METHANOL PLANTSHIP

Implementation Study

Cost Shared by

TRADE DEVELOPMENT PROGRAM
of the
UNITED STATES DEPARTMENT OF STATE
WASHINGTON, D.C.

And by Co-Sponsors

YANKEE ENERGY CORPORATION
80 BOYLSTON STREET
BOSTON, MA 02116

and

TENNECO OIL COMPANY OF TRINIDAD, INC.
1100 LOUISIANA STREET
HOUSTON, TX 77200

Appropriation #72-1171001
July 30, 1988

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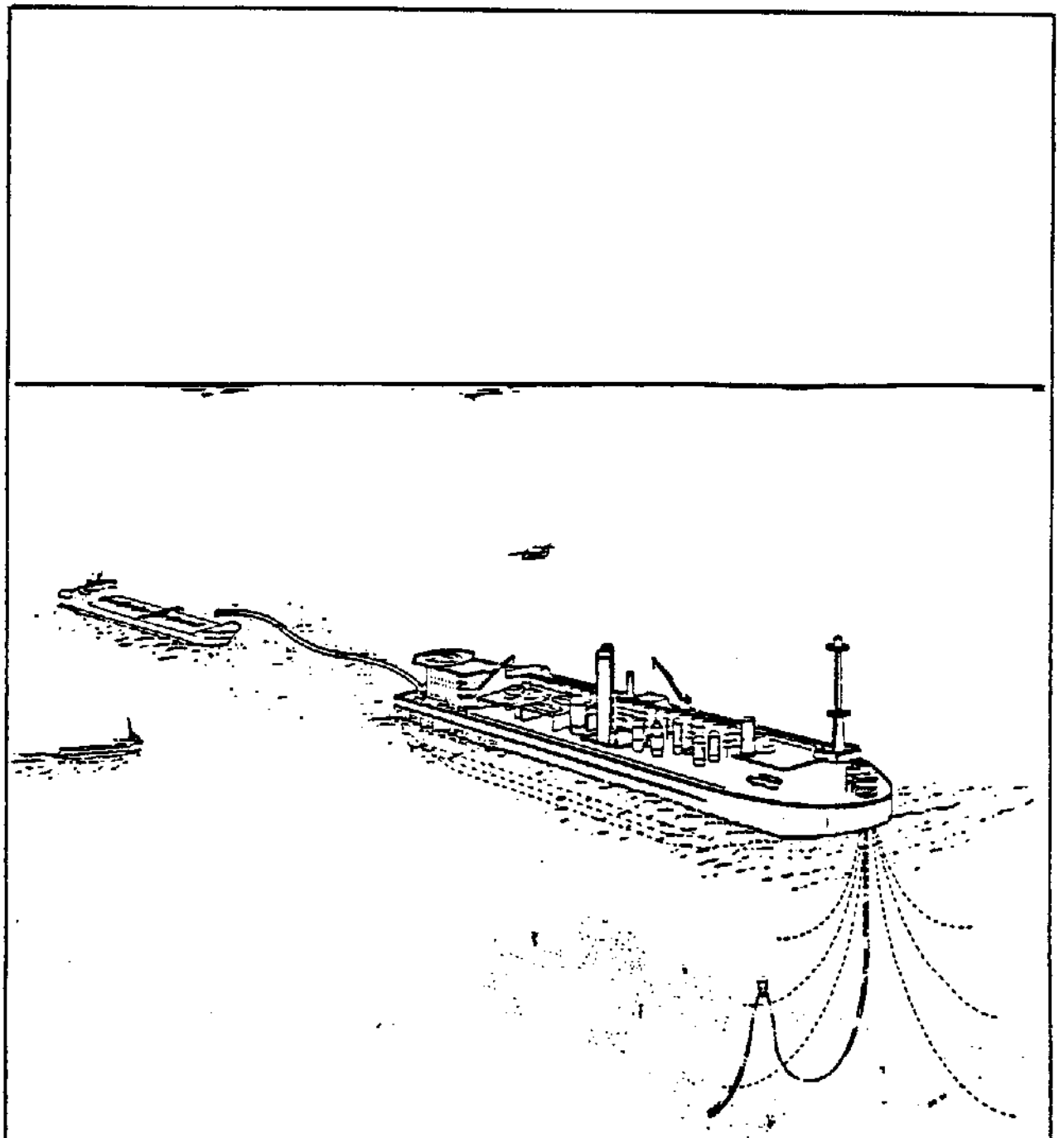


FRONTISPIECE: FLOATING METHANOL PRODUCTION SYSTEM

EXECUTIVE SUMMARY

On May 1, 1987, a reimbursable grant (appropriation #72-1171001) was awarded to Yankee Energy Corporation and Tenneco Oil Company of Trinidad, Inc. by the U.S. Trade and Development Program under its charter from the International Development Cooperation Agency of the U.S. Department of State.

