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Report No.8767-BR

STAFF APPRAISAL REPORT

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

JUNE 6, 1991

Energy and Industry Operations Division
Country Department I
Latin America and the Caribbean

CURRENCY EQUIVALENTS

Currency Unit	=	Cruzeiro (Cr$)
US$1	=	Cr$234 (March 1991)

PETROBRAS' FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

1 Metric Ton (m ton)	=	1,000 Kilograms (kg)
1 Metric Ton (m ton)	=	2,204 Pounds (lb)
1 Meter (m)	=	3.28 Feet (ft)
1 Kilometer (km)	=	0.62 Miles (mi)
1 Cubic Meter (m^3)	=	35.3 Cubic Feet (cu ft)
1 Barrel (Bbl)	=	0.159 Cubic Meter
1 Barrel (Bbl)	=	42 US Gallons
1 Metric Ton of Oil (API 30°)	=	7.19 Barrels
1 Kilocalorie (kcal)	=	3.97 British Thermal Units (BTU)
1 Ton of Oil Equiv. (t.o.e.)	=	10 Million kcal (39.7 million BTU)
b/d	=	Barrels per day
m^3/d	=	cubic meter per day
1 Cubic Foot of Natural Gas	=	950 BTU
1 Kilowatt-hour	=	3,411 BTU

ABBREVIATIONS AND ACRONYMS

ACO	Automation Component
BCM	Billion Cubic Meters
BNDES	National Bank for Social and Economic Development
BPD	Barrels per day
BR	PETROBRAS Distribuidora, S.A.-BR
CNP	National Petroleum Council
COMGAS	Gas Company of Sao Paulo
CVM	Comissao de Valores Mobiliares
DNC	Department of Combustible Fuels
ELETROBRAS	Centrais Eletricas Brasileiras S.A.
ESIS	Energy Strategy and Issues Study
HDT	Hydrotreatment Plant
ICB	International Competitive Bidding
IDC	Interest Dining Construction
LCB	Local Competitive Bidding
LPG	Liquid Petroleum Gas
LRMC	Long-Run Marginal Cost
MDWT	Millions dead weight tons
MBTU	Million BTU
MIC	Ministry of Industry and Commerce
MOE	Ministry of Economy
MOI	Ministry of Infrastructure
PASEP	Public Employees Financial Reserve Fund
PASP	Petroleum Sector Action Plan
PCU	Project Coordinating Unit
PETROBRAS	Petroleo Brasileiro S.A.
PLANGAS	National Plan on Natural Gas
REDUC	Duque de Caxias Refinery
REPAR	Parana Refinery
REPLAN	Planalto Refinery
RELAM	Landulpho Alves Mataripe Refinery
REVAP	Vale do Paraiba Refinery
RIMA	Environmental Impact Study
RPBC	Presidente Bernardes Refinery at Cubatao
SCADA	Supervisory Control and Data Acquisition
SEST	Secretariat of State Enterprises
SNE	National Secretariat of Energy
TEMADRE	Terminal Madre de Deus
TOE	Tons of Oil Equivalent

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HYDROCARBON TRANSPORT AND PROCESSING PROJECT

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This report is based upon the findings of project preparation and appraisal missions that visited Brazil in September and December 1989 and August 1990. The missions comprised Messrs./Ms. Bates (Principal Economist), Baratz (Sr. Industrial Pollution Specialist), Dick (Sr. Transport Economist), Krishnamurthy (Sr. Industrial Specialist), Khelil (Unit Chief), Ristorcelli, Zuniga (Consultants), Sheehan (Financial Analyst) and Markus (Sr. Financial Analyst) - Task Manager (until December 1990); Sobotka (Research Assistant), Bodely and Perez (Consultants), assisted in the project preparation. Messrs. Vietti (Sr. Financial Analyst), Task Manager (since April 1991), and Waldrop (Financial Analyst) also participated in the report.

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MAPS

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HYDROCARBON TRANSPORT AND PROCESSING PROJECT

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LOAN AND PROJECT SUMMARY

Borrower:	Petroleo Brasileiro S.A. (PETROBRAS)
Guarantor:	Federative Republic of Brazil
Amount:	US$260.0 million equivalent
Terms:	Fifteen years, including a five year grace period, at the Bank's standard variable interest rate.
Beneficiary:	PETROBRAS
Project Objectives and Description:	The main objectives are to: (i) enhance natural gas utilization as a substitute for other sources of energy with higher economic and environmental costs; (ii) reduce the distribution costs of petroleum products by substituting pipelines for road and water transport; (iii) reduce petroleum product losses through processing optimization; and (iv) reduce environmental costs and safety risks in petroleum product transport and refining. In supporting these aims, the project would include a Transport Component consisting of: (i) a pipeline and related facilities to deliver natural gas to Sao Paulo; (ii) three pipelines (with tank and pump stations) to deliver liquid products more economically to distribution centers; (iii) engineering design; environmental impact studies; and training in pipeline operations and transportation planning. Processing Component consisting of: (i) a Hydrotreatment Plant at the Cubatao refinery to increase productivity, upgrade the quality of petroleum products, and reduce product losses; (ii) automation studies focusing on optimization of process and centralized control for loading, storage and offsite facilities and, on the basis of these studies, an action program in three refineries; (iii) an industrial safety and environmental program including: (a) development of norms for risk assessment, hazardous waste handling and relevant training; (b) comprehensive risk evaluation at the Cubatao refinery;

(c) acquisition of air quality monitoring mobile laboratories; and (d) training to help institutionalize safety and environmental awareness.

Project Benefits: The quantifiable benefits are expected to generate an economic rate of return (ERR) of about 21% for the transport component, and 23% for the hydrotreatment plant. The project will also produce considerable safety and environmental benefits such as lower levels of air and water contamination, and improved safety standards and public health.

Project Risks: There are no serious technical or gas reserve risks associated with the project. The primary risk regarding the hydrotreatment plant is related to international petroleum prices; however, sensitivity analyses confirm the robustness of the component.

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PROJECT COSTS AND FINANCING PLAN
(US$ million [1])

	Local	Foreign	Total
A. Estimated Costs			
(1) Transport Component			
Materials	28.2	31.5	59.7
Works	26.7	101.6	128.3
Equipment	19.4	5.0	24.4
Engineering Design	14.1	-	14.1
Training and Planning	-	1.0	1.0
Land and Easements	1.2	-	1.2
Total Base Cost	89.6	139.1	228.7
Working Capital	5.0	5.0	10.0
Physical Contingencies	16.1	12.0	28.1
Price Contingencies	22.6	18.2	40.8
Sub Total	133.3	174.3	307.6
Interest During Construction	-	27.1	27.1
Taxes and Duties	27.4	-	27.4
Financing Requirement	160.7	201.4	362.1
(2) Processing Component			
(a) Hydrotreatment Plant			
License and Engineering	6.5	1.6	8.1
Equipment, Materials, Spares, Catalyst & Chemicals	12.0	65.4	77.4
Works	48.2	-	48.2
Digital Control	0.4	1.0	1.4
Project Management	14.9	-	14.9
Start-up	2.9	-	2.9
Industrial/Safety Program	0.2	2.8	3.0
Training	0.6	-	0.6
Total Base Cost	85.7	70.8	156.5
Physical Contingencies	14.0	9.2	23.2
Price Contingencies	21.5	14.2	35.7
Sub Total	121.2	94.2	215.4
Interest During Construction	-	14.0	14.0
Taxes and Duties	18.2	-	18.2
Financing Requirement	139.4	108.2	247.6

	Local	Foreign	Total
(b) Automation Program			
Diagnostic Study	0.5	0.9	1.4
Basic Engineering & Design	0.8	1.5	2.3
Instrumentation	0.6	2.3	2.9
Training	0.4	0.1	0.5
Installation, Commissioning	0.6	1.0	1.6
Total Base Cost	2.9	5.8	8.7
Physical Contingencies	0.2	0.4	0.6
Price Contingencies	0.4	0.5	0.9
Sub Total	3.5	6.7	10.2
Interest During Construction	-	1.0	1.0
Taxes and Duties	2.2	-	2.2
Financing Requirements	5.7	7.7	13.4
B. Total Project			
Base Cost	178.2	215.7	393.9
Physical Contingencies	30.3	21.6	51.9
Price Contingencies	44.5	32.9	77.4
Working Capital	5.0	5.0	10.0
Sub Total	258.0	275.2	533.2
Interest During Construction	-	42.1	42.1
Taxes and Duties	47.8	-	47.8
Total Financing Requirements	305.8	317.3	623.1
Financing Plan			
PETROBRAS	227.0	136.1	363.1
IBRD	78.8	181.2	260.0
TOTAL	305.8	317.3	623.1

1/ Prices as of March 1991.

Estimated Disbursement:

	Bank Fiscal Year			
	1992	1993	1994	1995
Annual	99.4	127.9	29.7	3.0
Cumulative	99.4	227.3	257.0	260.0

Economic Rate of Return

Transport Component	about 21%
Hydrotreatment Plant	about 23%

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

I. THE ENERGY SECTOR

A. Introduction

1.01 The Bank strategy in the energy sector in Brazil is to support the Government in moving towards economically efficient energy pricing, investment and operational policy, taking into account environmental, fiscal, financial, and income-distribution considerations. Specific elements in this general strategy are: (a) bringing energy prices closer to economic costs; (b) basing the energy investment program on a realistic demand forecast and the least-cost method of supplying the demand; (c) strengthening energy sector institutions and improving coordination among them toward the effective execution of an integrated national energy policy; (d) wider use of market-based incentives; and (e) increasing participation of the private sector. To implement this strategy, key policy issues should be addressed at the level of the energy sector as a whole within a long-term perspective.

1.02 The Hydrocarbon Transport and Processing Project would extend the direct relationship of the Bank in the energy sector to Petroleo Brasileiro S.A. (PETROBRAS) and address a number of high priority issues such as efficient inter-fuel substitution, supply based on programs of lowest investment and operating costs, the environment, and energy pricing. These and other sectoral issues are also being dealt with by the Bank through other ongoing and future lending operations and through energy sector work, notably, the Energy Strategy and Issues Study (ESIS, discussed with the Brazilian authorities in March 1991 and scheduled to be issued in September 1991). Also, the Brazilian authorities established by presidential decree in September 1990 a Commission to Reexamine the Energy Matrix to identify the implications of alternative policies on the long term supply of and demand for different final energy sources. Work on the Energy Matrix is now being completed, taking into account the result of the ESIS. The Energy Matrix, in conjunction with ESIS, will provide the basis for the continuing dialogue of the Bank with the Brazilian authorities on the full range of energy issues.

B. Energy Resources

1.03 Brazil is relatively well endowed with energy resources, both renewable and non-renewable. According to the National Energy Balance, as prepared by the National Secretariat of Energy - SNE, now part of the Ministry of Infrastructure - MOI), the proven energy resources in 1989 included, in million tons of oil equivalent (toe): petroleum - 379; natural gas - 106; coal - 3,882; and hydroelectric power - 271 per year. There are also substantial deposits of shale oil and gas, uranium and peat, but their economic potential is far less. Moreover, sugar cane is used to produce alcohol for mixing with or substituting for gasoline, and bagasse produced by the sugar industry could supply electricity. The Bank is supporting the study of this latter option through its electric power lending.

C. Energy Demand and Supply

1.04 Primary energy consumption increased by 4.5% p.a. from 1971 to 1990. Currently, petroleum accounts for 33% of total energy consumption,

hydroelectricity for 33%, firewood 15%, alcohol from sugar cane 10%, coal 5% and gas 2%. Primary energy production expanded more rapidly, at 5% p.a., indicating a slight decline in Brazil's relative dependence on imported energy. The percentage of total energy demand that Brazil had to import increased from 24% in 1971 to 37% in 1979, declined to 16% in 1985, and then rose to 18% in 1990. Data on primary energy production and consumption in Brazil for 1971-1990 are in Annex 1.01.

1.05 The increase in primary energy production during the period was provided mainly by hydropower and, to a lesser extent, coal and sugar cane. Between 1980 and 1990, the contribution of petroleum and sugar cane increased significantly, although hydropower continued to meet a substantial part of the growth in energy demand.

1.06 Petroleum imports represented 68% of petroleum consumption in 1971. After reaching a peak of 85% in 1979, the degree of dependence on imported petroleum had fallen to 46% by 1990. In absolute terms, petroleum imports were 360,000 barrels per day (bpd) in 1971, reached a peak of nearly 1 million bpd in 1979, and fell to 571,000 bpd in 1990. Dependence on the Middle East for petroleum imports fell slightly from over 90% in 1979 to 87% in 1990.

D. Energy Sector Investments

1.07 During most of the 1980s, 15-20% of the country's total fixed investments were made by the energy sector, mainly by PETROBRAS and the group of power utilities associated with Centrais Eletricas Brasileiras S.A. (ELETROBRAS). ELETROBRAS is a Government-owned holding company which coordinates a number of sector functions, including planning for generation and transmission expansion. At the peak, in 1981-83, following the second oil price shock of 1979, the sector was absorbing 20% of all investment in Brazil and over 4% of GDP. Energy investments declined thereafter, as demand growth and resource availability fell. Within the energy sector, electricity has traditionally absorbed double the investment of petroleum. Annual investments by PETROBRAS have been US$1.9-2.3 billion during the past three years, well below the levels of the early 1980s (US$3-4 billion). The bulk of this investment went to crude oil and natural gas exploration and production. In addition to financing all of these investments from its own resources or from borrowing on its own account, PETROBRAS made annual net transfers to the Government (para. 2.16). Total annual investment in the electric power subsector averaged about US$4-6 billion for most of 1977-1989. After 1980 the financial situation in electricity deteriorated rapidly, and by 1987 the Government had become the major source of financing. The amounts contributed by the public sector (Federal, State and local governments) increased from US$400 million on average in 1977-1982, to US$2 billion in 1983-1985, US$5 billion in 1986 and US$6 billion in 1987, before declining as total investment fell to below $4 billion in 1989-90. Still, the energy sector is likely to continue to account for a significant part of Brazil's public investment, probably some US$8-10 billion annually, as the economy and energy demand grow.

E. Energy Pricing

1.08 As a general principle, energy prices should reflect their scarcity values or opportunity costs. For non-tradeable sources of energy, this value is the long-run marginal cost (LRMC) of supply, including geographical differences.

This principle may be tempered to meet the basic needs of low-income households. In theory, it may also need to be adjusted to meet sector financial and cost-recovery objectives; however, in practice, LRMC pricing in Brazil would also serve these objectives very well. Efficient pricing would encourage efficient inter-fuel substitution (which would reduce the cost of energy consumed), optimal location of energy intensive activities, and energy conservation, strengthen public sector management, and reduce public investment, external debt, the public sector deficit, and, in the medium and long term, inflation.

1.09 In the electric power subsector, with Bank support (e.g., Loan No. 1300-BR, Northeast Power Distribution) Brazil has made considerable progress in formulating an LRMC-based tariff structure, while providing a minimum level of consumption at a tariff which is affordable to lower-income consumers. However, since 1980 the average electricity tariff level has generally been too low, which has discouraged energy conservation, over-stimulated demand and investment, and damaged the financial position of sector enterprises, which in turn eliminated the potential for self-financing. Also, except for small differences due to state and local taxes in the retail prices, the tariff has been nationally uniform which has caused excessive consumption in high-cost areas and deprived regions of the incentive to use local energy-supply options.

1.10 In the hydrocarbons subsector, Brazil has adjusted the level of prices for petroleum products, even during periods of high inflation, and generally kept the average domestic price of a composite barrel of oil products above the economic cost or border parity equivalent (adjusting for transport costs to the final consumer). However, this price level was achieved mainly by a high gasoline price, which cross-subsidized naphtha, kerosene and liquid petroleum gas (LPG), relative to their economic costs. While diesel was priced close to its economic cost, it was under-priced relative to gasoline, which has caused some undesirable inter-fuel substitution. LPG was subsidized primarily to assist low-income families; however, the low price may also have encouraged its (clandestine) substitution for gasoline as a vehicle fuel. Finally, the price of alcohol as an automotive fuel, is maintained artificially below that of gasoline, although its economic cost is higher.

1.11 Like electricity tariffs, petroleum product prices were subject to a system of uniform, national retail prices. While ex-refinery prices are still nationally uniform, steps are now being formulated towards partial deregulation of retail prices, with price competition emerging in the distribution and transport of petroleum products. Also, as with electricity, the states and municipalities are now establishing different rates of tax (Annex 1.02). The adverse impact of uniform ex-refinery prices on PETROBRAS finances is minimal; however, from an economic view point, the subsidies are more troublesome, because they, as in electricity, distort patterns of development away from activities which would exploit regional comparative advantage, and discourage energy conservation where costs are high. Finally, the tax element in petroleum products prices is low by world standards, around 20% of the average retail price.

1.12 Two sets of Federal legislation regulate the determination of domestic retail prices of petroleum products, and thus have had an impact on the financial performance of PETROBRAS. The first (Resolutions 002 and 004 of the National Petroleum Council - CNP) establishes general guidelines for pricing,

including the principle that prices should reflect the cost of imports, and that regular adjustments for inflation should be made, consistent with the Government's exchange rate policy. The second set (Federal Decree 61 and Law 7453) assures that prices would provide minimum rates of return on investment from each of PETROBRAS' major activities. The legislation was applied with reasonable consistency by CNP in the past, and thus was partially responsible for PETROBRAS' strong historic financial performance. There were major lags in 1987-1988 but the situation has improved significantly since then, due to regular retail price adjustments which have mitigated the effect of inflation on revenues. The Department of Combustible Fuels (DNC) established in 1990 within the SNE took over the regulatory mandate of CNP and, in line with the new Government policy, began to liberalize retail prices (para. 1.11).

1.13 In the past, natural gas pricing was geared mainly to encourage its use in petrochemicals and fertilizer production. Natural gas prices were not to exceed those of naphtha, which was subsidized (para. 1.10). This situation is changing and progress is being made in the reform of natural gas retail pricing policy, under the Bank-assisted Sao Paulo Natural Gas Distribution Project (Loan No. 3043-BR), by developing and gradually introducing in Sao Paulo, a gas tariff structure reflecting economic costs. The 1988 Constitution established that the states will be responsible for the retail gas prices charged by local distribution companies. The Federal Government fixes wholesale or transfer prices from PETROBRAS to the distributing companies at the city gates, and it has confirmed its intention to pursue economic principles, by using the cost of substitutes as a reference. Since the Government also fixes the prices of the major competing fuels for natural gas (notably fuel oil and LPG), it has an indirect influence on natural gas prices at the consumer level.

F. Energy Conservation

1.14 As energy costs and consumption increase, and environmental concerns become more acute, energy conservation, especially in industry and transport, has become a priority (Annex 1.03). Various indices of energy intensity show an upward trend relative to the unit value of output, and specific electricity consumption has risen in a wide cross-section of Brazilian industries since 1980. The potential for conserving electricity in industries, and diesel, gasoline and alcohol in transport, is high. In addition, the use of natural gas might be feasible in urban areas, as a substitute for diesel and gasoline in buses and taxis.

1.15 Experience from a variety of countries shows that the level and structure of energy prices is the critical element in any effective demand management and conservation strategy. Brazil has pursued a variety of other approaches including technical methods, legislation, education and promotion. In 1981, the Ministry of Industry & Commerce (MIC) launched an ambitious program (CONSERVE) promoting the rationalization of energy use in industry, although it was principally a program to substitute petroleum products with electricity rather than a broad program of energy conservation. More recently, the Government launched a National Program of Electric Energy Conservation (PROCEL), elements of which the Bank is supporting through its electric power lending program. Other conservation programs were: the Program for Economizing Fuels (PECO); the Voluntary Program to Economize Diesel and Lubricants (PRODEL); and the Program to Rationalize Energy (PROEN). Given the importance of energy

conservation and the plethora of programs, an umbrella National Program for the Rationalization of Energy (PRONRE) has been established under the coordination of the Secretary of Science and Technology in the Presidency to bring about some degree of consistency and integration between existing programs and to establish priorities in energy conservation. A concern is that all of these non-price approaches carry a clear risk that they may not be cost-effective and may introduce additional market distortions beyond the ones they are designed to address. As a prerequisite for any effective energy conservation policy, the Federal Government should create a policy framework in which energy prices can secure a more efficient allocation of resources.

G. Environmental and Social Aspects

1.16 The electric power sector faces important environmental and resettlement issues in the construction of hydroelectric generation schemes. Major improvements have been achieved under the Power Sector Loan (2720-BR) in the capability of the sector to address such issues, and proposals for Amazonian hydro development have been postponed, scaled down or dropped. Other environmental and social issues facing the energy sector are: (a) the depletion of forests, due to land clearing and increasing charcoal production for the iron and steel industry in the state of Minas Gerais; (b) air and water pollution caused by the consumption of high-sulphur industrial fuels; (c) air pollution related to the operation of coal-fired power plants; and (d) environmental and safety aspects of nuclear power plants. The environmental issues relating to the power sector are being monitored by the Bank through the implementation of the Environmental Master Plan agreed under Loan 2720-BR. Other non-power environmental and social issues are being addressed by the Government with Bank assistance through the National Environmental Loan (3173-BR) and other operations. PETROBRAS has a strong environmental orientation and capacity (para. 2.09).

H. Institutional Structure

1.17 Energy planning, decision-making and policy implementation in Brazil have been characterized by a lack of coordination and clearly-defined goals. ELETROBRAS and PETROBRAS, which are powerful public enterprises under the jurisdiction of MOI, are major players in the energy sector. At the same time, there are numerous privately-owned companies or individual entrepreneurs in subsectors such as fuelwood, coal and alcohol, which are subject to different or no central control. Three parts of the Government -- the Ministry of Economy (MOE), MOI and the Secretariat for Regional Development -- for example, have responsibilities for alcohol. Although the Federal Government, through the MOE, in principle continues to approve the investment programs of ELETROBRAS and PETROBRAS, and ensures their consistency with the overall level of public sector spending, its efforts have at times been handicapped by a shortage of staff with detailed sectoral knowledge. In addition, the Government has at times been swayed by short-term annual budgetary and inflationary considerations, rather than long-term objectives, and by its decisions impact on the finances of PETROBRAS and ELECTROBRAS.

1.18 The situation with regard to energy pricing is illustrative. In the case of ELETROBRAS, PETROBRAS and the alcohol producers, different policies (and practices) are pursued in establishing output prices. The retail prices of

natural gas are established in yet a different way, according to different criteria, by the individual states. Further distortions are introduced by additional controls on retail energy prices as part of the Government's anti-inflationary policies, which are typically in conflict with pricing principles based upon economic cost.

I. The Refinery Subsector

1.19 Brazilian output of refined petroleum products has grown steadily over recent years by about 2.1% p.a. Output was close to 69 million m^3 of products in 1990; 98% produced by PETROBRAS and 2% by privately-owned refineries. Diesel oil accounted for 33% of output; gasoline, 16%; and fuel oil, 17%. The share of domestic crude as a feedstock increased from 17% of consumption in 1980 to 54% in 1990.

1.20 PETROBRAS bases decisions regarding the mix of domestic crude production and imports, the growth of refinery capacity and the mix of petroleum products on a production model in which relative prices are a major determinant. The model predicts: (i) a need to increase refinery capacity by 1.7% p.a. to 1997; (ii) the product balance to shift, with diesel increasing to 38% by 1997, fuel oil recovering to 23% and gasoline declining to 13%; and (iii) increased self-sufficiency in crude oil, rising to over 70% (paras. 2.21-2.23). However, the predictions and conclusions of the model are highly sensitive to future Government energy policy, primarily with respect to the alcohol program and pricing and investment in the hydrocarbon sector.

J. Hydrocarbon Transport System

1.21 The transport system of Brazil is extensive, with about 1.5 million km of roads (of which about 10% are paved), 29,000 km of railways, 35 important deep-water ports with numerous specialized bulk-facility terminals, 40,000 km of navigable rivers and many airports and airstrips. The transport sector accounts for about one-quarter of the total energy and almost one-half of the oil products consumed in Brazil, so that the potential for conservation of petroleum and alcohol products is important (Annex 1.04).

1.22 Within the transport system, the movement of fuels is substantial and expanding. PETROBRAS operates its own pipeline system which is growing in importance. The onshore and offshore product pipeline system has increased from 503 km in 1970 to over 4500 km in 1990. Additionally, natural gas pipelines in 1990 extended nearly 4000 kms, all installed since 1980.[1] The movement of petroleum products and alcohol from the refineries to the retail outlets is estimated to cost over US$1 billion. In terms of ton/km, about 54% is carried by coastal shipping, 3% by river transport, 20% by railways, 16% by road and 7% by pipelines. PETROBRAS meets most of its own coastal shipping and part of its international shipping requirements, the rest being provided, as market conditions dictate, by various forms of charter service. The fleet, 72 tankers, has grown from 1.3 millions dead weight tons (mdwt) to 5.3 mdwt between 1973 and

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[1] Five systems scattered along the Atlantic coast: three in the Northeast and one each in the states of Rio de Janeiro and Sao Paulo.

1990. This fleet provided 68% of the company's domestic coastal transport and about 45% of its international haulage in ton/km. The present strategy is to continue to increase Brazilian carriage of international movements but reduce road and short-haul coastal shipping in favor of more economic pipeline movements. Nine marine transportation terminals provide on- and off-loading facilities and total storage capacity of about 60 million barrels. Platforms, terminals, refineries and other facilities are linked through a network of on- and off-shore pipelines. PETROBRAS does not operate trucking or rail services. PETROBRAS carries out transport planning which focuses on optimum cost solutions from the company point of view. Transport planning needs greater sophistication, in particular to evaluate and compare the relative merits of the use of different transport modes in the light of future economic activities. The proposed project would address this issue (para. 3.02 (f)) with consultancy assistance.

K. The Natural Gas Subsector

1.23 Proved Brazilian natural gas reserves increased from 52.4 BCM in 1980 to 115 BCM in 1990.[2] Half of the reserves are located offshore and about 60% are associated with oil production. The development of associated gas reserves has followed that of crude oil. The development of the higher-cost non-associated gas reserves has lagged behind. In 1986, the reserve-to-production ratio for non-associated gas was 44 years compared to 12 years for associated gas. Out of a total natural gas supply of 6.3 BCM in 1990, only about 1.2 BCM (19%) was contributed by non-associated gas.

1.24 Private sector participation in the hydrocarbon sector has focused on oil exploration (para. 2.04). However, recently a major non-associated gas field was discovered by Shell-Pecten in the Santos basin. Reserves are estimated at 12 BCM. According to its contract with PETROBRAS, Shell will spend in excess of US$200 million on field development offshore and on transport facilities, and will begin commercial delivery of gas and liquid condensates in September 1992.

1.25 Gross primary production of natural gas amounted to 17.2 million m^3/day in 1990. Much of this production was either flared (19%), reinjected in oil fields to maintain pressure (17%) or used by PETROBRAS directly in its field operations (20%), resulting in a net supply to users of about 7.6 million m^3/day. The natural gas availability from domestic sources by the year 2000 is estimated to more than double, but this is small compared to potential demand of up to 100 million m^3/day, the level depending primarily on the pricing policy adopted for natural gas and its competitors.

1.26 The current consumption of natural gas by non-PETROBRAS consumers is limited primarily by the lack of adequate transmission and distribution infrastructure. Natural gas consumption in 1990 was equivalent to only about 2.3% of final energy consumption. Natural gas was used primarily: (a) to replace fuel oil in industrial and commercial uses (63%); (b) in steel making (5%); (c) as a feedstock for the petrochemical (9%) and fertilizer (16%) industries; and (d) in residential uses, after conversion from town gas (7%). About 61% of the usage was in northeastern Brazil, 31% in Rio de Janeiro and 8% in Sao Paulo.

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2 Excluding reserves in deep offshore water beyond a depth of 400 meters or in the Amazon jungle.

Until recently, there was no consumption of natural gas in Sao Paulo, which is the largest potential market in Brazil. Only manufactured gas was distributed, derived from naphtha and refinery gases. However, the Gas Company of Sao Paulo, COMGAS (assisted by Loan No. 3043-BR) received from PETROBRAS 0.6 million m^3/day of natural gas in 1990, which will rise to 3 million m^3/day in 1992. Long-term plans are to completely replace manufactured gas in Sao Paulo. In Rio de Janeiro, the second largest potential market, about 1.1 million m^3/day of natural gas is distributed by the State Gas Company (CEG).

L. Government Policy in the Energy Sector

1.27 The sharp increases in international oil prices in the 1970s had a serious impact on the economy, especially on its balance of payments position, and profoundly affected Government energy policy. Brazilian dependence on imported petroleum had increased since 1970, reaching a peak of 85% of total petroleum needs in 1979 and making Brazil the largest net petroleum importer among the developing countries. Therefore, a national energy strategy was articulated, with three basic aims: (i) to improve energy conservation and to reduce the use of petroleum products through inter-fuel substitution; (ii) to increase the production and the proven reserves of domestic crude oil and natural gas; and (iii) to maximize the development of other domestic energy resources. In terms of supply, greater emphasis was placed on investments in petroleum exploration, production and refining; hydroelectric and nuclear power plants; and alcohol production. Some studies were conducted on alternative energy sources, e.g., vegetable oil to replace diesel, but with no practical results. More recently, natural gas production and use have been expanded. On the demand side, the price of alcohol has been set below the price of gasoline to encourage its substitution (para. 1.10); a relatively low diesel price has been set to stimulate the diesel fleet, again in substitution for gasoline; wood and coal burning were promoted, in ceramics and cement respectively, to substitute for fuel oil; and tariff incentives were provided for the consumption of hydroelectric power at a time when it was in excess supply, again to reduce fuel oil use.

