The problem, which will be undertaken in the Risk Managment task of the Pre-contract Engineering Phase of the project, will be to establish the appropriate break-even level where it is more cost effective to insure than to self-insure. The opportunity, savings realization, exists when significant reductions in the total cost of risks can occur through effective use of risks retention.

11.8 CONTINGENCY PLANNING

CONSEQUENTIAL LOSS insurance is designed to protect companies against the financial consequence - in terms of lost earning power - of major property losses, or other events which interrupt the earning capacity of the company.

As discussed in "Risk Managment" the purchase of insurance is only one of the pieces in the overall strategy and therefore, unfortunately, it can provide a false sense of security. In today's highly competitive market any loss of essential production can lead to a permanent or almost permanent loss of market. The risk manager's purpose is, therefore, to concentrate on putting in place measures designed to prevent losses or, at worst, to restore production as rapidly as possible, all at least cost.

Many companies do not survive a major loss. Many who do not survive could have done so had they taken precautions beforehand. Those who are realistic and who accept that the best laid plans will not always succeed in preventing all emergencies, take pain to ensure that those emergencies which they cannot avoid have consequences which do as little damage as possible. Such 'contingency' planning will be a major element of the Pre-contract Engineering Phase of the plantship project.

The three essential features in constructing and developing a contingency plan are:

i) to construct scenarios of what might take place if a serious accident or other earnings-interruption event occurs;

ii) to develop a plan to cope with those scenarios and to do so in consultation with and in agreement with all the properly interested parties; and

iii) then to practice or rehearse the agreed contingency plan.

Classification of Risks and Exposures

The classification of risks and exposures that should be looked at, range across:

1) Direct: Fire
Corrosion
Explosion
Structural defect
War

2) Consequential:	Loss of profits Strikes
3) Social:	Consumer pressure Moral liability
4) Legal	Civil liability Statutory liability Contractual liability
5) Political:	Governmental intervention Sanctions Acts of foreign governments
6) Financial:	Incorrect customer marketing decisions Incorrect supplier decisions Incorrect inflation/costs forecasts

A look at the main areas of exposure in a trading operation, for example, reveals:

1) Suppliers
   - stock
   - other suppliers and services

2) Transport
   - sea
   - port or inland depot
   - inland transport
   - warehouse/yard

3) Sales or Distribution Point
   - any processing prior to sale
   - include services
   - selling point (the need to be at a particular point)

4) Customers
   - adverse action by any large customer

In application to the plantship project the following areas of study will be undertaken in 'contingency planning':

1) Construction Phase Exposures:

   (a) As a result of any physical loss of or damage to:

      - the contract work

- the yards, premises, etc., of builders, fabricators, suppliers, their sub-contractors, etc.

- materials, components, parts, etc., at yards etc., or while in transit

- the offshore location site

(b) As a result of:

- strikes

- locked-out workmen, labor disturbances, civil commotions, etc.

(c) As a result of any other cause, e.g.:

- breakdown of operating or electrical machinery, etc.,

- shortage of material

- weather down-time

- blockage of access to/from ports(s)

- export/import restrictions

- contract frustration

- performance deficiency of plant

- deficiency in gas feedstock flowrate

- sea-water impurity/pollution

It is also necessary to check the exposure and dependencies of important suppliers and customers because any interruption there can impinge on the business.

The contingeny planning work will concentrate on the foregoing main exposure areas including, as mentioned, suppliers (with services to the ship/process plant), transport, production, distribution and customers including interdependencies.

Contingency Planning Factors

The contingency planning factors that need to be taken into account are:

- consideration of the probability and the possible extent of loss

- deciding whether supply can be re-established by repair or by the provision of alternatives and how long this would take to implement to restore production to prior levels.

- calculating what the loss is per unit of time and in total for the total exposure period and then seeing what can be done to reduce the loss, and what this will cost, so that the value of each contingency planning measure can also be evaluated in relation to the impact on earnings and the cost of the loss control measures.

- a good working solution at minimal cost

- the accounting procedure; this determines the exposure measured in annual profit.

For each risk exposure there are two consequential loss exposures:

1) the profit earned and overhead recovered in a particular sub-process;

2) the total profit earned and overheads recovered during the whole production operation of which element (1) is a part.

It may be that only particular processes are threatened but if they cannot be carried out then overall profit and overhead recovery will be threatened.

The following ten point list covers the general approach to be taken to contingency planning:

1) Starting with raw material or other input, examine for each main process the earnings at risk in ultimate:

   - profit

   - overhead recovery

2) Consider the probability of loss and its likely and possible extent.

3) How quickly can the process be:

   - re-established?

   - replaced by alternative facilities elsewhere?

4) What is the loss per week and how long will it last? What measures can be taken to reduce the loss and how much additional cost is involved?

   Consideration needs to be given to:

   - production capacity and required production where several factors are involved?

   - cost penalties in transferring production, e.g., transport, tax, duty.

5) In rebuilding the affected process element or, in the extreme, the facility:

- how long will it take to restore completely production?
- breakdown the rebuilding into stages and allocate timings?
- can emergency measures reduce the period?
- what are the alternatives in cost terms, such as cost of faster rebuilding, use of outside facilities?

6) The analysis proceeds until one has established a good working solution with minimum cost. The factors on which this optimum solution are based are noted for future monitoring as changes in supply and price will affect the result.

7) The same analysis is applied to all suppliers. In most cases there are adequate alternatives but all restricted supply situations are noted. Service facilities are treated as a special supply situation.

8) Key customers, i.e., those taking more than 1% of overall sales are considered in the same way. If the customer is a distributor, the effect may be limited but a customer engaged in a re-processing may be difficult to replace.

9) At the conclusion of the exercise the most serious potential situation is taken as the measure of consequential loss insurance needed.

