First Phase Construction : Construction of the power house and procurement of the DEG and distribution equipment and materials to supply electricity to the central area of the island and such public facilities as health centres, schools, etc., on Hulhudhoo/Meedhoo Island.

Second Phase Construction : Procurement of distribution equipment and materials to supply electricity to ordinary households on Hulhudhoo/Meedhoo Island and procurement of distribution equipment and materials to supply electricity to all users on Hithadhoo Island.

2-3-2 Basic Design

(1) Overall Design

1) Design Conditions

Having examined the various conditions and principles for the basic design, it was decided to adopt the following design conditions.

① Climatic and Site Conditions

a) Outdoor Air Temperature : maximum 34.1°C (the maximum design temperature for air-conditioning: 32°C)
b) Diesel Generator Room : maximum 40°C (indoor)
c) Relative Humidity : average 95%
d) Average Annual Rainfall : approximately 2,000 mm
monthly average approximately 160 mm/month
daily maximum 176 mm/day
hourly maximum 10 mm/hour
e) Wind Velocity : maximum 115 km/hour (31.9 m/s)
f) Earthquakes : not considered
g) Salt Damage Prevention : generators and other machinery to be installed indoors; distribution cables to be buried underground
h) Noise : to be applied to Japanese Regulations
i) Dust Prevention : not considered
j) Bearing Strength : 10 tons/m^2 (assumed)
k) Frequency of Thunderstorm: Average 34 times/year

2) Applicable Codes and Standards

The following standards will be referred to in the design of the project contents.

① Japanese Industrial Standards (JIS)
② Standards of the Japanese Electrotechnical Committee (JEC)
③ Standards of the Japan Electrical Manufacturers' Association (JEM)
④ Japanese Electrotechnical Codes (JEAC)
⑤ Japanese Cable Makers Association Standards (JCS)
⑥ Technical Standards for Electrical Installations in Japan
⑦ International Electrotechnical Commission (IEC)
⑧ International Organization for Standardization (ISO)
⑨ British Standards (BS)

3) Layout Plan

① Generation Facilities (Hulhudhoo/Meedhoo Island)

The generation facilities shall be located taking into consideration of the following matters:

a) Location will be in a central a position as possible to the demand area to minimize transmission loss.
b) The diesel engines will be located as far as possible from existing houses and public facility to minimise noise disturbance.
c) To facilitate future expansions of the facility to cope with demand increases, space for one diesel generator within the power station building and a site for additional fuel tanks will be secured.
d) Sufficient space will be available inside the power station building to facilitate maintenance of the diesel generators.

② Distribution Equipment (Hulhudhoo/Meedhoo Island and Hithadhoo Island)

a) The distribution substations will be located in the most suitable location to minimize the voltage drop.
b) Low voltage distribution panels shall be located considering ease of maintenance and so that the maximum cable length to each residence is less than 80 meters.

(2) Outline of the Basic Plan

Based on the Design Principles (see 2-3-1) of the Plan, the outline of the Basic Plan is as in Table 2-3-1.

Table 2-3-1 Outline of Basic Plan

(1/2)

Project Phase		First Phase Construction	Second Phase Construction	
Project Site		Hulhudhoo/Meedhoo Island (Seenu Atoll)	Hulhudhoo/Meedhoo Island (Seenu Atoll)	Hithadhoo Island (Seenu Atoll)
Power Station Construction	Building Structure	• Power house building (247.5 m^2) • Foundation work for generator, fuel tanks, and auxiliary equipment • Rainwater tanks and well • Roads and street lighting within facility • Incidental facilities	—	Scope of work to be undertaken by the Maldive side (taking over and operation of existing generation facilities by MEB)
	Generator Construction	• Procurement and installation of Diesel engine generators (3 units of 165kW, one of which is a stand-by) • Procurement and installation of the following equipment necessary for the facility - fuel supply system (including tank) - air supply and ventilation system - piping • Procurement and installation of the following electrical equipment necessary for the facility - remote control panel - local control panel - DC power supply system - distribution panel - step-up transformer (415V/11kV) - 11kV distribution panel - distribution system and grounding • Procurement and installation of workshop equipment • Procurement of spare parts for generator and auxiliary equipment and tools for inspections • Procurement of manuals for operation of the generation facility, inspections and repairs, and implementation of OJT		

(2/2)

Project Phase	First Phase Construction	Second Phase Construction	
Target Island	Hulhudhoo/Meedhoo Island (Seenu Atoll)	Hulhudhoo/Meedhoo Island (Seenu Atoll)	Hithadhoo Island (Seenu Atoll)
Procurement of Distribution Equipment	• The distribution following equipment necessary for distribution to household in the central area and public facilities - distribution substations [high voltage fuse box, transformers (11kV/415V/240V), low voltage distribution board] - high voltage (11kV) distribution cable (approx. 5,000m) - low voltage (600V) main distribution cable (approx. 7,000m) - low voltage (600V) branch cable (approx. 24,000m) - outdoor distribution panel - grounding equipment - maintenance equipment for distribution line • VHF communication station • Manuals for installation of electrical equipment and inspection and repair manuals	• The following distribution equipment necessary for distribution to household - low voltage (600V) main distribution cable (approx. 11,000m) - low voltage (600V) branch cable (approx. 43,000m) - outdoor distribution panel - street lighting facility (150 sets)	• Following distribution equipment for the island in general - distribution substations [high voltage fuse box, transformers (11kV/415V/240V), low voltage distribution board] - high voltage (11kV) distribution cable (approx. 5,000m) - low voltage (600V) main distribution cable (approx. 28,000m) - low voltage (600V) branch cable (approx. 113,000m) - outdoor distribution panel - street lighting facility (150 sets) - grounding equipment - maintenance equipment for distribution line • VHF communication station • Manuals for installation of electrical equipment and inspection and repair manuals

(3) Contents of Construction Plans (Hulhudhoo/Meedhoo Island)

1) Plan Contents

This plan aims at constructing the following facilities at the power station on Hulhudhoo/Meedhoo Island.

- Power house building	1 building	one floor, total floor area of 247.5 m^2
- Foundation work	1 set	including oil tank foundation
- Rainwater tank (drinking water)	1 set	5.0m^2 × 2 tanks (useful storage capacity)
- well (multi-purpose)	1 set	depth: 5m, diameter: 60cm
- septic tank	1 set	

2) Layout

The layout of the planned power station is as set in basic design drawings [see 2-3-2-(4)]. Regarding the layout, consideration should be given to the points previously mentioned in section 2-3-2-(1)-3.

3) The plan (main details are as follows) maximizes the facility's function as a power plant.

① Power house building

Table 2-3-2 Power House Building Floor Area

	Room	Floor Area (m^2)	Building Facilities
1	DEG Room	117.0	lighting, ventilation
2	Control Room	49.5	lighting, air-conditioning
3	Battery Room	9.0	lighting, ventilation
4	Engineer Room	24.0	lighting, air-conditioning
5	Entrance Hall	6.0	lighting
6	Toilet	3.0	lighting, ventilation, sanitation
7	Warehouse	18.0	lighting, air-conditioning
8	Workshop	18.0	lighting, ventilation
9	Kitchenette	3.0	lighting, ventilation, sanitation
Total		247.5 m^2	

② Building Facilities Plan

The specifications for the major facilities to be constructed are as in Table 2-3-3.

a) Rainwater collection and supply system (Drinking Water System)

Rainwater for use as drinking water and cooling water will be collected from the roof of the power house building and be stored in ground tanks ($5m^3$ × 2 tanks, capacity as defined as Maldive regulations). It will be pumped to an elevated tank and be supplied from the elevated tank.

b) Well water system

A well will be dug within the compounds for water for various uses (toilets, sprinklers, cleaning of the battery room, etc.). The water will

be pumped to an elevated tank where it will be distributed to the toilets in the office building, power station building, etc.

c) Fire-Fighting Facilities

An ABC fire extinguisher (3kg type) will be provided in each room, except the toilet and corridors, and 4 sets of the fire extinguisher will be provided in the generator room. One halogen fire extinguisher will be provided in the control room.

③ Foundations

Foundations and pits for cables and pipes will be constructed for the diesel engine generators, auxiliary equipment, electrical installations and oil tanks, etc.

Table 2-3-3 General Specifications for Main Building Facilities

Main facilities	No. of units	General specifications
(1) Drinking water system		
1) Collection tank	2 tanks	Type : outdoor tank (concrete) Capacity : 5m^3
2) Supply system	1 system	Type : pump, outdoor installation (2 pumps with control panels) Capacity : 20l/min (14mWG)
3) Elevated tank	1 tank	Capacity : 1m^3
(2) Well water system		
1) Collection tank	1 tank	Type : outdoor tank (concrete) Capacity : 10m^3
2) Supply system	1 system	Type : pump, outdoor installation (2 pumps with control panels) Capacity : 20l/min (14mWG)
3) Well pump	1 system	Underwater pump (1 pump with control panel)
4) Elevated tank	1 tank	Capacity : 1m^3
5) Well		Depth : 5m Diameter : 60cm

(4) Details of Power Station Construction Plan (Hulhudhoo/Meedhoo Island)

The general specifications of each generation facility is as in Table 2-3-8.

1) Basic Items

① Generation Method

A diesel generator was selected on the basis of ease of operation and maintenance and in consideration of similar existing facilities in the Maldives.

② Fuel

The composition of the diesel oil currently imported from Singapore and used by the Male Power Station is shown in Table 2-3-4. The same diesel oil will be used for the new power stations.

Table 2-3-4 Composition of Fuel (Diesel Oil) Used by Male Power Station

Item	Unit	Value
Specific Gravity (60℉)	-	0.82 - 0.89
Kinematic Viscosity (40℃)	Stokes (cst)	1.80 - 5.00
Pour Point	℃	9
Flash Point	℃	60
Sulphur Content	wt%	1.0
Water Content	Vol.g	0.05
Ash Content	wt.g	0.01
Calorific Value	kJ/kg	42,700

(Source: MEB)

③ Lubricant Oil

The use of lubricant oil of the API-class, service CD-class and SAE No. 30~40 is recommended.

④ Cooling Water

Since ground water from wells contains salt, rainwater will be used as in the case of the existing power stations.

2) Plan Components

① Engine Output and Generator Capacity

The rated output for the generators to be provided in the Project was calculated by adding the predicted demand in the year 2000, 292kW, to

the internal load and demand of the power station (approximately 38kW) and dividing this amount, 330kW by two, the number of generators to be continually in operation, arriving at 165kW per generator. Resultingly, the engine output and rated output for the generators was calculated as follows. The values indicated below should be used for rough guidance only as the specification slightly varies from one manufacturer to another.

– Engine Output

$$Pe \geqq \frac{P}{0.7355 \times \eta_G} = 250PS$$

Pe : engine output (PS: Metric System horse-power)
P : generator output (165kW)
η_G : generator efficiency (90%)

– Generator Capacity

$$P_G = \frac{P}{Pf} = 200kVA$$

P_G : generator capacity (kVA)
P : generator output (165kW)
Pf : generator power factor: 0.8

As the high voltage distribution method will be used in the Project, it is necessary to determine the charging current of the high voltage equipment when determining the output of the generators. The charging current of the high voltage equipment in the Project is approximately 76kVA, and the generator must be able to accommodate this capacity. However, generators generally start to increase their generation voltage at about 40% of the rated output. Also considering the extension of high voltage distribution lines in the future, the Project will set the generator capacity at 285kVA as follows.

76kVA ÷ 0.4 × 1.5 = 285kVA
(charging capacity) (margin for future charging current increase)

Table 2-3-5 Generator Capacity

Item	Hulhudhoo/Meedhoo Island
Engine Output Pe (PS)	250
Generator Capacity P_G (kVA)	285

② Mechanical Systems

a) Fuel Supply System

An outdoor diesel oil storage tank will be installed for power station and the capacity is determined based on the following two conditions.

- Tank Capacity

  The arrival of oil supply ships may not be regular due to the difficulties of maritime transportation caused by the prevailing strong seasonal southwest wind from May to July. The storage of at least one months (30 days) supply of fuel for the two continuously operating generators appears necessary.

- Consumption Rate

  The following consumption rate is assumed based on a 100% operation rate of the two generators.

The required tank capacity can be calculated using the following equation.

$$V = \frac{V_1 \times 24 \times 30}{1{,}000} = 75.14k\ell \fallingdotseq 80k\ell$$

V : capacity (kℓ)
V_1 : consumption rate (ℓ/hour), 104.4ℓ/hr

The resulting nominal capacity of the fuel tank is 80kℓ.

A daily tank with a capacity of 1.0 kℓ will be installed indoors to store fuel oil equivalent to 10 hours consumption. Two fuel pumps (one as reserve) will be installed indoors with the capability to fill the daily tank in 25 minutes. Fuel will be pumped from the jetty to the storage tank. Also, due to the possibility of water mixing with the oil, a de-oiler will be installed at the outlet of the fuel pump.

b) Lubricant Oil Supply System

This system is integral to the diesel engine body and oil will be manually replenished.

c) Water Cooling System

This system is also integral to the diesel engine body and rainwater will be used as the cooling water.

d) Ventilation System

A ventilation system for engine operation and cooling of generating room will be installed in the power station building and exhaust gas from the engines will be discharged outside the building via the silencer.

e) Start-Up System

An electrical start-up system using a DC motor will be used. A DC power unit (24V) for this purpose will also be used for the control source of the power station and will be installed in the Battery Room.

f) Waste Oil Treatment System

In order to prevent the planned generating facilities from causing environmental pollution, a de-oiler will be installed to the diesel oil storage tank to separate oil from water for the manual scooping of oil. The collected sludge and waste oil must be properly treated by the MEB to avoid any environmental pollution caused by their disposal.

g) Piping

With regard to the fuel pipeline to supply fuel to the generators, the indoor section will be laid in a trench for easy maintenance while the outdoor section will be directly buried to make sure the maximum use of available land. All piping will be accompanied by the necessary support and protective measures, such as a jute sheath.

③ Electrical Systems

The main electrical systems of this network are designed as follows.

a) 415V Main Distribution Board

The power station voltage, 415V/240V, is stepped up to 11kV by a step-up transformer for distribution, however, customers in close vicinity of the station will receive electricity directly from power house. The 415V main distribution panel with feeders to the step-up transformer and

neigbouring customers will be located in the control room along with the generator control panel. The 415V distribution feeder will be accompanied by ACB or MCCB, an earth fault relay and a number of instruments, including an ammeter and its change-over switch, and a spare feeder. The feeder to the transformer will have a transformer protection relay.

