Pet-46). ,
Languages: English
This paper describes a newly developed nonlinear computer program that predicts internal reaction forces and motions of a multiline marine production riser exposed to wave and current forces. The paper also presents an analytical method that accounts for large geometric displacements and nonlinear wave forces. A simulation of the response of a prototype articulated multiline marine production riser during a mild tropical storm illustrates the program's capability. (A)

12/7/36
0040998
X (No Journal)
MARINE PRODUCTION RISER - A SUBSYSTEM OF THE SUBMERGED PRODUCTION SYSTEM.
GRAMMAGE, W.E. ; ORTLOFF, J.E.; TEERS, M.L.; CALDWELL, J.B.
EXXON CO., U.S.A. EXXON PROD. RES. CO., U.S.A.
IN: PROC. EIGHTH ANNUAL OFFSHORE TECHNOL. CONF. %HOUSTON TEXAS, MAY 3-6, 1976<, DALLAS, TEXAS, OFFSHORE TECHNOL. CONF., VOL. 2, 1976, OTC 2525, PP. 45-46.,
Languages: English
THE MARINE PRODUCTION RISER %MPR< SUBSYSTEM IS DESIGNED TO TRANSPORT OIL

AND GAS FROM A SUBMERGED PRODUCTION SYSTEM %SPS< TO A FLOATING STORAGE VESSEL AND TO PERMANENTLY MOOR THE VESSEL.

THE PROTOTYPE RISER TO BE TESTED IN THE GULF OF MEXICO INCLUDES A PILE FOUNDED BASE %INSTALLED OCTOBER, 1974< WITH PIPING MANIFOLD TO CONNECT PIPELINES TO THE RISER, A REMOTE MULTILINE CONNECTOR, AN ARTICULATED MULTILINE RISER, A SUPPORT BUOY AND A MOORING SYSTEM.

FABRICATION AND LAND TESTING OF ALL COMPONENTS IS COMPLETE.

DETAILED PLANS HAVE BEEN DEVELOPED AND THE NECESSARY EQUIPMENT TO COMPLETE INSTALLATION OF THE MPR IS ON HAND OR READILY AVAILABLE.

%A<.

12/7/37

0001061

FE

Production risers.

Rodda, N.

BP Int. Ltd.

Graham &Trotman Ltd.

In: Advances in Underwater Technology and Offshore Engng., Volume 2, Design and Installation of Subsea Systems, Subsea Int. '85, Proc. Int. Conf., (London, U.K.: Jan. 15-16, 1985), London, U.K., Graham & Trotman Ltd., 1985, Chapter 8, p.125-148. (ISBN 0-86010-667-5) , 0-86010-667-5

Languages: English

Discussed are production riser systems which are used for transferring oil from subsea wells to floating production facilities. The bundled rigid riser system adopted by BP at the Buchan Field is described and its operation outlined. Also described is the individual rigid riser proposed by BP for the SWOPS concept of an itinerant floating production, storage and transport system. Flexible production risers are summarized and a comparison given between the flexible and rigid varieties. (from author's abstract)

?

F

13/7/1
0172037
An evaluation for new semis.
Knecht, H.I.; Thomas, P.V.
Zapata Offshore Co.
Oilman, Sep. 1985, p.92-94. , ISSN 0143-6694
Languages: English
Describes the 'design balance' approach adopted by Zapata for evaluation of designs. This requires e.g. good heave motion response time (rather than an apparent improved RAO) and reasonable riser clearance. The Zapata Arctic semisubmersible required an increase in deck load of 50%, water depth three times that of Zapata Ugland, and increased weight of drilling package. The air gaps of 45 ft operating 60 ft survival was maintained. Discusses how to consider operator requirements, and contractor requirements. The capability of the rig is first assessed without consideration of the environment. Suggests that drill string mounted compensators have advantages over crown compensators. The Zapata Arctic has twin V-door and pipe rack arrangements. Brace connections are discussed. Maintenance aspects should be considered. (C.J.U.)
?

11/7/1
02669966 Monthly No: EI8811108318

SIMPLE AND EFFICIENT ALGORITHM FOR THE STATIC AND DYNAMIC ANALYSIS OF FLEXIBLE MARINE RISERS.

Ghadimi, Rumbod
Coll of Aeronautics, Bedforshire, Engl

Source: Computers and Structures v 29 n 4 1988 p 541-555
Publication Year: 1988
CODEN: CMSTCJ ISSN: 0045-7949
Language: English
Document Type: JA; (Journal Article) Treatment: T; (Theoretical)
Journal Announcement: 8811

The lumped mass discretization method is used to derive the equations of motion of flexible risers in three dimensional space. Nodal shear forces and bending moments are included in the formulations and fluid loading on the structure is calculated using the Morison equation. A simple model of the sea bed contact for catenary risers is given and tested. Nonlinear equations describing the riser motions are solved in the time domain using the tangent stiffness incremental approach combined with the Wilson-theta numerical integration algorithm. Computational efficiency is improved via a compact 'profile storage' technique, used for the assembly of element matrices, given by R. L. Taylor. Consideration is also given to natural periods and mode shapes for small oscillations about the static equilibrium position of the riser. Comparison of results with experimental values, analytical solutions and independent results from the published literature show very good agreement. (Edited author abstract). 13 Refs.

11/7/2
02661615 Monthly No: EIM8810-055696

QUASI-STATIC ANALYSIS PROCEDURE FOR FLEXIBLE RISERS.

Riggs, H. R.
Univ of Hawaii at Manoa, Honolulu, HI, USA

Conference Title: Current Practices and New Technology in Ocean Engineering - 1988. Presented at the Eleventh Annual Energy-Sources Technology Conference and Exposition.
Conference Location: New Orleans, LA, USA Conference Date: 1988 Jan 10-13
Sponsor: ASME, Ocean Engineering Div, New York, NY, USA
E.I. Conference No.: 11647
Source: ASME Ocean Eng Div Proc OED v 13. Publ by ASME, New York, NY, USA p 163-169
Publication Year: 1988
CODEN: OEDDD7
Document Type: PA; (Conference Paper)
Journal Announcement: 8810

A procedure to determine the quasi-static response of flexible risers as the vessel position in the plane of the riser varies is presented. The procedure is based on the equations for a cable, and is suited for preliminary design. Application to five common riser configurations is described, and the resulting systems of nonlinear equations are solved by iteration. An example illustrates the strong convergence characteristics of the iterative scheme. (Author abstract) 8 refs.

11/7/3
02624193 Monthly No: EI8808074995

FIRST-OF-A-KIND DEEPWATER PRODUCTION RISER INSTALLED.

Berner, Paul C.

Cameron Offshore Engineering Inc, Houston, TX, USA
Source: Oil and Gas Journal v 86 n 18 May 2 1988 p 50-51, 55
Publication Year: 1988
CODEN: OIGJAV ISSN: 0030-1388
Language: English
Document Type: JA; (Journal Article) Treatment: A; (Applications)
Journal Announcement: 8808
The fist floating production system (FPS) in the Gulf of Mexico was installed in Placid's Green Canyon Block 29. The most innovative part of the system is the self-supporting rigid riser. This is the world's largest production riser. It is designed for a 20-year life that includes remaining connected during a Gulf of Mexico 100-year storm if such an event occurs. Placid's floating production system uses the converted drilling rig Penrod 72 located on Green Canyon Block 29 in 1,522 ft of water. Provisions are made for 20 subsea completions arranged on a template structure and four satellite completions that will produce through the self-supporting, multiple-bore, rigid riser.

11/7/4
02622037 Monthly No: EI8808074994
FORCES ON MARINE RISERS IN COEXISTING ENVIRONMENT.
Demirbilek, Zeki
Conoco Inc, Houston, TX, USA
Source: Journal of Waterway, Port, Coastal and Ocean Engineering v 114 n 3 May 1988 p 346-359
Publication Year: 1988
CODEN: JWPED5 ISSN: 0733-950X
Language: English
Document Type: JA; (Journal Article) Treatment: T; (Theoretical); X; (Experimental)
Journal Announcement: 8808
Experimental results for hydrodynamic loading from the combined effect of oscillatory motion and current on two production-riser configurations are presented. The experimental study showed a significant reduction in the drag coefficients when the oscillatory motion and the added current were parallel. The magnitude of this reduction depends primarily on the ratio of the maximum velocity of oscillatory motion to the steady current speed. The prediction of forces on marine risers using Morison's formula in a coexisting environment at low Keulegan-Carpenter numbers yields unsatisfactory results due to vortex shedding. However, the use of this equation at high Keulegan-Carpenter numbers in a coexisting environment was demonstrated to be safe and appropriate. (Edited author abstract) 13 refs.

11/7/5
02580650 Monthly No: EIM8805-028601
NONLINEAR TRANSIENT RESPONSE OF FLEXIBLE DEEPSEA RISERS BY TIME DOMAIN SIMULATION.
Ebecken, N. F. F.; Lima, E. C. P.; Jacob, B. P.
Federal Univ of Rio de Janeiro, Rio de Janeiro, Braz
Conference Title: OMAE 1988 Houston, Proceedings of the Seventh International Conference on Offshore Mechanics and Arctic Engineering.
Conference Location: Houston, TX, USA Conference Date: 1988 Feb 7-12
Sponsor: ASME, New York, NY, USA; ASCE, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; JSME, Tokyo, Jpn; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 11083
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 7th v 1. Publ by ASME, New York, NY, USA p 551-555
Publication Year: 1988
CODEN: PIOSEB

Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8805

In this work the nonlinear transient response of flexible risers is focused on. For accurate and economical time domain analysis of deep risers, a realistic representation of hydrodynamic forces along the riser and an efficient numerical method are required. The Lanczos mode superposition method associated with pure incremental formulation is proposed to treat this class of highly nonlinear problem. The proposed approach was applied to a typical configuration to show its effectiveness and robustness. (Author abstract) 14 refs.