- The period of indemnity will be related to the most serious situation.
- For some losses, additional increased cost of working, e.g., at an increased operating/production rate, can supplement or partially replace "turnover" cover.
- A safety margin is added to allow for unexpected difficulties or changes. It is important to bear in mind that charges after loss can only be provided for by pre-loss anticipation in buying.

10) The exercise will probably reveal the need for special technical evaluation of some aspects. Other subsequent activity includes:

- monitoring
- emergency insurance action plan to restore cover after loss. A loss may well result in a temporary increased exposure to further loss of earnings from another loss.

The development of the contingency plan is likely to include:

- measures to be taken if and when the dedicated off-take tanker is unavailable.

- emergency manning measures, e.g., up - to - date inventories of non-employees having critical operating/repair skills.

- designation of certain plant or machinery which is currently in low priority use as standby equipment (making sure that this plant or machinery is capable of speedy conversion to other more essential purposes in the event of a loss);

- regular monitoring of alternative sources of gas supply to make sure that production can be maintained following loss.

Process control computers can present special problems; the contingency plan will usually cover two basic aspects:

1) A Standby Mode of operation, concerned with the provision of alternative resources of capabilities in the event that existing ones become unavailable.

2) A Recovery Mode, where the methods and facilities to be used in returning to a normal state of operation are described. Note that this 'normal' state may not necessarily be the same as the original state. For example, after a major fire, it may be the case that an opportunity is taken to install an improved hierarchial control system.

A final factor in contingency planning is the time-scale of interruption to operations. This will be a critical factor when eventually the question of interruption insurance is considered.

A possible list is as follows:

1) Time required to rehabilitate hull or moorings or gas supply system and to replace machinery and plant. It is prudent to allow a margin for contingencies which may cause delay. Examples are:

   - Need to obtain planning permission, e.g., to activate new well drilling.

   - Effect of local authority requirements and legislation.

   - Time required for planning and design, particularly if the opportunity is taken to alter process plant design or to move to a different site. Similar considerations apply if an improved mooring design is to be purchased and deployed.

   - Items of plant that are specialized and made to order.

- Time required for erection, testing and running-in of plant and machinery.

- Strikes affecting service boats, port operators or transport.

- Bad weather.

- Shortage of essential materials.

2) Availability of suitable alternative operating sites, discharge facilities, etc.

3) The extent to which the business is dependent on licenses.

4) Time required to regain lost markets. In markets where competition is intense, shortage of revenue from this source may take a long time to recover. If the indemnity period is long enough then cover does not cease when full production capacity is available but continues until, at normal cost of working, turnover reaches the level that would have been attained had no interruption occurred.

5) Time needed to engage and train the required number of employees.

The Contingency Plan of the Pre-contract Engineering Phase will be thorough because if a major loss occurs, its ultimate magnitude and impact on the running of the plantship project will largely depend on how swiftly and competently action is taken. If the action has not been planned for, it is inevitable that in the event of a major loss, action will not be swift or, if it is, it will be ill-considered. Therefore, the plan will also make proper provision for the delegation of authority (with a successor list of persons in case of casualties), the safeguarding of vital records (duplicate sources, agreements with manufacturers etc.), keeping up good service contracts with contractors, suppliers, lawyers, architects, etc., for restoring normal working. Finally, all planning will be preserved in multiple copies and stored in distinctly different locations. It will be appropriate for the subject project that duplicate copies be stored aboard the plantship, ashore at the Trindad-based Administrative Office, and at corporate headquarters, presumably in Boston, MA.

12.0 PRODUCT METHANOL TRANSPORTATION

The shipping cost, Trinidad to Houston, was examined in the course of DOT contract work; chartering versus ownership was considered; barges vs tankers, size, speed and number of vessels in use were varied. It was concluded that use of a single 50,000 DWT, 15 KT tanker, was near optimum; it would carry methanol at a cost of $9.76/MT (2.93 cents/gal).

It was believed prudent that this value be validated in the course of this study, particularly since it was known that a small land-based methanol plant in Trinidad was exporting 600 T/D to the U.S. Gulf Coast at a shipping cost of 6 cents/gal (a chemical product carrier of less than 15,000 DWT is being used).

Waller Marine, Inc., marine engineers and naval architects for this project, validated shipping costs. Costs were developed on the premise that Waller would specify tanker design, have it constructed, and would subsequently charter the vessel to Yankee. Vessel cost, financing and operating information utilized in the determination of charting rates was prepared for Waller by Ocean Ships, Inc., a tanker operating company of Houston, TX. The vessel cost, $30 million, was offered by the shipbuilding division of Hyundai Heavy Industries, Co., Ltd. of Korea; they had recently constructed a similar vessel, Figure 8, for another buyer.

On the premise that 955,000 MT of methanol is moved annually, a per gallon cost of 3.2 cents was derived for the first year of plant operation. Application of an operating expense rate escalation of 5 percent per year inflates the cost/gallon to 3.9 cents in the tenth year. The charter rate computation assumed a 12 month tanker construction period, 9.5 percent construction financing and a 10 year financing period at a fixed rate of 10.5 percent. The assumed residual value of the vessel at the end of the ten year charter period was $4.9 million. Costs included in the charter rate determination are:

- hull and P&I insurance coverage
- fuel and lubricating oil
- crew and associated costs (consumables, etc.)
- port charges (pilots, docking fees, etc.)
- maintenance/repair including periodic drydocking