The rated current for the buses will be the value to be achieved by 4 simultaneously operating generators. When the bus voltage is lost, the MCCB will be automatically tripped by an under-voltage relay. Manual switching of the MCCB will be required to resume normal operation. The buses will have a structure which allows it expansion in the future.

b) Local Control Panel

A local control panel will be installed above each generator to start, stop, control and measure the generating system as well as to start the warning system.

c) Remote Control Panel

All the generating facilities of the planned power stations will be centrally controlled by the remote control panels in the control room. The synchronous operation of the generators will be instructed from the control room.

d) Excitor

A brushless thyristor-type excitor will be installed.

e) DC Power Supply System

A DC power supply system will be installed for the power source of the start-up motors for the diesel engine as well as the circuit breaker and control equipment.

f) Step-up Transformer

An outdoor type transformer will be located outside of the power house building, however, to protect it from the direct rays of the sun and heavy wind and rain, a simple sun-shade will cover it.

g) 11kV Distribution Board

A distribution board for the 11kV lines from the step-up transformer will be located in the control room. The distribution feeder will be equipped with a vacuum circuit breaker or SF6 gas circuit breaker, the necessary voltmeters and change-over switches, and ammeter and change-over switches.

h) Grounding

The following 4 grounding system will be provided.

i) Ground to protect the electricity generating system (direct earth from the neutral point of the generator)
ii) Ground to prevent electric shocks from metal surfaces or electrical equipment
iii) Ground for the fuel tank [to be separated from i) and ii) above]
iv) Ground for lightning rod [to be separated from i), ii) and iii) above]

i) Radio Station for Maintenance Purpose

A VHF radio station will be provided for communication between each power station in Seenu Atoll and daily inspection of the distribution network.

j) Laying of Cable

The main cable connecting the generators and 415V main distribution panel will be without armour and will be laid on a cable tray inside the trench.

(5) Procurement Plan of Distribution Equipment (Hulhudhoo/Meedhoo Island and Hithadhoo Island)

The electricity generated at the planned power station will be distributed to citizens and social welfare and public facilities via the 415V distribution panel or distribution substation. The general specifications of the main distribution equipment are as in Table 2-3-8.

The main design features of the distribution facilities are as follows.

1) Distribution Method

To prevent the total voltage drop from power station or the secondary side of distribution substation to consumer from being more than 7.5% as prescribed in the MEB standards, in principle the following distribution method will be used.

Table 2-3-6 Distribution Method

Type	Area	Distribution Method
Primary distribution	from power station to substation	3 phase 3 wire, 11kV
Secondary distribution	from substation to local distribution panels	3 phase 4 wires, 400V/230V
Tertiary distribution	from local distribution panels to consumers	single phase 2 wires, 230V

Note: Tertiary distribution to public facilities with large loads will be by 3 phase 4 wire, 400V/230V.

As the island subject to electrification in the Project is relatively larger than the island in Phase I Project and, as a result, the length of wiring is also longer, primary distribution will be by high voltage 11kV lines. Therefore, a step-up transformer to raise the power station voltage (415V) to 11kV will be required within the facility compounds, and step-down transformers (11kV to 415V/240V) for distribution will be required in consumer areas.

2) Distribution Substations

Distribution substations which step-down the primary distribution voltage of 11kV to the secondary distribution voltage of 415V/240V as mentioned in 2-3-2-(1)-6 will be located within the compounds of public facilities. The distribution substations will be composed of a 11kV fuse box, a 11kV to 415V/240V transformer and a low voltage distribution board all of which will be of the all weather type as they will be installed outside.

3) Main and Branch Cables

a) Load Capacity

The size of the distribution cables will capable of handling loads predicted for the year 2000.

From the load survey, the demand per household in each island slated for electrification for year 1995 are as follows.

Table 2-3-7 Load Demand per Household in the Electrification Islands

Name of island to be electrified	Year 1995	Year 2000
Hulhudhoo/Meedhoo Island	230W/household	370W/household
Hithadhoo Island	240W/household	387W/household

The size of main and branch cables will be determined based on the 370 and 387 W/household, as shown in Table 2-3-7.

b) Voltage Drop

The voltage drop between the main 415V distribution panel or 415V side of the distribution transformer to the consumer will be less than 7.5%, the MEB standard commonly used in U.K. will be used.

c) Cable Specifications

As the trunk line will be directly buried underground, cable with armour will be used.

d) Laying Depth and Location of Cable

The laying depth of all underground cable will be approximately 75cm below the ground surface. Only one side of the roads will be used for the laying of cable as the other side will be required for communication cable. Underground warning tape made of vinyl will be laid in view of the easy recognition of the cable location for future expansion work. (see Fig. 2-3-1)

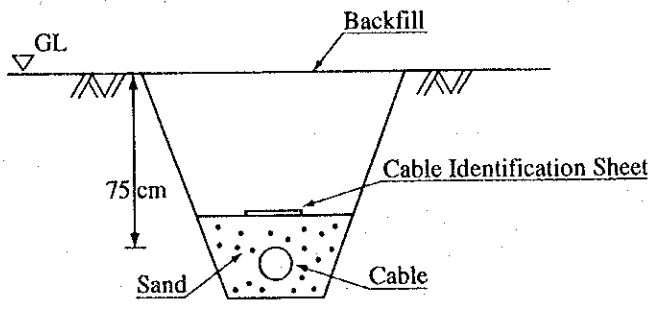


Fig. 2-3-1 Typical Arrangement of Distribution Cable Installation

4) Local Distribution Panels

Local distribution panels will be used to distribute electricity from the trunk line to consumers and one panel will be equipped with 15 branch feeders to serve houses and street lighting (single phase, 2 wire, 240V), one feeder for public buildings (3 phase, 4 wire, 415/240V) and space of 2 feeders for future extensions. The location of each local distribution panel should ensure that the maximum length of the branch cable to users is not more than 80m. These panels will be installed on the walls at the side of roads.

Table 2-3-8 General Specifications of the Main Facilities

1. First Phase Construction

(Hulhudhoo/Meedhoo Island)

Facility	No. to be procured	General Specifications
(1) Diesel Engine Generator (DEG) 1) Diesel Engine	3 engines (including 1 stand-by)	Standard Operation Mode: continuous Output: 250PS Revolutions: under 1,500 rpm Engine Type: 4 cycle diesel engine Cooling Method: radiator-type Fuel: diesel oil (with common base and anti-vibration rubber)
2) Generator	3 generators (including 1 stand-by)	Standard Operation Mode: continuous Rated Output: 285 kVA Phase: 3 phase, 4 wire Rated Voltage: 415/240V Revolutions: under 1,500 rpm Power Factor: 0.8 (lag) Frequency: 50 Hz Coil Connection: Y connection, with neutral line Excitor: brushless thyrister-type
3) Electrical Systems		
① 415V Main Distribution Board	1 lot	With mold case circuit breaker (MCCB)
② Local Control Panel	1 lot	Control panel attached to generator
③ Remote Control Panel	1 lot	Self-stand type, including synchronization system
④ DC Power Supply System	1 lot	Lead acid battery, 24V
⑤ 11kV Distribution Panel	1 lot	self-stand type
⑥ Step-up Transformer	1 unit	415V/11kV, 3 phase 50Hz 400kVA
4) Mechanical Systems		
① Fuel Supply System		
a) Main Oil Storage Tank	1 set	Type : vertical type, for outdoor installation Capacity: 80 kℓ
b) Day Tank	1 set	Type : angular (with supporting bed), for indoor installation Capacity: 1,000 ℓ
c) Oil Transfer Pump	2 sets (including 1 stand-by)	Type : gear pump, for indoor installation Capacity: 40 ℓ/min. (3 kg/cm^2)
d) De-oiler System	1 set	Type : filter element Capacity: 40 ℓ/min.
(2) Spare Parts for Diesel Generator	for 2 years (12,000 hours operation)	Oil filter elements, lubricating oil filter elements, air cleaner elements, O-rings, fuel injector nozzles, etc.
(3) Maintenance Tools for Diesel Generator	1 lot	Spanner with double end type (1 set) 45° double offset wrench (1 set) Hand screw driver (+, -) (1 set) Hexagonbar wrench, w/bar (1 set) Thickness gauge (1 set) Tool box (1 set)

Facility	No. to be procured	General Specifications
		Removing tool for fuel oil injection valve (1 set) Crank deflection gauge (1 unit) Guide piece for piston (1 set) Pressure tester for fuel oil injection valve (1 unit) Lifting tool (portable gantry type with casters, min. lifting capacity: 0.5 ton) (1 unit) Torque wrench for overall purpose (1 set) Horning tool for cylinder liner (1 set)
(4) Repair Equipment for Diesel Generator	1 lot	Bench drilling machine (1 unit) Air compressor (1 unit) Bench grinder (1 unit) Bench vise (1 unit) Arc welder (1 unit) Tool set for mechanic (1 set) Tool set for electrician (1 set) Measuring tools (1 set) Electric hand drill (1 unit) Electric hand grinder (1 unit) Earthing tool (2 sets) Watt-hour meter calibration equipment (1 set)
(5) Distribution System		
1) Distribution Substation	7 sets (including 1 spare)	High voltage fuse box Step-down transformer (11kV/415V/240V, 3 phase 50Hz, 200kVA) Low voltage distribution board
2) Local Distribution Panel	32 sets	With mold case circuit breaker (MCCB), outdoor wall mounted type
3) High Voltage (11kV) Cable (trunk line)	5,050m	11kV cable with armour, 3C 70mm^2
4) Low Voltage (600V) Cable (main line)	1,000m	600V cable with armour, 4C 35mm^2
5) Low Voltage (600V) Cable (main line)	5,970m	600V cable with armour, 4C 25mm^2
6) Low Voltage (600V) Cable (branch line)	670m	600V cable, 4C 6mm^2 (for public facilities)
7) Low Voltage (600V) Cable (branch line)	23,400m	600V cable, 3C 6mm^2 (for household)
8) Grounding Equipment	1 lot	
(6) VHF Communication Station	1 lot	Home base (1 set), walkie-talkies (6 sets) (capable of communications between Site and Gan Islands)
(7) Distribution Line Repair Tools	1 lot	Meggar tester (500V) (1 unit) Circuit tester (1 unit) Phase rotation detector (1 unit) Ground fault locator (1 unit) ELCB tester (1 unit) Clip ammeter (1 unit) DC dielectric insulation tester for 11kV (1 unit) Transformer insulation oil tester (1 unit) Insulation tester for 11kV (1 unit)

2. Second Phase Construction

(Hulhudhoo/Meedhoo Island)

Facility	No. to be procured	General Specifications
(1) Distribution System		
1) Local Distribution Panel	7 sets (including 5 spare)	With mold case circuit breaker (MCCB), outdoor wall mounted type
2) Low Voltage (600V) Cable (main line)	2,750m	600V cable with armour, 4C 35mm^2
3) Low Voltage (600V) Cable (main line)	8,020m	600V cable with armour, 4C 25mm^2
4) Low Voltage (600V) Cable (branch line)	1,960m	600V cable, 4C 6mm^2 (for public facilities)
5) Low Voltage (600V) Cable (branch line)	41,600m	600V cable, 4C 6mm^2 (for household)
6) Street lighting facilities	150 sets	6m pole, 36W Fluorescent lamp

(Hithadoo Island)

Facility	No. to be procured	General Specifications
(1) Distribution System		
1) Distribution Substation	7 sets (including 1 spare)	High voltage fuse box Step-down transformer (11kV/415V/240V, 3 phase 50Hz, 200kVA) Low voltage distribution board
2) Local Distribution Panel	140 sets (including 5 spare)	With mold case circuit breaker (MCCB), outdoor wall mounted type
3) High Voltage (11kV) Cable (trunk line)	5,030m	11kV cable with armour, 3C 70mm^2
4) Low Voltage (600V) Cable (main line)	4,300m	600V cable with armour, 4C 50mm^2
5) Low Voltage (600V) Cable (main line)	7,300m	600V cable with armour, 4C 35mm^2
6) Low Voltage (600V) Cable (main line)	17,200m	600V cable with armour, 4C 25mm^2
7) Low Voltage (600V) Cable (branch line)	5,000m	600V cable, 4C 6mm^2 (for public facilities)
8) Low Voltage (600V) Cable (branch line)	108,500m	600V cable, 3C 6mm^2 (for household)
9) Grounding Equipment	1 lot	
10) Street lighting facilities	150 sets	6m pole, 36W Fluorescent lamp
(2) VHF Communication Station	1 lot	Home base (1 set), walkie-talkies (6 sets) (capable of communications between Site and Gan Islands)

Facility	No. to be procured	General Specifications	
(3) Distribution Line Repair Tools	1 lot	Meggar tester	(1 unit)
		Circuit tester	(1 unit)
		Phase rotation detector	(1 unit)
		Ground fault locator	(1 unit)
		ELCB tester	(1 unit)
		Clip ammeter	(1 unit)
		DC dielectric insulation tester for 11kV	(1 unit)
		Transformer insulation oil tester	(1 unit)
		Insulation tester for 11kV	(1 unit)

(4) Basic Design Drawings

The drawings prepared for the basic design for the planned generating facilities are as follows.

1) Hulhudhoo/Meedhoo Island

Power Station

FM-G01 General Arrangement of the Site
FM-G02 Single Line Diagram for Power Station
FM-G03 Fuel Flow Diagram
FM-G04 Power House Building (Floor Plan)
FM-G05 Power House Building (Section Plan)
FM-G06 Arrangement of Diesel Engine Generator Set

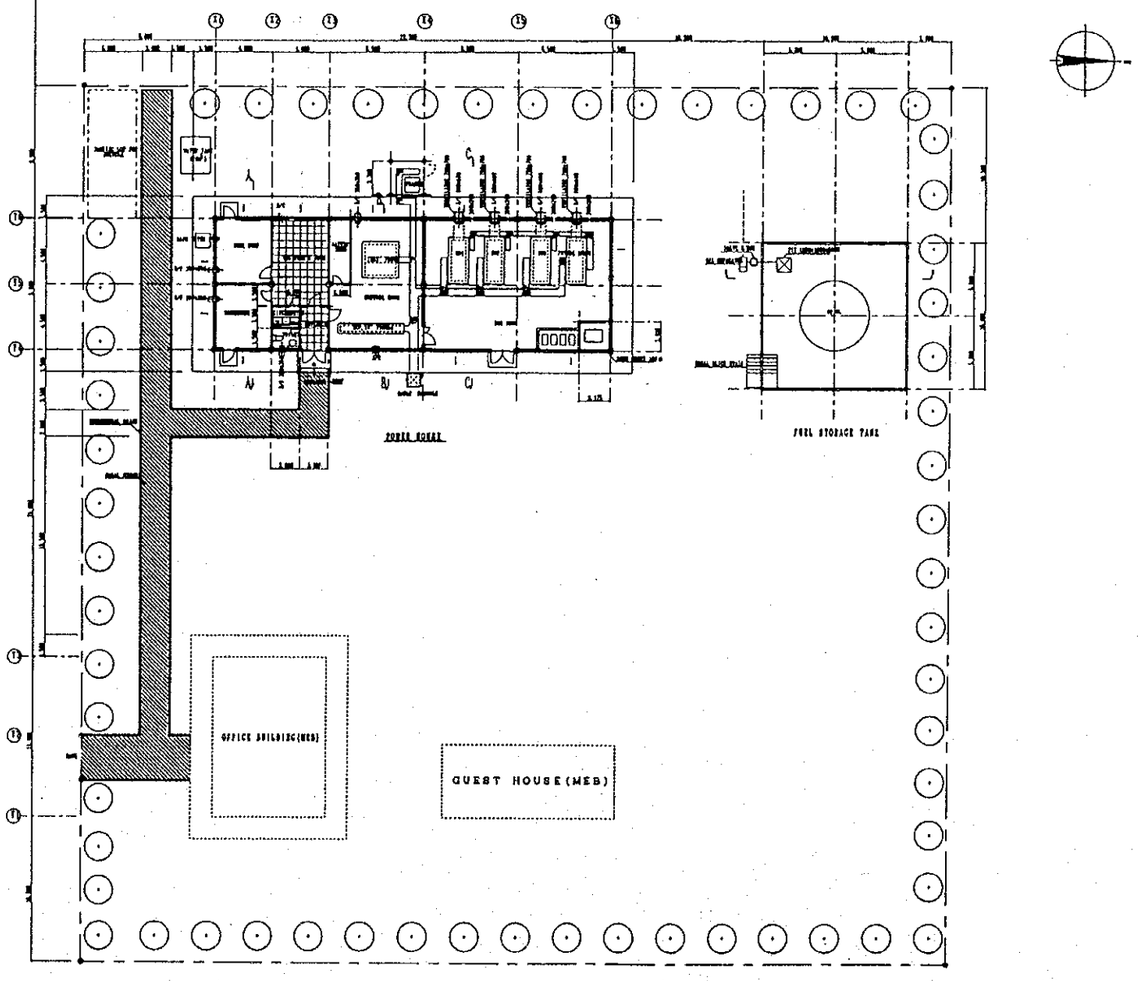
Distribution System

FM-D01 Single Line Diagram for Distribution System
FM-D02 Block Diagram for Distribution System
FM-D03 Cable Route Plan for Distribution System