1.28 These programs and policies succeeded in reducing Brazil's dependence on imported petroleum from 85% in 1979 to 46% in 1990. However, the resources needed to increase the domestic energy supply required a major increase in public expenditures, which contributed significantly to the country's foreign debt, fiscal deficit and inflation. The cost of the alcohol program, which was to support self-sufficiency, has been particularly high, since the economic cost of production exceeded the opportunity value of alcohol (measured by the import cost of gasoline). The annual subsidy to alcohol is estimated on this basis to be on the order of US$1.7 billion.

M. The Bank's Role and Strategy

1.29 The Bank strategy in Brazil has been to support policies and investments that encourage economic growth and social development in the context of macroeconomic stability. The emphasis is on efficient natural resource use and allocation, improved public sector management and the appropriate targeting and delivery of support to the poor. The energy sector is a key element in this strategy: a secure and efficient supply of energy is indispensable to economic growth. Because capital intensity and high foreign exchange requirements

characterize the sector, rational investment and pricing policies are being promoted by the Bank to lead to a more efficient development and use of energy resources.

1.30 The Bank strategy for the energy sector is being elaborated through its sector work (the ESIS - para. 1.02) and through various lending operations. The ESIS gave particular attention to the links between the energy sector and the macroeconomy. These linkages demonstrate that some of the key policy issues can only be addressed at the level of the energy sector as a whole and they require a far-sighted approach, extending beyond the scope of any single Bank operation.

1.31 The Bank has had a long involvement in the Brazilian electric power subsector, with total lending of some US$4 billion since 1949. However, due to issues concerning nuclear power and electricity pricing, no loans were made in the period 1987-1989. Furthermore, the Electricity Transmission and Conservation Loan (3227-BR), approved on June 14, 1990, has not yet been signed because of lack of progress towards meeting the average tariff level which is a condition of effectiveness.

1.32 There has been only one lending operation in hydrocarbons, the Sao Paulo Natural Gas Distribution Project for US$94 million in 1988 (Loan No. 3043-BR). Some hydrocarbons sector work was also carried out, including the Oil and Gas Sector Review of 1983 (Report No. 4816-BR) and the Public Sector Investment Review of 1985 (Report No. 6600-BR). The Sao Paulo project permitted the Bank to establish a significant starting role in the development of natural gas, principally at the retail level, and to broaden its involvement in issues related to general energy sector policy, planning and implementation. However, for further progress with the policy dialogue a direct relationship with PETROBRAS, the key player in the hydrocarbon subsector, is essential; and the proposed loan would accomplish this objective.

1.33 Through continued involvement in the gas subsector, the Bank would help the Government and PETROBRAS develop an overall strategy to: (a) stimulate the economic utilization of natural gas resources; and (b) clarify natural gas utilization priorities. Bank involvement with the hydrocarbons subsector is also important to support environmental and energy conservation activities (as well as programs of lowest investment and operating cost), which would otherwise be constrained. Investments of this type are typically the first to be deferred in any energy company, where production is given greater emphasis when there are resource constraints.

1.34 Finally, the proposed project would permit continued progress in natural gas and petroleum product pricing policy. Under Loan 3043-BR, the state of Sao Paulo has accepted that the retail prices of natural gas should be based on principles reflecting the economic cost of gas; and the Government has already confirmed its intention to pursue a wholesale pricing policy for natural gas based on economic cost, subject to macroeconomic, social and financial considerations. The Gas Utilization Study being implemented under Loan 3043-BR will analyze the level and structure of economic costs and propose a rational retail gas tariff structure. An analogous exercise is required for wholesale gas pricing, and PETROBRAS has taken the first critical step by developing profit centers and upgrading its costing system (paras. 2.11 to 2.13). The system will provide essential information, now lacking, on the financial and economic cost

of bulk supply; ascertain the transfer prices which are necessary to provide the incentive to conserve gas reserves and increase supply, especially from existing non-associated reserves; and serve as a basis for pricing proposals to the Government.

1.35 Cost-of-service studies are also a prerequisite for establishing economic opportunity costs in the determination of petroleum product prices. The upgrading of the costing system by PETROBRAS, in conjunction with the establishment of profit centers, is necessary to establish a more efficient pricing structure. Also, it will provide essential base information for cost-effective operating policies. PETROBRAS has welcomed Bank participation in the continuing process of developing and refining its cost-of-service studies. The project would provide for periodic reviews of gas and petroleum product costs with the Brazilian authorities. Such reviews would complement the Bank-Government dialogue in the context of the Energy Matrix and ESIS.

II. THE EXECUTING AGENCY - PETROBRAS

A. Corporate Activities

2.01 PETROBRAS has responded well to its mandate to lead Brazil towards greater self-sufficiency in hydrocarbons, and has become a rare public sector success story in Latin America. While PETROBRAS has a dominant (and often monopoly) role in several areas of hydrocarbons (particularly in exploration and production), the company displays a strong commercial orientation, largely because of its significant private sector ownership. In consequence, it is efficient and technologically advanced, with successful international operations.

2.02 Since the founding of PETROBRAS in 1953, its responsibilities have gradually increased. The company, through its six subsidiaries (Annex 2.01), has been responsible for: exploration and production of hydrocarbons; provision of services and technical assistance abroad; import and export of selected commodities; evaluation of the hydrocarbon and mineral potential of sedimentary basins; some mineral production; marine and pipeline transport; and refining. PETROBRAS also dominates both Brazilian petrochemical and fertilizer production and has over 35% of the domestic retail market for petroleum products. Following the privatization policy of the current Administration, the group is in the process of reducing its interest in trading, mineral production, chemicals and fertilizer, progressively divesting itself of activities which are not directly related to hydrocarbons, its primary mandate.

2.03 With the objective to strive for petroleum self-sufficiency PETROBRAS, following the oil price shocks of the 1970s, emphasized exploration and production to discover and develop Brazil's significant hydrocarbons reserves. At the end of 1990, the company had 5,716 wells producing oil and condensate and 59 wells producing non-associated gas. Total 1990 production was 653,000 barrels per day of crude and condensates, and 17.2 million m^3/day of natural gas. PETROBRAS has 10 refineries, with a combined crude charge capacity of 1.5 million BPD, most of which are located in the South and Northeast coastal regions.

2.04 PETROBRAS is not alone in the hydrocarbon exploration and development field. Although the 1988 Constitution bans new risk contracts, "farm-ins"[3] are permitted. Hence, there is a large presence of international companies in upstream oil operations in Brazil. A total of 243 contracts have been signed since 1976 (2 are still in effect), with the participation of both foreign and domestic firms. These companies invested US$1.8 billion in exploration and development activities (US$138 million in 1989), drilling about 200 wells and "shooting" 165,000 km of seismic lines. The President of the Republic has announced that he will seek an end to PETROBRAS' monopoly power when the Constitution is amended in 1993.

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[3] Arrangements for risk capital and/or operational expertise to explore/develop hydrocarbon field(s) in exchange for a share of the production.

B. Ownership, Management and Organization

2.05 The Borrower and Executing Agency, PETROBRAS, was established in 1953 by Federal Law 2004 as a mixed (public/private) capital corporation. The company is owned 51.0% by the Federal Government, 10.7% by the National Development Bank (BNDES), 33.8% by individuals and private legal entities through publicly-traded shares, and 4.5% by other public sector entities. Only Brazilian companies or citizens can purchase shares; however, many Brazilian affiliates of foreign firms own shares. Although PETROBRAS may increase its equity funds by issuing new shares, the company's statutes stipulate that at least 51% of shares must remain in the hands of the Federal Government. Due to lack of funds, the Government is currently unable to subscribe to additional shares; thus, the raising of additional equity capital from private sources is constrained.

2.06 The President of the company is appointed by the President of the Republic, and presides over a 12-member Administrative Council, representing the shareholders for 3-year terms. The Administrative Council establishes general business policies, approves annual budgets, local and foreign borrowing, participation in other companies and annual investment programs. A Board of Directors (they are also members of the Council) is responsible for the day-to-day operations of the company and for execution of guidelines established by the Administrative Council. A Fiscal Council of five members appointed by the shareholders examines the financial accounts, cash and investment position of the company, and reports on the annual financial statements to the Administrative Council. The MOI represents the Federal Government at the annual ordinary general meeting of shareholders. Organization charts for the PETROBRAS Group and PETROBRAS, S.A. are shown in Annex 2.01.

2.07 PETROBRAS is divided into six operational departments (exploration, drilling, production, industrial, transport and commercial), and eight service departments (planning, data processing, engineering, legal, finance, public relations, supplies and human resource development). Departments for safety and environment, research and development, central administration and a general secretary report directly to the presidency. In addition, the company has specialized agencies for research and development and for the handling of exploration contracts, and representative offices in New York and London.

2.08 Staff of the PETROBRAS group numbered about 60,000 at the end of 1989. While salaries and benefits have historically been higher than in most state companies, salary levels, which are controlled by the Federal Government, have been eroded substantially in real terms by inflation. Because there is no other local provider, all training in petroleum sciences in Brazil is done by PETROBRAS.

2.09 PETROBRAS is well organized to handle environmental problems and is responsive to the requirements of environmental authorities. Environmental responsibilities, previously dispersed, have been centralized in a recently created superintendency reporting directly to the President in order to make the handling of environmental issues a clear corporate priority. This superintendency (incorporating the former Division of Engineering and Environmental Safety) prepares company-wide norms and guidelines on safety and environment, and is responsible for contracting environmental impact studies (RIMAs), as well as other policy related matters. Within the refinery

operations, an Environmental Division manages efforts of the individual environmental field-units located at the refineries. The field units are operationally-oriented, handling industrial safety, developing pollution control systems, and monitoring environmental performance. Every project requires an environmental evaluation and must be separately licensed by appropriate state environmental agencies for design, construction and operation. Aside from tackling the environmental and safety issues related to the production, refining and transport of petroleum products, PETROBRAS is making efforts to assist with reducing the air pollution caused by the consumption of high-sulphur industrial fuels in the main cities, notably Sao Paulo. Although staff have had some training in risk assessment and management, further training and professional strengthening is considered necessary, and will be provided under the project (para. 3.08 (b)).

C. Costing, Accounting and Audit

2.10 PETROBRAS submits annual capital and operating budgets to the Federal Government by September for approval before January. The extreme inflation of the past several years has led to almost continuous revision of the budget, making planning difficult. Since the early 1970s, investment decisions have been based on financial and economic cost-benefit analysis prepared by the company's Planning Department, with assistance from operational departments.

2.11 To improve the information flow for management decision-making, a Costing Division under the Financial Services Department was established in 1988 to bring into operation an upgraded costing system developed in conjunction with international consultants. The new system will gradually introduce economic concepts to complement existing financial information, thereby providing a fuller basis for decision-making regarding pricing, operational policies, investments and resource allocation. Notably, it will provide PETROBRAS with a more solid basis for submissions of its cost recovery requirements to the DNC, which in turn would use this information for natural gas and petroleum product price recommendations. Other goals include converting from the current system of cost centers to profit centers (which should result in organizational restructuring; hence, the gradual nature of system introduction), and segregating costs by project, product, activity, organizational unit, and market. Costs will be in constant, comparable values; and economic costs would be reflected by taking into account, inter alia, both the expansion and the replacement cost of assets, and the international "border" prices of crude oil and petroleum products. The new system, which is being implemented in phases and is scheduled to be fully operational by December 31, 1993 (Annex 2.02), is of central importance to the continuing dialogue between the Bank and the Government on economic choices in the energy sector.

2.12 The Bank has reviewed the consultant's diagnostic study (which is the basis of upgrading the costing system) and the implementation program which, in some areas, is already at an advanced stage. The work represents an important step toward generating transparent information for corporate decision-making, including economically efficient pricing and investment policies. The Costing Division, established to implement this new system, is adequately staffed with trained personnel.

2.13 PETROBRAS management intends to continue implementation of the upgraded system and completion of the costing exercise; and to this end has been gradually expanding the role of the Costing Division. During negotiations, agreement was reached with PETROBRAS that it will put into effect the new costing system by December 31, 1993 to provide more accurate and appropriate information for decision making. In addition, agreement was reached with both PETROBRAS and the Government to exchange views from time to time on its implementation and application.

2.14 Accounting is practiced according to internationally-accepted standards. The system is comprehensive with well-defined cost centers, and adjustments made to compensate for inflationary distortions. The Internal Audit Department is accountable directly to the President. Annual financial statements are audited by international external auditors with expertise in the petroleum industry, as well as by the MOI and the Tribunal de Contas. Annual audits are normally completed within four months after the end of the financial year. During negotiations, agreement was reached that: (a) the accounts, records and financial statements of PETROBRAS, and supporting evidence for Statements of Expenditures, would be audited each fiscal year by independent auditors with qualifications and experience acceptable to the Bank; and (b) the audit reports would be submitted to the Bank within four months after the end of the financial year together with the certified copies of the audited financial statements.

D. Financial Performance

2.15 Historically, PETROBRAS has had healthy revenues and a robust investment program which was largely self-financed. The main source of revenue (90-95%) has been product sales to the domestic market. Diesel, gasoline and alcohol sales have represented about two-thirds of total sales. Annual gross revenues of the PETROBRAS Group (including subsidiaries) during 1984-1987 averaged US$19-20 billion, but in 1988-1989 fell to about US$15-16 billion, largely due to a decrease in real domestic retail prices. Revenues have come primarily from the parent company, PETROBRAS S.A. (about 47-52%), and from the distribution affiliate, Petrobras Distribuidora-(BR) (about 22-26%).

2.16 Unlike the majority of state-owned enterprises, PETROBRAS has not relied on Government subsidies. Instead, it has regularly transferred substantial funds to the Federal Treasury. Between 1980-1982, in the era of comparatively high international oil prices, net transfers to the Federal Government (sales taxes, other duties, corporate income tax and dividends, less Government equity contributions) from PETROBRAS S.A. and BR alone amounted to about US$2.1 billion annually (Annex 1.02 gives a detailed description of hydrocarbon taxation policy). Between 1983 and 1986, the average net transfers fell to about US$1.3 billion. With an increasing tax on gasoline and alcohol, average transfers rose to US$2.7 billion in 1987-1989. Tax transfers from the private retail distributors would represent an additional US$0.6-1.5 billion each year.[4]

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[4] The fiscal regime was altered following adoption of the new Constitution of October 1988. The changes, which were implemented gradually over 1989, focus on transferring most fiscal revenues from the Federal Government to states and municipalities. It is expected, however, that the overall level of transfers

2.17 In 1985 and 1986, PETROBRAS generated net profits in the range of US$2.1 to 2.2 billion. With the relatively healthy income levels prior to 1985, the company was able to generate sufficient funds internally for debt service and the bulk of its investments. Investment-related borrowings rarely exceeded 25% of needs, and despite the large investment programs (in the early 1980s about US$3-4 billion per annum), PETROBRAS consistently ended its fiscal years with cash surpluses.

2.18 After 1986, a peak year, financial performance deteriorated. In 1990, revenues (net of sales tax) fell to US$11.4 billion, and net profits declined by about 75% (from US$2.2 billion to US$560 million). The decline was due primarily to: (a) the precipitous fall in international oil prices after 1986 which reduced margins because the border price of crude has been a major factor in establishing local prices; and (b) delayed and inadequate price adjustments in circumstances of increasing and high inflation. Because of its decreased earning power, PETROBRAS reduced its investment program, as a matter of commercially prudent policy and to safeguard its financial independence, from US$2.3 billion in 1987 to US$1.8 billion in 1989, still maintaining a high level of self-financing. In 1990, internally generated cash (net), covered more than three-quarters of the 1990 investment program of about US$850 million, and debt service coverage level was in excess of 2. The balance sheet position as of December 1990 was healthy. The debt/equity ratio was 18/82. With more regular (and adequate) price adjustments, the 1991 financial results are expected to significantly improve, even though the first quarter results will show the impact of increased international oil prices due to the Persian Gulf conflict. The past financial performance of PETROBRAS S.A. is shown on Table 1 (next page) and in Annex 2.03 (notes and assumptions are included as Annex 2.04).

2.19 The conflict between cost-recovery policy and pricing adjustments under high inflation has generated a complex financial environment for PETROBRAS, especially with respect to the formulation of development plans. To address this complexity and to improve coordination between macroeconomic policy and specific policies of the state owned firms, the Government is experimenting with the concept of "contract management" on a yearly basis. PETROBRAS became in May 1991 the first organization to draft such a contract with the Government. The contract comprises commitments in terms of financial and productivity targets as well as agreement on the rules for price adjustments. The combination of this mechanism with the on-going upgrading of the costing system (para. 2.11) could increase dramatically the transparency of the economic relations between the Government and PETROBRAS, facilitating the development of a more stable environment for planning purposes, and less pricing control. However the effectiveness of this "contract management" approach has yet to be tested in Brazil.

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from the sector will remain roughly the same as those of the period 1987-1988, i.e., in the range of 20% of gross revenues.

TABLE 1
Revenue Generation and Funds Flow - PETROBRAS
1984-1990
(US$ Millions)

	1984	1985	1986	1987	1988	1989	1990
SOURCES	5,139	4,802	4,813	2,238	3,096	2,417	4,192
Gross Revenues	14,809	13,890	15,087	14,734	13,324	14,327	11,434
Less: Sales Taxes	1,951	1,955	2,127	3,221	2,820	2,900	2,307
Less: Expenses	12,285	9,810	10,724	11,319	9,880	10,574	8,568
Net Profit	573	2,125	2,236	194	624	853	559
Plus: L-T Interest	2,071	877	649	432	370	238	1,932
Plus: Depreciation	429	464	515	557	497	398	356
Plus: Inv. Charged to Ops.	1,301	1,311	716	800	895	631	840
Plus: Other Non-Cash	246	(210)	374	(458)	212	(195)	253
Total Internal Sources	4,620	4,567	4,490	1,525	2,598	1,925	3,940
Borrowing	502	221	271	690	479	472	224
Equity Contribution	17	14	53	22	20	20	28
Total External Sources	519	235	323	713	498	492	252
USES	5,139	4,802	4,813	2,238	3,096	2,417	4,192
Investments	1,732	1,729	1,678	2,254	2,147	1,861	731
Debt Service	2,761	1,746	1,192	1,311	1,139	803	2,048
Dividends	163	195	391	307	256	213	54
Other	374	725	751	283	175	21	120
Inc/Dec in Work. Cap.	109	407	801	(1,351)	(621)	(439)	1,234
Self-financing ratio	73%	87%	88%	68%	77%	67%	66%
Debt service coverage	1.7	2.6	3.8	1.2	2.3	2.4	2.8
Current Ratio	1.01	1.11	1.34	0.97	0.88	1.02	1.00
Debt/Equity Ratio	0.33	0.29	0.20	0.19	0.14	0.16	0.14

2.20 PETROBRAS pays its debts, both long- and short-term in a timely fashion. Short term lines of credit exist in foreign exchange to provide PETROBRAS an assured source of funds to cover crude and product imports, and also in local currency for general working capital requirements. Fixed assets in property, plant and equipment are undervalued, as in most Brazilian state enterprises. However, implementation of the new costing system will gradually remedy the situation, since it will base asset valuation on replacement costs.

E. Development Scenarios, Performance Projections

2.21 In November 1988, PETROBRAS issued an Action Plan (PASP) (Annex 2.05) which laid out the broad lines of a 10-year development program. The strategic targets for 1997 were to attain 96% national self-sufficiency in oil and increase national gas production to 70 million m^3/day. These ambitious targets were accompanied by a program to reduce the cost of petroleum transport and increase the efficiency of the refineries. The program called for an annual average investment of US$3.4 billion. Within a few months of its publication, PASP had become obsolete due to the anti-inflationary program ("Plano Verao") in early 1989 which dramatically reduced, inter alia, PETROBRAS' investment budget. Mainly due to the accelerating inflation and the constantly changing macroeconomic policies, PETROBRAS until recently had been, for all practical purposes, without a clearly articulated, medium term investment and operational program.

2.22 In the last four years, with constraints on revenue generating capacity and external funding, PETROBRAS has adopted a policy stressing efficiency and cost effectiveness, both in operation and investment. This policy was implemented through, inter alia, improvements ("debottlenecking") to transportation networks, and the upgrading of technology to improve productivity in refinery operations. From 1987 to 1989, this has led to a 74% increase in investment funds allocated to transportation (from US$192 million to US$334 million) and of 238% increase in funds spent on the refinery subsector (from US$78 million to US$264 million).

2.23 Recently, in light of forecast volatility in international oil prices, PETROBRAS has revised its plans for the development and production of indigenous crude to reach 70% self-sufficiency in the next 4 years (from about 54% currently). Depending on the availability of financial resources, implementation of the program may take longer than the projected 4 years. The objectives and direction are logical and justified, particularly considering the size of the known indigenous resources and advanced technology of PETROBRAS, especially for deep-sea production. The program, if carried out over a four year period, would involve annual investments averaging US$3.4 billion. About 12% (US$2.1 billion) would be invested in new and upgraded transport systems; 14% (US$2.4 billion) in the refinery sector; and 74% (US$12.4 billion) primarily in exploration and production. The proposed project would represent about 17% of total transport investment and 11% of [illegible]nery investments planned in the program.

2.24 The future performance of PETROBRAS and its ability to undertake the above program within four years, are expected to be affected basically by: (a) changes in sector priorities and policies by Federal Government; (b) success of

economic measures currently underway and the resultant rate of domestic inflation; (c) level of international oil prices; and (d) the extent to which local prices reflect international prices. The Persian Gulf crisis is not expected to affect the future financial performance of PETROBRAS. The financial forecast for 1991-1997 (Annex 2.03) is based on Bank projections for international petroleum prices, domestic prices (retail and ex-refinery) roughly paralleling the assumed international price trend, and sales growth on the average of about 3.5% p.a. The projections indicate an average annual net profit of US$1.3 billion during the next five years. The net internal cash generation (on the average US$2.0 billion p.a.) would allow PETROBRAS to undertake, at a minimum, an investment program of US$1.8-2.2 billion p.a., extending the implementation period program from 5 to 8-9 years. In that case, borrowing on the average would be no more than 30% of the investment requirements, and PETROBRAS would still maintain a very healthy debt service coverage (Annex 2.03, page 2).

2.25 To ensure that financial performance continues to be strong, during negotiations agreement was reached that PETROBRAS would: (a) incur no long-term debt without Bank agreement if: (i) a reasonable financial forecast shows an annual debt-service coverage ratio of less than 1.4 times, or (ii) after the incurrence of such debt, the ratio of debt to equity is greater than 40 to 60; (b) maintain a current ratio of not less than 0.8; (c) produce funds from internal sources equivalent to not less than 30% of capital expenditures in 1991, 35% in 1992, 40% in 1993 and 1994 and 45% in 1995 and thereafter; (d) review with the Bank, by November 30 of each year, a financial forecast satisfactory to the Bank, the object of such review being to determine whether PETROBRAS would meet the above financial targets; and (e) take all necessary measures to meet the above financial targets.

III. THE PROJECT

A. Objectives

3.01 The project's main objectives are to: (a) enhance natural gas utilization as a substitute for other sources of energy with higher economic and environmental costs; (b) reduce the distribution costs of petroleum products by substituting pipelines for road and water transport; (c) reduce petroleum product losses through processing optimization; and (d) reduce environmental costs and safety risks associated with petroleum product transport and with refining. The project would include a Transport and a Processing Component, together with related operational and industrial safety training. The proposed loan would address several of the highest-priority issues identified by ESIS, viz.: efficient substitution of gas for other fuels; supply based on lowest investment and operating costs; the environment; and energy pricing. Furthermore, the project would reduce the public sector deficit and improve the balance of trade. It would also support the ESIS in promoting dialogue on energy policy with the Government.

B. Transport Component

(1) Description

3.02 The transport component comprises the following:

(a) A 42 km, 12" pipeline and related facilities to deliver 1.7 million m^3 per day of natural gas (originating in the Merluza field) to Sao Paulo City and to blend the extracted condensates with other products at the Presidente Bernardes Refinery at Cubatao (RPBC).

(b) A 153 km, 18" petroleum products pipeline from a products terminal at Guararema (near Sao Paulo) to the Planalto Refinery near Campinas (REPLAN) plus related pump station additions. The pipeline will be connected at Tegua to an existing line from the Vale do Paraiba Refinery near Sao Jose dos Campos (REVAP) and will allow transfer of refined products and alcohol between the two refineries and their consuming areas.

(c) A 253 km petroleum products pipeline with 8" and 10" diameter from the Parana Refinery (REPAR) near Curitiba, to Joinville/Itajai and Florianapolis, all in the State of Santa Catarina. Also included are related pump station additions at REPAR, a new pump station, storage tanks, spheres and truck loading facilities at Itajai, Joinville and Florianapolis.

(d) A 361 km, 10" and 8" products pipeline from the PETROBRAS Terminal at Madre de Deus (TEMADRE) near Salvador, Bahia, to Ipiau, where the line will bifurcate with branches going to Jequie and Itabuna, both in the State of Bahia. Also included are related pump station additions at TEMADRE and storage tanks, spheres and truck loading facilities at Jequie and Itabuna.

(e) Engineering design and environmental impact studies for the above; and

(f) Assistance to enhance transport planning capacity and training (inside and outside of Brazil) for pipeline staff in: (i) corrosion control; (ii) design and maintenance of instrumentation, automation and supervisory control and data acquisition systems (SCADA) for the product pipelines; (iii) operation of the latter including product metering and quality and interface control; (iv) operation of instrumentation, automation and SCADA equipment for gas pipelines; and (v) economic evaluation of liquids and gas transport by pipelines.

Detailed descriptions of the components are in Annexes 3.01 and 3.02 and Map IBRD 21867.

(2) Cost and Financing

3.03 The total cost of the transport component is estimated at US$362 million equivalent including all contingencies, interest during construction (IDC), and taxes. Without taxes and IDC the cost is US$307 million, with the foreign exchange cost at US$174 million or 57%. The Bank would finance 49.8% of the costs (excluding IDC, taxes and duties) of the transport component or US$153.2 million equivalent. PETROBRAS would finance the remainder and IDC, taxes and duties. The cost estimates are based on recent supplier prices for similar equipment and on recently completed similar works. Design and project engineering costs are based on recent man-months rates for local consultants. The cost estimates include average physical contingencies of 12% and price contingencies of 3.4% p.a. during the period 1991-1994 on both the foreign exchange and local currency costs. It is assumed that periodic local currency devaluations would compensate for differences between the projected US dollar and local inflation rates. However, construction costs have risen more rapidly than devaluation recently, and project costs will be carefully monitored throughout project implementation. The table on the following page summarizes the cost estimates; Annex 3.03 shows further details.

3.04 Shell, which is the operator of the Merluza field, will finance the development of the field and the facilities to deliver the wet gas to the RPBC. These facilities are not part of the project. However, the timely availability of natural gas for the Santos to Sao Paulo pipeline from Merluza field must be ensured. During negotiation, as a condition of disbursement of this part of the project, PETROBRAS agreed to furnish satisfactory evidence on the timely availability of gas from such field.

TRANSPORT COMPONENT
ESTIMATED PROJECT COSTS
US$ MILLION

	LOCAL	FOREIGN	TOTAL COSTS
Materials	28.2	31.5	59.7
Works	26.7	101.6	128.3
Equipment	19.4	5.0	24.4
Engineering Design	14.1	-	14.1
Training and Planning	-	1.0	1.0
Land and Easements	1.2	-	1.2
Total Base Cost	89.6	139.1	228.7
Physical Contingencies	16.1	12.0	28.1
Price Contingencies	22.6	18.2	40.8
Incremental Working Capital	5.0	5.0	10.0
Sub Total	133.3	174.3	307.6
Interest During Construct.	-	27.1	27.1
Taxes & Duties	27.4	-	27.4
Financing Requirement	160.7	201.4	362.1

(3) Implementation

3.05 The basic designs for the transport component, including equipment specifications and pipeline route selections, have been substantially completed by PETROBRAS. The detailed designs are being done by local consultants who will do the field supervision and quality control as well. By September 1991, detailed designs would be substantially completed. The construction contractors selected will do the pipeline construction plan and profile. All consultants and contractors will be supervised by Engineering Services (PETROBRAS), which will be in charge of implementation of the transport component. The component is scheduled for completion over 4 years (Annex 3.04). This schedule, in view of experience of PETROBRAS in similar projects, is realistic. Training in pipeline technology and transport planning and in project preparation would be financed by the Bank and would be carried out by consultants selected according to Bank Guidelines. Procurement methods are summarized in Annex 3.04. During negotiations, PETROBRAS agreed to exchange views with the Bank annually and not later than October 1, on the training program for the following calendar year. The Terms of Reference, the basis of the consultants' work, will be subject to Bank review and concurrence.

