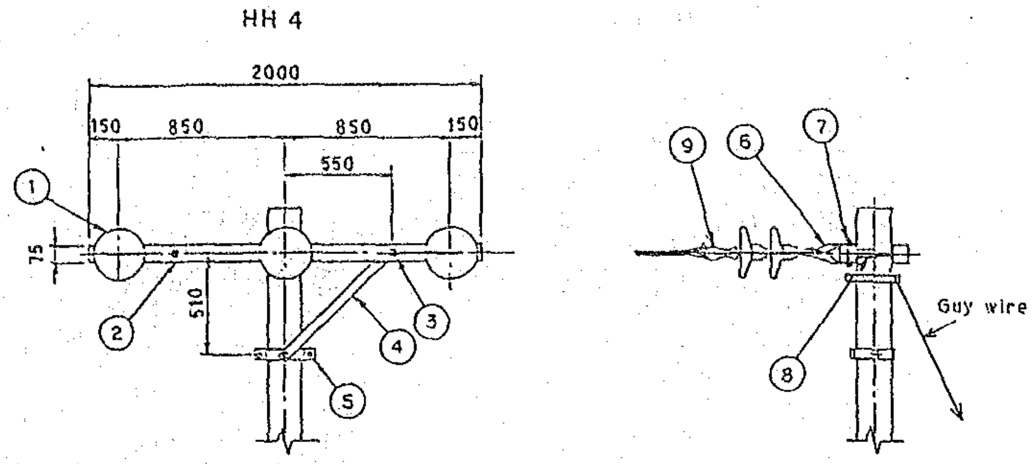
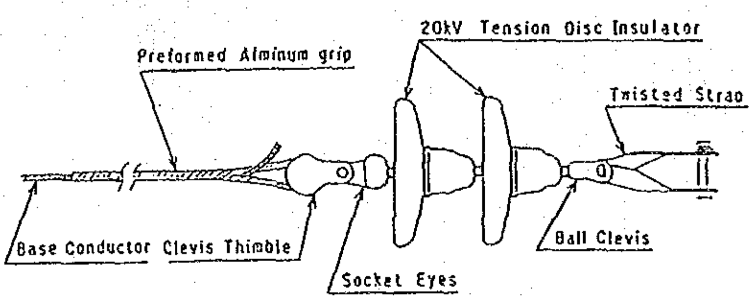




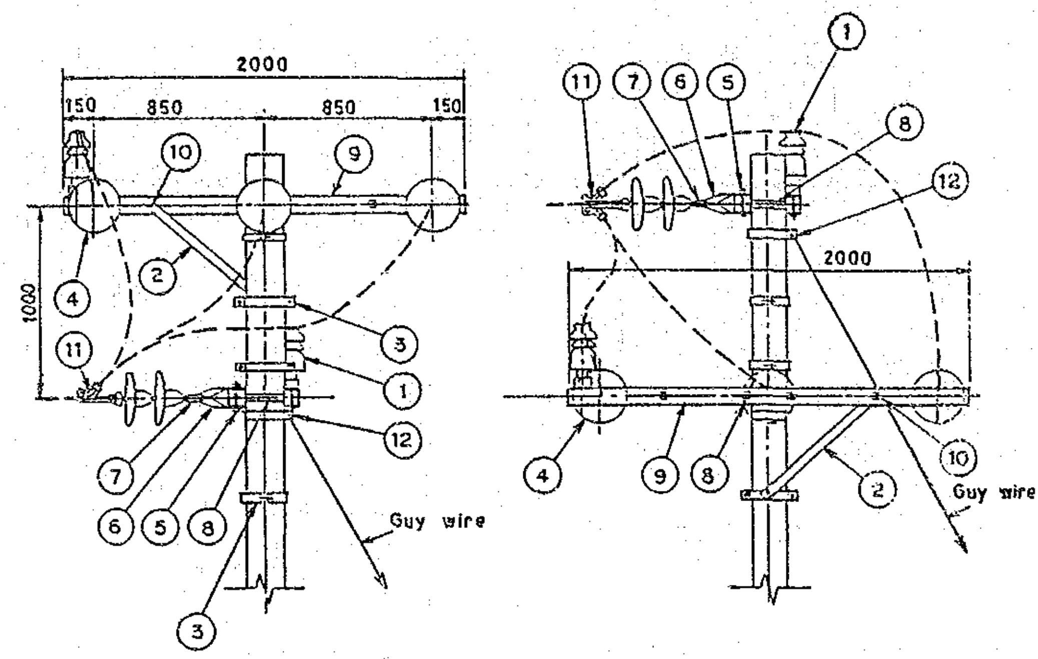
Detailed assembly for tension disc insulator

9	3	Clevis thimble with ball clevis & Socket eye & preformed aluminum grip
8	1	Double arm band
7	3	Bolts & Nuts M16×120
6	3	Twisted strap
5	1	Arm tie band
4	2	Arm tie type-750
3	2	Double arm bolts & Nuts M16×400
2	2	Cross arm type-2000B
1	6	Tension disc insulator
Item	Q'ty	Components

Note:
To channel crossarms the same components applied.

Figure 11-17 Pole Assembly at Dead-End

HH 10

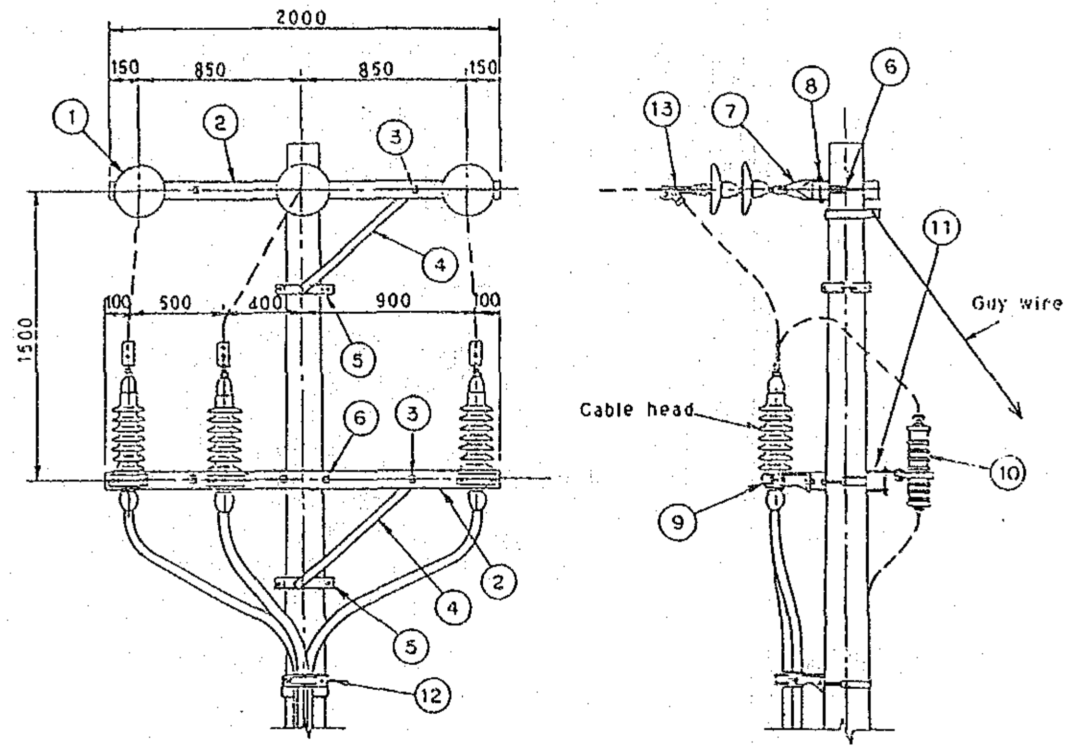


Item	Q'ty	Components
12	2	Guy wire band
11	6	M.V Dead end clamp with socket eye
10	4	Double arm bolts & Nuts M16x400
9	4	Cross arm type-2000B
8	2	Double arm band
7	6	Ball clevis
6	6	Twisted strap
5	6	Bolts & Nuts M16x120
4	12	Tension disc insulator
3	2	Arm tie band
2	4	Arm tie type-750
1	2	P.P. Insulator with tie

Note:
To channel crossarms the same components applied.

Figure 11-18 Pole Assembly at Locations of Large Angle Turns

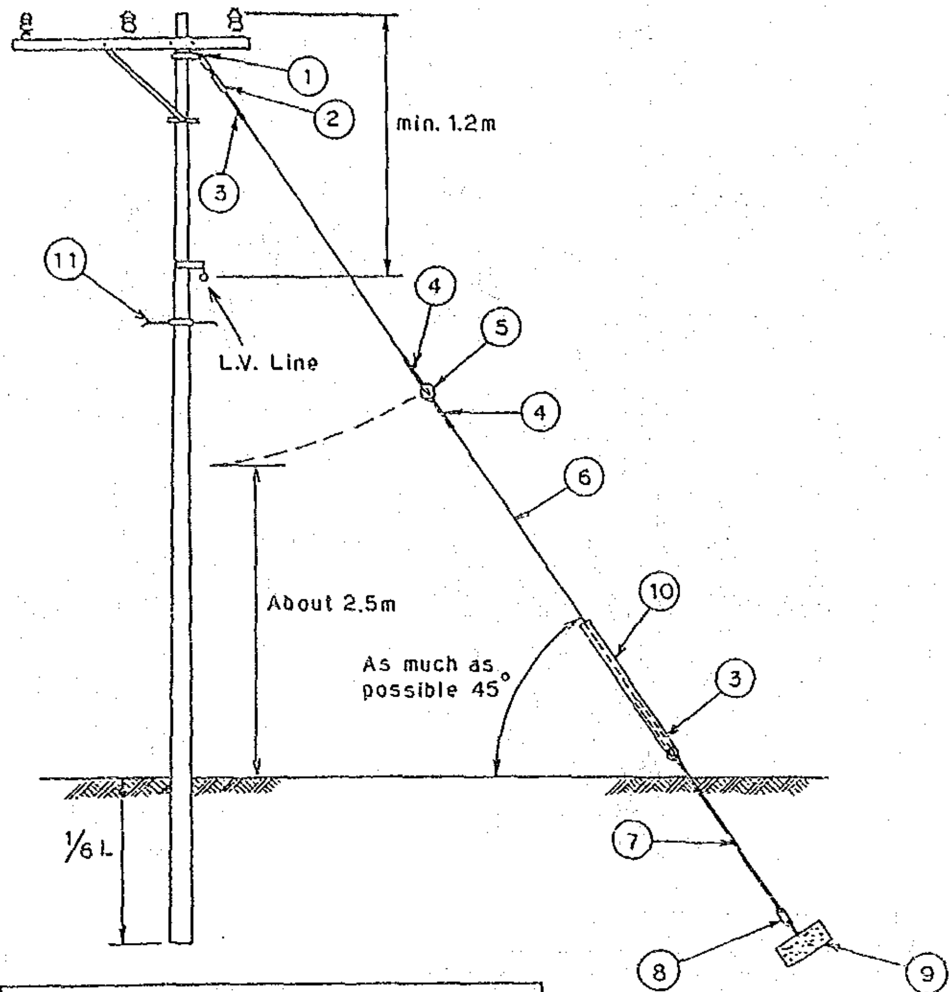
HH 11



13	3	Dead end clamp with socket eye
12	2	Cable band
11	3	Arrester mounting bracket
10	3	Line arrester
9	3	Cable bracket supporter
8	3	Bolts & Nuts M16x120
7	3	Twisted strap
6	2	Double arm band
5	2	Arm tie band
4	4	Arm tie type-750
3	4	Double arm Bolts & Nuts M16x400
2	4	Cross arm type-2000B
1	6	Tension disc insulator
Item	Q'ty	Components

Note:
To channel crossarms the same components applied.

Figure 11-19 Pole Assembly at Connections with Underground Cables



11	1	Climb preventive fitting
10	1	Guy guard
9	1	Anchor block
8	1	Anchor rod clamp
7	1	Anchor rod
6	1	Guy wire
5	1	Guy insulator
4	2	Preformed grip type B
3	2	Preformed grip type T
2	1	Turn buckle
1	1	Guy wire band
Item	Q'ty	Components

Figure 11-20 Stay Wire Supporting A Dead-End Pole

Figure 11-19 shows the top of the pole at which the distribution line will be connected with an underground cable or cables leading to factories or other similar establishments. The dead end pole should be provided with a stay wire on the opposite side of the distribution line. Given in Figure 11-20 is the method of installation of such a wire.

11-4-5 Distribution Control Board

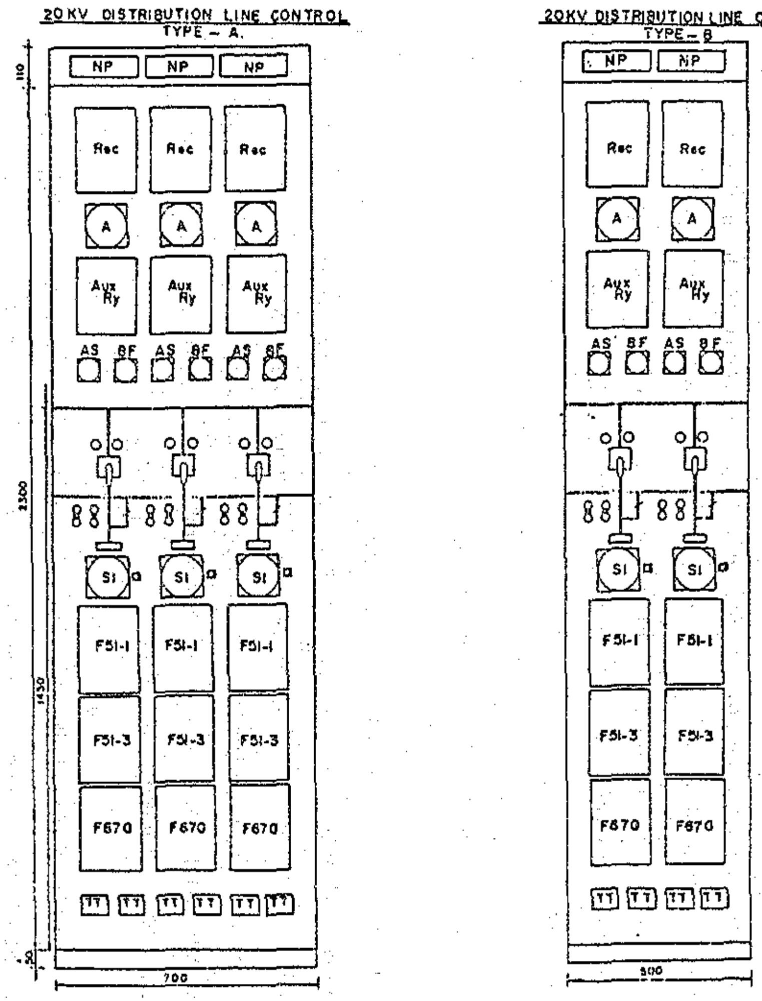
A control board for the operation of the three distribution circuits will be installed at the proposed power plant of this Project.

The board will be connected with the circuit breakers through a bus line. The circuit breakers could be actuated either by hand through the board or automatically on a signal indicating the occurrence of abnormality, such as excess current or excess voltage within or outside the system. The board will be equipped with instruments to monitor moment-by-moment changes in current and voltage of distribution lines, annunciators and alarm lamps to give an alarm for any abnormal phenomenon. Figure 11-21 shows the front view of the control board.

11-4-6 Switchgear and Auxiliary Power Board

A circuit breaker will be installed for each circuit and it will be connected with an outgoing cable through a bus line. A switchgear will consist of a circuit breaker, a disconnecting switch (to be opened by hand for maintenance and inspection), and a current transformer (to be connected with an ammeter), and its panel will be equipped with display lamps.

An auxiliary power board will be provided for disconnecting switches, potential transformers, arresters, etc., and it will be equipped with display lamps, overcurrent relays and directional ground protection relays. Figure 11-22 shows the front view of the board and one-line diagram of the connection.



NP : Name plate
Rec : Reclosing relay
A : Ammeter
Aux Ry : Auxiliary relay
AS : Ammeter switch
8F : Control source switch
SI : Section indicator
F51 : Overcurrent relay
F67G: Directional ground current relay
TT : Test terminal

Figure 11-21 Front View of the Distribution Control Board

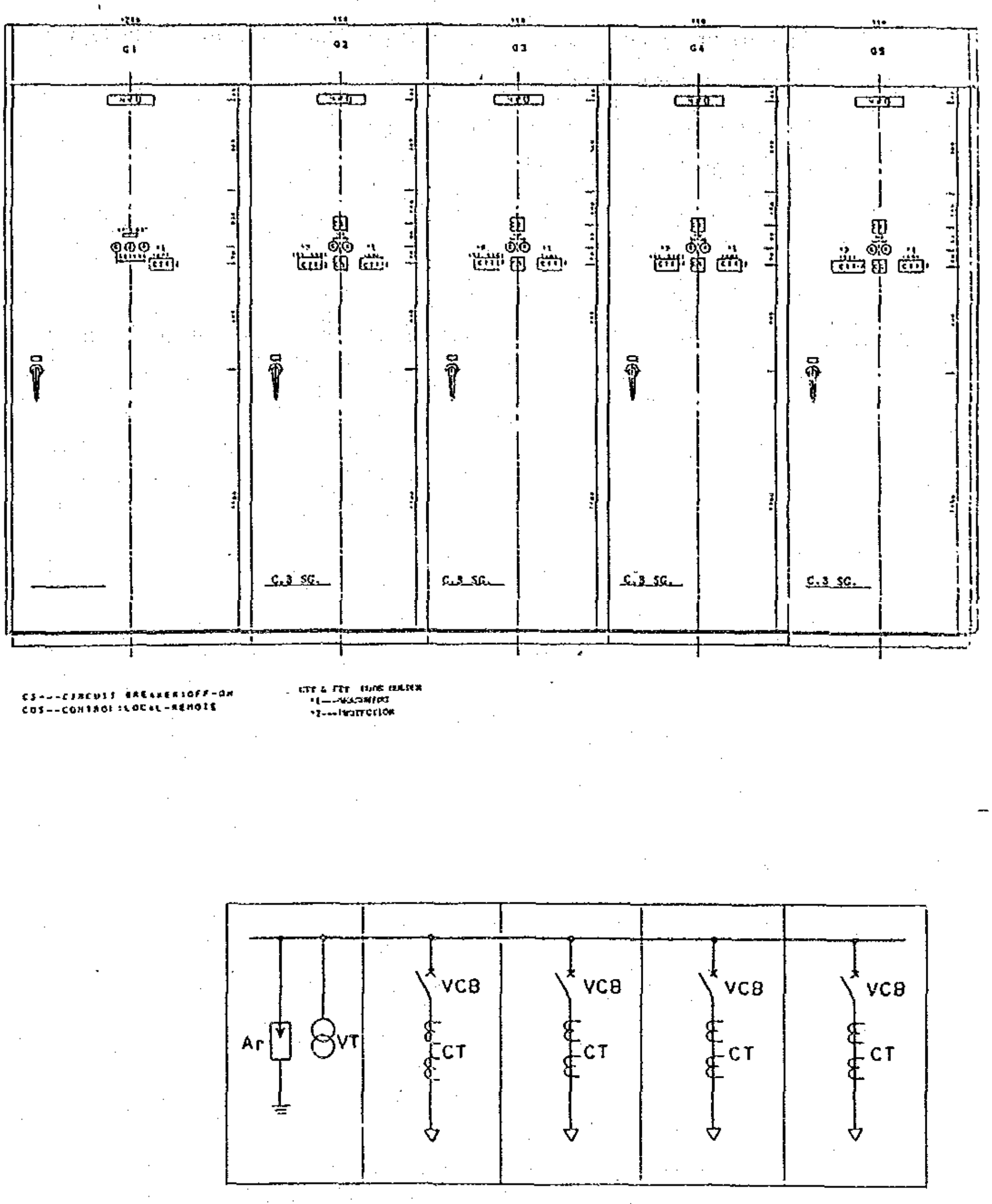
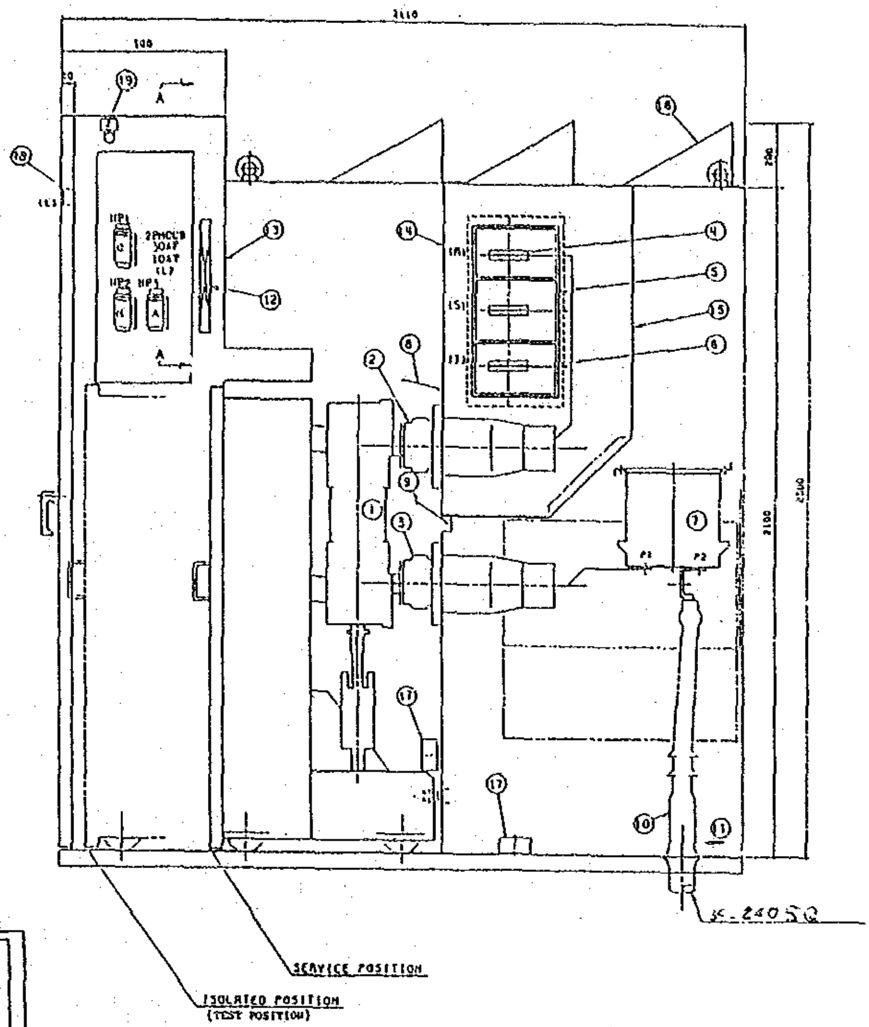


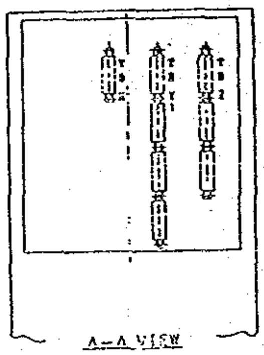
Figure 11-22 Arrangement of the Metal-Clad Switchgear

The circuit breakers will be of the following specifications:

Type: Vacuum type
Operation duty: Open-1 min-Close/Open-3 min-Close/Open
Rated voltage: 24 kV
Rated circuit breaking current: 16 kA
Rated current: 630A
Rated break time: 5 cycles

Figure 11-23 shows the cross sectional profile of the switchgear.





NO	NAME	Q'TY	RATING
1	VACUUM CIRCUIT BREAKER	1	24KV, 630A, AC25KA
2	ISOLATING CONTACT	3PH	630A
3	ISOLATING CONTACT	3PH	630A
4	MAIN BUSBAR	3PH	1250A, 50HZ
5	BUSBAR SUPPORTER	1	
6	CONNECTING CONDUCTOR	3PH	630A
7	CURRENT TRANSFORMER	3	200-100/5/5A 15VA/15VA 1.0CL/5P10
8	METAL SHUTTER	1SET	
9	METAL SHUTTER	1SET	
10	CABLE END	1	
11	EARTH BUSBAR	1	Cu 5×40
12	TERMINAL BLOCK	1SET	
13	PARTITION	1SET	
14	PARTITION	1SET	
15	PARTITION	1SET	
16	PRESSURE RELIEF VENT	3SET	
17	SPACE HEATER	2	220V 100W
18	DOOR SWITCH	1	
19	ILLUMINATION LAMP	1	220V 10W

Figure 11-23 Cross Sectional Profile of the Switchgear

12. CONSTRUCTION WORKS

12-1 General

Plants for the Project shall be constructed at the following four places, according to the conclusion in Chapter 6;

(1) At Sengeti:

. Natural gas production plant
. Natural gas pretreatment facility
. LPG recovery plant

(2) Between Sengeti and Payo Selincah:

. Natural gas pipeline

(3) Payo Selincah:

. Power station

(4) Jambi City area:

. Power transmission and distribution lines

Operation of these facilities has close relation each other, for example, natural gas supply by the pipeline shall be made available before starting the operation of the power station and also LPG can be recovered from condensate to be supplied from the natural gas production plant and the natural gas pretreatment facility. Therefore, these works shall be done in parallel at four places and shall be scheduled that each work completes timely in concert with other works.

Jambi city and its surroundings are consisted of swamp and low hill less than 30 meters in altitude from sea level. The land is formed with thick alluvial soil, which consist of sand layers sandwiched by clay layers.

Surface of the land is covered by clay in general and it turns muddy in rainy season. There are swamp on north bank of the Batang Hari river, where will be flooded when the river swells. Therefore, construction works shall be carried out mainly in dry season to avoid disturbance caused by rain.

A paved road connects Jambi and Palembang, however, for transportation from Jakarta, it is recommendable to use the Batang Hari river with flat barge, especially in case of transportation of heavy equipment and materials. The Batang Hari river has 5 meter depth and 100 meter width up to Jambi port even in dry season. It swells 8 meters in rainy season, when 3,000 DWT ship can sail alongside the pier of Jambi port. The pier can not be used in dry season. Flat barge comes to a quay at Sengeti only in high water season of the river.

A bridge is currently under construction at the down stream of Sengeti quay, however, barges can pass under the bridge, with cargo 7.5 meter high from the water level, even in flooded season. Transportation shall be planned to concentrate at the period when the river swells, in order to utilize barges.

12-2 Natural Gas Pretreatment Facility and LPG Recovery Plant (at Sengeti)

12-2-1 Outline

At Sengeti, the natural gas pretreatment facility, the LPG recovery plant and the auxiliary facilities will be constructed. In addition to the above, the existing natural gas production plant and the gas oil separation plant will be repaired, although they are excluded in this project.
Most of the new equipment will be imported taking the form of skid-mounted or package units. Therefore, the main construction works would be transportation and installation of these units.

12-2-2 Transportation and Storage of Equipment and Materials

Equipment and materials shall be transported by barge on the Batang Hari river to Sengeti during the swelling season of the river, i.e. the end of rainy season. After unloaded at the existing quay, the equipment and materials will be transported to the plant site by truck.
Main road to Sengeti area is a road of 3 meter width, but unpaved. The city authorities have a plan to construct a 2-lane-paved-road by the time of completion of the bridge across the Batang Hari river.
The materials will be transported using the new road mentioned above and an access road connecting the new road to the plant site. Since the access road having 300 meter length will also be used for transportation of LPG cylinder after the completion of construction, it shall be paved with macadam. Jambi area does not produce any rock nor rubble, therefore macadam shall be made artificially from sand and cement.
Imported equipment shall be transferred from ship to barge and importing procedures shall be cleared at Jakarta port, and then transported to Sengeti.
The natural gas pretreatment facility and LPG recovery plant will be imported taking the form of a skid-mounted unit. The unit will be divided into several pieces for easy transportation to the plant site.
Since there are no storehouses in Sengeti, the buildings such as office, control room, warehouse will be constructed first and used as temporary storehouse for equipment and materials.