2) Hithadhoo Island

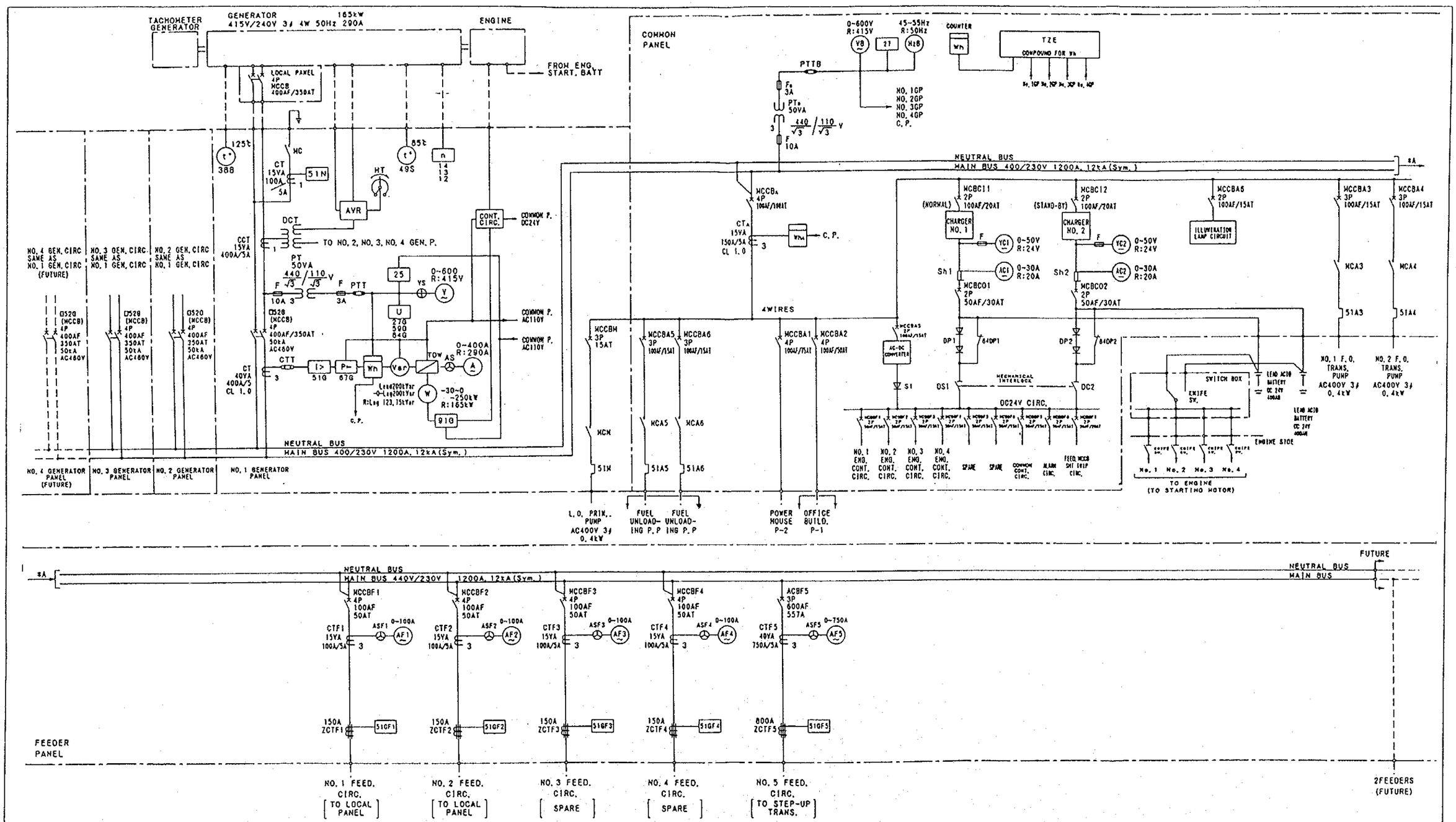
Distribution System

HD-D01 Single Line Diagram for Distribution System
HD-D02 Block Diagram for Distribution System
HD-D03 Cable Route Plan for Distribution System



Hulhudhoo/Meedhoo Island

Drawing No. FM–G01 General Arrangememt of the Site

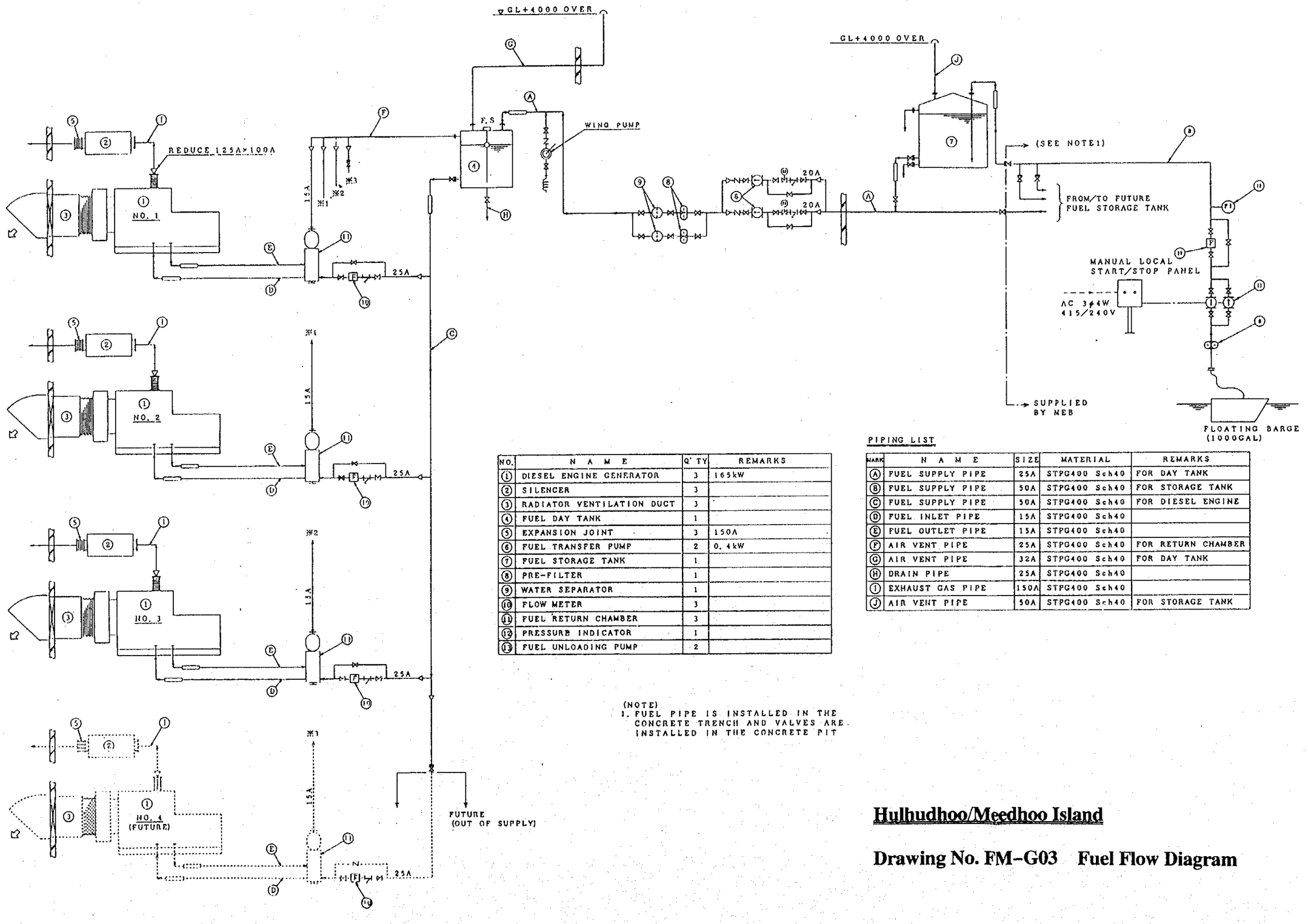


(NOTE)

[SHOWS MEB SUPPLY

Hulhudhoo/Meedhoo Island

Drawing No. FM-G02 Single Line Diagram for Power Station



NO.	NAME	Q'TY	REMARKS
①	DIESEL ENGINE GENERATOR	3	165kW
②	SILENCER	3	
③	RADIATOR VENTILATION DUCT	3	
④	FUEL DAY TANK	1	
⑤	EXPANSION JOINT	3	150A
⑥	FUEL TRANSFER PUMP	2	0.4kW
⑦	FUEL STORAGE TANK	1	
⑧	PRE-FILTER	1	
⑨	WATER SEPARATOR	1	
⑩	FLOW METER	3	
⑪	FUEL RETURN CHAMBER	3	
⑫	PRESSURE INDICATOR	1	
⑬	FUEL UNLOADING PUMP	2	

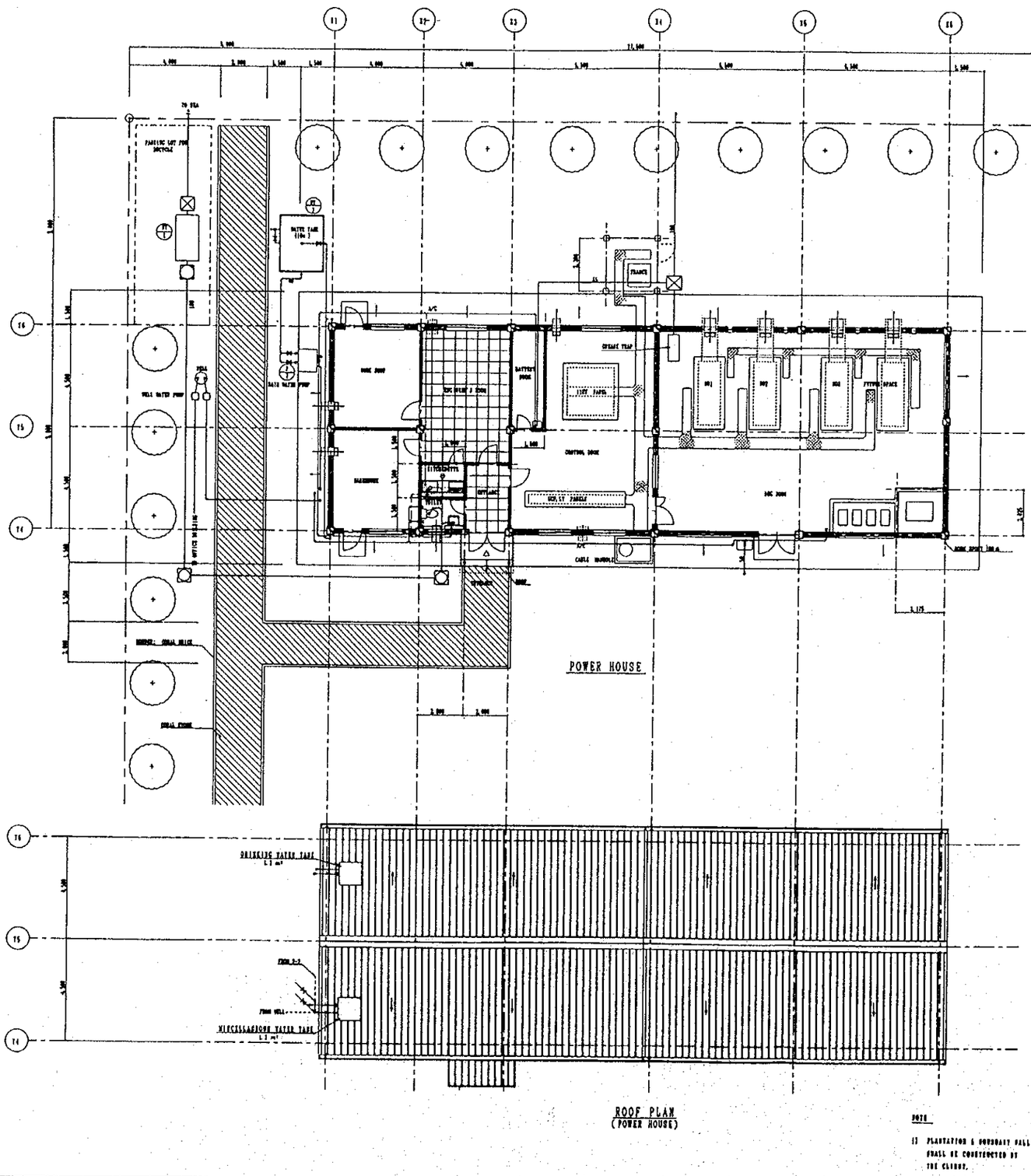
(NOTE)
1. FUEL PIPE IS INSTALLED IN THE CONCRETE TRENCH AND VALVES ARE INSTALLED IN THE CONCRETE PIT

