9.0 FIELD DEVELOPMENT, GAS COLLECTION AND DELIVERY

This section discusses the selection and development of a specific offshore site for the supply of natural gas feedstock to a turret moored methanol plantship. The site and development plan is presented; the design, cost and scheduling requirements for drilling and completions, pipeline and riser installation, and for process equipment fabrication and installation are discussed briefly and critical design areas are identified. Details of capital requirements and of operating and maintenance costs are given in Appendices A and B.

9.1 FIELD DESCRIPTION

Tenneco plans to use the gas from the Poinsetta Field to supply the methanol plantship. Poinsettia field is located in block KK4 of the North Coast Marine Area (NCMA) of offshore Trinidad. The field is located 30 miles off the north coast of Trinidad in a water depth of approximately 530 feet.

The Poinsettia field was discovered in August of 1975. Four wells have been drilled in this field with one well being a dry hole. The field contains approximately 13,500 productive acres. Tenneco Trinidad owns a 20% interest and is operator of the field. Deminex and Agrip own 20% each, and Occidental the remaining 40%.

The Poinsettia field is a large anticlinal closure with its axis essentially trending east-west. A small ridge feature extends to the south of this main structure forming a nose off to the south. These two features are incorporated under the same gas column. A third smaller enclosure is present to the southwest of the main field. It is separated by a syncline, and has a different gas water contact.

Gas reserves are seen in the Pliocene age MII sand. The approximate depth to the MII sands is -7600 ss. The KK4-2 and 4 were drilled on the main structure and encountered 56' and 60' of net gas on water respectively. The KK4-5 well was drilled at the edge of the field and was a dry hole. The KK4-3 well was drilled on the smaller closure to the southwest and saw 48' net gas on water.

The MII is a thick, unconsolidated, very fine grained turbidite sand with high porosities and good permeabilities. Porosities average over 30%.

9.2 FIELD DEVELOPMENT

The methanol plantship envisioned requires a sustained natural gas supply of nominally 100 MMSCFD during the 20-year project life; therefore, the field to be developed must contain reserves of at least 730 BCF. Tenneco has several fields offshore Trinidad which are suitable or potentially suitable for this project. The Poinsettia field, 30 miles north of Trinidad, is typical of the area and has been selected as the model for this study. The field lies in 480 to 530 feet of water. Fluid analyses from existing wells reveal a composition of

99.6% methane, 0.4% ethane, propane, butane and nitrogen with no free liquids. The gas has a molecular weight of 16.1, a specific gravity of 0.556 and a heat content of 1011.8 BTU/SCF.

Field development will consist of four subsea completions around the perimeter of a circle with a radius of 10,000 ft. Each completion will be sized to deliver 35 MMCFD (any 3 of 4 wells being capable of full service demands) but in normal operation will deliver one quarter of plantship demand. A 6-inch steel flowline, 10,000' long, will connect each of the wells to a centrally located PLEM (Pipeline End Manifold). The required well spacing and anchor clearances between drilling rigs and the plantship dictate the radius of 10,000'. Production will pass from the PLEM to the plantship through four flexible risers. Flow will continue through a gas processing train before entering the methanol plant at 500 psi and 60°F.

This scope of work will require 18 months to complete at a cost of $48,814,000.

9.3 DRILLING AND COMPLETIONS

The development requires that four wells be drilled and completed. This work will be performed by a semi-submersible drilling rig mobilized from the Gulf Coast and anchored at each location. All wells will have straight hole, single zone, gravel packed, 4-inch completions. The wellheads, rated for 5000 psi, will be typical of a Cameron or FMC diverless subsea completion. All wellhead and subsurface controls will be hydraulically actuated utilizing a 12-line umbilical from the plantship to each wellhead; they will be installed with and strapped to the pipelines. The pipeline and umbilical wellhead connections will be performed by divers working off of the pipelay vessel.

The drilling and completion costs presented in Appendix A include all tangible and intangible costs to be encountered. Following a 20-day mobilization of the rig and 7 days for installation of the PLEM, each well will require 6.5 weeks to drill and complete for a cost of $7,162,000 per well, totaling $28,648,000.

9.4 PIPELINE AND RISER INSTALLATION

The pipelines were sized using the Weymouth gas equation. Each line will normally transport one quarter of required gas; however, the completions and flowlines have been designed such that any three wells can satisfy a nominal plantship requirement of 100 MMSCFD if one well is shut-in.

Applicable pipeline installation methods include conventional stalk-on of 40-foot pipe joints; pre-spooling all four pipelines and then unspooling them on location; and welding the pipelines onshore then towing them to the final location. The costs presented are representative of either conventional or spooled pipelay. A towed installation may offer significant cost savings and will be examined in detail as the project progresses. Towed installations have been performed world-wide. R.J. Brown and Associates, of Houston, is currently supervising the towed installation of Conoco's Green Canyon pipelines in 1500 feet of water, approximately 70 miles off-shore Louisiana (twice as far at sea and in three times the water depth of this project).

The hydraulic control umbilical for each well will be spooled and placed onboard the lay vessel. The umbilical will be unspooled and attached to the pipe ondeck using Avon-type piggyback clamps as shown on Figure 4. The pipelines will be laid, gauged pigged, and hydrotested. The tie-ins to the subsea wellheads and PLEM will be performed by divers using hard pipe, flanged spool pieces.

Four flexible risers, each approximately 800 feet long, will connect the PLEM to the plantship. The pipelay contractor will connect the risers to the PLEM and leave them buoyed for retrieval and tie-in to the plantship. The risers will be rated to 5000 psi and will initially operate at 3000 psi. This is state-of-the-art design practice for flexible risers furnished by Coflexip for dynamic service. Final riser design and analysis will be quite detailed and will include the examination and costing of a composite riser system consisting of a hardpipe conduit from the seafloor to a shallow depth with short, flexible jumper lines to the surface.

The produced gas will cool from a reservoir temperature of 160°F to the seafloor temperature of 50°F as it travels to the PLEM. McKetta and Wehe predict that a saturated gas will condense 86 lbs of water/MMSCF and form hydrates during this cooling. The Hammerschmidt equation indicates that hydrate formation may be prevented by injecting 5 BPD of methanol at each wellhead via the hydraulic control umbilical; provision has been made for this in the current design.