11/7/6
02580630 Monthly No: EIM8805-028581
SYNTACTIC FOAM BUOYANCY FOR PRODUCTION RISERS.
Watkins, L.
Cuming Corp, Taunton, MA, USA
Conference Title: OMAE 1988 Houston, Proceedings of the Seventh International Conference on Offshore Mechanics and Arctic Engineering.
Conference Location: Houston, TX, USA Conference Date: 1988 Feb 7-12
Sponsor: ASME, New York, NY, USA; ASCE, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; JSME, Tokyo, Jpn; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 11083
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 7th v 1. Publ by ASME, New York, NY, USA p 403-410
Publication Year: 1988
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8805

The offshore industry's shift in emphasis from exploration to deepwater production has resulted in much interest in the long-term performance of riser buoyancy materials. There is a need for buoyancy systems capable of continuous service at great depth for twenty years or more. This paper discusses the factors governing long-term performance of syntactic foam and suggests various predictive techniques to assist in the design of safe and efficient production risers. (Author abstract) 5 refs.

11/7/7
02580628 Monthly No: EIM8805-028579
CURRENT-INDUCED OSCILLATIONS AND INSTABILITIES OF A MULTI-TUBE FLEXIBLE RISER.
Paidoussis, M. P.; Price, S. J.; Mark, B.
McGill Univ, Montreal, Que, Can
Conference Title: OMAE 1988 Houston, Proceedings of the Seventh International Conference on Offshore Mechanics and Arctic Engineering.
Conference Location: Houston, TX, USA Conference Date: 1988 Feb 7-12
Sponsor: ASME, New York, NY, USA; ASCE, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; JSME, Tokyo, Jpn; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 11083
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 7th v 1. Publ by ASME, New York, NY, USA p 383-389
Publication Year: 1988
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8805

Experiments have been conducted on a five cylinder cluster, of similar

geometry to that of a multi-tube riser, in steady cross-flow. In the majority of experiments four of the five cylinders were sensibly rigid, whereas the fifth, one of the peripheral ones, was flexible mounted. The experiments were conducted in a wind tunnel, with the cluster mounted on a rotative arrangement, so that the flexible cylinder could be at any desired azimuthal orientation vis-a-vis the flow vector. Motion of the flexible cylinder was measured by imbedded accelerometers. In addition to the vibration measurements, hot wire anemometers were used to measure periodicities in the flow in and around the cluster, when all the cylinders were rigid. Both the vibration and hot wire signals were analyzed by FFT techniques. (Edited author abstract) 22 refs.

11/7/8
02580623 Monthly No: EIM8805-028574
STUDY OF THE EFFECTS OF WAVES AND CURRENT ON A DEEP WATER PRODUCTION RISER.
Hartnup, G. C.; Airey, R. G.
Heriot-Watt Univ, Edinburgh, Scotl
Conference Title: OMAE 1988 Houston, Proceedings of the Seventh International Conference on Offshore Mechanics and Arctic Engineering.
Conference Location: Houston, TX, USA Conference Date: 1988 Feb 7-12
Sponsor: ASME, New York, NY, USA; ASCE, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; JSME, Tokyo, Jpn; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 11083
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 7th v 1. Publ by ASME, New York, NY, USA p 339-345
Publication Year: 1988
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8805
Results from tests in waves and simulated current on a scale model of a deep water (600m) production riser are compared with results from time domain computer simulations. Values are presented for drag, added mass, and inertia coefficients of the model, which have been deduced from the test results. While the values of drag coefficient found in test cases in pure current were those predicted from the Reynolds number at which the tests were carried out, the values from cases involving waves were typical of post critical flow. (Author abstract) 11 refs.

11/7/9
02580584 Monthly No: EIM8805-028535
DEEP WATER RIGID PRODUCTION RISER.
Berner, P. C. Jr.
Cameron Offshore Engineering Inc, Houston, TX, USA
Conference Title: OMAE 1988 Houston, Proceedings of the Seventh International Conference on Offshore Mechanics and Arctic Engineering.
Conference Location: Houston, TX, USA Conference Date: 1988 Feb 7-12
Sponsor: ASME, New York, NY, USA; ASCE, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; JSME, Tokyo, Jpn; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 11083
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 7th v 1. Publ by ASME, New York, NY, USA p 23-29
Publication Year: 1988
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8805

The Placid Green Canyon Production System, the first floating production system (FPS) in the Gulf of Mexico, uses the world's largest production riser in terms of both size and number of lines. The unique rigid riser system is the most innovative part of the FPS especially in that it accommodates simultaneous production and drilling or workover. The paper reviews the design features, the analysis techniques, manufacturing considerations, installation procedures, schedules, and cost for the riser components. (Author abstract)

11/7/10
02361271 Monthly No: EIM8712-088743
MODEL TESTS AND ANALYSIS OF FLEXIBLE RISER SYSTEMS.
Owen, D. G.; Qin, J.
Heriot-Watt Univ
Conference Title: UK Offshore - Maintaining Self-Sufficiency, Proceedings of the Conference.
Conference Location: London, Engl Conference Date: 1985 Oct 9-10
Sponsor: ICE, London, Engl
E.I. Conference No.: 10431
Source: Publ by Thomas Telford, London, Engl p 133-145
Publication Year: 1986
ISBN: 0-7277-0267-X
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8712
A catenary flexible riser system is studied in relation to a typical field development in the North Sea. The paper presents simple and approximate formulae developed by catenary theory. Catenary solutions accurately describe the shape, tensions and inclinations of a riser if its flexural stiffness is low. A formal asymptotic expansion is presented and this method is applied to the non-linear behaviour of a long, flexible riser. A series of model tank tests were carried out in a wave flume in order to observe the non-linear response of the flexible riser system. The system consisted of a flexible pipe suspended in a catenary between a subsurface buoy and a surface buoy. These tests were designed to cover different waves including both operating and severe environmental conditions. The test results showed a reasonable agreement with analytical results. (Edited author abstract) 17 refs.

11/7/11
02341850 Monthly No: EI8712124808
LINEAR DYNAMICS OF FLEXIBLE RISERS.
Patrikalakis, N. M.; Kriezis, G. A.
MIT, Cambridge, MA, USA
Source: J Offshore Mech Arct Eng v 109 n 3 Aug 1987 p 254-262
Publication Year: 1987
CODEN: JMOEEX
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: T; (Theoretical)
Journal Announcement: 8712
The objective of this paper is to present solutions for the linear dynamics of flexible risers using a novel combination of efficient embedding and asymptotic techniques. Numerical examples for a buoyant flexible riser are included and the effects of the principle parameters are discussed. Finally, a numerical scheme employing the linear solutions to develop a solution of the nonlinear problem is outlined. (Author abstract) 20 refs.

11/7/12
02341848 Monthly No: EI8712124807

DYNAMICS OF FLEXIBLE HOSE RISER SYSTEMS.
Vogel, H.; Natvig, B. J.
Aker Engineering A/S, Oslo, Norw
Source: J Offshore Mech Arct Eng v 109 n 3 Aug 1987 p 244-248
Publication Year: 1987
CODEN: JMOEEX
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: T; (Theoretical)
Journal Announcement: 8712
The paper describes a highly effective method for computing the dynamics of the catenary-shaped suspensions of flexible hose systems. The method accounts for a number of nonlinearities, it is 3-dimensional and it is preformed in the time domain. The paper addresses the analysis method and demonstrates its effectiveness on a sample flexible riser analysis. (Author abstract) 4 refs.

11/7/13
02261065 Monthly No: EIM8707-047730
HIGH PERFORMANCE COMPOSITE PIPES FOR DEEP WATER MULTILINE PRODUCTION RISERS.
Falcimaigne, J. R.
Inst Francais du Petrole, Rueil-Malmaison, Fr
Conference Title: Proceedings of the Sixth (1987) International Offshore Mechanics and Arctic Engineering Symposium.
Conference Location: Houston, TX, USA Conference Date: 1987 Mar 1-6
Sponsor: ASME, Offshore Mechanics & Arctic Engineering Div, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Inst of Mechanical Engineers, London, Engl; London Cent for Marine Technology, London, Engl; Norwegian Soc of Chartered Engineers, Oslo, Norw; et al
E.I. Conference No.: 09552
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 6th v 3. Publ by ASME, New York, NY, USA p 39-44
Publication Year: 1987
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8707
The replacement of steel by lightweight materials is a new approach to improve performances of deep water offshore structures and to reduce their cost. The paper addresses the application of fiber-reinforced composite pipes to multiline production risers. High-pressure composite pipes have been developed by Institut Francais du Petrole and Aerospatiale since 1978 for drilling and production systems. The paper presents some specific advantages of composite pipe in comparison to a conventional steel alternative for several riser arrangements. The adequacy of composite pipe performances to requirements for this application is then discussed. Finally, the weight saving obtained for a typical case of multiline production riser is evaluated. (Author abstract) 5 refs.

11/7/14
02260950 Monthly No: EIM8707-047615
NON-LINEAR DYNAMICS OF FLEXIBLE RISERS BY THE FINITE ELEMENT METHOD.
Owen, D. G.; Qin, J. J.
Heriot-Watt Univ, Edinburgh, Scotl
Conference Title: Proceedings of the Sixth (1987) International Offshore Mechanics and Arctic Engineering Symposium.
Conference Location: Houston, TX, USA Conference Date: 1987 Mar 1-6
Sponsor: ASME, Offshore Mechanics & Arctic Engineering Div, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Inst of Mechanical Engineers, London, Engl; London Cent for Marine Technology, London, Engl; Norwegian

Soc of Chartered Engineers, Oslo, Norw; et al
E.I. Conference No.: 09552
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 6th v 1. Publ by ASME, New York, NY, USA p 163-170
Publication Year: 1987
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8707

A finite element solution for the analysis of the non-linear dynamic axial and lateral motions of a flexible riser is presented. The governing equations are derived including non-linear stiffness, excitation due to surface vessel surge, pitch and heave motions, and the effects of waves and currents. The technique accounts for non-linearities such as hydrodynamic damping and large angle deflections in the flexible riser. Results from the simulation model are obtained in the time domain and make use of a general purpose finite element computer program and software developed by the authors. The static analysis under current loading only as well as normal mode analyses are presented and results are included for risers having relatively low bending stiffness. The results from the dynamic simulation of the flexible riser, using the finite element approach, are compared with those obtained in scale model experiments, where riser motions are monitored using a purpose-designed underwater TV viewing system. (Edited author abstract) 8 refs.