PIPING LIST

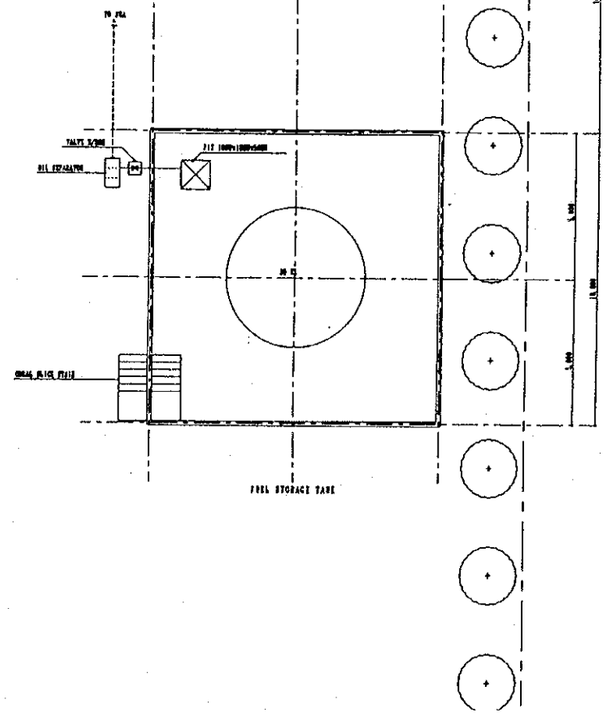
MARK	NAME	SIZE	MATERIAL	REMARKS
Ⓐ	FUEL SUPPLY PIPE	25A	STPG400 Sch40	FOR DAY TANK
Ⓑ	FUEL SUPPLY PIPE	50A	STPG400 Sch40	FOR STORAGE TANK
Ⓒ	FUEL SUPPLY PIPE	50A	STPG400 Sch40	FOR DIESEL ENGINE
Ⓓ	FUEL INLET PIPE	15A	STPG400 Sch40	
Ⓔ	FUEL OUTLET PIPE	15A	STPG400 Sch40	
Ⓕ	AIR VENT PIPE	25A	STPG400 Sch40	FOR RETURN CHAMBER
Ⓖ	AIR VENT PIPE	32A	STPG400 Sch40	FOR DAY TANK
Ⓗ	DRAIN PIPE	25A	STPG400 Sch40	
Ⓘ	EXHAUST GAS PIPE	150A	STPG400 Sch40	
Ⓙ	AIR VENT PIPE	50A	STPG400 Sch40	FOR STORAGE TANK

Hulhudhoo/Meedhoo Island

Drawing No. FM-G03 Fuel Flow Diagram



ROOF PLAN
(POWER HOUSE)

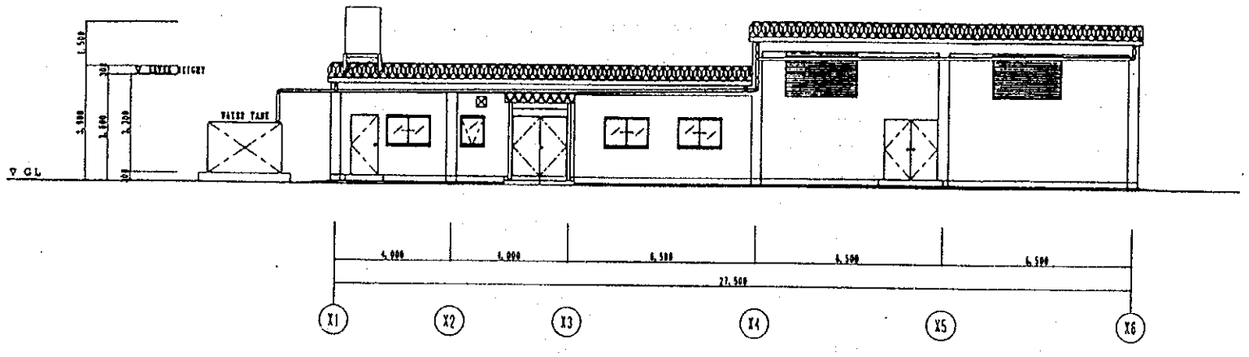


FUEL STORAGE TANK

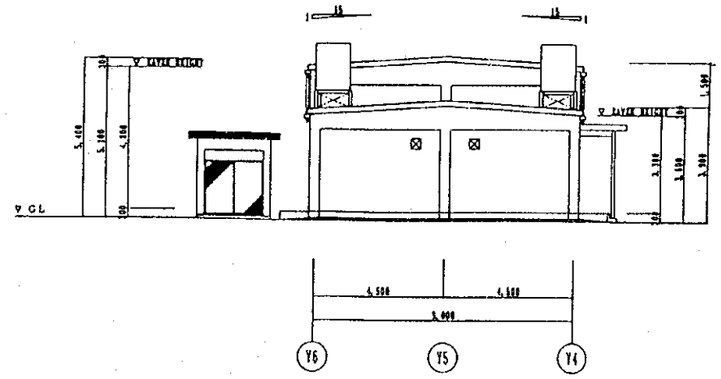
Hulhudhoo/Meedhoo Island

Drawing No. FM–G04

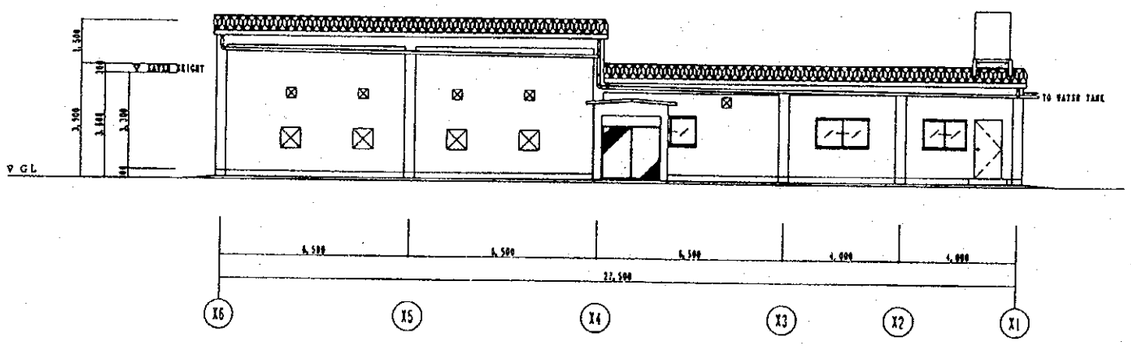
Power House Building (Floor Plan)



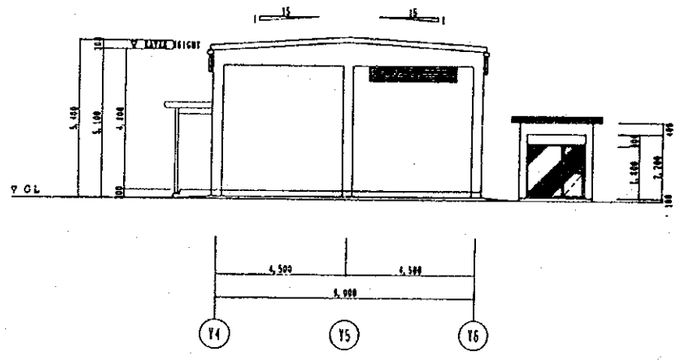
EAST ERECTION S=1/100



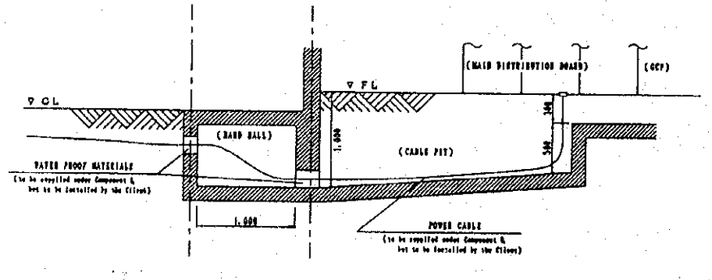
SOUTH ELEVATION S=1/100



WEST ELEVATION S=1/100



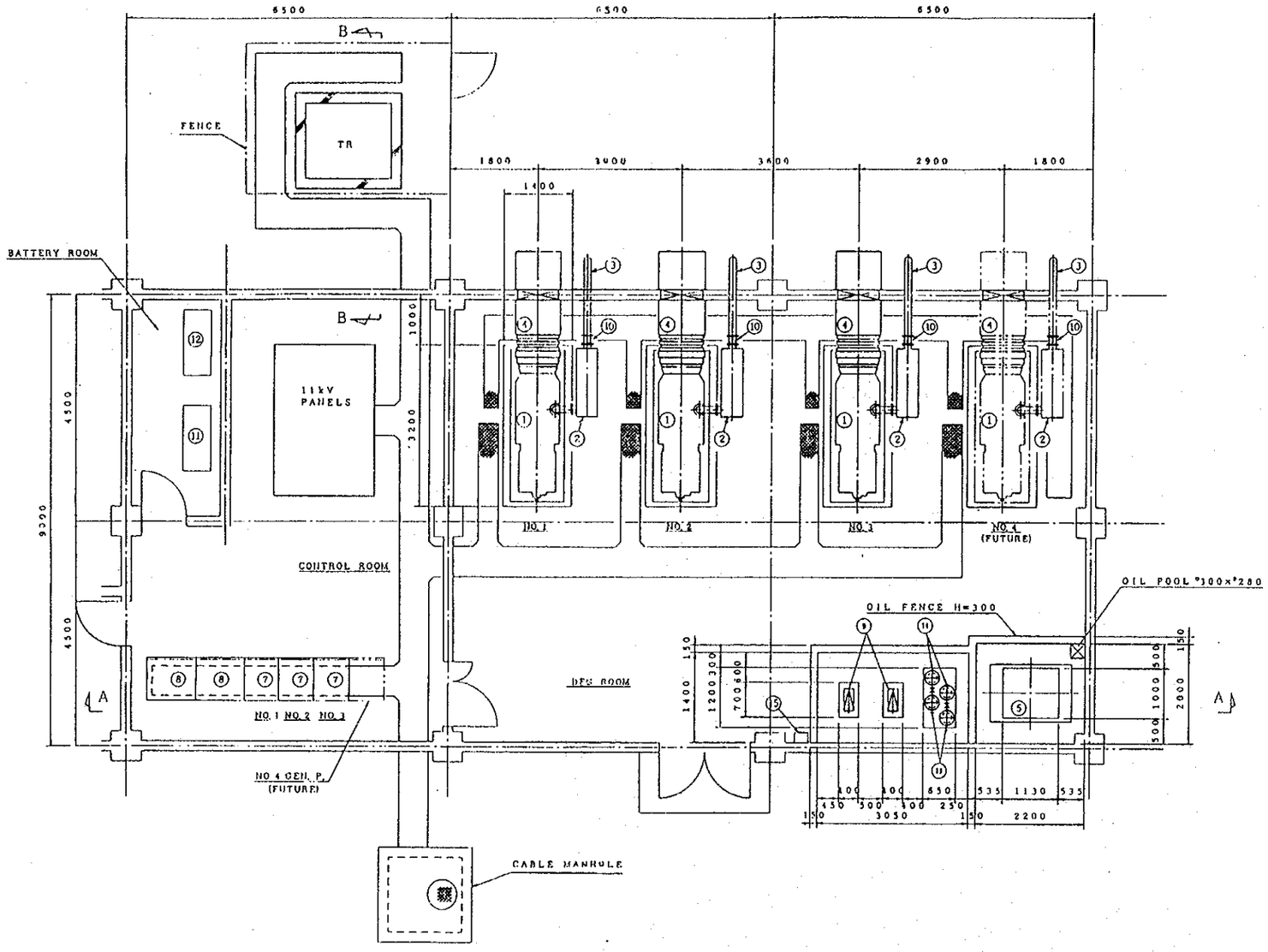
NORTH ELEVATION S=1/100



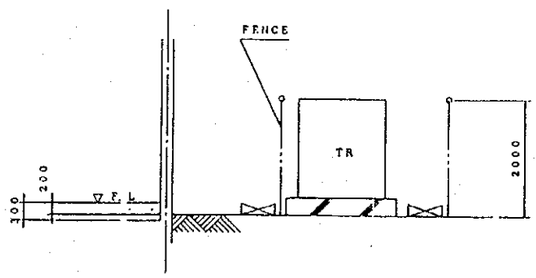
E-E SECTION S=1/30

Hulhudhoo/Meedhoo Island

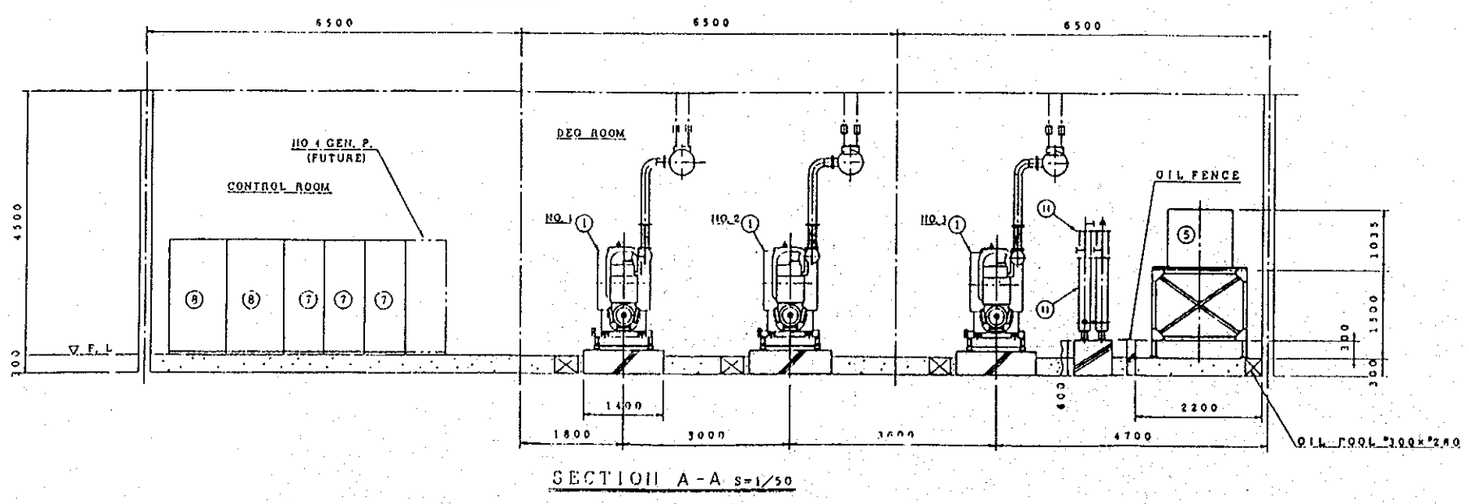
Drawing No. FM-G05 Power House Building (Section Plan)



NO.	NAME	Q'TY	REMARKS	WEIGHT
①	DIESEL ENGINE GENERATOR	3	165kW	3500kg
②	SILENCER	3		130kg
③	EXHAUST GAS PIPE	3	150A	
④	RADIATOR VENTILATION DUCT	3		
⑤	FUEL DAY TANK	1		1506kg
⑥	FEEDER PANEL	1		
⑦	GENERATOR PANEL	3		
⑧	COMMON PANEL	1		
⑨	FUEL TRANSFER PUMP	2	0.4kW	25kg
⑩	EXPANSION JOINT	3	150A	
⑪	BATTERY	1SET		850kg
⑫	BATTERY (STAND-BY)	1SET		850kg
⑬	PRE-FILTER	1		30kg
⑭	WATER SEPARATOR	1		30kg
⑮	CONTROL PANEL	1	FOR FUEL TRANSFER PUMP	