12-2-3 Electricity and Water Supply

The diesel engine-driven power generator to be installed in the LPG recovery plant will be used for supply of electricity required for the construction work.
The well water, planned to be used for fire fighting water, will be used for the construction work.

12-2-4 Foundations

Foundations shall be completed during the dry season one year before the installation works of equipment start. There are almost no construction machines available in Jambi area for the project and all necessary machines shall be transported by barge from Jakarta during the rainy season when river water rises, before commencement of construction works.

Reinforced concrete or macadam ring foundation will be constructed as foundation for newly installing equipment. As mentioned before, macadam shall be made artificially.

12-2-5 Installation, Piping and Instrumentation

The skid-mounted unit, being divided and transported, will be reassembled at site and installed on the foundation. After installation, all equipment will be connected by piping. Distortion of the position of equipment in the skid-mounted unit caused by installation work will be adjusted by connecting spool pipes. Then all equipment and pipings will be tested hydraulically.

Instrumentation work will be started in parallel with piping works, and instruments will be connected to equipment and pipings after hydraulic test.
Installation, piping and instrumentation shall be started in May when rainy season ends, and shall be completed before the end of September, namely, before rainy season comes back.

12-2-6 Test Operation and Commissioning

Rotating machinery such as power generator and pumps shall be tested of their running conditions at the manufactures' factories so as to avoid independent running test at site.

The test operation and commissioning of the natural gas production plant and pretreatment plant will be carried out with burning gas at the flare stack. Pressures and temperatures of the plants and flow rates will be measured and the gas will be analyzed. The commissioning of the LPG recovery plant will be followed, and production of LPG meeting the specification and safety operation will be confirmed.

12-3 Natural Gas Pipeline

12-3-1 Outline

The natural gas pipeline is constructed for the purpose of sending the gas produced and pretreated at Sengeti, for distance of 20 kilometers to the proposed power station at Payo Selincah.

Pipeline is to be constructed with 6 inches nominal size and Sch. 40 seamless steel pipe and be buried underground for safety. However if it runs more than 30 meter apart from any building, as mentioned in Item 9-1-4 2), it can be placed above ground. 6 meters wide foot path shall be constructed along the right of way in swamp area. The path shall be about 1.5 meters higher from the water level at flood, and pipeline is buried at its center. Typical examples of pipeline construction are shown in Figure 12-1.

The pipeline passes through the swamp in the north bank area of the river, and crosses the river at east of the city, then passes the city area to the power station at Payo Selincah, as shown in Figure 12-2.

Specialized pipeline construction machines are sometimes utilized for time saving, however in this project, 20 km distance is not so long to require specialized machines. The pipeline shall be constructed by conventional construction machines and local labor, because construction period is sufficient for conventional works.

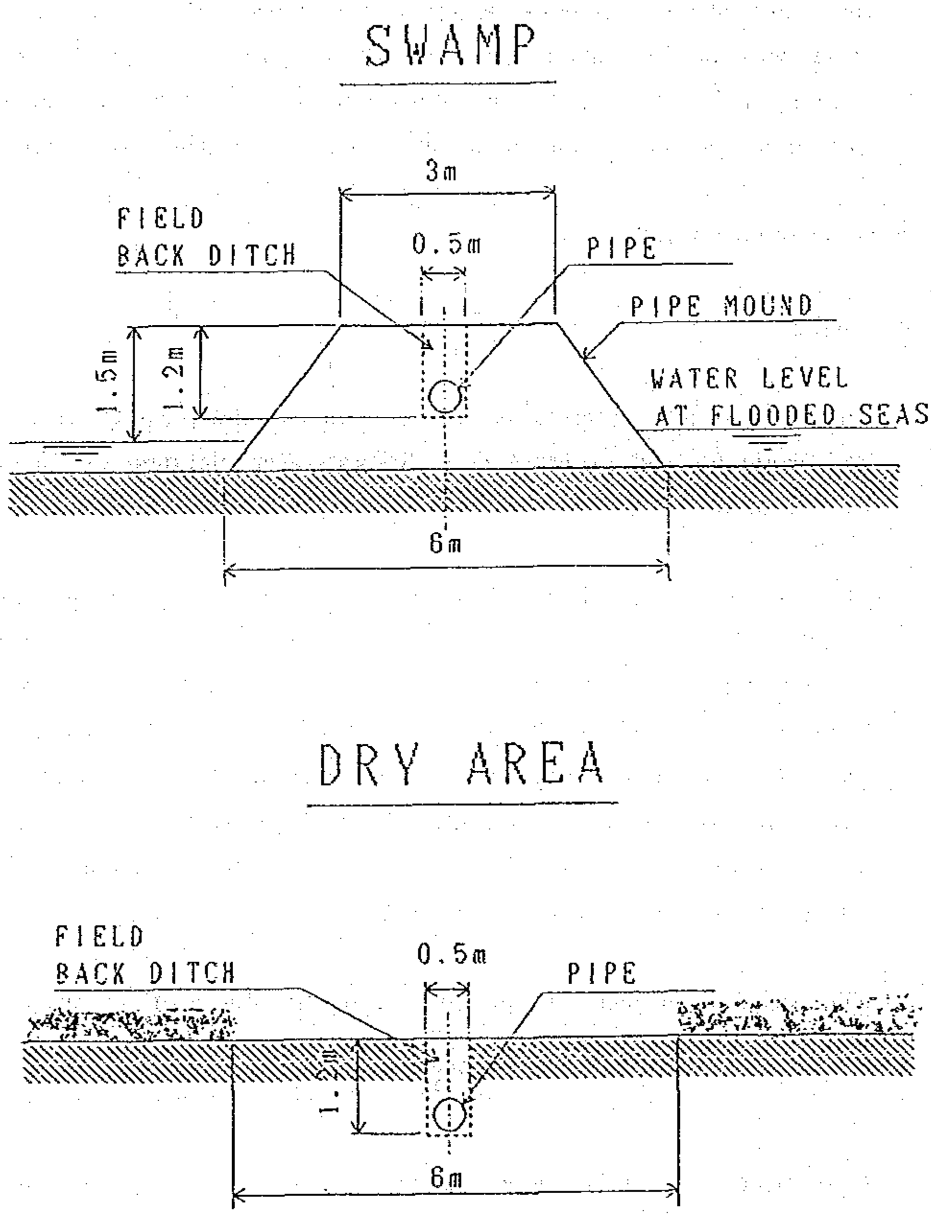


Figure 12-1 Examples of Pipeline Construction

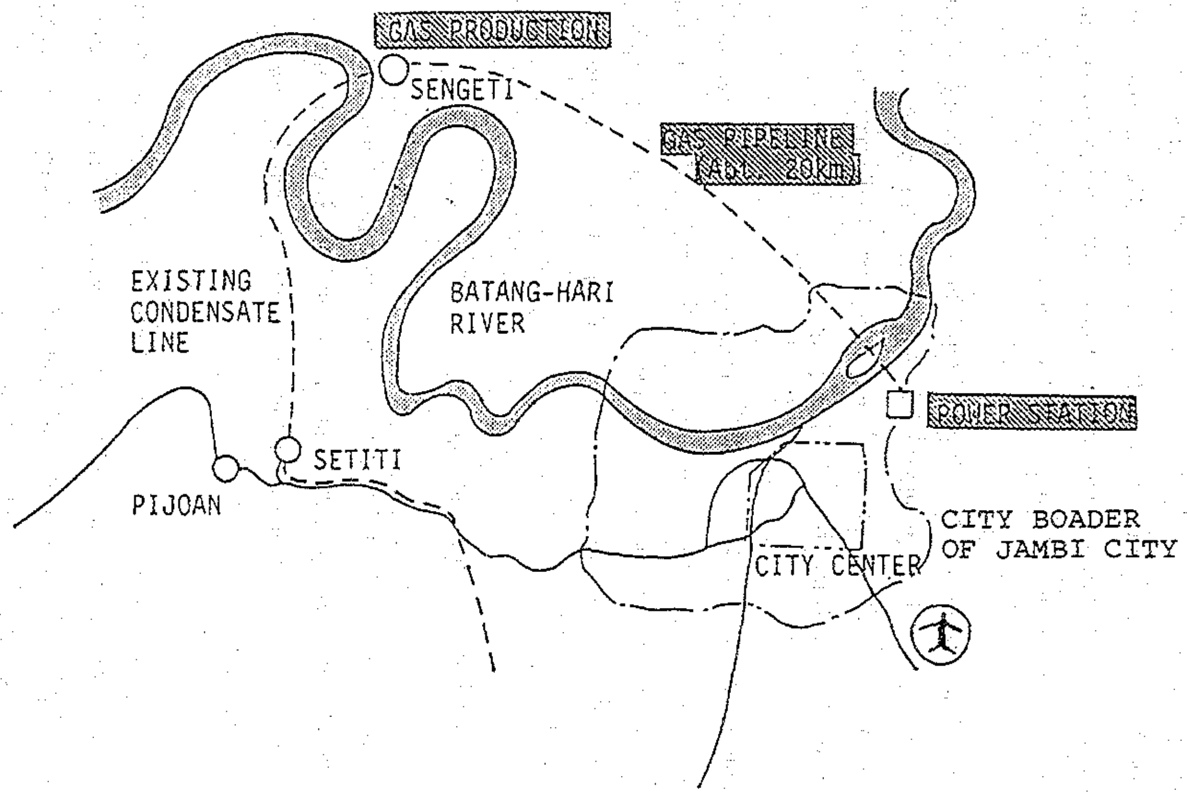


Figure 12-2 Route of Gas Pipeline (Plan)

12-3-2 Local Survey

Piping route between Sengeti and the proposed power station shall be selected based on land survey, then permission of land owner and consent of neighboring peoples for installation of pipeline shall be obtained. Based on the measurement of piping route, permanent right of way shall be acquired for the finalized piping route.

Crossing point of the river shall be selected after conducting field survey, regarding geographical shape of the river bottom, river width, conditions of bottom sediment, water flow velocity and so on, in order to establish pipe laying plan across the river.

The pipeline route shall be planned as short as possible, however, in view of easy access during construction and maintenance, it is also necessary to provide as many access points by truck as possible. Therefore, the pipeline shall pass the route connecting these access points by the shortest line.

12-3-3 Preparation of Right of Way

Right of way shall be cleared and leveled. Foot path shall be constructed in swampy area as mentioned in Sub-section 12-3-1. When it is necessary for the construction work, temporary access road shall be constructed.

Concrete pit for block valve shall be prepared at both sides of the crossing point of the Batang Hari river. A fixing point of the winch also shall be constructed at the point for river crossing pipeline laying as explained in Sub-section 12-3-12.

12-3-4 Delivery of Piping Materials

Piping materials shall be transported by barge, then by truck to temporary store houses for equipment and materials. Two material stock yards shall be provided, because the gas pipeline is divided into two sections by the river. One stockyard shall be at Sengeti and the other at the proposed power station site. All pipeline works shall be carried out by the direction from these two stock bases. Pipes shall be carefully handled with appropriate lifting gears to avoid any permanent deformation or damages.

12-3-5 Ditch

Piping route shall be determined after measurement and marking piles shall be installed along the center of the right of way at every 50 to 100 meter distance. Pipe ditch shall be excavated in about 1.2 meters depth, in which the pipe shall be laid and covered by soil with thickness of more than 0.9 meter, in general. However the depth shall be modified according to environment. Width of the ditch shall allow 15 cm space at each side of the pipe, therefore overall width of the ditch shall be about 0.5 meter.

12-3-6 Welding

Pipes shall be welded together by electric arc welding. Welding shall be conformed with ASME Pressure Vessel Code IX or API standard 11.04, and welders shall be qualified for above mentioned code or standard.

Sampling X-ray test shall be carried out on welded connections according to ANSI B 31.8, which defines sampling numbers for different type of districts. In spite of the above, river crossing pipe and pipe passing through densely populated area shall be 100% tested of the connections by X-ray.

12-3-7 Bending

Pipeline shall not be allowed bending by curvature of less than 18 times of pipe diameter. When it is necessary to bend smaller curvature than above, hot bended pipe shall be prepared in a factory.

12-3-8 Corrosion Protection Coating

Pipe shall be coated with corrosion prevention film before burying. Tape of the film shall be manually wound over pipes at site. Coating shall be tested by holiday tester after winding.

12-3-9 Burying

Pipeline shall be covered firstly with soft screened soil and then buried with ordinary soil in order to avoid damage on the coating. Soil shall be carefully refilled over the pipe to recover natural condition. Refuse of works shall be cleaned and not be left on the right of way.

12-3-10 Cleaning of Pipeline

After numbers of pipe are connected, inside of some section of pipeline or total length of pipeline shall be cleaned with cleaning pig to remove debris and rust.

12-3-11 Hydraulic Test

Hydraulic test shall be conducted after completion of pipeline. Inhibitor shall be added to water for the test, in order to prevent corrosion. Pipeline shall be confirmed that there will be no leakage with 53 kg/cm^2G pressure for a period of 24 hours, according to ANSI B 31.8. During the test, utmost attention shall be paid for the safety of workers and peoples living near the pipeline.
Inside of the pipeline shall be dried by introducing hot air after the test. Pipeline shall be sealed with nitrogen gas after pipeline is

completely dried, and sealing shall be kept upto the time of commencement of operation.

12-3-12 River Crossing

Pipeline will cross the Batang Hari river twice, width of which will be about 500 meters at the candidate point of crossing, because there is an island in the river. Because it is too expensive to provide supporting bridge for the pipeline, it is planned to lay the pipeline at bottom of the river. In order to prevent damage by ship's anchor, the pipeline shall be buried in a ditch dug at its bottom by a river bottom dredger.

There are several methods for laying pipeline in the river such as floating pipe method, pipe laying ship method and bottom pulling method. Floating pipe method is not suitable because of high water flow velocity, and also pipe laying ship is too expensive to hire for this operation in this case. Bottom pulling method is most recommended to be adopted for this case.

A winch shall be fixed at a bank in order to pull the pipeline which is welded together at the opposite bank of the river, as shown in Figure 12-3. The pipe end shall be tightly closed in order to avoid river water intrusion, and also the pipe of the river crossing portion shall be heavy enough not to float in water nor move in the river current.

12-3-13 Road Crossing

Steel casing shall be provided at the crossing point of main road as shown in Figure 12-4, in order to prevent over-stress on the pipeline caused by traffic of heavy vehicles.

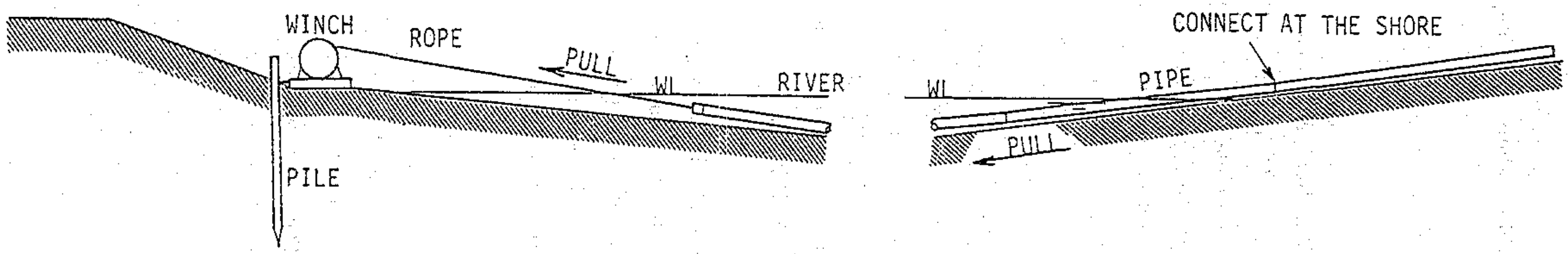


Fig 12-3 Crossing River Operation of Piping

Figure 12-3 Construction of River Crossing Pipeline

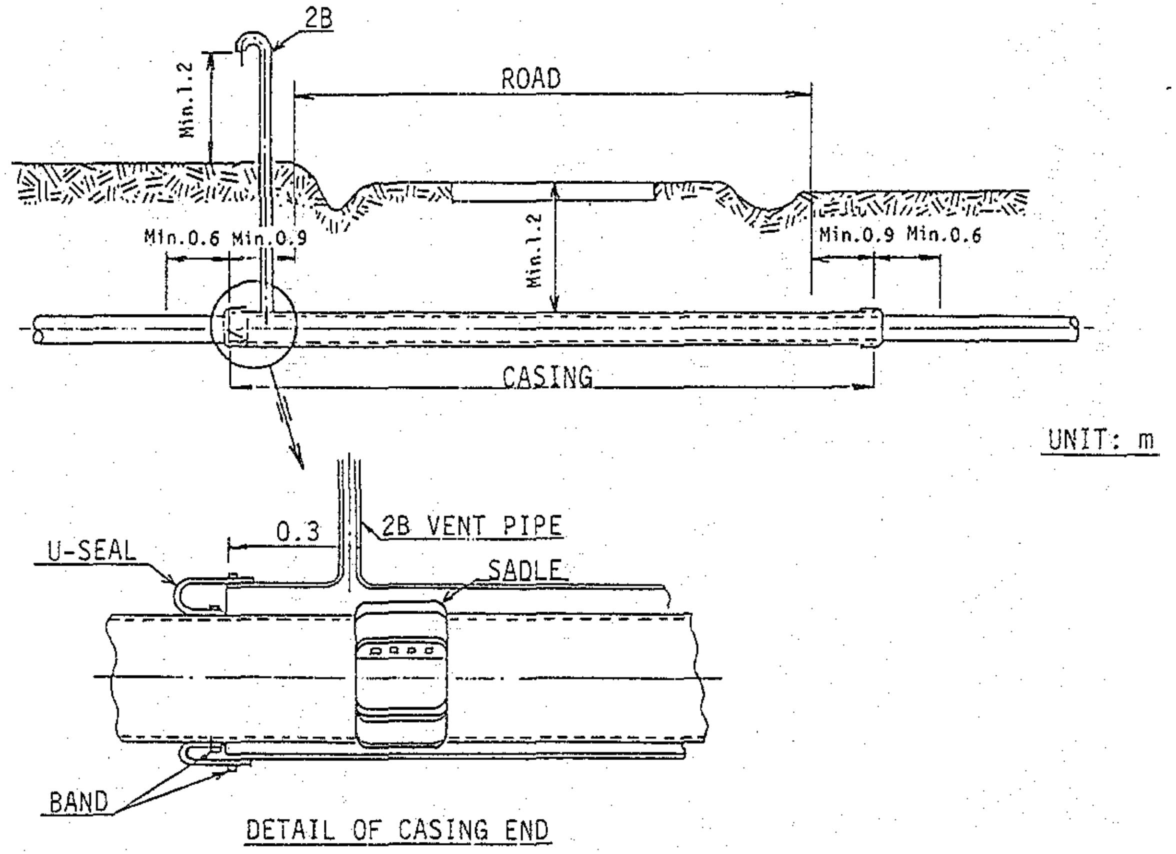


Figure 12-4 Construction of Road Crossing Pipeline

12-4 Power Plant

12-4-1 Outline

Construction works of the power plant will become critical pass in the whole project schedule, because large and heavy pieces of equipment such as dual-fuel engines shall be installed.
Equipment to be installed in the building are;

1) Dual-fuel engines and generators
2) Auxiliaries of engines
3) Panels for generator and electric distribution

Equipment to be installed outside of the building are;

4) Engine cooling system (radiators)
5) Air intake and gas exhaust system (filters and silencers)
6) Transformers

And also followings shall be provided in the power station area;

7) Fuel oil storage tank
8) Water supply system (well, pumps and head tank)
9) Electric utilities

Most of these equipment including engines, generators, auxiliaries and so on are imported. Heaviest piece, namely engine and generator, shall be packaged within a weight limit of transportation of 8 tons per axis.

In the past, 12 axes trucks are used in the roads of Jambi area, therefore, the weight of one cargo will be limited practically less than 90 tons per piece. The engine shall be overhauled periodically by extracting pistons after detaching cylinder heads. An overhead travelling crane and maintenance space shall be provided in the building for the purpose.

Site of the proposed power station shall be selected at east part of the city in accordance with the conclusion in Section 6-3. The location shall be near the existing Payo Selincah power station and apart from any residence more than 300 meters. The site shall be about 120 meters x 80 meters flat area. Figure 12-5 shows an example of general arrangement of the station.

Foundation of the engines shall be strong enough for the continuous operation, because moving parts of the engines and generators require precise alignment. An example of engine and generator foundation is shown in Figure 12-6.

Piles of the foundation shall support engine, generator and their foundation, total of which are about 500 tons. Size and numbers of piles shall be decided by examining boring data after survey.

12-4-2 Local Survey

The site area shall be measured after a proposed site is selected. Boring sample shall be taken from several points of the site for soil strength test. Boring depth is recommended to be more than 50 meters, in order to obtain data for piling.

Land shall be acquired for the site and access road according to the plan and the results of measurement. Whole route to the site from the Jambi port shall be checked for the transportation of 90 tons cargo by the trailer. Reinforcement of bridges and repair of road pavement shall be planned and executed accordingly.

There is no adequate facility to handle 90 tons cargo at Jambi port. Temporary pier mentioned in Sub-section 14-4-8 shall be prepared. Location of the pier shall be selected after conducting survey around the coast of the port area. Permit of the port authority shall be obtained for the construction of the temporary pier.

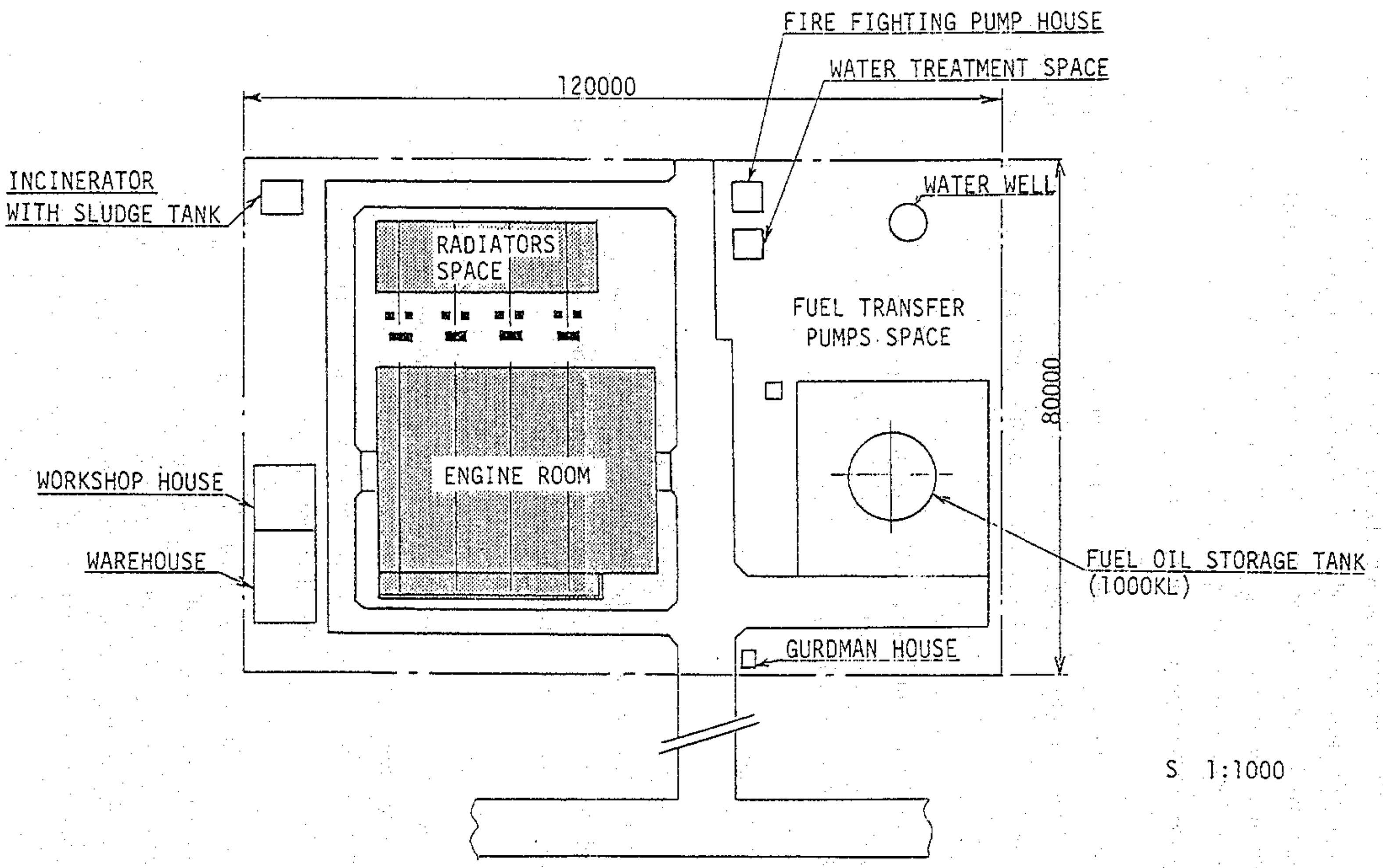


Figure 12-5 Plot Plan of Power Plant

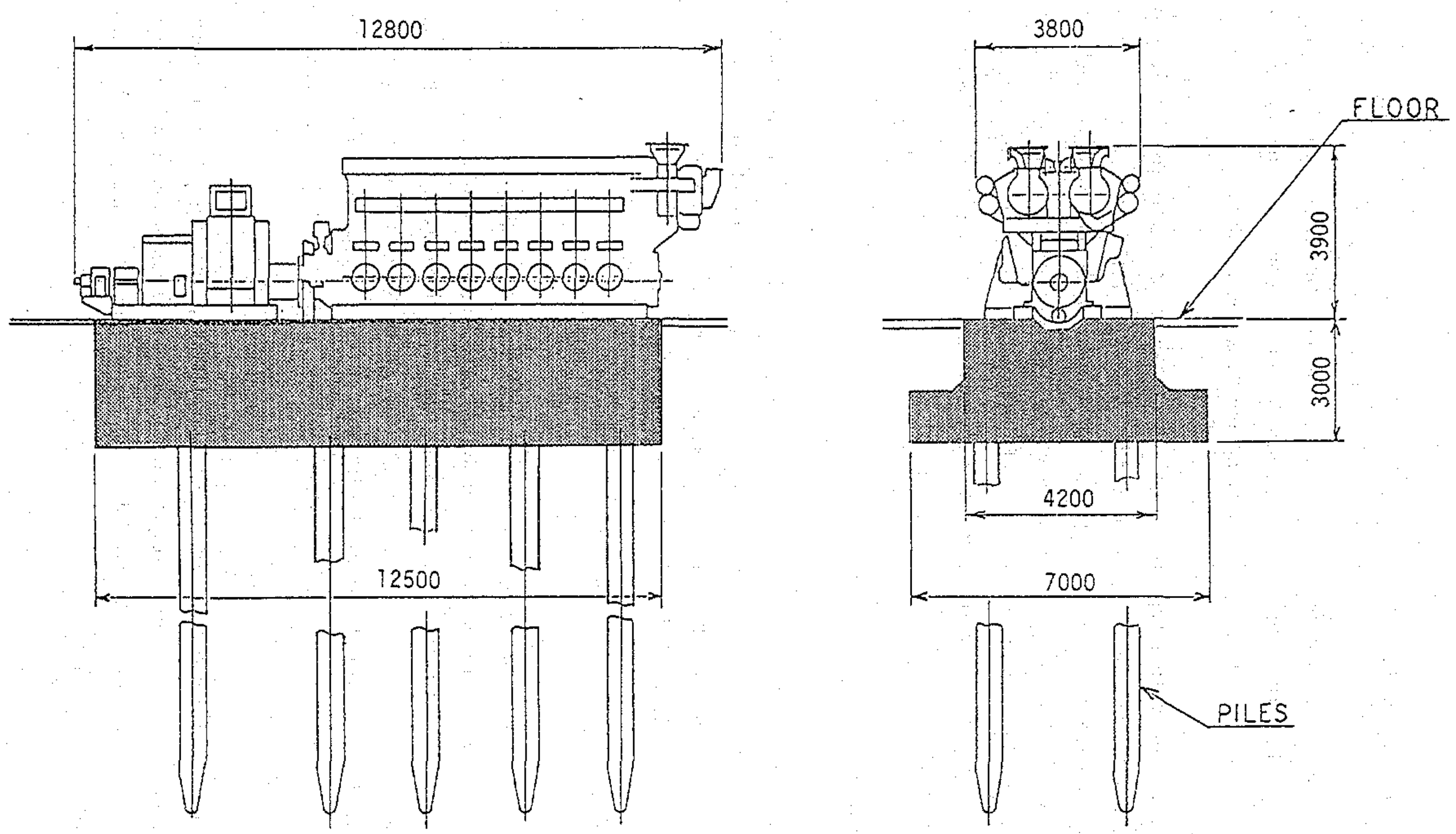


Figure 12-6 Foundation of Engine and Generator

12-4-3 Land Preparation

As land preparation of the power station site consists an important part of critical pass in the construction schedule of the project, it shall be done efficiently by using construction machines.