(4) Procurement

3.06 Individual contracts for goods and works estimated to exceed US$250,000 and US$2.5 million respectively will be procured under International

Competitive Bidding (ICB) in accordance with Bank Guidelines for Procurement, and will require prior Bank review of the bid documents and of bidder selection. Some 20 such bid documents would be issued for all pipeline construction, pipes, valves, tanks and spheres including erection, and pump and compressor station equipment and for about half of the pipeline and station materials. These bids would generally comprise large groupings of like goods and works, divisible into smaller packages, to ensure the interest of both large international suppliers and contractors and that of the smaller local ones. Individual bidders and consortia with proper safeguards, such as joint and several liability, will be allowed to bid after proper prequalification, for the Joinville/Itajaí and Florianápolis, and the Jequié-Itabuna pipelines. In bid evaluation, under ICB, a domestic preference will apply to Brazilian suppliers in accordance with Bank Guidelines for Procurement. Goods whose value is estimated at equal to or less less than US$250,000 equivalent would be procured under Local Competitive Bidding Procedures (LCB) acceptable to the Bank up to an aggregate of US$ 5 million. The Bank would not finance any contract for works whose value is estimated at less than US$2.5 million. Goods whose value is estimated at less than US$25,000 equivalent would be procured under International and Local Shopping procedures satisfactory to the Bank up to an aggregate of US$6 million. The balance of the goods, works and services covering consultants' services for engineering design and supervision, land acquisition, the balance of materials, all industrial construction at the pump station and terminal sites, and all civil construction would be procured under PETROBRAS procurement rules, which were reviewed and found acceptable to the Bank. The Bank would not finance these contracts. Procurement methods are summarized in Annex 3.04.

(5) Technical and Financial Justification

3.07 In Sao Paulo, demand for natural gas is considerably higher than the available supply for COMGAS through its existing gas purchase contract with PETROBRAS. To meet at least part of this pent-up demand, COMGAS intends to purchase from PETROBRAS all the available natural gas from the Santos basin. There are no technical alternatives to a pipeline if Santos basin gas is to be made available to Sao Paulo. The design capacity of the line ensures least cost solution. The three liquid (products) pipelines constitute technologically and financially advanced means of transporting products from refineries to consuming areas. These pipelines will transport a significant volume of products in the heavily populated coastal regions, resulting in considerable transport cost savings by avoiding costly land and sea transportation together with handling costs and product losses. Two of the pipelines would replace combined land and sea transportation: (a) the pipeline from TEMADRE Terminal in Salvador to Itabuna which will provide a net savings of about US$6.80/m3 (US$1.08/bbl); and (b) the line from the REPAR Refinery to Florianopolis which would provide a savings of roughly US$11.50/m3 (US$1.83/bbl). The third pipeline from Guararema to REPLAN, which replaces only road transport, would provide savings of about US$13/m3 (US$2.07/bbl). The total cost savings from the three lines would be on the order of US$70 million per year. Sensitivity analysis indicates that changes in international oil prices have small impact on the financial benefits.

C. Processing Component

(1) Description

3.08 The processing component of the Project consists of:

(a) Hydrotreatment Plant - the installation of hydro desulphurization and treatment facilities (HDT) of 5,000 m^3/day capacity at the RPBC to treat with hydrogen the gas oil streams and convert them into diesel oil of appropriate specification and to remove over 90% of the sulphur present in the feed gas oils in the form of elemental sulphur. The plant, comprising hydrogen treatment, hydrogen generation, off-gas treatment and sulphur recovery, will increase the net production of marketable diesel oil and contribute to pollution abatement at the fuel user's end by reducing the sulphur content of diesel oil and fuel oils;

(b) Industrial Safety Program - basically aimed at the Cubatao area (to be expanded later to other refineries), would include: 1) a comprehensive risk assessment of the RPBC Refinery operations and an odor evaluation study; 2) appropriate training to enhance the risk assessment and risk management capacity of PETROBRAS staff at both Cubatao and the headquarters (including the establishment of an appropriately staffed risk assessment unit by September 1991). The training would focus on hazard analysis and management in petroleum products storage, manufacturing and refining processes, hazardous material handling and toxicological risk assessment; and 3) acquisition of mobile air quality monitoring laboratories to be used in and near refineries; and

(c) Automation (ACO) Program - to improve process and storage control systems in the refineries with the objective of achieving higher refinery capacity utilization, reducing product and quality losses, and improving the safety and reliability of operation. Specifically, the program would include: (1) feasibility/diagnostic studies for installing advanced control and optimization (ACO) systems in different processing units of PETROBRAS refineries; and (2) subject to the findings of the feasibility studies, installation of ACO systems at three atmospheric and vacuum destillation units, as pilot projects for progressively introducing ACO systems in all the PETROBRAS refineries.

Detailed descriptions are in Annex 3.01.

PROCESSING COMPONENT
ESTIMATED PROJECT COSTS
US$ MILLION

	LOCAL	FOREIGN	TOTAL COST
(a) Hydrotreatment Plant			
License and Engineering	6.5	1.6	8.1
Equipment, Materials, Spares, Catalyst & Chemicals	12.0	65.4	77.4
Works	48.2	-	48.2
Digital Control	0.4	1.0	1.4
Project Management	14.9	-	14.9
Start-up	2.9	-	2.9
Training	0.6	-	0.6
(b) Industrial Safety Program	0.2	2.8	3.0
Sub Total (a)+(b)	85.7	70.8	156.5
Physical Contingencies	14.0	9.2	23.2
Price Contingencies	21.5	14.2	35.7
Sub Total (a)+(b)	121.2	94.2	215.4
Interest During Construction	-	14.0	14.0
Taxes and Duties	18.2	-	18.2
Financing Requirement (a)+(b)	139.4	108.2	247.6
(c) Automation Program			
Diagnostic Study	0.5	0.9	1.4
Basic Engineering & Design	0.8	1.5	2.3
Instrumentation	0.6	2.3	2.9
Training	0.4	0.1	0.5
Installation, Commissioning	0.6	1.0	1.6
Sub Total (c)	2.9	5.8	8.7
Physical Contingencies	0.2	0.4	0.6
Price Contingencies	0.4	0.5	0.9
Sub Total (c)	3.5	6.7	10.2
Interest During Construction	-	1.0	1.0
Taxes and Duties	2.2	-	2.2
Financing Requirement (c)	5.7	7.7	13.4
Total Financing Requirement [(a)+(b)+(c)]	145.1	115.9	261.0

(2) Cost and Financing

3.09 The total cost for the processing component is estimated at US$261.0 million equivalent, including all contingencies, IDC, taxes and duties. Without taxes and IDC the cost is US$225.6 million with a foreign exchange cost of US$100.9 million or 45%. The following table summarizes the cost estimates, Annex 3.02 shows the details.

3.10 The cost estimates are based on recent US Gulf Coast and French costs for equipment, materials, spares, and man-hours estimates for construction and erection (corrected for labor/productivity differences). The cost estimate includes physical contingencies of 15% and price contingencies of 3.4% p.a. during the period 1991-1994 on both local and foreign exchange costs (para. 3.03). The Bank would finance US$106.8 million of the cost (excluding IDC, taxes and duties (or 47.1%) and PETROBRAS, in addition to its share of the project cost, would finance IDC, taxes and duties.

(3) Implementation

3.11 The technology for the gas oil hydrogen treatment unit has been developed jointly by Institut Francais du Petrole and the research and design unit of PETROBRAS, under a long-term technology development agreement, based on a proprietary process of the Institut. This process for hydrogen treatment of distillates is well proven throughout the world. "Know-how" for the furnace part of the hydrogen generation unit has been obtained from KTI (USA), and the hydrogen purification part is based on pressure swing absorption technology from Union Carbide (USA). All basic engineering and a substantial part of detailed engineering has been completed by PETROBRAS for the hydrogen treatment, hydrogen generation, sulphur recovery, and off-gas offsites units. Piping and other remaining engineering work has been contracted to a Brazilian engineering company.

3.12 The HDT component will be implemented by a full-time PETROBRAS task force headed by a properly qualified project manager. The task force will include experts in planning and control, technical studies, procurement, quality control, construction, and administration services. The task force organization and linkage with the central corporate departments (Annex 3.05) are typical of the structures for implementation of large refinery projects, and are acceptable to the Bank.

3.13 The hydrogen treatment reactors, which involve long delivery times, were ordered in April 1988. Detailed engineering for all the other facilities will be substantially completed by September 1991. Orders for other equipment and materials will be placed beginning in late 1991 and would be delivered progressively beginning in August 1992. Site clearances have been started and construction works are scheduled to begin in late 1991. Feedstock introduction and commencement of production operations are expected by mid-1994. Annex 3.06 shows the implementation schedule, which is considered realistic.

3.14 The diagnostic part of the ACO program will be carried out by consultants under the supervision of Industrial Department of PETROBRAS. During negotiations, PETROBRAS agreed to complete the ACO diagnostic study by

December 31, 1991 and to complete execution of the pilot project by December 31, 1993 if recommended in the diagnostic study.

3.15 The Industrial Safety Program will be carried out under the supervision of Environmental Division of PETROBRAS. Draft TORs have been developed; final TORs will be subject to Bank review, and selection of consultants will be according to Bank Guidelines. The studies will address current problems of safety and reliability at the refineries; and are expected to result in concrete programs and plans of actions which will also be reviewed by the Bank (paras. 3.20 and 3.23). During negotiations, PETROBRAS agreed to: (a) carry out the industrial safety program studies; (b) allow the Bank to comment on findings and recommended programs; and (c) make its best efforts to carry out such programs. PETROBRAS also agreed to establish and maintain a Risk Assessment Unit. It is expected that such unit will be operational by September 31, 1991.

(4) Procurement

3.16 The packaging for the HDT procurement has been done on the basis of discrete and homogenous groupings that will ensure receiving an adequate number of competitive bids, while keeping the number of bid packages to a minimum.

3.17 The Bank would finance goods (comprising equipment, materials, spares, catalysts and chemicals) and industrial works which are expected to exceed respectively US$250,000 and US$2.5 million per contract. These contracts would be procured under ICB in accordance with Bank Procurement Guidelines. Prior Bank review of bid documents and contract awards would be required. The Bank would finance one contract for industrial works, estimated at $8.8 million. In bid evaluation, domestic preference would be given to Brazilian suppliers in accordance with Bank Procurement Guidelines. Goods, the value of which is equal to or less than US$250,000 would be procured under Local Competitive Bidding (LCB) procedures acceptable to the Bank up to an aggregate of US$5 million. Bid packages for goods under US$25,000 would be procured under Local and International Shopping procedures satisfactory to the Bank up to an aggregate of US$2.6 million. Civil works would not be financed by the Bank, and would be contracted under PETROBRAS procedures which have been reviewed and found acceptable by the Bank. Procurement methods are summarized in Annex 3.04.

3.18 Selection of consultants for: (a) implementing the recommendations of the ACO diagnostic studies; and (b) process and detailed engineering, software development, supervision of installation, commissioning and training for tasks resulting from Stage I of the ACO Program and agreed by the Bank, will follow Bank Guidelines. Consultants for carrying out the diagnostic studies (Stage I) for the ACO, and procurement of computer hardware, and its installation will be the responsibility of PETROBRAS and will not be financed by the Bank.

(5) Technical and Financial Justification

3.19 The RPBC, with a nominal crude oil charge stock capacity of 24,000 m^3/d, produces a variety of refined products for energy and non-energy uses. Because of the types and capacities of refining equipment and because of the characteristics of the crude oil, significant amounts of gas oil fractions do not meet the required specifications for diesel oil and are downgraded into low-value

fuel oil. Furthermore, because of the lack of sulphur removal facilities, the sulphur in the gas oils is blended into fuel oil, resulting in a fuel oil with a relatively high sulphur content. Such fuel oil contributes to sulphur dioxide pollution. Current Brazilian diesel oil specifications permit up to 1% sulphur but PETROBRAS intends to reduce this progressively to 0.25% to mitigate diesel oil pollution. The HDT component will help to upgrade production to increase diesel oil output by 5,000 m^3/day, currently in deficit and imported (about 1.9 million m^3 per year). At the same time, production of high-sulphur fuel oil, currently in excess and exported (at a lower price than the import price of the diesel oil), will be reduced by about the same amount. The corresponding net reduction in sulphur dioxide would be equivalent to about 70 tons per day. Including the incremental feedstock, operating costs and the costs of financing, the unit would add net value of approximately US$31.50/$m^3$ (US$5.00/bbl) of product processed, or, about US$57 million per year. Changes in international oil prices would affect the benefits, more or less proportionately: an increase of 100% in the price would double the net value per unit of product processed, while a reduction of 50% in the oil price would reduce the benefit by about half.

3.20 The process and operations control instrumentation systems, when initially built for the ten PETROBRAS refineries, were of the pneumatic type. Recent advances in instrumentation and the advent of computerized control systems permit a faster control response-time and closer approach to the limits of controlled variables. Also, modelling techniques for process units permit simulation and selection of optimum operating parameters for regulatory control. Interfacing the advanced instrumentation with computerized digital control and with process simulation would permit PETROBRAS to respond flexibly and quickly to changes in products, markets, and prices, while maximizing yield under any given set of objectives. ACO systems also permit safer, more reliable production operations, reducing product and quality losses. Over time, PETROBRAS has modernized the instrumentation systems into electronic types in some of its refineries, permitting interfacing with computers for supervisory/ monitoring controls. Supervisory control systems have been installed in two PETROBRAS refineries. The proposed ACO Program represents the next step towards control system modernization that eventually would be installed in all the other PETROBRAS refineries.

D. Safety and Ecology

3.21 Pipeline transport of hydrocarbon products is distinctly superior environmentally to the current mode of truck and marine transport in four ways. First and most important, the risk associated with traffic accidents and subsequent spillage of hazardous and environmentally damaging materials is eliminated. Second, vehicular emissions are eliminated completely and replaced by negligible emissions from pump operations. Third, even in non-accident situations, small but persistent leaks in transport or transfers into and out of tank cars would be eliminated. Fourth, energy requirements are significantly less.

3.22 The pipelines will be coated, buried and protected from corrosion, thus greatly reducing the risk of leaks and giving the pipelines a life cycle equal to that of the protective coating, i.e., several decades. The pipe and tanks for all the facilities will be fabricated according to the standards of the American Petroleum Institute (API); and the installations will be governed by the

guidelines of the American National Standards Institute (ANSI). The facilities to be installed by Shell-Pecten for natural gas supply from the Merluza field will be governed by the same standards (para. 3.26).

3.23 Regarding safety there is a real concern, particularly at the older refineries. A recent fire at the vacuum distillation units of the RPBC is believed to have been caused by an obsolete control system. As a rule, proper automation of refinery operations will reduce human error, resulting in more stable operations with smaller variations in process variables (temperature, pressure, flow rates, etc.). This was one of the chief reasons for including institutional strengthening and special studies in the area of risk assessment for PETROBRAS (Annex 3.07). Automation of the tank farm operations will reduce the possibility of contamination and hence reduce the potential ecological risk from disposal of contaminated products.

E. Disbursements

3.24 The Bank would disburse 100% of foreign expenditures and 100% of local expenditures net of taxes for those parts of the Project which it is financing. Advance contracting of $60 million has been undertaken by PETROBRAS for urgently needed project components with long procurement lead time. Retroactive financing of up to $25 million (about 10% of the loan) for project components implemented since September 1, 1990 (one year before the estimated date of loan signing) would be provided.

3.25 Disbursement categories and amounts are shown in Annex 3.08. The proposed schedule of disbursements (Annex 3.09) is based on a four year implementation schedule, which is considered realistic, given the related experience of PETROBRAS, and the fact that the refinery work comprises only modifications to an existing plant. There are no relevant disbursement profile comparators in the Bank. Disbursements are expected to be completed in September 1994, and the closing date for the loan would be March 31, 1995, six months later. The minimum amount submitted to the Bank for direct disbursement from the loan account will be US$1.0 million. During negotiations PETROBRAS agreed to establish two Special Accounts: one (called CESA) for local expenditures with US$10 million initial deposit in the Central Bank; and one (called FESA) with US$10 million initial deposit in a commercial bank acceptable to the Bank, outside Brazil, for foreign expenditures. Replenishment of the Special Accounts would be according to standard Bank procedures and would be based on Statements of Expenditures. PETROBRAS also agreed that the Special Accounts will be audited by independent auditors acceptable to the Bank.

3.26 The project will be carried out in conformity with existing environmental legislation. To this end, during negotiations, as a condition for disbursement for the pipelines included in the transportation component, PETROBRAS agreed to provide the Bank with satisfactory evidence of formal approval (RIMAs) by the appropriate Federal and state environmental authorities. With respect to two product lines (REPAR to Florianapolis and TEMADRE/Jequie/Itabuna), which cross particularly sensitive areas, PETROBRAS agreed that disbursement for these facilities would be conditioned to Bank review and approval of the corresponding RIMAs prior to that of Federal and state authorities.

F. Monitoring, Coordination, and Reporting Requirements

3.27 Physical implementation and supervision of the transport and processing components will be the direct responsibility of Engineering Services of PETROBRAS. The Environmental Division will take direct responsibility for the industrial/safety sub-component. The Financial Services Division will coordinate all project related matters vis-a-vis the Bank, including procurement and disbursement administration, maintenance of the project accounts and preparation of periodic reports; and has considerable experience with these functions. The proposed arrangements are satisfactory. Within the Financial Services Division, a Project Coordinating Unit (PCU) will be the primary contact point vis-a-vis the Bank. During negotiations PETROBRAS agreed to maintain the PCU at all times during project implementation, headed by a manager with suitable qualification and experience assisted by qualified staff in adequate numbers. Also PETROBRAS agreed to furnish to the Bank monitoring reports on project implementation, operations and financial performance, within one month after the end of each quarter starting not later than three months after the signing of the loan agreement. Detailed reporting requirements are shown in Annex 3.10.

G. Economic Evaluation

3.28 Of the seven sub-projects, the following five,[5] representing about 97% of total project costs, are amenable to quantified economic analysis:

1) Petroleum products pipeline: REPAR - Florianopolis
2) Petroleum products pipeline: TEMADRE - Jequie - Itabuna
3) Petroleum products pipeline: REPLAN - Guararema
4) Gas pipeline: Santos-Sao Paulo
5) Hydrotreatment unit: RPBC

There are significant non-quantifiable benefits associated with the project as well. From an environmental viewpoint, pipeline transport of hydrocarbon products will be distinctly superior to the current mode of truck and marine transport (para. 3.07). The HDT unit will reduce the sulphur content of diesel and fuel oil produced at the Cubatao Refinery (paras. 3.19-3.23). The use of natural gas as a replacement, mainly for fuel oil, is also significant in terms of reduction in emission of air pollutants. The economic evaluation is summarized below; details are in Annex 3.11.

3.29 The costs analyzed included capital investment costs, less taxes, duties and subsidies, plus cash operational costs. The latter are based on actual costs of comparable units and annually account for up to 2.5% of capital costs. Benefits, in the case of the petroleum product lines, are derived from the net savings associated with replacement of road and sea transport, plus avoided port expansion and other relevant investments. These economic benefits are estimated to reach about US$100 million per year, when the pipelines are fully operational. In the case of the natural gas line, the quantifiable benefits are derived from natural gas to be sold to industrial consumers in

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[5] The two sub-projects for which the analysis is qualitative rather than quantitative are the Automation and the Industrial Safety Programs.

Santos, and to industrial, commercial and residential consumers in Sao Paulo, replacing other fuels with higher economic costs. These benefits are expected to reach at least US$29 million per year. Benefits from the HDT unit are derived from the net foreign exchange savings to the country. The unit would permit Brazil to lower (high price) diesel oil imports, and to reduce (lower priced) fuel oil exports. The average projected international CIF price of diesel (imported) and FOB price of fuel oil (exported) have been used to arrive at annual savings of about US$45 million per year. The following table summarizes the economic rates of return (ERRs) for the various project components. In all cases the first year rates of return are above the opportunity cost of capital, indicating the timeliness of the project.

	ERR - %		
	PROJECT	1st YEAR	SENSITIVITY ANALYSIS (minimum ERR)
1) REPAR - Florianopolis Pipeline	19	22	15
2) TEMADRE - Jequie - Itabuna	16	18	12
3) REPLAN - Guararema Pipeline	38	33	28
4) Santos - Sao Paulo Gasline	18	27	15
5) RPBC Hydrotreatment Plant	23	22	17
Weighted average	21	22	16

3.30 The minimum ERR under sensitivity analysis is based on the following assumption: costs were increased by 10% in real terms; as most of the expenditures are for plant and machinery, with well known techniques, the allowance is reasonable; benefit reductions for three product pipelines reflect about 30% lower rates of product demand growth and capacity utilization. For the natural gas pipeline, the assumption of 10% lower benefits was used. This is reasonable as the base case benefits already assumed a minimum value product substitution mix. Finally, for the HDT system a 10% cost increase was combined with inclusion of the ACO system costs, and a reduction of 10% in benefits. A specific calculation was made of the effects of increases or decreases in the price of crude oil and the associated product mixes. A decline to US$12/bbl for Arabian light crude would reduce the overall project ERR to 18%, while an increase to US$24/bbl would increase the project ERR to 29%. A delay of a year in implementation of project components would have little effect on ERR; for example the ERR on the Santos - Sao Paulo natural gas pipeline would decline from 18.7% to 16.8% (details of the analysis are in Annex 3.11).

H. Project Risks

3.31 From the standpoint of gas reserves and deliverability, the project carries minimal risk since PETROBRAS and Shell have signed a take or pay gas supply contract and Shell is already building the offshore facilities. After an initial phase-in period of two years, Shell commits to deliver and PETROBRAS commits to accept up to 2.3 million m^3/day from the Merluza field for a period of 15 years including phase-in. As for the implementation of the project, the

risks are also minimal; PETROBRAS is both technically and administratively well versed in implementing projects of this size and kind.

3.32 Similarly, there are no appreciable financial risks associated with the project. The pipelines would result in more cost effective operations and as they would carry only a small portion of the overall product demand, cost effectiveness of their use would be largely immune to variations in market conditions. The financial benefits derived from the HDT plant are sensitive to variations in oil prices. However, only a drastic drop in oil prices (below US$10/bbl) would reduce the financial benefits significantly (by about 50%). Nor does availability of counterpart funds for the project present a risk, particularly considering the history of sound commercial management and financially prudent corporate policy on the part of PETROBRAS. Moreover, the financial loan covenants further mitigate this risk.

I. Project File

3.33 Annex 3.12 includes a list of the documentation utilized to process the project and to prepare the SAR.

IV. AGREEMENTS REACHED DURING NEGOTIATIONS AND RECOMMENDATION

4.01 The Government agreed to exchange views from time to time with the Bank and PETROBRAS on the implementation and technical application of the new ("upgraded") costing system (para. 2.13).

4.02 PETROBRAS agreed to:

(i) put into effect by December 31, 1993 the new costing system to provide more accurate and appropriate information for decision making; and exchange views from time to time with the Bank and the Government, at the request of any of them, on the implementation of the system and its application (para. 2.13);

(ii) have audited, each fiscal year, financial statements and supporting evidence for Statement of Expenditures by independent auditors acceptable to the Bank; and to furnish to the Bank certified copies of the audited reports of its financial statements, including Statement of Expenditure, within four months after the end of each such fiscal year (para. 2.14);

(iii) incur no long-term debt without Bank agreement if: (a) a reasonable financial forecast shows an annual debt-service coverage ratio of less than 1.4 times, or (b) after the incurrence of such debt, the ratio of debt to equity is greater than 40 to 60 (para. 2.25);

(iv) maintain a current ratio of not less than 0.8 and produce funds from internal sources equivalent to not less than 30% of capital expenditures in 1991, 35% in 1992, 40% in 1993 and 1994 and 45% in 1995 and thereafter; review with the Bank, by November 30 of each year, a financial forecast satisfactory to the Bank, the object of such review being to determine whether PETROBRAS would meet the above financial targets; and take all necessary measures required to meet the above financial targets (para. 2.25);

(v) exchange views with the Bank annually and not later than October 1, on the training program for the following calendar year (para. 3.05);

(vi) complete the: (a) ACO diagnostic study by December 31, 1991, and (b) execution of pilot projects by December 31, 1993, if recommended in the diagnostic study (para. 3.14);

(vii) carry out the industrial safety program studies; allow the Bank to comment on findings and recommended programs; make its best efforts to carry out the industrial safety programs agreed with the Bank; and establish and maintain the Risk Assessment Unit (para. 3.15);

(viii) a limit of US$25 million for retroactive financing for project components implemented since September 1, 1990 (para 3.24);

(ix) establish and maintain two Special Accounts, one in the Central Bank in the amount of US$10 million equivalent for local expenditures, to be replenished according to standard Bank procedures on the basis of Statements of Expenditure, and one outside Brazil in the amount of US$10 million equivalent for foreign expenditure payments; the Special Accounts would be audited by independent auditors acceptable to the Bank (para. 3.25);

(x) maintain a PCU headed at all times by a Project Manager with suitable qualifications and experience, assisted by qualified staff in adequate numbers (para. 3.27); and

(xi) furnish to the Bank monitoring reports on the progress of the Project, its operations and financial performance within one month after the end of each calendar quarter; the first report shall be furnished to the Bank not later than three months after the signing of the Loan Agreement (para. 3.27);

4.03 Prior to Disbursements for the relevant project components, the Bank will receive satisfactory evidence of: (a) timely availability of natural gas for the Santos to Sao Paulo pipeline from the Merluza gas field (para 3.04), and (b) formal approval by the appropriate environmental authorities of the environmental impact statements (RIMAs). For two product lines (REPAR to Florianapolis and TEMADRE-Jequie-Itabuna), disbursements will be conditioned to Bank review and approval of the corresponding RIMAs prior to that of Federal and state authorities (para. 3.26).

Recommendation

4.04 With the above assurances, agreements and conditions, the proposed project would be suitable for a Bank loan of US$260 million equivalent, to be repaid over a period of 15 years, including five years of grace, at the Bank's standard variable interest rate.