11/7/15
02260943 Monthly No: EIM8707-047608
MODEL BASIN TESTS ON MULTI-TUBE PRODUCTION RISERS.
Hartnup, G. C.; Airey, R. G.; Shiells, D. F.
Heriot-Watt Univ, Edinburgh, Scotl
Conference Title: Proceedings of the Sixth (1987) International Offshore Mechanics and Arctic Engineering Symposium.
Conference Location: Houston, TX, USA Conference Date: 1987 Mar 1-6
Sponsor: ASME, Offshore Mechanics & Arctic Engineering Div, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Inst of Mechanical Engineers, London, Engl; London Cent for Marine Technology, London, Engl; Norwegian Soc of Chartered Engineers, Oslo, Norw; et al
E.I. Conference No.: 09552
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 6th v 1. Publ by ASME, New York, NY, USA p 109-117
Publication Year: 1987
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8707

Model basin tests carried out at approximately 1/14 scale on two production risers in a towing tank are described. One of the risers considered is modelled on that used in the Buchan field, while the other has a compact low drag configuration of the same production capacity. The tensioning system was carefully modelled, and vessel surge motions were accurately represented in both regular and irregular waves. Current was represented by carriage motion. Some results are presented for bending moment and displacement distribution for both models and comparisons are made with computer simulations to deduce appropriate values for hydrodynamic coefficients. (Author abstract) 8 refs.

11/7/16
02141556 Monthly No: EIM8612-089522
DESIGN, TESTING AND OPERATION OF THE PRODUCTION RISER CONNECTORS FOR THE HUTTON FIELD.

Chapman, J. C.; Dier, A. F.; Dowling, P. J.; Hobbs, R. E.; Myers, R. J.; Penfold, B. L.
Chapman & Dowling Associates Ltd
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 434-441
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612
The background to the main design decisions and the method of analysis are described. The connector sustained the specified proof loading and an overload without damage. Torque/rotation/preload relations are given. The specified service fatigue spectrum was applied to each of three specimens for the equivalent of 60 years without any cracking being detected. Increasing levels of constant amplitude loading were then applied to one specimen to establish the approximate life and the mode of cracking. Operational torque/rotation measurements are reviewed and suggestions are made whereby the control system might be improved. (Edited author abstract) 5 refs.

11/7/17
02141548 Monthly No: EIM8612-089514
NONLINEAR ANALYSIS OF FLEXIBLE RISERS USING HYBRID FINITE ELEMENTS.
McNamara, J. F.; O'Brien, P. J.; Gilroy, S. G.
Univ Coll, Galway, Irel
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 371-377
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612
A method is developed for the two-dimensional static and dynamic analysis of flexible risers and pipelines in the offshore environment under conditions of arbitrarily large motions due to wave loading and vessel movements. A mixed finite element formulation is adopted where the axial force is independently interpolated and only combined with the corresponding axial displacements via a Lagrangian constraint. Results are presented for the motions and forces on a flexible riser connecting a tanker to a subsea tower and also on a combined flexible riser and subsea support buoy structure which is part of a floating offshore production system. (Edited author abstract) 13 refs.

11/7/18
02141547 Monthly No: EIM8612-089513

DYNAMICS OF FLEXIBLE HOSE RISER SYSTEMS.
Vogel, H.; Natvig, B. J.
Aker Engineering A/S, Oslo, Norw
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 363-370
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612
The paper describes a highly effective method for computing the dynamics of the catenary shaped suspension of flexible hose systems. The method accounts for a number of nonlinearities, it is 3-dimensional and it is performed in the time domain. The paper addresses the analysis method and demonstrates its effectiveness on a sample flexible riser analysis. (Author abstract) 4 refs.

11/7/19
02141546 Monthly No: EIM8612-089512
MODEL TESTS AND ANALYSIS OF FLEXIBLE RISER SYSTEMS.
Owen, D. G.; Qin, K.
Heriot-Watt Univ, Edinburgh, Scotl
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 354-362
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612
The paper first presents simple and approximate formulae developed by catenary theory. Catenary solutions accurately describe the shape, tensions and inclinations of a riser if its flexural stiffness is low. A formal asymptotic expansion is then presented and this method is applied to the nonlinear behaviour of a long, flexible riser. The paper develops the governing equations for the non-linear dynamic analysis of a flexible riser system and outlines one method of solution based on a finite element approach. A series of model tank tests were carried out in a wave flume in order to observe the non-linear response of the flexible riser system. The system consisted of a flexible pipe suspended in a catenary between a subsurface buoy and a surface buoy. (Edited author abstract) 25 refs.

11/7/20
02141545 Monthly No: EIM8612-089511
NONLINEAR DYNAMIC ANALYSIS OF FLEXIBLE RISERS DURING ENVIRONMENTAL LOADING.
Hansen, H. T.; Bergan, P. G.

Inst for Statikk, Trondheim, Norw
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 346-353
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612

A method for computation of forces from waves and current on bar and beam type structures during large displacement and large rotational motion is presented. Two types of stationary waves are considered: Airy wave theory and Stokes '5th order theory'. Short term sea states are also generated from wave spectra using linear wave theory and stochastic processing. From this particle velocity and acceleration histories are generated in a three-dimensional grid that encompasses the entire structure. The forces on the structure are then derived from the relative motion between the water particles and the dynamically responding structure using the socalled Morison equation. The paper presents the simulation in time of the dynamic response of a flexible riser during loading from waves and current. Graphical display of the large amplitude response as well as some statistical treatment of the results are given. (Author abstract) 14 refs.

11/7/21
02141544 Monthly No: EIM8612-089510
NONLINEAR STATIC ANALYSIS OF FLEXIBLE RISERS.
Mathisen, K. M.; Bergan, P. G.
Norwegian Inst of Technology, Trondheim, Norw
Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 337-345
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612

A method for computation of buoyancy forces on cable and beam type structures is presented. A general large displacement formulation which allows for displacements and rotations of unlimited size is assumed. The finite deformation bending of flexible risers may be very large. Second order hydrostatic pressure effects due to the curvature may therefore be of particular importance for flexible risers. Alternative ways of introducing hydrostatic nodal forces are discussed. Equilibrating forces for nodal points as well as incremental force-displacement relationships are given. Alternative ways of making the geometric load correction matrix symmetric for incremental analysis is discussed. (Edited author abstract) 20 refs.

11/7/22

02141514 Monthly No: EIM8612-089480

CONSISTENT, LARGE-AMPLITUDE ANALYSIS OF THE COUPLED RESPONSE OF A TLP AND TENDON SYSTEM.

Paulling, J. R.; Webster, W. C.
Univ of California, Berkeley, CA, USA

Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 126-133
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612

The tension leg platform (TLP) together with its mooring tendons and drilling or production risers, forms a dynamic system with an infinity of degrees of freedom. In the deep water applications for which it is anticipated that TLP's will be the most attractive, the mass of the moorings and risers may be appreciable in comparison with the platform mass, and there will probably be considerable dynamic interaction between the two systems. The present paper presents a consistent, nonlinear procedure for the prediction of the large-amplitude coupled motions which result from the action of wind, waves and currents on the platform and risers. (Author abstract) 7 refs.

11/7/23

02141508 Monthly No: EIM8612-089474

LIGHTWEIGHT COMPOSITE PRODUCTION RISERS FOR A DEEP WATER TENSION LEG PLATFORM.

Sparks, C.
Inst Francais du Petrole, Paris, Fr

Conference Title: Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering (OMAE) Symposium.
Conference Location: Tokyo, Jpn Conference Date: 1986 Apr 13-18
Sponsor: ASME, New York, NY, USA; Soc of Naval Architects of Japan, Jpn; Chinese Soc of Ocean Engineers, China; Chinese Soc of Naval Architects & Marine Engineers, China; Inst of Mechanical Engineers, London, Engl; et al
E.I. Conference No.: 08905
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 5th v 3. Publ by ASME, New York, NY, USA p 86-93
Publication Year: 1986
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8612

This paper describes the architecture of the individual composite production risers of the PLTB 1000 concrete tension leg platform, designed for 500 - 1000 m water depths, and presents the design procedure that determines their dimensions. It emphasises the important influence of riser apparent weight on platform payload. It shows that TLPs are more sensitive to such weight than they are to structural deadload. Methods of calculating the equivalent elastic characteristics of composite tubes are presented. These characteristics allow wellheads to be fixed at deck level without continual compensation of vertical relative movements. The principal factors leading to differential profiles between adjacent risers are

identified and their relative influence discussed. It is shown that individual production risers are a valid proposition in 1000 m of water, if they are fabricated from lightweight, high strength composite materials. (Edited author abstract) 12 refs.

11/7/24
02119511 Monthly No: EIM8609-062533
DYNAMIC BEHAVIOR OF FLEXIBLE RISER.
Bratu, Ch.; Narzul, P.
Inst Francais du Petrole, Rueil-Malmaison, Fr
Conference Title: Behaviour of Offshore Structures, Proceedings of the 4th International Conference.
Conference Location: Delft, Neth Conference Date: 1985 Jul 1-5
Sponsor: Delft Univ of Technology, Delft, Neth; London Univ, Cent for Marine Technology, London, Engl; MIT, Cambridge, MA, USA; Norwegian Inst of Technology, Trondheim, Norw
E.I. Conference No.: 08202
Source: Publ by Elsevier Science Publishers BV (Developments in Marine Technology, v 2), Amsterdam, Neth and New York, NY, USA p 375-381
Publication Year: 1985
ISBN: 0-444-42513-6
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8609
A time-domain simulation model of flexible riser dynamic behavior is presented. Various configuration can be analyzed by this computer program: catenary flexible pipe between the surface support vessel and subsurface intermediate buoy, and 'lazy' or 'steep' pipe configuration to the sea bottom. Features of the long finite element of the riser, submitted to water waves, current and surface support movements are described. The numerical model, which allows a short CPU time, simulates the dynamic behavior of the riser, and calculates tensions and motions at various points, i. e. top tension, radius of curvature at the lowest part, etc. Comparison between some results of ten-month sea test (FRIGG FIELD, NORTH SEA) of a flexible catenary pipe and computations is presented. (Author abstract) 10 refs.