The grant was funded as a result of a proposal by Yankee Energy Corporation dated August 28, 1986 describing a project off the north shore of the island of Trinidad for a proposed floating plantship to produce methanol from non-producing natural gas reserves originally discovered by Tenneco Oil Company of Trinidad, Inc. and its partners more than 10 years ago.

Yankee Energy Corporation was designated the project managing co-sponsor with responsibilities of project administration, accounting, subcontractual management, etc.

The project consisted of Yankee's developing the economics, commercial and financing requirements of a floating plantship with a production capacity of 3,000 tons per day of methanol; Tenneco Oil of Trinidad, Inc. as co-sponsor was to furnish the data needed to determine the design and associated cost to develop the estimated reserves into a producing natural gas system with all the required sub-sea installation to bring gas of sufficient volume to meet the plantship needs for at least 10 years.

Yankee Energy Corporation retained the Bank of New England as its financial adviser; the Bank of New England prepared the detailed financial plans for the Project and has assisted in discussions with the U.S. Export Import Bank, the Korean Export Import Bank, the World Bank, and the I.F.C.

Arthur Young and Company and its affiliate were retained to advise Yankee Energy Corporation on income tax matters pertaining to Trinidad and Tobago and on the influence of U.S. taxes on the project.

Gray and Wendell of Boston, MA was retained as Yankee Energy Corporation's legal advisor.

Thomas Sears of Boston and Price Forbes of the Sedgwick Group, London were the advisers to Yankee Energy Corporation in the area of insurance coverage and general underwriting matters.

The methanol plantship is a plant capable of producing 3,000 short tons per day of chemical grade methanol installed on a barge. The process equipment will be manufactured in the USA; it will be assembled and mounted on the floating barge at a site on the U.S. coast of the Gulf of Mexico. The barge, most probably built in Korea, will measure about 780 feet in length, 200 feet in width, have a draft of 55 feet and a displacement of 180,000 long tons. When operating it will be moored in approximately 500 feet of water about 30 miles north of Trinidad over a currently non-producing natural gas field. The

exploitation rights for this natural gas is held by a group headed by Tenneco, the co-sponsor of this project. The reserves are adequate to produce for a period of 20 years approximately 100 million cubic feet/day of natural gas; gas will be delivered to the plantship to serve as feedstock for conversion to methanol at a rate of 3000 STPD. Interim methanol storage will be aboard the plantship. Offloading to a dedicated product tanker will occur on a bi-weekly basis; product will be transported to the United States for delivery to one or more "takers" who are party to long-term, variable rate, methanol "take" agreements with a floor price.

The estimated costs for the project are as follows:

Natural Gas Field Development	$48	-	61 MM
Plant Process Equipment	118	-	150 MM
Barge	77	-	84 MM
Pre-Operating Costs			37 MM
Financing Costs			65 MM
Contingencies and Reserves			49 MM
Total	$394	-	446 MM

Pro-forma computations on plantship expectations (see paras. 4.1.5 and 4.1.6) have been made using several scenarios; the base case is shown below:

- Gas cost - 50 cents/MCF and $1.00/MCF
- Methanol - 35 cents/gallon
- Natural gas field development paid by others.
- Equity 91 MM
- Ex-Im Bank (US and Korean) debt financing
- Tax rate (U.S.) Federal 34% Average State 4-8%
- Operating costs (annual) $15 MM, (excluding feedstock)

Tax rate does not include Trinidad taxes. Such taxes may potentially be relieved by fiscal incentive legislation or otherwise through negotiation. For discussions of Trinidad taxes in general see Section 3.

The internal rate of return for this base case is 16% for the $0.50/MCF case and 6.73% for the $1.00/MCF case. (Royalties and taxes are included in the gas cost).