Detailed soils data for this area is unavailable. The area is a carbonate environment and is assumed to be similar to West Florida. Figure 5 is an echo sounder track from West Florida which shows significant seafloor variations which would result in unacceptable pipeline spans. A contingency of $1,000,000 has been included to cover span rectification or rerouting of the pipelines to avoid spans.

Pipeline and riser mobilization, installation and tie-ins will require 13 weeks with a total cost of $16,999,000.

9.5 GAS DELIVERY PROCESS EQUIPMENT

The gas exiting the riser will be at 3000 psi and 50°F. This gas must be reduced to 500 psi and heated to 60°F before entering the plantship. Any free liquids must be removed.

Upon reaching the turret, each of the four gas streams will flow through a 6.2 MM BTU/hr line heater to raise its temperature to 150°F prior to reducing the pressure to 600 psi. This 2400 psi pressure drop is expected to reduce the temperature of the flowstream to the desired 60°F. The low pressure gas will then pass through a multipath swivel and exit the turret. Two 100 MMSCFD reverse flow coalescers, one test and one production, will receive the production and separate gas and liquids. Gas will be metered and forwarded to the methanol plant. Liquids, consisting of water, methanol and condensate,

FIGURE 4

AVON - Type Umbilical Clamp

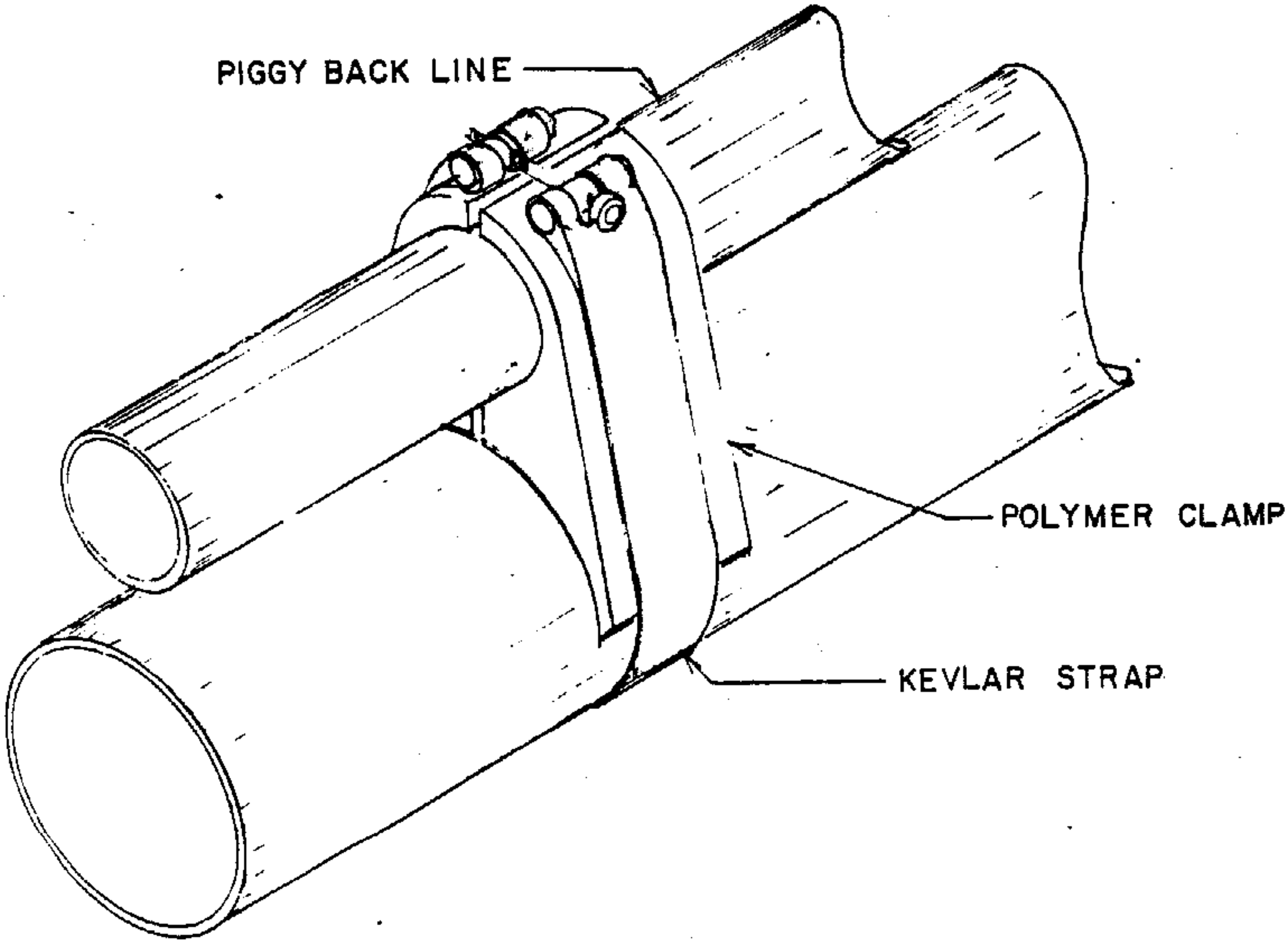
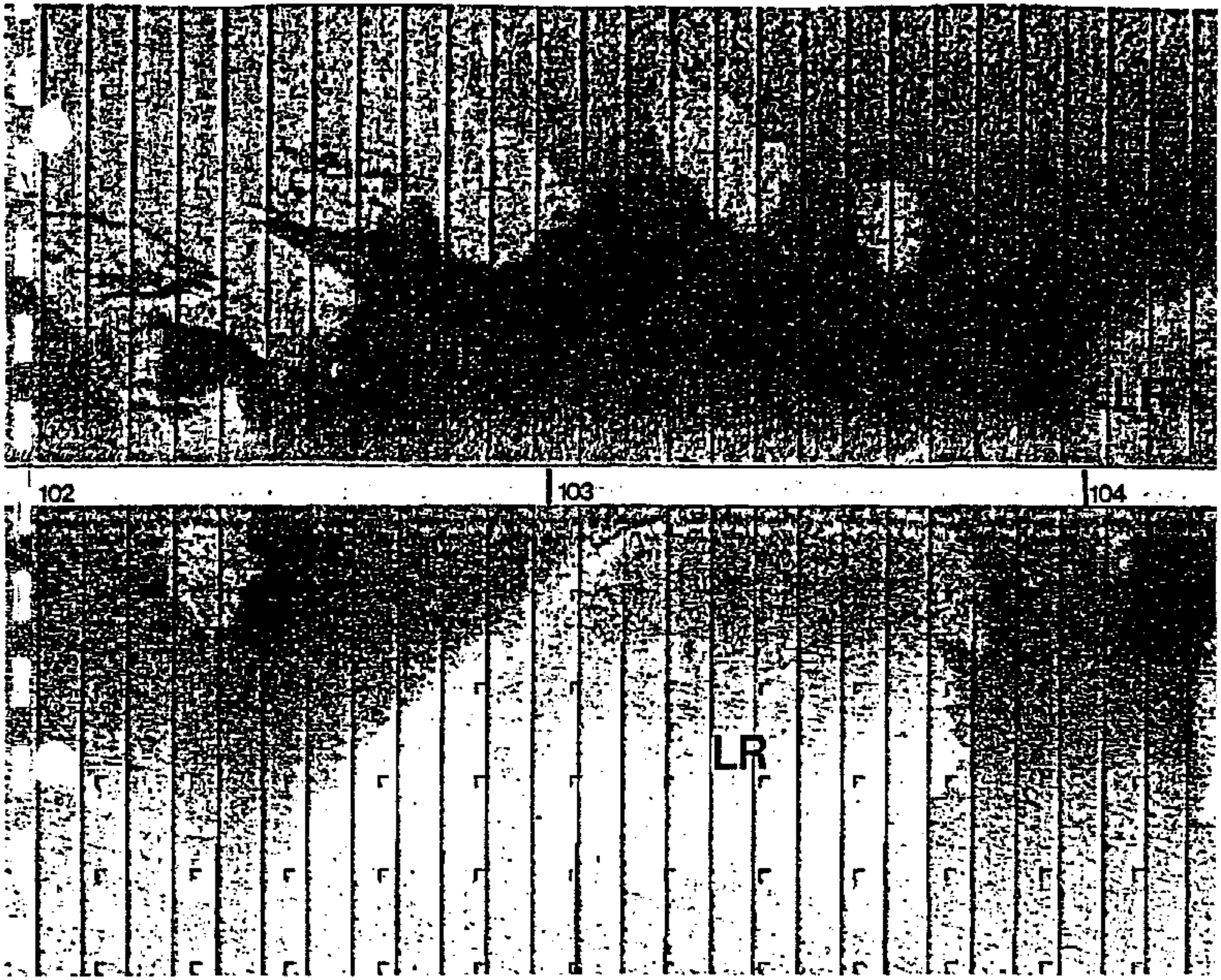
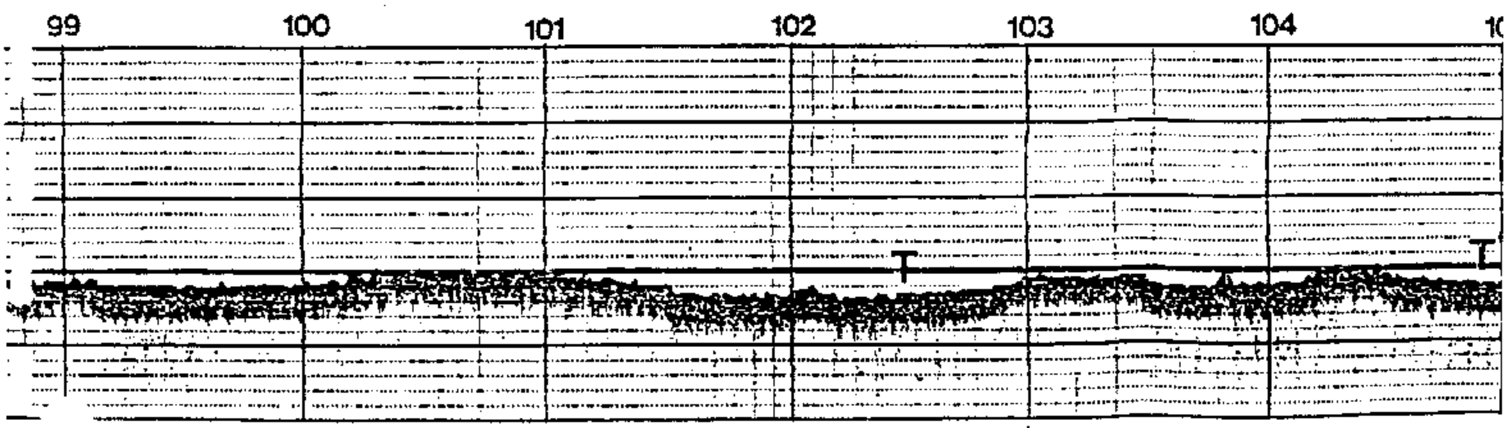