11/7/25
02119507 Monthly No: EIM8609-062529
VALIDITY OF QUASI-STATIC AND APPROXIMATE FORMULAE IN THE CONTEXT OF CABLE AND FLEXIBLE RISER DYNAMICS.
Ractliffe, A. T.
Univ of-Newcastle-upon-Tyne, Newcastle-upon-Tyne, Engl
Conference Title: Behaviour of Offshore Structures, Proceedings of the 4th International Conference.
Conference Location: Delft, Neth Conference Date: 1985 Jul 1-5
Sponsor: Delft Univ of Technology, Delft, Neth; London Univ, Cent for Marine Technology, London, Engl; MIT, Cambridge, MA, USA; Norwegian Inst of Technology, Trondheim, Norw
E.I. Conference No.: 08202
Source: Publ by Elsevier Science Publishers BV (Developments in Marine Technology, v 2), Amsterdam, Neth and New York, NY, USA p 337-346
Publication Year: 1985
ISBN: 0-444-42513-6
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8609
The main purpose of this paper is to have a general study of the limits of validity of quasi-static and linearized models when used in a dynamic context. Two types of catenary cables are distinguished: the so-called

slack catenary where the lower end is tangential to the sea-bed and any change of tension causes the cable to partially lift from or drop on to the sea-bed. A slack catenary may become tight if the tension is sufficient to lift the whole cable off the sea-bed, but the two terms do not necessarily imply greater or lesser tension, since a tight catenary may have a large dip. The first part of the paper presents all the formulae relating these parameters on a static basis in a form which can be used directly and the second part compares the static and dynamic response of slack catenaries. 14 refs.

11/7/26
02113051 Monthly No: EIM8608-055647
ABAQUS/AQUA APPLICATION TO OFFSHORE RISERS AND PIPELINES.
McNamara, J. F.; Gilroy, J. P.; Sorensen, E. P.; Hibbitt, H. D.
Univ Coll, Galway, Irel
Conference Title: Maritime Simulation, Proceedings of the First Intercontinental Symposium.
Conference Location: Munich, West Ger Conference Date: 1985 Jun 3-5
Sponsor: Control Data GmbH, Frankfurt, West Ger; Int Marine Simulator Forum; Soc for Computer Simulation, La Jolla, CA, USA
E.I. Conference No.: 07947
Source: Publ by Springer-Verlag, Berlin, West Ger and New York, NY, USA p 191-202
Publication Year: 1985
ISBN: 0-387-15620-8
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8608
This paper outlines the capabilities of the AQUA subset of the ABAQUS finite element program for simulating marine risers and pipelines under operational conditions. The AQUA suite is used mainly for nonlinear cases, the nonlinearities being due to the fluid loading and the large motions and stresses in the piping structures. Typical examples include the response due to waves and currents in deep water drilling and production risers; mooring lines; flexible risers and tanker loading hoses; tension leg tethers; offshore mining pipes; and the towing, drawdown and installation of long strings of piping. AQUA also models the J-tube pull operation, with rigid or flexible J-tubes. (Edited author abstract) 10 refs.

11/7/27
02075677 Monthly No: EIM8602-013013
HIGH RELIABILITY RISER TENSIONERS FOR THE HUTTON TLP.
Myers, R. J.; Adam, L. J.; Harvey, D. W.
Conoco Inc
Conference Title: Offshore Europe 85 Conference.
Conference Location: Aberdeen, Scotl Conference Date: 1985 Sep 10-13
Sponsor: Soc of Petroleum Engineers of AIME, Richardson, TX, USA
E.I. Conference No.: 07384
Source: Society of Petroleum Engineers of AIME, (Paper) SPE Publ by Soc of Petroleum Engineers of AIME, Richardson, TX, USA SPE 14028 19p
Publication Year: 1985
CODEN: SEAPAZ
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8602
This paper details the approach taken to maximise the reliability of the Hutton Tension Leg Platform (TLP) production riser tensioners. The design, development, testing and operational performance of the tensioners are described. In addition, the paper outlines the reliability analyses and quality assurance procedures used. Operational experience of the production

riser tensioners installed to date on the Hutton TLP is summarised. (Edited author abstract)

11/7/28
02050864 Monthly No: EI8612124059 E.I. Yearly No: EI86069707
COMPUTER CONTROL OF A COMPLEX BLOCK-LOADING TEST.
Dier, A. F.; Hobbs, R. E.
Source: International Journal of Fatigue v 8 n 3 Jul 1986 p 151-157
Publication Year: 1986
CODEN: IJFADB ISSN: 0142-1123
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: A; (Applications); X; (Experimental)
Journal Announcement: 8612
This paper describes the rig used for the full-scale fatigue testing of an oilfield production riser connection. The complex block-loading spectrum and the need to co-ordinate data acquisition with the loading made a real-time, computer-based control system an attractive, perhaps an essential, solution. It is seen that in the integrated system of electronics, servohydraulics and rig hardware, the computer functioned as a man/machine interface. Aspects of safety to which the computer contributed are highlighted, but the importance of electro-mechanical devices is also recognized. It was found that a multiple checking technique was a valuable tool in avoiding nuisance tripping of the safety circuit. Finally, the main advantages of the computer-based control system are summarized. (Author abstract)

11/7/29
01969878 Monthly No: EI8605040548 E.I. Yearly No: EI86069701
DOCKING CONTROL OF THE FLEXIBLE RISER END IN AN OFFSHORE LOADING SYSTEM.
Saelid, Steinar
Kongsberg Albatross A/S, Kongsberg, Norw
Source: Modeling, Identification and Control v 6 n 2 Apr 1985 p 75-90
Publication Year: 1985
CODEN: MIDCDA
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: A; (Applications)
Journal Announcement: 8605
The SUBLOAD system for offshore loading of oil directly from a seafloor terminal by a flexible riser deployed from a dynamically positioned shuttle tanker is briefly described. The flexible riser is terminated at the lower end by a Lower Riser Package (LRP). The LRP is equipped with thrusters to control the lower riser end position during the docking- and LRP connection-phase. A mathematical model of the vessel/riser/LRP system is given, and a simulation model is used for design of some of the LRP parameters (weight, buoyancy, metacentre). This is done in order to minimize the thrust force requirement for docking control purposes. Finally a docking control system is designed based on a simplified model of the LRP dynamics. (Edited author abstract) 4 refs.

11/7/30
01946434 Monthly No: EI8602013359 E.I. Yearly No: EI86069705
'HUTTON' PRODUCTION RISERS - A NOVEL CLEANING PROBLEM. AN UP-TO-THE-MOMENT CASE HISTORY.
Tyson, J. A. G.
Conoco (UK) Ltd, UK
Source: Corrosion Prevention & Control v 32 n 6 Dec 1985 p 111-117
Publication Year: 1985
CODEN: CRPCAK ISSN: 0010-9371
Language: ENGLISH

Document Type: JA; (Journal Article) Treatment: G; (General Review); L; (Literature Review/Bibliography); X; (Experimental)
Journal Announcement: 8602

Conoco's innovative Tension Leg Platform in the northern North Sea has presented the industry with a novel cleaning problem. Production risers transport reservoir fluids from seabed to surface on Hutton. The cleaning problem arises because these risers are protected from corrosion by a thin, relatively-fragile, coating of flame-sprayed aluminum (FSA). There is a requirement to keep these risers free of marine growth, and the challenge was offered to a wide spectrum of UK-based companies to come up with a viable, and necessarily innovative, system to remove this marine growth without damaging the FSA. This paper describes the nature of the coating, the coating's susceptibility to damage from conventional cleaning methods and gives an evaluation of some relevant cleaning techniques available today. (Edited author abstract) 1 ref.

11/7/31
01876819 Monthly No: EIM8506-034427
HYDRODYNAMIC FORCES ON MULTITUBE PRODUCTION RISERS EXPOSED TO CURRENTS AND WAVES.
Demirbilek, Z.; Halvorsen, T.
Conoco Inc, Research & Development Dep, Ponca City, OK, USA
Conference Title: Proceedings of the Fourth International Offshore Mechanics and Arctic Engineering Symposium. (Presented at the 1985 ASME Energy-Sources Technology Conference & Exhibition.)
Conference Location: Dallas, TX, USA Conference Date: 1985 Feb 17-21
Sponsor: ASME, New York, NY, USA; Inst of Mechanical Engineers, London Cent for Marine Technology, London, Engl; Norwegian Soc of Chartered Engineers, Oslo, Norw; Soc of Naval Architects of Japan, Japan Ocean Engineering Div, Tokyo, Jpn; Conseil de Liaison de Assoc de Recherche sur les Ouvrages en Mer, Fr; et al
E.I. Conference No.: 06296
Source: Proceedings of the International Offshore Mechanics and Arctic Engineering Symposium 4th v 1. Publ by ASME, New York, NY, USA p 363-370
Publication Year: 1985
CODEN: PIOSEB
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8506

This paper presents the experimental results of a joint industry riser test program. Over a five-year period, an extensive experimental investigation of hydrodynamic loads acting on various production risers was carried out. The program included the laboratory testing of many multitube riser configurations as well as a single cylinder. The primary objective of this investigation was to establish an accurate measurement of the hydrodynamic forces on bundle-type risers. The findings from this study will present the hydrodynamic force coefficients for some marine risers consisting of one or more cylinders interacting either only with currents or oscillatory flow separately. Among the results outlined are the drag, inertia, and lift coefficients for various composite risers as a function of the Reynolds and Keulegan-Carpenter numbers. An analysis and synthesis of the test data are also presented. 10 refs.