Financing of the project exclusive of the gas field development is expected to be from the following sources:

	Construction Period		Operating Period	
U.S Export-Import Bank	$144.0	40%	144.0	40%
Korean Export-Import Bank	45.0	13%	45.0	13%
Commercial Banks	166.0	47%	75.0*	21%
Equity	0	0%	91.0	26%
	$355.0	100%	355.0	100%

* This assumes the entire $22.5 million contingency construction contruction reserve is spent during the construction period. Any unspent contingency will reduce the commercial loan amount.

World market projections made by independent groups are now in consensus that supply and demand for methanol will come in balance in the early 1990s even with the new output expected from Chile during the latter part of 1988. The reasons for this forecast of balanced supply and demand are:

1) six existing US methanol plants, now moth balled representing more than 2,500,000 tons annual capacity are generally not expected back on stream because of the relative high expense to reactivate. Tenneco, however, did announce plans that it will restart its plant of 390,000 tons annual capacity in the fall with a significant portion of the methanol being shipped to Europe.

2) an expected increase in demand both in Western Europe and the U.S.A. for MTBE as a gasoline oxygenate because of the leaded gasoline phase out and the mandated state and federal regulations for lower levels of ozone and NOx in certain areas of the country, and

3) a continuing growth in world demand for methanol by the chemical industry, 4.5% per annum, based on the assumption that the world GNP will continue to grow at a positive rate.

In the case of US methanol demand, estimates by Chem Systems* show that US consumption will necessitate the annual importation of approximately 5 million MT by the year 2000. This equals 5 times the annual output of the plantship proposed. As the earliest that plantship production can occur is 1992 (assuming all financial agreements are completed by late 1988), it is expected that World demand and supply will at that time be in balance and that methanol prices will be rising to reflect an increasing supply shortage.

Methanol imported to the United States is subject to restrictions (duties) in specific instances. Specifically, methanol imported for use as a chemical feedstock is dutiable at 18.8% ad valorem when imported from non-Caribbean and non-qualifying non-LDC nations. Methanol for use as a fuel or as a fuel additive is not subject to import duties irrespective of country of origin. The foregoing means that the methanol to be produced by this project will not be subject to import restrictions, either because it is from the Caribbean, or, because it is intended for fuel use (John Hurley, Tariff Classification of U.S. Custom Service; 6/3/88).

A proposed organizational structure consists of Yankee Energy Corporation, a U.S. corporation, which will form in the Cayman Islands a marketing company and a separate operating company. The marketing company will purchase the plantship and subsequently transfer it to the operating company which will conduct a branch operation in Trinidad. Processed methanol will be sold by the operating company to the marketing company which will then sell the methanol to U.S. consumers.

* Chem Systems, Inc. Sept. 1987 "A briefing paper on methanol supply/demand for the United States and the impact of the use of methanol as a Transportation Fuel. Prepared for the American Gas Association.

U.S. corporations with no offshore activities would be taxed in the U.S. on income received on the investments. These investors also would be able to take advantage of the foreign tax credit with respect to any foreign taxes paid on the income. Additionally, the infusion of foreign source income may enable these investors to utilize carryover tax credits.

The project could have off-shore investors in the marketing company. The choice of U.S. investors and the level of off-shore investment will be made only after the U.S. participation level is known.

The selected methanol manufacturing process is that known throughout the chemical industry as the I.C.I. (Imperial Chemicals Industry, Ltd.) process. Approximately eighty percent of world methanol production capacity (about 25 million tons/year) uses the I.C.I. process. The I.C.I. process is selected over other methanol production processes because of reliability, efficiency, feedstock adaptability and because economy of scale in single train plants is realized only with the I.C.I. process at the intended 3000 STPD plant size.