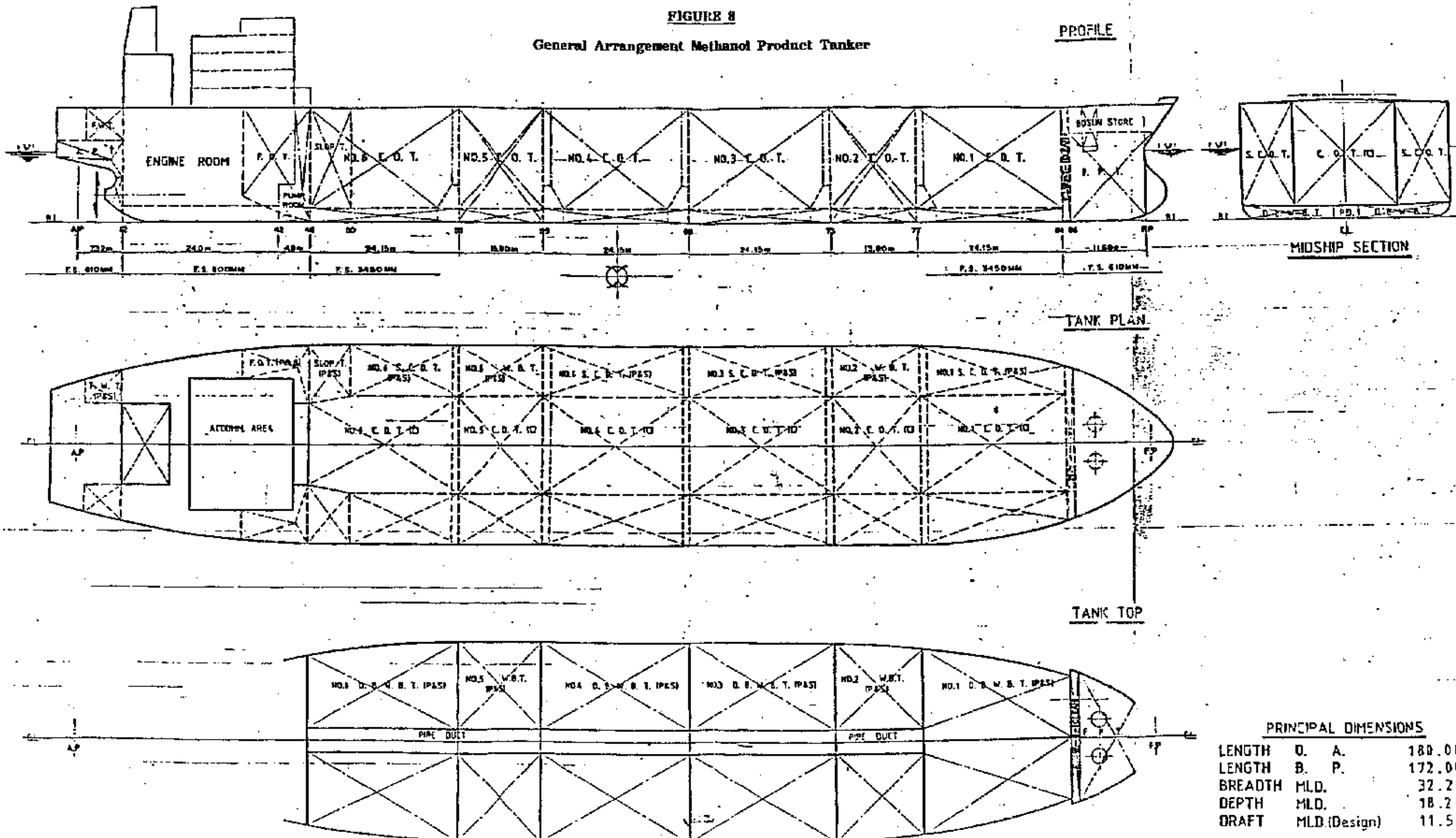
Particulars provided to Ocean Ships, Inc. by Waller Marine, and/or developed for Ocean Ships, Inc., by Hyundai were as follows:

1) Transportation of methanol product will occur from the plantship in Trinidadian waters to a U.S. Gulf Coast port. A single ship of approximately 45,000 deadweight ton capacity will be utilized. This decision is based upon the DOT transportation parametric study that demonstrated that a single ship provides lower costs than multiple ships. Transportation reliability will be achieved through spot charter of clean product vessels during planned maintenance or unscheduled downtime.

GENERAL ARRANGEMENT

FIGURE 8

General Arrangement Methanol Product Tanker



2) The ship will be dedicated to the project; it will be newly constructed with deadweight/beam/draft characteristics to suit proposed terminals and ports.

3) The ship will be foreign flag - Trinidad or Panama - and will be operated with foreign crews.

4) The ship will be time chartered for a 10 year period with an option for a further 10 years (20 years ship life).

5) Vessel's physical characteristics are:

Length O.A.	590' - 0"
Length, B.P.	565' - 0"
Breadth	105' - 0"
Depth	60' - 0"
Draft	38' - 0" (note 1)
Deadweight	45,000 M. Tons
Horsepower	10,500 Diesel

6) Operating and service parameters are:

Service speed 14 knots
Distance between ports 4508 n. miles round trip
Voyage time 16.4 days round trip
Port time 3 days
Utilization 350 days/year
Fuel usage (transit) 31 m. tons/day, IFO 180
Fuel usage (port) 23 bbl/day, diesel
Crew size 25 persons

Note 1 - Port specifics: Allemania, LA - 40 ft draft; fresh water
Beaumont, TX - 40 ft draft; salt water
Wilmington, NC - 37 ft draft; fresh water

Port costs: $15,000 in each LA and TX; $17,000 in NC. (All costs are estimates provided by the product shipping department of Tenneco.)

13.0 PROJECT SCHEDULE

Figure 9 presents the design, construct, and deployment schedule for the methanol plantship; the figure is excerpted from the Phase II Final Report of the DOT plantship study. In the course of the TDP study, major in-depth review was made of significant controlling elements of the project. Spantime remains 40 to 44 months from the first commitment of financing to pre-contract engineering (the period in which system design is advanced to the point of readiness for offer to subcontractors for the purpose of obtaining fixed price tenders) until plantship commissioning/start-up of methanol production operations. Paragraphs to follow address schedules for critical events.