SECTION B-B S=1/50

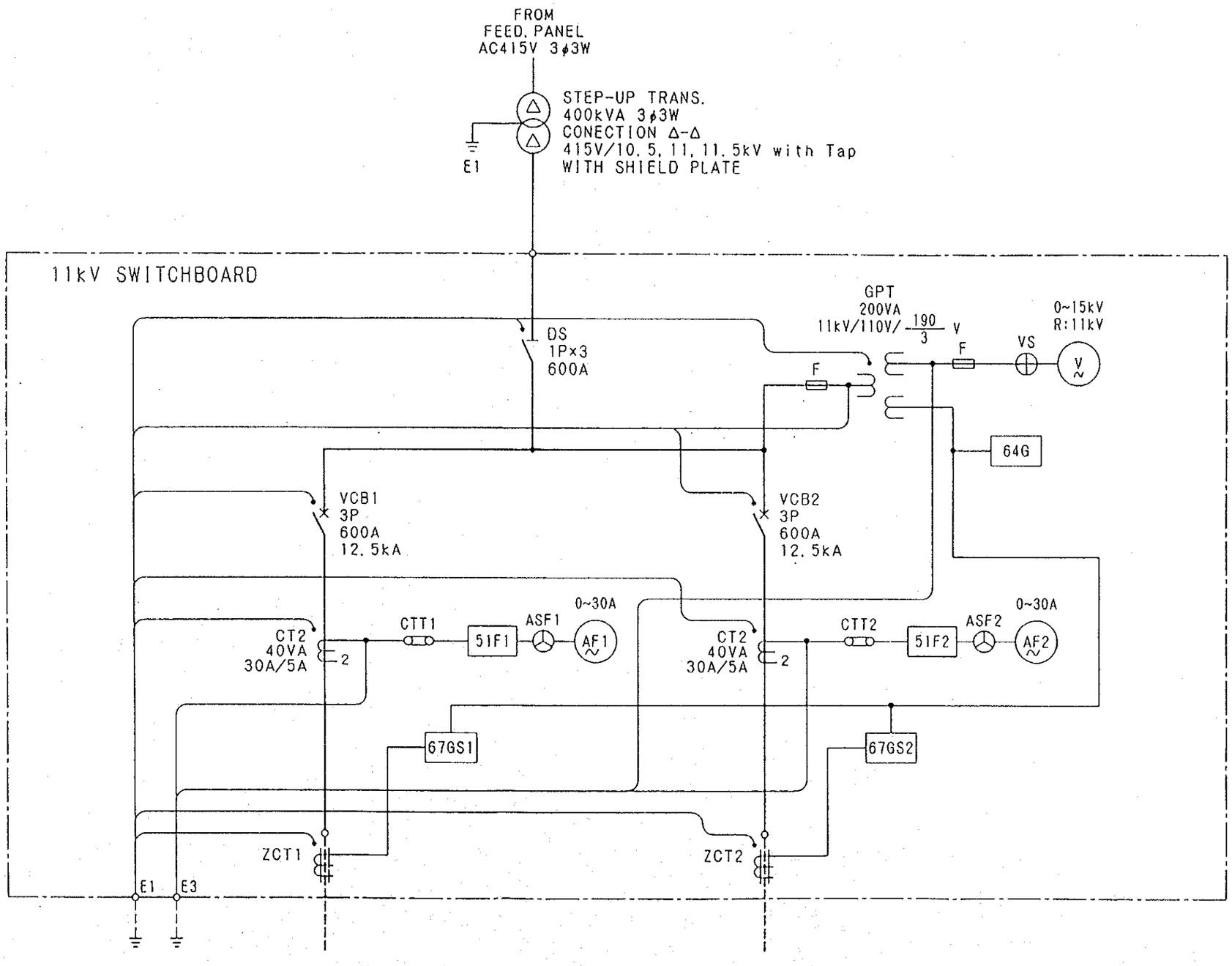


SECTION A-A S=1/50

Hulhudhoo/Meedhoo Island

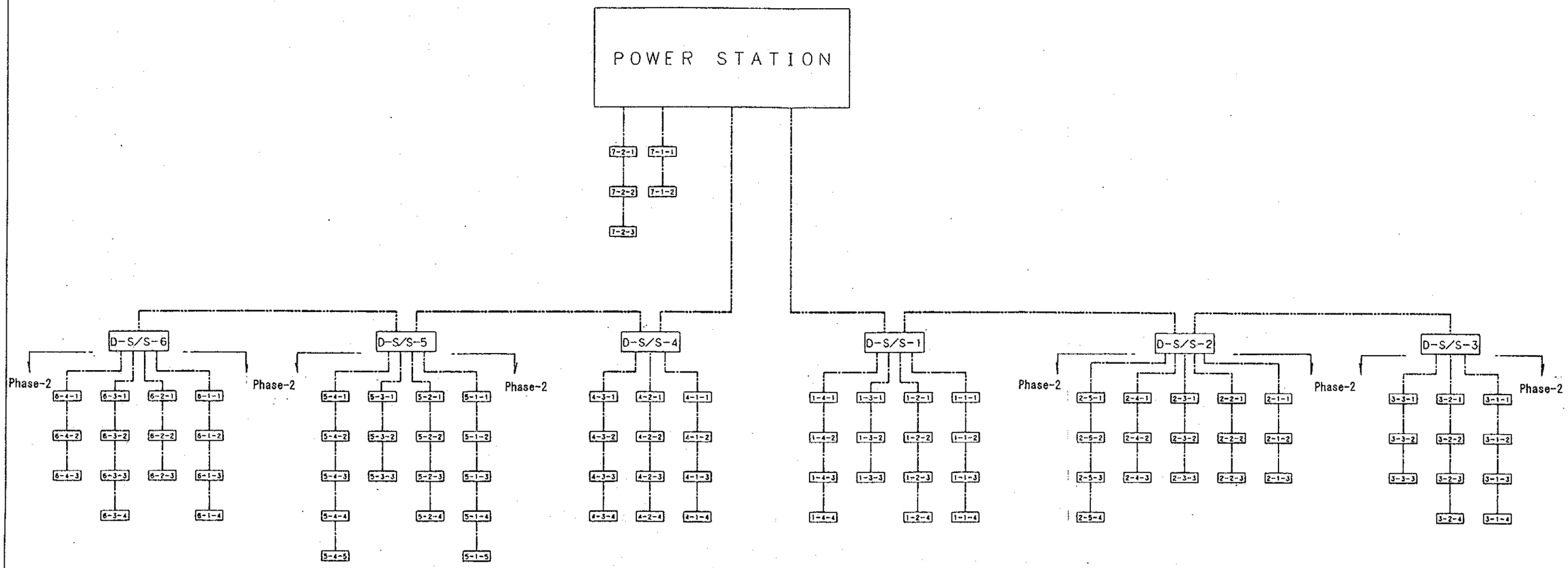
Drawing No. FM-G06

Arrangement of Diesel Engine Generator Set



Hulhudhoo/Meedhoo Island

Drawing No. FM-D01 Single Line Diagram for Distribution System

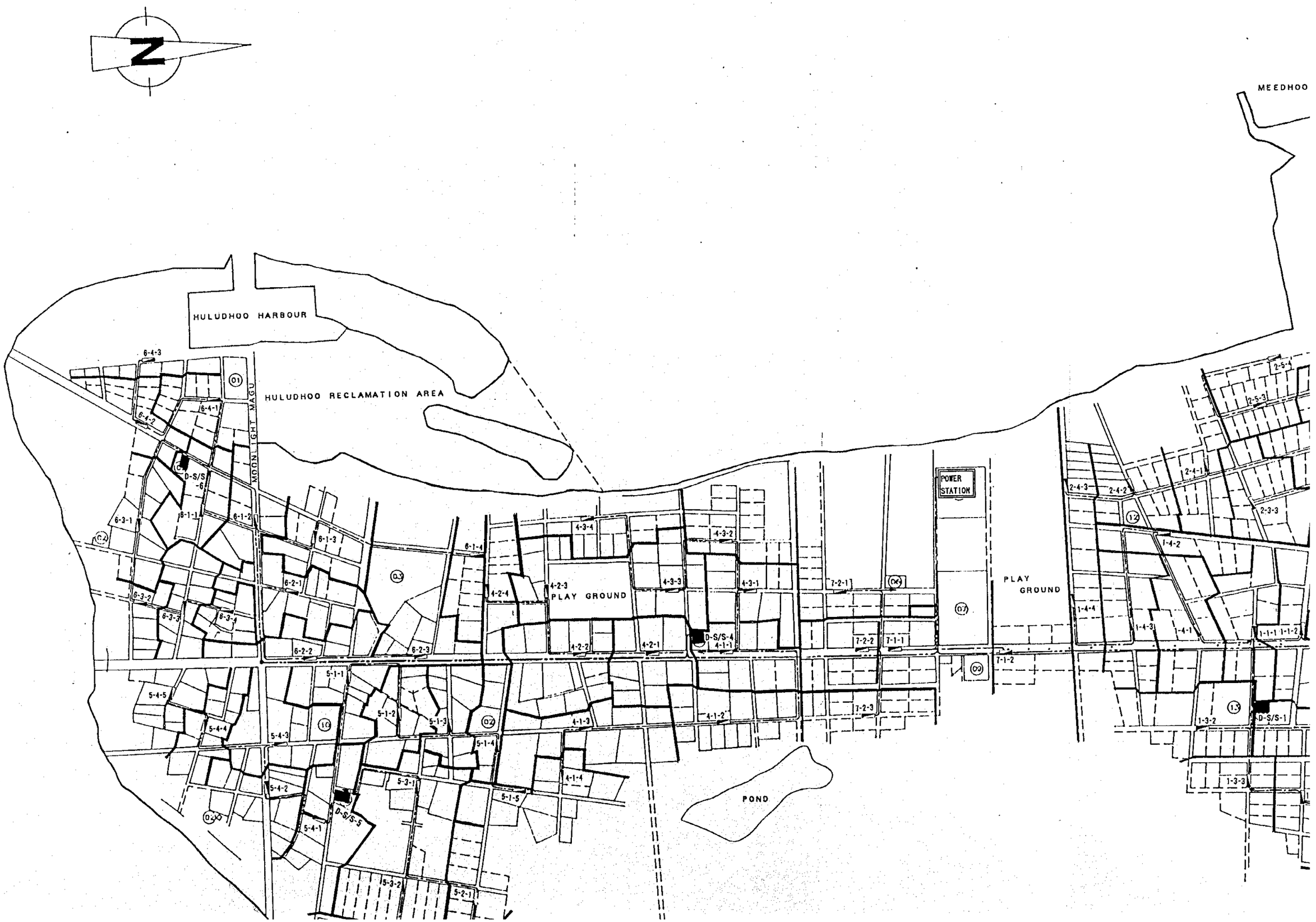


LEGEND

SYMBOL	NAME	REMARK
D-S/S-1	LOCAL DISTRIBUTION NO	
1-1-1	DISTRIBUTION SUBSTATION NO	
	MAIN CABLE ROOTE	HIGH VOLTAGE
	MAIN CABLE ROOTE	LOW VOLTAGE