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

A. Gross Domestic Production of Primary Energy

TOE Thousands

SOURCES	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NON-RENEWABLE ENERGY	10,256	11,928	13,530	15,529	21,464	25,589	32,467	36,930	37,611	37,923	36,560	38,242	40,639
Petroleum	8,009	8,565	9,063	10,675	12,984	16,596	23,216	27,493	29,784	29,463	27,833	29,845	31,612
Natural Gas	1,153	1,482	2,011	2,257	2,763	3,660	4,471	4,966	5,186	5,272	5,331	5,555	5,245
Steam Coal	599	729	1,463	1,884	2,158	2,306	2,605	2,572	2,443	2,533	2,442	2,179	2,142
Metallurgical Coal	495	547	973	715	718	737	821	897	938	625	775	663	631
Uranium	0	0	0	0	2,846	2,289	1,374	902	360	1,130	179	0	0
RENEWABLE ENERGY	47,088	68,185	78,064	78,762	83,047	89,878	98,708	103,954	103,217	107,918	109,806	114,299	107,171
Hydroelectricity	11,542	20,953	37,833	37,922	40,928	43,928	48,812	51,729	52,902	53,824	57,737	62,129	60,047
Wood	31,789	32,739	30,607	29,809	29,127	29,727	32,677	32,138	31,772	32,130	31,771	32,800	27,448
Sugar Cane Derivatives	3,536	4,105	9,081	9,955	11,944	15,056	16,342	18,899	18,796	20,220	18,512	17,968	17,868
Other Renewables	221	388	993	1,076	1,148	1,165	1,877	1,498	1,747	1,734	1,786	1,904	1,735
TOTAL	57,344	80,488	91,594	94,291	104,511	115,445	131,195	140,884	140,828	145,741	146,366	152,541	147,804

Percent

SOURCES	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NON-RENEWABLE ENERGY	17.9	16.8	14.8	16.5	20.5	22.2	24.8	26.2	26.7	26.0	25.0	25.1	27.4
Petroleum	14.0	12.8	9.9	11.3	12.4	14.4	17.7	19.5	20.4	1.5	19.0	19.6	21.4
Natural Gas	2.0	2.1	2.2	2.4	2.6	3.2	3.4	3.5	3.7	3.6	3.6	3.7	4.2
Steam Coal	1.0	1.0	1.6	2.0	2.1	2.0	2.0	1.8	1.7	1.6	1.7	1.4	1.4
Metallurgical Coal	0.9	0.8	1.1	0.8	0.7	0.6	0.6	0.6	0.6	0.4	0.5	0.4	0.4
Uranium	0.0	0.0	0.0	0.0	2.7	2.0	1.0	0.7	0.3	0.8	0.1	0.0	0.0
RENEWABLE ENERGY	82.1	83.7	85.2	83.5	79.5	77.8	75.2	73.8	73.3	74.0	75.0	74.9	72.6
Hydroelectricity	20.1	30.2	40.6	40.2	39.2	38.1	36.8	36.7	37.6	36.9	39.4	40.7	40.7
Wood	55.4	47.1	33.4	31.6	27.9	25.7	24.9	22.8	22.6	22.0	21.7	21.2	18.6
Sugar Cane Derivatives	6.2	5.9	9.9	10.6	11.3	13.0	12.5	13.2	11.9	13.9	12.6	11.8	12.1
Other Renewables	0.4	0.5	1.1	1.1	1.1	1.0	1.0	1.1	1.2	1.2	1.2	1.2	1.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Brazil MME National Energy Balance, 1989
August, 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

A. Gross Domestic Consumption of Primary Energy

TOE Thousands

SOURCES	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NON-RENEWABLE ENERGY	27,567	47,411	60,850	58,957	60,433	59,550	64,810	68,947	71,517	74,270	73,279	73,868	72,466
Petroleum	25,060	43,904	54,319	52,478	51,656	50,905	54,124	54,579	58,081	59,481	59,570	59,771	58,741
Natural Gas	169	571	1,123	1,068	1,462	2,007	2,480	3,096	3,550	4,047	3,624	4,174	4,177
Steam Coal	600	650	1,195	1,794	2,193	2,163	2,198	2,472	2,931	2,697	2,247	2,224	1,920
Metallurgical Coal	1,738	2,198	4,018	3,617	3,768	4,475	6,008	6,800	6,955	7,251	7,638	7,596	7,648
Uranium	0	0	0	0	1,154	0	0	0	0	814	0	0	0
RENEWABLE ENERGY	47,088	58,165	78,064	78,762	83,047	89,878	98,706	103,954	103,217	107,918	109,805	114,299	107,171
Hydroelectricity	11,542	20,963	37,383	37,922	40,928	43,928	48,312	51,729	52,902	53,824	57,737	62,128	60,497
Wood	31,789	32,739	30,607	29,809	29,127	29,727	32,677	32,138	31,772	32,120	31,771	32,300	27,448
Sugar Cane Derivatives	3,536	4,105	9,081	9,955	11,844	15,056	16,942	18,589	16,796	20,220	18,512	17,966	17,873
Other Renewables	221	358	993	1,076	1,148	1,165	1,377	1,498	1,747	1,754	1,785	1,904	1,735
TOTAL	74,655	105,576	138,714	137,719	143,480	149,426	163,516	170,901	174,734	182,188	183,084	188,164	179,657

Percent

SOURCES	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NON-RENEWABLE ENERGY	36.9	44.9	43.7	42.8	42.1	39.8	39.8	39.1	40.9	40.8	40.0	39.3	40.3
Petroleum	33.6	41.7	39.2	38.1	36.1	34.1	33.1	31.9	33.2	32.6	32.5	31.8	32.7
Natural Gas	0.2	0.5	0.8	0.8	1.0	1.3	1.5	1.8	2.0	2.2	2.1	2.2	2.3
Steam Coal	0.8	0.6	0.9	1.3	1.5	1.4	1.3	1.4	[illegible]	1.5	1.2	1.2	1.1
Metallurgical Coal	2.3	2.1	2.9	2.6	2.6	3.0	3.7	4.0	[illegible].0	4.0	4.2	4.1	4.2
Uranium	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	[illegible].0	0.4	0.0	0.0	0.0
RENEWABLE ENERGY	63.1	55.1	56.3	57.2	57.9	60.2	60.4	60.9	59.1	59.2	60.0	60.7	59.7
Hydroelectricity	15.5	19.9	26.9	27.5	28.5	29.4	29.5	30.3	30.3	29.5	31.5	33.0	33.4
Wood	42.6	31.0	22.1	21.6	20.3	19.9	20.0	18.8	18.2	17.6	17.4	17.2	15.3
Sugar Cane Derivatives	4.7	3.9	6.5	7.2	8.3	10.1	10.0	10.9	9.6	11.1	10.1	9.5	10.0
Other Renewables	0.3	0.3	0.7	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Brazil MME National Energy Balance, 1989
August, 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

HYDROCARBON TAXATION

1. The retail prices of petroleum products and alcohol include a variety of taxes, although alcohol has been exempt from some. Prior to the adoption of the 1988 constitution the fiscal regime was essentially oriented towards the Federal Government, and comprised mainly: the Imposto Unico sobre Combustiveis Liquidos e Gasosos e Lubrificantes (IUCL); a compulsory loan (FND); an industrial production tax, the Imposto sobre Produtos Industrializados (IPI); and various taxes to cover employee and social programs, notably the PIS (Programa de Integracao Social), PASEP (Programa de Assistencia aos Servidores Publicos) and FINSOCIAL (Fundo de Investimento Social). Gradually, during 1989, the old tax system has been largely replaced by a system which transfers the bulk of the receipts to the States and the municipalities, leaving a much lower proportion for the Federal Government. The main features of the present system are:

- The introduction of the ICMS to replace the IUCL. It is a value added tax charged by the States, typically at 17% of the retail price, although in some States 18%, for most products. LPG is an exception, having a tax rate of 12%. PETROBRAS is exempt from ICMS in the State of Rio, where much of its production is located;

- The Imposto sobre Venda no Varejo de Combustivel (IVVC), which is levied by the municipalities. The tax varies locally, but in Rio de Janeiro, as in most other municipalities, it has been set at the maximum limit of 3% of the pump price; and

- The IPI, PIS and FINSOCIAL, which have been retained from the old system, but together account for less than 2% of the price.

The "fiscal load" by individual products, as of January 8, 1990, when most of the fiscal reform was in place, shows a weighted average tax of more than 19%.

2. Beyond the taxes on fuels, there are various taxes on vehicles and vehicle ownership and there are road user charges. The vehicle ownership tax discriminates in favor of alcohol vehicles.

Source: Bank Mission, PETROBRAS
August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

ENERGY CONSERVATION

1. Since 1980, energy consumption has increased more rapidly than GDP and urgent attention needs to be given to the rational use of energy, especially in industry. Various indices of energy intensity for the economy show an upward trend relative to the unit value of output. For example, the aggregate final consumption of energy as a whole and energy excluding fuelwood, expressed in toe per Cz$1000 of GDP in 1980 prices, increased respectively from 10.15 and 8.11 in 1980 to 10.75 and 9.20 in 1987. With regard to industry, the intensity of non-fuelwood energy consumption increased steadily from 1970 to 1987. While the experience naturally varied between different types of industry, specific consumption rose in a wide cross--section of Brazilian industries during the 1970s and 1980s.

2. The potential for energy conservation is high in transport, with regard to diesel, gasoline and alcohol. The consumption of these fuels in toe per Cr$1,000 of GDP in 1980 prices increased from 49.4 in 1980 to 51.1 in 1987. In freight transport, the potential lies mainly within the trucking industry itself, through efficiency improvements. Further savings could also be achieved through inter-modal shifts, in particular if the railways succeed in their efforts to capture a substantial part of the increasing demand for inter-regional transport. In passenger transport, cars are responsible for 70% of the total energy consumed, although they account for only 24% of total passenger-km; while buses, with 70% of the passenger-km, use only 16% of the energy. Contrary to expectations, lower-income households own a substantial share of passenger cars and there is some evidence that this may be due in part to the deterioration in the level of service offered by public transport systems, especially in urban areas. Since the energy consumption of buses per unit of transport is about 1/12th that of private cars, there is potential for conserving gasoline and alcohol through improving the level of service of public transportation to attract private car users; and the efficiency of the buses themselves could be increased by rationalizing networks, routes and schedules, with consequent savings in diesel. Finally, the use of natural gas in urban areas might be feasible, in particular for buses and taxis, and should be further studied.

3. Experience from a variety of countries shows that the level and structure of energy prices can be a critical element in any effective demand management and conservation strategy: they can induce the desired entrepreneurial behavior, for example, with regard to the choice of type of fuel, technological process and investments in energy saving measures. In the case of Brazil, it can be observed that the price of several important energy products rose more slowly in the 1980s than in the 1970s or even declined in real terms: energy consumption may have been boosted as a result. Such was the case, notably, with gasoline, alcohol, LPG, domestic electricity and, for most of the period, industrial electricity.

4. In transport, aside from questions related to the price structure of diesel, gasoline and alcohol, the Government should review its current policies with regard to public transport tariffs: instead of maintaining those tariffs at lower levels at the expense of service quality, levels of service should be promoted which would respond effectively to demand.

5. The Brazilian authorities have pursued a variety of non-price approaches towards energy conservation, including technical methods, legislation, education and promotion. In 1981, the MIC launched an ambitious program promoting the rationalization of energy use in industry. A special conservation fund (CONSERVE) was established in BNDES to provide free energy audits as well as conservation loans at subsidized interest rates to industry. CONSERVE was principally a program to substitute petroleum products with electricity rather than a broad program of energy conservation. Considerable progress has been made but there is still scope to improve the implementation of CONSERVE. More recently, the Government launched a National Program of Electric Energy Conservation (PROCEL), which the Bank is expecting to support through its electric power lending program. Other conservation programs have generally been less successful: the Program to Economize Diesel and Lubricants (PRODEL) has existed since 1985 only on paper, although it was temporarily resuscitated in December 1988; and the Program to Rationalize Energy (PROEN), set up in 1986 in conjunction with BNDES, has to date approved only 10 projects with a value of about US$14 million. Given the importance of energy conservation and the plethora of programs, an umbrella agency -- the National Program for the Rationalization of Energy (PRONE) -- has been established under the coordination of the Secretary of Science and Technology in the Presidency to bring about some consistency and integration between existing programs and to establish priorities in energy conservation.

Source: Bank Mission August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PETROLEUM TRANSPORT

A. The Transport System

1.1 Brazil's transport system is extensive with about 1.50 million km of roads, about 29,000 km of railways, 35 important deep-water ports and numerous specialized bulk-facility terminals, 40,000 km of navigable rivers and a large number of airports and airstrips. The backbone of the transport system is constituted by 18 major transport corridors, mostly intermodal, that carry the country's export and import trade traffic as well as the major interregional flows. The modal share of freight traffic, in ton-km, nationwide is estimated at 56% by road, 24% by rail, 16% by coastal and inland shipping and 4% by pipeline. Roads account for about 95% of intercity passenger traffic. The transport sector (excluding own-account transport, services by truck owner-operators and private automobile use), accounts for about 3.7% of Brazil's GNP.

B. Transport, Energy Consumption and Conservation

1.2 Energy consumption in the transport sector is about one-fourth of the total energy and almost 50% of the oil products consumed in Brazil. The potential for conservation of petroleum and alcohol products is important. In freight transport, the main potential for conservation of diesel-oil lies within the trucking industry itself. Some savings, however, could also be obtained through intermodal shifts, in particular if the railways succeed in their efforts to capture a substantial part of the increasing demand for inter-regional transport, resulting in particular from the densification of agriculture in the Center-West. In passenger transport, there is evidence that the deterioration of the level of service offered by the public transport systems is responsible for the relatively high use of private cars, particularly in urban areas. Since the energy consumption of buses per unit of transport is about 1/12th that of private car users, there is potential for conservation of gasoline and alcohol through improving the level of service of public transportation, in particular through traffic management and the creation of bus lanes and corridors in urban areas, improved frequencies and reduced bus occupancy ratios.

C. Petroleum Transport

1.3 The petroleum sector in Brazil is substantial and expanding and consumes transport services in various forms. PETROBRAS operates its own pipeline system which is growing in importance. Partial expansion of this system forms part of the proposed project. Additionally, PETROBRAS, through its transport department, meets most of its own coastal shipping requirements (all coastal shipping is legally restricted to Brazilian ownership), and nearly half of its international shipping requirements, the rest being provided, as market conditions dictate, by various forms of charter service. PETROBRAS does not operate trucking or rail services, although some 30-40% of retail outlets for petroleum products are in fact operated by the subsidiary retailing company BR.

1.4 The recent development and immediate plans for expansion of the transport activities within PETROBRAS' control can be summarized as follows:

(a) the product pipeline system has increased from 503 km in 1970 to 3,136 km in 1980 and 3,963 in 1988. Additionally, natural gas pipelines now extend to nearly 4,000 km, all installed since 1980;

(b) PETROBRAS'coastal and international shipping fleet has grown from 1.3 mdwt to 5.2 mdwt between 1973 and 1989. As a result PETROBRAS in 1988 carried 52% of its crude and products in its own ships, compared with 26% in 1973. The present strategy is to continue to increase Brazilian carriage of international movements, but reduce coastal shipping, in favor of pipeline movements.

1.5 In terms of total volumetric movement of products, coastal shipping dominates. In total movements, coastal and inland waterways accounted for some 60%, railways about 20%, highways about 16% and pipelines the remainder. The coastal shipping movements are largely from four main terminals (associated with refineries) to distribution terminals. Rail movements are largely from refineries to distribution terminals with the average haul varying from a surprisingly short 240 km to 800-900 km. Movement of petroleum products constitutes an important part of rail traffic--about 19% of FEPASA's and 12% of RFSSA's total ton-km. Truck transport is generally shorter haul than rail, but can be over several hundred kilometers where rail transport is unavailable. It is, however, mainly local distribution and, although substantial in volume (of the order of 9,000 million ton-km), it is unimportant (under 5%) as a percentage of total estimated truck movements though presumably more important in heavy truck movements.

D. Potential Issues in Petroleum Transport

1.6 There are major potential issues in petroleum transport:

(a) Trucking tariffs: Whether trucking (and less importantly, rail) transport tariffs are adequate to ensure long-run equilibrium in the supply of and demand for services. Tariffs for movement of petroleum products by truck (and rail) are presently set by the CNE and based upon one-way revenue per kilometer calculations. As most road tankers return empty, the system is logical. However, in a country of substantially varying terrain and climatic conditions, both of which (particularly the former) affect vehicle operating costs (voc), and during a period of high inflation, it is by no means certain that tariffs always reflect current operating costs. In an analysis conducted, specifically for the petroleum product movements in the corridors affected by this project, tariffs were higher, by 2-11%, than the assessed voc, making adequate provision for depreciation. Currently, therefore, the control of tariffs in substitution for their determination by the interplay of market forces is an issue in conceptual rather than practical terms.

(b) Coastal shipping. Product movement by coastal shipping raises an issue which is a by-product of the general Brazilian tendency to limit foreign intervention in certain areas. The ships employed are both constructed in Brazil and manned under Brazilian manning scales. Both tend to produce costs which are higher than international average. It is difficult to be precise as to the difference from international shipping costs, but estimates show this could be 20-25%. This is not, however, a problem which could in practical terms be resolved by opening up the market, as the comparatively short distances involved in typical Brazilian coastal movements of products would inhibit the substitution of charter for local vessels. In other words, the high costs are more a function of Brazilian practices than the lack of free entry to the coastal shipping market. PETROBRAS, which, as noted earlier, is directly affected financially, is addressing the issue by developing pipeline systems as substitutes for coastal and land transport where the volumes are sufficient to justify modal change and the company's financial situation permits.

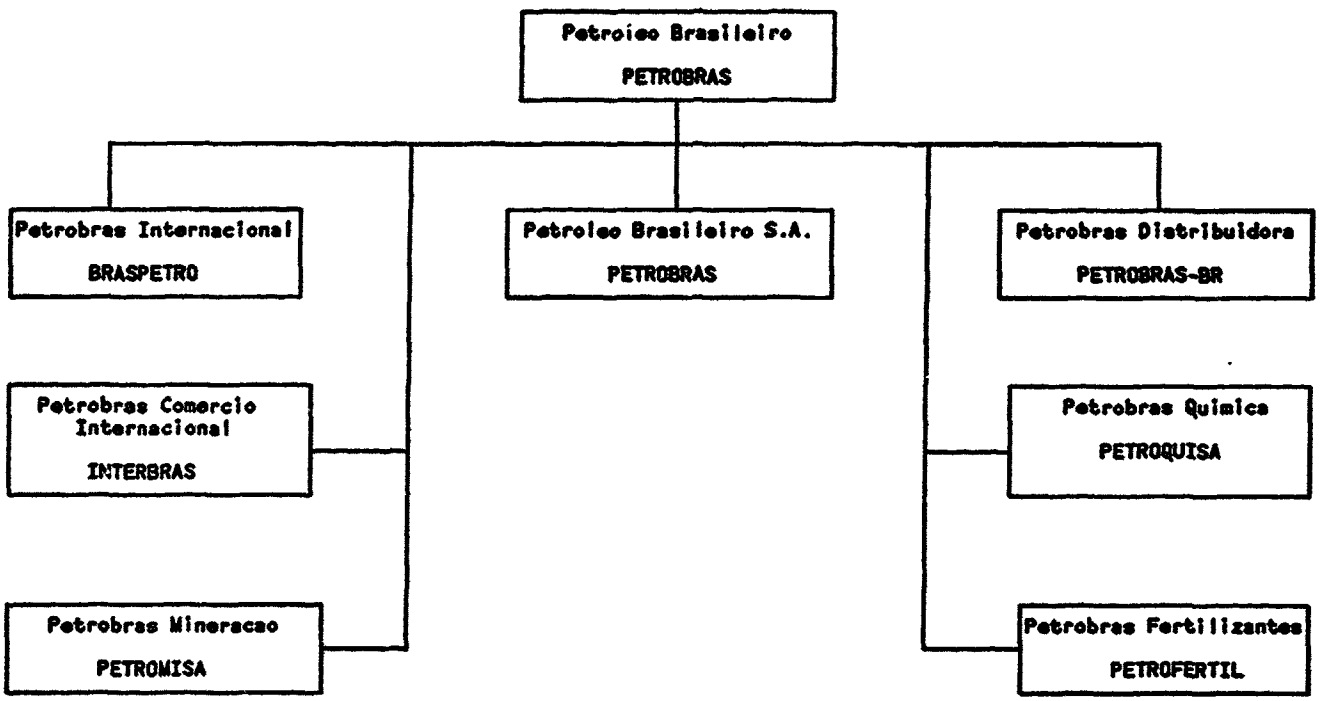
(c) Petroleum transport planning. While the distribution of productive activities between refineries and the balance of Brazilian production imports and exports is subject to a rather sophisticated model, the process of optimizing movements from refineries to distribution centers is presently based upon much less sophisticated techniques. It relies heavily upon the knowledge and experience of the transportation department of PETROBRAS and while there is no reason to doubt that the department is correctly prioritizing its investment proposals within the limitations of its existing knowledge of markets, it considers, probably correctly, that development of a transportation model, compatible with computer simulation, would greatly improve its long-term planning capability. Accordingly, PETROBRAS has prepared the outlines of a distribution model which would take as its starting point the consumption patterns in the 4,000 Brazilian municipalities, and asked the Bank for its observation. One issue that is likely to arise is the extent to which the optimal distribution pattern differs from that which exists and the means by which, within budgetary constraints, the degree of sub-optimality can be reduced (i.e. the means by which a constrained "second best" solution can be achieved).

Source: Bank Mission August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PETROBRAS GROUP ORGANIZATION CHART



PETROBRAS Group

Company	Year Established
PETROBRAS	1953
PETROQUISA	1957
PETROBRAS-BR	1971
BRASPETRO	1972
PETROFERTIL	1976
INTERBRAS	1976
PETROMISA	1977

INTERBRAS and PETROMISA are being liquidated.

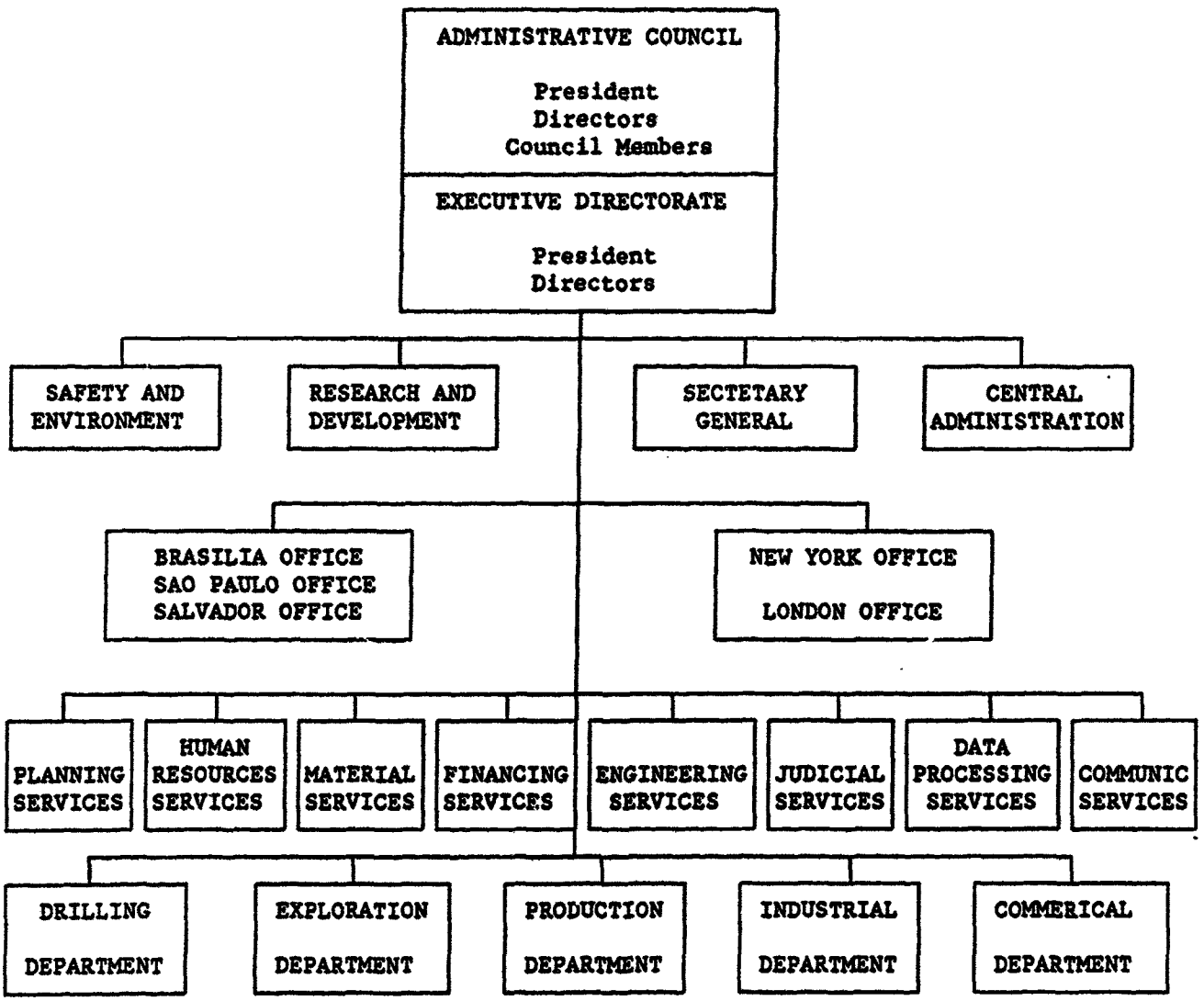
PETROBRAS expects private sector involvement in PETROQUISA and PETROFERTIL

Source: PETROBRAS, August 1990

BRAZIL

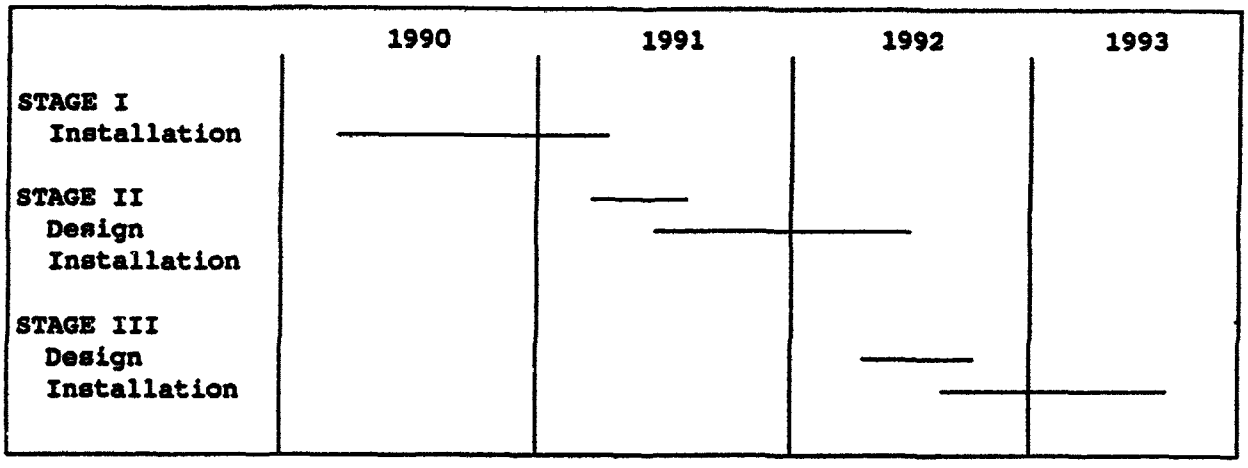
HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PETROBRAS S.A. ORGANIZATION CHART



SOURCE: PETROBRAS, August 1990

BRAZIL
HYDROCARBON TRANSPORT AND PROCESSING PROJECT
COSTING SYSTEM IMPLEMENTATION TIMETABLE



ASPECTS	PURPOSE	NUMBER OF MONTHS REQUIRED FOR DESIGN	NUMBER OF MONTHS REQUIRED FOR INSTALLATION
Stage I			
Organization	Study costs incurred by different areas of responsibility.		12
Societal	Analyse PETROBRAS' financial and economic information from the point of view of the company's external users.		
Activities	Analyse costs for each activity while it is being executed.		
Stage II			
Projects	Study costs of large, integrated projects as they proceed.	5	10
Markets	Analyse contribution to profits generated by each market to which PETROBRAS supplies goods and services.		
Units	Analyse contribution to profits and cash flow generated by each operational unit.		
Products/Services	Analyse contribution to profits and cash flow generated by the various commercial products and services.		
Stage III			
Activities	Analyse costs for each activity as they are completed.	4	8
Governmental	Analyse economic benefits derived directly from PETROBRAS operations for each unit of the federation or significant government entities.		

BRAZIL
HYDROCARBON TRANSPORT AND REFINERY PROJECT
PETROLEO BRASILEIRO S.A.-PETROBRAS
Income Statement
(in current US$ millions)

	historic							estimate						
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Gross Revenues	14,809	13,890	15,087	14,734	13,324	14,327	11,434	16,021	16,822	17,663	18,370	19,105	19,869	20,664
Products Sales	14,640	13,727	14,927	14,608	13,210	14,200	11,365	15,877	16,671	17,504	18,205	18,933	19,690	20,478
Services	168	163	160	125	114	127	69	144	151	159	165	172	179	186
Taxes	1,951	1,955	2,127	3,221	2,820	2,900	2,307	3,137	3,262	3,393	3,528	3,669	3,816	3,969
Net Revenues	12,858	11,934	12,960	11,512	10,504	11,427	9,127	12,885	13,560	14,271	14,842	15,435	16,053	16,695
Operating Costs	8,643	8,225	8,810	11,188	10,220	10,575	7,468	11,495	12,070	12,613	13,117	13,642	14,188	14,755
Feedstock and refining	8,244	7,744	8,276	10,619	9,824	10,204	7,038	11,035	11,587	12,108	12,593	13,069	13,620	14,165
Commercialization	30	26	38	111	108	106	77	115	121	126	131	136	142	148
General/Administrative	222	318	296	365	418	425	338	437	447	467	485	505	525	546
Taxes	56	52	92	105	52	53	45	57	60	63	66	68	71	74
Technical R&D costs	20	26	71	53	51	53	60	57	60	63	66	68	71	74
Others	72	58	38	(11)	(182)	(213)	(90)	(207)	(205)	(214)	(223)	(232)	(241)	(251)
Net operating income	4,215	3,710	4,150	324	284	798	1,659	1,389	1,490	1,658	1,724	1,793	1,865	1,939
Net financial charges	3,340	1,570	517	376	230	447	(905)	395	390	396	410	433	464	500
Net participation in subs.	350	312	289	251	302	500	(197)	200	200	200	200	200	200	200
Net non operating costs	3	(14)	3	3	(2)	2	2	2	2	2	2	2	2	2
Extraordinary items	0	0	0	0	(270)	0	0	0	0	0	0	0	0	0
Net inflation adjustments	(599)	(355)	(330)	(7)	0	0	0	0	0	0	0	0	0	0
Before-tax profit	629	2,083	3,594	194	624	853	559	1,196	1,302	1,464	1,516	1,562	1,603	1,641
Income tax	56	214	183	0	0	0	0	84	91	102	106	109	112	115
Net profit	573	1,869	3,411	194	624	853	559	1,113	1,211	1,361	1,410	1,453	1,491	1,526

BRAZIL
HYDROCARBON TRANSPORT AND REFINERY PROJECT
PETROLEO BRASILEIRO S.A.-PETROBRAS
Statement of Origins & Applications of Resources
(in current US$ millions)

	historic							estimate							
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1990-1997 TOTALS
TOTAL SOURCES OF FUNDS	5,139	4,802	5,988	2,238	3,097	2,417	4,192	2,950	3,272	3,610	3,872	4,154	4,452	4,739	31,241
Internal sources	4,620	4,567	5,665	1,525	2,598	1,925	3,940	2,408	2,679	3,017	3,251	3,499	3,760	4,019	26,573
Net profit	573	2,125	3,411	194	624	853	558	1,113	1,211	1,361	1,410	1,453	1,491	1,526	10,123
Plus:															
Interest on long-term debt	2,071	877	649	432	370	238	1932	204	206	216	235	261	294	333	3,681
Expensed investments	1,301	1,311	716	800	895	631	860	622	659	686	719	762	809	844	5,942
Net part. in subs. equity	(395)	(344)	230	(426)	(870)	(500)	197	(500)	(500)	(500)	(500)	(500)	(500)	(500)	(3,303)
Dividends of subsidiaries	20	22	30	22	228	213	64	278	303	340	352	363	373	382	2,455
Depreciation and amort.	429	464	515	557	497	398	356	581	680	784	892	1,007	1,129	1,256	6,685
Residual asset value	234	24	6	31	276	40	6	58	68	78	89	101	113	126	639
Result of ops. w/ subs.	176	87	107	(90)	576	50	-13	50	50	50	50	50	50	50	337
Other	211	3	2	2	2	2		2	2	2	2	2	2	2	14
External sources	519	235	323	713	499	492	252	542	593	593	621	655	692	720	4,668
Borrowing	500	217	249	663	444	447	112	497	548	548	576	610	647	675	4,213
Proposed IBRD loan	0	0	0	0	0	0	0	39	138	50	8	0	0	0	235
Other long-term debt	3	4	22	28	35	25	112	25	25	25	25	25	25	25	287
Government credits	17	14	53	22	20	20	28	20	20	20	20	20	20	20	168
TOTAL USES OF FUNDS	5,030	3,817	3,586	4,216	3,718	2,856	2,953	2,874	3,281	3,606	3,875	4,159	4,456	4,843	30,047
Financial investments	321	137	206	380	167	100	115	100	100	100	100	100	100	100	815
Property, plant & equipment	1,752	1,729	1,678	2,254	2,147	1,861	731	1,989	2,108	2,193	2,302	2,440	2,587	2,700	17,051
Proposed project invest.	0	0	0	0	0	0	0	186	256	75	34	0	0	0	551
Deferred investments	0	0	1	1	1	1	5	1	1	1	1	1	1	1	12
Debt service	2,762	1,746	1,192	1,311	1,139	803	2,048	732	758	773	808	846	879	907	7,751
Amortization	691	869	543	879	769	565	116	528	532	557	573	585	585	574	4,050
Interest on l-t debt	2,071	877	649	432	370	238	1932	204	206	216	235	261	294	333	3,681
Dividends	163	195	391	307	256	213	54	278	303	340	352	576	685	819	3,407
Inc. in long-term assts	50	8	118	(38)	8	(123)		(226)	30	199	312	195	205	317	1,031
Others	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
(Inc)/dec in work. cap.	109	985	2,403	(1,977)	(621)	(439)	1,239	76	(9)	5	(4)	(4)	(5)	(105)	