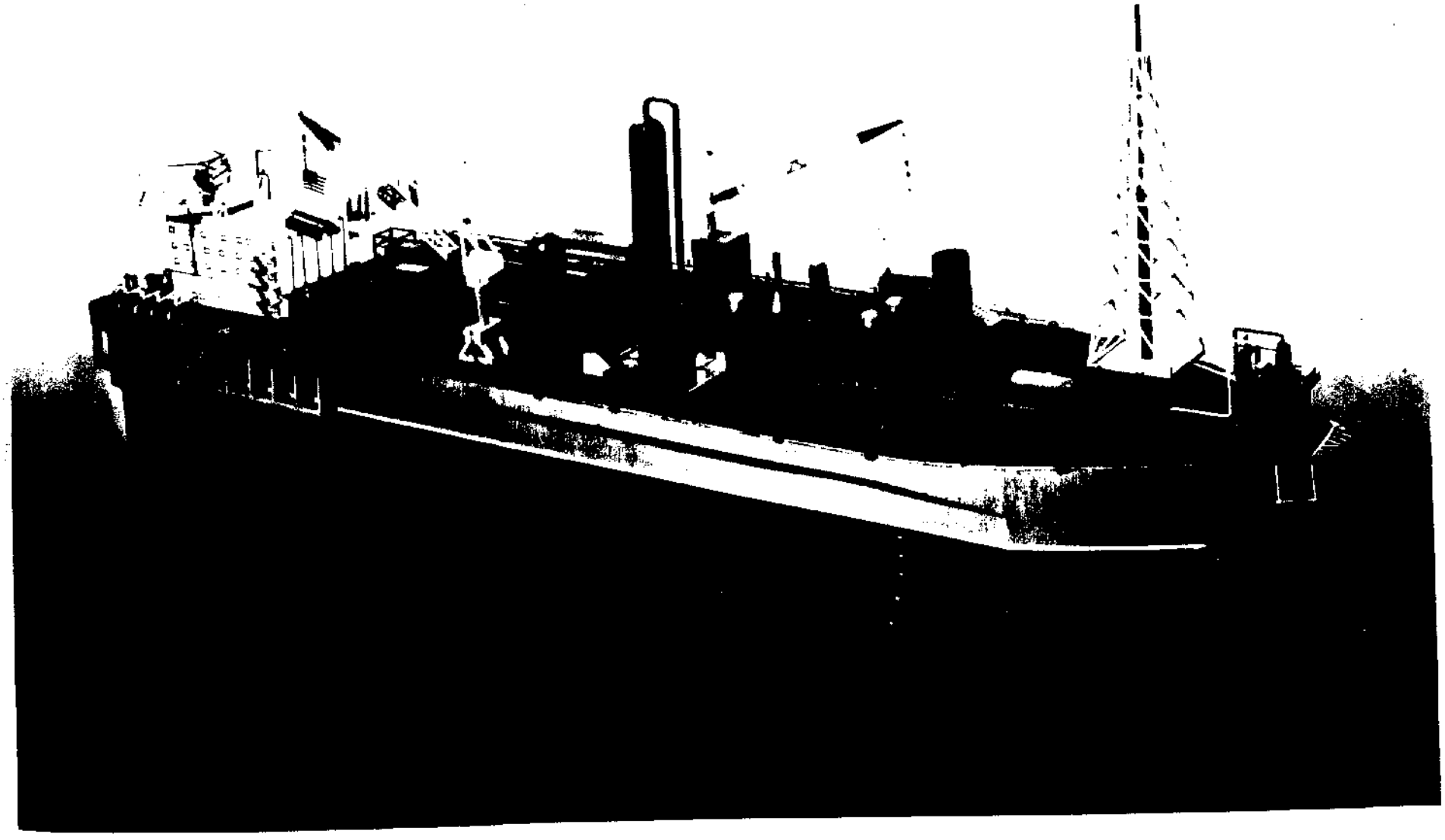
For security of supply, four wells are manifolded together on the ocean floor; any three will meet plant requirements for gas. Four separate risers provide reliability via redundancy of delivery paths; for assured continuity of availability, each riser will be replaced twice in the course of system life.

Since the cost of the feedstock translates into the cost of methanol at a ratio of approximately 10:1, it has been a major goal of methanol producers to have access to low cost natural gas. It is indeed exactly such an incentive to have access to low priced gas which has seen new methanol plants being constructed in Chile, Malaysia, Burma, Saudi Arabia, etc. and the "moth-balling" of U.S. methanol plants where $1.80 per MCF natural gas converts to approximately 18 cents per gallon methanol before any debt repayment, depreciation, operating and maintenance, etc., are accounted for.

In negotiations between Yankee and Tenneco to determine a suitable price for this gas, factors considered included the subsea gathering costs, operating costs, and various indirect costs imposed by the GOTT such as employment taxes, taxes on interest, etc. It is these indirect costs imposed by the GOTT that are difficult to determine until a formal application is made to waive them as provided by the present 10 year tax holidays offered on new projects. This discussion cannot be held until the project is fully defined and funded. Consequently, a range of price for the gas has been developed for this study that extends from $0.50 to $1.00 per MM BTU.

The low range will require the concession of all taxes as offered while the higher range assumes that the project will need to meet all payments as they presently stand.