FIGURE 5: ECHO - Track; Seafloor West of Florida





300 m

NOTE: Vertical scale = 0.4 m per minor divisio will flow to the plantship separators for processing and disposal. A safety system and methanol pump skid have been included in the cost estimate.

The design and fabrication of the process equipment is expected to require six months and should be completed on such schedule that the equipment can be installed in the shipyard during outfitting. The cost of the process equipment will be $2,867,000.

9.6 FIELD/DELIVERY SYSTEM OPERATIONS AND MAINTENANCE

Operations and maintenance of the subsea wells and gas processing train have been examined separately from the methanol plantship. The costs presented in Appendix B are the O&M costs to be incurred annually during the 20-year project life. All costs are in non-escalated 1987 dollars.

The following assumptions apply:

1) The personnel cost includes 2 men per 12-hour shift working on a 28 day rotation out of Houston. Catering is charged at $50/man/day.

2) Warehouse space will be furnished by the plantship operator at a cost of $2000/month.

3) Each well will require one major workover during its lifetime. The cost of four workovers at $5,400,000 per well is divided equally throughout 20 years.

4) Maintenance will be performed on the subsea wellheads and controls for one week each year during the annual plant turnaround. A four-point anchor boat with divers will be mobilized from the Gulf Coast.

5) All risers will be replaced twice during 20 years.