It is not anticipated to move huge amount of earth for leveling of the site, because the land is not so steep in the area. However, it is necessary to estimate amount of the earth to be removed from the site for leveling, and to plan where removed earth shall be disposed and how it shall be transported. The leveling work shall be started immediately after the rainy season ends and be completed within short period of time.

12-4-4 Access Road

An access road shall be constructed before the land leveling work is commenced. The road will be used for the transportation of fuel oil after commencement of commercial operation. The road shall be paved with artificial macadam.

12-4-5 Foundation

Four engine foundations as shown in Figure 12-6 shall be constructed. The works shall be done by utilizing construction machines in order to shorten construction period. They shall be completed before the rainy season starts. Foundation work for the building and other equipment shall be started in parallel with the engine foundation works, however these works shall be planned not to disturb smooth execution of engine foundation works.

The other foundations shall be completed in the same time or before completion of engine foundations. Engine foundation shall be reinforced by steel rods, and shall be strong enough to support the heavy vibrating machines.

12-4-6 Building

A steel framed structure is considered for the building as mentioned in Sub-section 10-4-2, so that the construction period can be shorten by utilizing this construction method. Engine noise attenuation by closed engine room is not so practical in this area in view of its climate, therefore machine noise pollution for residence shall be avoided by providing a distance of more than 300 meters from the proposed power station to the nearest residential area. Control panels of generators and electric distribution panels shall be located in the room divided from the engine space by noise attenuating wall.

12-4-7 Electric and Water Supply

A well and pumps with water storage head tank shall be provided at the site, because there is no public water supply available. The water storage will also be served for fire fighting purpose. If water quality is not suitable to be used as cooling water for engines, appropriate treatment shall be considered.

Electricity for construction works will be supplied from existing distribution lines in Payo Selincah. It is necessary to install poles and a transformer for this purpose. The above facilities shall be modified to be used as a part of electric utility upon completion of the proposed power station.

12-4-8 Temporary Pier

Because there is no adequate facility to unload the cargo of the engine at Jambi port, it shall be transported by trailer on barge. A temporary pier to land the trailer from the barge shall be built in the port area. The pier shall be constructed by sand bags and steel piles as shown in Figure 12-7. Pier shall be constructed any time before the transportation, therefore it can be constructed by crane ship in high water season of the river.

The pier shall be removed completely after the transportation operation for the project is completed, when the port authority requests to remove.

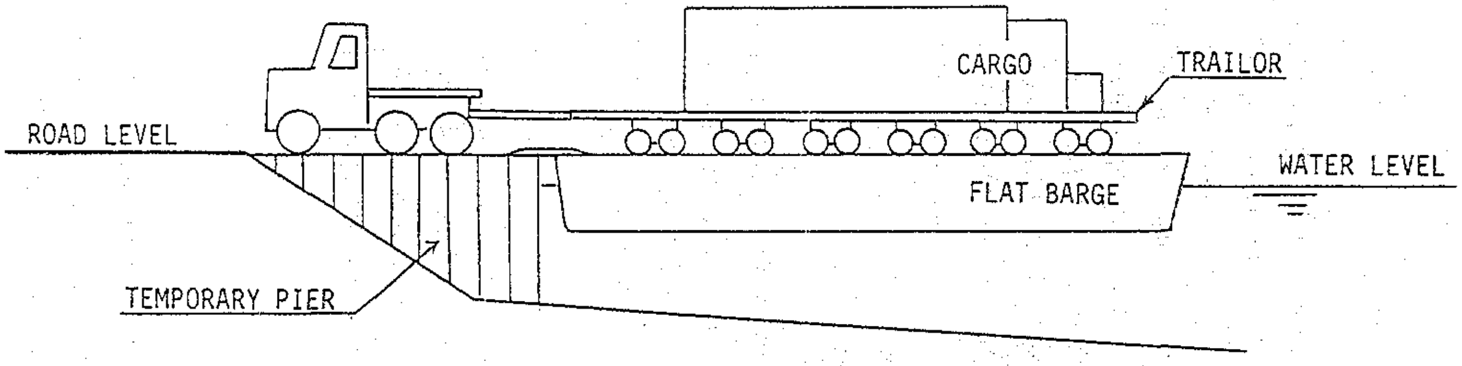
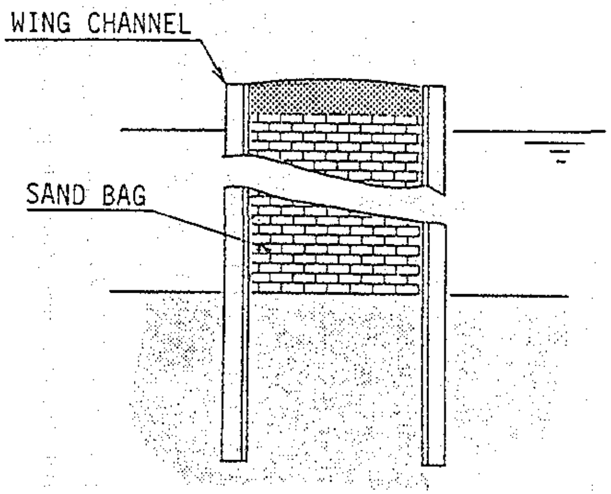


Fig 12-7 Landing of Cargo at Temporary Pier



Construction of Temporary Pier

Figure 12-7 Construction of Temporary Pier

12-4-9 Transportation

Main equipment such as engines are imported. These equipment shall be shipped to Jakarta for clearing importation procedures, then transported to Jambi by flat barge. As an alternative, the equipment can be transported from Singapore, because sea distance from Singapore to Jambi is less than the distance from Jakarta to Jambi. This alternative is worth evaluating for saving transportation time and cost. Furthermore Singapore is a candidate country to export some equipment required for the project. Bintan island near Singapore is one of the new industrial areas in Indonesia where some of equipment are manufactured. Import procedures shall be cleared at Jambi or at Bintan island in this case.

The 12 axes trailer shall be placed on the barge. The cargo engine shall be loaded on the trailer, which is placed on the barge beforehand. The barge shall travel sea route and ascend the Batang Hari river to the temporary pier at Jambi, then the trailer is connect to a tractor for landing. The cargo of the engine shall be transported to the site on the same trailer. Load shall be carefully distributed not to create a load more than 8 tons on any one axis. Trailers and tractors shall be arranged in Jakarta or Singapore and returned to the original port by barge after completion of transportation.

12-4-10 Installation

Engines, generators, auxiliaries and panels are installed under the roof, therefore their assembly and adjustment works can be extended to rainy season. Engine and generator shall be aligned after installation. Oil or water flushing shall be carried out for cleaning of pipe connections. Instruments shall be attached after installation of each equipment and piping. Electric wires shall be connected after installation of equipment and pipings, and shall be confirmed its insulation by test.

Radiators, air intakes and gas exhausts, transformers, fuel storage tank and so on shall be installed outside of the building. These outdoor equipment shall be installed before rainy season comes. Water supply and electricity supply shall be completed after the land leveling and completed timely for the construction works. When water quality is not satisfactory for radiator, adequate treatment facility shall be added.

12-4-11 Trial Operation

Engine and auxiliary shall be adjusted at low speed and gradually take load for running-in. Official trial shall be carried out in completely adjusted condition. Performance of the engine shall be measured during the trial operation by using instruments provided for the power station. These instruments shall be calibrated before the trial operation. Local operators shall be trained through the trial for commissioning. It shall be confirmed that commissioning of the power station can be carried out by local operators before the hand over of the proposed power station.

12-5 Electric Lines

12-5-1 Outline

The proposed power station increases supply of electricity by about 17,000 kW in Jambi. This electricity will be distributed mainly to industries in the east area of the city during daytime and to residences in the south west area at night as mentioned in Section 6-3. Connection between the power stations (Interconnection), connection between the power station and the switching station and distribution lines shall be constructed for the purpose.

As it is not so easy to change gas supply rate to the proposed power station frequently, the power station will be operated for base load. About 300 meters tie line shall be provided between the proposed station and the existing Payo Selincah power station for parallel running and interchange of power supply. About 9 km tie line shall be constructed between the switching station at the city center and the power station in Payo Selincah, for sending electricity to the south west area of the city. These two lines will be constructed by underground cable. It will be necessary to add a total of five feeders to cover the demand of the city. It is planned that those feeders will be the type of overhead cable. Other distribution lines shall be provided before commencement of operation of the proposed power station. However these are not included in this plan. It shall be reviewed by PLN in conjunction with their Jambi electrification plan, because all electric lines will be constructed by PLN.

12-5-2 Material and Erection

It is planned to apply PLN standard for electric cable, pole and insulator. Erection works also conform to PLN's practice, in order to keep uniformity with other electric lines in the city and for easy maintenance. Tie lines shall be completed before the power station trial operation, because it is necessary to take load.

12-6 Schedule

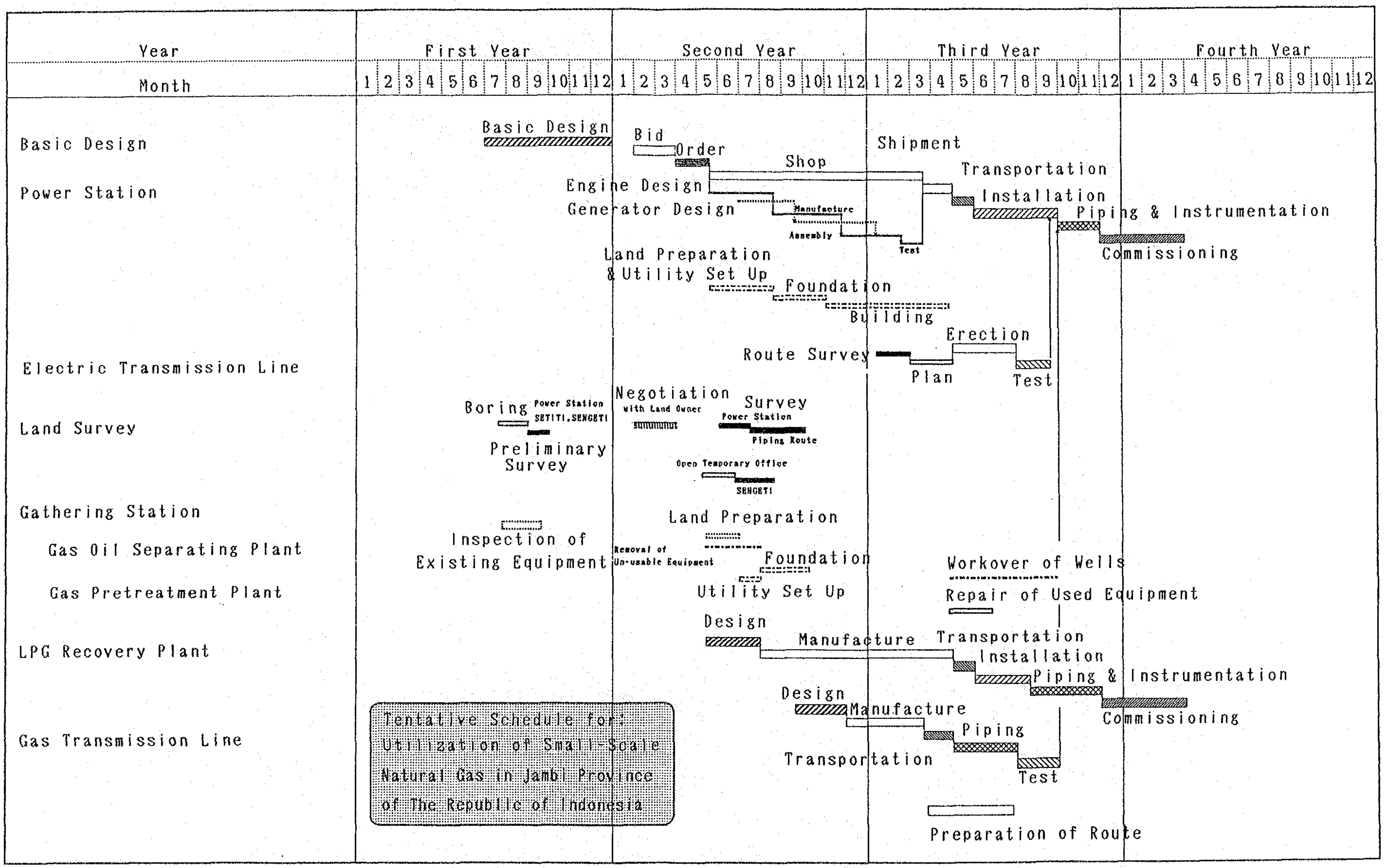
Construction schedule is planned considering following two points:

1) Outdoor works shall be done in dry season; between the end of April and the end of September.

2) Transportation by barge shall be concentrated between March and May during water rises in the Batang Hari river.

A Gunt chart for the construction works is shown in Figure 12-8.

Figure 12-8 Construction Schedule



12-7 Scheduling of Construction Machines

From the viewpoint of development of local economy, a large number of local labor might be used instead of use of construction machines. However, long rainy season limits period of the construction works. It is indispensable to introduce construction machines for smooth execution of the construction works. Construction machines are not available in Jambi area and shall be transported from Jakarta. It is difficult to plan utilization of construction machines at this stage. Following explanations are given for tentative purpose. Machines to be used at each place of works are followings:

1) Payo Selincah: power station:

truck crane about 100 t		1
piling hammer about 3,600 kg-cm		1
backhoe	0.3 m^3	1
bulldozer		1
road roller	about 10 t	1
small compactor		2
concrete mixer	3.0 m^3	2
welding machine		5
fork lift		2

2) Sengeti: natural gas production plant, pretreatment facility and LPG recovery plant

bulldozer		1
truck crane	about 20 t	1
concrete mixer	1.0 m^3	2
welder		3
fork lift		1
concrete cutter (manual)		1

3) Between Sengeti and Payo Selincah: natural gas pipeline

bulldozer		1
truck for pipes	(4WD)	1
truck for earth	(4WD)	2
truck crane	2 t	2
road roller		1
welding machine		5
winch (6,200 kg driven by diesel)		1
river bottom dredger		1
portable generator	100 kVA	2

Some of fork lifts shown above are used continuously after the construction for transportation of materials and products. A Gunt chart of the schedule for construction machines is shown in Figure 12-9.

12-8 Supervisors

12-8-1 Outline

Supervisors shall be dispatched as shown in Figure 12-10. Performance expected to each supervisor will be explained as follows:

12-8-2 Survey for Basic Design

(1) Indonesian enterprise shall be basically responsible for selection and aquisition of land where the plants and the pipeline in this project are constructed. However a consultant to advise for these activities shall be dispatched. He also acts as an adviser for obtaining necessary soil data to design foundations.

(2) Inspection of existing equipment

A consultant shall be dispatched for the inspection of the existing equipment in Sengeti. Method of inspection, evaluation of the result and advice how to repair will be given by him.

Figure 12-9 Schedule of Utilization of Construction Machines

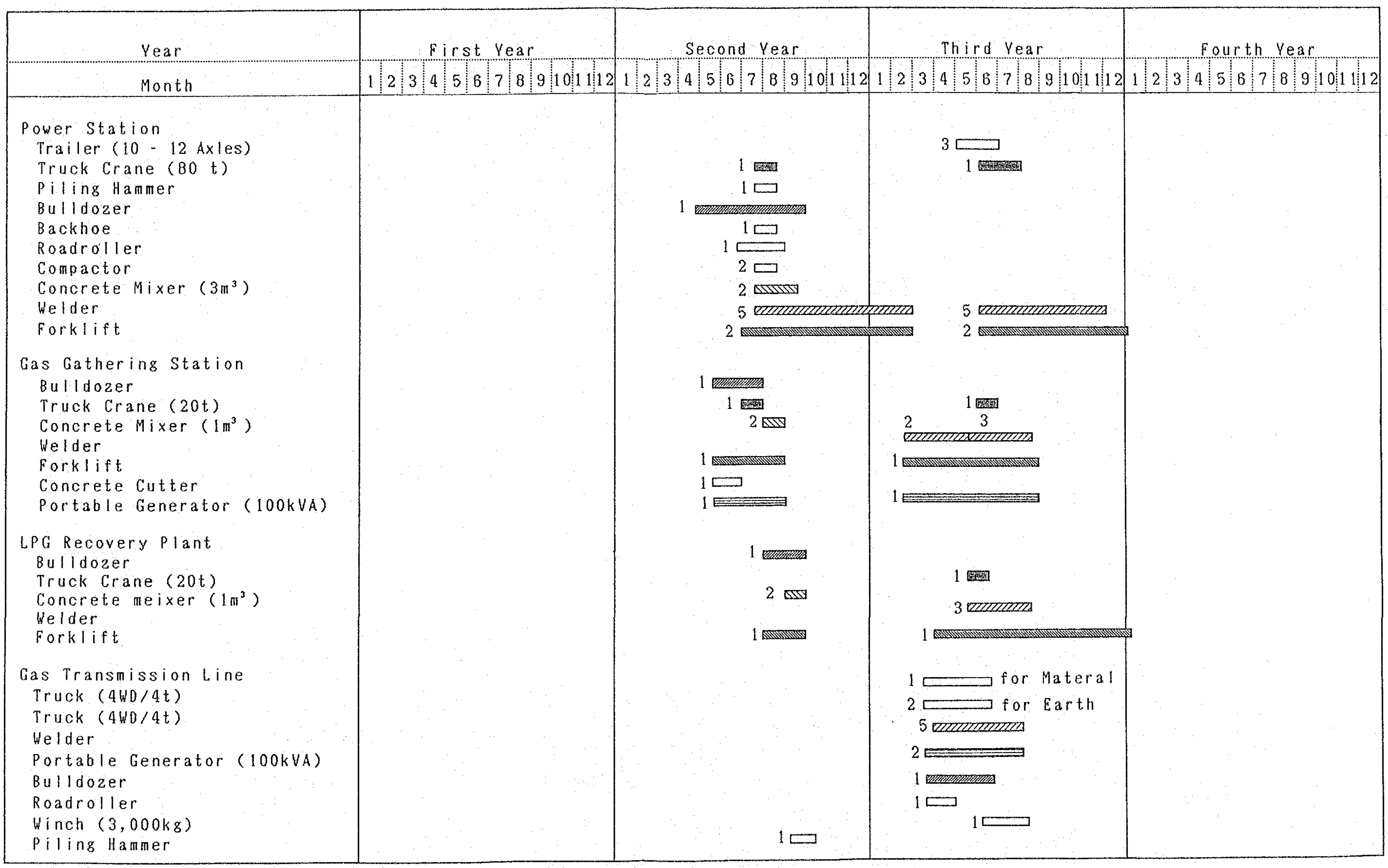
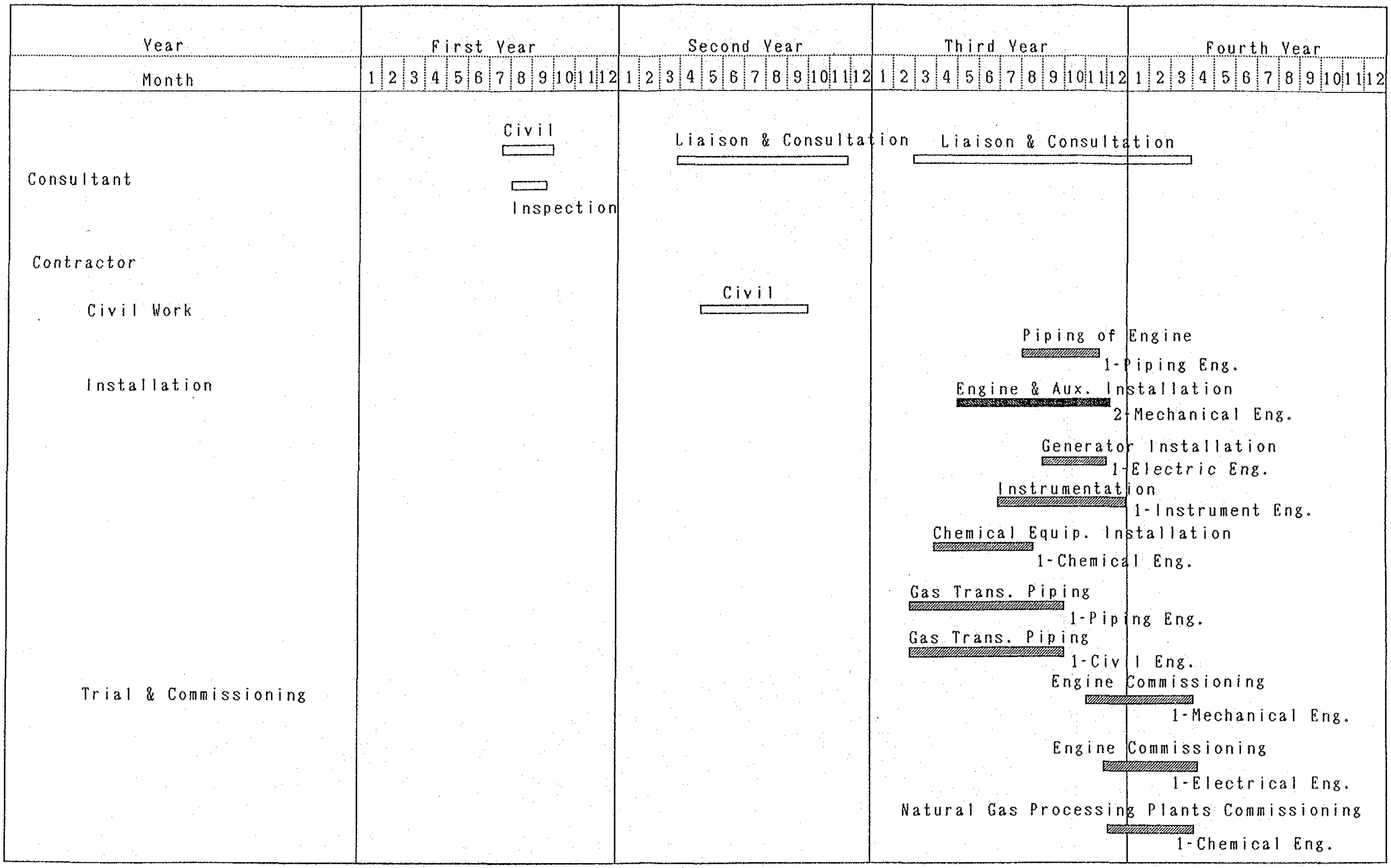


Figure 12-10 Schedule of Supervisor Dispatch



(3) As an alternative for above (1) and (2), PLN and PERTAMINA can undertake all these works by their own specialists and provide all the necessary data and information for the basic design.

12-8-3 Foundations and Buildings

A supervisor shall be dispatched from the contractor to advise construction methods of foundations and buildings and also to attend inspection of the foundations during the construction and at completion. *This supervisor can be dispatched from a local affiliate of the contractor* or entrusted local contractor.

12-8-4 Installation

Two mechanical engineers shall be dispatched as supervisors from engine maker. They shall witness transportation of engines and supervise installation works of the engines and auxiliaries. Alignment, hydraulic test, result of flushing and etc., shall be confirmed by them. These two engineers shall work by two shifts, when it is necessary to keep construction schedule, because the engine installation is a key process in the critical pass of the project schedule.

12-8-5 Piping attached to Engines

A piping engineer shall be dispatched for supervising piping works attached to the engines and the auxiliaries including connection to tanks and instruments.

12-8-6 Generator and Panels

An electrical engineer shall be dispatched by engine maker or generator maker. Electric wiring for generators and panels shall be supervised and electric isolation after the wiring shall be tested by him.

12-8-7 Instrumentation

An engineer specialized for instrumentation shall be dispatched for supervising installation of control panels, instrumentations and control equipment.
He is basically responsible for instrumentation of the natural gas pretreatment facility, the LPG recovery plant and the gas pipeline, however, he shall also assist engineers for the power station construction.

12-8-8 Natural Gas Pretreatment Facility and LPG Recovery Plant

An engineer specialized for chemical equipment installation shall be dispatched for supervising installation of the natural gas pretreatment facility and the LPG recovery plant. Hydraulic tests and confirmation after cleaning shall be attended by him. He shall supervise test operation of the facility and shall be responsible for commissioning of the facility.

12-8-9 Natural Gas Pipeline

A pipeline engineer shall be dispatched for supervising material transportation, welding and installation. He shall witness cleaning and hydraulic test of the pipeline.

In addition to above mentioned engineer, a civil engineer shall be dispatched for supervising preparation of right of way and burying the pipeline in the way. He shall also supervise crossing river works of the pipeline.

12-8-10 Trial and Commissioning

A mechanical engineer and an electrical engineer shall be dispatched for supervising adjustment of the engines, their auxiliaries and the generators. After the trial operation, these engineers shall train local operators and put the power station into commission.

About one month of overlapping period is taken for transferring duties to local operators by installation engineers.

12-8-11 Coordination

It is necessary to coordinate construction works at four locations mentioned in Section 12-1.

A coordinator shall be dispatched for controlling the progress of works and acting quickly for any accidental delay in order to keep the construction schedule. He shall coordinate to secure utilities such as water supply and electricity, and to obtain timely permissions of transportation by authorities, advising to the contractor and other local agencies.

13. CONSTRUCTION COST

13-1 Scope of Construction Cost

The project is planned to supply electricity and LPG for Jambi City, by utilizing natural gas produced at Sengeti. Consequently, the cost required to accomplish above purpose is estimated as the construction cost of the project.

There are used equipment for oil and condensate production in Sengeti, which have not been used since February 1982. These used equipment need repair, replacement of parts and restoration of instrumentation before restarting the production of gas. However, the expenses for these works are not included in the cost of the project. The cost for flare stacks is not included, but the cost for new connection pipework from the natural gas pretreatment plant to the flare stack is included. The cost for low voltage lines after pole transformer is not included, because the cost of these lines are borne by consumers directly.

Interconnection, connection and main distribution lines are included in the project cost.

As a result, the costs for the following items are estimated:

1) Natural gas pretreatment plant
2) LPG Recovery plant
3) Natural gas pipeline
4) Power station
5) Transmission and distribution lines

The cost is estimated based on the conceptual designs mentioned in Chapters 7, 8, 9, 10 and 11 respectively and construction works as mentioned in Chapter 12.

Values of the cost are indicated by Japanese Yen. Exchange rates with Indonesian Rupiah (Rp) and U.S.Dollars are as shown below:

U.S.Dollars 1.00 = Rp 1,665 = Japanese Yen 128.08

Japanese Yen 1.00 = Rp 13.0

The cost is indicated by the value on February/March 1988. Foreign portion is estimated based on international market price when they are imported from industrial countries including Japan, U.S.A., European countries and NIES. Local portion is estimated based on domestic market price in Indonesia.