Tenneco and its partners would make the required investment for the development of the gas field including the drilling, under-sea pipelines to PLEM shut off valves, and risers and instrumentation described in section 9.0 of this report. Tenneco would deliver natural gas at a minimum of about 100 million cubic feet per day, for at least 10 years, with adequate allowances to permit periodic maintenance.



METHANOL PLANTSHIP

Production: 3000 STPD		Displacement:	180,000 T
Length: 780 FT	Draft: 55 FT	Width:	200 FT

1.0 INTRODUCTION

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The site specific project was a direct outgrowth of a previous generic evaluation also made by Yankee Energy Corporation for the U.S. Department of Transportation under contract DTFH-61-85-C-00076.

Yankee Energy Corporation was designated the project managing co-sponsor with responsibilities of project administration, accounting, subcontractual management, etc.

The project consisted of Yankee's developing the economics, commercial and financing requirements of a floating plantship with a production capacity of 3,000 tons per day of methanol; Tenneco Oil of Trinidad, Inc. as co-sponsor was to furnish the data needed to determine the design and associated cost to develop the estimated reserves into a producing natural gas system with all the required sub-sea installation to bring gas of sufficient volume to meet the plantship needs for at least 10 years. These objectives for the study are met in the sections to follow.

The project was to also include an analysis of a similar revenue generating plant located on-shore in order to compare profitability levels. This comparison is presented in Section 5.0; the plantship approach is the preferred means for methanol production.

The project was completed despite unforeseen events beyond Yankee Energy Corporation's control; specifically, the government of Trinidad and Tobago experienced a major change following elections in 1986, with the consequences of resignation by several ministers who were familiar with the plantship concept. This discontinuity was further compounded by the reassignment of ministerial departmental responsibilities in an effort to rationalize the governemntal bureaucarcy. The other major unforeseen circumstance was that co-sponsor Tenneco make the decision to sell its entire worldwide oil and gas properties in May 1988.

These unforeseen events did not alter the conclusions and recommendations of the study, Section 15.0. They will, however, have a delaying effect on the finalization of a gas purchase agreement under which the project can go forward, at least until the new owners of the gas field are known and royalty negotiations can be held with the responsible authorities in the Government of Trinidad and Tobago.

2.0 PROJECT DESCIPTION

The methanol plantship is a plant capable of producing 3,000 short tons per day of chemical grade methanol installed on a barge. The process equipment will be manufactured in the U.S.; it will be assembled and mounted on the floating barge at a site on the U.S. coast of the Gulf of Mexico. The barge, most probably built in Korea, will measure about 780 feet in length, 200 feet in width, have a draft of 55 feet and a displacement of 180,000 long tons. When operating, it will be moored in approximately 500 feet of water about 30 miles north of Trinidad over a currently non-producing natural gas field. The exploitation rights for this natural gas is held by a group headed by Tenneco, the co-sponsor for this project (see Figure 1). The reserves are adequate to support the project with approximately 100 million cubic feet/day of natural gas for 20 years; gas will be delivered to the plantship to serve as feedstock for conversion to methanol at a rate of 3000 STPD. Interim methanol storage will be aboard the plantship. Offloading to a dedicated product tanker will occur on a bi-weekly basis; product will be transported to the United States for delivery to one or more "takers" who are party to long-term, variable rate, methanol "take" agreements with a floor price.

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Pre-Operating Costs	37 MM
Financing Costs	65 MM
Contingencies and Reserves	49 MM
Total	$394 -446 MM

The entire output of the plantship will be sold to the U.S. market under a long term off-take agreement with a major U.S. company.

Pro-forma computations on plantship expectations (see paras. 4.1.5 and 4.1.6) have been made using several scenarios; the base case is shown below:

- Gas cost - 50 cents/MCF and $1.00/MCF
- Methanol - 35 cents/gallon
- Natural gas field development paid by others.
- Equity 90 MM
- Ex-Im Bank (US and Korea) debt financing
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Financing of the project exclusive of the gas field development is expected to be from the following sources:

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Equity	0	0%	91.0	26%
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* This assumes the entire $22.5 million contingency reserve is spent during the construction period. Any unspent contingecy will reduce the commercial bank loan amount.

2.1 BONA FIDES OF PROJECT PARTICIPANTS

This section identifies those who have rendered expert legal, financial and tax counsel to Yankee Energy Corporation; it also presents the bona fides of participants to the study who are expected to continue in a co-sponsor or a subcontractor role in the development, construction and deployment phases of the project.