13.1 PRE-CONTRACT ENGINEERING

The following detail covers the engineering and model testing activities that are be necessary to produce the definitive design required to obtain a firm fixed price for construction of the vessel, including vessel and cargo related systems, accommodations and electrical power generation. The work assumes that the current vessel concept, dimensions and arrangement remain basically the same only to be modified in form, structurally and system-wise, as the detail design work and the interfaces between ship and plant components dictate.

1) Finalize exact plant arrangement in cooperation with Davy McKee, cqmplete with component and module dimensions, pipe sizing and runs of all interconnecting piping.

2) Obtain module and component working loads from Davy McKee for structural support design.

3) Carry out complete structural determination for vessel including component loading, longitudinal strength, stiffness between plant modules, mooring loads and turret support structure. Produce structural details accordingly, so that exact steel weight determination can be made.

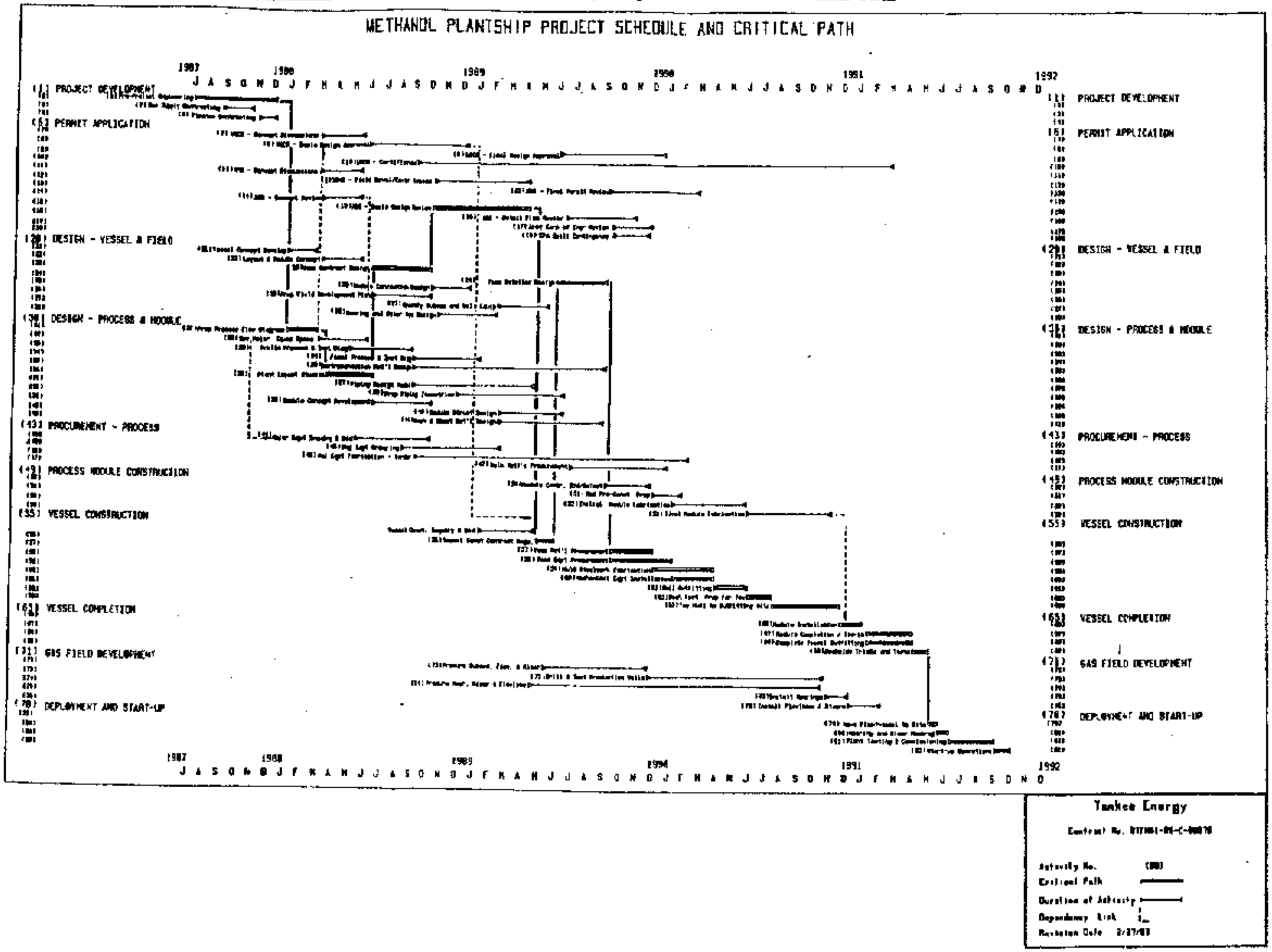
4) Finalize sizing and detail of the following piping systems, including specification of all materials, valves, pumps and instrumentation:

   Bilge and ballast system
   Cooling water system
   Fire and general service
   Diesel fuel system & lube oil
   Potable water & boiler feed water
   Sanitary waste systems
   Inert gas system
   Cargo/product storage and discharge systems

5) Redefine and complete detail design of vessel ventilations, tank venting and sounding systems including instrumentation.

FIGURE 9

Methanol Plantship Project Schedule and Critical Path



6) Review DOT model test data and extrapolate to site water depth. Reassess hull weights and physical characteristics, producing constant draft conditions for further testing and analysis. Run additional tests with modified hull form for reduction of mooring forces and motion.

7) Produce drawings and specifications necessary to solicit bids from mooring system contractors; evaluate bids and make recommendations to Yankee; assist negotiation of contract. Define mooring loads to the degree that a final mooring system can be designed comprising required production features, turn-table, swivels, chains, pilings, deployment methodology, etc.