11/7/32
01871593 Monthly No: EIM8505-028641
ASSESSMENT OF VORTEX SUPPRESSION DEVICES FOR PRODUCTION RISERS AND TOWED DEEP OCEAN PIPE STRINGS.
Rogers, A. C.
Southwest Research Inst, San Antonio, TX, USA
Conference Title: 1983 Proceedings - Fifteenth Annual Offshore Technology

Conference.
Conference Location: Houston, TX, USA Conference Date: 1983 May 2-5
Sponsor: AIME, New York, NY, USA; American Assoc of Petroleum Geologists, Tulsa, OK, USA; AIChE, New York, NY, USA; ASCE, New York, NY, USA; ASME, Petroleum Div, New York, NY, USA; et al
E.I. Conference No.: 06444
Source: Proceedings - Annual Offshore Technology Conference 15th v 3. Publ by Offshore Technology Conference, Dallas, TX, USA OTC 4594, p 119-126
Publication Year: 1983
CODEN: OSTCBA ISSN: 0160-3663
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8505

This paper discusses vortex suppression devices as applied to deep ocean production risers and pipestrings. The basic problem of flow induced structural excitation is discussed as well as the present state-of-the-art of vortex suppression devices. One of the most promising devices discussed, the guiding vane principal, is of 1945 vintage and on the average, all the other concepts available for discussion are estimated to be of 1967 vintage. Based on a conclusion that drag reduction and structural symmetry to flow are considered to be of equal importance to vortex suppression, several basic types of devices are suggested. Configurations and pipestring arrangements are portrayed and the need for an evolution of new concepts is emphasized. 20 refs.

11/7/33
01871591 Monthly No: EIM8505-028639
SENSITIVITY OF MARINE RISER RESPONSE TO THE CHOICE OF HYDRODYNAMIC COEFFICIENTS.
Labbe, J. R.; Nikkel, K. G.; Wang, Eade
Standard Oil Co of California, CA, USA
Conference Title: 1983 Proceedings - Fifteenth Annual Offshore Technology Conference.
Conference Location: Houston, TX, USA Conference Date: 1983 May 2-5
Sponsor: AIME, New York, NY, USA; American Assoc of Petroleum Geologists, Tulsa, OK, USA; AIChE, New York, NY, USA; ASCE, New York, NY, USA; ASME, Petroleum Div, New York, NY, USA; et al
E.I. Conference No.: 06444
Source: Proceedings - Annual Offshore Technology Conference 15th v 3. Publ by Offshore Technology Conference, Dallas, TX, USA OTC 4592, p 103-112
Publication Year: 1983
CODEN: OSTCBA ISSN: 0160-3663
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8505

The sensitivity of the response of typical marine risers to choices of hydrodynamic coefficients is assessed. A time and frequency domain study of typical drilling and production risers for water depths from 500 to 3000 feet investigates the influence of the technique used to include the hydrodynamic coefficients in the riser program as well as the value of the coefficients for a range of environmental conditions. Data are presented to guide the designer and analyst in determining how to model the riser hydrodynamic coefficient and how accurately the coefficients must be known. The results of the study show that for most cases, constant coefficients based on the maximum values of Reynolds and Keulegan-Carpenter numbers occurring anywhere along the riser are sufficient for determining operating parameters such as top tension and base angle. 1 ref.

11/7/34
01871548 Monthly No: EIM8505-028596

BEHAVIOR OF A FLOATING VESSEL/ARTICULATED COLUMN SYSTEM.
Dumazy, Christian; Leturcq, Michel
Soc Natl Elf Aquitaine, Fr
Conference Title: 1983 Proceedings - Fifteenth Annual Offshore Technology Conference.
Conference Location: Houston, TX, USA Conference Date: 1983 May 2-5
Sponsor: AIME, New York, NY, USA; American Assoc of Petroleum Geologists, Tulsa, OK, USA; AIChE, New York, NY, USA; ASCE, New York, NY, USA; ASME, Petroleum Div, New York, NY, USA; et al
E.I. Conference No.: 06444
Source: Proceedings - Annual Offshore Technology Conference 15th v 2. Publ by Offshore Technology Conference, Dallas, TX, USA OTC 4547, p 295-308
Publication Year: 1983
CODEN: OSTCBA ISSN: 0160-3663
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8505
The paper deals with prediction of the behavior of a system including a floating vessel (tanker, barge or semisubmersible) linked to an articulated column used as anchoring facility and production riser. The simulation program developed for this purpose is a 3-dimensional program taking into account non-colinear environmental conditions. Slow drift motions and forces on the vessel are considered and integrated in a time simulation. Extensive model tests were performed in order to calibrate the program on a bi-articulated column. 5 refs.

11/7/35
01871515 Monthly No: EIM8505-028563
DEEPWATER PRODUCTION RISER.
Panicker, N. N.; Yancey, I. R.
Mobil Research & Development Corp
Conference Title: 1983 Proceedings - Fifteenth Annual Offshore Technology Conference.
Conference Location: Houston, TX, USA Conference Date: 1983 May 2-5
Sponsor: AIME, New York, NY, USA; American Assoc of Petroleum Geologists, Tulsa, OK, USA; AIChE, New York, NY, USA; ASCE, New York, NY, USA; ASME, Petroleum Div, New York, NY, USA; et al
E.I. Conference No.: 06444
Source: 15th v 2. Publ by Offshore Technology Conference, Dallas, TX, USA OTC 4512, p 9-18 OSTCBA
Publication Year: 1983
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8505
A deepwater production riser design developed by Mobil Research and Development Corporation is presented. The riser consists of a lower rigid section terminated about 200 feet below the sea surface with a tensioning buoy assembly and a flexible upper section made of a bundle of flexible pipes. It is designed to be compliant to waves, currents and vessel motions and applicable to both mild and severe environments. Design, analysis, testing, and installation method are discussed. 9 refs.

11/7/36
01799700 Monthly No: EI8509079826 E.I. Yearly No: EI85066532
DESIGN AND ANALYSIS OF DEEP WATER MARINE RISER SYSTEMS FOR FLOATING PRODUCTION FACILITIES.
Olson, Richard J.
Battelle Petroleum Technology Cent, Houston, TX, USA
Source: Courses Lect Int Cent Mech Sci n 283, Case Hist in Offshore Eng. Publ by Springer-Verlag, Vienna, Austria and New York, NY, USA, 1985 p

207-254
Publication Year: 1985
CODEN: CICMDR ISSN: 0254-1971 ISBN: 3-211-81817-0
Language: ENGLISH
Document Type: MC; (Monograph Chapter) Treatment: A; (Applications); G; (General Review); T; (Theoretical)
Journal Announcement: 8509
This article discusses the design and analysis of deep water marine riser systems for floating production facilities. Since the details of the specific riser designs are generally proprietary and because the narrowness of the overall topic, risers, easily allows a general treatment for all floating production facility riser designs, rather than focusing on a specific riser installation, a slightly broader treatment is given. Specific topics to be considered are basic floating production riser system characteristics, global riser system analysis fundamentals, and applications of the first two topics to a floating production riser system design. 3 refs.

11/7/37
01796393 Monthly No: EI8509079827 E.I. Yearly No: EI85066535
MODERN PRODUCTION RISERS: PART 14 - SIMILARITY TERMS FOR MODELING DEEPWATER RISERS.
Morgan, George W.
Source: Petroleum Engineer International v 56 n 14 Nov 15 1984 p 14, 16, 19
Publication Year: 1984
CODEN: PENGA6 ISSN: 0164-8322
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: T; (Theoretical); X; (Experimental)
Journal Announcement: 8509
When a test program is planned, the test objectives should be clearly defined. According to the scope of the objectives, one must decide whether only partial data are required, or if complete physical coverage of all pertinent parameters is required. The most difficult, and most expensive, type of program is one designed to provide sufficient data for computer analysis verification. Complete information on both forcing and response functions must be simultaneously recorded, along with related data on variations that concurrently occur at the boundaries. A complete set of data on a riser's deflected configuration is meaningless without full knowledge of the pertinent force history that caused it. Conversely, complete data on all aspects of the forcing functions are not usable in the verification analysis without full knowledge of the deflected configuration of the riser.

11/7/38
01786163 Monthly No: EI8508068507 E.I. Yearly No: EI85066541
RANDOM DYNAMIC RESPONSE OF A TETHERED BUOYANT PLATFORM PRODUCTION RISER.
Etok, E. U.; Kirk, C. L.
Cranfield Inst of Technology, Offshore Structures Group, Cranfield, Engl
Source: Prog Eng Sci v 1, Dyn Anal of Offshore Struct Recent Dev. Publ by CML Publ, Southampton, Engl, 1982 p 81-94
Publication Year: 1982
CODEN: PESCEN ISBN: 0-905451-07-4
Language: ENGLISH
Document Type: MC; (Monograph Chapter) Treatment: A; (Applications); N; (Numeric/Statistical); T; (Theoretical)
Journal Announcement: 8508
A new normal mode spectral analysis method is presented for calculating r. m. s. riser deflections, bending stresses and lower ball joint angles.

Forces on the riser consist of: non-linear fluid drag taking account of the relative velocity due to tethered buoyant platform (TBP) motion, riser elastic deflection and wave induced fluid velocity, wave induced fluid acceleration, inertia forces due to TBP acceleration, and buoyancy. The non-linear fluid drag forces are linearized using Tung and Wu's approximation based on the r. m. s. relative fluid velocity and current. A wide range of results is presented for risers in water depths up to 1000 m and it is observed that 6 normal modes are sufficient for calculating bending stresses. A static analysis is also presented for bending stresses due to wave and current induced drag forces and riser offset. 10 refs.

11/7/39
01774323 Monthly No: EI8507057250 E.I. Yearly No: EI85066545
MODERN PRODUCTION RISERS - 13: HYDRODYNAMIC TEST PROGRAMS FOR DEEPWATER RISERS.
Morgan, George W.
Source: Petroleum Engineer International v 56 n 12 Oct 1984 5p between p 48 and 58
Publication Year: 1984
CODEN: PENGA6 ISSN: 0164-8322
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: X; (Experimental)
Journal Announcement: 8507
In the past decade, many hydrodynamic test programs have been conducted to provide various levels of engineering insights into the force-response mechanisms of drilling and production risers. The principal objective of most full-scale test programs has been the verification of theoretical analyses used for riser performance predictions by use of computer methods. Before these present-day test programs were conducted very limited in-situ performance data were available to corroborate calculated values of hydrodynamic-force systems and associated riser response properties.