Hulhudhoo/Meedhoo Island

Drawing No. FM-D02 Block Diagram for Distribution System


N
HULUDHOO HARBOUR
HULUDHOO RECLAMATION AREA
MOONLIGHT MAGU
MEEDHOO
POWER STATION
PLAY GROUND
PLAY GROUND
POND
D-S/S-6
D-S/S-4
D-S/S-5
D-S/S-1
6-4-3
6-4-1
6-4-2
6-1-1
6-1-2
6-1-3
6-1-4
6-2-1
6-2-2
6-2-3
6-3-1
6-3-2
6-3-3
6-3-4
4-2-3
4-2-4
4-2-2
4-2-1
4-3-4
4-3-2
4-3-3
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5-4-4
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2-5-4
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1-4-2
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1-4-3
1-4-1
1-1-1 1-1-2
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01
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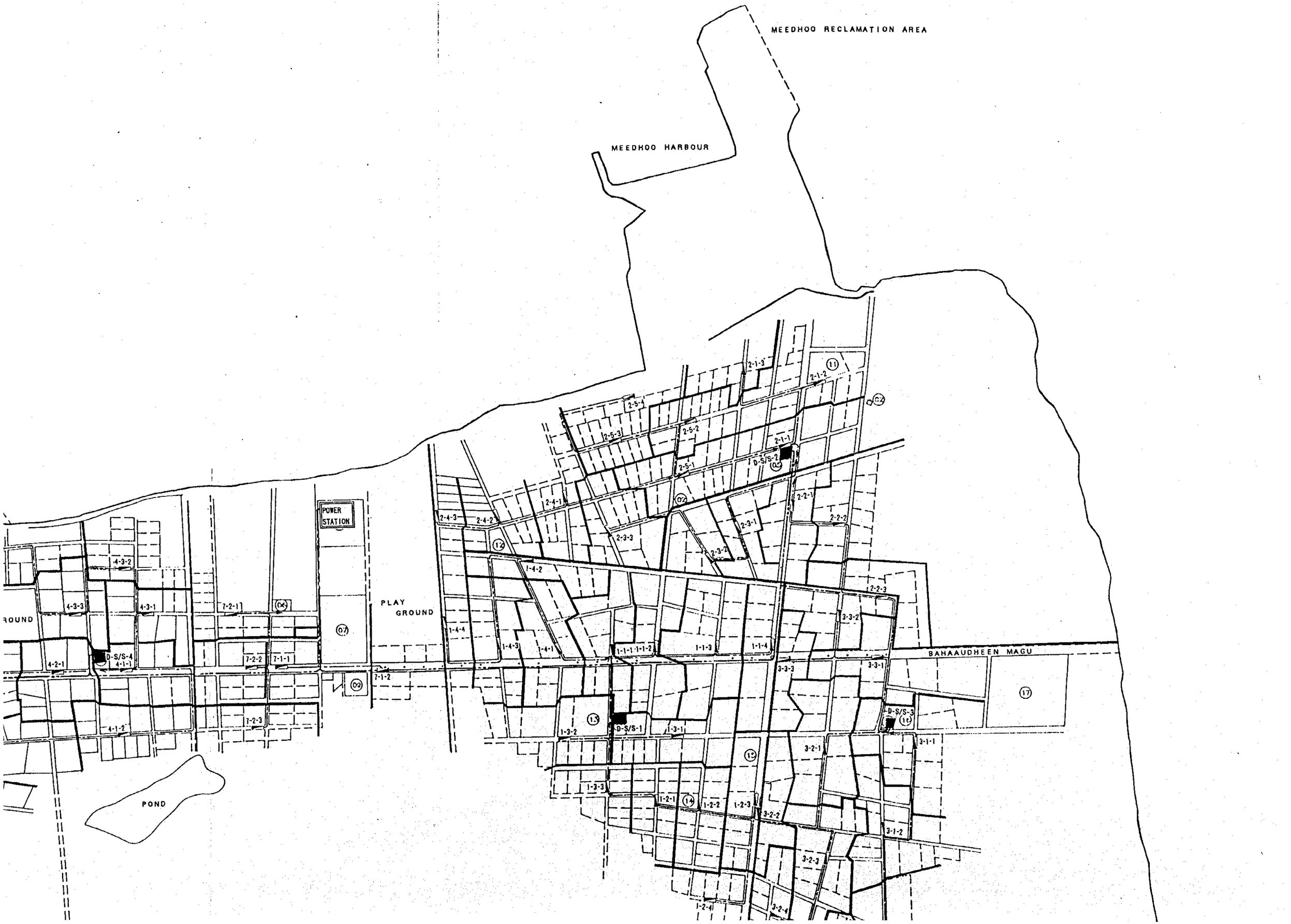
MEEDHOO RECLAMATION AREA
MEEDHOO HARBOUR
POWER STATION
PLAY GROUND
POND
BAHAAUDHEEN MAGU
D-S/S-1
D-S/S-2
D-S/S-3
D-S/S-4
2-1-3
2-1-2
2-5-4
2-5-3
2-5-2
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2-5-1
2-4-1
2-4-3
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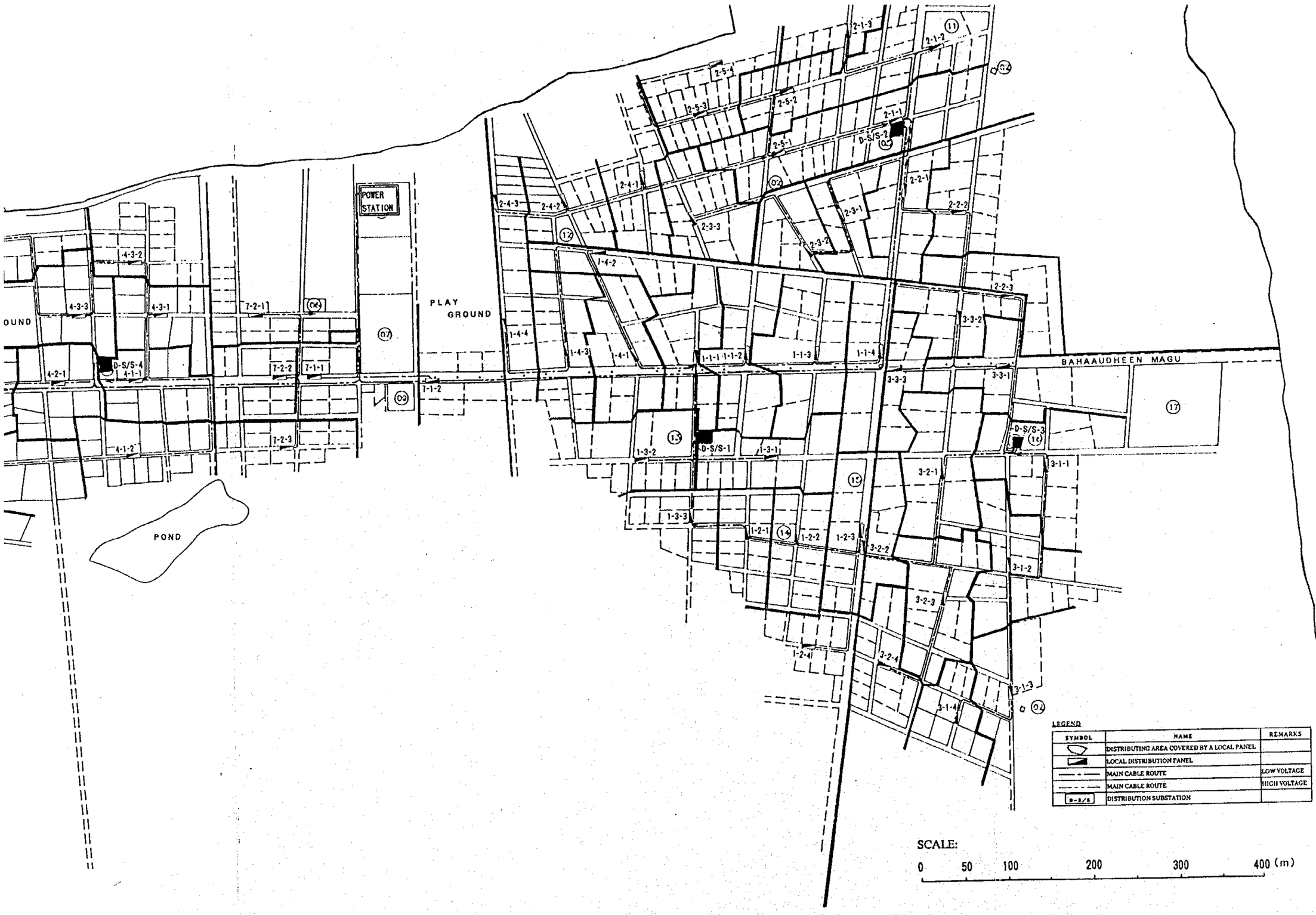
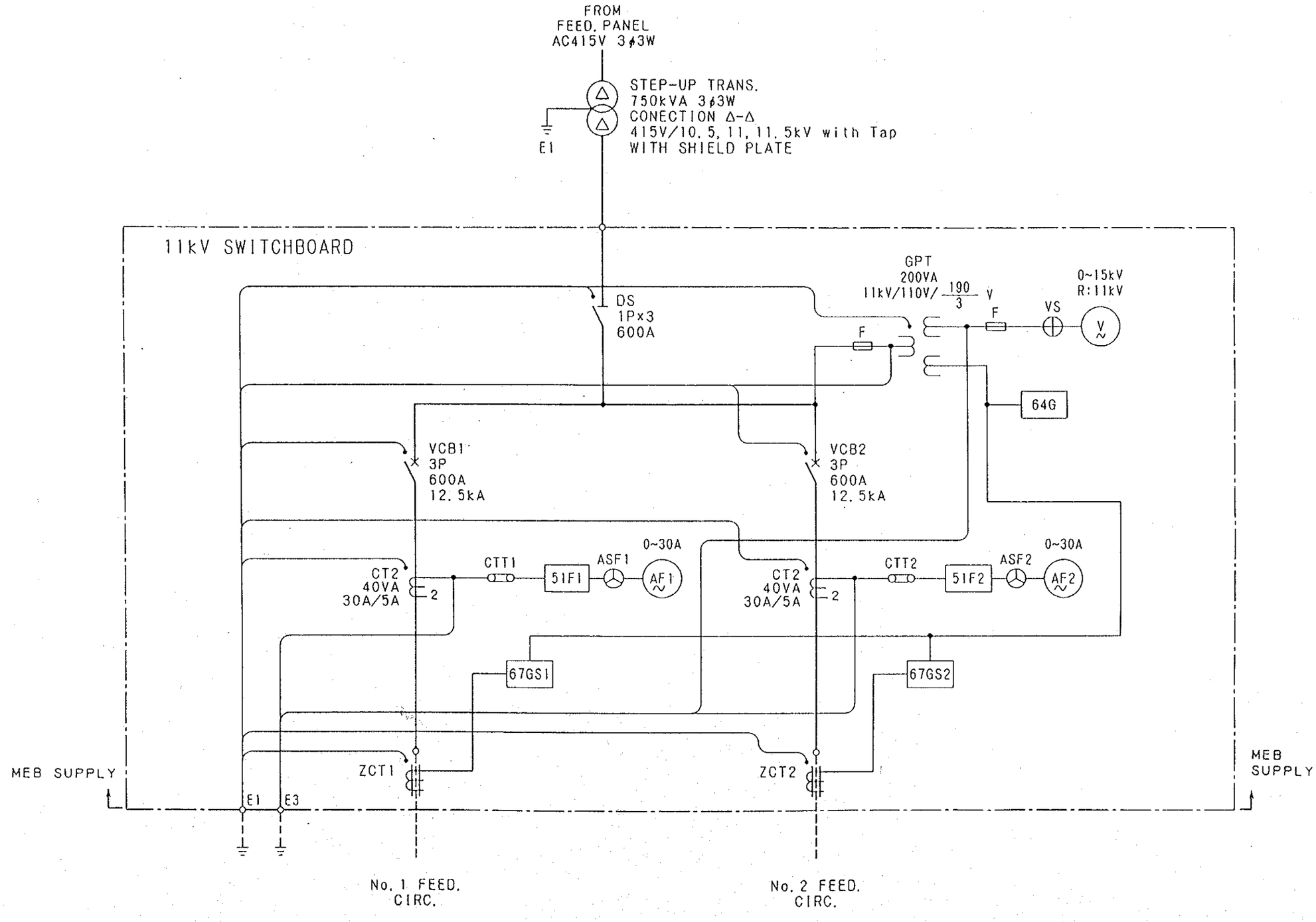
7-1-2
11
12
13
14
15
16
17
01
02
03
04
05
06
07


HULUDHOO HARBOUR
HULUDHOO RECLAMATION AREA
MOONLIGHT MAGU
POWER STATION
PLAY GROUND
PLAY GROUND
POND
D-S/S-6
D-S/S-4
D-S/S-5
D-S/S-1
01- HULUDHOO ISLAND OFFICE & COURT
02- OLD MOSQUE
03- OLD MOSQUE WITH GRAVE YARD
04- PROPOSED MOSQUE
05- FRIDAY MOSQUE
06- DHIRAAGU SITE
07- ATOLL SCHOOL
08- M. E. B. SITE
09- HEALTH CENTRE
10- HULUDHOO SCHOOL
11- MEEDHOO ISLAND OFFICE & COURT
12- OLD & NEW MOSQUE
13- MEEDHOO SOCIAL CENTRE
14- NEW MOSQUE
15- EXISTING POWER HOUSE
16- GHAAZEE MOHAMED SAMSUDDHEEN SCHOOL
17- 3 OLD MOSQUE WITH GRAVE YARD