Price of equipment and services is liable to change by economical conditions and sometimes by competition among suppliers. The cost is estimated based on competitive prices obtained through information by suppliers.

Custom duties are supposed to be exempted for all the imported equipment and materials because goods imported are those which are not manufactured in Indonesia.

It is possible to transport equipment and materials using Indonesian flag vessels, however in view of flexibility of shipping arrangements, ocean shipment by foreign flag vessels are considered and ocean freight charges are estimated by foreign currency portion.

PERTAMINA and PLN are deemed as enterprises to own and manage the plants after their construction. Internal expenses of these enterprises are not included in the cost. Expenses originated by Indonesian central government and the local government are also not included in the cost.

Consequently, costs for improvement of public road and public utilities are not included in the estimation. Engineering, supervising, administration and land aquisition of transmission lines are undertaken by PLN, and costs for these items are not included in the estimation.

13-2 Cost Calculation

13-2-1 Natural Gas pretreatment Plant and LPG Recovery Plant

The natural gas pretreatment plant and the LPG recovery plant are installed in the same site. There are many common equipment and works for these two plants, for example, electric generator, water supply and so on. The cost of these common facilities is calculated and distributed proportionally to the ratio of costs independently required and estimated for each plant. Table 13-1 and 13-2 show the cost of the equipment proper to the natural gas pretreatment plant and the LPG recovery plant respectively. Table 13-3 shows the cost of the common portion and Table 13-4 shows the cost of plants after adjustment for common facilities.

The cost for spare parts for three year operation is included.

The cost of the facilities for the natural gas pretreatment plant and the LPG recovery plant are estimated based on the conceptual designs as explained in Chapters 7 and 8 and per construction works explained in Section 12-2.

Table 13-1 Cost Estimation of Natural Gas Pretreatment Plant Equipment

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Drum	0.6 mø x 1.8 m CS	850	0	1.1 ton
Heat Exchanger	1 x 8.0 m^2 CS/SUS	1,400	0	1.2 ton
Pumps	1 x 50 l/hr x 21 kg/cm^2 0.5 kW	1,000	0	
Total		3,250	0	

Table 13-2 Cost Estimation of LPG Recovery Plant Equipment

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Towers	1 x Deethanizer CS 0.25/0.4 mφ x 13.4 m 1 x Debutanizer CS 0.45 mφ x 11.9 m	8,000	0	8.8 ton
Drums	2 x 0.6 mφ x 1.8 m 1 x 0.5 mφ x 1.5 m	2,000	0	3.1 ton
Heat Exchanger	1.5m^2, 18m^2, 5m^2, 2m^2 CS 4 m^2, 18 m^2 CS/Al-fin with fan	9,800	0	
Pumps	2 x 7 m^3/hr x 3 kg/cm^2 2 x 3 m^3/hr x 3 kg/cm^2	4,000	0	
LPG Bottling	10 t/8 hr Tank 2 x 20 ton	32,000	0	
Odorant		1,000	0	
Hot Oil Supply		16,000	0	
Laboratory		10,000	0	
Total		82,800	0	

Table 13-3 Cost Estimation of Other Equipment and Works in Sengeti

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Erection	3,250 M-H Crane 30 days	0	14,200	
Building	Total 600 m^2	0	54,000	
Civil	Foundation 150 m^2 Pavement 3,000m^2 & etc.	0	52,000	
Structure	30 ton	4,500	0	
Piping	50 ton	20,000	5,800	
Electrical System	2 x 125 kW Generator Fuel Oil Tank Distribution Panels & etc.	20,000	12,800	
Instruments	Indicators, Controllers Control Valves Comp. Air System	30,400	6,000	
Water Supply System	Pumps & Head Tank & etc.	5,000	5,000	
Painting		0	1,500	
Total		79,900	151,300	

Table 13-4 Cost of Natural Gas Pretreatment and LPG Recovery

(Unit: Thousand Yen)

	Natural Gas Pretreatment Plant		LPG Recovery Plant	
	Foreign	Local	Foreign	Local
Equipment	3,250 (3.8%)	0	82,800 (96.2%)	0
Others	3,000	5,800	76,900	145,500
Total	6,250	5,800	159,700	145,500

13-2-2 Natural Gas Pipeline

Seamless pipes are imported and used for the entire length of the natural gas pipeline. Contruction works are undertaken by local enterprises.

Table 13-5 shows the cost estimation of material and construction works for the pipeline.

Acquisition and transportation of soil for the construction of foot path mentioned in Section 12-3 are included in civil works.

Assuming employment of qualified welders is possible in Indonesia, all construction works are considered as local portion.

Table 13-5 Cost Estimation of Pipeline

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Piping	Pipes, Flange	68,400	0	570 ton 20 km
Other Material	Valves, Coatings & etc.	17,100	0	
Civil Works	Land Preparation & etc.	0	26,900	
Erection Work	Welding, Cleaning, Test & etc.	0	24,000	
Total		85,500	50,900	

13-2-3 Power Station

Dual-fuel engines and all other equipment for the power station are imported, except transformers. Building construction and civil works are undertaken by Indonesian enterprises.

Expense for engine maker's technicians to carry out engine installation works is included in the foreign portion in the erection cost.

The cost is estimated based on the conceptual design explained in Chapter 10. The cost for spare parts for three years operation are included in the cost estimation.

Table 13-6 shows the cost of equipment, building and construction works.

Table 13-6 Cost Estimation of Power Station

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Main Engines & Auxiliaries	4 x 5,000 kW Dual-Fuel Engine	1,900,000	0	
Main Generators	4 x 6,250 kVA		0	
Transformers & Panels		330,000	45,000	
Other Facilities	Main Fuel Tank 1 x 1,000 kl Water Supply, Incinerator Workshop Machines	30,000	0	
Civil Works	Foundations & Pavement	0	117,000	
Buildings	Main 1,400 m^2 Others 200 m^2	0	146,000	
Erection	Local 30,000 M-H Foreign 15,000 M-H Machine 150 days	255,000	92,000	
Total		2,515,000	400,000	

13-2-4 Transmission and Distribution Lines

The cost of a 0.3 km interconnection between the proposed power station and the existing Payo Selincah power station, 9 km connection between the Payo Selincah power station and the Kantor switching station and 5 distribution lines of about 3 km each are estimated. The cost for switch gears and automatic pole switches necessary for the above lines are also estimated. The result of the estimation is shown in Table 13-7.

The cost is estimated based on the conceptual design mentioned in Chapter 11.

Table 13-7 Cost Estimation of Transmission Line

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Inter Connection Line	20 kV 3ϕ U.G. 0.3 km x LPE 325 mm^2	0	1,600	Incl. Erection
Connection Line	20 kV 3ϕ U.G. 9.0 km x LPE 400 mm^2	0	59,000	Incl. Erection
Distribution Lines	20 kV 3ϕ O.H. 5 x 3.0 km	6,300	18,000	Incl. Erection
Switch Gears	1 x 7 Feeder 1 x 5 Feeder plus auxiliary Panel	48,200	6,200	Incl. Erection
Automatic Pole Switches	10 switches	17,200	100	Incl. Erection
Total		71,700	84,900	

13-2-5 Ocean Freight and Insurance

Ocean freight and insurance are estimated using in house data.
The cost for loading of cargos to ocean going vessel and unloading to barge alongside the vessel is included in the ocean freight charge. Insurance covers marine transportation for the imported goods.
The result of the estimation is shown in Table 13-8.

Table 13-8 Ocean Freight & Insurance

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Equipment to Sengeti	about 150 ton value 165,950	8,300	0	5.0 %
. Pretreatment		300	0	
. LPG		8,000	0	
Pipeline	about 600 ton value 85,500	3,000	0	3.5 %
Power Station	about 800 ton value 2,515,000	102,000	0	4.0 %
Electric Line	value 71,700	2,500	0	3.5 %
Total		115,800	0	

13-2-6 Inland Transportation

Transportation by barge to Jambi and Sengeti after importation at Jakarta and land transportation to the site after arrival at the port of Jambi and Sengeti is estimated, based on the concept mentioned in Chapter 12.

Four 12 axles trailers are assumed to be arranged from outside of Indonesia, concequently rent of them is included in the foreign portion. The cost for construction of the temporary pier is included in the local portion. The result of the estimation is shown in Table 13-9.

Table 13-9 Inland Transportation Cost

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Equipment to Sengeti	about 200 ton	0	4,000	Barge
. Pretreatment		0	200	
. LPG		0	3,800	
Pipeline	about 600 ton	0	3,500	Barge
Power Station	Main Engine about 500t Others about 500t Temporary Pier 100 t Trailor 4 x 14 days	55,000	54,000	Barge and Trailor
Electric Line		0	1,000	Barge
Total		55,000	62,500	

13-2-7 Engineering Fee

Engineering fee comprises cost for planning and designing plant. The cost for designing each equipment is not included as engineering fee, but included in the cost listed as equipment.
In principle, planning and basic design of plants are included in the foreign portion and detailed design in the local portion.
The result of the estimation is shown in Table 13-10.

Table 13-10 Engineering Fee

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
Equipment to Sengeti	Foreign : 3,125 M-H Local : 2,000 M-H	25,000 -	- 5,000	
. Pretreatment		1,000	-	
. LPG		24,000	5,000	
Pipeline	Foreign : 500 M-H Local : 1,200 M-H	4,000 -	- 3,000	
Power Station	Foreign : 8,000 M-H	64,000	-	
Basic Design	Foreign : 12,000 M-H Local : 4,000 M-H (Land Survey)	150,000 -	- 20,000	
Total		243,000	28,000	

13-2-8 Supervising Fee

Supervising fee is calculated based on the planning in Section 12-10. Expenses for local personnel are included as the local portion. Travel expense is assumed tentatively as 300,000 yen for each round trip. Table 13-11 shows the calculation result.

Table 13-11 Supervising Fee

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
(Sengeti)	8.5 M-M, 2 Travels	21,850	1,800	
. Pretreatment	0.33 M-M, 0.08 Travel	849	0	
. LPG	8.17 M-M, 1.92 Travel	21,001	0	
	Assist 9 M-M x 2	0	1,800	
Pipeline	7.0 M-M, 1 Travel	17,800	0	
	7.0 M-M(Local,Civil)+ Assist 7 M-M x 2	0	2,800	
Power Station	31 M-M, 8 Travels	79,900	0	
Consultant	27 M-M, 4 Travels	68,700	0	
	Assist 27 M-M	0	2,700	
Total		188,250	7,300	

13-2-9 Acquisition Cost of Land

Price of the land in Jambi area may not be expensive compared with that of other areas in Indonesia, because demand of land utilization is still in low level. However by the same reason, market price of land is seemed not yet established to be used for estimation in ordinary way.

Assuming full collaboration be extended by land owners who understrand public contributions of the project, the land acquisition cost is estimated. Table 13-12 shows the result. Areas to be acquired are based on plan showed in Chapter 11.

The land for the natural gas pretreatment plant and the LPG recovery plant is possessed by PERTAMINA, however the cost of the land is estimated in balance to other plant and is included in the cost.

Table 13-12 Land Acquisition Cost

(Unit: Thousand Yen)

Items	Description	Cost		Remarks
		Foreign	Local	
(Sengeti)	8,000 m^2	0	21,000	
. Pretreatment		0	2,000	
. LPG		0	19,000	
Pipeline	200,000 m^2	0	38,000	
Power Station	9,600 m^2	0	12,300	
Total		0	71,300	

13-2-10 Administration Cost

Administration cost comprises the indirect cost such as main office expenses, cost for inventory, guarantee works and so on for the companies who will furnish the equipment and the services for the project.
The administration cost is estimated about 6 percent of the total cost except the land acquisition, the contingency and the administration cost itself.

13-2-11 Contingency

Cost is estimated based on the conceptual designs in this report, however it is not avoidable to under estimate the cost, because there are two sorts of difficulties; one caused by lack of detailed specification and the other caused by uncertainty of the cost information. In order to cover the risk, 2 to 10% contingency is added on the cost, after exercising good judgment for applicable percentage of the contingency for each item.
There are some uncertainty for the land acquisition cost, however it is not added because of difficulty to assume under the current situation described in Section 13-2-9.

13-3 Summary

Table 13-13 shows the summary of the cost estimation.
The construction cost in total is;
Foreign portion: Japanese Yen 3,750,016,000
= U.S.Dollars 29,278,700
Local portion: Japanese Yen 923,800,000
= Rp 12,009,400,000

As it is assumed to utilize Indonesian technology and products to the maximum possible extent, the result of the cost estimation shows relatively higher local portion than other projects experienced in Indonesia.

Table 13-13 Summary of Cost Estimation

(Unit: Thousand Yen)

Items	Natural Gas Pretreatment Facility 3.1 MMSCFD		LPG Recovery Plant 10.8 ton/day		Natural Gas Pipeline 6 inch - 20 km		Power Station 4 x 5,000 kW		Electric Transmission Line		Basic Design and Consulting		Total	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local
Plant Equipments, Building Foundation Construction	6,250	5,800	159,700	145,500	85,500	50,900	2,515,000	400,000	71,700	84,900	0	0	2,838,150	687,100
Ocean Freight and Insurance	300	0	8,000	0	3,000	0	102,000	0	2,500	0	0	0	115,800	0
Inland Transportation	0	200	0	3,800	0	3,500	55,000	54,000	0	1,000	0	0	55,000	62,500
Engineering Fee	1,000	0	24,000	5,000	4,000	3,000	64,000	0	0	*	150,000	20,000	243,000	28,000
Supervising Fee	849	0	21,001	1,800	17,800	2,800	79,900	0	0	*	68,700	2,700	188,250	7,300
Administration Cost	864	0	22,128	0	10,230	0	196,194	0	0	0	0	0	229,416	0
Contingency	600	600	16,000	15,000	2,500	5,000	61,300	47,000	0	*	0	0	80,400	67,600
Land Acquisition	0	2,000	0	19,000	0	38,000	0	12,300	0	*	0	0	0	71,300
Total	9,863	8,600	250,829	190,100	123,030	103,200	3,073,394	513,300	74,200	85,900	218,700	22,700	3,750,016	923,800
		18,463		440,929		226,230		3,586,694		160,100		241,400		4,673,816

Note: * Covered by PLN

14. OPERATION PLAN

An enterprise to implement and manage the project is yet to be decided. However, if practical capability for planning, production, sales and maintenance is considered, in addition to securing of trained personnel, the most desirable scheme will be that PLN will own and operate the power plant and PERTAMINA will own and operate the natural gas treatment facilities including LPG Recovery Plant.

The discussion hereunder is based on the understanding that the proposed plants are managed and operated by PLN and PERTAMINA as presumed as above.

14.1 Operation Plan

The following operation plan is contemplated for the major facilities of this project, which are scheduled to start operation in April, 1995.

(1) Power Plant

The continuous operating output of dual-fuel engine generators for the proposed power plant, namely, the normal capacity of the power plant is 85% of the rated plant capacity, but the continuous operation for a certain period of time at 90% of the rated output is possible and will not pose any problems.

As described in Chapter 6, the proposed power plant is planned to be used as a base load power plant and the demand at the outlet of the power plant is forecast in 1995 to exceed 17 MW which is the normal output of the power plant. Therefore, the proposed power plant will commence its operation at the output of 17 MW (4.25 MW x 4 sets) and will be kept at that output level normally all the operating time. Each of four installed generating units requires maintenance period of twice a year, each 20 days. In order not to interrupt the total operation of the power plant, maintenance work will be carried out one unit at a time. While any one unit is withdrawn from operation for the purpose of maintenance, the remaining three units will be operated at 90% of the rated output of machines, aiming to keep power reduction minimum. Figure 14-1 shows annual operation plan of the power plant.

Therefore, the output of the proposed power plant is scheduled as follows:

- Normal operating period (205 days): 4.25 MW x 4 sets = 17 MW

- Maintenance period (160 days): 4.5 MW x 3 sets = 13.5 MW

Supply shortages for base load demand during maintenance period and for peak load demand will be covered by supplies from PLTD Kasang, PLTD Payo Selincah or from a diesel power plant of 5 MW x 2 sets planned by PLN to commence its operation in 1992.
Daily operation control of these power plants is managed by PLTD Kasang of PLN, as being done at present.

(2) Natural gas production facility, pretreating facility and pipeline

Main purpose of operation of these facilities is to supply fuel gas to the power plant.
Therefore, its processing gas rate varies corresponding to the required fuel gas rate by the power plant and the processing gas rate will be 80% of normal flow rate during the maintenance period of the power plant.
If gas flow rate is remained unchanged during maintenance period to ease operation, approximately 20% of the gas has to be flared and this is not recommendable in view of effective use and conservation of natural resources.

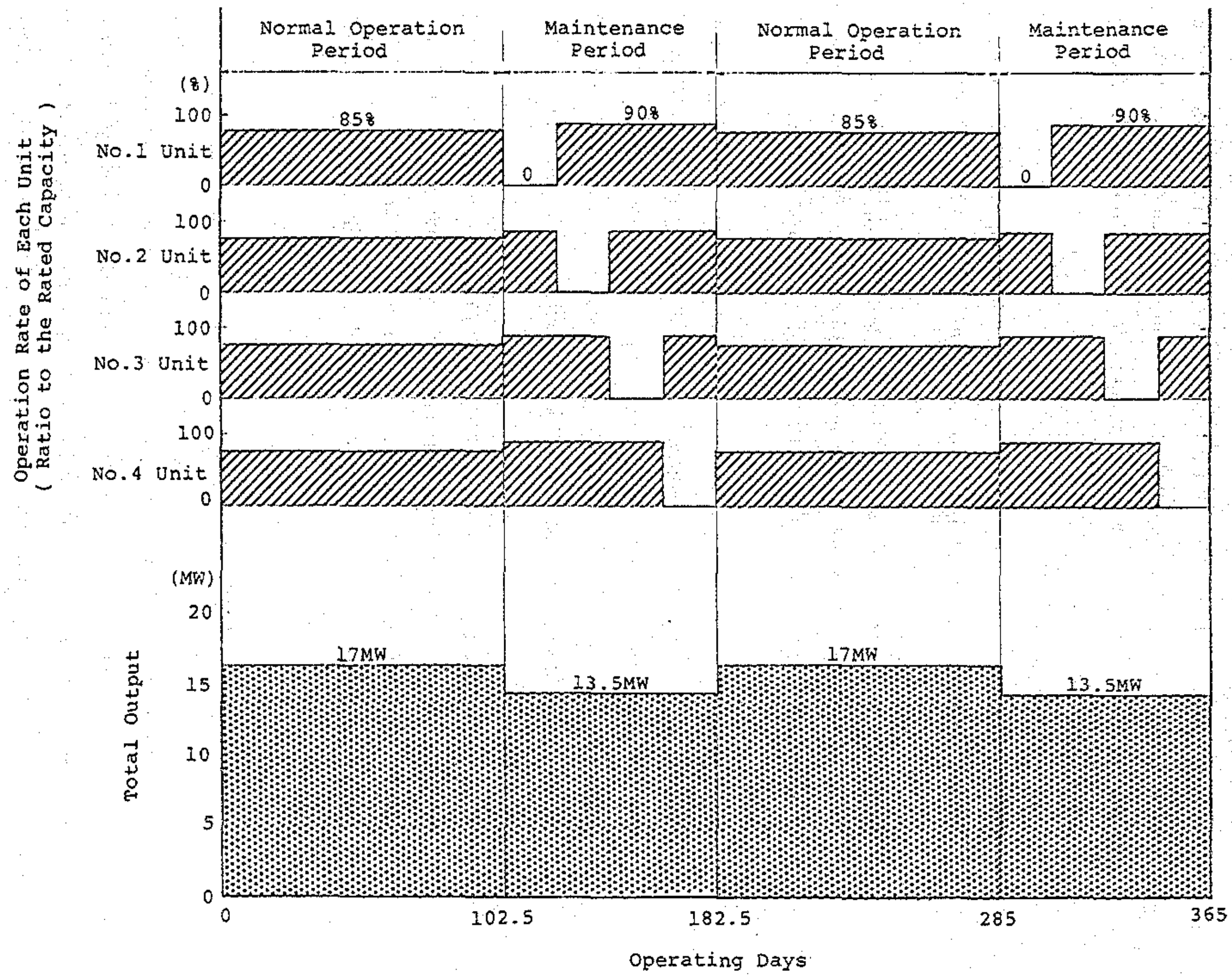


Figure 14-1 Annual Operation Plan of the Power Plant

(3) LPG Recovery Plant

Since the raw material for this LPG Recovery Plant is the condensate produced at the natural gas processing facilities where natural gas is treated to fuel gas for the proposed power plant, LPG production rate will vary, corresponding to output of the power plant as follows:

Normal operating time of power plant: 9.03 tons per day
During maintenance period of power plant: 7.24 tons per day

Although it is possible to operate the power plant continuously, it is necessary to cease operation of LPG Recovery Plant once a year for a duration of 30 days for the purpose of maintenance work.
It is possible to carry out a maintenance work of the LPG Plant concurrently with that of the power plant to maximize LPG production. If maintenance is planned as above, operating days at 9.03 tons per day and at 7.24 tons per day are 205 days and 130 days, respectively, and total LPG production will be 2,792 tons per year.
While LPG plant is not operated, raw material condensate will be sent to oil storage tank via Medium and Low Pressure Separators in the existing GOSP. If there is trouble in LPG Recovery Plant, the condensate will be handled in the same manner.

14-2 Organization and Personnel

Scenes of operation of this project are divided in two places, namely, Payo Selincah where the power plant is located and Sengeti where the LPG Recovery Plant is installed. Therefore, it is necessary to divide numbers of operating personnel into two organizations for two locations. Since kind of plant is different in itself, completely separate two organizations are required.

(1) Power Plant

Figure 14-2 shows the organization and numbers of personnel required for operation of the proposed power plant.

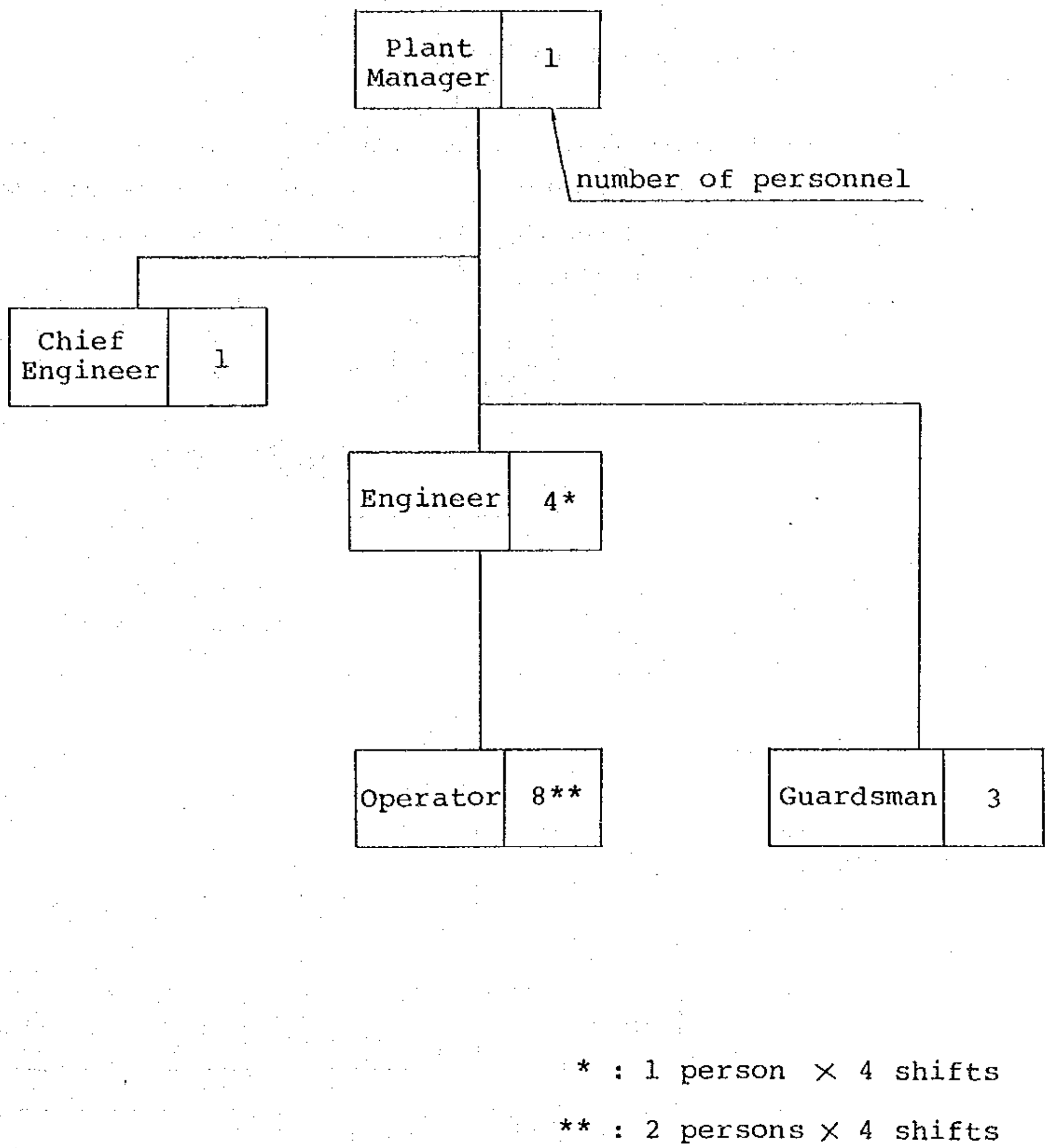


Figure 14-2 Organization Chart of Power Plant

As has already been explained, control of transmission of electricity among all power plants is managed and carried out by PLTD Kasang, so the organization required in the proposed power plant will mainly be operating personnel for the generating facility. It is assumed that maintenance personnel required for maintenance work of the proposed power plant will be assisted by experienced maintenance personnel of other power plants.

2) Natural Gas related Facilities

Figure 14-3 shows the organization and number of personnel required for operation of the natural gas pretreating facility, the LPG Recovery Plant and auxiliary facilities being constructed at Sengeti area.