6) The annual cost of maintaining the process equipment will equal 5% of the total process equipment cost.

7) Methanol for hydrate prevention will be supplied by the plantship at a cost of $0.35/gallon. The rate will be 20 BPD.

9.7 CONDITIONS AND ASSUMPTIONS

Presented below is a summary of the premises upon which are based gas field development and the design of the gas delivery system:

Drilling

1) Drill and complete four (4) subsea wells in 500' W.D. No existing wellbores are re-entered. All completions are 5000 psi.

2) Drill rig is mobilized from the U.S.

3) All wells are straight holes from unique locations.

4) All wells contain one (1) clean gas sand which is gravel packed.

5) There is no recompletion potential uphole.

6) The subsea completions are diverless.

7) All controls are hydraulic.

8) Each well will undergo one (1) major workover during the 20-year life of the project.

Pipelines

1) Each pipeline will be rated at 5000 psi.

2) Each line will normally transport 20 MMSCFD; however, each line is sized to carry 35 MMSCFD in the event one (1) completion is lost.

3) The produced gas is saturated with liquids.

4) Hydrate formation in the flowlines is prevented by methanol injection at the wellhead.

5) All pipelines terminate at a central PLEM.

6) Four flexible risers run from the seafloor to the vessel turret using a simple catenary profile.

7) The PLEM is located at the anchor point for the flexible risers.

8) The control umbilicals for the subsea wells will be strapped to the pipelines during installation.

9) Tie-ins of the pipelines and umbilicals to the subsea wells and PLEM will be by divers.

10) Produced gas is cooled to the seafloor temperature of 50 degrees F in the pipeline.

Process Equipment

1) The process equipment consists of:

   a. Four 6.7 MM BTU/HR heat exchangers (20' x 23')

   b. A four (4) well manifold (14' x 18')

   c. A methanol injection pump skid (5' x 14')

d. Two reverse flow coalescers sized for 100 MMSCFD complete with gas and liquid metering (12' x 32')

e. *A flotation cell to treat overboard water (5' x 7')

f. A master panel to monitor the process equipment.

g. One (1) wellhead panel to control the subsea completions.

2) All liquids go to the methanol plantship separator.

3) Gas is delivered at 500 psi and 60 °F with no free liquids.

4) The heat exchangers and manifold are located in the turret.

5) Warehouse space, catering and transportation offshore for operations personnel is provided by the plantship operator.

* This item is unnecessary if all liquids go to the plantship separator. Current planning is that all liquids go to the plantship separator, therefore, no provision is made in the process equipment cost estimate for a flotation cell; see item (2).

10.0 SERVICES: TOWING AND RESUPPLY/LINE HANDLING

Present expectation is that the plantship hull will be constructed in Korea. It will subsequently be towed to the U.S. Gulf Coast for installation of the methanol processing plant; a second tow will follow to the operating site. At the operating site a service boat will be required for provisioning of the make and break connection with the plantship for purposes of methanol plantship, for crew exchange and for assisting a tanker to make and break connection with the plantship for purposes of methanol offloading.

10.1 TOW SERVICE

The Sears/Price Forbes Group counseled that insurance costs for the periods of tow (nominally 4 percent of plantship value at departure from Korea and one-half percent of plantship value at departure for the operating site) will be influenced by:

- the route sailed
- the equipment and expertise of the towing company, and
- the time of departure from Korea and arrival on the Gulf Coast.

The latter is of importance as insurers consider the typhoon season in the Far East and the hurricane season in the Gulf of Mexico as additional risks. The suggested route is westward from Korea around the Cape of Good Hope; it is shorter by 1500 n.m. than around Cape Horn and also offers more intermediate ports for refuge and bunker stops.

Price Forbes investigated with Wijsmuller the feasibility and economy of using a heavy lift semi-submersible such as Mighty Servant for an out-of-water plant hull transfer rather than an in-water tow. Two lifts would be required. Insurance costs would be lower but transport costs greater than for the typical tow; a nominal wash existed in-so-far as an economic basis for choice was concerned. Yankee believed greater flexibility for tow scheduling existed if tugs were used; Waller Marine was requested to obtain estimates from reputable firms with appropriate equipment. Smit Towing and Goliath Towing submitted very competitive bids for towing costs requested over two routes:

1) Tow of the vessel hull, partially outfitted, from Korea to Morgan City, LA, and,

2) Tow of the completed plantship from Morgan City, LA, to the operating site off the northwest coast of Trinidad.

Interestingly, each company specified a stage 1 passage westward around the Cape of Good Hope, South Africa, with bunker stops made at Singapore; Capetown, South Africa; and Recife, Brazil. Comparative costs were:

STAGE 1

Smit Towing	22,000 I.H.P. Tug	135 days	$1,550,000
Goliath Towing	16,000 I.H.P. Tug	130 days	$1,400,000

STAGE 2

Smit Towing	22,000 I.H.P. Tug	22 days	$300,000
Goliath Towing	16,000 I.H.P. Tug	20 days	$300,000

10.2 UTILITY VESSEL

Sears/Price Forbes estimated vessel value at $1,000,000 and projected a premium cost of $10,000 for damage risks and physical loss and a $5,000 annual premium for crew/third party liabilities. Subsequently, Waller Marine investigated the alternative of vessel ownership versus the alternative of chartered service.

Investigation of charter costs/or purchase of a supply/service vessel in the 135 ft to 165 ft length range resulted in the following findings:

1) Used 135 ft. to 165 ft. supply/service vessels ready for immediate sale are readily available, this according to local (Gulf Coast) brokers at August 1987. The majority of these vessels are held by banks and mortgage companies. Prices range between $110,000 and $130,000 depending upon age and/or condition.

2) The following day rates for similar vessels are provided by Zapata Marine Service, Inc., one of the largest of domestic supply/utility vessel operators. Zapata Marine Services, Inc., has supply vessels on charter working in the Trinidad area; they advise that charter boat operators there reflag and crew their vessels with Trinidad nationals.

Charter rates for a vessel to suit the Yankee needs are quoted by Zapata as follows:

Normal charter rate - $1750 to $2500 per day.

Reflagged and with Trinidad crew - an additional $600 per day.

Consumable costs - i.e., with fuel oil, lube oil, etc., being owner (Yankee) furnished; $1000 per day (based on 2 trips/day).