8) Finalize electrical demand requirements with Davy McKee and design power generation system, including diesel generator components, heat recovery, power distribution, motor control centers, etc.

9) Complete accommodation package, including furnishings, safety systems, communications, etc.

10) Produce all drawings and complete specifications for submission of design package to shipyards for bid purposes.

11) Submit design drawings to Lloyds' Register of Ships for their review and approval as being in compliance with Class rules and international standards.

The price to accomplish this work is $450,000. The required span time is six to eight months, the final figure to reflect requirements for and availability of model test facilities, also, the readiness of interface partners to freeze design requirements.

13.2 PROJECT MANAGEMENT, PLAN APPROVAL, SUPERVISION

Premise is made that construction of the methanol plantship structure will occur in Korea or some other Far East shipyard after award of a negotiated fixed price contract. The construction project shall entail the development of working drawings (by the shipyard using Waller Marine's final design and specifications), procurement of major equipment (by Waller) and construction and testing of the hull, hull systems, cargo systems and accommodation spaces. After completion of the hull in Korea, the vessel will be prepared for ocean tow in accordance with insurance underwriter's recommendations and will be towed to a U.S. Gulf Coast site where the methanol plant modules will be installed, connected and tested. At the same time, the mooring turret will be installed. The completed plantship will then be towed to site, offshore Trinidad, where the mooring/riser installations will be carried out and the vessel made ready to receive the initial supply of gas.

The foregoing activities require both technical and management support on behalf of the Owner, to assure competitive initial cost, compliance of the construction process with plans and specifications, equipment suitable for prolonged life with available spare parts and maintenance capability and compliance with underwriter's requirements. Below is outlined the work and responsibilities which would be undertaken by Waller Marine in behalf of Yankee:

1) Project Term - the period required from shipyard tender/contract review and negotiation to site completion offshore Trinidad is some 34 months; this period encompasses the following major activities:

a. Tender review and shipyard contract negotiation.
b. Plan approval and major equipment procurement.
c. Construction supervision in Korea.
d. Module and mooring turret installation in the U.S.
e. Mooring and riser completion, offshore Trinidad.

2) Activity Descriptions - the five major activities are described below:

a. Tender Review and Negotiation

The final vessel design produced by Waller Marine will accommodate the process plant design of Davy McKee and will reflect the results of model testing and performed to obtain minimum motion response and mooring loads; it shall be offered to Far East shipyards and others for fixed priced tender purposes. Responsive bids shall be evaluated by Waller and recommendations provided to Yankee. Waller shall assist Yankee in negotiation with the shipyard with respect to finalizing a construction contract.

b. Plan Approval and Equipment Procurement

The shipyard will develop detailed working drawings based upon the Waller design, for construction purposes and also for approval by the Classification Society, regulatory agencies and the Owner. Waller Marine shall receive the several thousand drawings and calculations produced by the shipyard for specific review, approval and/or comment and shall distribute such review in accordance with contract terms, to the shipyard and Owner; it shall maintain the Classification Society interface. The essence of thorough plan approval is to assure that the vessel is constructed in full accordance with the original design drawings and specifications. Concurrently, Davy McKee will also be developing final design details of the process plant components and modules. Waller shall assure that the plant module/hull interfaces are correct and shall issue such change orders as are necessary through Yankee.

Waller shall also assist Yankee in the procurement of major machinery and equipment during this period. Since Yankee and their operators will want machinery items installed with future long term maintenance, repair and spare parts support adequately considered, they will want to participate in both its selection and price negotiation. Waller shall produce purchase specifications for this activity and assist Yankee in the procurement process. Items of particular interest to Yankee will be the mooring system, diesel generators and switchgear, main cooling water pumps, heat exchangers, thrusters, methanol cargo system and accommodations for ships crew and plant operators.

c. Construction Supervision in Korea

Immediately prior to actual receipt of material at the shipyard and initiation of the construction process, Waller will provide a supervisory team of three (3) people in Korea. Their duties will be as follows (redundant, in part, to detailed inspections and design approvals, e.g., of the major pressure vessels/system components, by Underwriter and Classification Society representatives such as Lloyds' Register of Industrial Services):

- To inspect all materials entering the yard for compliance with Owner's requirements and for proper certification.
- To receive approved plans and calculations and to assure that Owner's requirements are included in the construction process.
- To interface with yard personnel including management and to coordinate with the construction contractor's engineering, planning and inspection departments.
- To inspect all aspects of the construction process and to witness the testing of components, systems and machinery.
- To interface with regulatory and Classification Society personnel during inspection and testing activities.
- To review construction schedules with responsible shipyard departments to determine timely construction and completion, also, to determine percentage of work completion for progress payment purposes, if required.
- To report to Yankee concerning all aspects of the construction process; to advise Yankee respecting acceptance upon completion of dockside trials and other delivery requirements.
- To assist in the preparation of the vessel for tow from Korea to a U.S. site, in accordance with underwriter requirements.

d. Module and Mooring Turret Installation

Upon arrival of the hull at a U.S. Gulf Coast site, provide the same supervisory team to assist in the installation of process plant modules and the pre-assembled mooring turret on the vessel. Supervision shall assure proper interface and connection of modules to hull and hull systems, regulatory body approval and general inspection, similar to the work performed in Korea. The vessel shall be prepared for the final tow to Trinidad.

e. Mooring and Riser Completion

Waller shall provide technical support in Trinidad upon arrival of the vessel at site. Such support shall include arrangement for the mobilization of equipment required to set mooring anchors, PLEM, risers and mooring chains and supervision of these activities. Technical support shall be given and shall remain on site until the moored hull is commissioned/accepted by the operating company, is operational and the first cargo is discharged.

3) Manpower and Cost - The activities outlined above span a period of approximately 34 months. Plan approval, equipment procurement and overall technical support would emanate from Waller's Houston office. A team of five people is estimated. Supervision in Korea, the U.S. Gulf Coast and at the

production site would entail 3 people. The total manpower effort is estimated at 650 man weeks. The cost, including expenses and per diem is estimated at $1,400,000.