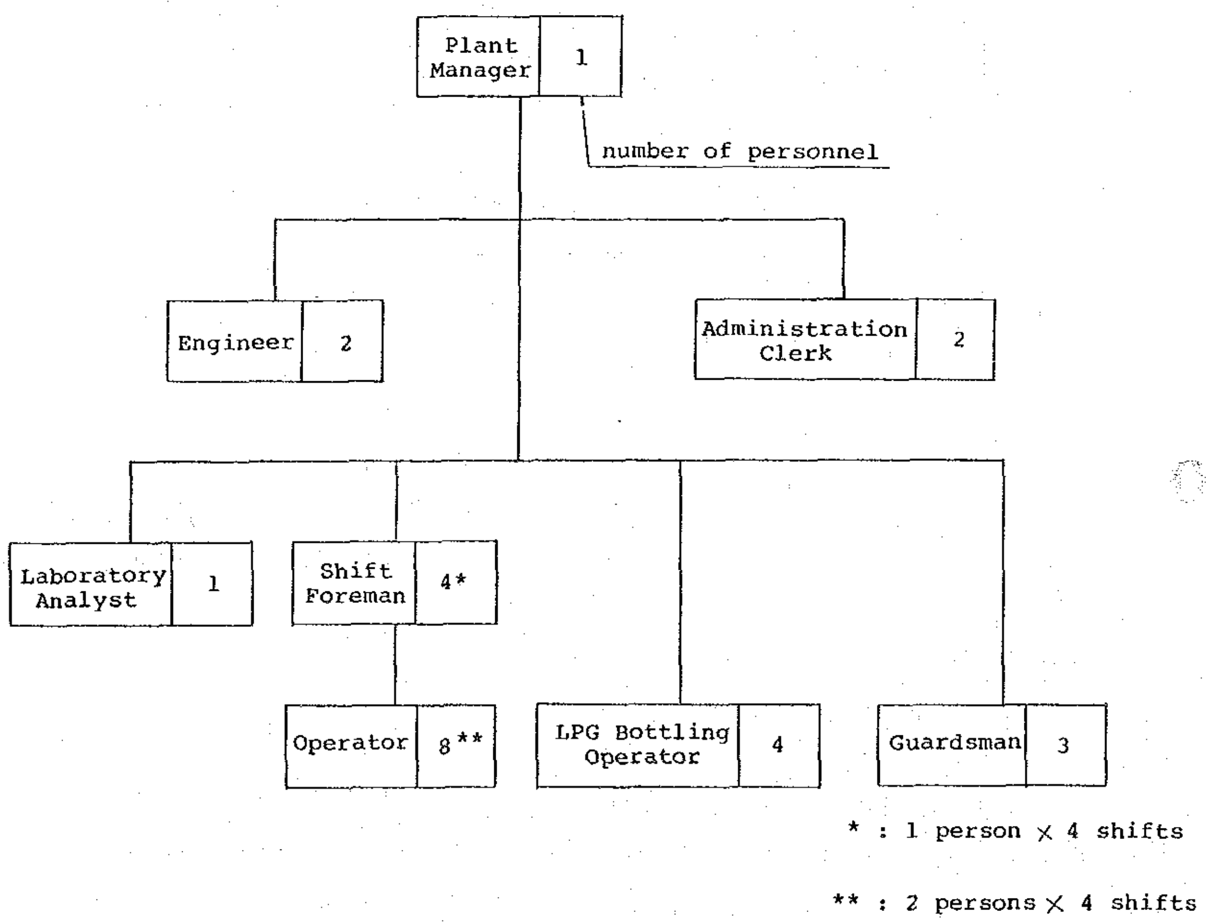


Figure 14-3 Organization Chart of Natural Gas Processing Plants

In Sengeti area, there exists wellhead facility and GOSP which are not operated at present. When this project is implemented, these facilities will have to be operated. However, since these facilities are outside of scope of work for this project, operating personnel for those facilities are not included in this Figure.

It is possible for personnel required for this project to take care operation of the existing facilities, as number of operators as planned as above will not increase even if operation of the existing facilities is included. It is planned that maintenance personnel for the facilities in Sengeti will be assisted by maintenance personnel from similar facilities such as Kenali Asam.

14-3 Operation Supervision and Training Plan

This project handles natural gas and LPG which are inherently risky substances and possesses a high social responsibility to supply electricity to the society. Therefore, the operation should be carried out efficiently and safely without interruption. In order to satisfy their requirements, all operating personnel should be trained thoroughly, so that each member does recognize his responsibility and is well versed to his own duty of operation.

Operators for each facility should be trained overseas or in similar plant domestically prior to commencement of operation, in addition to training by supervisors dispatched from foreign countries.

(1) Power Plant

Dual-fuel engines will be adopted for this project. The mechanical features are very similar to those of diesel engine, thus it is planned to employ experienced operators of diesel engine generator. Therefore, main purpose of training is to understand difference of operation of dual-fuel engine generator from that of diesel engine generator and its training program is described hereunder.

(a) Training in the country of supply of the generator

Objective:

To understand mechanical features and operation characteristics of the dual-fuel engine generator

Trainee:

1 - mechanical engineer

1 - electrical engineer

Duration:

One month prior to commissioning

Location:

Factory of the manufacturer of the generator equipment and of its users

Trainer:

Engineers of the manufacturers of the generator equipment

(b) Training at jobsite

Objective:

To master actual operation of the dual-fuel engine generator

Trainee:

All operating personnel

Duration:

During commissioning period

Location:

In the proposed power plant at Payo Selincah

Trainer:

Commissioning supervisors

(2) Natural Gas related Facilities

Since the natural gas related facilities handle high pressure natural gas and LPG which are inherently risky materials, training to aim at safe operation of the plant is particularly required. Fortunately, PERTAMINA who is supposed to own and operate these facilities possesses many of similar facilities in various places in the Republic. Therefore, it is very feasible to recruit experienced operators and also it is possible to train operators at some of the existing plants prior to completion of construction of the plant contemplated in this project.

(a) Education and training of engineer

Objective:

To understand actual operation of production and treatment of natural gas, LPG recovery, LPG filling.

Trainee:

2 engineers

Duration:

2 months

Location:

Plants of PERTAMINA

Trainer:

Engineers of PERTAMINA

(b) Understanding of operation manual

Objective:

To master operation method by complete understanding of operation manual.

Trainee:

All operators

Duration:

Two months prior to commencement of commissioning

Locations:

Office at Sengeti

Lecturer:

Engineers of the entity

(c) Education and Training by Supervisors

Objective:

To learn actual operation, especially start-up and shut-down operation and operation procedure for emergency cases.

Trainee:

All operators

Duration:

During commissioning period

Location:

Plants newly erected at Sengeti

Lecturer:

Commissioning supervisors

Please refer to Figures 12-2 and 12-3 in Chapter 12, regarding dispatching schedule of supervisors.

15. TOTAL INVESTMENT COST

15-1 General

In this Chapter, the total investment cost required to implement this project is calculated by computing pre-operation cost, initial working capital and interest during construction, based on the investment cost described in Chapter 13 and the construction schedule mentioned in Chapter 12. In computing the total investment cost, the following premises are used in accordance with the discussion with BPPT.

(1) Conversion Rate of Currencies

It is difficult to foresee future conversion rate of currencies. Therefore, the conversion rates prevailed at the time of February, 1988, when field survey was conducted, is applied for this feasibility study.

1 U.S.Dollar = 1,665 Indonesian Rp = 128 Japanese Yen

(2) Price Escalation

All cost are calculated by the present value of 1988 and escalation is not applied.

(3) Tax

Import duty is exempted for all imported materials and equipment for this project.

(4) Source of Funds

It is assumed that the funds to cover the foreign portion will be financed by long term loan of appropriate loan conditions and the funds for the domestic portion will be covered by own equity.

For the purpose of conducting financial analysis, two interest rates are introduced, namely, Case 1 with annual interest rate of 12% and Case 2 with 3.5% (Refer to Chapter 16 for detail).

(5) Construction Period

Although the construction period is defined as 22 months in Chapter 12 CONSTRUCTION WORK, a contruction period of 24 months (2 years) is adopted for the purpose of conducting the financial analysis.

15-2 Summary of Total Investment Cost

Summary of the total investment cost based on the financial sources as defined above is shown in Tables 15-1 and 15-2.

Table 15-1 Total Investment Cost (Case 1)

(Unit: Million Yen)

	Foreign Portion	Local Portion	Total
Plant Construction Cost			
Land Acquisition	0.00	71.30	71.30
Plant	2,838.15	687.10	3,525.25
Ocean Freight & Insurance	115.80	0.00	115.80
Inland Transportation	55.00	62.50	117.50
Engineering Fee	243.00	28.00	271.00
Supervising Fee	188.25	7.30	195.55
Administration Cost	229.42	0.00	229.42
Contingency	80.40	67.60	148.00
Sub-total	3,750.02	923.80	4,673.82
Pre-operation Cost	1.40	46.26	47.66
Initial Working Capital	0.00	19.24	19.24
Interest during Construction	496.74	0.00	496.74
Total	4,248.16	989.30	5,237.46

Table 15-2 Total Investment Cost (Case 2)

(Unit: Million Yen)

	Foreign Portion	Local Portion	Total
Plant Construction Cost			
Land Acquisition	0.00	71.30	71.30
Plant	2,838.15	687.10	3,525.25
Ocean Freight & Insurance	115.80	0.00	115.80
Inland Transportation	55.00	62.50	117.50
Engineering Fee	243.00	28.00	271.00
Supervising Fee	188.25	7.30	195.55
Administration Cost	229.42	0.00	229.42
Contingency	80.40	67.60	148.00
Sub-total	3,750.02	923.80	4,673.82
Pre-operation Cost	1.40	46.26	47.66
Initial Working Capital	0.00	19.24	19.24
Interest during Construction	139.84	0.00	139.84
Total	3,891.25	989.30	4,880.56

15-3 Plant Construction Cost

Plant construction costs are consisted of the following items (For detail, refer to Chapter 13).

(1) Land Cost

The following costs for acquisition of land are estimated.

Land for the natural gas pretreating plant and the LPG Recovery Plant

: 8,000 m^2

Land for the pipeline laying

: 120,000 m^2

Land for the power plant

: 9,600 m^2

(2) Plant Cost

All necessary costs for materials, equipment, construction materials and equipment, land preparation, foundation work, installation works and so on are estimated for construction of the natural gas pretreatment facility, the LPG Recovery Plant, the pipeline, the power plant and the transmission lines.

(3) Ocean Freight and Insurance

Ocean freight and insurance fee are estimated to transport the equipment and materials on surface from the source of origin to the port of disembarkation of Jakarta.

(4) Inland Transportation

Necessary inland transportation cost is estimated to transport the equipment and materials from Jakarta to plant sites.

(5) Engineering Fee

Design fee and survey cost for the project are estimated. However, the design fee for individual equipment is included in the cost of the equipment.

(6) Supervising Fee

Cost for supervisors and their travelling expenses are estimated, who will be dispatched to job sites to supervise the installation work and operation training.

(7) Administration Charge

Administration charge is estimated to cover head office fee, interest, compensation work, insurance fee for employee dispatched for oversea job and so on.

(8) Contingency

Contingency is calculated and included in order to cover unknown factors which may cause overrun of a budget estimated by the conceptual design stage.

15-4 Pre-operation Cost

Prior to commencement of operation, various costs and expenses will be required. The following costs are estimated for the project.

(1) Training Cost (Oversea)

The following costs are estimated as the foreign currency portion for training of two persons for a period of one month in the country where the equipment is to be manufactured, to learn operation of the dual-fuel engine for the power plant.

Travelling cost: Y300,000 x 2 persons = Y600,000
Living expense: Y400,000/M.M x 2M x 1M = Y800,000

(2) Training Cost (Domestic in Indonesia)

One year prior to commencement of operation, necessary persons for operation will be employed and be trained. For this project, 600 million Rupiah (about 46 Million Yen) are estimated to train necessary number of operators. For detail of the labour cost, refer to Chapter 16 FINANCIAL ANALYSIS.

(3) Commissioning Cost

The first one month of 4 month trial operation and commissioning period will be spent to operate the dual-fuel engine on diesel mode without imposing any load (LPG will not be recovered as a matter of course). Remaining 3 months will be used to operate the engine at 50% load (on gas consumption basis) for commissioning purpose.

Costs for raw materials consumed during the 3 month period are considered compensated by revenue of final products of electricity and LPG. Labour cost for this period is estimated in (2) above and not counted as the commissioning cost.

15-5 Initial Working Capital

Some sort of the cost are prepared to maintain smooth operation of plant, before commencement of operation. The cost of spare parts and purchase price of raw materials are usually included. However, the cost of spare part is included in the investment cost for this project and raw material will be readily available in this case. Therefore, the amount of 200 Million Rupiah (about 15.4 Million Yen) to purchase diesel oil of full volume of the storage tank (1,000 kilo liter) is considered as the initial working capital, in addition to 50 Million Rupiah (about 3.85 Million Yen) to cover the labour cost for one month period.

15-6 Interest during Construction

Interest during construction of the plant is estimated based on the disbursement schedule for the plant cost. For the purpose of conducting the financial analysis for this study, the payment is scheduled to make 15% of the contract amount at the time of commencement of construction, 15% after 6 months, 40% after 12 months, 25% after 18 months, 5% at the time of completion of construction (24 months after commencement of construction). Tables 15-3 and 15-4 show the payment schedule of the total investment cost during the plant construction period.

Table 15-3 Payment Schedule of Total Investment Cost (Case 1)

(Unit: Million Yen)

	1st time	2nd time	3rd time	4th time	5th time	Total
Applications of Fund						
Foreign Portion						
Plant Investment	562.50	562.50	1,500.01	937.50	187.50	3,750.02
Pre-operation Cost	0.00	0.00	0.00	0.00	1.40	1.40
Initial W/C	0.00	0.00	0.00	0.00	0.00	0.00
Interest during Construction	0.00	33.75	69.53	163.70	229.77	496.74
Sub-total	562.20	596.25	1,569.53	1,101.20	418.67	4,248.16
Local Portion						
Plant Investment	138.57	138.57	369.52	230.95	46.19	923.80
Pre-operation Cost	0.00	0.00	0.00	23.13	23.13	46.26
Initial W/C	0.00	0.00	0.00	0.00	19.24	19.24
Interest during Construction	0.00	0.00	0.00	0.00	0.00	0.00
Sub-total	138.57	138.57	369.52	254.08	88.56	989.30
Total Applications	701.07	734.82	1,939.05	1,355.28	507.23	5,237.46
Sources of Fund						
Equity	138.57	138.57	369.52	254.08	88.56	989.30
Long-term Loan	562.50	596.25	1,569.53	1,101.20	418.67	4,248.16
Total	701.07	734.82	1,939.05	1,355.28	507.23	5,237.46

Table 15-4 Payment Schedule of Total Investment Cost (Case 2)

(Unit: Million Yen)

	1st time	2nd time	3rd time	4th time	5th time	Total
Applications of Fund						
Foreign Portion						
Plant Investment	562.50	562.50	1,500.01	937.50	187.50	3,750.02
Pre-operation Cost	0.00	0.00	0.00	0.00	1.40	1.40
Initial W/C	0.00	0.00	0.00	0.00	0.00	0.00
Interest during Construction	0.00	9.84	19.86	46.46	63.68	139.84
Sub-total	562.50	572.35	1,519.87	983.96	252.58	3,891.25
Local Portion						
Plant Investment	138.57	138.57	369.52	230.95	46.19	923.80
Pre-operation Cost	0.00	0.00	0.00	23.13	23.13	46.26
Initial W/C	0.00	0.00	0.00	0.00	19.24	19.24
Interest during Construction	0.00	0.00	0.00	0.00	0.00	0.00
Sub-total	138.57	138.57	369.52	254.08	88.56	989.30
Total Applications	701.07	710.92	1,889.39	1,238.04	341.14	4,880.56
Sources of Fund						
Equity	138.57	138.57	369.52	254.08	88.56	989.30
Long-term Loan	562.50	572.35	1,519.87	983.96	252.58	3,891.25
Total	701.07	710.92	1,889.38	1,238.04	341.14	4,880.56

16. FINANCIAL ANALYSIS

16-1 Method of Financial Analysis

In this study, evaluations of LPG recovery project and electric power generation project are conducted based on the following assumptions.

. PERTAMINA owns and operates the facilities of natural gas production, pretreatment, LPG recovery and gas pipeline.

. PLN owns and operates the power plant and transmission and distribution lines.

In the evaluation of LPG recovery project, firstly, the production cost of LPG is calculated based on the investment cost and the operation cost, and the results are summarized in a form of Production Cost Accounting Table. In case that the calculated production cost is adequately cheaper than the wholesale price at which PERTAMINA sells LPG to retailers, following financial statements are prepared and Financial Internal Rate of Return (FIRR) is calculated.

. Profit and Loss Statement
. Fund Flow Table
. Balance Sheet

In case that the production cost is higher than the wholesale price, LPG selling price at which investment cost can be covered is calculated.

On the other hand, the major objective of the financial analysis of the electric power generation project is to calculate the recommendable fuel gas price at the inlet of the power plant. Concretely, the above financial statements are prepared for three cases of fuel gas prices and FIRR is calculated. In addition, a comparison of generating cost with diesel power plant, that is considered to be the most realistic alternative at this stage, is conducted.

16-2 Major Premises for Financial Analysis

This section describes the basic data and conditions for financial analysis.

(1) Project Life

Construction Period: 2 years
Operation Period: 20 years

(2) Price Base

All prices and costs such as investment cost, production costs and sales prices are calculated at the fixed price in February 1988, and price escalation is not incorporated. The calculation is made in local currency, and the foreign currency portion is converted by using the following exchange rate.

US$1 = 1,665 Rp
1 Yen = 13.0 Rp

(3) Operation and Sales Plan

(a) Power Plant

Based on the "Operation Plan" mentioned in Chapter 14, the power plant will be operated at 17.0 MW for 205 days and at 13.5 MW for 160 days. The energy, deducting a station service energy (5%) and transmission and distribution losses (10%) from the generated energy, is regarded as energy being sold. The selling price of electricity is set at 100 Rp/kWh based on the average selling price at Jambi City and surrounding areas.

(b) LPG Recovery Plant

The recovered LPG is sold in Jambi area. However, surplus LPG is sent to Palembang during the period when production exceeds the demand in Jambi. Table 16-1 shows the summary of sales plan prepared based on the results of the market study.

Table 16-1 Sales Plan of LPG

(Unit: tons/year)

	Jambi City	Palembang	Total
1st-year	1,563	1,229	2,792
2nd-year	1,725	1,067	2,792
3rd-year	1,916	876	2,792
4th-year	2,132	660	2,792
5th-year	2,389	403	2,792
6th-year	2,691	101	2,792
7th-year and after	2,792	0	2,792

Marketing of LPG is entrusted to the domestic sales department of PERTAMINA (PDN). LPG is to be delivered to PDN at 240 US$/ton at a gate of the plant, and PDN sells the LPG to retailers at 500 Rp/kg (300 US$/ton). In this case, the gross profit of PDN is 25% of ex-factory price of their purchasing price. The sales price for Palembang is set a 75 Rp/kg (45 US$/ton) by deducting transportation cost from Jambi to Palembang (125 Rp/kg; 75 US$/ton) from transfer price (200 Rp/kg; 120 US$/ton) at which the production department of PERTAMINA sells LPG to PDN.

(5) Income Tax

The following income tax is levied on this project based on the National Taxation System enforced in 1984.

Taxed Income (Million Rp)	Tax Rate (%)
Upto 10	15
Over 10 to 50	25
Beyond 50	35

In case that loss is counted, the loss can be carried forward for 5 years.

(6) Depreciation

The bases for depreciation are as follows:

Item	Method for Depreciation
Machinery & Equipment	10 %, Declining Balance
Building	5 %, Declining Balance
Pre-operation Cost	50 %, Declining Balance
Interest during Construction	50 %, Declining Balance

(7) Working Capital

Working capital is the fund required for the continuation of daily operation. In this study, the working capital is defined as the balance by deducting the current liability from the current assets as shown below.

(a) Current Assets

. Cash
The amount to cover the labor cost for one month is reserved as cash.

. Account Receivable

Sale revenue of one month is counted to be account receivable assuming that sales proceeds of LPG and electricity will be collected one month after the sales.

. Raw Material Inventory

1,000 kiloliters of diesel oil is reserved at the power plant as inventory.

(b) Current Liabilities

. Account Payable

The equivalent of one month of costs for fuel and utilities are counted as account payable.

(8) Financing Plan

The financing plan for the execution of this project is not fixed yet. In this Chapter, based on the calculation results of "Total Capital Investment" mentioned in Chapter 15, it is assumed that 20% of the plant investment cost is covered by the own fund and 80% is covered by the long-term loan. The financing conditions of long-term loan is set as follows in accordance with the discussion with BPPT.

	Case-1	Case-2
. Interest	12 %	3.5 %
. Installments, times	20	18
. Repayment, years	10	18
. Grace Period, years	0	7

In case that shortage of fund is occurred after the start-up of plant operation, the shortage will be covered by the equity and paid off when surplus becomes positive.

16-3 Total Capital Requirement

Although the total costs for the entire project is calculated in Chapter 15 "TOTAL INVESTMENT COST", in this Chapter, capital costs for LPG recovery project and the electric power generation project (including transmission lines) are calculated in order to evaluate the profitabilities of each project. In calculating the capital cost for each project, the costs for basic design and consulting are allocated in proportion to the plant cost. Tables 16-2 and 16-3 show the breakdown of total capital investment for two cases of financing conditions.

Table 16-2 Total Capital Investment (Case-1)

(Unit: Million Rp)

Plant Investment Cost	
LPG Recovery Plant	6,045.90
Power Station & Transmission Line	51,375.79
Natural Gas Pretreatment & Pipeline	3,337.92
Sub-total	60,759.61
Pre-operation Cost	
LPG Recovery Plant	277.86
Power Station & Transmission Line	272.28
Natural Gas Pretreatment & Pipeline	69.46
Sub-total	619.60
Initial Working Capital	
LPG Recovery Plant	23.15
Power Station & Transmission Line	221.17
Natural Gas Pretreatment & Pipeline	5.79
Sub-total	250.11
Interest during Construction	
LPG Recovery Plant	640.69
Power Station & Transmission Line	5,444.35
Natural Gas Pretreatment & Pipeline	353.72
Sub-total	6,438.76
Total	
LPG Recovery Plant	6,987.60
Power Station & Transmission Line	57,313.59
Natural Gas Pretreatment & Pipeline	3,766.89
Sub-total	68,068.08

Table 16-3 Total Capital Requirement (Case-2)

(Unit: Million Rp)

Plant Investment Cost	
LPG Recovery Plant	6,045.90
Power Station & Transmission Line	51,375.79
Natural Gas Pretreatment & Pipeline	3,337.92
Sub-total	60,759.61
Pre-operation Cost	
LPG Recovery Plant	277.86
Power Station & Transmission Line	272.28
Natural Gas Pretreatment & Pipeline	69.46
Sub-total	619.60
Initial Working Capital	
LPG Recovery Plant	23.15
Power Station & Transmission Line	221.17
Natural Gas Pretreatment & Pipeline	5.79
Sub-total	250.11
Interest during Construction	
LPG Recovery Plant	180.36
Power Station & Transmission Line	1,532.64
Natural Gas Pretreatment & Pipeline	99.58
Sub-total	1,812.58
Total	
LPG Recovery Plant	6,527.27
Power Station & Transmission Line	53,401.88
Natural Gas Pretreatment & Pipeline	3,512.75
Sub-total	63,441.90

16-4 Operation Expenses

Followings are costs and expenses necessary for LPG recovery and power generation.

(1) Raw Materials

(a) LPG Recovery

Condensate required for the recovery of LPG is 2.35 tons/ton.LPG. The price of the condensate supplied from GOSP is set at zero because of the following reasons.

. Condensate should be transported to Palembang because there is no demand in Jambi.
. LPG fraction will be volatilized during transportation, if LPG is not recovered by this project.
. Separated gas and liquid at LPG recovery plant are effectively used as fuel gas and natural gasoline, respectively.
. In view of the above, in this project, unusable by-product is used as a raw material to LPG project.

(b) Power Generation

The required fuel gas and diesel oil for power generation by using dual-fuel engine are as follows:

Fuel Gas: 1.30×10^6 MMBTU/year
Diesel Oil: 4,413 kiloliters/year

The price of fuel gas is not fixed yet. Therefore, the financial analysis is conducted for the following three cases of gas price in order to calculate the recommendable price.

. Case-A: 2.53 US$/MMBTU (4,212.45 Rp/MMBTU)
. Case-B: 2.10 US$/MMBTU (3,496.50 Rp/MMBTU)
. Case-C: 1.50 US$/MMBTU (2,497.50 Rp/MMBTU)

(2) Utilities

(a) LPG Recovery

The required utility at LPG recovery plant is only fuel gas for a power unit and for a hot oil facility, and a part of fuel gas for the power plant is used as a utility gas. The requirement of utility gas is 7.0 MMBTU/ton of LPG and the price is set at 2.1 US$/MMBTU, which is the middle case of 3 set prices mentioned above.

(b) Power Generation

At the power plant, electricity is required for lighting and power sources of auxiliary equipment, and power loss is occurred at transformers. In this study, the total amount of the above consumption and loss (station service energy) is estimated to be 5% of total generating energy. The main consumable goods at the power station is lubricating oil. The unit consumption and unit price of lubricating oil are 1.65 liter/MWh and 1,501.5 Rp/liter, respectively.

(3) Labor Cost

Based on the "Operation Plan" mentioned in Chapter 14, the following labor cost including allowance are calculated.

Table 16-4 Labor Cost

Unit: US$/year

Natural Gas Processing Plants		
Plant Manager	(1 Person)	21,000
Engineer	(9 persons)	100,800
Operator	(8 persons)	67,200
LPG Bottling Operator	(4 persons)	11,200
Guardsman	(3 persons)	8,400
Sub-total	(25 persons)	208,600
Power Plant		
Plant Manager	(1 Person)	21,000
Engineer	(5 persons)	56,000
Operator	(8 persons)	67,200
Guardsman	(3 persons)	8,400
Sub-total	(17 persons)	152,600
Total:	(42 persons)	361,200

To allocate the labor cost of natural gas processing plants (Pretreatment, LPG recovery and pipeline) to each plant is rather difficult, therefore, in this study, 80% of the labor cost is allocated to LPG recovery plant and 20% are allocated to other plants. Based on the above, the required annual labor cost of this project is summarized as follows:

LPG recovery plant: 166,880 US$ = 277.8 MMRp
Power plant: 152,600 US$ = 254.0 MMRp
Pretreatment facility and pipeline: 41,720 US$ = 69.5 MMRp

(4) Maintenance Cost

The cost for maintenance of LPG recovery plant is set to 3% of the plant cost. Maintenance cost of the power plant is estimated to be 13 Rp/kWh (1,761 MMRp/year).

(5) Insurance Cost

The annual insurance costs of LPG recovery plant and the power plant are set to 0.5% of each plant cost.

16-5 Result of Financial Analysis

16-5-1 LPG Recovery Plant

The results of financial analysis based on the above premises are summarized in the following financial statements attached at the end of this report.

- Production Cost Accounting Table (Tables A-2 and A-6)
- Profit and Loss Statement (Tables A-3 and A-7)
- Fund Flow Table (Tables A-4 and A-8)
- Balance Sheet (Tables A-5 and A-9)

The summary of each financial statement and overall evaluations are given in the followings:

(1) Production Cost Accounting Table

The average production costs for 20 years are 218 US$/ton in Case-1 of normal city bank interest rate and 204 US$/ton in Case-2 financed by soft loan. In both cases, calculated production cost is cheaper than sales price.

(2) Profit and Loss Statement

In both cases, sales revenue can not cover the production cost for some years after start-up of commercial operation. In Case-1, sum of profit after tax for 20 years is negative owing to the limitation of loss carry forward for 5 years. In Case-2, profitability of project is sound in total, and the sum of profits after tax amounts to 800 million Rp.

(3) Fund Flow Table

In Case-1, shortage of fund is occurred because cash is not sufficient for repayment on long-term loan. Even if the annual shortage is compensate by the own fund or funds of no interest, cash position is negative through the operation period. In Case-2, shortage of loss occurs at the first year of operation. However, surplus cash is expected from the second year and the good profitability can be expected. Followings are calculated FIRR for two cases (N.R. means negative return).

	Case-1	Case-2
ROI (before/tax)	3.6%	3.6%
ROI (after/tax)	2.0	2.0
ROE (before/tax)	N.R.	7.5
ROE (after/tax)	N.R.	4.4

(4) Balance Sheet

In Case-1, cash on hand is minus throughout the operation period. In such a financial situation, plant operation can not be continued. On the other hand, in Case-2, balance of long-term loan amounting to 1,400 million Rp will remain at the end of operation. However it can be repaid by the appropriation of reserved cash amounting to 2,300 million Rp.

(5) Overall Evaluation

In Case-1, this project is not viable due to a shortage of fund for the repayment of long-term loan. In Case-2, although shortage of fund occurs at the first year, cash surplus can be expected from the second year and the profitability of the project is favorable.

16-5-2 Power Plant

Following financial statements for 6 cases are prepared and attached at the end of this Report.

- Production Cost Accounting Table (Tables A-10, 14, 18, 22, 26 and 30)
- Profit and Loss Statement (Tables A-11, 15, 19, 23, 27 and 31)
- Fund Flow Table (Tables A-12, 16, 20, 24, 28 and 32)
- Balance Sheet (Tables A-13, 17, 21, 25, 29 and 33)

The summary of each financial statement and overall evaluations are given in the following:

(1) Production Cost Accounting Table

Unit generating cost for each case are shown in Table 16-5.