Maximum charter operations costs - $4100/day.

Probable charter days/months - six (approximately 75/year).

11.0 OWNER/OPERATOR'S ISSUES

Several ancillary issues have been addressed in the course of this site-specific study. These issues are not seen to be of a "go, no-go" nature respecting the project, however, to have had them addressed gives a greater sense of completeness to the effort and, additionally, gives assurance that when the final "definitive design" is undertaken it will encompass all essential issues.

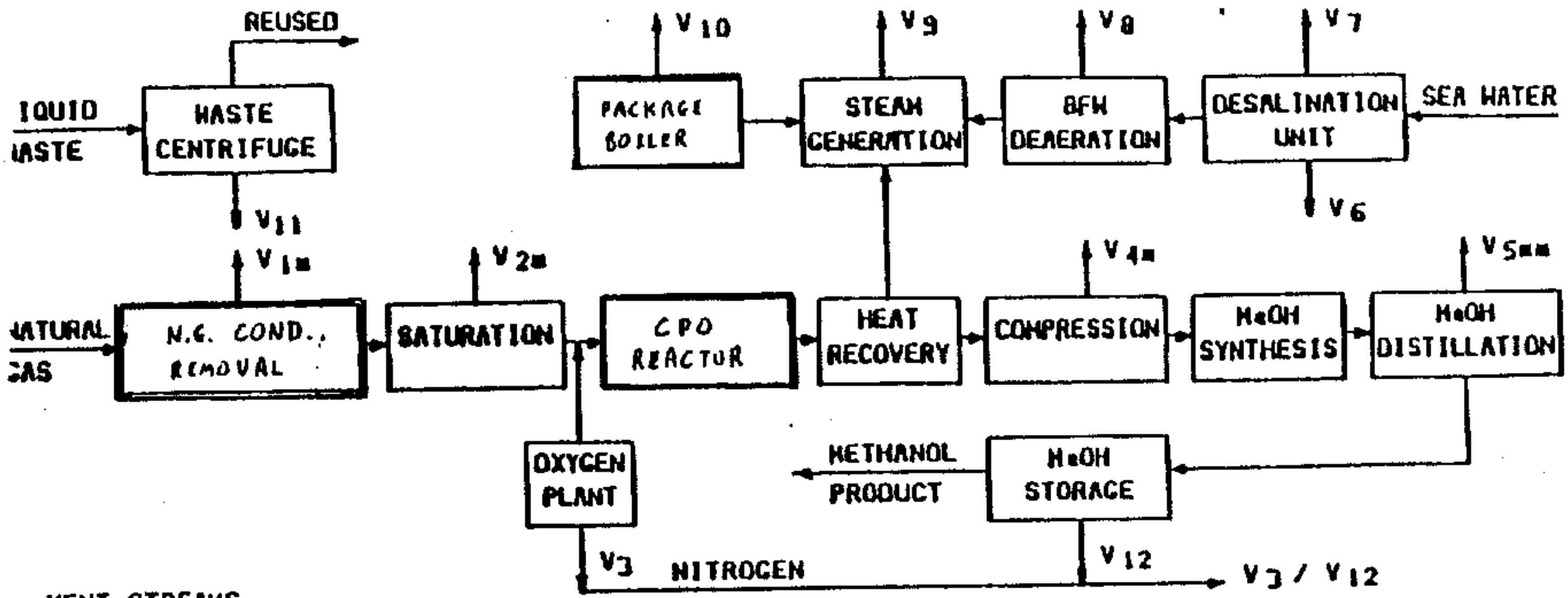
11.1 ENVIRONMENTAL

An extraordinarily thorough effort was made in the course of the DOT plantship study to execute a design in accordance with all domestic regulatory factors, most especially environmental, in order that required licenses and permits would issue. Similarly, compliance was maintained with applicable international conventions. For process plant carriers which are not self-propelled, i.e., such as this plantship, the proceedings of the International Conference on Marine Pollution, 1973, are applicable. Special requirements for process facilities are outlined in Regulation 21; oily water separators and oily water discharge monitoring and control are covered in Regulation 16; and sludge tanks of sufficient capacity are covered in Regulation 17. Surface drainage, production water discharge and displacement of ballast discharge are also addressed by the Convention, and by the TDP plantship design.

As noted in Paragraph 7, the TDP plantship differs from that of the DOT study in that equipment changes have been made which cause process plant effluents to differ, specifically, the gas turbine has been exchanged for a package boiler and a third diesel generator has been added. Figure 6 and Table 2 provide detail on the emissions from this redesigned process plant. Only flue gases from the package boiler, the flare pilots, warmed seawater and clean blow-down waters are discharged from the plant during normal operations; the table and figure also list discharges that could occur in an emergency, mal-performance and other intermittent modes of operation.

11.2 LOCAL INFRASTRUCTURE INTERFACES

Visits to Trinidad-Tobago confirmed that the site specific plantship design has been executed in a manner well complemented by the host country (see Appendix I). It will be possible to conduct necessary administrative operations at the dock site, Port-of-Spain/San Fernando. Storage facilities will be available for chemicals, catalyst and spare parts, housekeeping and foodstuffs not stored aboard ship. Temporary living quarters for crews in transit can be obtained; service/supply vessels of adequate capability are available for charter, similarly, emergency helicopter service. A methanol plant operates ashore so it is presumed maintenance/repair services not present aboard ship are available ashore. Similarly, a trained/trainable populace exists. The administrative offices ashore will encompass training facilities to assure a ready supply of operating personnel.



VENT STREAMS

V_{1*} = Natural gas to flare on start-up - non-continuous.
V_{2*} = Flue gas from start-up heater - non-continuous.
V_3 = Excess nitrogen - continuous.
V_{4*} = Reformed gas to flare - non-continuous.
V_{5**} = Column vent gas to flare - continuous.
V_6 = Concentrated sea water to sea - continuous.
V_7 = Steam / air to atmosphere from ejector - continuous.
V_8 = Vent steam from deaerator - continuous.
V_9 = Vent steam from LP / ejectors - continuous.
V_{10} = Stack gas from package boiler - continuous.
V_{11} = Separated water from waste streams - continuous.
V_{12} = Vent gas from methanol storage - intermittent.