2.1.1 ADVISORS AND EXPERT COUNSELORS TO THE PROJECT

Yankee Energy Corporation retained the Bank of New England as its financial advisor; the Bank of New England prepared the detailed financial plans for the Project and has assisted in discussions with the U.S. Export Import Bank, the Korean Export Import Bank, the World Bank, and the I.F.C.

Arthur Young and Company and its affiliate were retained to advise Yankee Energy Corporation on income tax matters pertaining to Trinidad and Tobago and on the influence of U.S. taxes on the project.

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Thomas Sears of Boston and Price Forbes of the Sedgewick Group, London, were the advisors to Yankee Energy Corporation in the area of insurance coverage and general underwriting matters.

2.1.2 PROJECT DEVELOPMENT TEAM/RESPONSIBILITIES

Although not all decisions reached so far are final, Yankee Energy expects to have the following structure for project management purposes.

During the development process phase, the staff structure will be relatively small, but it will be assisted by outside legal, financial and tax counsels already familiar with the project. Also during this phase, the staff will be gradually increased to the required size for the following phase.

During the construction phase, Yankee Energy expects to have a project staff of approximately 20 people; their responsibility under the authority of the project manager will be to assure as complete a coordination as possible between the following groups:

a. Davy McKee is expected to continue its role as the principal process engineer and module designer including the preparation of plans and specifications for bid requests to be sent to a general contractor. Davy McKee will have as part of their overall contractual process plant responsibilites, the procurement of the process plant components.

b. Waller Marine is expected to continue its role as the principal naval architect. As such, it will be responsible for the shipyard bid request consisting of plans and specifications for the barge and, subsequently, for supervision of barge construction and classification coordination. The construction contract will be negotiated by Yankee Energy with the assistance of Waller Marine for a lump sum in US dollars guaranteed delivery date with a penalty/bonus clause. In addition, Yankee Energy will use its best efforts to include in the lump sum price, the cost of towing the barge to the Gulf of Mexico where the process modules are expected to be installed.

c. Yankee will employ a general contractor such as Brown & Root, McDermott, Kellogg, Davy McKee or similar organization of sufficent size and experience for construction of the process modules, their installation on the barge with required interconnecting, the testing of the plant prior to delivery and a guaranty of the process plant performance. Yankee Energy is expecting to negotiate such contract on a fixed price lump sum basis, with a guaranteed delivery date and appropriate damage for failure to perform on time and/or to pass a contractual performance test.

d. Yankee will select an oxygen plant supplier; the oxygen plant represents a major portion of the cost of the process plant. Specifications for the oxygen plant will have been written by Davy McKee and Waller Marine (for structural integration purposes) and the bid replies will be evaluated by Yankee Energy with the assistance of both the above companies. This contract is also expected to be of a lump sum type. The oxygen plant may be procured as an international tender.

During the operating phase, Yankee Energy will have a staff which by necessity will again have a different structure. See section 3.

2.1.3 MARINE ARCHITECT-ENGINEER

Waller Marine is a full service, diversified marine support organization that has integrated the talents of dedicated professionals into a single source. In a difficult and competitive market, Waller Marine has prospered since 1974 by seeking out difficult and unusual projects and performing them successfully. The cumulative experience of the professionals at Waller Marine covers the entire range of marine design, construction and project management in a broad spectrum of projects.

DESIGN

The company's design capabilities cover a broad range of activities from traditional naval architecture to practical construction support functions. Waller Marine has designed vessels for the marine transportation industry - tugs, barges, tankers, cargo ships, passenger vessels and heavy lift ships, both for ocean and intracoastal waterway service. Similarly, the company has designed equipment for the offshore oil industry - supply and utility vessels, derrick barges, support barges, production platforms, and floating and jack-up drilling units. All designs have met domestic and international regulatory standards for construction, pollution abatement and safety of life at sea.

PROJECT MANAGEMENT

The company provides a project management role on behalf of owners not having in-house engineering staffs. In such cases, Waller Marine acts for the owner in the planning, costing and implementation of a wide variety of projects: -

-The design, plan approval and construction supervision of integrated tug-barge units in Spain.

-The plan approval and construction supervision of a series of 37,500 dwt product tankers, constructed in California.

-The salvage, reflagging and reconstruction of a heavy-lift ship for U.S. owners.