Table 16-5 Comparison of Generating Costs

Case	Interest (%)	Gas Price ($/MMBTU)	Unit Generating Cost (Rp/kWh)
1-A	12.0	2.53	95
1-B	12.0	2.10	89
1-C	12.0	1.50	79
2-A	3.5	2.53	91
2-B	3.5	2.10	85
2-C	3.5	1.50	75

(2) Profit and Loss Statement

In every case, sales revenue can not cover the operation cost for some years after the start-up of commercial operation. Under the current taxation system at which loss carry forward is limited for 5 years, the cases sum of profits after tax amount to plus are only Case 1-C and 2-C.

(3) Fund Flow Table

In Cases 1-A, B, C and 2-A, the operation of power plant is difficult as the independent profit organization due to the shortage of fund.
In Case 2-B, long-term loan can be repaid by the application of reserved cash during the grace period. In Case 2-C, shortage of fund is not occurred.
Table 16-6 shows the calculated FIRR for 6 cases.

Table 16-6 Internal Rate of Return (Power Plant)

(Unit: %)

	ROI (B/Tax)	ROI (A/Tax)	ROE (B/Tax)	ROE (A/Tax)
Case 1-A	0.0	N.R.	N.R.	N.R.
Case 1-B	2.9	1.6	N.R.	N.R.
Case 1-C	6.2	4.2	1.7	N.R.
Case 2-A	0.0	N.R.	N.R.	N.R.
Case 2-B	2.9	1.6	7.6	3.9
Case 2-C	6.2	4.2	22.1	20.7

N.R.: Negative Return

(4) Balance Sheet

Judging from the projected balance sheet, in Cases 1-A, B, C and 2-A, operation of the power plant is not justifiable. In Cases 2-B and 2-C, the project is considered to be financially feasible, and balance of long-term loan at the end of operation can be repaid by the appropriation of reserved cash which exceeds the balance of loan.

(5) Overall Evaluation

In view of the above, the project is not financially feasible in case that gas price is 2.53 US$/MMBTU and/or ordinary city bank loan is applied. However, in case that the gas price cheaper than 2.1 US$/MMBTU and soft loan is applied to this project, the power plant can be operated without the introduction of external funds.

16-6 Comparison with Diesel Power Plant

16-6-1 Major Premises

In principle, mechanism of dual-fuel engine is same as diesel engine. Therefore, financial analysis of diesel power plant can be done by the same way, while the fuel consumption volume and the plant cost are naturally different from the gas power plant.
Major differences are given below.

	Dual-Fuel	Diesel
Engine Price	1,900.0 MMY	1,425.0 MMY
Fuel (HSD) Tank Capacity	1,000 kl 1 unit	1,000 kl 3 units
Fuel (HSD) Tank Cost	30.0 MMY	90.0 MMY
Fuel Gas Consumption	1,262,698 MMBTU/y	-
Fuel (HSD) Consumption	4,413 kl/y	32,845 kl/y

Furthermore, corresponding to the capacity of fuel tank, three times of diesel oil should be reserved at the commencement of operation. Therefore, the initial working capital for fuel oil becomes three times.

16-2-2 Results of Analysis

Same kinds of financial statements as the dual-fuel engine power plant are prepared and attached at the end of this Report.
Unit generating costs for Case-1 and Case-2 are 94 Rp/kWh and 90 Rp/kWh, respectively. Comparison of generating cost with the dual-fuel engine plant and variation of Return on Investment (ROI) due to the change of gas price are summarized in Figure 16-1.

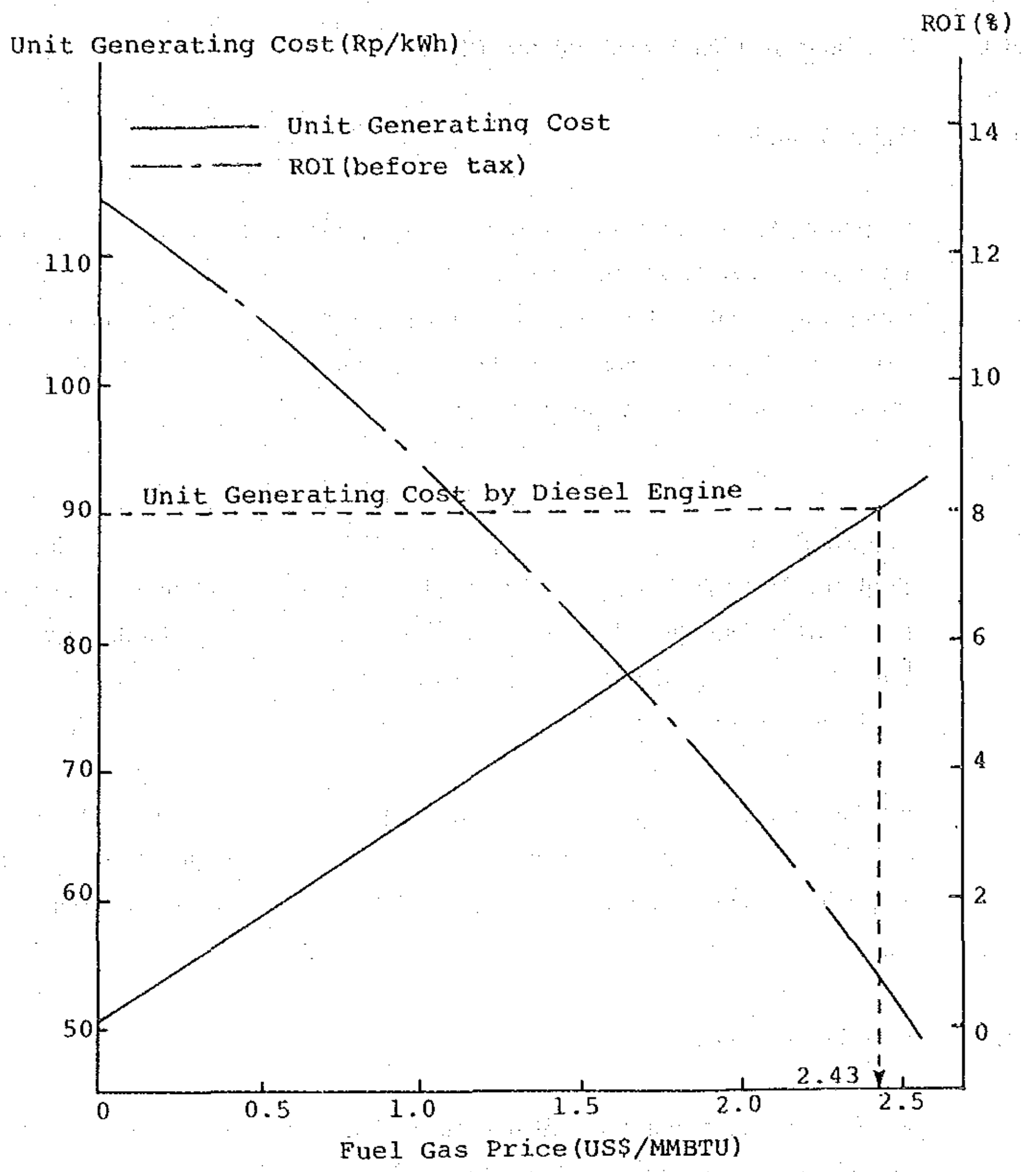


Figure 16-1 Comparison of Generating Cost

As shown in the above figure, the electricity can be generated at the price cheaper than that of the diesel plant if the gas price is set below 2.43 US$/MMBTU.

16-7 Sensitivity Analysis

With the above case as the base, a study is made to evaluate the influence of the variation of the presumed conditions on the profitability of the project. The analysis is conducted only for Case-1 regarding loan condition because profitability of the project in Case-1 of normal city bank loan interest is not good. Regarding fuel gas price, Case-B (2.1 US$/MMBTU) is applied to the analysis because this price seems to be recommendable from the financial point of view.

(1) Establishment of Parameter

The following parameters and ranges of variation are considered.

(a) Construction Cost of LPG Recovery Plant
Variation of -20% to +20% to the base case

(b) LPG Sales Price
Variation of -20%, to +20% to the base case

(c) Construction Cost of Power Plant
Variation of -20% to +20% to the base case

(d) Average Selling Price of Electricity
Variation of -10% to +20% to the base case

(e) Gross Production
Variation of -10% and -5% to the base case

(2) Results of Sensitivity Analysis

The results of sensitivity analysis are shown in Table 16-7, Figures 16-2 and 16-3.

Table 16-7 Summary of Sensitivity Analysis

(Unit: %)

Parameter	ROI (B/Tax)	ROI (A/Tax)	ROE (B/Tax)	ROE (A/Tax)
LPG Recovery Plant				
(a) Plant Cost				
- 20 %	6.5	4.5	15.6	13.2
- 10 %	4.9	3.2	11.5	9.0
Base Case	3.6	2.0	7.5	4.4
+ 10 %	2.4	1.0	3.1	N.R.
+ 20 %	1.3	0.0	N.R.	N.R.
(b) Product Price				
- 20 %	N.R.	N.R.	N.R.	N.R.
- 10 %	1.4	0.2	N.R.	N.R.
Base Case	3.6	2.0	7.5	4.4
+ 10 %	5.5	3.6	13.3	10.9
+ 20 %	7.2	5.0	18.2	15.9
Power Plant				
(c) Plant Cost				
- 20 %	5.3	3.5	18.7	17.2
- 10 %	4.0	2.5	13.3	11.4
Base Case	2.9	1.6	7.6	3.9
+ 10 %	1.9	0.7	N.R.	N.R.
+ 20 %	1.0	N.R.	N.R.	N.R.
(d) Electricity Rate				
- 20 %	N.R.	N.R.	N.R.	N.R.
- 10 %	1.2	0.1	N.R.	N.R.
Base Case	2.9	1.6	7.6	3.9
+ 10 %	5.9	3.9	20.9	19.5
+ 20 %	8.5	5.9	30.3	28.4
(f) Gross Production				
- 10 %	1.7	0.6	N.R.	N.R.
- 5 %	2.3	1.1	3.6	N.R.
Base Case	2.9	1.6	7.6	3.9

N.R.: Negative Return

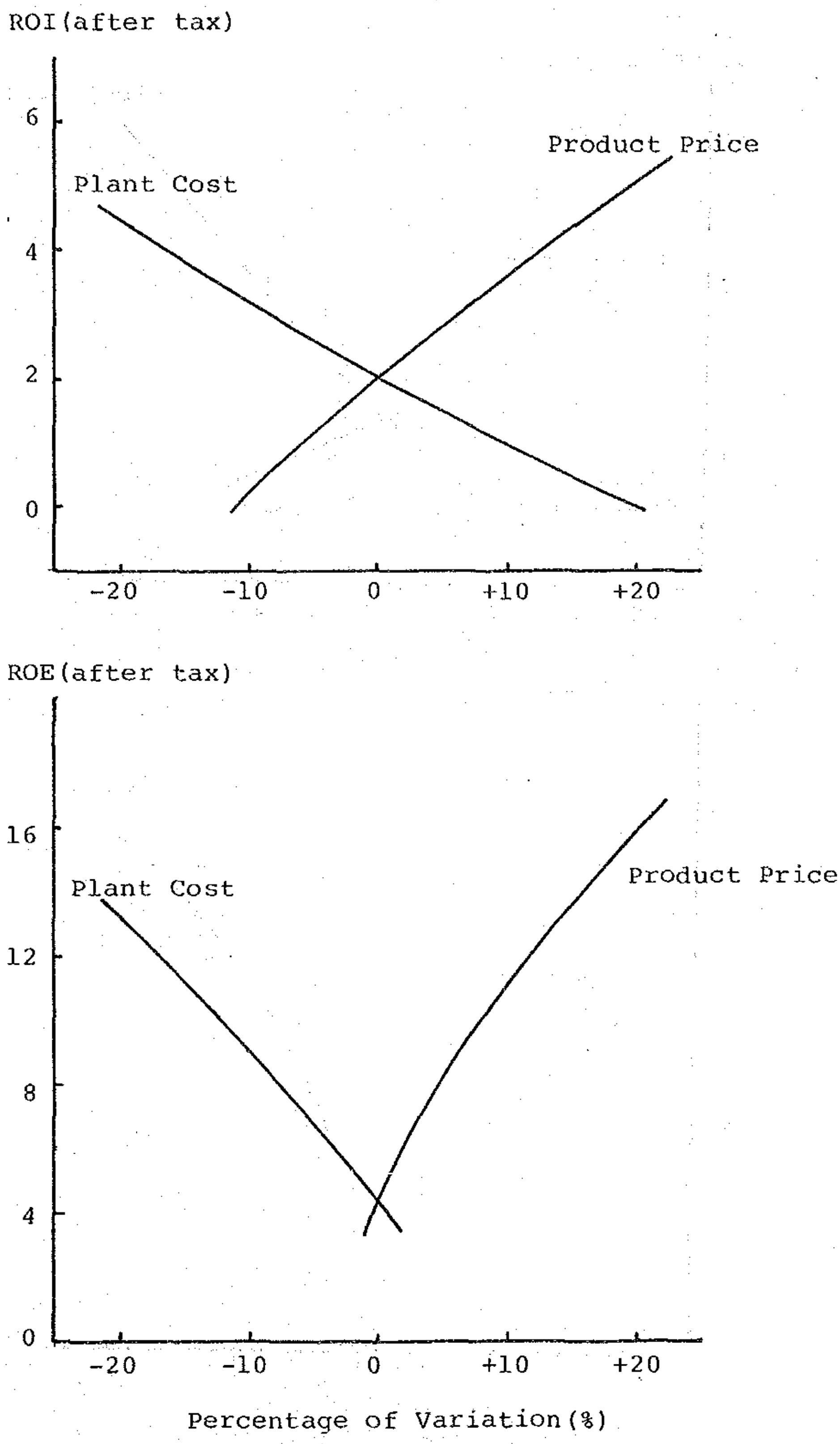


Figure 16-2 Summary of Sensitivity Analysis (LPG Recovery Plant)

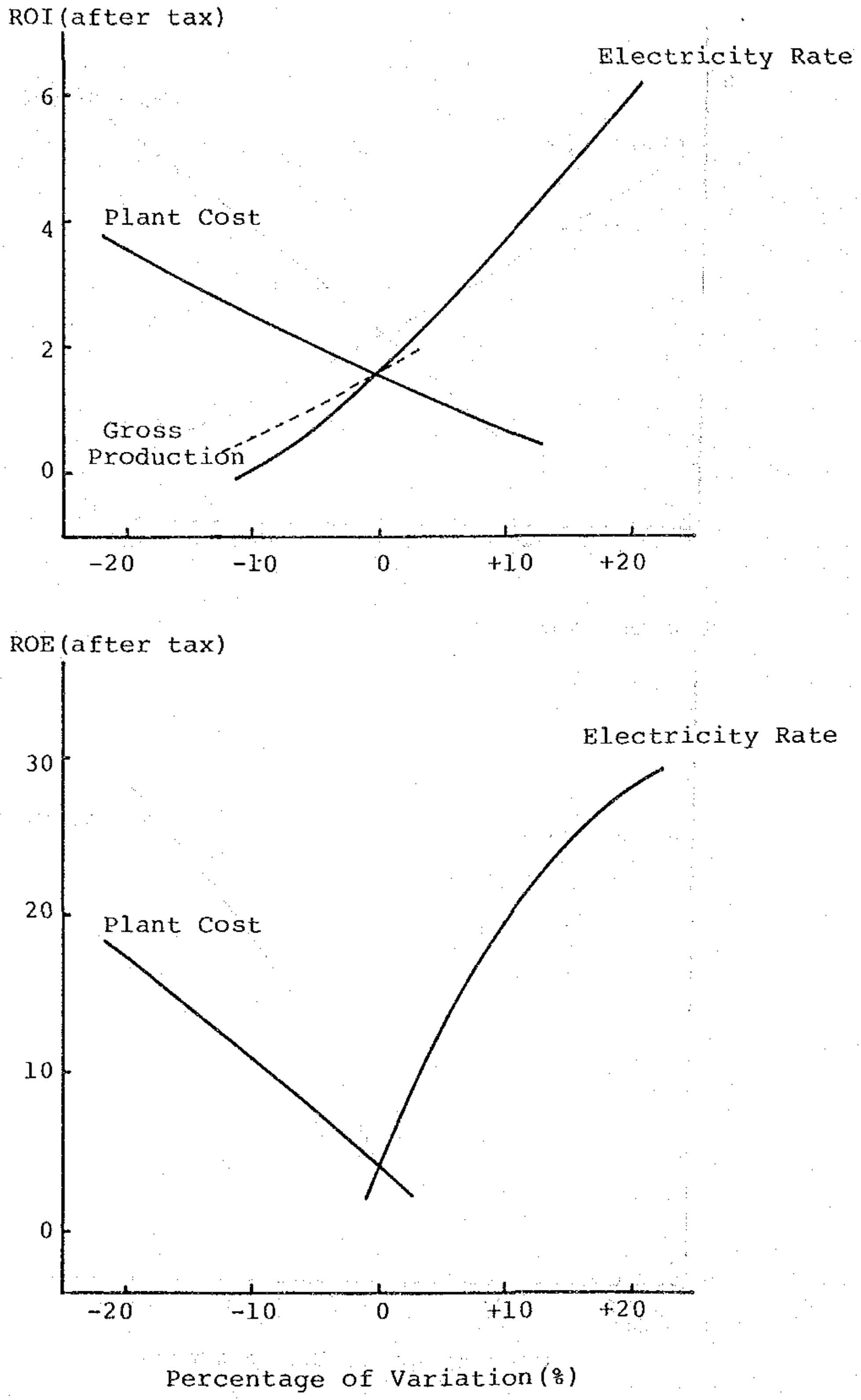


Figure 16-3 Summary of Sensitivity Analysis (Power Plant)

(a) Construction Cost of LPG Recovery Plant

If the plant cost increases by 10% compared with the base case, ROI (before tax) and ROE (before tax) will decrease by 1.2% and 4.6%, respectively. Further, in the above case reserved cash at the end of operation will be lower than the balance of long-term loan.

(b) LPG Sales Price

As shown in Table 16-7, the fluctuation of the product price have significant effect upon the profitability. If LPG price is set at 90% of the base case, the reserved cash at the end of operation will be lower than the balance of long-term loan.

(c) Construction Cost of Power Plant

If the plant construction cost increases by 10%, the balance of long-term loan exceeds the reserved cash at the end of operation. Therefore, introduction of external funds is required for the repayment of the long-term loan.

(d) Average Selling Price of Electricity

If average selling price falls to 90 Rp/kWh by the increase of small customers, operation of the power plant cannot be continued as an independent profit organization. On the other hand, if average selling price raises to 120 Rp/kWh by the increase of big customers or revision of electricity rates, financial situation of the power plant is improved considerably.

(e) Gross Production

The power plant is projected to operate continuously at a high operation rate, reasonably achievable from the technical viewpoint. Therefore, it is not realistic to consider that the power plant can generate more energy continuously than presumed level. On the other hand, if gross production decreases, financial situation will be deteriorated as shown in Table 16-7. In order to cope with the high demand continuous operation for the proposed power plant after the implementation of this project, the operators should be trained thoroughly to the first class level and appropriate maintenance work should be done timely to achieve the continuous operation as scheduled.

16-8 Summary of Financial Analysis

Followings are evaluation and conclusion of this project.

(1) LPG Recovery Plant

. Since calculated average production cost of LPG is 204 US$/ton for the interest rate of 3.5% p.a., LPG recovery plant is viable if LPG can be sold at the presumed price of 240 US$/ton.

. In case that soft loan is applied to this project, a favorable financial situation can be expected and the long-term loan can be repaid smoothly.

. If LPG demand in Jambi district increases greatly, the amount of LPG sold at a low price in Palembang will be decreased and the profitability of this project will be improved considerably.

. Accordingly, the study team considers that LPG recovery project is financially feasible, unless the premises used in this study change greatly in adverse direction.

(2) Power Plant

- In case that a soft loan is applied and fuel gas price is fixed below 2.1 US$/MMBTU, the power plant can be operated without the introduction of subsidy.

- The electricity can be generated more economically than diesel plant, if the gas price is set blow 2.43 US$/MMBTU.

  If the above conditions are satisfied, the power plant project is considered to be financially feasible, while justification of the basic infrastructure such as electricity should not be done only from the financial viewpoint.

- As mentioned in the sensitivity analysis, if the gross production is reduced due to some reason, accidents for example, the financial situation is deteriorated. Therefore, at the execution of the project, sufficient training for operators and appropriate maintenance work should be programmed and carried out to achieve the continuous power generation as scheduled.

17. ECONOMIC ANALYSIS

17-1 General

This Chapter describes how this project contributes to Indonesian national economy by the generation of electricity and LPG recovery. In the economic analysis, by considering following conditions in Indonesia, contribution to saving of petroleum products is mainly investigated. Concretely, economic benefits and costs are evaluated and Economic Internal Rate of Return (EIRR) is calculated. Further foreign currency balance is also calculated.

Indonesia is one of the largest oil producing countries, and the export of petroleum products have been contributing to obtaining foreign currencies. However, crude oil in Indonesia contains small amount of middle distilate such as kerosene and diesel oil, and crude oil rich in middle distilate is imported unavoidably from other countries such as Saudi Arabia. Under these circumstances, if a power generation project using unused natural gas is implemented as an alternative of diesel power plant, diesel oil will be saved and the saving will contribute to national economy. The recovered LPG will be used as an alternative fuel of kerosene.

17-2 Economic Benefit and Cost

Although the direct benefits of this project are electric power and LPG, the economic benefits are defined in this study as follows.

(1) Power Plant

Supply of electricity is one of the basic infrastructure, and construction of a power plant is planned in Jambi to improve the standard of living and to promote the development of the area. At this stage, diesel power plant is considered to be the most realistic alternative of this project.

Therefore, if this project is regarded as an alternative to a diesel plant, the economic benefit is defined as a saving of diesel oil. The amount of diesel oil to be saved by the implementation of this project is 28,432 kl/year. The economic price of diesel oil is set at 0.14 US$/l (233 Rp/l) which is the international price of diesel oil at February, 1988.

(2) LPG Recovery Plant

As mentioned in Chapter 4 MARKET STUDY, the recovered LPG is considered as an alternative fuel of kerosene. Therefore, the economic benefit of this project is defined as a saving of kerosene. The amount of kerosene to be replaced by LPG is calculated by the following formula considering calorific value of two fuels.

Kerosene Substitution Volume
= LPG Production Volume x Calorific Value of LPG
÷ Calorific Value of Kerosene
= 2,792 t/y x 12,000 kcal/kg ÷ 11,125 kcal/kg
= 3,012 t/y

The economic price of kerosene is set at 170 US$/ton (283,052 Rp /ton) which is an international price of kerosene. In addition to the above, reduction of transportation cost of LPG is expected as an economic benefit. The average transportation cost from Palembang to Jambi is 75 US$/ton, and the cost from Sengeti to Jambi is estimated to be 10 US$/ton. Therefore the reduction of transportation cost is calculated to be 65 US$/ton of LPG. The annual saving of this cost is calculated by multiplying the above cost to sales volume in Jambi (Refer to Table 16-1).

17-2-2 Economic Cost

(1) Power Plant

Since the power plant is considered as a replacement of diesel power plant in this study, the economic costs are difference of increase of the plant cost, the gas cost and the insurance cost linked with the plant cost.

As mentioned in Chapter 16, the difference of the plant cost is 415 million yen (5,395 million Rp), and the difference of the insurance cost is 26.73 million Rp. The economic price of fuel gas is set at equivalent to the heating value of crude oil, and the price is calculated by the following formula.

Gas Price = 15 US$/bbl ÷ 159 l/bbl ÷ 9,250 kcal/l
x 252,000 kcal/MMBTU
= 2.57 US$/MMBTU

(2) LPG Recovery Plant

All costs except that for utility gas are considered to be equal to the costs used in the financial analysis. The economic price of the gas is evaluated to be equal to the above price (2.57 US$/ MMBTU).

17-3 Economic Internal Rate of Return

Based on the economic benefits and costs described in the previous section, Economic Internal Rate of Return (EIRR) has been calculated. EIRR of the power generation project and LPG recovery project are given below.

. Power Generation Project: 16.4%
. LPG Recovery Project : 5.5%

The calculated EIRR of the power generation project is higher than ROI before tax in the financial analysis. The calculation result that EIRR is higher than ROI implies that the implementation of the project has higher economical significance to the national economy.
LPG recovery is a dependent project on the power generation project, and EIRR is not so high due to its small capacity. However, as mentioned in the financial analysis, this project is aiming at the recovery of volatile fraction being vaporized into atmosphere if it is not recovered by LPG plant, and the significance to prevent the waste of natural resources is great.

Economic benefits and costs for each year which are used as bases of calculating EIRR are shown in Tables 17-1 and 17-2.

17-4 Sensitivity Analysis

With the above case as the base, sensitivity analysis of EIRR is carried out for the following parameters:

. Economic Investment Cost ±20%
. Crude Oil Price ±20%

In the evaluation of the influence by changing the crude oil price, economic prices of diesel oil, kerosene and fuel gas are considered to change at the same rate as crude oil, because the prices of petroleum products changes according to the fluctuation of crude oil price.

Table 17-1 Economic Benefits and Costs (Power Generation Project)

EIRR(%)= 16.4 (Unit : Million Rp)

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
<< Economic Benefit >>																							
HSD Saving	0	0	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	132,493
<< Economic Cost >>																							
Capital Investment	3,777	1,619	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,395
Fuel Gas	0	0	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	5,563	111,255
Insurance	0	0	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	540
Total Cost	3,777	1,619	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	5,590	117,190
<< Balance >>	-3,777	-1,619	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	1,035	15,303

Table 17-2 Economic Benefits and Costs (LPG Recovery Project)

EIRR(%)= 5.5 (Unit : Million Rp)

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
<< Economic Benefit >>																							
Kerosene Saving	0	0	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	17,051
Transport. Cost Saving	0	0	169	187	207	231	259	291	302	302	302	302	302	302	302	302	302	302	302	302	302	302	5,574
Total Benefit	0	0	1,022	1,039	1,060	1,083	1,111	1,144	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	22,625
<< Economic Cost >>																							
Capital Investment	4,232	2,092	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,324
Fuel	0	0	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	1,673
Labor	0	0	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	5,560
Maintenance	0	0	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	3,628
Insurance	0	0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	605
Total Cost	4,232	2,092	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	573	17,789
<< Balance >>	-4,232	-2,092	448	466	487	510	538	571	581	581	581	581	581	581	581	581	581	581	581	581	581	581	4,836

The results of the sensitivity analysis are summarized in Figure 17-1.