*V_1, V_2, V_4 - Only vents during start-up and emergencies to the Flare System.
** Distillation vent gas used to "sweep" flare header.

FIGURE 6: -Emission Sources: 3002.8 Ton/Day Methanol Plant

Table 2: Estimated Emissions From 3002.8 Ton/Day Methanol Plant

STREAM	●V_1	●V_2	V_3/V_{12}	●V_4	●●V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	Total Continuous
COMPONENT	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	LB/HR	Venting LB/HR
CO	-	-	-	201232	-	-	-	-	-	-	-	-
CO_2	-	13058	-	113202	9831	-	-	-	-	78479	-	88310
NOX	-	-	-	-	-	-	-	-	-	-	-	-
SO_2	-	-	-	-	-	-	-	-	-	-	-	-
O_2	-	3783	-	-	1408	-	-	-	-	15800	-	17208
N_2	-	73877	519597	-	27500	-	-	-	-	340722	-	887819
Ar	-	1269	-	1084	481	-	-	-	-	6828	-	7309
H_2	-	-	-	42164	-	-	-	-	-	-	-	-
CH_4	94535	-	-	18609	-	-	-	-	-	-	-	-
H_2O (g)	-	13233	-	1542	5997	-	500	3220	2100	57092	-	68909
H_2O (L)	-	-	-	-	-	284100	-	-	-	-	14157	298257
Oil (L)	-	-	-	-	-	-	-	-	-	-	<5 ppmw	-
TOTAL	94535	105220	519597	377833	45217	284100	500	3220	2100	498921	14157	1367812

● Non-continous; venting only on start-up or emergency to flare system. Valves are maximum in case of emergency and will be burned in flare.

●● Combustion product of distillation column vent gas (continuous).

Payscales are acceptable; representative are these:

	$TT/mo(1)
Skilled labor/technicians:	3,600
Engineers (junior/novice):	4,000
Senior Engineer/Division Manager:	20,000

(1) Conversion rate 3.5 TT/ U.S., 11/17/87

11.3 DRYDOCKING AND INSPECTION

The normal requirement to drydock the plantship at nominally frequent intervals, e.g., bi-annually for inspection/repair, would entail absorbing a severe adverse impact on operating revenues; plant operations would be shutdown for several months while the vessel was taken off station for repair yard availability. In the course of the DOT study the question was put to the U.S. Coast Guard respecting allowance of an extended period, up to ten years, before removal of the plantship from station to an inspection/repair facility; the following answer was received (excerpted from U.S. Coast Guard letter April 26, 1986, No. 16715; from G-MTH-4 to C.R. Fink, Homeport Associates):

> - U.S.C.G. regulations require vessels to be drydocked periodically. Special examinations in lieu of drydocking are permitted under certain circumstances when approved by the Coast Guard. Owners requesting such exams must submit a request that details the method that will be used to determine the condition of the hull as outlined in 46 CFR 107.265 for MODUS. This request should also contain justification for conducting a special examination in lieu of drydocking, also, documentation that the proposed special exam will be as accurate and effective as a regular drydocking. <u>There is no limit to the use of the special exams in lieu of drydocking</u> (underlining emphasis by Yankee Energy) but at some point an evaluation of the condition of the vessel necessitating a drydock will have to be performed.

As noted earlier, the ship will operate outside U.S. waters, therefore, rather than design to U.S. statutory regulation and the Rules of the American Bureau of Shipping, the decision has been made to design for Classification in accord with Rules of Lloyds' Register of Ships; plant certification will be sought in accord with design and survey requirements of Lloyds' Register of Industrial Services. On the matter of periodic surveys for classed facilities, the general Lloyds' Rule is that for permanently moored deep-water floating process plants, annual and special surveys can be held on station if in-water surveys of the nature prescribed by LRS Rules are held at 2 1/2 year intervals. If the results of the in-water survey are satisfactory, the drydocking may be waived for a further 2 1/2 years.

The design of the plantship has been executed with the goal of achieving a minimum of four in-water surveys prior to drydocking. Selection of external coating systems, design of the hull and external appendages for longevity in a salt water environment, and design for under water cleaning and for confident inspection are such that each contributes to achievement of this 10 year goal.

11.4 INSURANCE ISSUES OF CONSEQUENCE

Commercial viability of the project requires that risk of property loss and business interruption be insurable at tolerable costs. These matters were examined through Price Forbes, discussed with Price colleagues within the Sedwick Group and with other prominent underwriters in the London Market. The response was quite clear; Physical Loss or Damage Coverage should be available for the entire project, from initial construction through to operation including start-up/commissioning. With respect to Business Interruption Coverage, the consensus was that until a formal Risk Management Analysis is performed and Contingency Plans are drafted and implemented, it is too early to be specific as to the scope of such coverage, including monetary limits, which can be made available at acceptable premium costs. Subsections to follow address the Risk Management/Contingency Planning which will be performed in the pre-contract engineering phase of the project; the immediately following subsection places at rest insurability/insurance rate questions respecting a number of the more critical aspects of project development and execution.

11.5 INSURABILITY AND INSURANCE RATES

The results of investigations into the numerous individual issues requiring resolution respecting insurability are presented below:

Insurance During Construction

Preliminary Risk Management Planning has suggested that this coverage may be available from the shipyard(s), either Korean or Brazilian. However, in view of the scale of the project it may well prove possible to obtain competitive insurance terms from other insurers. The premium cost will be a function of accumulating values and exposure period.

While there is no experience with insuring of a floating methanol plant while it is under construction, that which is the process plant or "factory building" is a straightforward non-marine risk. The rate based on the FCV of this element would be approximately 0.25 % per annum.

Towing Insurance

Section 6.4.2 of the Yankee report to the Department of Transportation and to the Congress correctly identifies this as the situation of greatest risk. If Korea is the hull construction site, tow around either Cape Horn or The Cape of Good Hope are the available options; the route around Cape of Good Hope appears to be approximately 1500 miles shorter, and perhaps offers more imtermediate ports of refuge. (This is the route for which tow costs were subsequently obtained). Discussions with underwriters would suggest that for total loss and physical damage during the tow the rate of 4% of the value of the barge at the time of leaving Korea is a reasonable estimate.

For the second tow from the U.S. Gulf Coast to Trinidad, underwriters suggest that a rate of one-half percent of the value of the plant vessel at the time of leaving the Gulf Coast can be expected.