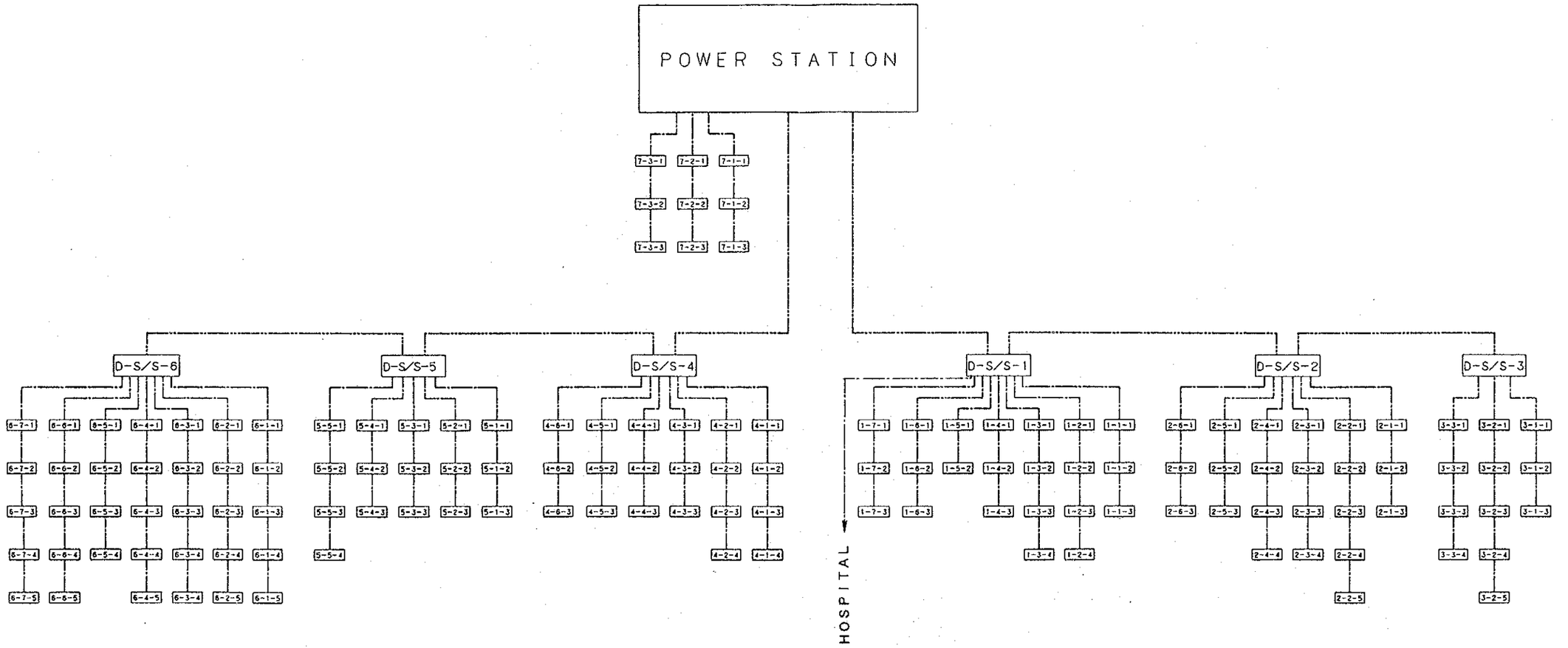
Hulhudhoo/Meedhoo Island

Drawing No. FM–D03 Cable Route Plan for Distribution System



Hithadhoo Island

Drawing No. HD-D01 Single Line Diagram for Distribution System

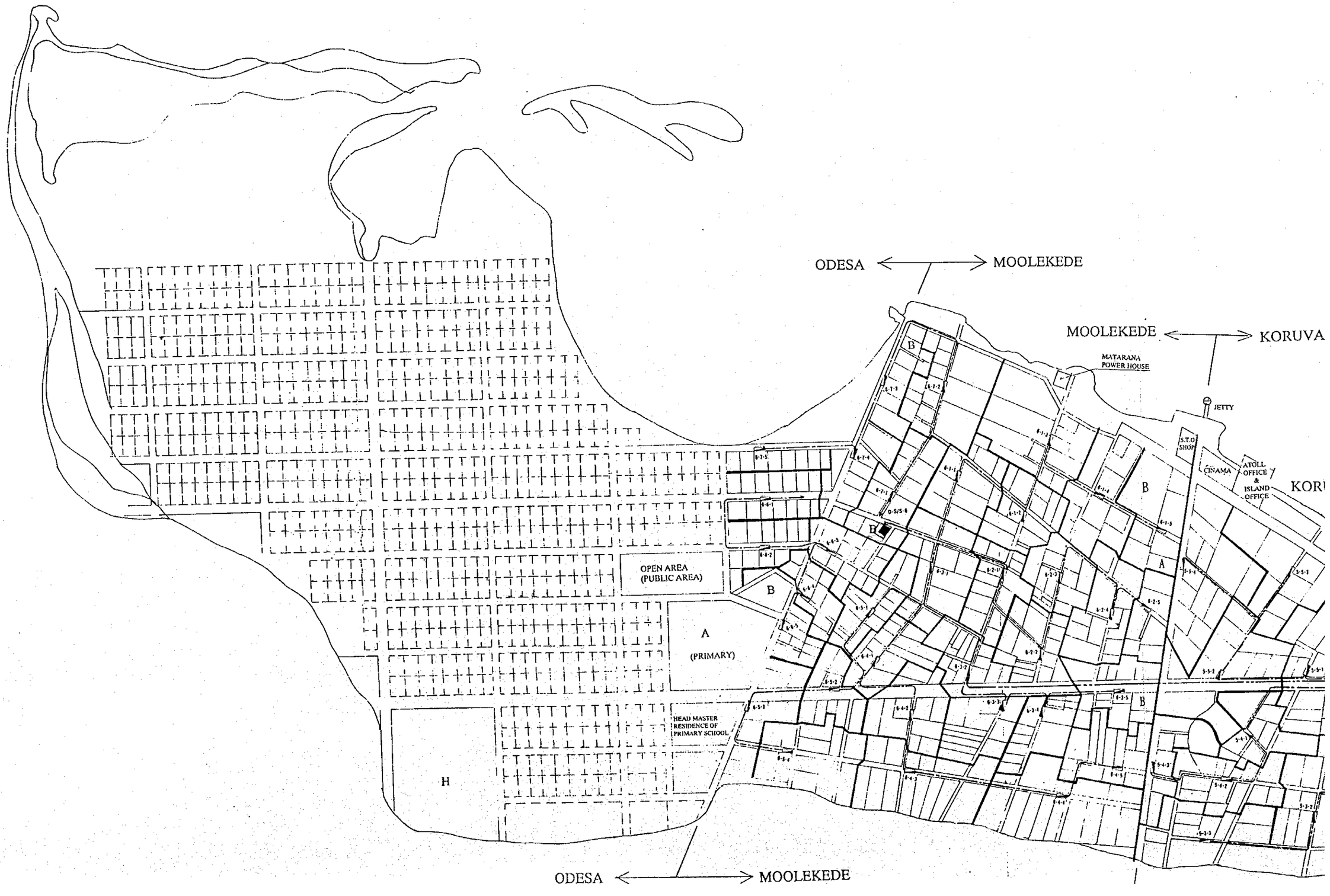


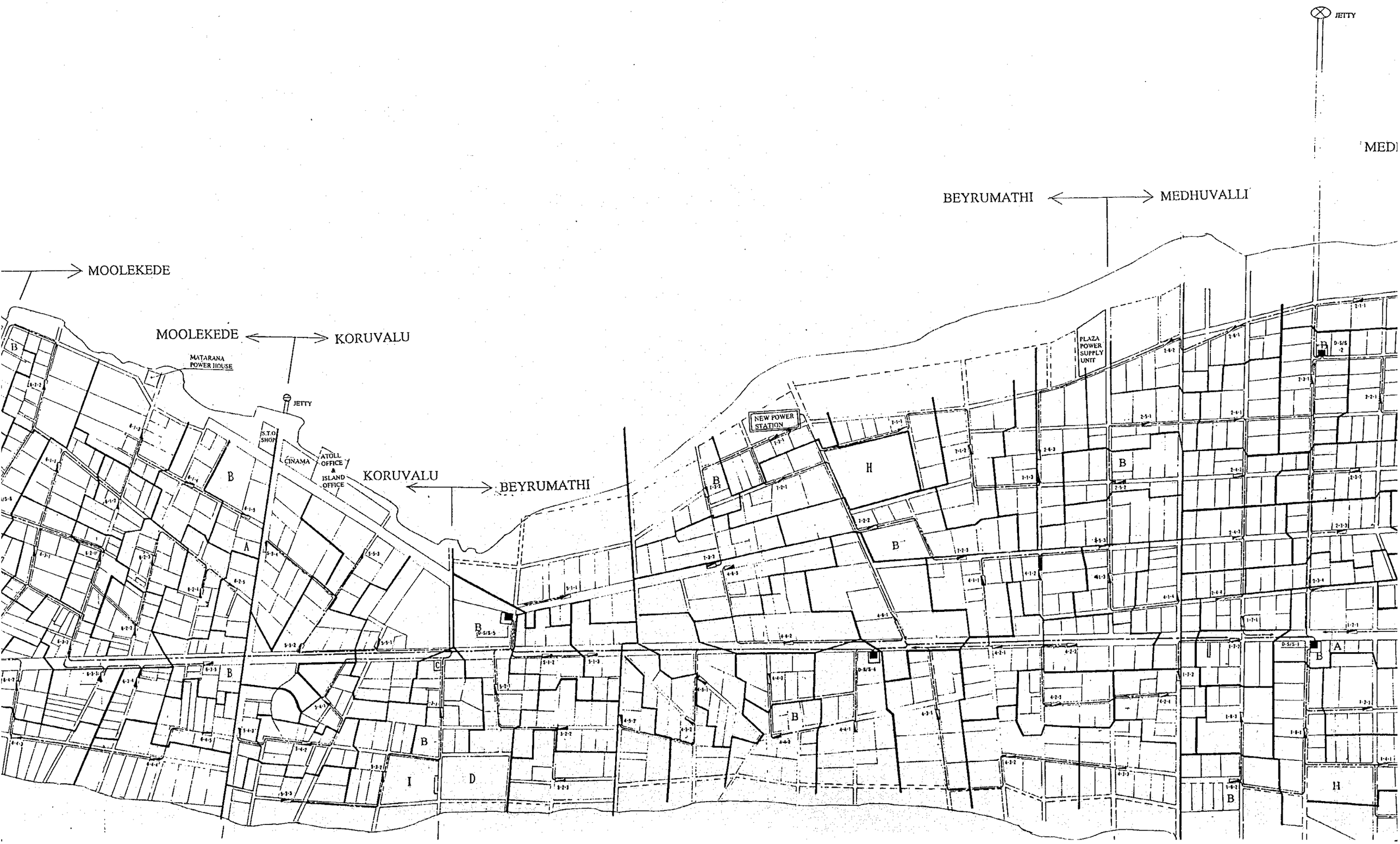
LEGEND

SYMBOL	NAME	REMARK
D-S/S-1	LOCAL DISTRIBUTION NO	
1-1-1	DISTRIBUTION SUBSTATION NO	
———	MAIN CABLE ROOTE	HIGH VOLTAGE
———	MAIN CABLE ROOTE	LOW VOLTAGE

Hithadhoo Island

Drawing No. HD-D02 Block Diagram for Distribution System


ODESA
MOOLEKEDE
MOOLEKEDE
KORUVA
MATARANA POWER HOUSE
JETTY
S.T.O SHOP
CINAMA
ATOLL OFFICE & ISLAND OFFICE
KORI
OPEN AREA (PUBLIC AREA)
A (PRIMARY)
HEAD MASTER RESIDENCE OF PRIMARY SCHOOL
H
B
A
ODESA
MOOLEKEDE


JETTY
MEDH
BEYRUMATHI
MEDHUVALLI
MOOLEKEDE
MOOLEKEDE
KORUVALU
MATARANA POWER HOUSE
JETTY
S.T.O SHOP
CINAMA
ATOLL OFFICE & ISLAND OFFICE
KORUVALU
BEYRUMATHI
NEW POWER STATION
PLAZA POWER SUPPLY UNIT

JETTY

RASGEDHARH ⟷ MAAMENDHOO

MEDHUVALLI ⟷ RASGEDHARH

⟷ MEDHUVALLI

BEACH ROAD

PLAZA POWER SUPPLY UNIT

A (PRIMARY, SEENU ATOLL EDUCATIONAL CENTER)

A (SECONDARY)

F SECONDARY SCHOOL EXPANSION

H (FOOTBALL GROUND)

A (ISLAMIC SCHOOL)

HEAD MASTER SECOND. SCHOOL

NEW ATOLL CHIEF RESIDENCE (PLAN)

NEW ATOLL OFFICE (PLAN)

G (DHIRAAGU)