11/7/40
01772180 Monthly No: EI8507057252 E.I. Yearly No: EI85066547
HYDRODYNAMIC FORCES ON MULTITUBE PRODUCTION RISERS EXPOSED TO CURRENTS AND WAVES.
Demirbilek, Z.; Halvorsen, T.
Conoco Inc, Research & Development Dep, Ponca City, OK, USA
Source: Journal of Energy Resources Technology, Transactions of the ASME v 107 n 2 Jun 1985 p 226-234
Publication Year: 1985
CODEN: JERTD2 ISSN: 0195-0738
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: X; (Experimental)
Journal Announcement: 8507
This paper presents the experimental results of a joint industry riser test program. Over a five-year period, an extensive experimental investigation of hydrodynamic loads acting on various production risers was carried out. The program included the laboratory testing of many multitube riser configurations as well as a single cylinder. Several major oil companies sponsored the project. The tests were made with rather large-scale models which were: 1) held stationary in steady current, 2) moved at constant speed or constant acceleration through a quiescent fluid or through a moving fluid, and 3) held stationary in oscillating flow or in steady current superimposed on oscillating flow. 10 refs.

11/7/41
01746469 Monthly No: EI8504029212 E.I. Yearly No: EI85066544
MODERN PRODUCTION RISERS. PART 15 - SELECTION OF HYDRODYNAMIC TEST PARAMETERS.

Morgan, George W.
Source: Petroleum Engineer International v 57 n 2 Feb 1985 p 44, 48, 50
Publication Year: 1985
CODEN: PENGA6 ISSN: 0164-8322 ISBN: 0-89520-421-5
Language: ENGLISH
Document Type: JA; (Journal Article) Treatment: T; (Theoretical); X; (Experimental)
Journal Announcement: 8504

Regardless of the care devoted to design and construction of the riser model, if the sea states are not properly simulated and monitored, the tests may be inconclusive. Because the sea is ever-changing, it is claimed that both the force systems and response envelopes should be treated in a statistical manner. Most computer programs, however, develop the riser response based on discrete load distributions according to definite statements of time increments. To verify theories for these types of computer programs, logical courses of action regarding selection of hydrodynamic test parameters are considered. 4 refs.

11/7/42
01651697 Monthly No: EIM8405-037497
INFLUENCE OF PRODUCTION-RISER DESIGN ON THE CONFIGURATION AND OPERATION OF SEMI-SUBMERSIBLE FLOATING PRODUCTION SYSTEMS.
Shotbolt, K.
Brown & Root (UK) Ltd, UK
Conference Title: Offshore Europe 83.
Conference Location: Aberdeen, Scotl Conference Date: 1983 Sep 6-9
Sponsor: Soc of Petroleum Engineers of AIME, Dallas, Tex, USA
E.I. Conference No.: 04071
Source: Society of Petroleum Engineers of AIME, (Paper) SPE Publ by Spearhead Exhibitions Ltd, Kingston-upon-Thames, Engl SPE11915, p 569-584
Publication Year: 1983
CODEN: SEAPAZ
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8405

11/7/43
01636264 Monthly No: EIM8403-020502
ON THE DYNAMICS OF PRODUCTION RISERS.
Patel, M. H.; Sarohia, S.
Univ Coll London, London, Engl
Conference Title: Behaviour of Off-Shore Structures, Proceedings of the 3rd International Conference (BOSS 82).
Conference Location: Cambridge, Mass, USA Conference Date: 1982 Aug 2-5
Sponsor: Delft Univ of Technology, Delft, Neth; Imperial Coll of Science & Technology, London, Engl; MIT, Cambridge, Mass, USA; Norwegian Inst of Technology, Trondheim, Norw
E.I. Conference No.: 02530
Source: Behaviour of Off-Shore Structures, Proceedings of the International Conference 3rd v 1. Publ by Hemisphere Publ Corp, Washington, DC, USA p 599-617
Publication Year: 1983
CODEN: BOPCDP ISBN: 0-80116-343-3
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8403

11/7/44
01551361 Monthly No: EI8408080032 E.I. Yearly No: EI84074554
FORCE MEASUREMENTS ON PRODUCTION RISERS INTERACTING WITH WAVES AND

CURRENTS.

Demirbilek, Zeki; Halvorsen, Tore
Conoco Inc, Research & Development Dep, Ponca City, Okla, USA

Source: Soc Pet Eng AIME Pap SPE Unsolicited Manuscr, May 1984 SPE 12896, 28p
Publication Year: 1984
CODEN: SEAPAZ
Language: ENGLISH
Journal Announcement: 8408

This paper presents the experimental results of a joint industry riser test program. Over a five-year period, an extensive experimental investigation of hydrodynamic loads acting on various production risers was carried out. The program included the laboratory testing of many multitube riser configurations as well as a single cylinder. Among the results outlined here are the drag, inertia, and lift coefficients for various composite risers as a function of the Reynolds and Keulegan-Carpenter numbers. 9 refs.

11/7/45
01506965 Monthly No: EI8404033928 E.I. Yearly No: EI84074549

INFLUENCE OF PRODUCTION-RISER DESIGN ON THE CONFIGURATION AND OPERATION OF SEMI-SUBMERSIBLE FLOATING PRODUCTION SYSTEMS.

Shotbolt, K.
Brown & Root (UK) Ltd

Source: Journal of the Society for Underwater Technology v 9 n 3 Autumn 1983 p 14-21
Publication Year: 1983
CODEN: JSUTDD ISSN: 0141-0814
Language: ENGLISH
Journal Announcement: 8404

Since 1975, many alternative risers for use with SSFPSs (Semi-Submersible Floating Production Systems) have been proposed and some have been tested. The objective of this paper is to examine the fitness of a particular type of riser for its purpose in the overall production system. First, the alternative risers are described, and then their influence on various aspects of system configuration and operation is compared. Finally, comments are made regarding an SSFPS with optimized configuration and operating characteristics. 26 refs.

11/7/46
01478572 Monthly No: EI8401004728 E.I. Yearly No: EI84074553

BUCKLING OF RISERS IN TENSION DUE TO INTERNAL PRESSURE: NONMOVABLE BOUNDARIES.

Bernitsas, M. M.; Kokkinis, T.
Univ of Michigan, Dep of Naval Architecture & Marine Engineering, Ann Arbor, Mich, US

Source: Journal of Energy Resources Technology, Transactions of the ASME v 105 n 3 Sep 1983 p 277-281
Publication Year: 1983
CODEN: JERTD2 ISSN: 0195-0738
Language: ENGLISH
Journal Announcement: 8401

Open-ended tubular columns may buckle globally as Euler columns due to the action of internal fluid pressure even while they are in tension along their entire length. Hydraulic columns, marine drilling and production risers are, therefore, prone to such static instability. This paper explains this phenomenon, defines the critical riser length for which this instability may occur and provides graphs with values of the critical length which can readily be used for design proposes. 17 refs.

11/7/47
01409657 Monthly No: EI8312100040 E.I. Yearly No: EI83015377
BUCKLING OF COLUMNS WITH NONMOVABLE BOUNDARIES.
Bernitsas, Michael M.; Kokkinis, Theodore
Univ of Michigan, Dep of Naval Architecture & Marine Engineering, Ann Arbor, Mich, USA
Source: Journal of Structural Engineering v 109 n 9 Sep 1983 p 2113-2128
Publication Year: 1983
CODEN: JSENDH
Language: ENGLISH
Journal Announcement: 8312
The global buckling problem of slender tubular columns subject to distributed load is studied. The load consists of the column weight, tension / compression exerted at the top of the column, and internal and external variable static pressure forces due to fluids in gravity field. Nonmovable supports at the upper and lower columns ends define the boundary conditions. The resulting nondimensionalized eigenvalue problem is general, and applicable to columns, tubes, pipelines, marine drilling and production risers, mining risers and legs of tension leg platforms. 16 refs.

11/7/48
01366919 Monthly No: EI8307057364 E.I. Yearly No: EI83076734
HIGH-PRESSURE SWIVEL FOR NATURAL GAS SERVICE AND OSCILLATING MOTION IN A MARINE ENVIRONMENT.
Herbert, J. T.; Ortloff, J. E.
Aeroquip Corp, Product Development, Jackson, Mich, USA
Source: Journal of Energy Resources Technology, Transactions of the ASME v 104 n 3 Sep 1982 p 229-234
Publication Year: 1982
CODEN: JERTD2 ISSN: 0195-0738
Language: ENGLISH
Journal Announcement: 8307
A joint development program has produced a unique flowline swivel for high-pressure natural gas service under continuous, small degree rotation, oscillating service. The swivel uses an elastomeric bearing element made up of alternate, frusto-conical shaped rings of metal and rubber (elastomer) to absorb continuous small degree rotary oscillations or flexures of the swivel. The swivel should be useful in offshore marine production riser systems and loading terminals. 12 refs.