Assuming a value of $75 million at the time of leaving Korea and of $225 million at time of leaving the Gulf Coast (Morgan City, LA is probable) the premium costs would be $3 million and $1.125 million, respectively.

Factors that would alter/influence these estimates are:

a) The route of travel

b) The tugs and expertise of the towing company

c) The time of departure from Korea, also the time of towing in the Gulf of Mexico.

Item c) is of importance as insurers consider the typhoon season in the Far East and the hurricane season in the Gulf of Mexico as additional risk factors, and they have indicated a 5% loading on the tow rates for this risk depending upon the timing of the tows.

Operating Insurance

Preliminary indications from underwriters would suggest an estimated rate of 0.75% of the value of the plant vessel for physical loss and damage based on a deductible of, say $1 million any one loss; this is made up of a combination of a named peril type of insurance for the plant, plus marine perils including total loss of the barge. As to "loss of revenues" coverage due to business interruption, see the discussion under Subpara 4.1.7, Contingency Planning.

Special Package Insurance Coverage

Investigation has shown that insurers are interested in the concept of an insurance package running from construction through to 12 months of operation. It is imperative however, that before proceeding to the package concept it be determined that the scope, cost and marketability of the package to insurers is more advantageous than those of the component parts. Such a determination will preceed a commitment to any specific insurance program.

Other Insurances

In estimating/budgeting insurance costs for the project, these other areas of exposure are included in the whole:

a) Turret Mooring System, Flowlines, Risers

Insurance for construction, tow (or shipment), installation and commissioning, operation of this system will be an element of negotiation with the feedstock (natural gas) suppliers.

b) Shuttle Tanker (12 months operation)

An estimated value of $30 million would suggest a premium cost of $225,000 for physical loss and damage risks and a premium cost of $100,000 for crew, cargo liability, pollution liability and third party liabilities; both these figures depend upon the level of deductible that would be applied to these risks. Again, if the shuttle tank service is chartered, the insurance costs would become an element of the charter rate.

c) Utility Vessel/Service/Supply Boat (12 months operation)

On an estimated value of $1 million, investigations would suggest a premium cost of $10,000 for physical loss and damage risks, and a premium cost of $5,000 for crew, third party liabilities, etc. These costs will be a factor in the own or lease decision which is yet to be made; a lease/charter decision is most probable.

d) Employees/Crew

The US insurance market may well be the best source of insurance for the Yankee Energy employees; respecting the operating company, the marine market may be best prepared to cover process plant technician/engineers and the crew of the plantship.

e) Cargo/Product (12 months operation)

Elements of concern include coverage whilst stored on the plant vessel, during hose transfer, carriage in shuttle tanker, off loading at discharge port; also, 'All Risks' coverage whilst owned and liability coverage whilst being carried for purchaser, if appropriate. For costing purposes the suggested rates are a rate of 0.0625% per voyage with a deductible of 0.5% on Bulk Oil clauses; or, a rate of 0.25% if insured against guaranteed out-turn, again, excess of 0.5%. This coverage includes leakage/shortage/contamination, etc., however arising.

11.6 MARINE CONSULTANTS/SURVEYORS/INSPECTION SERVICES

There will be underwriter requirements for surveyors/inspections in the course of plant and hull construction. It is probable they will request that London Salvage Association be appointed at owner's expense to undertake the necessary surveys; LSA has offices both in the Far East and on the U.S. Gulf Coast. Alternatives to use of LSA include use of Lloyds' Register of Industrial Services (LRIS) or the employing of Noble Denton, LTD.

The marine consultant/surveyor/inspection service will be retained early in the project so that he can be involved in the finalization of vessel/process plant designs.

11.7 RISK MANAGEMENT

Risk control exercised to date on this project has most intimately involved decisions respecting plantship design, process plant design, mooring design, how cargo will be transferred, etc. Risk control has been a direct objective of system design; how best to protect the crew, the property, the product methanol in the work/operating environment. Risk Management as it will be discussed in this section (and practiced in the pre-contract engineering phase of the project) pertains largely to the avoidance of cost incurrence due to an experienced loss, also, the avoidance of costs thought of as necessary to insure against losses that may occur after plantship operations begin.

Risk management has evolved as a by-product of insurance management with the original need and emphasis being the monitoring and controlling of risks in order to limit premium expenditure. Today, risk managment is an imperative management discipline, concerning itself with the systematic anticipation, prevention, treatment of any risk which threatens the people, property and profit performance of an enterprise with insurance subordinated to it as just one of the risk financing options.

The reduction of risk is an analytical discipline, subject to the same logic and cost assessment techniques as are other corporate and financial decisions. It must take into account balance sheet strengths or weaknesses as well as the legal, technical, tax and social environments in which the project operates.

As illustrated in the chart attached, Figure 7, the process starts with the identification, analysis and interpretation of operating risks.

A key requirement of risk management is risk analysis, expertise in the interpretation of exposure information, also, an appropriate statistical data base and expertise in actuarial techniques. The objective of risk analysis is to build a financial assessment of the highly unlikely catastrophic exposures, the inevitable and repetitive losses. The end product is a quantification of:

1) The true risk exposure; the total financial value of the risks to which the balance sheet is exposed, and

2) The total cost of risk.

The total cost of risk is the critical factor in the planning of a risk protection strategy. Total cost of risk includes:

1) The cost of insurance premiums; plus

2) The cost of losses within the self-insurance area. (self-insurance - a deliberate absorption of risk by the corporation, either funded or paid as part of operating expenses); plus

3) Risk control - the cost and expenses incurred in risk and loss reduction; plus