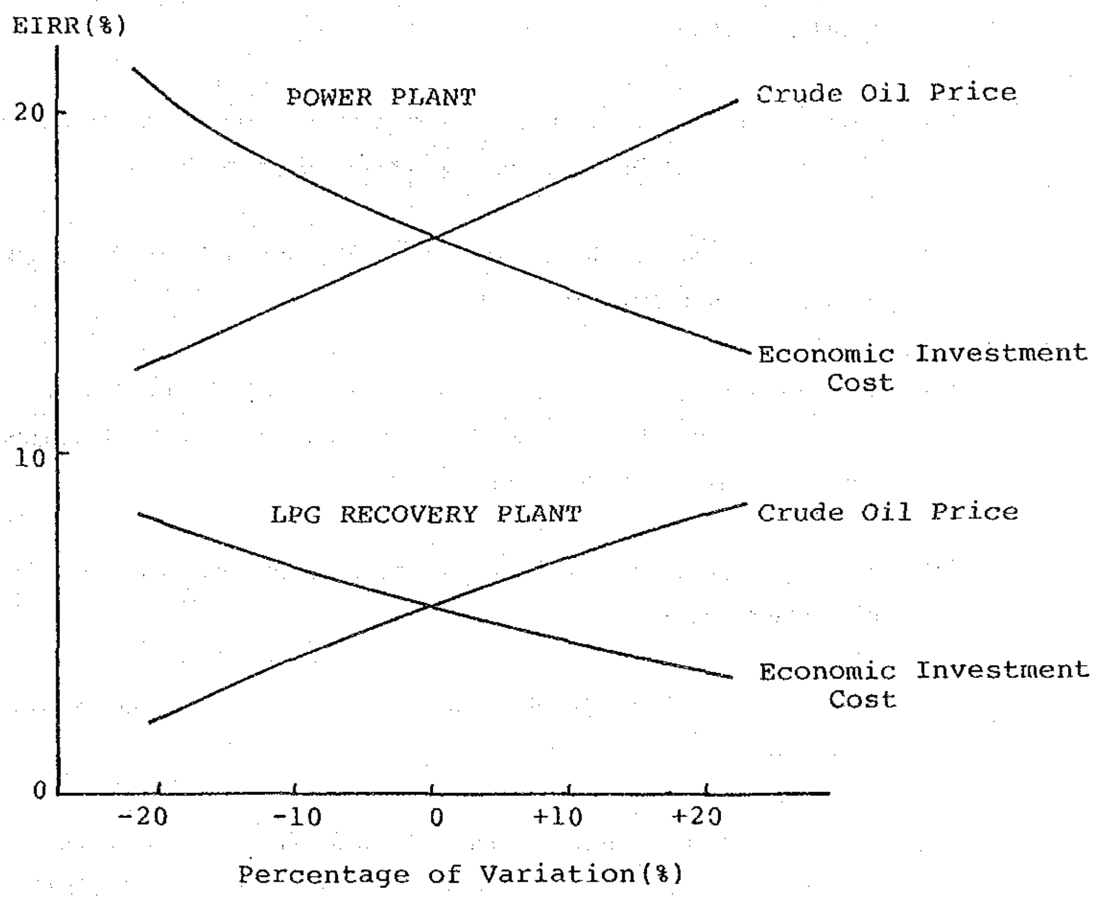


Figure 17-1 Results of Sensitivity Analysis

17-5 Calculation of Foreign Currency Balance

The contribution to foreign currency balance that may be expected by the implementation of this project is calculated in the following manner:

(1) All prices employed in this calculation are the constant price in February, 1988.

(2) All of the saving of diesel oil and substituted kerosene are regarded as the substitute for the imported products.

(3) Operation costs excluding fuel and raw material are regarded as a local currency portion.

(4) The borrowing of foreign loan is an inflow of the foreign currency, which will be offset in the same amount by the repayment for the investment cost.

(5) The repayment and interest on the foreign loan are an outflow of foreign currency.

(6) The balance of the foreign loan at the end of operation will be repaid at that time.

(7) Natural gas pretreatment facility and pipeline are required to supply a suitable fuel gas to the power station. Therefore, the interest and repayment on foreign loan related to these facilities are incorporated into an outflow of the foreign currency of the power generation project.

The results of the foreign currency balance are shown in Tables 17-3 (power generation project) and 17-4 (LPG recovery project). The total foreign currency savings of the power generation project and LPG recovery project are 38 million U.S.Dollars and 6 million U.S. Dollars, respectively.

Table 17-3 Foreign Currency Balance (Power Generation Project)

Total Saving of Foreign Currency(MMRp): 63,289
Total Saving of Foreign Currency (MMUS$): 38

(Unit : Million Rp)

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
<< Foreign Currency Saving >>																							
HSD Saving	0	0	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	6,625	132,493
<< Outflow of Foreign Currency >>																							
Repayment on L/T Loan	0	0	0	0	0	0	0	0	0	2,524	2,524	2,524	2,524	2,524	2,524	2,524	2,524	2,524	2,524	2,524	2,524	15,146	45,438
Interest on L/T Loan	0	0	1,590	1,590	1,590	1,590	1,590	1,590	1,590	1,502	1,414	1,325	1,237	1,149	1,060	972	884	795	707	618	530	442	23,766
Total Outflow	0	0	1,590	1,590	1,590	1,590	1,590	1,590	1,590	4,026	3,938	3,850	3,761	3,673	3,585	3,496	3,408	3,319	3,231	3,143	3,054	15,588	69,204
<< Balance >>	0	0	5,034	5,034	5,034	5,034	5,034	5,034	5,034	2,598	2,687	2,775	2,863	2,952	3,040	3,128	3,217	3,305	3,394	3,482	3,570	-8,963	63,289

Table 17-4 Foreign Currency Balance (LPG Recovery Project)

Total Saving of Foreign Currency(MMRp): 9,409
Total Saving of Foreign Currency (MMUS$): 6

(Unit : Million Rp)

	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
<< Foreign Currency Saving >>																							
Kerosene Saving	0	0	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	853	17,051
<< Outflow of Foreign Currency >>																							
Repayment on L/T Loan	0	0	0	0	0	0	0	0	0	279	279	279	279	279	279	279	279	279	279	279	279	1,673	5,017
Interest on L/T Loan	0	0	176	176	176	176	176	176	176	166	156	146	137	127	117	107	98	88	78	68	59	49	2,624
Total Outflow	0	0	176	176	176	176	176	176	176	445	435	425	415	406	396	386	376	367	357	347	337	1,722	7,642
<< Balance >>	0	0	677	677	677	677	677	677	677	408	418	427	437	447	457	467	476	486	496	506	515	-869	9,409

17-6 Overall Evaluation

The objectives of this project are to generate electricity and to recover LPG from an unused natural gas. The economic benefits of this project are savings of diesel oil and kerosene. The expected economic effects of the power generation project and LPG recovery project are 16.4% and 5.5% respectively. Further, this project will contribute to saving of foreign currency. The total foreign currency saving on both projects amount to 44 million U.S.Dollars. According to the results of the economic analysis in this section, this project can be concluded feasible.

On the other hand, lots of small-scale gas reservoirs similar to that of Sengeti are scattered in Indonesia. If the validity of the development of electric power by using small-scale natural gas is proven by the implementation of this project, rural electrification in great many regions could be promoted encouraged by this project.

The study team believes that the implementation of this project has a great social significance to the Republic of Indonesia.

APPENDIX - 1 : STUDY TEAM AND FIELD SURVEY ITINERARY

(1) Members of the study team, their assignments and responsibilities are as follows:

Name	Assignment
Nobuo ISHII	Team Leader
Kenji CHIMURA	Market
Takehiko MASUDA	Oil Gas Production and Pipeline
Kunio KAWADA	LPG Plant
Kunio TAKAHASHI	Power Plant
Sadakazu HASEGAWA	Power Transmission and Distribution
Kazuo YAMANE	Cost Estimation and Infrastructure
Yoshitaka IMAEDA	Economic Analysis

Domestic supporting member is as follows:

Name	Assignment
Yuzuru KENMOCHI	Gas Reservoir Analysis

(2) Field Survey Itinerary

Field survey was conducted from January 31 to February 28, 1988 by the following schedule.

Date	Place	Activity, visit to
Jan. 31, Sun.	Jakarta	Move from Tokyo to Jakarta
Feb. 1, Mon.	"	Visit to JICA Office/Embassy of Japan Meeting with BPPT for schedule
Feb. 2, Tue.	"	Meeting with BPPT, Presentation and discussion of Inception Report, Meeting with Ministry of Mining and Energy
Feb. 3, Wed.	"	Meeting with MIGAS, Meeting with BPPT
Feb. 4, Thu.	"	Analysis of Data of PLN and PERTAMINA Visit to local contractor
Feb. 5, Fri.	"	Meeting with PERTAMINA (E&P) Visit to JETRO Jakarta Office
Feb. 6, Sat.	"	Discussion of Project Scheme
Feb. 7, Sun.	Jakarta - Jambi	Trip to Jambi Meeting with BAPPEDA for schedule

Date	Place	Activity, visit to
Feb. 8, Mon.	Jambi	Courtesy call to Vice Governor of Jambi Province and Meeting with Development Department of Jambi Province Meeting with PERTAMINA, Jambi
Feb. 9, Tue.	"	Site visit to Sengeti Gas Field and Gas Gathering Station, Pipeline route, Power Transmission Line route
Feb. 10, Wed.	"	Discussion with PERTAMINA, Jambi Discussion with PLN, Jambi
Feb. 11, Thu.	"	Discussion with BAPPEDA, Visit LPG users, Visit Electricity users, Visit to Port Authorities
Feb. 12, Fri.	"	Visit to Statistical Office, Jambi Meeting with PLN, Jambi
Feb. 13, Sat.	"	Meeting with BAPPEDA Meeting with PLN, Jambi
Feb. 14, Sun.	Jambi - Palembang	Move from Jambi to Palembang
Feb. 15, Mon	Palembang	Meeting with PERTAMINA, Palembang Meeting with PLN, Palembang
Feb. 16, Tue.	"	Meeting with PERTAMINA, Palembang Meeting with PLN, Palembang

Date	Place	Activity, visit to
Feb. 17, Wed.	Palembang - Jakarta	Meeting with PLN, Palembang Move from Palembang to Jakarta
Feb. 18, Thu.	Jakarta	Meeting with PERTAMINA, Domestic Supply Meeting with BPPT
Feb. 19, Fri.	"	Meeting with PLN Planning Department Meeting with BPPT
Feb. 20, Sat.	"	Preparation of Minutes of Discussion and Progress Report
Feb. 21, Sun.	"	Internal Meeting, Preparation of Minutes of Discussion and Progress Report
Feb. 22, Mon.	"	Meeting with BPPT, Preparation of Minutes of Discussion and Progress Report
Feb. 23, Tue.	"	- Ditto -
Feb. 24, Wed.	"	- Ditto -
Feb. 25, Thu.	"	- Ditto -
Feb. 26, Fri.	"	Signing of Minutes of Discussion Report to Embassy of Japan
Feb. 27, Sat.	"	Report to JICA Office for completion of the field survey. Leave Jakarta for Tokyo.

LIST OF ATTENDANTS

Agency for Assessment and Application of Technology: BPPT

Prof. M.T. Zen, M.Sc.
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Vice Governor

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Mr. Alamsyah Braksan
Chairman BAPPEDA

Drs. Hasmi Muchtar
Vice Chairman, BAPPEDA

Mr. A. Zubir Achmad
Liaison Officer for MME

Drs, Oesman Samad
BAPPEDA Secretary

Drs. N.S. Segonang
Cheif of Economic Div., BAPPEDA

Drs. Abd. Aziz
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Mr. Nasrial Nasir
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Mr. S. Kubota
President

Mr. N. Uto

P.T. Adiguna Mesintani

Mr. S. Nagai
Vice President

Mr. N. Makamura
Technical Advisor

P.T. Avlau Indonesia Fabricante

Mr. R. S. Basar
Vice President

P.T. Purna Bina Indonesia

Mr. Lynn C. Fister
Vice President

APPENDIX - 2 : RESULTS OF FIELD SURVEY

The followings are the results of the field survey and what have been agreed with the Indonesian counterpart.

1. Gas Supply Source

(1) Gas Volume

It has been confirmed that Sengeti gas field can supply the gas to the project at the rate of 10 MMSCFD for a period of 15 years. Since the required amount for this project will be approximately 3 MMSCFD, Sengeti gas field will have ample gas capacity for the project.

(2) Gas Compositions

(a) Data of gas compositions for 3 wells in Sengeti gas field and those for 10 layers of Sengeti gas reservoir were furnished by PERTAMINA.

(b) Regarding the design conditions for Gas Oil Separation Plant (GOSP), partial portion of design data had been given and it is necessitated that the study team would develop necessary data of design and operation of GOSP after return to Japan.

(c) It was agreed with BPPT that the gas compositions at the outlet of GOSP to be developed by the study team would be used as the basis for conducting this feasibility study.

(3) Gas Price

It was agreed that financial analysis would be carried out for the following three (3) cases of the gas price.

2.53 US Dollars per Million BTU
2.10 US Dollars per Million BTU
1.50 US Dollars per Million BTU

2. Scale of the Project

In accordance with preliminary market study by the study team, plan and forecast by PLN and the current sales situation of LPG by PERTAMINA, the following capacities of the plants were tentatively determined.

Power plant: 15 to 20 MW
LPG recovery plant: 5 tons per day

These tentative capacities will finally be decided upon further study of demand forecast of products in addition to technical study.

3. Candidate Sites for Project

(1) Power Plant

The study team made survey of 6 candidate sites and selected 3 locations of Sengeti, Setiti and Payo Selincah for detail technical and economical comparison to determine one proposed site for the project, on which financial and economical analysis will be conducted.

(2) LPG Recovery Plant

It will be desirable to install LPG recovery plant in Sengeti area, depending upon gas supply conditions at the outlet of GOSP. However, the location of LPG recovery plant will be preferable if it is

erected at the south side of the Batang Hari river, from viewpoints of sales and transportation of LPG product filled in cylinders.
Final selection of the site for LPG recovery plant will be made after further study.

4. Type of Generation

It was agreed that, after reviewing the following types of generation, dual-fuel engine generation would be the most appropriate method for the power plant capacity planned for this project.

- Dual-fuel engine generation
- Gas engine generation
- Gas turbine generation
- Gas fired boiler steam turbine generation

5. Process for LPG Recovery Plant

After studying process for LPG recovery from gas and condensate at the outlet of GOSP, the optimum process will be selected from viewpoint of technology and economy.

6. Others

Codes and standards applicable as the basis of the design of equipment will be as follows:

- Gas pretreatment facility
  : U.S.A. Standards (ASME, ASTM, etc.)
- LPG Recovery Plant
  : U.S.A. Standards (ASME, ASTM, etc.)
- Pipeline
  : U.S.A. Standards (ASME, ASTM, etc.)
- Power Plant
  : PLN Standard (SPLN)
- Transmission and Distribution Lines
  : PLN Standard (SPLN)

APPENDIX - 3 : PRESENT SITUATION AND FUTURE PLAN OF TRANSMISSION AND DISTRIBUTION SYSTEM IN JAMBI PROVINCE

The existing transmission and distribution systems in the Jambi Province are not interconnected with those in the neighboring provinces. The relatively large size network exists in Jambi City and its outskirt.
The other small independent networks in the Province are supplied by small diesel engine driven generating sets, and isolated each other.

A high voltage transmission project to interconnect the Jambi City grid with other principal networks is being planned by PLN (Perusahaan Umum Listrik Negara), the State Electricity Corporation. According to the plan, the Palembang City grid will be interconnected with the Jambi City grid through a 150-kV transmission system as shown in Figure A-1.
The detail of the project and the date of commissioning have not yet been determined, but it seems probable, under the present circumstances, that the system might not be put into service by the time this Project (Jambi Natural Gas Development Project) is completed.

The Jambi City grid comprises three diesel generating plants. PLTD Pasar, PLTD Kasang and PLTD Payo Selincah. All these power plants are located in the eastern region of the city. PLTD Kasang and PLTD Payo Selincah are in operation, but PLTD Pasar is out of service.

It is said that PLN has a plan to add to the Jambi City system a 10,000 kW diesel generating plant, probably, by 1992, well before the expected completion (1995) of the power plant proposed for this Project. Although the location of this plant has not yet been determined, it is very likely that it may be sited in the Payo Selincah district of the eastern region of Jambi City, close to its industrial zone where the electricity demand is expected to increase at a higher pace than elsewhere.

The distribution networks in the city consists of 20 kV and 6 kV lines as shown in Figure A-2.

Figure A-1 PLN Expansion Plan 150kV Transmission Line in PLN Palembang Branch

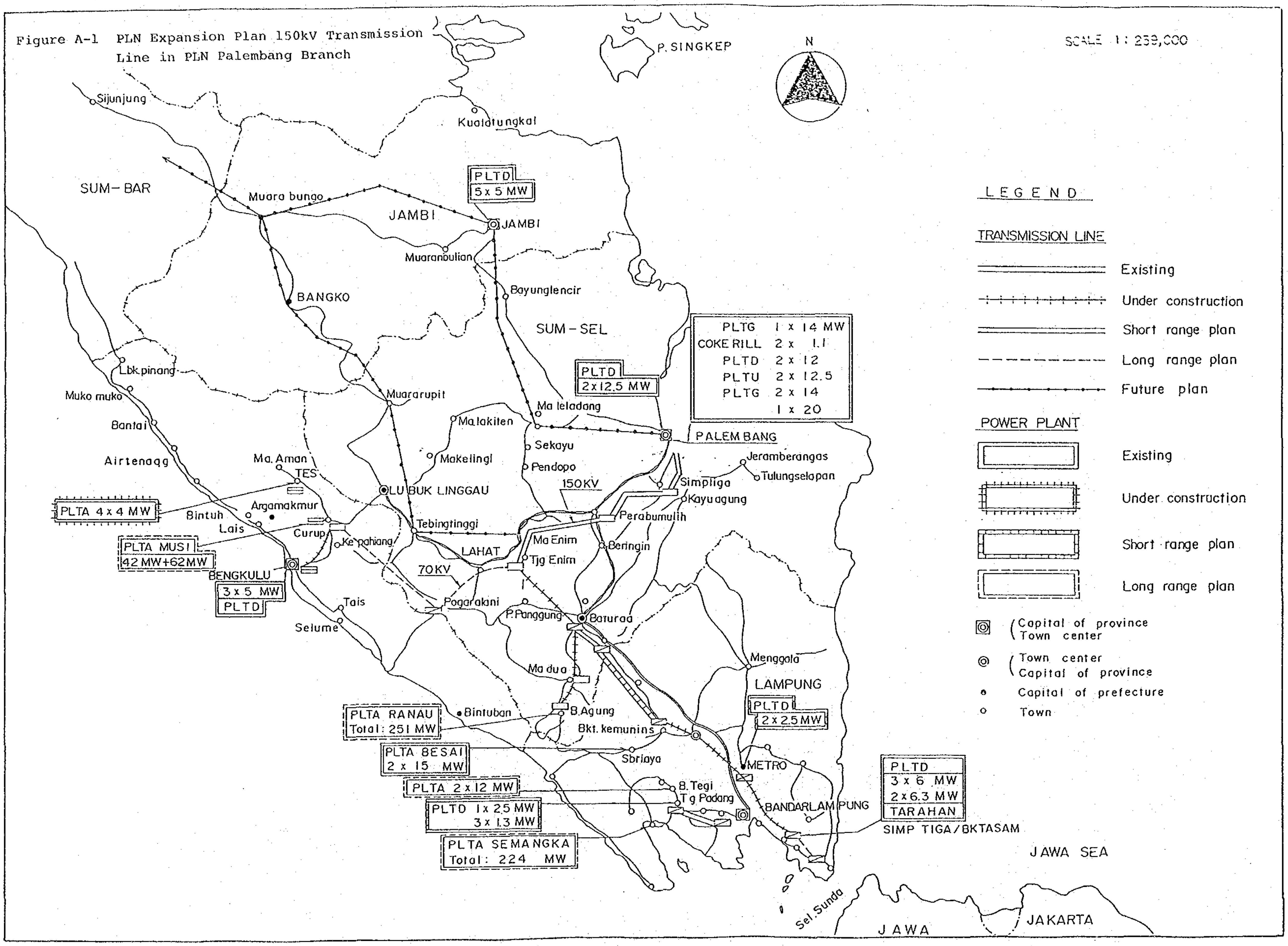
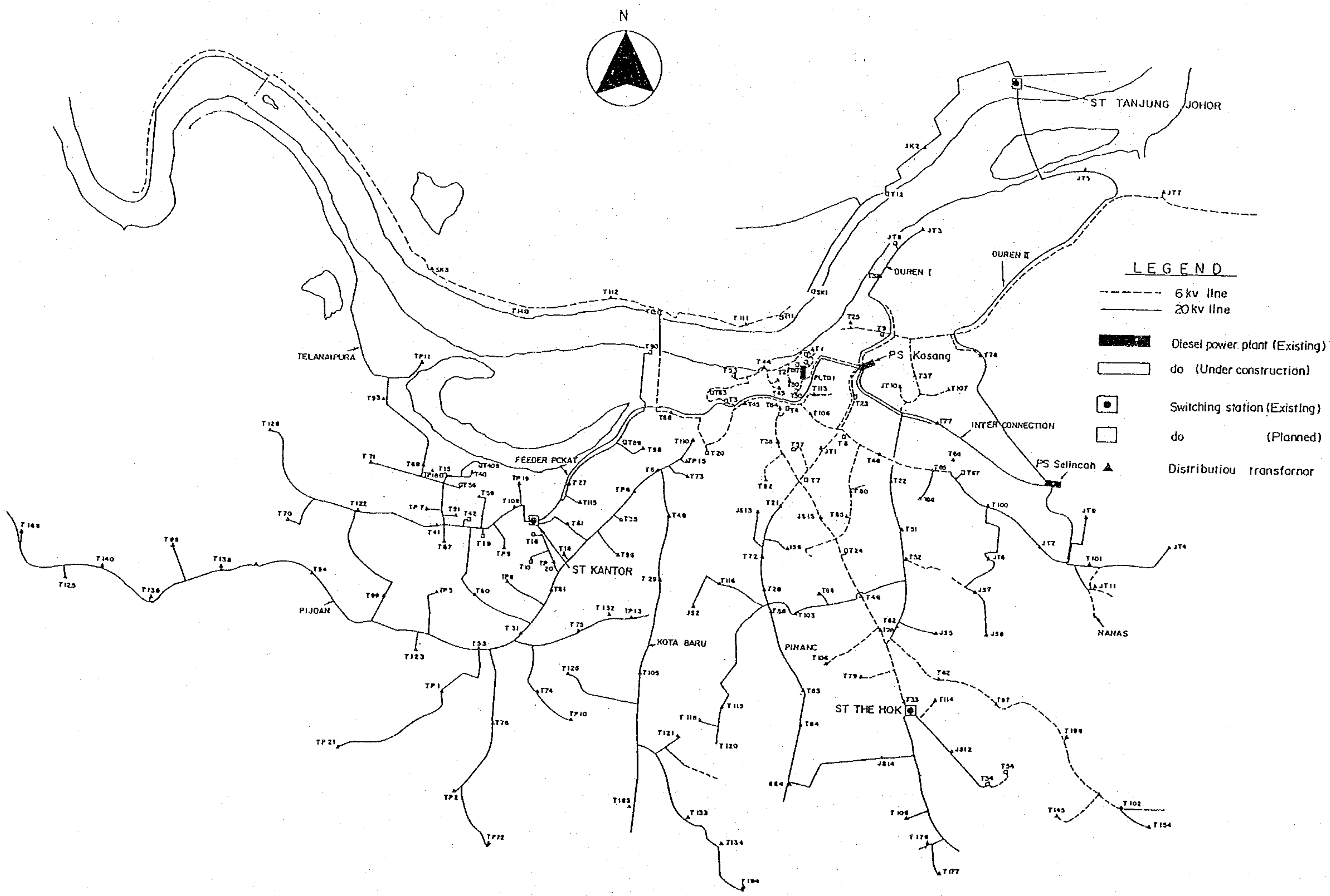


Figure A-2 Distribution System in Jambi City Area

SCALE 1:46,000



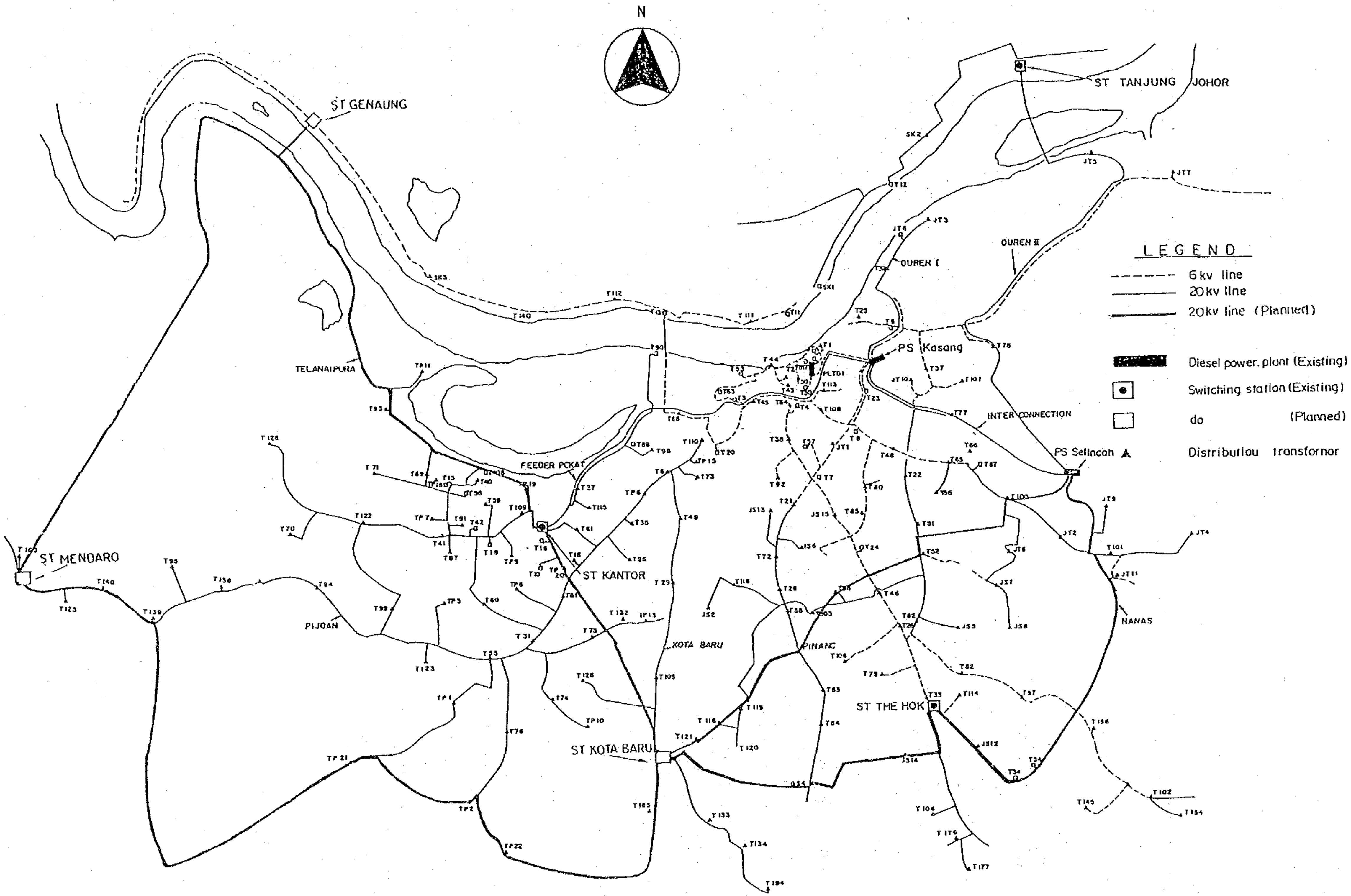
The power plants are interconnected with each other through the lines so as to be put into parallel operation. PLTD Kasang and PLTD Payo Selincah are also interconnected with three switching stations, ST Kantor, ST The Hok and ST Tanjung Johor, through tie lines, in order to transmit power directly from the power sources to the 20 kV and 6 kV distribution networks.

According to the PLN plan, three switching stations will be installed at Kota Baru, Mendalo and Behnuno, and these will be interconnected with the existing switching stations through the lines as shown in Figure A-3. The plan is to connect all these switching stations through a loop line, so that power may be transmitted through the sound tie lines in the event that a fault occurred in any tie line. Figure A-4 shows one-line diagram of the existing loop, running through PLTD Payo Selincah, PLTD Kasang, and three switching stations.
Figure A-5 shows one-line diagram of the proposed loop, running through two power plants and six switching stations. The completion of this expanded loop will make it possible to reduce, to a large extent, occurrences of forced power interruptions, thereby increase reliability of the service.