BRAZIL
HYDROCARBON TRANSPORT AND REFINERY PROJECT
PETROLEO BRASILEIRO S.A.-PETROBRAS
Balance Sheets
(in current US$ million)

	historic							estimate						
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
TOTAL ASSETS	12,864	11,708	13,730	12,107	12,817	13,634	11,543	15,785	16,966	18,285	19,677	21,175	22,728	24,347
Current assets	5,165	4,609	4,881	3,867	3,633	3,702	4,630	4,108	4,302	4,505	4,679	4,860	5,048	5,243
Cash and banks	248	202	265	123	73	100	112	106	109	113	116	119	123	127
Marketable securities	391	204	362	284	400	350	423	371	382	394	406	418	430	443
Accounts receivable	1,863	1,982	1,483	1,500	1,561	1,433	2,839	1,602	1,682	1,766	1,837	1,910	1,987	2,066
Inventories	2,581	2,111	2,650	1,861	1,518	1,719	1,167	1,923	2,019	2,120	2,204	2,293	2,384	2,480
Other	82	110	121	100	82	100	89	106	109	113	116	119	123	127
Long-term assets	500	508	626	588	596	473	328	107	137	336	648	843	1,047	1,265
Permanent	7,198	6,592	8,223	7,652	8,588	9,459	6,585	11,569	12,527	13,444	14,351	15,473	16,633	17,840
Gross fixed assets	6,257	5,936	7,388	6,215	6,286	8,027	5,647	11,685	13,668	15,743	17,920	20,216	22,643	25,191
Less: acumulated deprec'n.	(2,384)	(2,623)	(3,766)	(3,389)	(3,730)	(4,128)	(3,324)	(5,195)	(5,875)	(6,659)	(7,551)	(8,558)	(9,687)	(10,943)
Net fixed assets in op.	3,873	3,313	3,622	2,826	2,556	3,899	2,323	6,490	7,793	9,084	10,369	11,658	12,956	14,248
Work in progress	592	460	930	1,566	2,118	2,166	1,034	2,322	2,447	2,565	2,690	2,834	2,994	3,146
Fin. & def'd. investments	2,733	2,819	3,670	3,260	3,913	3,394	3,228	2,758	2,287	1,795	1,292	981	683	446
TOTAL LIABILITIES & EQUITY	12,864	11,708	13,730	12,107	12,817	13,634	11,543	15,785	16,966	18,285	19,677	21,175	22,728	24,347
Current liabilities	5,128	4,165	3,636	3,973	4,148	3,626	4,597	4,047	4,250	4,448	4,626	4,811	5,004	5,204
Short-term debt	3,846	3,591	3,113	2,529	2,407	2,272	2,118	2,699	2,834	2,976	3,095	3,219	3,347	3,481
Less mandatory deposits	(1,897)	(2,238)	(1,799)	(890)	(1,092)	(1,091)		(1,296)	(1,360)	(1,428)	(1,485)	(1,545)	(1,607)	(1,671)
Accounts payable	3,178	2,812	2,322	2,334	2,832	2,445	2,479	2,644	2,776	2,901	3,017	3,138	6,263	3,394
Long-term liabilities	2,310	1,862	1,775	1,326	1,293	1,455	1,083	1,550	1,621	1,720	1,877	2,099	2,342	2,616
Financing	2,725	2,350	2,023	1,579	1,195	1,674	876	1,543	1,631	1,755	1,951	2,229	2,532	2,875
Mandatory deposits	(589)	(609)	(452)	(281)	(192)	(335)	0	(309)	(326)	(351)	(390)	(446)	(506)	(575)
Subsidiaries	169	106	175	10	276	100	199	300	300	300	300	300	300	300
Credits for equity increase	5	14	28	17	13	15	0	15	15	15	15	15	15	15
Other	0	0	1	1	1	1	8	1	1	1	1	1	1	1
Equity	5,426	5,682	8,319	6,808	7,376	8,553	5,863	10,188	11,096	12,117	13,174	14,264	15,382	16,527
Share capital	569	720	3,393	2,680	3,050	3,486	2,798	3,486	3,486	3,486	3,486	3,486	3,486	3,486
Capital reserves	1,444	1,748	67	81	85	110	77	110	110	110	110	110	110	110
Revaluation reserve	658	569	704	715	1,050	1,125	1,041	1,125	1,125	1,125	1,125	1,125	1,125	1,125
Retained earnings	2,755	2,645	4,155	3,331	3,191	3,832	1,947	5,466	6,375	7,369	8,453	9,543	10,661	11,805
MEMO ITEMS:														
Current ratio	1.01	1.11	1.34	0.97	0.88	1.02	1.01	1.02	1.01	1.01	1.01	1.01	1.01	1.01
Debt/equity ratio	0.33	0.29	0.20	0..9	0.14	0.16	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.15

BRASIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

**Notes and Assumptions for
PETROBRAS Financial Projections**

General

1. Because the project is concerned only with the activities of PETROBRAS, S.A. (specifically transportation and refining), historical and forecast financial statements shown in this report are those of PETROBRAS, S.A. and do not include the accounts of subsidiaries which are part of the PETROBRAS Group. Financial projections are based on PETROBRAS historic data from 1984 to 1989, and were prepared in mid-1990 with prices of March/April 1990 including the rate of exchange at that time. Actual financial statements for 1990 reflect: (a) the change (about 20%) in the purchasing power parity CRz/US$ as took place between March/April 1990 and December 1990; and (b) the use of the BTN index for asset revaluation, which underestimates local inflation as measured by other indexes; accordingly the value of assets is underestimated.

2. Notes on historical financial statements and assumptions for the base case forecast (shown as Annex 2.03) are provided below. Given the volatility in international petroleum markets, the assumptions and cash flow projections for a high oil price scenario are shown in para. 17 below.

Income Statement

3. Project sales during the historic period consisted of about 90% sales to the domestic market and 10% to the international market. This ratio is assumed to remain relatively constant. It is assumed that total sales will increase about 3.5% annually over the period. Domestic retail prices are assumed to mirror, with a slight lag, the changes in international prices forecast by the Bank.

4. Historically most taxes were those levied by the federal government. Following changes in the tax regime brought about by the new Constitution of October 1988, most value-added taxes are now charged by the states and the municipalities. For 1989 these comprised about 19% of gross product sales. For the period 1990-1997, the total rate is forecast to be about 20% of gross revenues.

5. Operating costs which are variable with volumes sold (particularly feedstock and refining costs) are forecast to increase concurrent with this increase. Depreciation is included principally in the cost of feedstock, refining, technical research and development costs.

6. Net financial charges include those on both long and short term debt, and are shown net of financial revenues.

7. Participation in subsidiaries includes investments and other charges made on behalf of subsidiaries, and are shown net of flows to PETROBRAS from subsidiaries.

8. Non-operating costs include exchange losses from investments abroad and other non-operating expenses. These are shown net of non-operating revenues, such as asset sales and exchange gains.

9. The extraordinary item in 1988 was the result of a lump sum payment from the Brazilian Reinsurance Institute for an explosion on the Enchova Central Offshore Platform in the Campos Basin (with offsetting entries for respective carrying value of the platform and costs incurred with the explosion).

10. Inflation adjustments are made, according to Brazilian corporate legislation (Law 6404 and 1976), on all asset and liability accounts, according to appropriate indexes and exchange rates. As of 1988, PETROBRAS began preparing its statements using monthly inflation adjustment, in addition to the annual adjustments stipulated by law, according to guidelines of the Brazilian Securities and Exchange Commission (with the objective of increasing information available to shareholders and others). Thus, 1984-1987 statements are shown per "corporate," or Brazilian, legislation, while those of 1988-1989 are based on the more accurate monthly, or "integral" correction. Projections for 1990 onward are based on dollar values, thus inflation adjustments are not considered.

11. Income tax paid by PETROBRAS is subject to specific legislation. PETROBRAS is exempt from income taxes on its research, exploration, refining, import and transport of crude and petroleum derivatives activities. Thus the standard corporate tax rate of 35% is charged on only about 10-30% of PETROBRAS' activities. The projections assume no change in this element of the fiscal regime. As the result of a small second-quarter loss in 1987, PETROBRAS has made use of the loss-carry-forward provision (up to four years according to Brazilian legislation). Projections assume that the company will maintain in the appropriate tax register an amount to be compensated against income generated until 1991.

Sources and Uses of Funds

12. Investment levels have been projected on the basis of PETROBRAS declared program of US$17 billion to achieve 70% self-sufficiency of petroleum supply. It has been assumed that the company will implement this program over eight years (rather than the five proposed by PETROBRAS).

Balance Sheets

13. Long-term assets include long-term securities, financing, accounts receivable (a portion of which is due by ELETROBRAS), and transactions with subsidiaries.

14. Fixed assets are adjusted for inflation annually on the basis of relevant indexes (which have not always kept pace with inflation, specifically in the markets for those assets, i.e. replacement value is significantly higher than book value). Projections do not account for any additional revaluation of PETROBRAS' asset base, however, the costing exercise is likely, over the next five years, to cause assets to be increasingly based on replacement costs and over time to reflect real replacement values.

15. Provision for depreciation fo. on a straight-line basis at various rates based on the useful economic life and consistent with Brazilian legislation. These rates also will be reconsidered in the review made during the costing exercise of asset values; however, no specific changes in the forecasts have been made.

16. Debt, both long- and short-term, as of end 1990 totalled US$5.6 billion equivalent, and was held 15% in local currency (up to 12% interest), 7% by foreign suppliers (6-10% interest) and 78% in foreign exchange (up to 12.5% interest). Roughly 65% is held in current maturities, about 90% of which is in US dollars, in order to purchase crude and product imports in the international market. This ratio has been assumed to remain constant. Future borrowings for investment are assumed, under the base case, to be limited to 25% of total investment needs.

High Oil Price Scenario

17. Shown below is a summarized cash flow forecast for a high oil price scenario, which is based on the assumption that international crude prices, after the fluctuations of later 1990 and early 1991, reach US$25/bbl by October 1991 and thereafter remain constant. This scenario maintains the same assumptions as the base case regarding investment program, domestic price levels (paralleling international prices generally, with a lag of about 4-6 months), however assumes an increase in debt of about US$2 billion over the five-year period. As shown, this results in reduced levels of internal cash generation, however enables the company to maintain basically healthy financial ratios.

HIGH OIL PRICE SCENARIO
(in US$ millions)

	1991	1992	1993	1994	1995
Revenues After Taxes	13.8	14.2	14.7	15.4	16.1
Operating Expenses	13.4	13.5	14.0	14.5	15.0
Other	0.3	0.3	0.3	0.4	0.4
Net Profit	0.1	0.4	0.4	0.5	0.7
Plus: Interest	0.2	0.2	0.2	0.2	0.3
Expensed Investments	0.6	0.7	0.7	0.7	0.8
Depreciation	0.6	0.7	0.8	0.9	1.0
Other	(0.1)	(0.1)	0.0	0.0	0.0
Internal Sources	1.4	1.9	2.1	2.3	2.8
External Sources	0.6	1.1	1.2	1.1	1.2
Total Sources	2.0	3.0	3.3	3.4	4.0
Investments	2.1	2.3	2.7	2.9	3.2
Debt Service	0.7	1.0	1.0	1.0	1.1
Other	0.2	0.5	0.6	0.8	0.9
Total Uses	3.0	3.75	4.28	4.7	5.2
Inc./Dec. in W.Cap.	(1.0)	(0.8)	(1.0)	(1.3)	(1.2)
RATIOS:					
Internal Cash as % of Investments	35%	41%	42%	44%	52%
Debt Service Covg.	1.6	1.7	1.9	2.0	2.3
Debt/Equity Ratio	0.22	0.25	0.31	0.33	0.32
Current Ratio	1.00	1.00	1.00	1.01	1.01

Source: Bank Mission, PETROBRAS
August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PETROLEUM SECTOR INVESTMENT PROGRAM

Petroleum Sector Action Plan (PASP)

1. In November, 1988, PETROBRAS issued an Action Plan, the "Plano de Acao do Setor Petroleo" (PASP), which laid out the broad lines of a tentative development program to the year 1997. The strategic targets for the company were to reach a domestic production of crude oil of about 1.48 million bpd by 1997, to meet a consumption forecast of 1.54 million bpd, i.e. to attain a degree of national self-sufficiency in oil of 96%. In parallel, natural gas production would rise to 70 million m^3/day. A major portion of the production increase, for both oil and gas would come from the Campos basin, with the Marlim oil field playing a particularly important role. These highly ambitious production targets would be accompanied by a program to reduce the costs of petroleum transport, notably by making more extensive use of shipping and pipelines to substitute for road and rail. PASP required an investment program which would increase from US$3.4 billion per year. Within a few months of its publ. .ation, PASP had become obsolete as the Government introduced yet another of its anti-inflationary programs,the "Plano do Verao". PETROBRAS suffered drastic cutbacks in its investment and operating budget and was forced to rethink its short- to medium-term strategy.

2. At the same time that PETROBRAS issued PASP, an extensive analysis of the natural gas subsector was completed, under the auspices of the CNE. The analysis considered the natural gas supply situation in light of the potential market and proposed a development plan, including the investment requirements. The plan is known as PLANGAS. Two development scenarios were examined. Under the Basic Scenario, natural gas would be produced from known fields and delivered through an expanded pipeline network to the principal market regions. Production would increase by 8.5% per year and reach a level of 36.8 million m^3/day in 1997. Under the High Growth Scenario, production from known fields would be expanded and gas would also be produced from fields which have not yet been discovered. Production would increase 15% annually and reach 71.0 million m^3/day in 1997. In both cases, some of the gas would be reinjected; some used for field operations; and a declining portion would be lost. Heavier hydrocarbons, such as ethane, LPG and condensate, would also be extracted. Some of the natural gas was expected to replace town gas but in order to reach the consumption levels projected for the lower growth scenario, the pipeline network and NGL extraction plants would have to be greatly expanded and gas service would have to the extended to new industrial and domestic consumers.

Source: Brazil, Energy Strategy and Issues Study (LAC I Energy and Industry Division, May 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

Detailed Project Description

TRANSPORT COMPONENT

1. This component comprises four pipeline systems, of which one will transport natural gas and the remaining three will transport white petroleum products and alcohol. IBRD map no. 21867, attached, shows the existing and proposed systems. A detailed description of the facilities follows:

2. Santos-Sao Paulo Gas Pipeline - This sub-component comprises 42 km of 12 inch diameter gas pipeline which will deliver the Merluza offshore gas (produced by Shell-Pecten) to Santos and Sao Paulo. The pipe will be manufactured to API-5LX-65 standards and will have three thicknesses, 0.281 inch, 0.250 inch and 0.203 inch. The pipeline will have a scraper trap at each end to enable periodic launching of scrapers to clean the interior surface of the pipeline in order to maintain flow efficiency. Safety shut-down valves will be installed, spaced every 12 kilometers on average. These valves will be actuated by high and low line pressure and by rapid pressure decrease such as would occur during a line break. At least 10%, and up to 100% (depending on location), of the welds will be inspected by radiography to API 1104 standards. The pipeline will be coated externally with a corrosion resistant coating and will also be cathodically protected from corrosion by an impressed current and sacrificial anodes. Also included is a compressor station of 1800 horsepower to be installed in the RPBC Refinery to pump the gas to Sao Paulo.[1] A pressure regulating station will be installed where the pipeline connects with the facilities in Sao Paulo. The supervisory cum telecontrol system will be integrated with the Sao Paulo regional control system.

3. Guararema - REPLAN Products Pipeline - This multi-products pipeline will serve to transport diesel and LPG from the Guararema terminal (50 km east of Sao Paulo) or the REVAP Refinery (near Sao Jose dos Campos) to the REPLAN Refinery (14 km north of Campinas) and to transport in the opposite direction alcohol and gasoline from REPLAN to the Guararema terminal and REVAP. REVAP and Guararema are connected by an existing 16 inch 34 km pipeline. The new pipeline will have a diameter of 18 inch and a length of 153.5 km. In addition to the pipeline, the facilities will include scraper launching and receiving traps (to enable running scrapers through the pipeline in order to maintain internal cleanliness for high flow efficiency) at each end of the pipeline, a cross-connection between the new line and the Guararema manifold, piping cross-connections and an additional pump at REPLAN, and instrumentation and control facilities to make the pipeline operationally safe. The supervisory control system will be integrated with the regional control. The line will be buried one

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1 The gas will be dehydrated offshore by Shell-Pecten.

meter below the surface, in a 20-meter wide right-of-way, alongside two existing pipelines. The line will be coated and cathodically protected; it will be designed to ANSI B31.4 standards and the welds will be radiographed to API 1104 standards. Block valves will be installed every 15-20 km along the line and at all important river and road crossings. Internal corrosion detectors will be installed at each end of the line and at low places along the line.

4. REPAR - Florianopolis Products Pipeline - Consists of an 253 km white products pipeline from REPAR to Florianopolis, comprising 189 km of 10 inch line, 64 km of 8 inch line, pump stations at REPAR and Itajai and products distribution terminals at Joinville, Itajai and Florianopolis. The 8 inch and the 10 inch pipe will be manufactured to API-5LX-65 specifications and will have wall thicknesses of 0.203 in., 0.219 in., 0.250 in., and 0.279 in. for the 10 inch, and 0.188 in. for the 8 inch sizes. The pipeline will be externally coated with a corrosion resistant coating and cathodically protected by an impressed current. The pipeline will be buried inside a 20 m wide right-of-way which will allow room for future pipelines. The line will be provided with scraper launching and receiving facilities to facilitate internal cleaning of the line. To minimize damage to the environment, fifteen block valves will be installed in the cross-country section, many of these at large river and road crossings.

5. A new pump station will be installed at REPAR where the pump will be interconnected with the product storage tanks (anhydrous alcohol, alcohol, gasoline, automotive and marine diesels, jet fuel and liquefied petroleum products (LPG). Instrumentation and control will be provided to permit product change-over with minimum contamination. Two booster pumps of 120 hp each and two shipping pumps of 275 hp each will be installed.

6. Five tanks, three with cone roof and two with a floating roof totalling 13,700 cubic meters will be installed at Joinville to store gasoline, automotive diesel, anhydrous alcohol and alcohol, with batch interface control. A truck loading station with gravity loading will be provided as will support systems for electricity, fire fighting water, compressed air, potable water, oily drainage and sewerage.

7. At Itajai, the connection with the pipeline will consist of pressure/volume control, suction manifold, batch interface control, batch receipt and treatment facilities, emergency shut-off and relief valves and the related instrumentation and control system. A storage tank farm comprising four floating roof and eight cone roof tanks will be installed with a total capacity of 51,300 m^3 to store gasoline, motor diesel, anhydrous alcohol, alcohol, marine diesel and jet fuel. Two LPG storage spheres with a combined capacity of 6,400 m^3 will also be provided. Transfer pumps and truck loading facilities will be installed. Products will be pumped to Florianopolis by two centrifugal pumps (one reserve) of 360 hp each at a rate 130 m^3/hr. Facilities for fire fighting, potable water, drainage and sewerage, and telecommunications will also be installed.

8. At Florianopolis the products to be handled are gasoline, automotive diesel, alcohol and anhydrous alcohol. The connection with the pipeline will consist of pressure/volume control, manifold, automatic interface control, emergency shut-off valve and a pressure relief system. Scraper receiving facilities will also be installed. Seven tanks with a total capacity of 20,100 m^3 will be provided as well as a transfer/loading system comprising gravity systems, transfer lines and loading platforms for five loading positions for the products received. As in other storage/loading stations, supporting utilities systems will be installed.

9. For the safe and economical operation of the system, a supervisory cum telecontrol system will be installed which will provide remote read-out of critical operating values and will permit remote, as well as local control of the pump stations and storage tanks from a central control room as well as from the local control centers at each site.

10. TEMADRE - Jequie - ITABUNA Products Pipeline - This sub-component comprises a pipeline system consisting of 208 km of 10 inch line from TEMADRE to Ipiau, 65 km of 8 inch line from Ipiau to Jequie and 88 km of 8 inch line from Ipiau to Itabuna. A booster pump station with two pumps with a total capacity of 500 hp will be installed in Ipiau. Provisions will be made for a future pump station at Valença. About 22 km of the 10 inch line will be submerged across the Baia de Todos os Santos and will have a wall thickness of 0.438 inches, while the balance of the 10 inch will have a thickness of 0.203 inches. The 8 inch lines will have a wall thickness of 0.188 inches. The pipelines will be buried after the application of a corrosion-resistant coating; the underwater portion will have a concrete coating over the corrosion-resistant coating. The pipelines will be further protected against corrosion by an impressed electrical current and sacrificial anodes. Provisions will be made for internal cleaning of the pipelines by means of scraper launching and receiving traps which will also permit launching devices which will measure any corrosion along the length of the pipeline. The pipelines will transport anhydrous alcohol, alcohol, gasoline, automotive and marine diesel and LPG.

11. A new pump station will be built at TEMADRE which will be connected to existing storage tanks in two locations in the RELAM complex. Two booster pumps will be installed in parallel for gasoline, diesel, and alcohol, and three main pumps in series with a total of about 2,550 hp. New LPG booster pumps will be connected to the suction side of the main pumps. Utilities such as electricity, fire fighting, water, etc., will be provided.

12. At Jequie seven storage tanks totalling 29,400 m^3 will be installed for the liquid products as will be one sphere of 3200 m^3 and another of 1,600 m^3 for the storage of LPG. Two truck loading stations with meters will be provided for the liquid products and a special LPG loading point as well. Utilities such as electricity, fire protection, water, etc., will also be installed. Similarly, Itabuna will comprise the same facilities except that liquid product storage will be for approximately 27,200 m^3 and LPG storage for 4,800 m^3.

13. This pipeline will be controlled remotely from the central regional control center at TEMADRE. This will help ensure the safe and economical operation of the system. Critical operating values, e.g. pressure, flow, state of machinery, alarms, valve position, tank level, etc., will be transmitted to local and remote control centers, where an overview of the system always will be available and from which operational commands will originate.

Refinery Component

14. The RPBC refinery, situated between Sao Paulo and Santos port, was commissioned in 1955 with a distillation capacity of 7,150 cubic meters (cm) per day (or 45,000 barrels per day) of crude oil. Over the years, the refinery capacity was increased and several processing units were added. The current capacity and configuration of process units are as follows: (i) atmospheric distillation: 166,500 barrels per day (b/d); (ii) vacuum distillation: 111,600 b/d; (iii) catalytic cracking: 50,600 b/d; (iv) catalytic reforming: 10,500 b/d; (v) reformer feed hydrotreater: 10,500 b/d; (vi) delayed coking: 29,600 b/d; (vii) HF alkylation: 3,400 b/d; (viii) asphalt: 8,500 b/d; and (ix) aromatics extraction (Udex): 8,800 b/d. Utilities generation and offsites facilities include: (i) steam: 300 tph at 120 kg pressure in 2 units; 365 tph at 43 kg pressure in 5 units; and 130 tph at 12.3 kg pressure in 9 units; (ii) electricity: 37.5 MVA at 4,160 volts in 4 back pressure turbo generators; (iii) crude oil storage of 4.2 million barrels in 24 tanks; LPG storage of 204,000 barrels in 10 vessels; and 2.85 million barrels of other main fuel products in 32 tanks; and (iv) waste treatment facilities for spent caustic, sour water, oil-water separation (API), and biological treatment/aeration of process and storm sewerage. Except for small amounts of natural gas and electric power purchases from outside, the refinery is auto-sufficient in utilities. The refinery site covers a surface area of 6.9 sq.km. of which 3.7 sq.km. is built up. RPBC employs 2,142 personnel. It processes varying amounts of domestic and imported crudes and produces propane, butane and LPG, naphtha, motor and aviation gasolines, household and aviation kerosenes, diesel oil, fuel oils, asphalt, coke, solvents, and primary aromatics. Refinery throughput averaged 125,000 b/d in 1986-88 or the capacity utilization averaged 75%, conditioned by the overall optimization of costs of products supply to the domestic market from all the refineries of PETROBRAS.

15. The current configuration and constituent units' capacities constrains the RPBC refinery from producing the maximum possible amounts of diesel oil. Currently, the refinery degrades significant amounts of potential diesel oil (or gas oil) fractions (streams) with low-value fuel oil by blending, and also transfers part of such fractions to other PETROBRAS refineries for upgrading to marketable diesel oil. The Project aims at upgrading such fractions to increase the production of marketable diesel oil as well as improve the refining economics at RPBC. Furthermore, the Project will eliminate and recover about 90% of the sulfur present in the fractions which otherwise would end up, as it does now, in fuel oil or low quality but marketable diesel oil.

16. The Hydrodesulfurization and Treatment (HDT) Project will treat a combined feedstock consisting of (i) atmospheric distillation unit heavy gas oil; (ii) FCC unit light cycle oil; and (iii) coker unit light gas oil under high temperature and high pressure conditions with high-purity hydrogen produced separately to supplement some excess quantities of hydrogen from the existing catalytic reformer unit. The treated product separates into on-specification diesel oil liquid product and a gaseous fraction containing all the sulfur in the feedstocks in combination with hydrogen. The sulfur-hydrogen compound in the gas fraction is concentrated by absorption in diethanolamine (DEA) solution, and is subsequently released for conversion into elemental, pure sulfur. The overall HDT Project consists essentially of 4 constituent units: (i) the gas oil hydrogenation unit; (ii) hydrogen generation and purification unit; (iii) DEA absorption and treatment unit; and (iv) sulfur recovery unit. The Project would also include facilities for generation and distribution of some utilities, liquid waste streams treatment, and interconnections of the Project facilities with the existing refinery facilities. These are described below.

Hydrogen Treatment Unit

17. The unit would have a charge stock capacity of 5,000 m^3 per day consisting of heavy gas oil from atmospheric distillation unit, 50%; FCC light cycle oil, 29%; and coker unit light gas oil, 21%. The feedstock is characterized by sulfur content of 0.55%, unusually high nitrogen content of 1935 parts per million (ppm), cetane number of about 38, and high content of unstable unsaturates at 2.1%. The high nitrogen content requires the hydrogenation to be carried out at unusually high pressure (about 90 kg), and the unit will be designed to treat feedstock with up to 2.2% sulfur to provide for the eventuality of the refinery having to process increasing proportions of high-sulfur crude oils, as well as to operate efficiently at as low as 50% throughput. The unit will eliminate 90% each of the sulfur and nitrogen present in the feedstock. Treated gas oil will be sent to the diesel oil pool of the refinery, the gas fraction to the DEA unit, and some light naphtha produced to the primary distillation unit. Auxiliary systems include oxygen-stripping of feedstock by live steam, in-situ water wash of heat exchangers to reduce incrustations, and dimethyl disulfide (DMDS) injection to inhibit carbon lay-down on hydrogenation catalyst bed. The unit design is based on well-proven technology but with some modifications to take into account the unusual feedstock characteristics and flexibility required, in turn based on pilot plant facilities at PETROBRAS and Institut Francais du Petrole (IFP).

Hydrogen Generation and Purification Unit

18. The unit would be designed to produce 800,000 m^3 per day of 99.9%+ purity hydrogen with feedstock consisting of refinery off gases from the existing FCC, coker and reformer units, or of pretreated naphtha from the existing reformer unit. Constituent sections include: (i) refinery offgas pretreatment including autohydrogenation to remove unsaturates over a Cobalt-Molybdenum catalyst, followed by desulfurization over zinc oxide catalyst to remove sulfur compounds down to 0.5 ppm level; (ii) steam-reforming of pretreated gas or naphtha feedstock; (iii) shift conversion to convert carbon monoxide to

carbon dioxide over ferrous oxide on chromium catalyst; (iv) condensates separation; and (v) hydrogen purification over molecular sieves by pressure swing absorption (PSA) proprietory technology. The gas feedstock pretreatment section will be designed to take into account the possible wide swings in the quality of gas from the three different sources. Overall, the whole unit will be designed to operate efficiently with a turn-down of 50% of the nominal capacity. All the processes and technologies for each of the constituent sections are well understood (basically ammonia plant technologies) and the process design has been carried out by PETROBRAS, except for the PSA technology and basic engineering, which will be bought through UOP, USA.