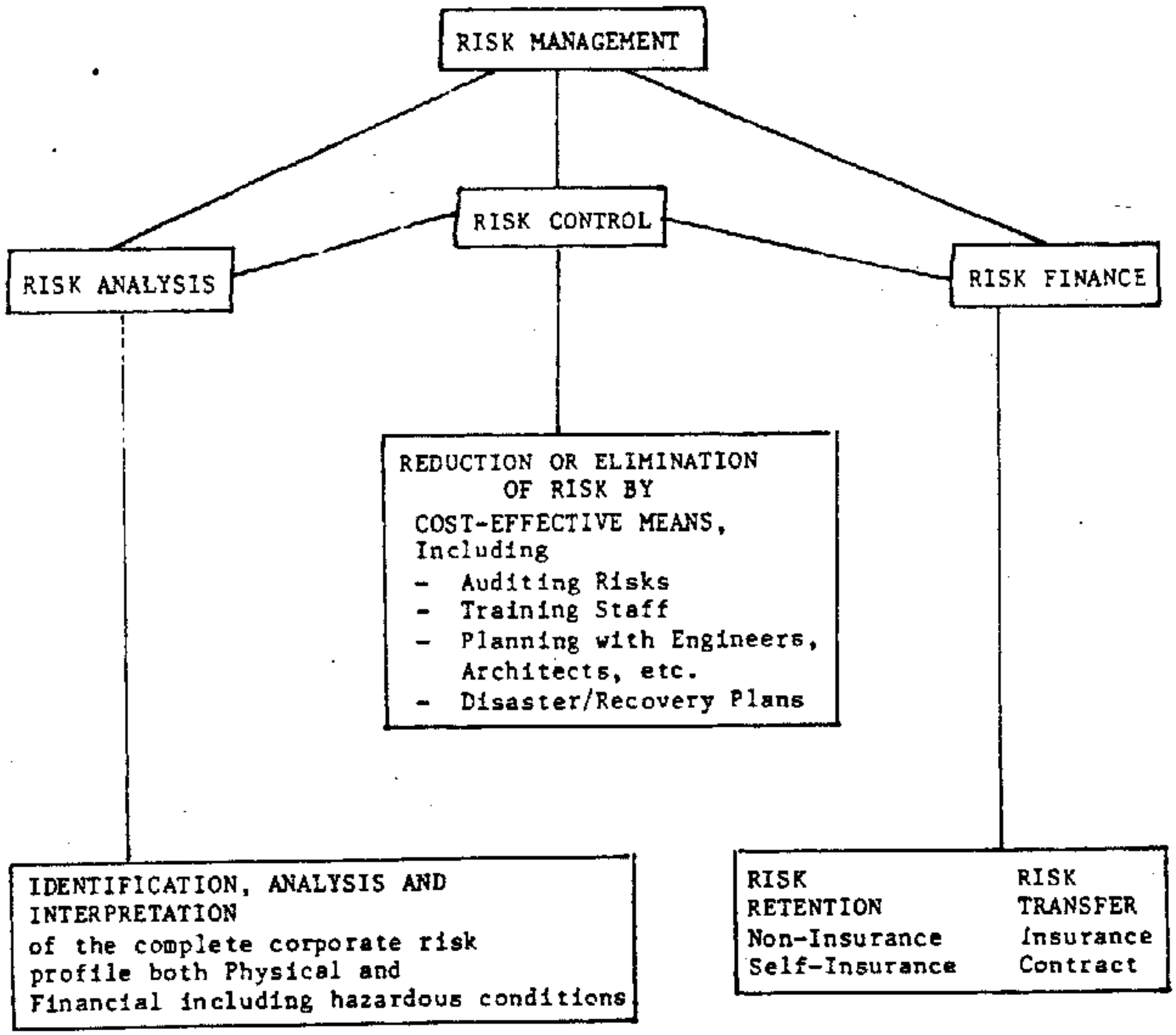
4) Administrative expenses; less

5) Insurance recoveries

The principle underlying a total cost of risk approach may be considered one of unification within modern risk management. Several factors support this inference:

FIGURE 7

The Risk Management Reimin



1) Any strategy which relies entirely on insurance and excludes considerations of self-insurance and risk control is lekely to be more expensive than a strategy which relies on a rational mixture of all three components.

2) Logically, there must exist some blending of these three components which results in minimization of the total cost of risk.

3) The responsibility to minimize total cost of risk rather than minimization of premium expediture in isolation from consideration of self-insurance, risk control, etc..

Thus, each is concerned with identifying where insurance is necessary, where self-insurance will be financially advantageous, and where risk control can have the greatest impact. The importance of high quality information to enable this to be acheived cannot be exaggerated. The better the information the better the decisions.

Risk Management decisions are not ones that can be taken for all time. They need constant reevaluation in the light of changing circumstances, particularly loss experience and shifts in the risk-bearing propensity of insurance markets.

There are many costs associated with a loss event which are not covered under a conventional insurance policy. A recent U.S. study on principles of accident prevention came up with a list of uninsured factors relating to accidents in the work place. This ranges from the cost of lost time per injured employee to the overhead wastage while that injured employee is a non-producer. Already, in the U.S., attempts to quantify these uninsured or hidden costs have led to what has become known as the "iceberg" principle, which holds that for every $1 visible in the loss experience of insurers there may be anything between $5 and $50 of expenditure incurred by the insured corporation which is irrecoverable from insurers.

Genuine risk managment today relies heavily on information coupled to analytical skills. An approach which recognize the need to minimize the total cost of risk to an enterprise may well fall short of its objectives, given the volatile nature of the risk environment today; however, this approach will come closest to making sense of the dangers implicit in the 'iceberg' principle, referred to earlier, while identifying the appropriate blending of specific actions as will protect the enterprise concerned at minimum cost.

Awareness of the broader implications of risk managment also builds an understanding of how the discipline itself fits the tactical and strategic objectives of the project, an important one of which is to improve its profits year by year.

In a major project such as this, losses will tend to fall into the three categories shown on the 'loss pattern' chart attached, Table 3. It is obvious that the upper layer is suited for complete risk transfer whereas the bottom layer is best suited for retention. The middle layer is where the problem and opportunity exist.

TABLE 3:

Loss Pattern

UPPER LAYER

THE TRUE CATASTROPHE LOSS

UNPREDICTABLE AS TO SIZE OR TIMING

BUT DEVASTATING IN EFFECT TO THE

ENTIRE COMPANY / PROJECT

MIDDLE LAYER

LOSSES WHERE

A. THE SCALE OF LOSS IS TOO GREAT FOR AN INDIVIDUAL UNIT

B. LOSS IS INEVITABLE BUT UNPREDICTABLE

LOWER LAYER

LOSSES WHERE EITHER

A. THE FREQUENCY IS PREDICTABLE, OR

B. THE SCALE OF LOSS IS MINIMAL