13.3 VESSEL CONSTRUCTION SCHEDULE, PROVISIONAL

Detailed negotiations have been conducted with Hyundai Corporation for the purpose of developing an accurate estimate of plant vessel cost and construction schedule. The schedule quoted is this; it is predicated on current order book and assumes a June/July 1988 start:

	Months After Contract Signing
Contract Signing; Design Start	0
Construction Start	12-13
Keel Laying	15
Vessel Launching	18
Vessel Delivery	22-23

13.4 METHANOL PLANT

As noted in Paragraph 7, the methanol process plant of the DOT study was redesigned to accommodate site specific requirements (the gas composition in the Poinsettia field; the available coolant water temperature, 80°F versus 75°F in the DOT design), also, decisions were reached respecting improved reliability of plant operations at a remote site (most importantly, substitution of a third diesel generator, steam turbine drives and a package boiler for a 37.5 MW gas turbine generator and for electric motor drives used on the syngas circulator and oxygen plant compressors). Finally, modularization studies were performed to enable improved cost estimating and the indentification of suitable U.S. Gulf Coast plant installation vendors/sites. When the foregoing design studies had been performed and process plant design changes agreed, a close review of probable schedule impacts was performed; it was conducted in the context of expected changes to the project schedule of Figure 10. The following conclusions were reached:

-Redesign to accommodate specific water temperatures and gas qualities will have no schedule impact.

-Redesign to assure more reliable plant operations will have a salutary effect...equipment procurement lead times (and costs) for the gas turbine generator and electric motors are much greater than for a packaged boiler, steam drives and a diesel generator...but not a material one; the project critical path does not run through process plant component procurement.

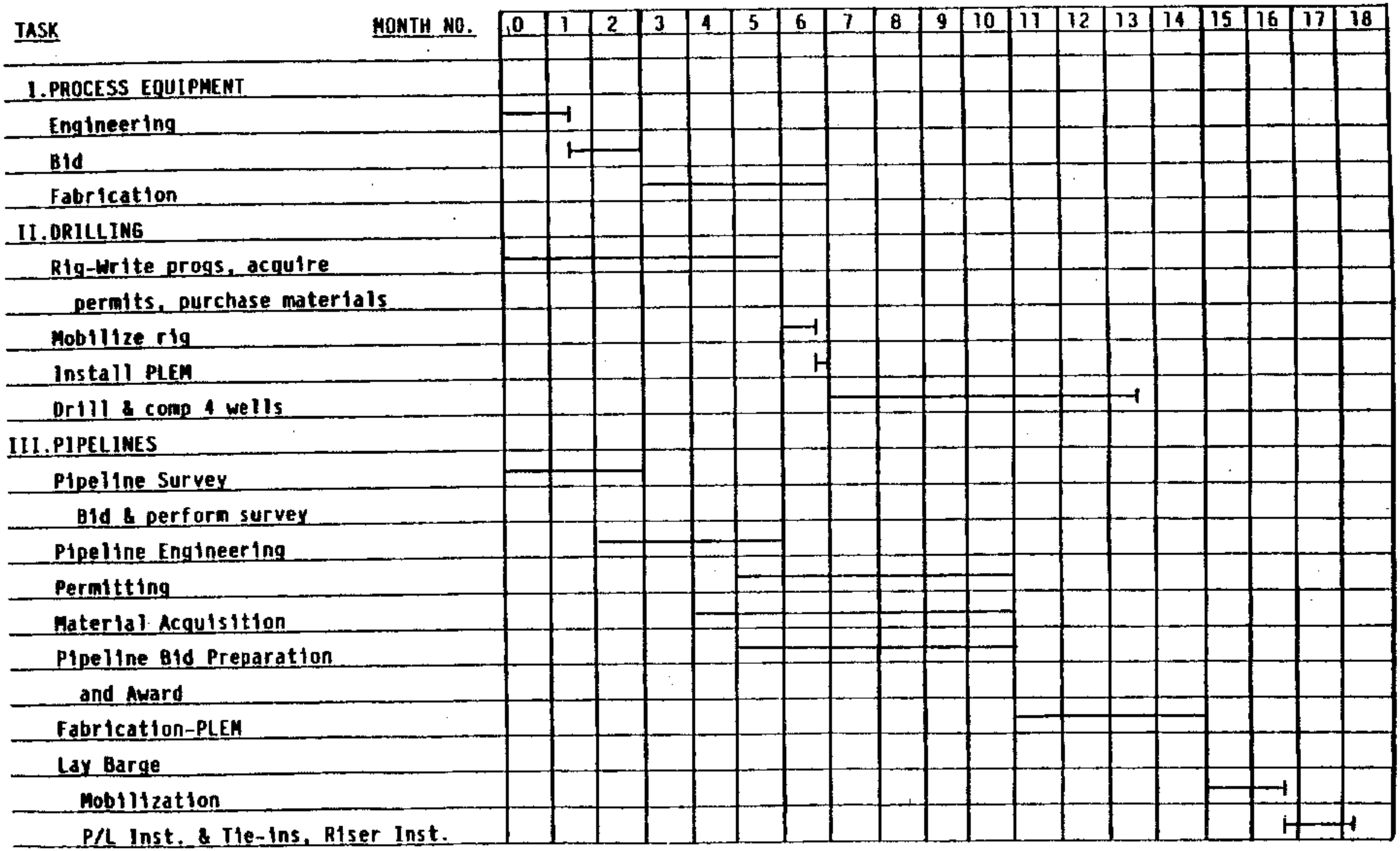
-Improved understanding of modularization and site requirements for module installation has increased confidence in prior scheduling; it provided no basis to lengthen or shorten span times made available for the modularizing of plant equipments/subsystems nor for their installation/interconnection of modules aboard the plant vessel.