DEA Unit

19. The unit is designed to process a charge of 130,000 cm/day of off-gas containing sulfur compounds from the gas oil hydrogenation unit. The sulfur compounds will be absorbed in a 20% solution of DEA, and subsequently thermally desorbed to yield acid-gas routed to the sulfur recovery unit. The unit would be interchangeably used to treat aviation kerosene hydrogenation off-gases which otherwise would normally be treated in the existing DEA unit attached to the FCC unit. Essentially all the sulfur in the charge gas is concentrated in the form of acid gas such that the remaining treated gas effluent contains less than 200 ppm of sulfur, sent to the refinery fuel system. Absorption is carried out in counter-current flow absorption towers, the rich DEA solution is depressurized, in the first step to remove hydrocarbon gases, and subsequently in the second step to release the acid gas containing practically all the sulfur in the feedstock. The lean DEA solution is filtered in carbon filters and recirculated to the absorption step. In case the downstream sulfur recovery unit is not operating, all the acid gas would be routed to a dedicated flare system where the sulfur-bearing gases will be burnt. The processes/technologies in the sections of the unit are commonly known, and the process design and basic engineering have been carried out by PETROBRAS.

Sulfur Recovery Unit

20. The total acid gases, consisting of off-gases as well as acid gases driven off from acid waters from the hydrogenation unit, plus residual off gases containing sulfur compounds from the existing units are treated in the sulfur recovery unit. Two trains with a capacity to recover 35 tons per day sulfur will be installed. The sulfur compounds in the feedstock off-gases, primarily hydrogen sulfide, as well as ammonia are burned in two reaction zones with air and reacted with sulfur dioxide formed as an intermediate product to produce elemental sulfur. The process for converting hydrogen sulfide to sulfur (Claus process) is commonly known. The knowhow for technology will be bought together with basic process design. Construction of two separate trains of 35 tpd has been envisaged to provide operational flexibility to handle fluctuations in quantities and quality of gas stream constituting the total feedstock, as well as to reduce the need for flaring the feedstock in case of malfunction of the sulfur recovery unit. The unit will be designed to operate efficiently at 50% turn down in each of the two trains, and to recover 90% of the sulfur in the feedstock gases in the form of elemental sulfur of 99.8% purity.

Utilities and Offsites Facilities

21. Incremental utilities and offsites facilities include: (i) cooling water system of 3,000 m^3 per hour consisting of cooling tower, pumps, chemicals dosage; (ii) debottlenecking, as required, of the existing boiler feed water demineralization system; (iii) expansion of the existing coking unit substation by installing a 20-MVA, 138/13.8 KV transformer, as well as installing a new substation consisting of 2 transformers of 13.8/4.16 KV and two transformers of 13.8/0.48 KV, all for the cooling water system expansion; (iv) construction of a new substation for the main process units consisting of 2 transformers each of 13.8/4.16 KV and 13.8/0.48 KV; (v) acid-water treatment system of 50 tons per hour charge capacity to oxidize traces of hydrogen sulfide in acid waters by air bubbling in towers; (vi) a dedicated flaring system for acid gases capable of handling all off-gases from the DEA unit in case of shutdown of the sulfur recovery unit; (vii) interconnections with existing facilities for hydrogen, diesel oil product, naphtha byproduct, purge gases to and from the fuel gas system, treated acid waters to process water system, small intermediate day-tanks, sulfur handling and storage, and blanketing nitrogen; and (viii) a central control room with distributed digital control system (DDS) linkage to the overall refinery control program.

SOURCE: PETROBRAS, Bank Mission
August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

TRANSPORT PLANNING

DRAFT TERMS OF REFERENCE

The main objective of the work is to assist PETROBRAS in further developing its "in-house" capability for optimizing the operation and expansion of its transportation network. The aim is to develop a sector-wide model, compatible with the network optimization model presently utilized by PETROBRAS to make operational decisions on the appropriate combination of the various modes of transport.

The work, inter alia, will include:

(i) the development of a computerized network optimization model, based on operational research techniques;

(ii) the projection of the consumption of the petroleum products, alcohol and natural gas, at the level of sub-geographical areas (to be determined) in line with the projected macro scenarios for economic development of the country;

(iii) development of a data base (a) for road transportation economic costs, existing and projected capacity taking into account facility requirements; (b) for railways: existing systems, physical and operational conditions, reliability, capacity of the links, projections of the traffic demand for other products and their impact on the capacity, economic cost of operation, facility and rolling stock requirements; (c) for pipelines: existing network capacity, utilization, operational costs; and (d) for maritime and waterways transportation operational costs, capacity of fleet and its utilization, waterway capacities, shore facilities, and expected technological developments.

The work is expected to be carried out in two phases: The first phase will focus on a specific region of the country, and the second phase will cover nationwide dimensions. For practical purposes, during the development of the first phase, a pilot application of the model will evaluate transport alternatives in a pipeline project under preparation.

The work will be coordinated by PETROBRAS' Transportation Division supported by external consultants. The first phase of the work would take about six months, and the second phase is expected to be completed over the subsequent eight months. The work would involve about 123 man-months out of which 63 man-months represent the involvement of PETROBRAS personnel (including study tours as appropriate) and about 60 man-months represent consultants' involvement.

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

Transport Training

Training is envisaged in the following pipeline specialties (about one month each):

No. of Staff	Specialty
1	Corrosion control to cover, inter alia, cathodic protection and "Intelligent Pigging," conceptual design and maintenance;
2	Conceptual design and maintenance of instrumentation, automation and SCADA;
8	Operation of instrumentation, automation and SCADA for products pipelines to include product metering and produce quality and interface control;
3	Operation of instrumentation and automation equipment for gas pipelines; and
7	Economic evaluation of liquids and gas transport by pipelines.

It is estimated that four (4) instructor-months will be required.

Source: PETROBRAS, Bank Mission, August 1990

BRAZIL

HYDROCARBON TRANSPORT AND REFINERY PROJECT *
SANTOS/SAO PAULO GAS PIPELINE

(Detailed Cost Estimate in Thousand US$)

DESCRIPTION	LOCAL CURRENCY	FOREIGN EXCHANGE	TOTAL
PIPELINE			
Right-of-Way Costs	250.00	0.00	250.00
Line-Pipe (Materials)	0.00	2,200.00	2,200.00
Other Materials	140.00	0.00	140.00
Construction	0.00	11,811.00	11,811.00
Eng & Supervision	460.00	0.00	460.00
Subtotal:	864.00	14,011.00	14,875.00
COMPRESSOR STATION			
Equipment	7,000.00	0.00	7,000.00
Materials	823.00	0.00	823.00
Construction	2,557.00	0.00	2,557.00
Eng & Supervision	435.00	0.00	435.00
Subtotal:	10,820.00	0.00	10,820.00
REDUCTION STATION			
Land Costs	50.00	0.00	50.00
Materials	826.00	0.00	826.00
Construction	532.00	0.00	532.00
Eng & Supervision	1,397.00	0.00	1,397.00
Subtotal:	2,805.00	0.00	2,805.00
Total, Base Cost	14,489.00	14,011.00	28,500.00
Physical Contingency	3,000.00	1,000.00	5,000.00
TOTAL	18,000.00	15,011.00	34,000.00
Price Contingency	5,000.00	3,000.00	8,000.00
GRAND TOTAL:	23,000.00	18,011.00	42,000.00

* Base: JUN/89 - Dollar: NCZ$ 1,519
Sources: PETROBRAS, Bank Mission

March 1990

BRAZIL

HYDROCARBON TRANSPORT AND REFINERY PROJECT *
GUARAREMA/REPLAN PRODUCTS PIPELINE

(Detailed Cost Estimate in Thousand US$)

DESCRIPTION	LOCAL CURRENCY	FOREIGN EXCHANGE	TOTAL
PIPELINE			
Line-Pipe (Materials)	0.00	12,700.00	12,700.00
Other Materials	500.00	0.00	500.00
Construction	0.00	24,350.00	24,350.00
Eng & Supervision	800.00	0.00	800.00
Subtotal:	1,300.00	37,050.00	38,424.00
PUMP STATION			
Equipment	200.00	0.00	200.00
Materials	1,434.00	0.00	1,434.00
Construction	942.00	0.00	942.00
Eng & Supervision	100.00	0.00	100.00
Subtotal:	2,676.00	0.00	2,676.00
Total, Base Cost	4,042.00	37,050.00	41,100.00
Physical Contingency	1,200.00	2,700.00	3,900.00
TOTAL	5,242.00	39,750.00	45,000.00
Price Contingency	1,300.00	8,400.00	9,700.00
GRAND TOTAL:	6,542.00	48,150.00	54,700.00

* Base: JUN/89 - Dollar: NCZ$ 1,519
Sources: PETROBRAS, Bank Mission

March 1990

BRAZIL

HYDROCARBON TRANSPORT AND REFINERY PROJECT •
REPAR/FLORIANOPOLIS PRODUCTS PIPELINE

(Detailed Cost Estimate in Thousand US$)

DESCRIPTION	LOCAL CURRENCY	FOREIGN EXCHANGE	TOTAL
PIPELINE			
Right-of-Way Costs	300.00	0.00	300.00
Line-Pipe (materials)	0.00	6,111.00	6,111.00
Equipment	0.00	1,600.00	1,600.00
Other Materials	1,919.00	0.00	1,919.00
Construction	0.00	27,836.00	27,836.00
Eng & Supervision	2,500.00	0.00	2,500.00
Subtotal:	4,719.00	35,547.00	40,266.00
REPAR PUMP STATION			
Equipment	1,200.00	900.00	2,100.00
Materials	931.50	0.00	931.00
Construction	720.00	0.00	720.00
Eng & Supervision	160.00	0.00	160.00
Subtotal:	3,011.50	900.00	3,911.00
JOINVILLE BASE			
Land Costs	25.00	0.00	25.00
Equipment	650	0.00	650.00
Materials	470.00	0.00	470.00
Tanks (Material)	750.00	0.00	750.00
Tanks (Erection)	759.00	0.00	759.00
Construction	1,225.00	0.00	1,225.00
Eng & Supervision	510.00	0.00	510.00
Subtotal:	4,389.00	0.00	4,389.00
ITAJAI BASE			
Land Costs	50.00	0.00	50.00
Equipment	2,900.00	0.00	2,900.00
Tanks (Material)	2,027.00	0.00	2,027.00
Spheres (Material)	2,300.00	0.00	2,300.00
Other (Materials)	1,520.00	0.00	1,520.00
Tanks (Erection)	2,027.00	0.00	2,027.00
Spheres (Erection)	1,700.00	0.00	1,700.00
Construction	2,320.00	0.00	2,320.00
Eng & Supervision	1,610.00	0.00	1,610.00
Subtotal:	16,642.00	0.00	16,642.00
FLORIANOPOLIS BASE			
Land Costs	25.00	0.00	25.00
Equipment	850.00	0.00	850.00
Tanks (Material)	810.00	0.00	810.00
Others (Materials)	1,150.00	0.00	1,150.00
Tanks (Erection)	1,050.00	0.00	1,050.00
Construction	1,373.00	0.00	1,373.00
Eng & Supervision	620.00	0.00	620.00
Subtotal:	5,890.00	0.00	5,890.00
Total, Base Cost	34,653.00	36,447.00	71,100.00
Physical Contingency	5,400.00	3,900.00	9,300.00
TOTAL	40,053.00	40,347.00	80,400.00
Price Contingency	9,300.00	5,500.00	14,800.00
GRAND TOTAL:	49,353.00	45,847.00	95,200.00

• Base: JUN/89 - Dollar: NCZ$ 1,519
Sources: PETROBRAS, Bank Mission

March 1990

BRAZIL

ENERGY TRANSPORT AND CONSERVATION PROJECT *
RELAM/JEQUIE/ITABUNA PRODUCTS PIPELINE

-----(Detailed Cost Estimate in Thousand US$)-----

DESCRIPTION	LOCAL CURRENCY	FOREIGN EXCHANGE	TOTAL	% OF BASE
PIPELINE				
Right-of-Way Costs	446.00	0.00	446.00	0.5
Line-Pipe (Materials)	0.00	10,489.00	10,489.00	12.1
Equipment	0	1,700.00	1700	2.0
Other Materials	2,048.00	0.00	2,048.00	2.4
Construction	0.00	37,595.00	37,595.00	43.2
Eng & Supervision	3,000.00	0.00	3,000.00	3.4
Subtotal:	5,488.00	49,784.00	55,272.00	63.5
TEMADRE PUMP STATION				
Equipment	800.00	800.00	1,600.00	1.8
Materials	520.00	0.00	520.00	0.6
Construction	800.00	0.00	800.00	1.0
Eng & Supervision	250.00	0.00	250.00	0.3
Subtotal:	2,430.00	800.00	3,230.00	3.7
IPIAU PUMP STATION				
Land Costs	10.00	0.00	10.00	0.0
Equipment	350.00	0.00	350.00	0.4
Materials	220.00	0.00	220.00	0.3
Construction	250.00	0.00	250.00	0.3
Eng & Supervision	70.00	0.00	70.00	0.1
Subtotal:	900.00	0.00	900.00	1.0
JEQUIE BASE				
Land Costs	25.00	0.00	25.00	0.0
Equipment	2,700.00	0.00	2,700.00	3.1
Spheres (Material)	3,150.00	0.00	3,150.00	3.6
Other (Materials)	1,653.00	0.00	1,653.00	1.9
Spheres (Erection)	1,400.00	0.00	1,400.00	1.6
Construction	3,700.00	0.00	3,700.00	4.3
Eng & Supervision	1,050.00	0.00	1,050.00	1.2
Subtotal:	13,678.00	0.00	13,678.00	15.7
ITABUNA BASE				
Land Costs	25.00	0.00	25.00	0.0
Equipment	2,750.00	0.00	2,750.00	3.2
Spheres (Material)	3,150.00	0.00	3,150.00	3.6
Other (Materials)	1,670.00	0.00	1,670.00	1.9
Spheres (Erection)	1,400.00	0.00	1,400.00	1.6
Construction	3,795.00	0.00	3,795.00	4.4
Eng & Supervision	1,130.00	0.00	1,130.00	1.3
Subtotal:	13,920.00	0.00	13,920.00	16.0
Total, Base Cost	36,416.00	50,584.00	87,000.00	100.0
Physical Contingency	5,900.00	3,500.00	9,400.00	10.8
TOTAL	42,316.00	54,084.00	96,400.00	110.8
Price Contingency	12,000.00	6,300.00	18,300.00	21.0
GRAND TOTAL:	54,316.00	60,384.00	114,700.00	131.8

* Base: JUN/89 - Dollar: NCZ$ 1,519
Sources: PETROBRAS, Bank

BRAZIL

HYDROCARBON TRANSPORT AND REFINERY PROJECT
AUTOMATION (ACO SYSTEM) COST ESTIMATES

---(in US$ Thousand equivalent)---

	LOCAL CURRENCY	FOREIGN EXCHANGE	TOTAL
PHASE 1			
(a) Feasibility Studies	500.00	900.00	1,450.00
PHASE 2			
(b) Basic Engineering	75.00	709.00	784.00
(c) Detailed Design	1,140.00	788.00	1,928.00
(d) Sofware Development	0.00	529.00	529.00
(e) Computers and Peripherals	0.00	1,125.00	1,125.00
(f) Analyzers	0.00	1,500.00	1,500.00
(g) Controllers	750.00	0.00	750.00
(h) Other Services	240.00	0.00	240.00
(i) Installation	135.00	506.00	641.00
(j) Commissioning	192.00	585.00	777.00
(k) Training and Study Visits	400.00	70.00	470.00
TOTAL (Including Contingencies)	3,432.00	6,712.00	10,194.00

Sources: PETROBRAS, Bank Mission

March 1990

BRAZIL

HYDROCARBON TRANSPORT AND REFINERY PROJECT
HDT COMPONTENT COST ESTIMATES

----(in US$ Thousand of June 1989)----

	LOCAL COST	FOREIGN COST	TOTAL
(1) Hydrogenation Unit	28,533.00	26,858.00	55,391.00
(2) Hydrogenation Generator Unit	8,132.00	20,915.00	29,047.00
(3) DEA Unit	2,123.00	3,290.00	5,413.00
(4) Sulphur Recovery Unit	2,903.00	4,440.00	7,343.00
(5) Offsites	9,552.00	11,561.00	21,113.00
(6) General	33,446.00	1,018.00	34,464.00
Base Cost	84,689.00	68,082.00	152,771.00
Training	600.00	0.00	600.00
Industrial Safety Prgoram	200.00	2,800.00	3,000.00
Physical Contingency	14,000.00	9,200.00	23,200.00
Price Contingency	21,500.00	14,200.00	35,700.00
TOTAL COST	120,989.00	94,282.00	215,271.00

Sources: PETROBRAS, Bank Mission

March 1990

BRASIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT [1]/

PROCUREMENT ARRANGEMENTS
ESTIMATED COST IN US$ MILLION EQUIVALENT

Expenditure Category	ICB	LCB	IS LS	Other	Total
I. TRANSPORT COMPONENT					
Material	25.8 (25.8)	5.0 (5.0)	3.0 (3.0)	44.0 [2] (-)	77.8 (33.8)
Works	96.2 (96.2)		- (-)	68.0 [2] (-)	164.2 (96.2)
Equipment	18.9 (18.9)		3.0 (3.0)	11.00 -	32.9 (21.9)
Engineering Design and Supervision	- (-)		- (-)	19.7 [2] (-)	19.7 (-)
Training & Planning	- (-)		- (-)	1.3 (1.3) [3]	1.3 (1.3)
Land & Easements	- (-)		- (-)	1.7 [2] (-)	1.7 (-)
Working Capital	- (-)		- (-)	10.0 [2] (-)	10.0 (-)
Total Transport Component	140.9 (140.9)	5.0 (5.0)	6.0 (6.0)	155.7 (1.3)	307.6 (153.2)

Expenditure Category	ICB	LCB	IS LS	Other	Total
II. REFINERY COMPONENT					
A. HDT Unit					
License and knowhow	- (-)		- (-)	2.3 [2] (-)	2.3 (-)
Basic & Detailed Engineering	- (-)		- (-)	9.1 [2] (-)	9.1 (-)
Equipment, Materials, Parts (CIF/ex-works)	75.8 (75.8)	5.0 (5.0)	2.6 (2.6)	11.1 [2] (-)	94.5 (83.4)
Catalysts & Chemicals	4.2 (4.2)		- (-)	- (-)	4.2 (4.2)
Training	- (-)		- (-)	0.8 (0.8) [3]	0.8 (0.8)
Industrial Works	8.8 (8.8)		- (-)	63.9 [2] (-)	72.7 (8.8)
DDC System	- (-)		- (-)	2.0 [2] (-)	2.0 (-)
Inland Freight, Startup, Proj. Mgt.	- (-)		- (-)	26.8[2] (-)	26.8 (-)
Subtotal	88.8 (88.8)	5.0 (5.0)	2.6 (2.6)	116.0 (0.8)	212.4 (97.2)
B. ACO Program					
Diagnostic Study	- (-)		- (-)	1.4 -	1.4 -

		ICB	LCB	IS LS	Others	Total
	Engineering & Design	-		-	2.7	2.7
		(-)		(-)	(2.7) [3]	(2.7)
	Hardware, Software & Installation	-		-	3.4	3.4
		(-)		(-)	(3.4)	(3.4)
	Training	-		-	0.5	0.5
		(-)		(-)	(0.5) [3]	(0.5)
	Installation, Commissioning	-		-	2.2	2.2
		(-)		(-)	(-)	(-)
	Subtotal	-		-	10.2	10.2
		(-)		(-)	(6.6)	(6.6)
C.	Industrial Safety Program	-		-	3.0	3.0
		(-)		(-)	(3.0) [3]	(3.0
Total Industrial Component		88.8	5.0	2.6	129.2	225.6
		(88.8)	(5.0)	(2.6)	(10.4)	(106.8)
III. TOTAL PROJECT		230.0	10	8.6	284.6	533.2
		(230.0)	(10.0)	(8.6)	(11.4)	(260.0)

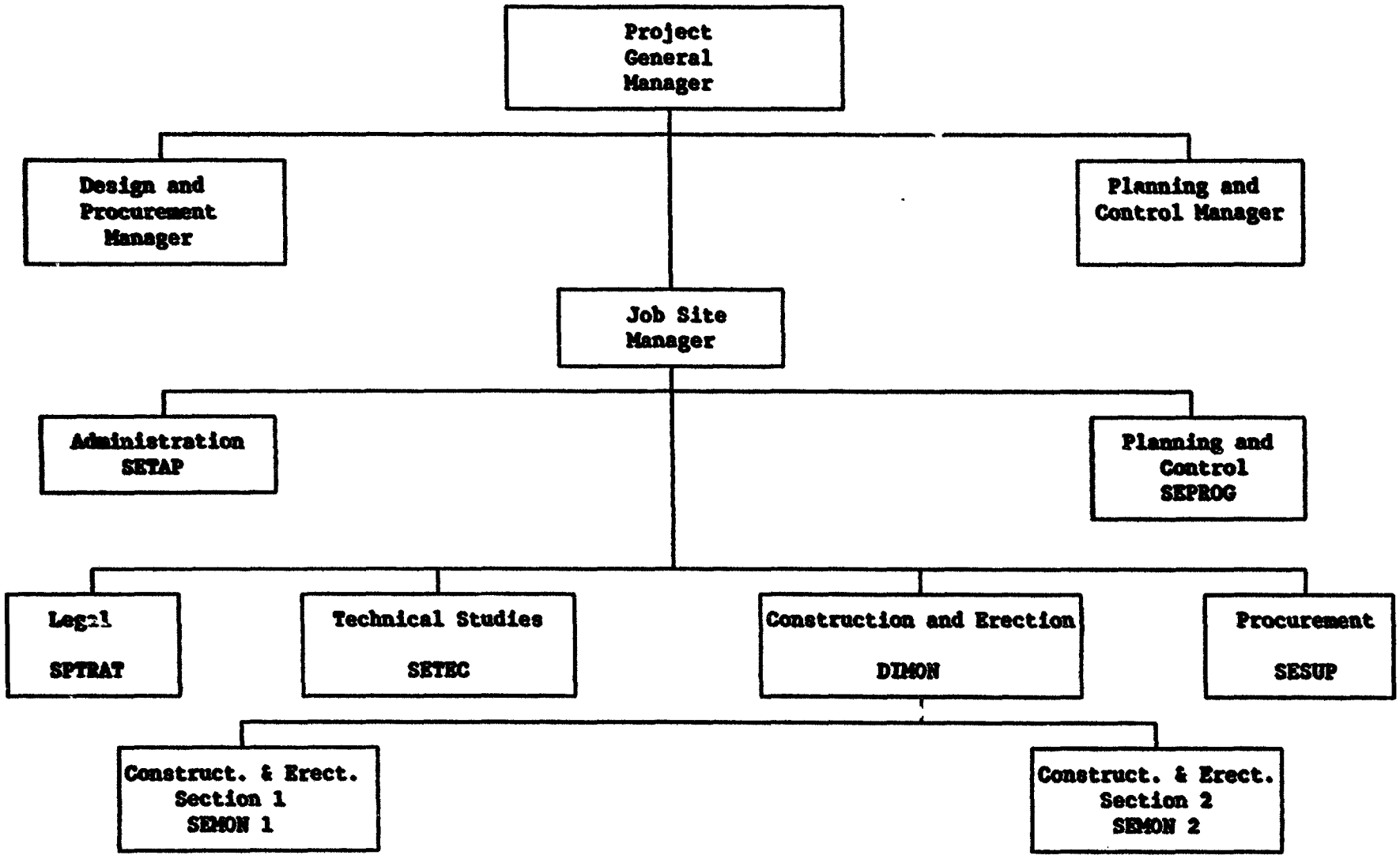
1/ Amounts include contingencies. Amounts in parentheses represent those proposed for Bank financing.

2/ According to PETROBRAS procurement rules.

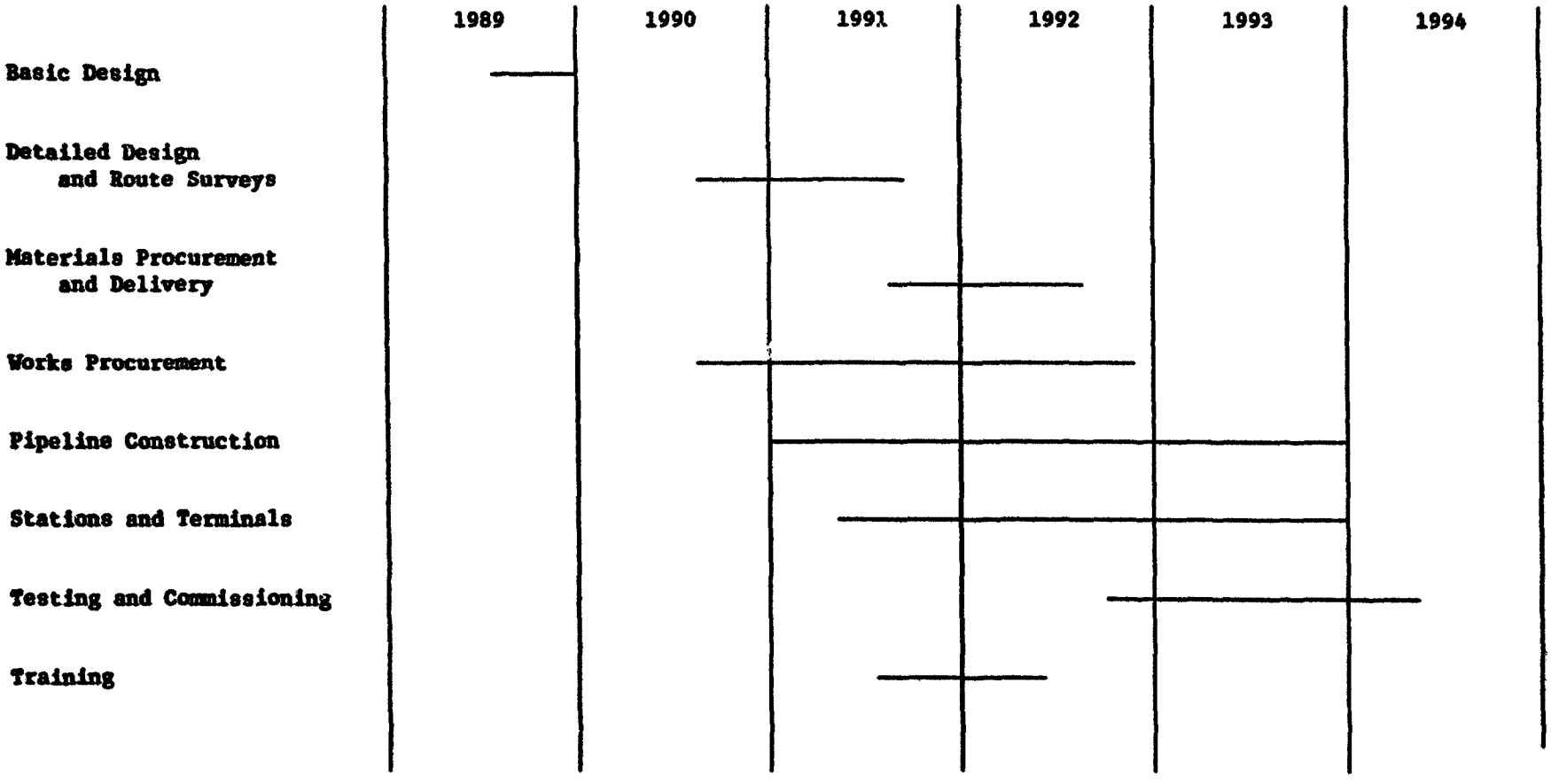
3/ Hiring of consultants, according to Bank Guidelines.

Source: PETROBRAS, Bank mission, August 1990.