11/7/49
01268569 Monthly No: EIM8301-001092
FLEXIBLE RISER FOR A FLOATING STORAGE AND OFFLOADING SYSTEM.
Beynet, Pierre A.; Frase, John R.
Amoco Prod Co, USA
Conference Title: 1982 Proceedings - 14th Annual Offshore Technology Conference.
Conference Location: Houston, Tex, USA Conference Date: 1982 May 3-6
Sponsor: AIME, New York, NY, USA; Am Assoc of Pet Geol, Tulsa, Okla, USA; AIChE, New York, NY, USA; ASCE, New York, NY, USA; IEEE, New York, NY, USA; et al
E.I. Conference No.: 01193
Source: Proceedings - Annual Offshore Technology Conference 14th, v 2. Publ by Offshore Technol Conf, Dallas, Tex, USA p 249-258
Publication Year: 1982
CODEN: OSTCBA
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8301

11/7/50
01241437 Monthly No: EIM8209-034963
APPLICATION OF FILAMENT-WOUND COMPOSITE TUBES TO PRODUCTION RISERS.
Falcimaigne, Jean; Sparks, Charles; Phan, Albert
Inst Fr du Pet
Conference Title: Proceedings - Deepsea Offshore Technology Conference. (Volume 2: Deepwater Production.)
Conference Location: Palma de Mallorca, Spain Conference Date: 1981 Oct 19-22
Sponsor: ASTEO (Assoc et Tech pour l'Exploit des Oceans), Paris, Fr; Offshore, Houston, Tex, USA; Pet Inf, Paris, Fr
E.I. Conference No.: 00597
Source: Publ by Deep Offshore Technol, Paris, Fr p 221-227
Publication Year: 1981
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8209

11/7/51
01241436 Monthly No: EIM8209-034962
SEA BED TO SURFACE CONNECTIONS IN VERY DEEP WATER: DYNAMIC PRODUCTION RISER.
Dumay, Jean Michel
COFLEXIP
Conference Title: Proceedings - Deepsea Offshore Technology Conference. (Volume 2: Deepwater Production.)
Conference Location: Palma de Mallorca, Spain Conference Date: 1981 Oct 19-22
Sponsor: ASTEO (Assoc et Tech pour l'Exploit des Oceans), Paris, Fr; Offshore, Houston, Tex, USA; Pet Inf, Paris, Fr
E.I. Conference No.: 00597
Source: Publ by Deep Offshore Technol, Paris, Fr p 208-220
Publication Year: 1981
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8209

11/7/52
01241418 Monthly No: EIM8209-034944
REVIEW OF ALTERNATIVE PRODUCTION RISERS.
Mason, J. Preston; Parlas, Solon C.
Conference Title: Proceedings - Deepsea Offshore Technology Conference. (Volume 2: Deepwater Production.)
Conference Location: Palma de Mallorca, Spain Conference Date: 1981 Oct 19-22
Sponsor: ASTEO (Assoc Sci et Tech pour l'Exploit des Oceans), Paris, Fr; Offshore, Houston, Tex, USA; Pet Inf, Paris, Fr
E.I. Conference No.: 00597
Source: Publ by Deep Offshore Technol, Paris, Fr p 35-50
Publication Year: 1981
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8209

11/7/53
01235318 Monthly No: EIM8208-028826
SWIVELS FOR PRODUCTION RISERS AND OFFSHORE TERMINALS.
Ortloff, J. E.
Exxon Prod Res Co, Houston, Tex, USA
Conference Title: Proceedings of the 1st Offshore Mechanics/Arctic

Engineering/Deepsea Systems Symposium. (Presented at Energy-Sources Technology Conference & Exhibition.)
Conference Location: New Orleans, La, USA Conference Date: 1982 Mar 7-10
Sponsor: ASME, Pet Div, Offshore Mech Comm, New York, NY, USA
E.I. Conference No.: 00623
Source: v 2. Publ by ASME, New York, NY, USA p 149-154
Publication Year: 1982
Language: English
Document Type: PA; (Conference Paper)
Journal Announcement: 8208

11/7/54
01184711 Monthly No: EI8204031217 E.I. Yearly No: EI82060044
FLOW-INDUCED MOTIONS OF MULTIPLE RISERS.
Overvik, T.; Moe, G.; Hjorth-Hansen, E.
Norw Inst of Technol, Trondheim
Source: ASME Pap 81-WA/FE-26 for Meet Nov 15-20 1981 13 p
Publication Year: 1981
CODEN: ASMSA4 ISSN: 0402-1215
Language: ENGLISH
Journal Announcement: 8204
Vortex-induced and galloping vibrations of flexible risers in steady, uniform currents have been investigated. The cross sections consisted of a bundle of pipes tied together to form a so-called multiple production riser. The tests have been carried out in a wind tunnel at subcritical Reynolds numbers, using spring mounted sectional models. 6 refs.

11/7/55
01101790 Monthly No: EI8203022321 E.I. Yearly No: EI82060033
DORADA FIELD PRODUCTION RISERS.
Wybro, P. G.; Davies, K. B.
Getty Oil Co, USA
Source: Offshore Technol Conf 13th Annu, Proc, v 2, Houston, Tex, USA, May 4-7 1981. Publ by Offshore Technol Conf, Dallas, Tex, USA, 1981 p 335-351
Publication Year: 1981
CODEN: OSTCBA ISSN: 0160-3663
Language: ENGLISH
Journal Announcement: 8203
The Dorada Field floating production system, located offshore Spain in 310 ft of water in the Mediterranean Sea, utilizes three individual production risers. This paper outlines the riser analysis methodology, identifies several new aspects of production riser design analysis, describes some pertinent results, and discusses the riser instrumentation system developed to verify these results.

11/7/56
01101789 Monthly No: EI8203023034 E.I. Yearly No: EI82071053
DORADA FIELD PRODUCTION SYSTEM: A SOLUTION TO INDIVIDUAL PERMANENT VERTICAL ACCESS TO SEVERAL WELLS FROM A SEMI-SUBMERSIBLE.
Montoya, Luis S.; Lopez-Fanjul, Gonzalo M.
Source: Offshore Technol Conf 13th Annu, Proc, v 2, Houston, Tex, USA, May 4-7 1981. Publ by Offshore Technol Conf, Dallas, Tex, USA, 1981 p 319-334
Publication Year: 1981
CODEN: OSTCBA ISSN: 0160-3663
Language: ENGLISH
Journal Announcement: 8203
This paper describes the industry's first functional installation of

individual production risers from a three-well cluster to a semi-submersible. It outlines the alternatives considered, the design criteria, the computer analysis developed, the equipment used and the instrumentation system for monitoring critical riser and rig parameters. To accomplish the described purpose, three innovations which are prototype for production risers have been introduced for each well in the Dorada Project: a flex joint installed between the sub-sea tree and the riser, a threaded riser, and the tensioning system devised for it.

11/7/57
01096406 Monthly No: EI8202014087 E.I. Yearly No: EI82070876
MULTIPLE STRING PRODUCTION RISER ANALYSES - A COMPARISON OF METHODS.
Olson, R. J.; McIver, D. B.
Battelle Houston Operat, Tex, USA
Source: Risers, Arct Des Criter, Equip Reliab in Hydrocarbon Process Workb for Eng, Presented at Pet Mech Eng Workshop and Conf, 37th, Dallas, Tex, USA, Sep 13-15 1981 Publ by ASME, New York, NY, USA, 1981 p 119-126
Publication Year: 1981
Language: ENGLISH
Journal Announcement: 8202
A comparison is made between two techniques for computer modeling of multi-tube marine riser production systems. One technique models the multi-tube system as a single equivalent riser, while the other technique simultaneously models the individual risers in the system and their structural ties. The riser equations of motion, multi-tube riser modeling considerations, and sample comparison results are presented. Results demonstrate that both riser system modeling techniques have limitations and that the ultimate choice of technique will depend upon accuracy and economic constraints.

11/7/58
01096404 Monthly No: EI8202013427 E.I. Yearly No: EI82060026
ARTICULATED MULTILINE PRODUCTION RISER FOR DEEPWATER APPLICATION.
Ortloff, John E.; Caldwell, J. B.; Teers, Michael L.
Exxon Prod Res Co, Houston, Tex, USA
Source: Risers, Arct Des Criter, Equip Reliab in Hydrocarbon Process Workb for Eng, Presented at Pet Mech Eng Workshop and Conf, 37th, Dallas, Tex, USA, Sep 13-15 1981 Publ by ASME, New York, NY, USA, 1981 p 105-110
Publication Year: 1981
Language: ENGLISH
Journal Announcement: 8202
The need to produce oil and gas in water depths beyond the physical and economical limits of fixed platforms and pipelines has led to the development of a feasible concept for an articulated multiline flexible marine production riser system. This study covers the history of the concept development from inception to readiness for engineering design and fabrication of a prototype test model. 4 refs.

11/7/59
01096403 Monthly No: EI8202013426 E.I. Yearly No: EI82060025
DESIGN, FABRICATION, AND INSTALLATION OF A PROTOTYPE MULTILINE MARINE PRODUCTION RISER SYSTEM.
Gammage, W. F.; Ortloff, J. E.; Teers, M. L.; Caldwell, J. B.
Exxon Co, New Orleans, La, USA
Source: Risers, Arct Des Criter, Equip Reliab in Hydrocarbon Process Workb for Eng, Presented at Pet Mech Eng Workshop and Conf, 37th, Dallas, Tex, USA, Sep 13-15 1981 Publ by ASME, New York, NY, USA, 1981 p 99-103
Publication Year: 1981
Language: ENGLISH
Journal Announcement: 8202

A multiline marine production riser and floating production, storage, and terminal facility may be required for economic development of oil and gas reserves in remote, deep water locations. A deep water production riser design has evolved through study, analyses, and model testing. In order to gain experience, development confidence, and improve the riser design prior to commercial application, a prototype has been built for testing as part of Exxon's Submerged Production System offshore test in the Gulf of Mexico. This study treats the design, manufacture, and installation of the prototype multiline marine production riser system. 5 refs.

11/7/60
01096400 Monthly No: EI8202010114 E.I. Yearly No: EI82016783
STRESS BALANCED TAPERED COLUMNS IN MARINE RISERS.
Dareing, D. W.
Maurer Eng Inc, Houston, Tex, USA
Source: Risers, Arct Des Criter, Equip Reliab in Hydrocarbon Process Workb for Eng, Presented at Pet Mech Eng Workshop and Conf, 37th, Dallas, Tex, USA, Sep 13-15 1981 Publ by ASME, New York, NY, USA, 1981 p 75-79
Publication Year: 1981
Language: ENGLISH
Journal Announcement: 8202
Tapered columns are widely accepted as a preferred method of controlling bending stresses at the lower end of production risers. In addition, they eliminate doglegs, which develop in flexible joints, and produce a smooth curvature between marine risers and well leads. This study gives a calculation method for determining dimensions of tapered columns. Example calculations show how this method is used to produce a stress balanced design.

11/7/61
01047182 Monthly No: EI8110083890 E.I. Yearly No: EI81056877
MECHANICAL BEHAVIOR OF MARINE RISERS MODE OF INFLUENCE OF PRINCIPAL PARAMETERS.
Sparks, C. P.
Fr Pet Inst, Rueil-Malmaison, Fr
Source: Journal of Energy Resources Technology, Transactions of the ASME v 102 n 4 Dec 1980 p 214-222
Publication Year: 1980
CODEN: JERTD2 ISSN: 0195-0738
Language: ENGLISH
Journal Announcement: 8110
This paper attempts to identify the principal parameters that influence the behavior of drilling and production risers and to explain how and why they do so. Clear understanding of these influences enables particular risers to be optimized rapidly without recourse to an inordinate number of computer analyses. The approach used in the paper has been to derive analytical expressions, for simplified riser cases. Conclusions drawn from these expressions have then been checked for validity, by using a dynamic analysis computer program to simulate a wide range of cases. 6 refs.