The final conclusion respecting project schedule, as affected by process plant redesign effected in this TDP study, is that no basis is found to alter schedules as developed under the DOT study.

13.5 GAS FIELD/DELIVERY SYSTEM DEVELOPMENT AND INSTALLATION

The 18-month duration of the Tenneco portion of this project is detailed in the schedule of Figure 10. Development of the gas field and design, manufacture and installation of the gas delivery system are not on the critical path of the project; see Figure 10. It is only necessary that delivery system equipments which are ship-mounted be designed, procured and available for installation when the vessel is at the U.S. Gulf Coast site, also, that field development through and including riser installation at the PLEM be completed prior to the plantship's arrival on location.

FIGURE 10: - Field Development and Gas Delivery System Schedules



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14.0 PROJECT TECHNICAL ASSESSMENT

The methanol plantship systems, as deployed in the North Coast Marine Area (NCMA), Trinidad-Tobago, is comprised by equipments, sub-systems, process and operating techniques which are, at once, practiced, state-of-the-art, redundant where appropriate and conservatively applied so as to provide efficient, safe, clean, and reliable service throughout the 20 years of designed-for system life. With respect to major system elements, the following observations are warranted:

Plant Vessel - the three principal alternatives available were a semi-submersible type hull, a deep draft barge type hull, and the conversion of an existing very large crude carrier. All technical arguments support selection of the barge type hull, e.g. probability of attaining 20 year life, allowance of design flexibility for product storage and process plant alternatives selections, tolerance of stresses due to severe adverse weather, least susceptible to catastrophic consequences from involvement with other vessels. Only an extraordinary economic or operating advantage for the semi or for the conversion could possibly have called selection of the barge type hull into question - operating advantage, respecting interfacing of the utility boat and product tanker, lies equally with the barge and the converted VLCC; operating advantage respecting mooring loads and platform motion lies with the semi - as to economics, analysis shows that respecting acquisition cost, there appears little basis on which to choose; as to operating economics, there is little question that a purpose-built barge will provide a consequential cost advantage - there is little doubt that the semi and converted VLCC will require more frequent extended periods of shipyard availability (process plant unavailability/non-productivity) for maintenance and repair than will the barge.

Mooring - the selected operating site is benign, a hurricane not having visited the site in more than 100 years. The water depth for mooring is nominally 500 ft. Since mooring in this water depth is routinely accomplished even under the prevailing adverse weather conditions of the North Sea, it will be quite safely accomplished here (as has already been demonstrated by preliminary but definitive model testing).

Gas Field Development and Gas Delivery System - Again, gas field development via semi-submersibles and sub-sea completions is routinely accomplished at this water depth in the adverse operating circumstances of the North Atlantic; it has, in fact, been accomplished in the East Coast Marine Area of Trinidad-Tobago; it will be readily accomplished to accomodate the plantship. Redundancy of wells and risers provides the necessary reliability of gas supply. Gas production via plantship is, in itself, unique at these water depths (barge-mounted gas production/processing facilities are operated in very shallow water, 30 to 50 ft, in Indonesian waters). The adequacy of high pressure gaseous riser technology was initially called into question. Investigation confirmed that numerous firms can handle the pressures, even claiming a capability for non-leak swivel connections at 5000 psi (field pressure is 4300 psis). By design, however, gas flow pressure from the area floor to the ship will occur at 3000 psi; pressure will be knocked down to 500 psi before the gas transits the rotary-seal of the morring turret. Riser technology will be by COFLEXIP, a French company. Table on the succeeding pages demonstrates the readiness of this technology for application.

Gas Supply - the Poinsetta Field of the NCMA has been well defined and flow tested by the Tenneco Group; it is estimated to contain 1.1 TCF of dry, high purity (99+%) methane, imminently convertible to methanol. Only 740 BCF of gas is required in the 20 year life of the system. The NCMA, in this and other fields, contains 2.8 TCF. The Patio Field, 28 miles west and 10 miles south of the proposed operating site, is in 330 ft of water and is estimated to contain 8.0 TCF (this lies in Venezuelan waters). The plantship is readily relocated; it is apparent gas supply in this region is not to be considered a problem.

Product Tanker/Transfer Operations - Reliability of transport service will be greatest with a dedicated, long term lease, tanker; this is the selected course. Requirements for standby tanker service, when the dedicated tanker is unavailable due to routine or emergency shipyard avaibility, will be met from the 'spot' charter inventory of chemical carriers (one or more of these is in routine service of an existing land-based GOTT methanol production facility. To add reliability to the transfer operation, the storage capacity provided on each tanker and the plantship is deliberately over-sized. In theory, since round trip duration including loading and offloading is 16 days, storage capacities need only be 48000 ST. However, for the tanker and plantship they are 50000 ST and 72600 ST, respectively.

Product transfer from the plantship to the product tanker is via floating hose deployed from the plantship. A utility boat accepts the transfer hose and a mooring line from the plantship and delivers them to the tanker which stands-off at a safe distance, several hundred meters, down-wind of the plantship. This alternative is nominally equally reliable as a system which would move methanol from the plantship via pipeline and two risers to a floating moor from which the tanker would receive product; it is safer and is accessed with greater reliability in severe weather than are product transfer connections designed for side-by-side mooring of plantship and tanker (this latter system is, also, less amenable to use by the wide variety of designs in which chemical tankers are available). Finally, the side-by-side technique is not only technically inferior to the over-the-stern system, it does not prevent much, if any, cost advantage. The floating moor system is the technical equal, or nominally superior system as compared to the over-the-stern system, however, not only is it much more costly to install and operate, it is a fixed system which makes movement of the plantship to a new operating site more costly to accomplish.