BRAZIL
HYDROCARBON TRANSPORT AND PROCESSING PROJECT
Project Implementation Organigram
Refinery Component

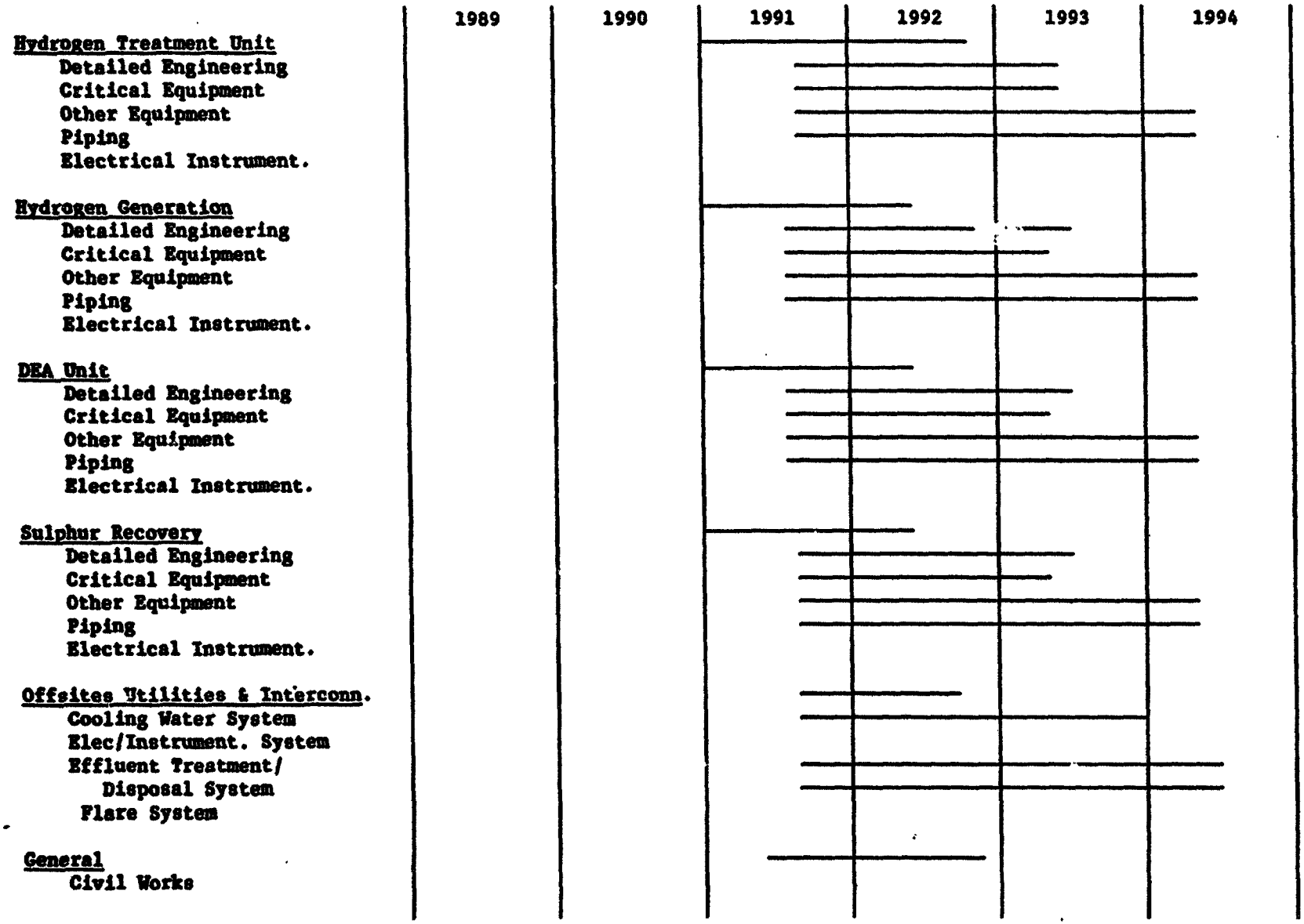


BRAZIL
HYDROCARBON TRANSPORT AND PROCESSING PROJECT
IMPLEMENTATION TIMETABLE
Transport Component



Source: PETROBRAS, Bank Mission, April 1990

BRAZIL
HYDROCARBON TRANSPORT AND PROCESSING PROJECT
IMPLEMENTATION TIMETABLE
HDT Component



BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

Industrial Safety

DRAFT TERMS OF REFERENCE

PETROBRAS RISK ASSESSMENT TEAM

Objective: To provide PETROBRAS with in-house capability to assure that all their refinery unit operations are designed and operated in a manner which minimizes hazards and risks to their own workers and populations residing in adjacent areas.

Rationale: Petroleum and petrochemical products are for the most part classified as hazardous. They are generally flamable, in some cases (e.g., acetylene), explosive and/or highly reactive. Many petroleum based materials are toxic as well both in a chronic and an acute sense. With the large quantities of these materials in storage or being processed at a given time in most PETROBRAS refineries, an in-house capability to actually assess their safety and offer modifications to improve operations, particularly in the older, larger installations (e.g., Cubatao) and to minimize risk, represents a vital corporate function.

Work Program: A corporate group (within DESEMA) is to be created which will consist of six staff members thoroughly trained in the fundamentals and methodologies for risk assessment and hazard analysis in five specialized areas. In addition, three staff members will be generally available for developing new procedures for risk and hazards analysis unique to PETROBRAS refinery operations. The following specialized staff and skills are required:

Four (4) professionals each trained in hazard and risk aspects of:

- -Petroleum products storage
- -Petroleum refining
- -Petrochemicals manufacture

One professional trained in hazardous materials management (handling disposal, etc.)

One professional trained in toxicological risk assessment

Three (3) professionals with in-depth training on the latest procedures in risk analysis as applied to refinery operations

The group will be responsible for design reviews, establishing safety programs, preparing guidelines and standards at existing facilities (starting with Cubatao) and act as coordinators with State and Federal authorities in

interpreting rules and regulations as they apply to various PETROBRAS refining activities, and to new projects.

The group should also be involved with community awareness and education programs and deal with technical aspects of inquiries, e.g., from community representatives. They should be responsible for setting design standards for community warning/response systems, as well as enhancing the training of local authorities (firefighters, police, medical and hospital emergency staff) in proper procedures.

Training Requirements: In order to establish an effective team, it will be necessary to provide appropriate training to select PETROBRAS staff (see Terms of Reference - Risk Assessment Training). The program will consist of six short term study tours and three scholarships for overseas university study in risk assessment.

Members of this group will be expected to actively participate in the risk assessment study for the Cubatao refinery (see TOR for Cubatao risk assessment).

Source: Bank Mission, March 1990

DRAFT TERMS OF REFERENCE

RISK ASSESSMENT TRAINING

1. Objective: Establish a special Risk Assessment Unit within PETROBRAS so that the potential hazards of existing and proposed (e.g., hydrotreatment) facilities at Cubatao can be addressed and PETROBRAS trained staff can actively participate in the Cubatao Risk Assessment Study.

PHASE I: SHORT TERM TRAINING

Six (6) PETROBRAS staff will attend specialized training in hazard evaluations and risk assessment in areas considered critical at Cubatao.

Courses will consist of generalized training in the methods of analysis and the specialized computer programs available for hazard analysis, risk assessment and consequence evaluations, as well as data requirements and data collection programs (estimated time: 1.5 months).

Subsequent to completion of the course effort, students will then spend one to three months (see below) at actual refinery locations to work with operational technical personnel, in on-the-job training specifically focussed on hazards and risk reductions in refinery and petrochemical operations:

Four professional will each spend one month at refinery installations to study hazard and risk aspects in each of the following topical areas (total of three months per person).

- -Petroleum products storage
- -Petroleum refining
- -Petrochemicals manufacture

One professional will spend one month at a refinery installation to study:

Hazardous materials management

One professional will spend one month at a refinery installation to study:

Toxicological risk assessment

PHASE II: LONG TERM TRAINING

Three selected PETROBRAS staff members will be sent abroad to obtain advanced (Master or equivalent) university degrees in the field of industrial risk assessment (one year each).

Source: Bank Mission, March 1990

DRAFT TERMS OF REFERENCE

RISK ASSESSMENT CUBATAO REFINERY

1. Objective: To evaluate in detail, with consultancy assistance, the hazard and risk potential of the PETROBRAS refinery/petrochemical complex of Cubatao and prepare a detailed program of improvements.

2. Rationale: The Cubatao refinery has been subject to some recent mishaps which suggest that a rigorous risk evaluation would lead to substantial improvements in refinery operating efficiencies, and increase the level of safety of both employees and local residents.

PHASE I: PRELIMINARY HAZARD IDENTIFICATION

In conjunction with staff of the (newly created) Risk Assessment Unit, the consultant will conduct a preliminary hazard identification survey of the Cubatao refinery, provide in detail the risk/hazard methodologies recommended for use in this and subsequent phases of the project. Major process elements w'll be evaluated in terms of their design parameters, actual operating conditions, and reliability history. It is anticipated that this effort will be closely coordinated with the automatic process control study also being supported as part of the Bank-financed project. The study will also lay the foundation for the more detailed risk assessment of the Cubatao complex (estimated time: two man-months).

In this phase, future PETROBRAS expansion and process modification plans for Cubatao (including the hydrotreater) are to be reviewed in order to determine any design constraints which may be necessary from a hazard/risk perspective. At the end of the first Phase, the consultant will present recommendations, for PETROBRAS' review and approval, to be used in Phase II.

PHASE II: DETAILED RISK ASSESSMENT

A detailed risk analysis of the entire complex will be conducted. The analysis will cover all process elements of the refinery and will examine in detail everything from deviations from good practice to quantitative hazard evaluations (consequence analysis).[1] The analysis will include all planned plant modifications and/or expansions.

In carrying out the analysis, the consultant is expected to work together with staff of the Risk Assessment Unit, considering them part of the overall technical team. This will provide PETROBRAS staff the opportunity to secure practical experience at their own facilities. Total estimated time: 120 man-months.

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[1]Detailed specifications of the model(s) to be used will be provided by the consultant.

PHASE III: DEVELOPMENT OF A RISK REDUCTION PLAN

Based on the accepted recommendation stemming from Phase II, a detailed program of hazard and risk reduction to the Cubatao complex is to be prepared. The program is to include, but not be limited to:

-Improvements in operator practices-maintenance and operation
-Critical process elements
-Identification of opportunities to reduce initiating events
-Identification of opportunities to reduce probabilities and/or consequences of event sequences.

Possible areas to be included in the program are:

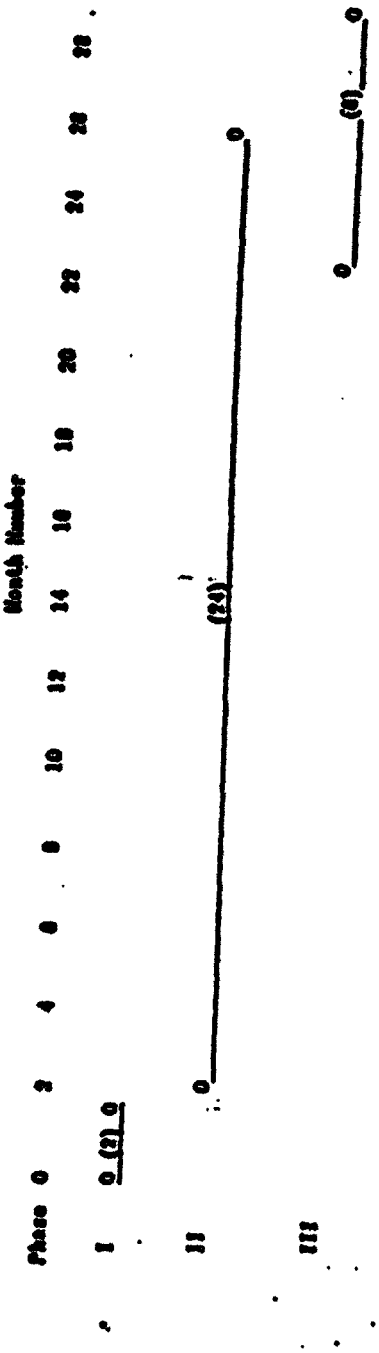
-Replacement of manual operations by automatic controls or vice versa
-Changes in process conditions
-Changes in processing, storage and/or transport equipment
-Improved monitoring/warning system and emergency response preparedness (in plant and neighboring community)
-Changes in plant layout

The risk reduction scheme should be in the form of an action plan and is to be quantified to the greatest extent possible and cost estimates for each action are to be provided, together with a timetable. Priorities are to be assigned to each of the proposed actions. (Estimated time: six man-months.)

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

RISK ASSESSMENT - CUBATAO REFINERY



Source: PETROBRAS, Bank Mission
August 1990

DRAFT TERMS OF REFERENCE

MOBILE ENVIRONMENTAL MONITORING LABORATORY FOR SPECIAL STUDIES (INITIALLY) AT THE CUBATAO REFINERY

1. Objective: To provide PETROBRAS with capability to collect full range of air quality data for specialized studies, including support in Cubatao both for the odor evaluation and any environmental licensing requirements for the proposed hydrotreatment facility.

2. Rationale: Environmental impact analysis as well as other specialized environmental studies require extensive capability for monitoring air quality. Since the Cubatao area has had extremely serious industrial air pollution problems in the past, air quality monitoring is essential to bring the situation under control. As a matter of efficiency, providing this capability in a mobilized unit will offer flexibility and reduce the costs of duplicating identical instrumentation at a number of sites. For acquiring the appropriate equipment and utilizing it in the most efficient manner the following work phases are considered necessary:

PHASE I: REVIEW ENVIRONMENTAL STUDIES/PROGRAMS OF CENPES AND DEPIN TO DETERMINE MONITORING NEEDS AND SCHEDULING (One month)

3. A detailed in-house review of environmental studies/monitoring programs planned for the next five years should be conducted to determine the types of measurements to be made together with the time table(s) for the program.

PHASE II: DETERMINATION OF ENVIRONMENTAL LABORATORY EQUIPMENT NEEDS (One month)

4. Based upon results of Phase I, the types of monitoring equipment needed for various air quality parameters will be specified.

PHASE III: DETAILED LABORATORY DESIGN AND EQUIPMENT PURCHASE (two months)

5. Detailed specifications will be prepared for the mobile laboratory including monitoring equipment, special agents, specialized heat and humidity protection and utility support systems. The equipment will be selected, inter-alia, on the basis of its accuracy, cost, robustness, ease of repair, ready access to spare parts, and availability of suppliers technical support (repairs, calibration, consultation).

PHASE IV: PETROBRAS STAFF TRAINING (one month)

6. Upon delivery of the laboratories, PETROBRAS technical staff will be trained in the utilization, calibration, maintenance and simple repair of all equipment.

Source: Bank Mission, March 1990.

DRAFT TERMS OF REFERENCE

ODOR EVALUATION AND CONTROL AT THE CUBATAO REFINERY

1. Objective: The purpose of this study is to determine the chief sources of odor at the Cubatao refinery and implement an effective program to eliminate the problem.

2. Rationale: PETROBRAS has made substantial progress eliminating pollution from air, water and hazardous wastes at Cubatao. Nevertheless, one of the most difficult problem remaining is that of odor control. This has proved to be rather elusive and a source of some friction with local communities.

Program Outline:

PHASE I With consultant assistance a survey based refinery-wide monitoring system to assess likely sources of odor will be developed. The system will include, but not be limited to:

- Continuous in stack-monitoring throughout the refinery area. Parameters to be measured shall include, but not be limited to, organo-sulphur compounds, hydrogen sulfide, organo-nitrogen compounds, ammonia, phenols, non-methane hydrocarbons, and other likely odiferous pollutants common to refinery operations.

- Continuous water quality monitoring of liquids with exposed surfaces: (open flows, aeration ponds, etc.) for odor-causing pollutants (e.g., organo-sulphur, organo-nitrogen, oxy-organics, such as phenols, and inorganics such as sulfides, ammonia, etc.)

- Continuous ambient air quality monitoring for odor causing compounds noted above. Stations to be located at the refinery (including waste disposal sites) as well as residential areas.

- Meteorological data collection it is anticipated that the system will be entirely automated with data collection reduction and storage completely computerized. Back-up recording systems are to be provided throughout. (Estimated time, three man-months).

PHASE II Based on the accepted recommendation of Phase I, PETROBRAS will implement a system and collect data for a period of at least one year.

PHASE III PETROBRAS will initiate a community awareness program where citizens of Cubatao will be apprised of the study. PETROBRAS will also develop a system of community reporting, so that odor incidents can be recorded (location of observer, time of incident, description of odor, etc.).

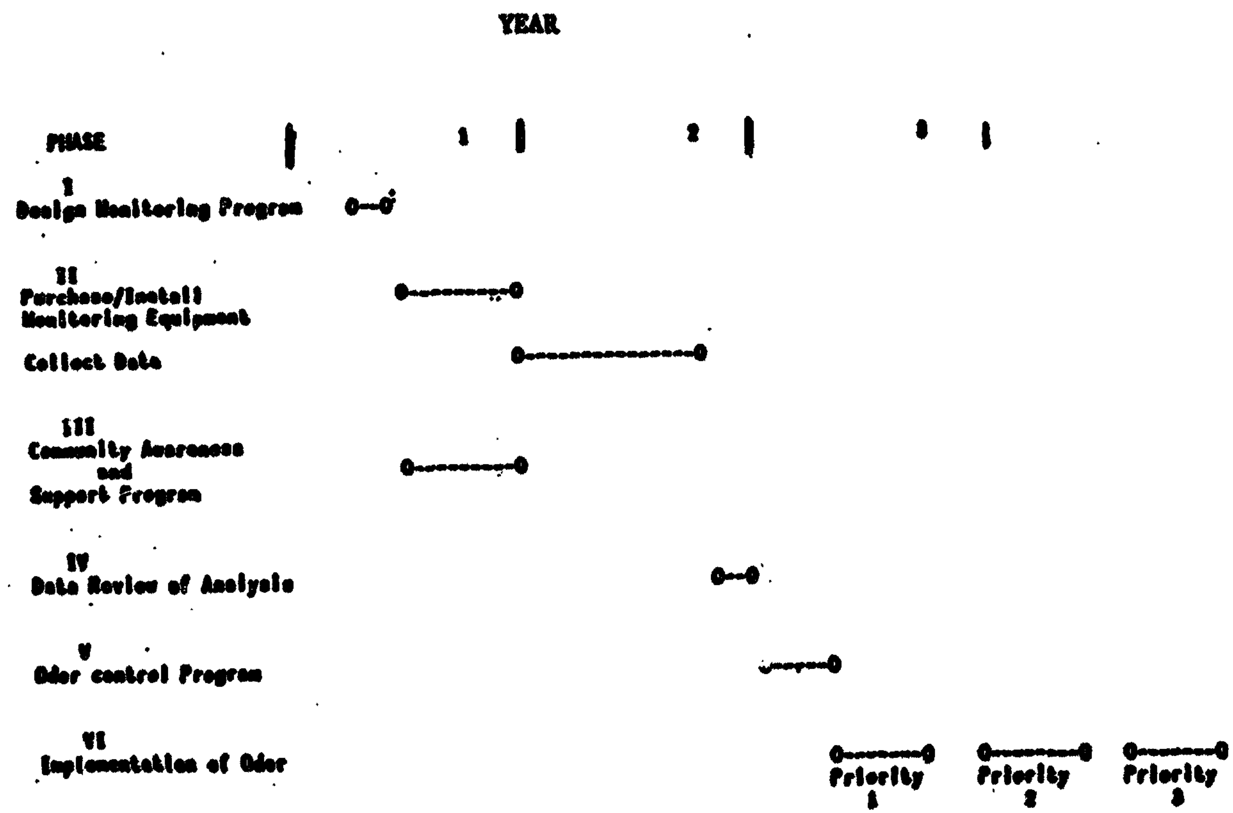
PHASE IV PETROBRAS with consultant support will review the data collected and correlate results with the incidence information reported by Cubatao residents, in order to identify likely odor sources at the refinery.

PHASE V A program of odor control will be prepared. The program will identify the sources, specify equipment needed and preliminary cost estimates. Sources will be ordered in terms of priority (most likely cause, ... least likely).

PHASE VI The odor control program will be implemented in accordance with the priority schedule with a period of at least three months between successive installations.

Source: PETROBRAS, Bank Mission, March 1990.

BRAZIL
HYDROCARBON TRANSPORT AND PROCESSING PROJECT
INDUSTRIAL SAFETY
RISK EVALUATION AND CONTROL, CUTABAO REFINERY
IMPLEMENTATION TIMETABLE



Source: PETROBRAS, Bank Mission
August 1990

DRAFT TERMS OF REFERENCE

POLLUTION CONTROL, HAZARDOUS WASTE AND

ENVIRONMENTAL MANAGEMENT TRAINING AND STUDY TOURS

1. Objective: To provide PETROBRAS with an international perspective of how pollution, hazardous waste and environmental management problems of refinery locations world-wide are addressed to provide insights into more effective technology transfer.

2. Rationale: The relative isolation of PETROBRAS' environmental staff from the latest world developments and practices for pollution control, hazardous waste management and environmental impact analysis techniques in the petroleum refining industry should be eliminated. Providing key staff members the opportunity to visit their counterparts and long-term study will allow them to acquire first hand knowledge on the state of the art for petroleum/petrochemical processing pollution management.

3. Approach: Specialized study tours will be conducted at several refinery locations world-wide (short term) where pollution control and hazardous waste management due to their particular nature, are advanced. Also, institutions specializing in environmental impact analysis training will be utilized for the long term programs (e.g., several European and North American universities). Refineries at the following locations are considered typical (extensive operations near major population centers):

-Los Angeles, California
-San Francisco Bay Area, California
-New Orleans, Louisiana
-Houston, Texas
-Rotterdam, Netherlands

In addition to refineries the study tours will also include visits to environmental authorities (e.g., USEPA and USEPA research centers, selected State Environmental Authorities)[2] trade organizations (American Institute of Chemical Engineers, American Petroleum Institute, Institut Francais du Petrole) and major engineering firms specializing in refinery designs and/or pollution control.

5. The study tours will be designed to address the following environmental issues of the petroleum/petrochemicals industry and which have been particularly applicable to the Cubatao complex:

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[2]States where petroleum refining/petrochemicals manufacture is a major sector, e.g., Texas, Louisiana, California.

-Air and water pollution control methods
-Hazardous waste management (including land farming)
-Air quality modelling
-Air and water quality monitoring (analytical techniques)
-Emergency response procedures in refineries
-Environmental impact assessment
-Ecotoxicology
-Ground water recuperation

Estimated time involvement: Six staff members from the environmental and biotechnology division at CENPES will participate in two short (one month) study tours (a) each consisting of three people. One group will travel to Europe, the other to USA. Another group of ten PETROBRAS staff members will be selected for short term, (b) (two months) study tours. From this group, two will be from the Industry Department (DEPIN), five from the Environment Department (DESEMA), and three from the Environment Department of the Cubatao refinery. Finally, three candidates from DESEMA will be chosen for the long term (one year) study program in environmental impact assessment.

7. Schedule:

PHASE I: Selection of Refinery location candidates (short term)
Selection of long term training institutions (2 months)

PHASE II: Arrange technical aspects of tours: contacts with organizations and refinery personnel (one month/tour)

PHASE III: Travel arrangements (short term and long term) (one month)

PHASE IV: Program implementation

Source: PETROBRAS, Bank Mission, March 1990.

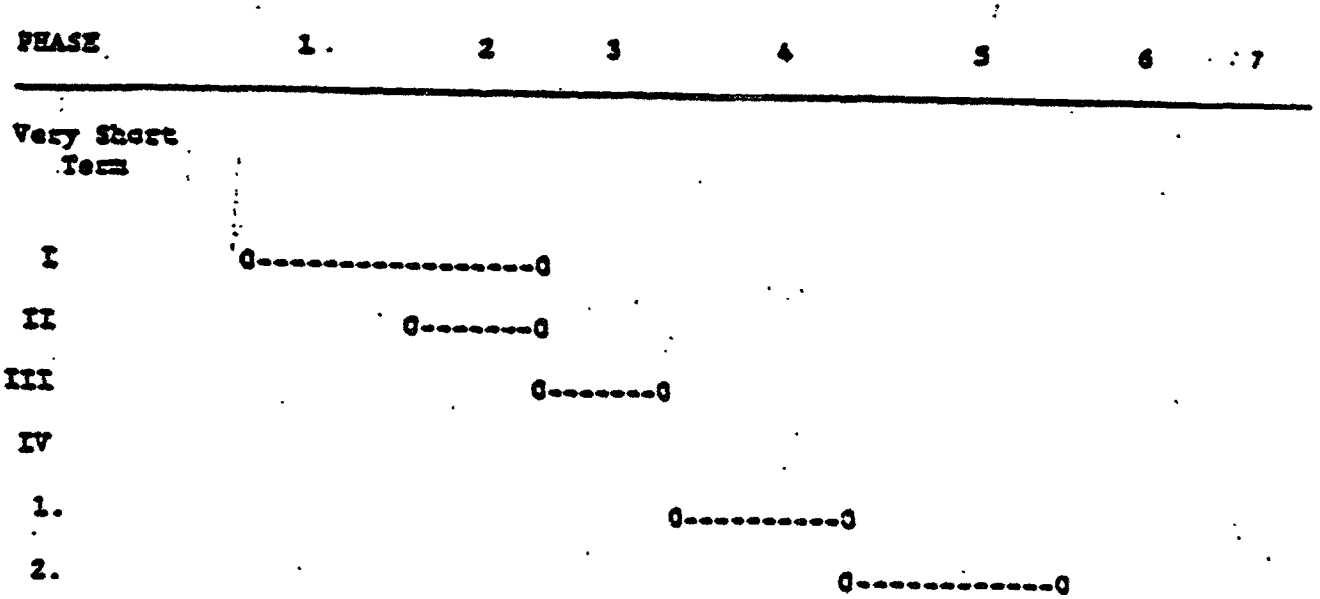
BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

INDUSTRIAL SAFETY

POLUTION CONTROL, HAZARDOUS WASTE AND ENVIRONMENTAL MANAGEMENT STUDY TOURS

IMPLEMENTATION TIMETABLE



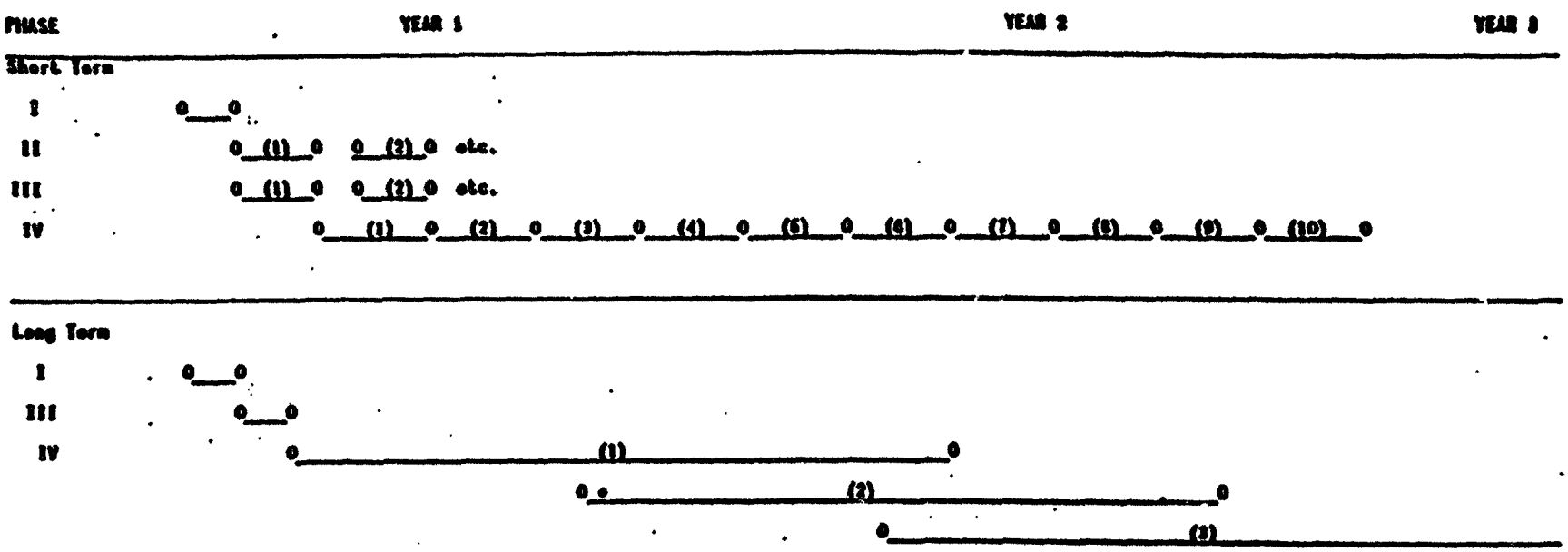
Source: PETROBRAS, Bank Mission
August 1990

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

INDUSTRIAL SAFETY COMPONENT

IMPLEMENTATION TIMETABLE



• Program initiating times may be subject to academic/institutional calendars

Source: PETROBRAS, Bank Mission August 1990

LOAN DISBURSEMENT SCHEDULE

In Million US$

IBRD Fiscal Year and Quarter Ending	Disbursements In Quarter	Cumulative Amount	Disbursement %
FY 1992			
Sept. 30, 1991	40.0[1]	40.0	15
Dec. 31, 1991	21.1	61.1	24
March 31, 1992	18.1	79.2	30
June 30, 1992	20.2	99.4	38
FY 1993			
Sept. 30, 1992	32.5	131.9	51
Dec. 31, 1992	35.4	167.3	64
March 31, 1993	35.2	202.5	78
June 30, 1993	24.8	227.3	87
FY 1994			
Sept. 30, 1993	13.1	240.4	92
Dec. 31, 1993	7.2	247.6	95
March 31, 1994	4.9	252.5	97
June 30, 1994	4.5	257.0	99
FY 1995			
Sept. 30, 1994	3.0	260.0	100

[1] Includes an initial amount of US$20.0 million to establish the Special Accounts (US$10 million in local currency with Central Bank, and US$10 million in foreign exchange in commercial banks outside Brazil.

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

DISBURSEMENT CATEGORIES

	Category	Loan Allocated (Expressed in Dollar Equivalent)	% of Expenditures to be Financed
(1)	Goods under Part A of of the Project:	55,700,000	100% of local expenditures net of taxes and 100% of foreign expenditures
(2)	Civil works under Part A of the Project	96,200,000	
(3)	Goods under Part B.1 of the Project	87,600,000	
(4)	Industrial under Part B.1 of the Project	8,800,000	
(5)	Computer equipment, software and engineering under Part B.3 of the Project	6,100,000	
(6)	Consultants' services and training under Parts A and B	5,600,000	
	TOTAL	260,000,000	

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

REPORTING REQUIREMENTS

1. The following information is to be reported from time to time in relation to the progress of work on the project and to the operations of PETROBRAS.