It is the intent of PLN to implement this plan at an earliest possible time as it is to provide for the expected increase in load due to the completion of PLTD Payo Selincah. It is, therefore, very likely that the plan will be completed by the time this Project has been commenced.

Figure A-3 PLN Reinforcement Plan of Distribution System in Jambi City Area

SCALE 1: 46,000



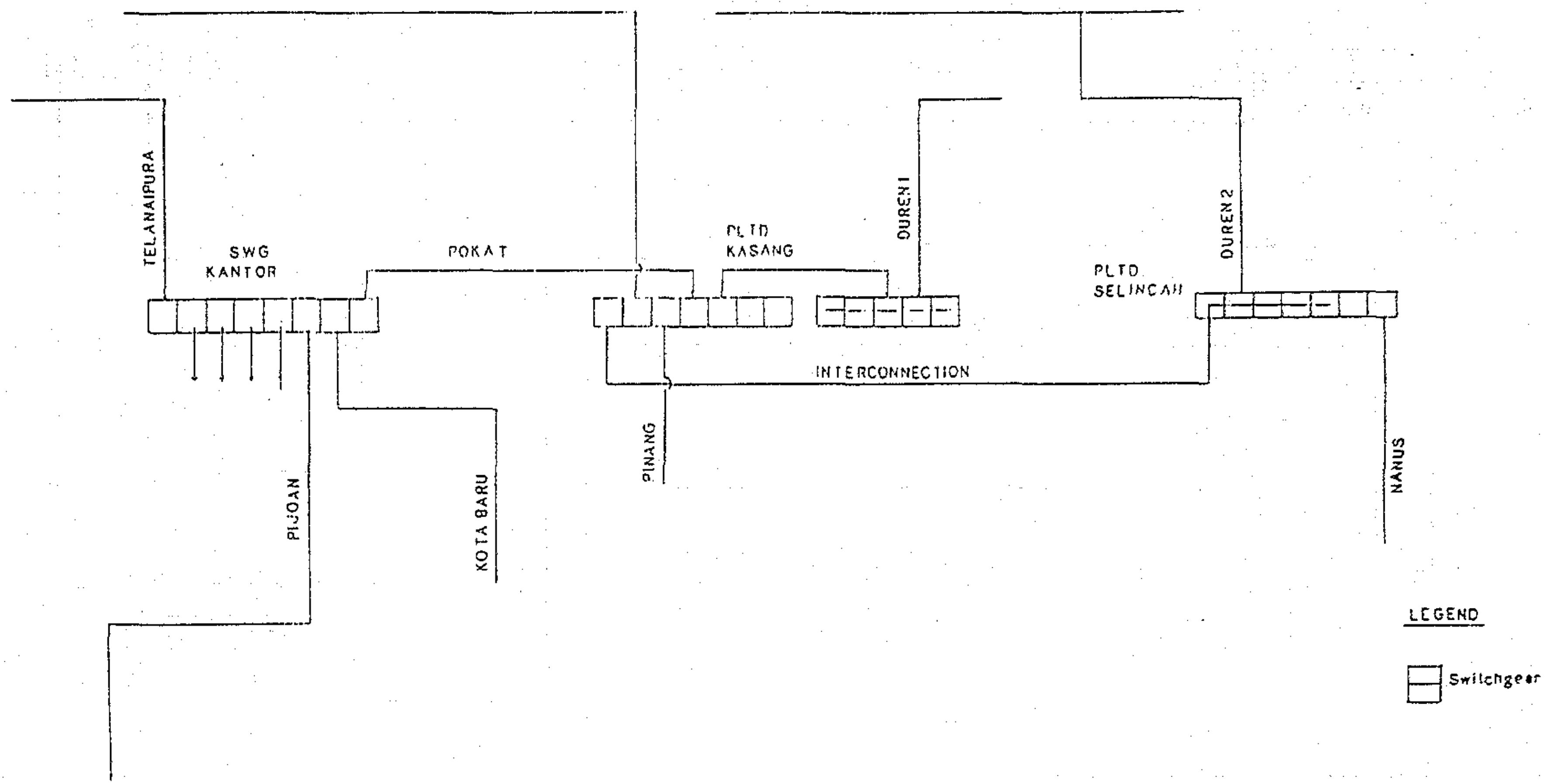


Figure A-4 One-Line Diagram of the Existing Distribution System in Jambi City Area

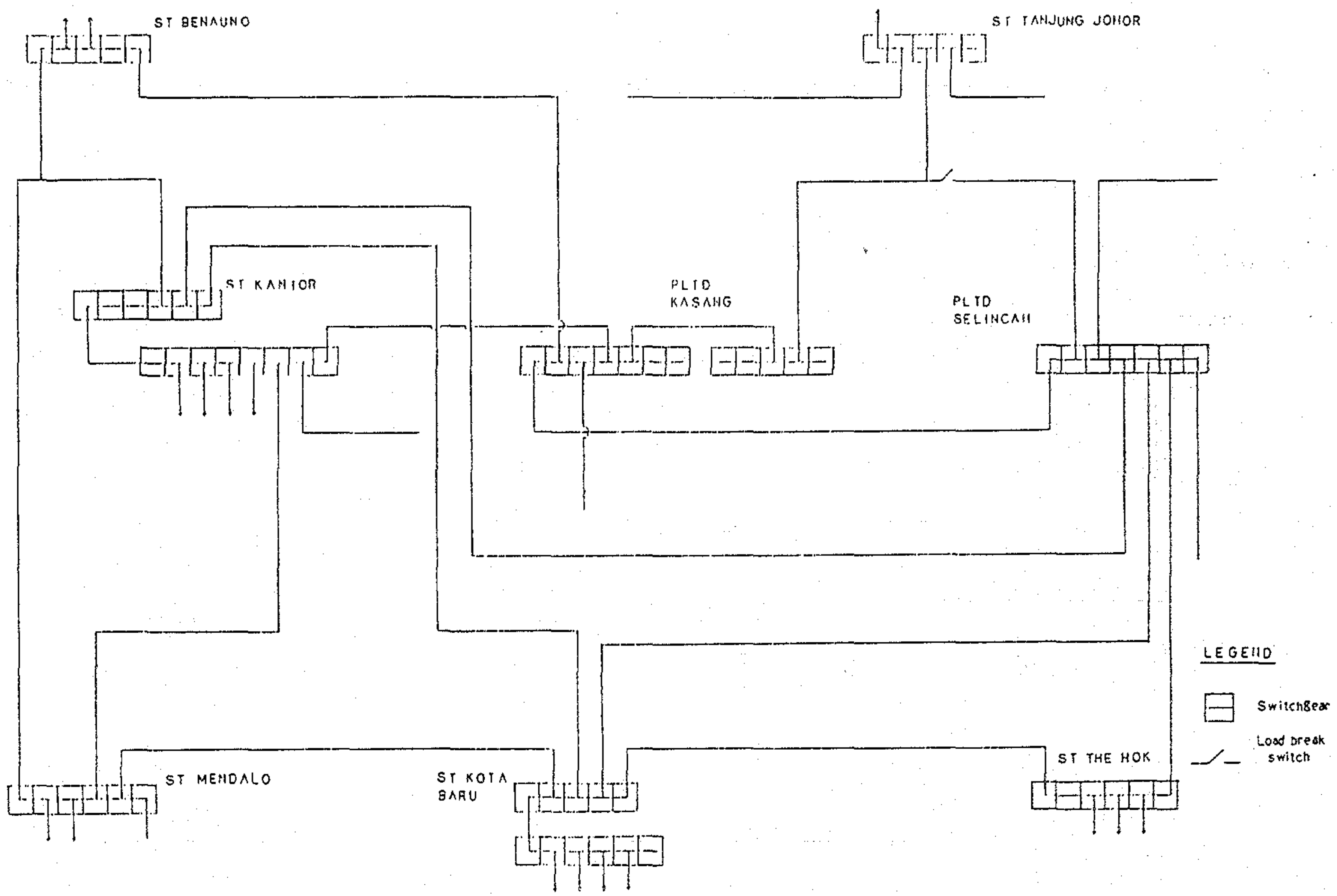


Figure A-5 One-Line Diagram of PLN Distribution System Reinforcement Plan in Jambi City Area

APPENDIX - 4 : LPG RECOVERY FROM HIGH PRESSURE SEPARATOR GAS

In general, LPG recovery means LPG recovery from a gas, not from a condensate, separated in a gas/oil separation plant. Therefore, in this section, an outline of LPG recovery processes from gas is described for a reference purpose. In addition, the LPG production costs of these two methods are compared assuming being applied to this project.

1. Outline of LPG recovery process from gas

When LPG is recovered from a natural gas, it needs an NGL recovery section, separating heavy components from the natural gas by means of liquefaction, and an LPG distillation section, separating LPG from NGL, as shown in Figure A-6. LPG recovery processes are classified by the processes used for NGL recovery.

There are three major LPG recovery processes now being used as listed below.

. Isentropic expansion process
. Absorption process
. Combination of external refrigeration process and isenthalpic expansion process

The characteristics of each process is briefly explained hereunder.

(1) Isentropic expansion process

A process flow diagram of this process is shown in Figure A-7. This process converts pressure energy of the feed gas into motive energy quite efficiently using a special equipment called turboexpander. At the same time, the temperature of the feed gas lowers automatically with expanding through the turboexpander. By using this self-cooling effect, heavy components contained in the natural gas are liquefied and separated. The generated motive energy is used for compression of the lean gas comprising of light components.

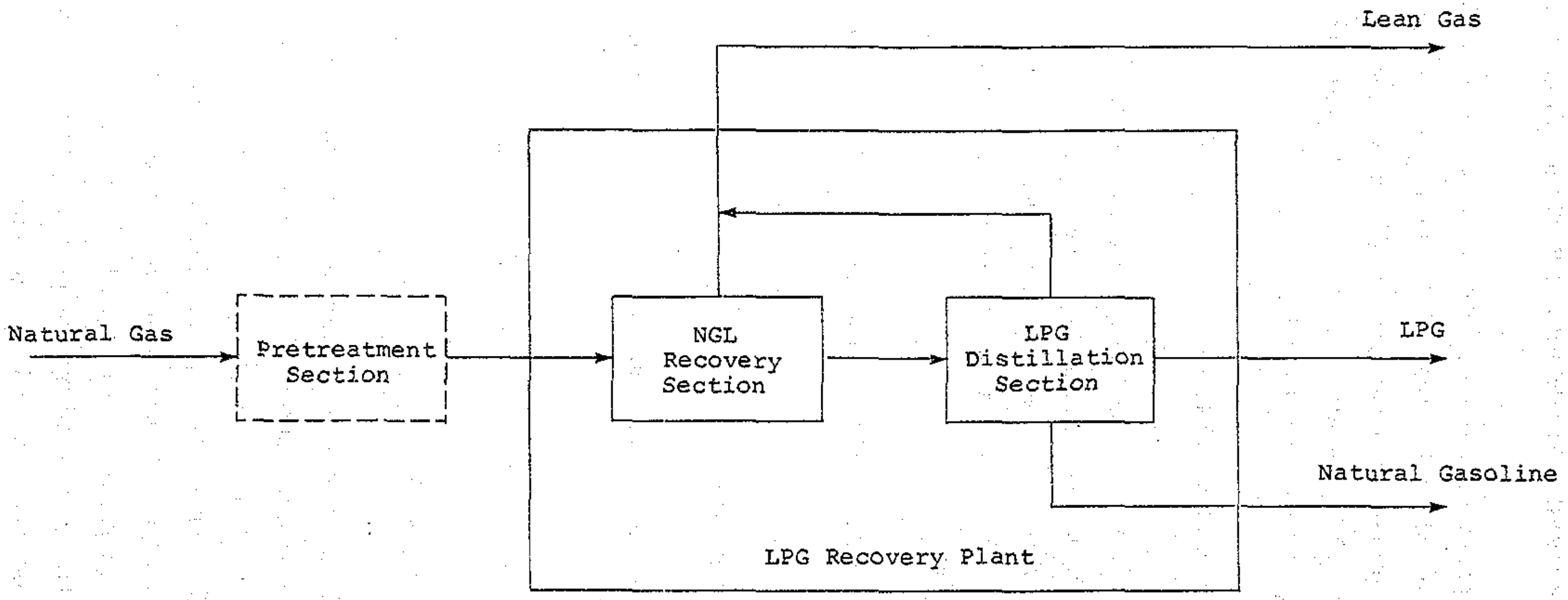


Figure A-6 Process Configuration of a Typical LPG Recovery Plant

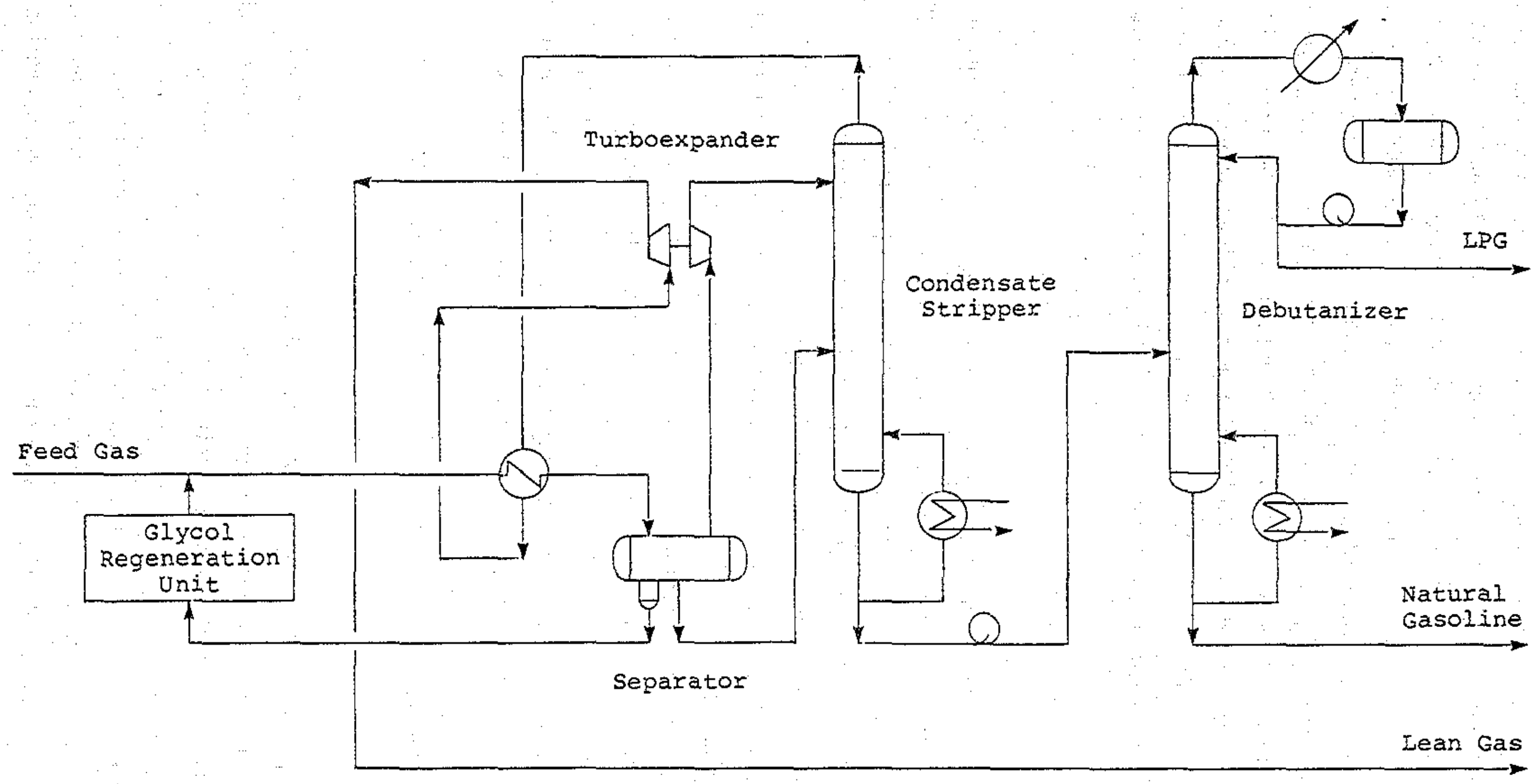


Figure A-7 Process Flow Diagram of Isentropic Expansion Process

A deep low temperature is efficiently generated and usable power is produced as a by-product, that is an outstanding point of this process. If the feed pressure is high enough, a low temperature of -60°C can be generated, which makes it possible to liquefy and separate not only LPG but also ethane. On the contrary, water and CO_2 shall be almost completely removed providing pretreatment facilities to prevent damages of equipment to be caused by dry ice and ice formation. Further, it requires high operation and maintenance skills to maintain the plant in high efficiency condition against anticipated variations of feed pressure and composition.

(2) Absorption process

Figure A-8 shows a process flow diagram of absorption process. This process uses a heavy hydrocarbon liquid such as heavy naphtha or kerosene as a solvent and absorbs C_3 and heavier components contained in the natural gas. However, since a small portion of solvent is entrained in the lean gas, a dew point control facility is required for removal of the solvent in order to transmit the lean gas through pipeline.

This process requires a fairly large size plant, because a large quantity of solvent is circulated through the whole system. Therefore, in case of small scale plant, this process is not economical.

Recently, an external refrigeration unit tends to be applied to cool the solvent aiming at reduction of solvent circulation rate.

(3) Combination of external refrigeration process and isenthalpic expansion process

A process flow diagram of this process is shown in Figure A-9. An isenthalpic expansion process cools the feed gas using self-cooling effect generated by adiabatic expansion of the feed gas through an expansion valve. However, since the self-cooling effect of isenthalpic expansion is lower than that of isentropic expansion, it is usually difficult to recover a required amount of LPG by using only isenthalpic expansion process. Therefore an external refrigeration unit is

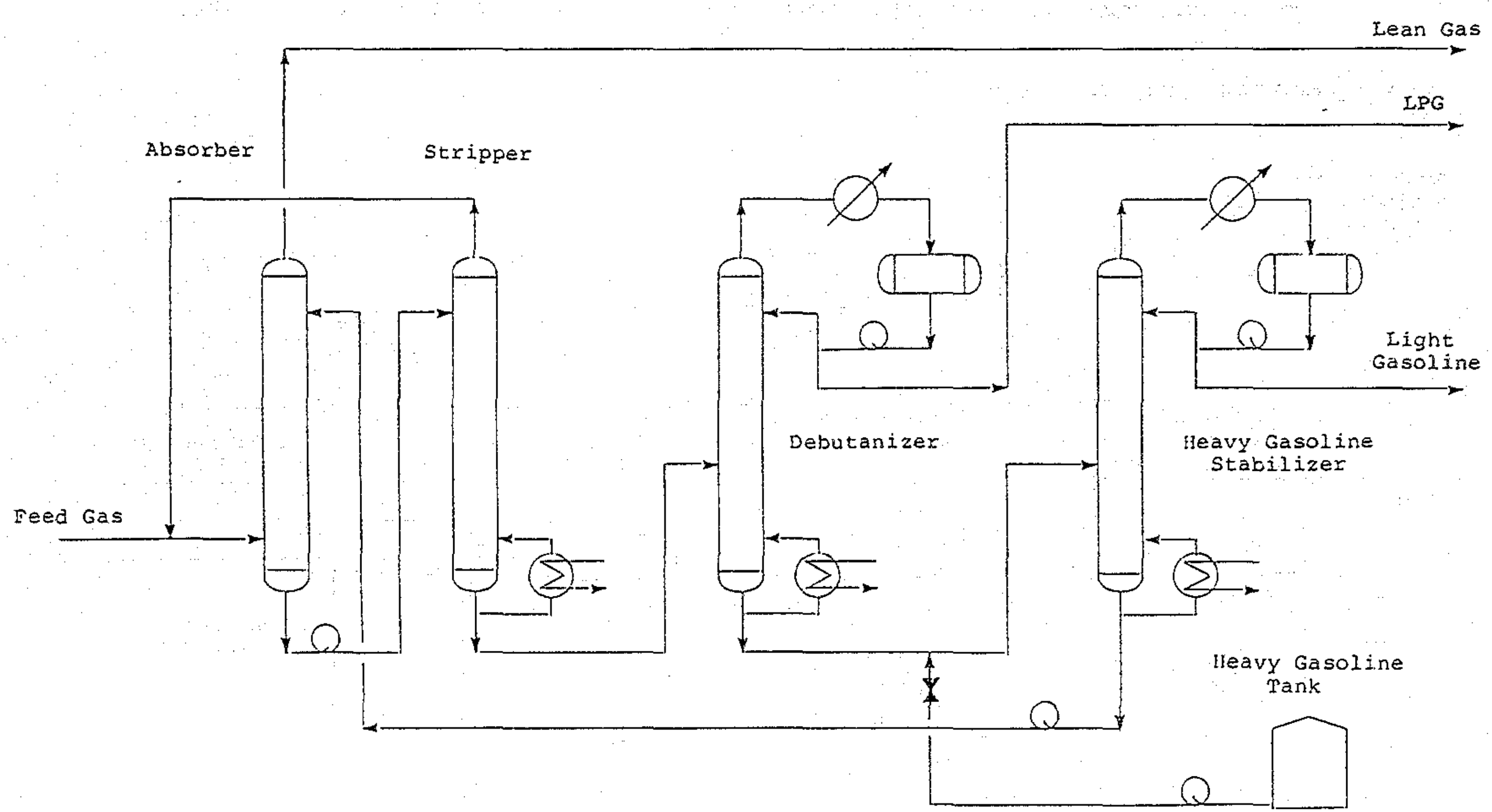
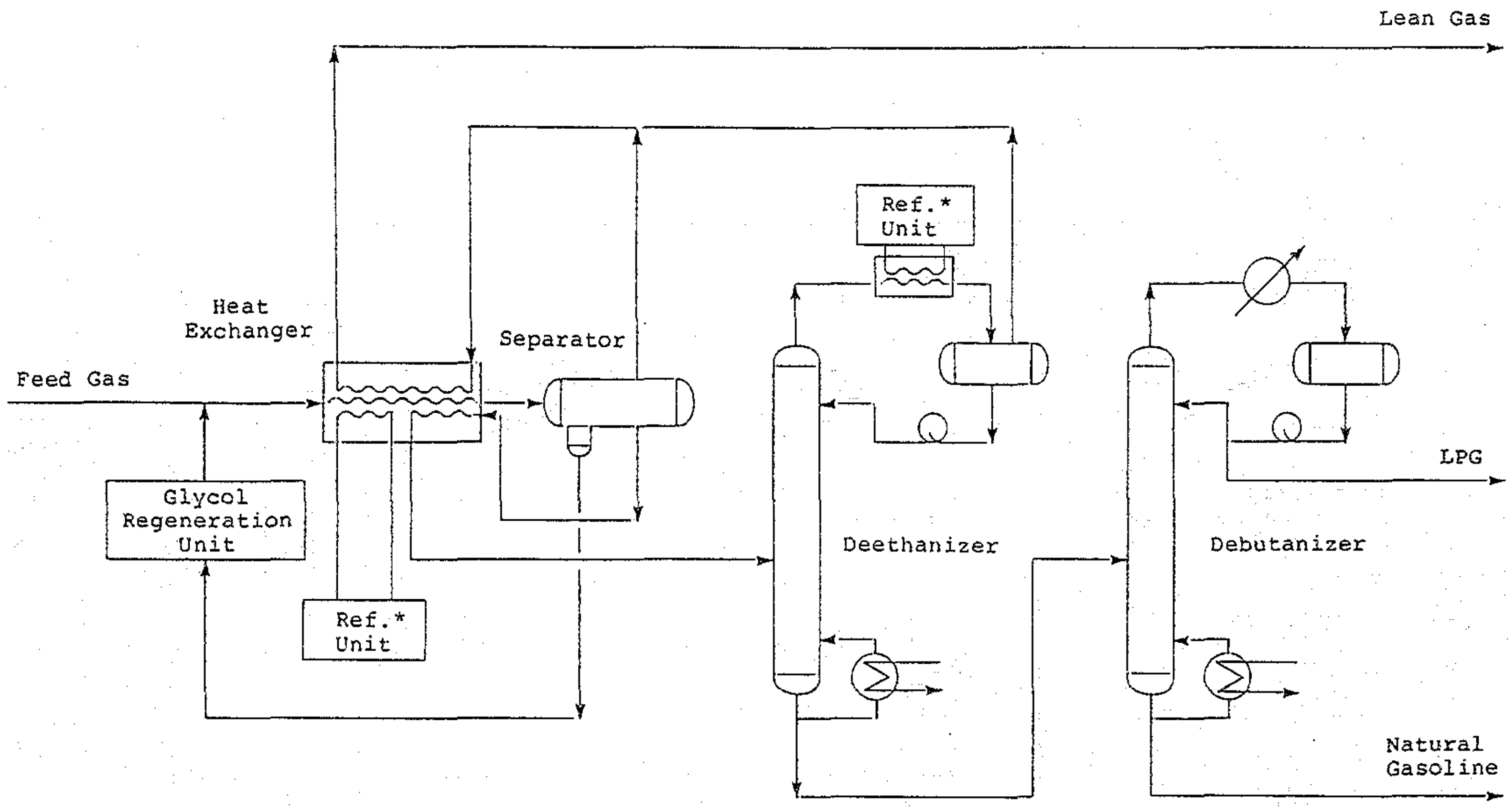


Figure A-8 Process Flow Diagram of Absorption Process



Note: Ref. Unit = Refrigeration Unit

Figure A-9 Process Flow Diagram of External Refrigeration + Isenthalpic Expansion Process

required to cool the feed gas down to the required level combined with an isenthalpic expansion process.
The application of this process is limited when the LPG recovery ratio is not so high, because it is impossible to generate a deep low temperature by using this process.

2. Optimum process for the project

In this section, selection of optimum process for LPG recovery from the high pressure separator gas is described.
Premises for the selection are set as follows in order to compare with LPG recovery process from gas.

Feedstock
: High Pressure Separator Gas

Feed rate and composition
: Refer to Table 8-3

Feed pressure
: 25 kg/cm^2G

Outlet pressure
: 16 kg/cm^2G

Plant capacity
: maximum 10.8 t/d
normal 9.0 t/d

The comparison of characteristics of the three processes is summarized in Table A-1.
The feature of the feedstock is a high content of LPG fraction. If 30% of LPG is recovered from the feedstock, it meets the target production rate.

Table A-1 Comparison of LPG Recovery Process

	Construction Cost	Operation Cost	Recovery Ratio	Operation Flexibility	Maintenance	Pretreatment	After-treatment
Isentropic Expansion Process	Low	Low	High	Low	Strict	Strict Dehydration + CO_2 Removal	None
Absorption Process	High	High	Low	High	Easy	None	Dew Point Control for Lean Gas
External Re-frigeration + Isenthalpic Expansion Process	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate Dehydration	None

Considering the above premises, application of each process is examined hereunder.

(1) Isentropic expansion process

This is the most popular process now being used, since it has merits of lower investment and operation costs and higher LPG recovery ratio over other processes. However, in case of applying to this project, the pressure difference between inlet and outlet of the plant is not sufficient to produce 10.8 t/d of LPG. Accordingly, a supplementary external refrigeration unit is to be installed. In addition, as the amount of Sengeti gas reserve is not so large, the natural gas supply pressure is estimated to decline along with time, at the same time the self-cooling effect will also decline resulting in reduction of LPG recovery rate. Therefore, to maintain the planned LPG production rate, the supplementary refrigeration unit shall have a large excess capacity. As a result, the investment cost for this project will become higher than usual.

(2) Absorption process

As this process is usually applied to a large scale LPG plant of 200 - 300 t/d, it is not economical when applied to a small plant of 10 t/d.

(3) Combination of external refrigeration process and isenthalpic expansion process

When producing 10 t/d of LPG from the high pressure separator gas, it is required to cool the feed stream down to -5°C in order to liquefy and separate LPG fraction. In general, the lowest temperature achieved economically by using this process is 0 - -20°C so this process seems applicable to the project in view of the required temperature level.