In the planned operating site, availability of a utility boat for line/hose houkling is not a problem; numerous adequate boats service the offshore oil/gas industry in GOTT waters. At another operating site it might make better economic sense to own rather than charter utility boat services.

Process Plant - Briefly recounted here are the decisions reached as to the technology to be employed in conversion of natural gas to methanol; the decisions were reached based on the study of available alternatives and the associated risks involved, both real (respecting safety and reliability) and potential (respecting acquiring financing, affordable insurance, necessary permits and licenses). Major process plant technology-driven decisions were:

a) use of the I.C.I. methanol synthesis process - efficiency and system size/weight; single stream capacity to at least 3000 STPD (used in 75% of worldwide methanol production)

b) use of CPOX for syngas production - safety, flexibility respecting feedstock, physical size, simplicity of design, water use

c) tube cooled methanol converter - low catalyst volume, simple and reliable design, useful at greater than 3000 STPD

d) packaged boiler - reduced requirement for mechanical skills and spares; reduced size (weight and ? area); elimination of a very high voltage system (13,000 volts), a safety consideration; improved maintainability

e) packed bed distillation columns - most tolerant of ship motion/acceleration

15.0 CONCLUSIONS

It has been the purpose of this grant to make findings as to the technical feasibility and commercial viability, hence, the financing feasibility of a methanol production facility aboard a plantship designed specifically for operation in the offshore waters of Trinidad and Tobago.

Now that the study under this grant has been completed, it will be necessary to make a formal presentation to the appropriate ministers and government officials of Trinidad and Tobago in order to formalize the tax conditions including tax holidays their government is ready to accept (see Appendix H for terms and conditions of investment policies in effect in August 1987). Once agreements in principle have been reached, the project can then proceed with its gas purchase agreements and product purchase agreements. An agreement for the price of the gas with Tenneco and its partners would permit the project's management to take the final steps to complete its previous negotiations with the product taker(s); an agreement with the product taker(s) hinges on a floor price for the methanol which would be acceptable to the methanol purchaser(s) and at the same time satisfy the investors and lending institutions.

The study did develop a range of price for the gas of $0.50 to $1.00 per MCF contingent upon certain variables such as Trinidad and Tobago tax concessions, the financing terms and conditions of the sub-sea development and its possible inclusion in the total project financing structure.

Based on the work of the co-sponsors, Tenneco Oil Company and Yankee Energy Corporation; major subcontractors, Bank of New England, Davy McKee Corporation, Waller Marine, Inc., Mays Associates and Homeport Associates; and, tax advice (as described above) from Arthur Young and Company and its affiliate, the following conclusions have been substantiated:

1) A methanol plantship project at the Poinsettia Field, on the north shore of Trinidad-Tobago, is technically feasible and is advantageous respecting considered alternatives when it is designed as described here-in; key features must include:

    a) a deep draft barge type hull of specific design and new construction

    b) a 3000 STPD capacity CPOX/ICI single stream process plant incorporating steam and diesel electric prime powers systems

    c) mooring and gas production systems which use establised means and proven hardware, similarly respecting product methanol storage and transfer means

2) A methanol plantship project as defined above is commercially viable. Specifically:

(a) Natural gas reserves at the operating site, based on sound engineering practices, contains sufficient recoverable natural gas to meet the needs of the plantship for a twenty year period of operation. The price for the natural gas is expected to be in the range of $0.50 to $1.00 per MCF.

(b) World chemical grade methanol markets are growing at a 4.5 percent annual rate; at this rate, new markets will exist for the product of 3 plantships by the time this project can be on-line, 1992. The foregoing forecast ignores the even faster growing (from a smaller base) fuel methanol market. The U.S. methanol market is expected to require approximately 2,000,000 MT of imports (about 2 plantships) with total demand slightly more than 5,000,000 MT in 1992.

(c) The methanol from this Trinidad project can be moved to the Gulf and East Coast markets for about 3.2 cents per gallon; to the West Coast for 6.7 cents per gallon, very reasonable and competitive transportation costs (as compared to transportation from competing offshore sources, e.g. distances are approximately 3 times longer from southernmost Chile and Saudi Arabia to the eastern U.S.).

(d) methanol from Trinidad-Tobago is imported duty free; chemical grade methanol from non-Caribbean, non-LDC designated countries is subject to an 18.8 percent ad valorem tax.

3) The financing of the methanol project characterized technically and commercially in the preceding paragraph 1. and 2. is entirely feasible, once the long term agreements for the natural gas and the methanol have been concluded.

(a) Capital requirements are $354,641,000. The U.S. Export Import Bank is expected to finance 80 percent of the export value of U.S. labor and materials, or $143,979,000. The Korean Export Import Bank is expected to finance $45,000,000.

(b) debt outstanding at the start of operations has been estimated at $263,027,000, assuming the entire contingency equipment reserve of $22.5 million has been spent.

(c) a reasonable internal rate of return of 16% is achieved for the base case of $.35/gallon methanol and $.50/MCF natural gas; such a rate is deemed sufficiently attractive to secure the equity requirements of $91,661,000. The cash flow to debt service ratio varies from 1.31 to 3.48 with an average of 1.7.

(d) the break even cost of methanol (i.e. no return to the equity owners and a cash flow to debt service ratio of 1.0) is 24.6 cents/gallon the first full year of operations and 20.1 cents/gallon the tenth year of operation for an average of 23.6 cents/gallon for $.50/MCF feedstock price.

(e) the risk profile for the project, e.g. market risk protection with a floor price, construction phase risk protected with fixed price turn-key contracts, operational phase risk protected with business interruption insurance, technical risk protected by guaranties from Davy McKee as technology supplier and potential operator, political risk protected with OPIC coverage, and other risks have been evaluated by Yankee and its team. It is believed that all risks can be adequately protected by a skilled and experienced management with: 1)insurance and 2) careful contract negotiations.