2. During the implementation of the project, quarterly reports covering:

(a) Technical progress;

(b) Cost estimates, expenditures and disbursements;

(c) Comparisons with targeted action plans, e.g., training, review diagnostic studies, etc.; and

(d) Consultants' work

should be delivered to the Bank not later than one month after the end of each calendar quarter.

3. In addition, annual reports covering compliance with the loan conditions and targets should be submitted to the Bank not later than three months after the end of the fiscal year.

4. Finally, PETROBRAS will be required to prepare, not later than three months after the project completion date, a completion report summarizing its the experience with the project and the lessons learned.

5. The following describes the reports in detail:

Quarterly Technical Progress Reports

6. The reports should cover the following events:

(a) physical work accomplished during the reporting period;
(b) a comparison between the planned and actual progress;
(c) changes, events or conditions which would materially delay the implementation;
(d) changes in key personnel;
(e) expected completion date.

7. Such progress reports shall concentrate on the main physical components of the project, broken down as follows:

Transport component

(a) Pipelines
(b) Pump and Compressor Stations
(c) Tanks and Spheres
(d) Truck Loading Facilities

Refinery component

(a) HDT Unit
(b) Hydrogen Generating Unit
(c) Sulfur Recovery Unit
(d) DEA Unit
(e) Offsites

Progress of construction should be covered in the text of the report and shown graphically in charts.

Construction Schedule

8. A chart showing planned and actual progress on each of the principal events referred to above shall be presented.

9. Simplified CPM or PERT diagrams can be presented with the chart to give a comprehensive picture of the schedule.

Schedule of Orders and Deliveries

10. A schedule of contracts/orders and completions/deliveries for major items of equipment and construction shall be presented in the following form:

Description of item
Date of bid invitation
Date of order/contract
Name of supplier/contractor
Contract amount
Completion/delivery dates
    Original
    Revised
    Actual

11. The schedule shall list major items for which contracts/orders have been placed or bid invitations issued, and those for which bid invitations are scheduled to be issued in the next quarter. The amount in the currency of the contract shall be shown and its equivalent in U.S. dollars to be rounded to the nearest $1,000 equivalent.

IV. Quarterly Report on Cost Estimate, Expenditure and Commitments Statement

12. The report consists of one table, which should be submitted with, and cover the same period as, the technical progress report. The figures of original estimated costs should be those submitted to the Bank.

13. The table should show any substantial changes in the cost estimates that have become necessary since the previous report, alongside the estimate of the previous report and the original estimate. The reasons for such changes should be explained in the text of the report. Estimates should be reviewed and revised or confirmed at last every quarter. Such revisions may be necessary after important contracts have been awarded.

14. The table shall include the following:

(a) Foreign costs-in US$

- Original estimate	(1)
- Estimate at last report	
- Revised estimate	(2)
- Disbursements	
Previous	(3)
- This quarter	(4)
- Total	(5) - (3+4)
- Balance of outstanding commitments	(6)
- Total	(7) - (5+6)
- Remaining costs to complete project	(8) - (2-7)

(b) Local Costs

Same as in (a) above in US$, clearly indicating conversion date and rates.

V. Project Completion Report

15. The project completion report is a comprehensive review of the extent to which expectations and objectives at the time the loan was made have been, or show promise of being achieved. For each major project component, the original cost and construction time estimate should be compared with the actual results with comments on the reasons for deviations. Non-physical objectives, such as the installation of new information systems, etc., should also be reviewed and the degree of accomplishment described, with an analysis of the reasons for any delays or lack of success.

16. The report should also cover, whenever appropriate, the following:

(a) The major problems (physical, financial, management, etc.) which have arisen, why they arose, and what was done to solve them or minimize their effects;

(b) the performance of consultants and contractors;

(c) any unusual features of procurement or disbursements;

(d) any unusual procedures of the Bank which gave rise to problems;

(e) staffing and training aspects of the project;

(f) any deviation from the original financing plan and reasons;

(g) any problems or changes of an environmental or sociological nature;

(h) any actions which need to be taken in order to maximize the benefits from the projects (associated investments, further technical training or advisory services, etc.).

17. In brief, the report should review the appraisal of the project in the light of events to date in order to determine if the original basic assumptions and judgments have turned out to be substantially correct.

Source: Bank Mission, March 1990.

BRAZIL

HYDROCARBON TRANSPORT AND PROCESSING PROJECT

PROJECT ECONOMIC EVALUATION

General

1. The project comprises seven sets of subprojects only five of which are amenable to detailed economic analysis. These comprise: (a) substitution of three product pipelines for sea and land transport; (b) construction of a natural gas pipeline; and (c) a hydrotreatment plant in one import refinery. The two elements where the analysis is qualitative rather than quantitative, comprise optimization automation processes and pollution reduction and account for less than 5% of the total project costs.

2. The economic benefits and costs are established on the basis of financial benefits and costs, excluding taxes and subsidies. No significant, quantifiable, externalities are present and there seems no more persuasive reason for employing non-official than official business exchange rates. Where the benefits result form substitution of pipelines for land transport, vehicle operating costs derived from the World Bank Highway Development Model (HDM) are employed and where substitution for coastal shipping is the basis, Brazilian data checked against international shipping data are employed.

Economic Analysis

3. The following table summarized the results of the economic analysis:

	ERR - %				
			SENSITIVITY ANALYSIS		
	PROJECT	1st YEAR	(minimum ERR)	(Fuel Pr.) -25%	(Fuel Pr.) +50%
1) REPAR - Florianopolis Pipeline	19	22	15	13	21
2) TEMADRE-Jequie-Itabuna	16	18	22	15	18
3) REPLAN - Guararema Pipeline	38	33	28	36	41
4) Santos - Sao Paulo Gasline	18	27	15	15	28
5) RPBC Hydrotreatment Plant	23	22	17	17	34
Weighted average	21	22	16	18	29

The main features of the economic analyses of the principal sub-component groups are described below:

Product Pipeline

REPAR - Itajai - Florianopolis Product Pipeline

4. This sub-project comprises a 10" diameter pipeline from the REPAR refinery to Itajai (189 km) and an 8" diameter pipeline from Itajai to Florianopolis (64 km). The pipeline would substitute for : (i) sea transport of products from the ports of Santos and Paranagua to Itajai port; and (ii) reduce average land transport distances by substituting distribution for Joinville, Itajai and Florianopolis for the present distribution concentrated on Itajai. Analysis at the pre-feasibility stage indicated that construction of a system from the refinery to Florianopolis yielded higher economic benefits than construction in two discrete stages. This economic analysis is therefore confined to consideration of the complete pipeline.

5. The base year (1991) traffic, together with projections to 2010 at 3.0% p.a. increase are shown in Table 6 (the 1989 traffic was about 6% lower). The pipeline diameters are basically geared to accommodating the higher traffic level. As the costs of marginal increments in pipeline capacity are basically the square root of the capacity increase it is clearly preferable to build in sufficient capacity, rather than risk having to install a second pipeline.

6. A particular feature is that the capacity of the berth at Itajai, presently used for the discharge of petroleum products, is limited in two respects: (i) it is physically impossible to increase the capacity of the berth and associated storage capacity, due to encroachment of surrounding urban development; and (ii) the river depth limits the size of ship which can enter the port and, in practice, means that the typical product tanker enters only two-thirds full. To ensure consistency between the capacity assumptions with and without the project, an estimate of the capital cost of relocating the terminal on the opposite side of the river, where there is space for expansion, has been made and its avoidance considered as a benefit. The effect of draught limitations come out as an abnormal cost of sea transport.

7. The best estimate Economic Rate of Return (ERR) is 19% (Table 1). Sensitivity Analysis (on the bases described in para. 29) yields a minimum ERR of 15%.

TEMADRE-Jequie-Itabuna Product Pipeline

8. Presently, products are partly moved by land from the TEMADRE refinery and partly by coastal shipping to the port of Ilheus, East of the larger city of Itabuna. The port is a major cocoa export terminal and as a result, interference occurs between petroleum vessels and cocoa ships, which use the same berths, during the six-months cocoa season. Some plans to expand the port with a dedicated berth exist, but physical work has not started. As the data on the level of congestion which occurs during the cocoa season is inconclusive the benefit, due to eliminating such congestion, is not quantified in this analysis. There are no draught, nor significant storage limitations on petroleum vessel operations. The proposed project would also reduce land transport costs by establishing two terminals, at Jequie and Itabuna, instead of the present single Ilheus terminal. PETROBRAS believes that this corridor has above normal

potential for consumption of petroleum products and accordingly predict a growth rate of 5.5% p.a. Table 6 shows the base and final year traffic volumes on this basis.

9. The best estimate ERR is 16% on the above conservative assumptions (Table 2). Sensitivity analyses described in para. 30 yield a minimum ERR of 12%.

REPLAN - Guararema Product Pipeline

10. This is a 18" pipeline which would parallel the existing 24" products pipeline between REPLAN and Guararema terminal (153 km) and complement the REPLAN-Barueri terminal pipeline to the West. These, and other terminals, are part of the complex of four interconnected refineries in Sao Paulo State.

11. The REPLAN refinery primarily serves the mid-West region of Brazil and has a planned capacity increase of about 25% to 60,000 m^3/day of products. Because of refinery characteristics, products are transferred between REPLAN and other refineries, principally REVAP (via the Guararema terminal). Without the proposed pipeline, the system could not accommodate the incremental flows which, in that case, would have to be transported by road. The benefits accordingly reflect the avoidance of this more expensive transportation form.

12. The new pipeline diameter (18") is designed to accommodate demand growth to about year 2000. This comparatively short time horizon was chosen because of uncertainty about speed and characteristics of modifications to the other three refineries in the region which, as noted, are closely integrated. The benefits are thus held constant for at least 10 years of the project analysis period.

13. The best estimate ERR is 38% (Table 3). Sensitivity analysis on the basis described in para. 31 yields a minimum ERR of 28%.

Natural Gas Pipeline - Santos-Sao Paulo

14. PETROBRAS has currently two important obligations concerning natural gas supply. These are a contract with COMGAS to supply 3.0 m^3/day to the Sao Paulo system by 1994 and a "take or pay" contract with Shell/Pecten for supply of non-associated gas from the Merluza field off Santos, which takes effect at approximately the same time.

15. The Merluza gas is from a field with reasonably clearly defined potential, and while the contract allows flexibility, in practice PETROBRAS expect to receive a sustained flow averaging 1.5 m m^3/day over about 19 years. In the absence of a pipeline connection with Sao Paulo, a substantial part of this production -- about 60% -- would have to be employed in the RPBD at Santos as a low value input, or flared off, while only about 0.6 m m^3/day could be absorbed by industrial in the Santos area.

16. With the proposed gas pipeline, the flow of gas would depend largely upon the demands of the Sao Paulo market, which in turn would depend upon the speed of development of the local distribution system, and the extent to which

supply was met by gas from the Campos field, Northeast of Rio. At a minimum, the aforementioned 0.9 m m^3/day would probably be passed through. For the purpose of analysis, 1.2 m m^3/day is assumed to be fed to Sao Paulo. This is well within the pipeline capacity which is designed to accept the maximum flow of 2.3 m m^3/day.

17. The Sao Paulo market has been analyzed in detail by COMGAS during appraisal of SPNGDP. This study postulated an interfuel substitution pattern in which the total supply of natural gas by the year 2000 would replace other energy sources as follows: (as percentages of gas supply 72% of fuel oil, 8% naphtha, and 12% of low voltage electricity. Because the cost of electricity is very high compared with other fuels, the benefits from natural gas supply are very sensitive to the extent of electricity substitution. Furthermore, more analysis is necessary to establish why users of electricity, who presumably could have changed to a comparatively close substitute for natural gas, such as LPG/naphtha, have not already done so. Accordingly, the conservative approach is taken in this analysis that only fuel oil, LPG and naphtha will be replaced, in the proportions of 76;12;12 by year 2000. The economic costs of the replaced energy sources are based upon the analysis carried out for the Sao Paulo Natural Gas Project.

18. The economic costs include the pipeline investment costs, plus a proportion of the investment costs not already expended, on establishment of the distribution system. Again a conservative approach has been adopted: 40% of the non-expended estimated costs, including investments by industrial users, have been attributed to the project (40% is the estimated contribution of the Merluza gas to the total Sao Paulo supply).

19. The economic cost of the Merluza gas is assumed to be the payment to Shell/Pecten a foreign company. The payment formula calls for PETROBRAS to pay Shell/Pecten on a sliding scale with respect to fuel oil prices; the greater the off-take rate, the lower the percentage payment. The proposed 1.5 m^3/day is at the boundary of two rates, and the higher rate is employed in this analysis; again, a conservative assumption. The fact that the gas is non-associated would normally suggest that a depletion premium would be applicable on the grounds that it is a non-renewable resource that could be retained in situ for future use. However, this does not seem to be the case under the existing contract. The initiative for the supply of the minimum contractual flow (1.2 m m^3/day) rests with Shell/Pecten. The company will supply the gas to shore, and at that point PETROBRAS have, literally, to use it or lose it: PETROBRAS can only accelerate deliveries not reduce them. In effect, the depletion premium is subsumed within the payment to Shell/Pecten which is directly linked to quantity.

20. On the basis of the above assumption which do not include any real price increases for natural gas or products, the ERR is a fully acceptable 18%. (Table 4) Sensitivity analysis, described in para. 31 yields a 15% minimum ERR.

Hydrotreatment Component (HDT)

21. The economic costs are based on the costs of upgrading the Cubatao refinery by the introduction of HDT. As for the other components, they exclude taxes and subsidies, and are not shadow priced.

22. The benefits stem primarily from the fact that gas oil fractions which are potentially usable for the production of (relatively high value) diesel currently have to be down-graded into fuel oil. Furthermore, this fuel oil is of comparatively high sulphur content and thus lower value--and less environmentally friendly--than the remaining product after introduction of HDT.

23. The economic value to be attributed to upgrading the product depends upon basic border price assumptions and whether the product is a net import (thus c.i.f.) or export (thus f.o.b.). The net directions of flow have been established for Brazil and, so far as this refinery's products are concerned, are not expected to alter during the period analyzed. The source and destination assumption are that net imports (LPG, HSFO, diesel, naphtha) will originate in the Mediterranean and net exports (LSFO and regular gasoline) will be destined for the US Gulf. Varying those assumptions to agree with PETROBRAS assumption of imports of LPG from Angola and Caribbean sources/destinations for other products has little effect on the analysis. Likewise, to maintain consistency with the analysis of other sub-projects, and also because of the notorious difficulty in forecasting future price changes of petroleum, whether crude or products, the basis scenario assumes constant absolute and relative product border prices, in real terms. (The sensitivity analyses vary these assumptions.) Taking into account the above-mentioned cost and beneficial HDT operating costs over the period to 2004 with the above-defined capital, the ERR is 23%.

24. Associated with the HDT are investments in assessment of and if appropriate, installation of advanced control and optimization systems (ACOs). The estimated cost of these feasibility assessments and installation, in two separate phases, is estimated at US$11 million. Lack of precise knowledge of the level of efficiency of PETROBRAS existing control systems makes quantification of the benefits impracticable at present. To test the effect of introduction of the system on the HDT economic viability, two scenarios can be postulated: (i) the feasibility studies are undertaken and show further investments unjustified. The effect is limited to an additional expenditure of under US$2 million with an insignificant effect on the ERR; or (ii) the feasibility studies justify installation of the ACOs system but the benefits fail to materialize in a quantifiable form. The total additional cost would be about US$11 million and the basic ERR would be reduced from 23% to 22%.

25. The best estimate ERR is 23%. (Table 5) Sensitivity analysis on the basis described in paras. 33 and 34 yields a minimum ERR of 17%.

Sensitivity Analyses

26. Sensitivity analyses were carried out for all sub-projects to assess whether the investments were timely; and (ii) economically justified under realistic alternative assumptions regarding the values attributable to the main parameters. The rates of return in the first full year of operation were in all

cases above the opportunity cost of capital (taken as 12%) and thus the investments are not premature.

27. The variations in parameter values are sub-project specific and are described below together with the results. Two observations are in order: (i) based on the most conservative assumption all sub-projects achieved satisfactory ERRs (ii) in some cases variations in parameter values which are perfectly reasonable given inherent difficulties in forecasting prices and substitution patterns yielded ERR appreciable higher than in the base cases.

REPAR - Florianopolis Product Pipeline

28. With cost increased by 10% (and other variables unchanged), the ERR is 17%; with demand growth reduced to 2.5% p.a. the ERR is 18%; with costs increased and demand reduced, the initial year benefit base reduced by 5%, the ERR is still acceptable at 15%.

TEMADRE - Jequie Itabuna Product Pipeline

29. With initial demand reduced 5% and the growth rate reduced to 3.5% (the national average) the ERR is 14%; with costs increased by 10% the ERR is 13%; with costs increased by 10% the initial demand reduced by 5%, and the growth rate reduced to 2.5% p.a. the ERR is still acceptable at 11.5%.

REPLAN - Guararema Product Pipeline

30. With costs increased by 10%, the ERR is 36%; with benefits reduced by 10% the ERR is 30% and with the combined effects of increased costs and reduced benefit the ERR is still a high 28%. Because the flows represent a balance between different directional movements of products, a sensitivity analysis based upon overall growth is not very meaningful; however, it should be noted that the aggregate increase under the basic scenario is only 1.7% p.a. well below the predicted national product demand growth of 3.5% p.a.

Santos - Sao Paulo Natural Gas Pipeline

31. There are several variables the values of which could change and alter the ERR significantly. However, these lead to mainly positive results. If costs increase by 10% the ERR is reduced by two percentage points to 17%; if benefits were reduced on average by 10%, the effect would be similar, and if costs were increased and benefits decreased the ERR would still be a satisfactory 15%. If, however, PETROBRAS was able to move to the next lowest Pecten payment basis, the ERR would increase significantly to 25%, while if the inter-fuel substitution pattern envisaged by COMGAS did indeed materialize, the ERR would increase dramatically to 36%. This latter figure is a reflection of the importance the Merluza/Santos gas supply will assume if the flows from the Campos field to Sao Paulo are restricted for any reason.

HDT

32. The HDT was subjected to several sensitivity analyses. A reduction in benefits by 10% reduced the ERR to 21%, an increase in costs of the same

percentage has a similar effect, and a combination of the two effects reduces the ERR to a still acceptable 18%. Substitution of the origin/destination assumption favored by PETROBRAS has a negligible effect as the freight costs for the main transported product, diesel oil, are virtually identical under the two scenarios. Adding the costs of the ACOs system, without any attribution of benefits reduces the ERR to 17%.

33. On the other hand, assumption of increase real prices of products increases the ERR. Employing Bank assumptions of a series of price increases based upon the hypothesis that Arab Gulf crude oil prices will increase from $16.2 bbl in 1989 to $18.2 in 1997 and $20.9 in 2004 increases the ERR to 26%, while adopting of the PETROBRAS scenario which envisages an increase to $19.9 in 1997 and $21.9 in 2004 increases the ERR to 33%.

Sensitivity to Oil Price Changes

34. Recent events have raised the question of the likely effect of an increase in the price of crude petroleum and petroleum products and substitutes on the project ERRs. This can only be done on a rather imprecise basis, using restricted assumptions. The hypotheses are: i) only operating, not capital, costs will be affected; ii) within these, only fuel and energy costs would increase in the first instance, and the extent and speed of effects on other operating cost components are too imprecise to be included in calculations; iii) neither the existing nor the proposed energy transport systems would experience efficiency improvements which could be attributed to the above-mentioned price increases, in quantifiable terms; and iv) the relative prices of crude, products and substitutes would not change, in the medium terms.

35. Under these circumstances, a say 50% price increase would result in a modest increase in the ERR for the three product pipelines (about 1.8%) For the natural gas pipeline and the HDT component, the effects depend upon the assumptions regarding the relative product prices. If, the relative prices are assumed to remain constant then in absolute terms the differences would increase by 50% and the ERRs would increase correspondingly. In what seems the unlikely event of the price of crude petroleum declining below the project benchmark price of US$15.8/bbl Arabian light in 1993, the adverse effect on the ERR would again be insignificant for the three product pipelines, but greater for the natural gas pipeline and HDT component; with a decline to US$12/bbl the base ERR would decline to 15.1% for the pipeline and to 16.5 for the HDT plant.

Total Project

36. The ERRs for the sub-projects under the sensitivity analyses described above are summarized in Table 7.

Source: Bank Mission, August 1990.

Table 1: Product Pipeline

REPAR - Florianopolis

Basic Case

N	A(N)	B(N)	RATE OF RETURN
1	-1.20	.00	18.72
2	10.20	.00	18.72
3	-2.00	.00	18.72
4	10.00	.00	18.72
5	1.40	13.70	18.72
6	1.40	14.18	18.72
7	1.40	14.68	18.72
8	1.40	15.19	18.72
9	1.40	15.72	18.72
10	5.30	16.27	18.72
11	1.60	16.84	18.72
12	1.60	17.43	18.72
13	1.60	18.04	13.72
14	1.60	18.67	18.72
15	1.60	19.33	18.72
16	1.60	20.00	18.72
17	5.80	20.70	18.72
18	1.80	21.43	18.72
19	1.80	22.18	18.72
20	1.80	22.95	18.72
21	-3.20	23.75	18.72

Source: PETROBRAS, Bank Mission
August 1990

Table 2: Product Pipeline

TEMADRE-Jequie-Itabuna

Basic Case

N	A(N)	B(N)	RATE OF RETURN
1	.20	.00	16.26
2	21.60	.00	16.26
3	46.10	.00	16.26
4	10.50	.00	16.26
5	1.60	14.30	16.26
6	1.60	15.09	16.26
7	1.80	15.92	16.26
8	1.80	16.79	16.26
9	1.80	17.72	16.26
10	4.30	18.69	16.26
11	1.80	19.72	16.26
12	2.30	20.80	16.26
13	2.30	21.95	16.26
14	2.30	23.15	16.26
15	2.30	24.43	16.26
16	2.30	25.77	16.26
17	13.00	27.19	16.26
18	3.00	28.68	16.26
19	3.00	30.26	16.26
20	3.00	31.92	16.26
21	-6.00	33.68	16.26

Source: PETROBRAS, Bank Mission
August 1990

Table 3: Product Pipeline

REPLAN - GUARAREMA

Basic Case

N	A(N)	B(N)	RATE OF RETURN
1	4.90	.00	37.76
2	9.30	.00	37.76
3	19.00	.00	37.76
4	15.00	.00	37.76
5	.20	16.20	37.76
6	.20	20.10	37.76
7	.30	24.80	37.76
8	.40	32.50	37.76
9	.50	39.20	37.76
10	.60	44.50	37.76
11	.60	45.80	37.76
12	.60	45.80	37.76
13	.60	45.80	37.76
14	.60	45.80	37.76
15	.60	45.80	37.76
16	.60	45.80	37.76
17	.60	45.80	37.76
18	.60	45.80	37.76
19	.60	45.80	37.76
20	.60	45.80	37.76
21	-4.30	45.80	37.76

Source: PETROBRAS, Bank Mission
August 1990

Table 4: Product Pipeline

Santos - Sao Paulo

Basic Case

N	A(N)	B(N)	RATE OF RETURN
1	12.60	.00	18.89
2	18.90	.00	18.89
3	30.70	.00	18.89
4	24.40	16.80	18.89
5	9.90	18.00	18.89
6	9.90	19.70	18.89
7	9.90	20.60	18.89
8	9.90	22.00	18.89
9	.00	23.60	18.89
10	.00	25.20	18.89
11	.00	27.00	18.89
12	.00	29.00	18.89
13	.00	29.00	18.89
14	.00	29.00	18.89
15	.00	29.00	18.89
16	.00	29.00	18.89
17	.00	29.00	18.89
18	.00	29.00	18.89
19	.00	29.00	18.89
20	.00	29.00	18.89
21	.00	29.00	18.89
22	.00	29.00	18.89

Source: PETROBRAS, Bank Mission
August 1990

Table 5: HDT Component

Basic Case

N	A(N)	B(N)	RATE OF RETURN
1	10.88	.00	22.98
2	23.03	.00	22.98
3	79.78	.00	22.98
4	74.48	.00	22.98
5	.00	36.00	22.98
6	.00	96.20	22.98
7	.00	84.70	22.98
8	.00	44.30	22.98
9	.00	45.40	22.98
10	.00	45.40	22.98
11	.00	45.40	22.98
12	.00	45.40	22.98
13	.00	45.40	22.98
14	.00	45.40	22.98
15	.00	45.40	22.98
16	.00	45.40	22.98

Source: PETROBRAS, Bank Mission
August 1990

Table 6: Product Pipeline Flows ($000m^3$)

	REPAR Florianopolis	TEMADRE-Jequie-Itabuna	RLAN [3] Guararema	
			Total	Incremental
1991	1058	785	10534	1234
2010	1854	2170	14528	5228
2010 [1]		1509		
2010 [2]	1691	1225		

1 at 3.5% p.a.
2 at 2.5% p.a.
3 Total flows to/from the refinery and increment to be carried by the new pipeline.

Source: PETROBRAS, Bank Mission
August 1990

Table 7: Sensitivity Analyses ERR

Sub-Project	(Basic ERR)	Sensitivity ERR			
		Min	(see text)		Max
REPAR - Florianopolis	19	15	17		18
TEMADRE - Jequie - Itabuna	16	12	13		14
REPLAN - Guararema	38	28	30		30
Santos - Sao Paulo	18	15	17	25	36
HDT	23	17	18	26	33
TOTAL	21	16	--	--	--

Source: PETROBRAS, Bank Mission
August 1990

BRAZIL

ENERGY TRANSPORT AND CONSERVATION PROJECT

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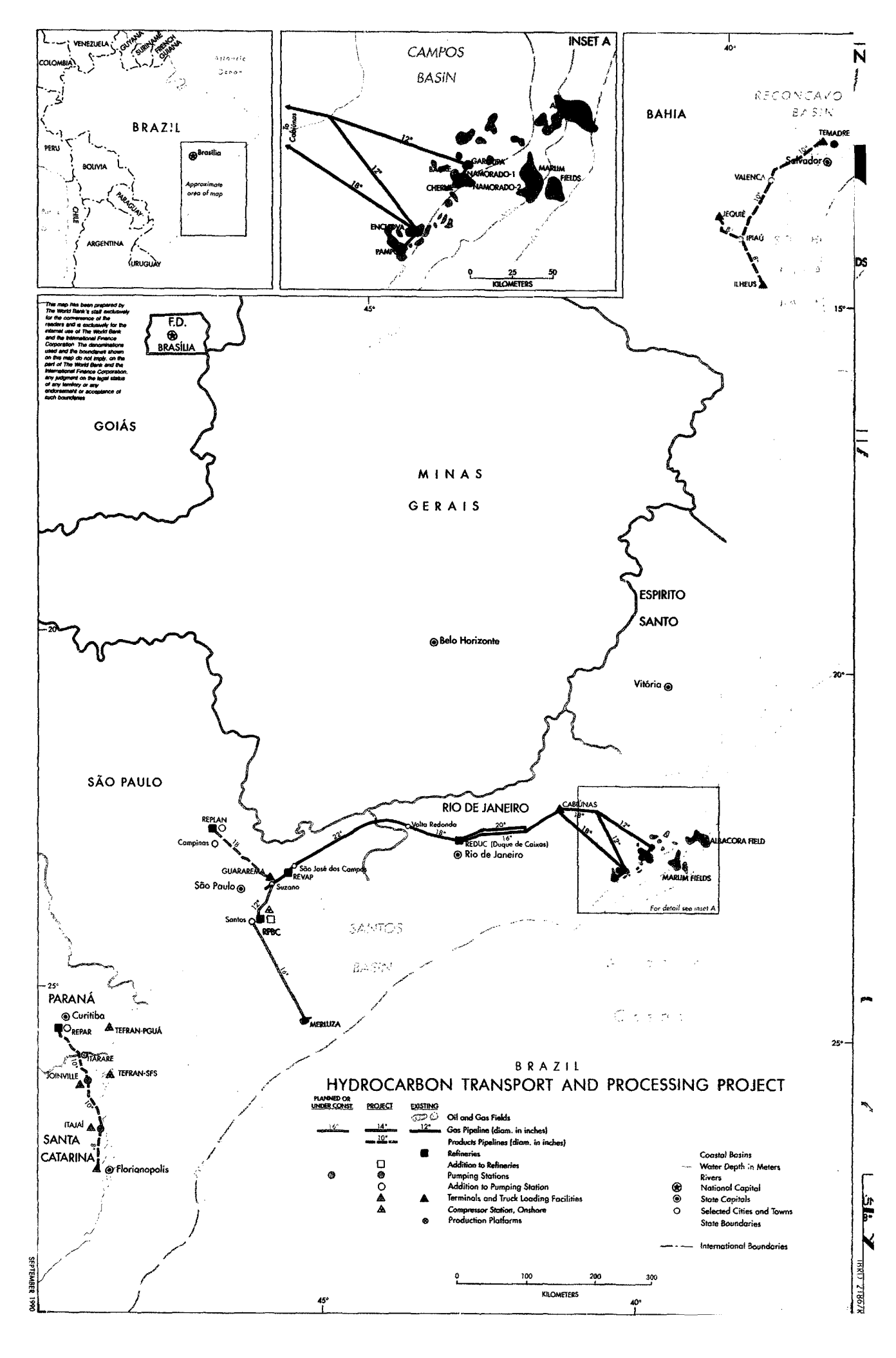

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