11/7/62
01040987 Monthly No: EI8109075480 E.I. Yearly No: EI81056866
Mechanical Behavior of Risers Influence of Key Parameters.
LE COMPORTEMENT MECANIQUE DES RISERS INFLUENCE DES PRINCIPAUX PARAMETRES.
Sparks, C. P.
Inst Fr du Pet
Source: Revue de l'Institut Francais du Petrole v 35 n 5 Sep-Oct 1980 p 811-831
Publication Year: 1980
CODEN: RIFPA9 ISSN: 0370-5552

Language: FRENCH
Journal Announcement: 8109
This article attempts to identify the key parameters influencing the behavior of drilling and production risers and then proceeds to explain this behavior. The following points of major concern to the riser designer are discussed: stress levels along the riser's main length; angular movement on seabed; and relative movement on the riser/platform connection. The approach used in this paper was to derive analytical expressions for simplified riser cases. 6 refs. In French with English abstract.

11/7/63
00967037 Monthly No: EI8011083861 E.I. Yearly No: EI80052014
PRODUCTION RISER ANALYSIS.
Harper, M. P.
K/Shell Explor en Prod Lab, Rijswijk, Neth
Source: Proc of the Int Conf on the Behav of Off-Shore Struct, 2nd (BOSS '79), v 2, Imp Coll, London, Engl, Aug 28-31 1979 Publ by BHRA (Br Hydromech Res Assoc) Fluid Eng, Cranfield, Bedford, Engl, 1979 p 207-212
Publication Year: 1979
Language: ENGLISH
Journal Announcement: 8011
The dynamic analysis of a multibore production riser in a northern North Sea environment is discussed. Results presented concern the bending moment response due to random wave loading and the sensitivity of these results to variations in hydrodynamic coefficients. 2 refs.

11/7/64
00962306 Monthly No: EI8011085282 E.I. Yearly No: EI80069426
ASPECTS OF HYDRODYNAMIC LOADING IN DESIGN OF PRODUCTION RISERS.
Loken, A. E.; Torset, O. P.; Mathiassen, S.; Arnesen, T.
Det Nor Veritas, Norw
Source: JPT, Journal of Petroleum Technology v 32 n 5 May 1980 p 881-890
Publication Year: 1980
CODEN: JPTJAM ISSN: 0022-3522
Language: ENGLISH
Journal Announcement: 8011
In recent years, much attention has been paid to analyzing the response of drilling risers. Most effort has been focused on the development of structural and analytical techniques to predict the stresses in riser systems. This paper describes an experimental program undertaken to understand better the hydrodynamic loading of multitube production risers. Test results are described, and a generalization is given for engineering applications. Sample design calculations are performed. 13 refs.

11/7/65
00934438 Monthly No: EI8007054777 E.I. Yearly No: EI80069425
SANTA BARBARA SALM -- A PROTOTYPE DEEPWATER PRODUCTION RISER AND FLOATING PRODUCTION SYSTEM.
Wolfram, W. R.; Law, T. E.
Exxon Prod Res Co, USA
Source: JPT, Journal of Petroleum Technology v 32 n 2 Feb 1980 p 311-318
Publication Year: 1980
CODEN: JPTJAM ISSN: 0022-3522
Language: ENGLISH
Journal Announcement: 8007
The Hondo offshore storage, oil treating, and off-loading system in the Santa Barbara Channel, California, contains most of the essential features of a deepwater floating production system. This paper discusses the design concept, including dynamic analysis, earthquake design, fatigue analysis, and the high-pressure flow system. A current status report and future plans

for the project are given. 9 refs.

11/7/66
00829257 Monthly No: EI7907054621 E.I. Yearly No: EI79062540
PRODUCTION RISER TECHNOLOGY MOVES INTO DEEPER WATER.
Gunderson, R. H.; Lunde, P. A.
Exxon Prod Res Co, Houston, Tex
Source: Oil and Gas Journal v 77 n 12 Mar 19 1979 p 79-86
Publication Year: 1979
CODEN: OIGJAV ISSN: 0030-1388
Language: ENGLISH
Journal Announcement: 7907
Oil production from deepwater wells requires special subsea production risers and equipment. This article examines latest developments in the design of deepwater production risers, with special emphasis on Exxon's production riser system. Exxon is now testing its Subsea Production System (SPS), which is designed for diverless operation to 2,000-ft water depths in an offshore Louisiana location. Riser flowlines and other components are described. 19 refs.

11/7/67
00810659 Monthly No: EI7904026182 E.I. Yearly No: EI79053236
EXXON'S NEW DEEPWATER PRODUCTION RISER.
Gunderson, R. H.; Lunde, P. A.
Exxon Prod Res Co, Houston, Tex
Source: Ocean Industry v 13 n 11 Nov 1978 p 67-70, 73
Publication Year: 1978
CODEN: OCIDAF ISSN: 0029-8026
Language: ENGLISH
Journal Announcement: 7904
Exxon's deepwater production terminal, applicable for use in water depths to over 5000 ft in rough water environments, consists of a SALM (Single Anchor Leg Mooring) production riser and a floating storage tanker with production facilities on board. The riser serves three main functions: (1) it moors the storage vessel, (2) serves as a support for the fluid lines, and (3) serves as a support for communication lines to subsea production equipment. Two basic analytical programs were used to design the riser: (1) RISDYN, a large-deflection special-purpose riser dynamic analysis program, and (2) RCYCLO, a fatigue analysis program. Initial sizing is based on design forces developed for the maximum design storm (usually, the 100-year storm). 19 refs.

11/7/68
00768150 Monthly No: EI7812091385
DEEPWATER PRODUCTION RISERS.
Gunderson, R. H.; Lunde, P. A.
Exxon Prod Res Co, Houston, Tex
Source: American Society of Mechanical Engineers (Paper) n 78-Pet-13 for Meet Nov 5-9 1978 9 p
Publication Year: 1978
CODEN: ASMSA4 ISSN: 0402-1215
Language: ENGLISH
Journal Announcement: 7812
Exxon's deepwater production terminal, applicable for use in water depths to over 5000 ft. and in rough weather environments, consists of a SALM (Single Anchor Leg Mooring) production riser and a floating storage tanker with production facilities on board. The separated gas and water are disposed of by reinjection into the formation. Shuttle tankers offload the crude oil by tandem mooring to the storage tanker. This paper describes the broad concepts of the riser system including the design criteria. Exxon has

conducted extensive model tests and analyses on this system to assess its feasibility and has designed several SALM systems for various parts of the world. The design of a new structural system requires establishing design criteria consistent with good engineering practice and safety considerations. The Exxon riser system design criteria has been developed using established codes and emerging code requirements for offshore loading terminals modified to fit the functional and structural characteristics of the Exxon SALM. 19 refs.

11/7/69
00677786 Monthly No: EI7706041396 E.I. Yearly No: EI77049803
METHOD FOR ANALYSIS OF A PROTOTYPE ARTICULATED MULTILINE MARINE PRODUCTION RISER SYSTEM.
Caldwell, J. B.; Gammage, W. E.
Exxon Prod Res Co, Houston, Tex
Source: Journal of Pressure Vessel Technology, Transactions of the ASME v 99 Ser J n 1 Feb 1977 p 170-175
Publication Year: 1977
CODEN: JPVTAS ISSN: 0094-9930
Language: ENGLISH
Journal Announcement: 7706
Paper No. 76-Pet-46.

11/7/70
00677785 Monthly No: EI7706041398 E.I. Yearly No: EI77049806
DESIGN, FABRICATION, AND INSTALLATION OF A PROTOTYPE MULTILINE MARINE PRODUCTION RISER SYSTEM.
Gammage, W. E.; Ortloff, J. E.; Teers, M. L.; Caldwell, J. B.
Exxon Co, New Orleans, La
Source: Journal of Pressure Vessel Technology, Transactions of the ASME v 99 Ser J n 1 Feb 1977 p 164-169
Publication Year: 1977
CODEN: JPVTAS ISSN: 0094-9930
Language: ENGLISH
Journal Announcement: 7706
Paper No. 76-Pet-45.

11/7/71
00677784 Monthly No: EI7706041397 E.I. Yearly No: EI77049805
ARTICULATED MULTILINE PRODUCTION RISER FOR DEEPWATER APPLICATION.
Ortloff, J. E.; Caldwell, J. B.; Teers, M. L.
Exxon Prod Res Co, Houston, Tex
Source: Journal of Pressure Vessel Technology, Transactions of the ASME v 99 Ser J n 1 Feb 1977 p 158-163
Publication Year: 1977
CODEN: JPVTAS ISSN: 0094-9930
Language: ENGLISH
Journal Announcement: 7706
Paper No. 76-Pet-44.

11/7/72
00668699 Monthly No: EI7711084698 E.I. Yearly No: EI77068651
FIRST FLOATING PRODUCTION FACILITY -- ARGYLL.
Hammett, D. S.; Johnson, J. S.; White, J. L.
Sedco-Hamilton Prod Serv
Source: Offshore Technol Conf 9th Annu, Proc, Houston, Tex, May 2-5 1977. Sponsored by AIME, New York, NY,1977 v 2 Pap OTC 2821 p 109-122
Publication Year: 1977
CODEN: OSTCBA ISSN: 0160-3663
Language: ENGLISH

Journal Announcement: 7711

This paper presents the history and 20-month operating experience of the first Floating Production Facility -- " Argyll Field -- North Sea " . The field was developed using subsea wells which produce through a production riser and up to a semisubmersible where the produced fluids are treated. The produced oil is shipped back down the riser to a Single Point Mooring System and tanker. Data on the design and operating experience of the subsea wells, flowlines, production riser. Semisubmersible, process equipment, SPM and tanker are reported. 3 refs.

11/7/73

>>>Item 73 is not within valid item range

?