-Production of specifications for dry docking and special survey of a variety of vessels including issuance of purchase orders, maintenance of budgets and supervision of work.

-Identification, survey, negotiation and commitment for purchase of vessels and marine equipment for owners.

CONSTRUCTION

Waller Marine's experience encompasses the design and actual construction of vessels. At one time, ship construction projects were completed at the company's own facilities in Texas. Recent construction projects have been managed by the company in facilities owned by others. A relatively wide range of vessels have been constructed by Waller Marine: -

- Fishing vessels for Gulf of Mexico shrimp, Alaskan king crab and East Coast clams and scallops.
- 10,000 BBL river chemical barges for hazardous materials.
- Utility vessels for the offshore industry.
- Early oil production vessel for Central America.
- Production platform for the Gulf of Mexico.
- Oceanographic vessel for Pacific service.

Construction of various marine equipments has also been part of Waller Marine's role; these have included ramps and door for car carrier, pipeline end manifolds, also, swivel pilings for offshore production and complete offshore mooring systems.

2.1.4 PROCESS ENGINEER

Davy McKee is part of Davy Corporation, the international engineering company which provides project management, undertakes engineering and construction, and provides equipment and services for a wide range of process industries. Davy has establishments in 15 countries and employs a permanent work force of over 10,000 who work on a multiplicity of projects, large and small, throughout the world.

Davy McKee is a technology company which undertakes plant design and manufactures specialized equipment. The company offers a wide range of expertise covering the oil and gas, chemical, nuclear, iron and steel, mining and minerals, precious metals, food and pharmaceutical and fertilizer industries.

More than 40% of total world methanol capacity installed or contracted since 1967, and an unparalleled 60% of the I.C.I. methanol process plants, has been backed by Davy McKee experience.

METHANOL PLANT EXPERIENCE

Engineering Company	Percentage of World Capacity Ordered Since 1968	Ordered Capacity (STD)
*Davy	42.5	28,240
Lurgi	22.9	15,200
*Uhde	8.5	5,665
*Humphreys & Glasglow	6.0	4,005
*Chemico	4.7	3,100
Mitsubishi Gas Chemical	4.5	2,960
*Allarco	3.6	2,400
*I.C.I. Engineering	2.2	1,530
Toyo	2.0	1,320
*Kellogg	1.6	1,100
*Technip	1.0	600
*Lummus	0.5	310
	100.0	

*I.C.I. Methanol Process

Some of the factors which have enabled Davy McKee to attain such an unrivaled reputation are:

a) Well Proven Technology

Davy McKee uses the Imperial Chemical Industries Low Pressure Methanol Process. Since its introduction in 1967, the I.C.I. low pressure process has accounted for more than 70% of the world's new plant capacity.

b) Unparalleled Large Plant Design Experience

Davy McKee has the most experience worldwide in the design, engineering and procurement of equipment for complete methanol production facilities with production capabilities in excess of 200 tons per day.

c) Excellent Plant Availability and Productivity

Data on long term availability on many of the methanol plants tends to be closely guarded for commercial reasons. However, data available shows that over the long term plant production availability exceeds 97%, an impressive record. The mechanical integrity and overall quality of Davy McKee designed units is demonstrated by this availability achieved on their plants in the first year of operation. Productivity figures of greater that 100% of nameplate have been quoted.

d) Low Energy Consumption

On each Davy McKee plant design energy consumption is critically examined on a cost effective basis with other factors such as plant availability, operational flexibility and reliability. Typically, total feedstock and fuel consumptions are in the range of 26.0 to 27.5 mm Btu per ton of refined methanol product.

e) Ease of Operation

Davy McKee design engineers have thorough knowledge of all aspects of methanol plant operation, from water and gas treatment through synthesis gas production to final product loading. A Davy McKee designed plant ensures ease of operation, not only during normal operation but through all stages of startup and shutdown conditions.

f) Minimum Environmental Impact

Effluents emitted by the plant are minimal and are controlled to meet the most stringent applicable regulations.

g) New Developments

Davy McKee is now introducing the revolutionary CPO technology for synthesis gas production. This technology will provide major cost advantages in the construction of large scale methanol plants because it offers a significant reduction in equipment size and significant reduction in offsite utility requirements. These items have a major impact on the capital cost of any methanol plant and an especially large impact on the cost of remotely located methanol plants as in the case of the methanol plantship.