POND

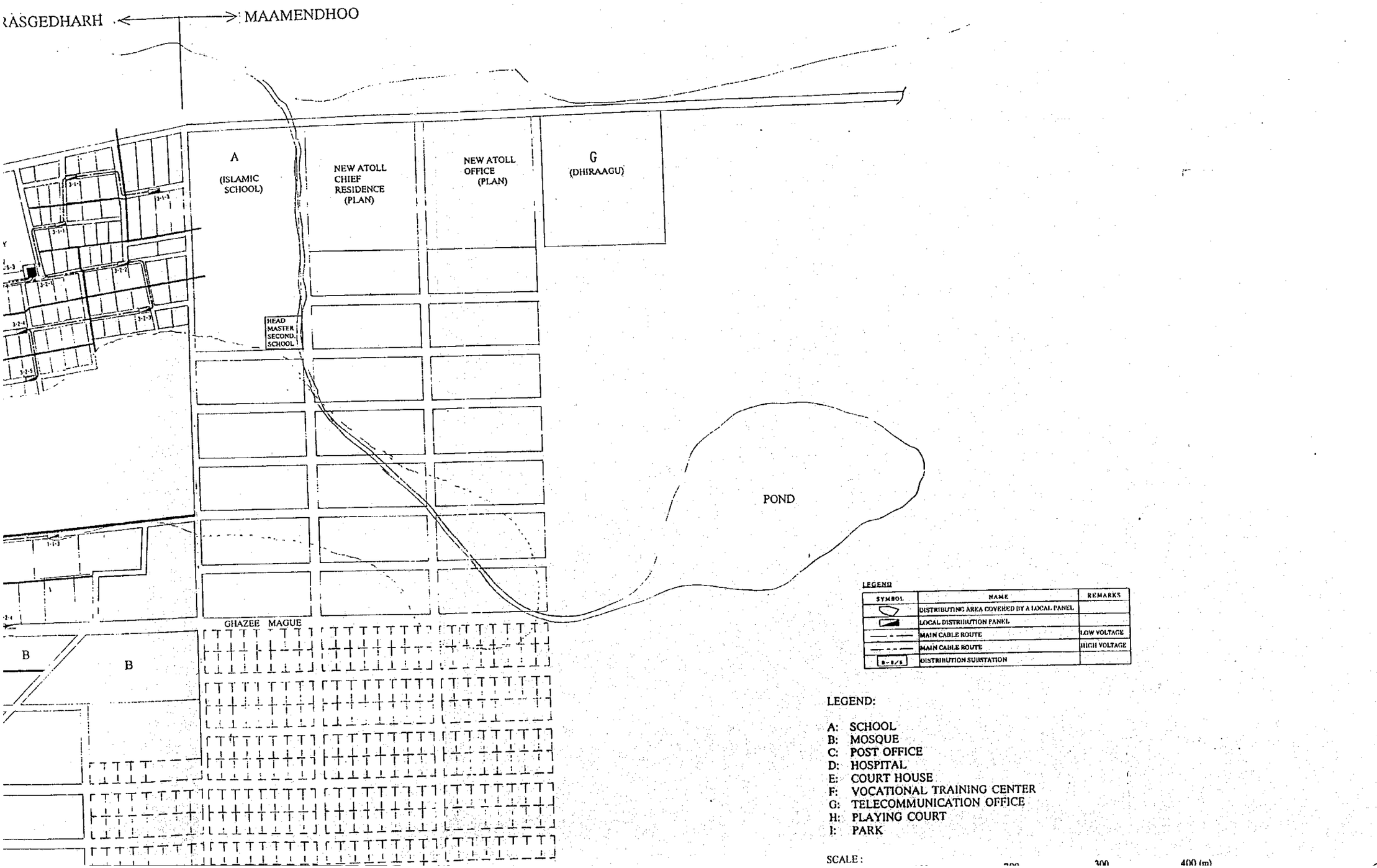
GHAZEE MAGUE

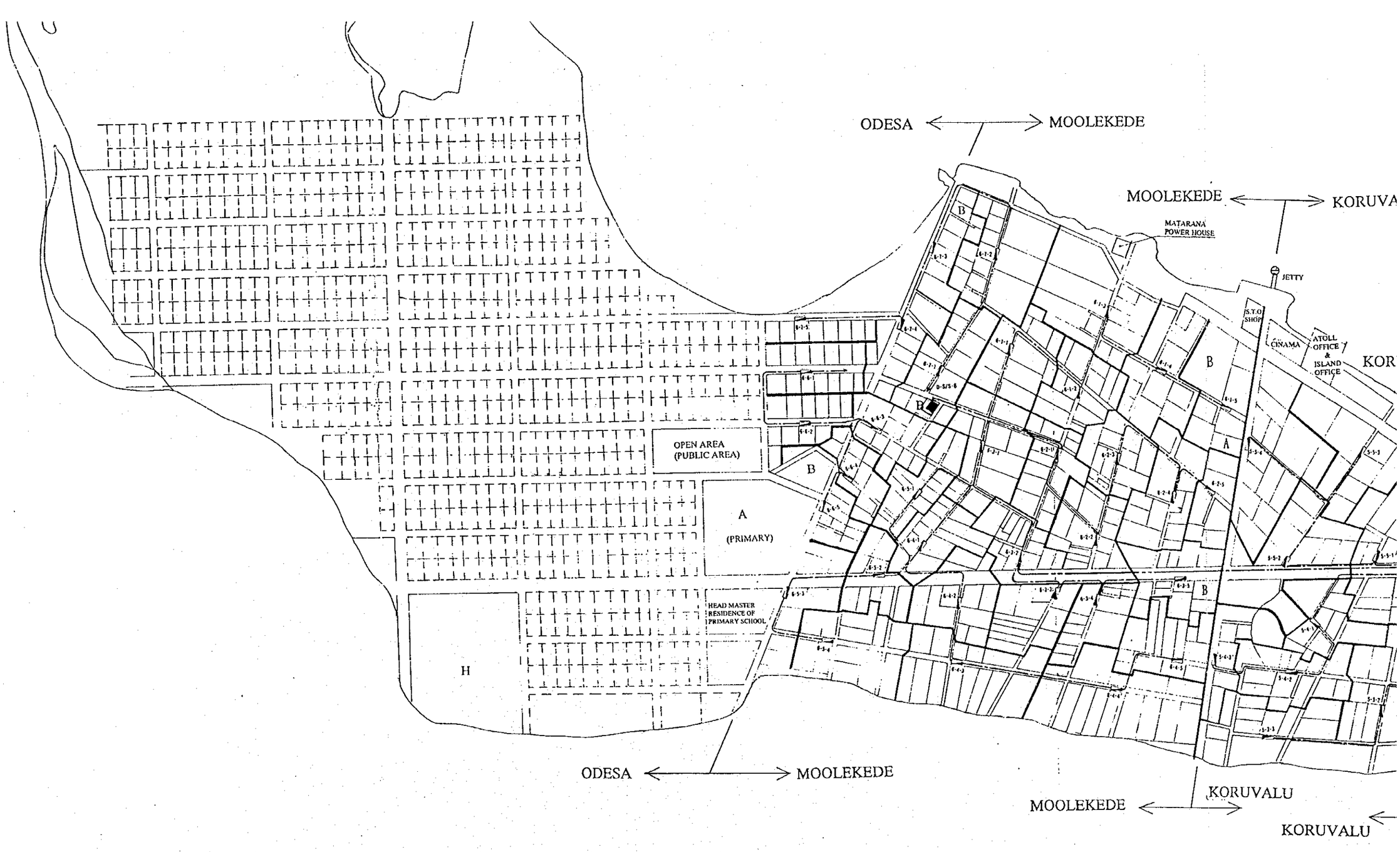
B

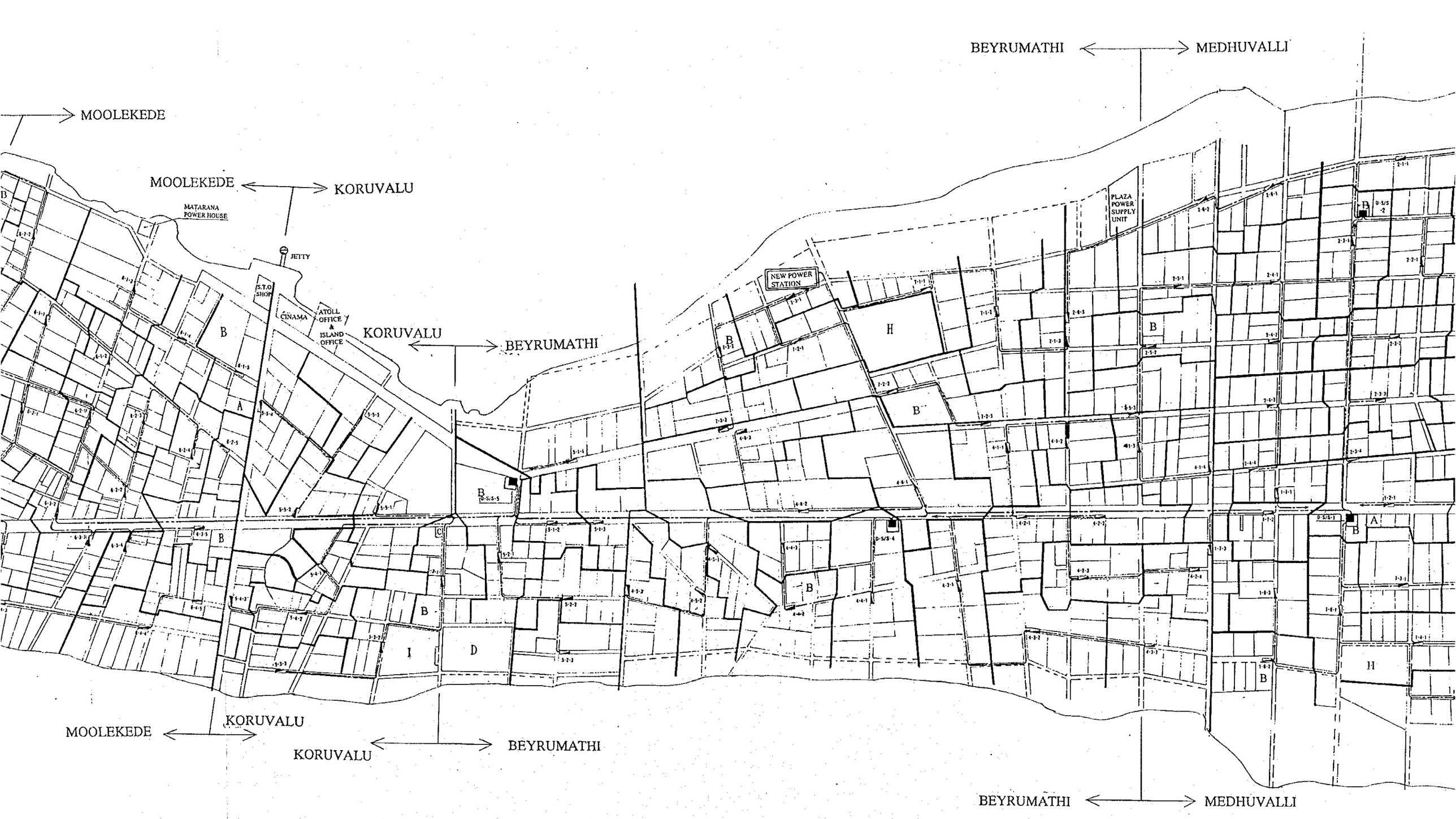
A

E

H


RASGEDHARH
MAAMENDHOO
A
(ISLAMIC SCHOOL)
NEW ATOLL CHIEF RESIDENCE (PLAN)
NEW ATOLL OFFICE (PLAN)
G
(DHIRAAGU)
HEAD MASTER SECOND. SCHOOL
POND
GHAZEE MAGUE
B
B
LEGEND
SYMBOL
NAME
REMARKS
DISTRIBUTING AREA COVERED BY A LOCAL PANEL
LOCAL DISTRIBUTION PANEL
MAIN CABLE ROUTE
LOW VOLTAGE
MAIN CABLE ROUTE
HIGH VOLTAGE
DISTRIBUTION SUBSTATION
LEGEND:
A: SCHOOL
B: MOSQUE
C: POST OFFICE
D: HOSPITAL
E: COURT HOUSE
F: VOCATIONAL TRAINING CENTER
G: TELECOMMUNICATION OFFICE
H: PLAYING COURT
I: PARK
SCALE :
300
400 (m)


ODESA
MOOLEKEDE
MOOLEKEDE
KORUVA
MATARANA POWER HOUSE
JETTY
S.T.O SHOP
CINAMA
ATOLL OFFICE & ISLAND OFFICE
KOR
OPEN AREA (PUBLIC AREA)
A
(PRIMARY)
HEAD MASTER RESIDENCE OF PRIMARY SCHOOL
H
ODESA
MOOLEKEDE
KORUVALU
MOOLEKEDE
KORUVALU


BEYRUMATHI
MEDHUVALLI
MOOLEKEDE
MOOLEKEDE
KORUVALU
MATARANA POWER HOUSE
JETTY
S.T.O SHOP
CINAMA
ATOLL OFFICE & ISLAND OFFICE
KORUVALU
BEYRUMATHI
NEW POWER STATION
PLAZA POWER SUPPLY UNIT
MOOLEKEDE
KORUVALU
KORUVALU
BEYRUMATHI
BEYRUMATHI
MEDHUVALLI

MATHI ⟷ MEDHUVALLI

PLAZA POWER SUPPLY UNIT

BEACH ROAD

A (PRIMARY. SEENU ATOLL EDUCATIONAL CENTER)

A (SECONDARY)

F SECONDARY SCHOOL EXPANSION

H (FOOTBALL GROUND)

A (ISLAMIC SCHOOL)

HEAD MASTER SECOND. SCHOOL

NEW ATOLL CHIEF RESIDENCE (PLAN)

NEW ATOLL OFFICE (PLAN)

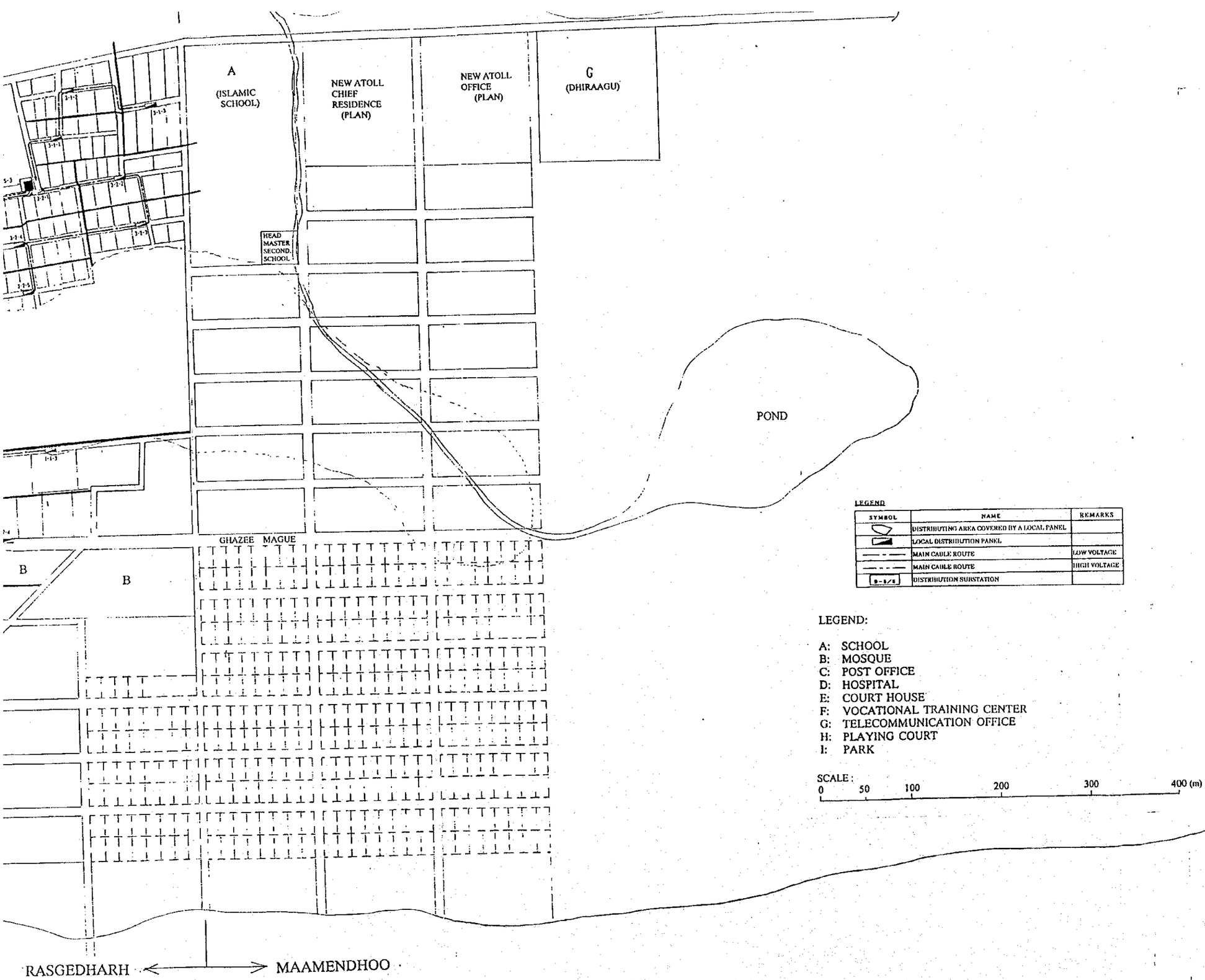
G (DHIRAAGU)

GHAZEE MAGUE

UMATHI ⟷ MEDHUVALLI

MEDHUVALLI ⟷ RASGEDHARH

RASGEDHARH ⟷ MAAMENDHOO



LEGEND

SYMBOL	NAME	REMARKS
	DISTRIBUTING AREA COVERED BY A LOCAL PANEL	
	LOCAL DISTRIBUTION PANEL	
	MAIN CABLE ROUTE	LOW VOLTAGE
	MAIN CABLE ROUTE	HIGH VOLTAGE
D-S/S	DISTRIBUTION SUBSTATION	

LEGEND:

A: SCHOOL
B: MOSQUE
C: POST OFFICE
D: HOSPITAL
E: COURT HOUSE
F: VOCATIONAL TRAINING CENTER
G: TELECOMMUNICATION OFFICE
H: PLAYING COURT
I: PARK

SCALE :
0 50 100 200 300 400 (m)

Hithadhoo Island

Drawing No. HD–D03 Cable Route Plan for Distribution System

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3-1 Implementation Plan

3-1-1 Implementation Concept

The Project will be implemented within the framework of Japan's grant aid and will formally commence with the Exchange of the Notes (E/N) between both governments upon approval of the Project by the Governments of Japan. The Government of the Maldives will then select the Consultant (Japanese firm) to conduct the detailed design work for the facilities and equipment. With the completion of the detailed design documents, the Contractor (Japanese firm responsible for building construction and equipment supply) which is the successful bidder will conduct the assigned work. The basic principles and points to note in relation to the implementation of the Project are described below.

(1) Project Implementation Body

The body responsible for the implementation of the Project on the Maldive side will be the MEB which is responsible for study, planning, construction, management and operation of the electricity service in the Maldives. The Project will actually be controlled by the Outer Male Division of the MEB. It will be necessary for the Government of the Maldives to maintain close communication links with the Japanese Consultant and the Contractor and to appoint a key person responsible for the implementation of the Project to ensure the Project's smooth progress. This responsible person must ensure that all staff members of the new power stations fully understand the contents of the Project, pay extra care to safety during the construction period, and provide all possible assistance for the smooth progress of the Project.

(2) Consultant

The Consultant, i.e., a Japanese firm selected by the Government of the Maldives, will enter into a design and work supervision agreement with the Government of the Maldives to proceed to the building construction and equipment procurement stage of the Project. The Consultant will prepare the detailed design for the buildings and equipment to be constructed or procured under Japanese grant aid and will then supervise the actual on-site work. The Consultant will also prepare the tender documents and will conduct the tender process on behalf of the Government of the Maldives.

(3) Contractor

The Contractor, i.e., a Japanese firm selected by open tender in accordance with the set procedure of Japan's grant aid system, will construct the buildings and procure and supply the equipment and other items. As the generating facilities will require the supply of spare parts and the provision of after-service in the case of breakdown following the completion of the Project, the Contractor should pay close attention to the need to establish communication links between the power stations and the Contractor after the delivery of the facilities and equipment.

(4) Necessity to Dispatch Japanese Engineers to the Maldives

During construction of a power house, the building construction work and DEG installation work being simultaneously conducted. It will, therefore, be necessary to dispatch a site manager who is capable of supervising the entire work in order to ensure the punctual completion, quality and safety of the said work. In addition, the dispatch of Japanese engineers will be required to supervise and ensure the quality and punctual completion of the power house construction work and building service work as local engineers in these fields are in short supply.

The installation of the DEGs in question will require experts who are fully conversant with the structure and functions of such DEGs. Accordingly, the manufacturer of the DEGs in question will be requested to dispatch engineers to the Maldives for the purpose of supervising the test operation, calibration and schedule control on site.

3-1-2 Implementation Conditions

(1) General Conditions of Local Construction Industry

1) While it is not impossible to employ engineers and workers for building foundation and construction work in the Maldives, the country's small pool of such personnel means that it is difficult to locally recruit a sufficient number of engineers and workers for the Project. In order to ensure technical quality and schedule control which meet the requirements of Japan's grant aid system, it will be necessary to consider the hiring of a third country construction firm(s) as a subcontractor(s) for the Japanese Contractor.
2) Although engineers capable of installing and tuning the small DEGs to be procured under the Project are available in the Maldives, Japanese engineers

will be assigned to these tasks for the reasons explained in 3-1-1-(4), including the need for strict schedule control.

3) As in the case of engineers described above, the local pool of construction machinery is quite small and, therefore, its temporary import from a third country(ies) is planned as a viable alternative.
4) As it is difficult to secure a sufficient on-site power supply for the work, it will be necessary to bring in a small generator unit (50 kVA).

(2) Points to Note Regarding Construction Plan

Common Issues for Two Islands

1) The landing port for the customs clearance of imported goods to the Maldives is on Male Island where the capital is located. As this port has no deep berth to allow direct access by large ships, tug boats are used to ferry goods to the land from vessels anchored outside the reef. It will, therefore, be necessary for the Project plan to take the necessary waiting time (approximately 2 weeks) for custom clearance into consideration in the schedule.
2) The domestic transportation of imported goods will involve maritime transportation for some 500km from Male Island to the Project sites and the use of 3 ton class barges to transfer the goods from inside the reef to the beaches on the islands. The goods will mainly be transported from the beaches to the Project sites by truck although the use of such heavy machinery as a crane or the manual method using rollers will be considered for the transportation of particularly heavy items.
3) Maritime transportation in the Maldives faces many problems due to the rough sea during the rainy season between May and October, particularly between May and July due to the strong southwestern monsoon. The construction schedule should, therefore, incorporate careful arrangements, including avoidance of the maritime transportation of goods during the above period.

Special Issue for Hulhudhoo/Meedhoo Island

4) The installation of the DEGs should commence immediately after the completion of the foundation work and the installation work for auxiliaries and electrical installation work, etc., should also be conducted concurrently in order to shorten the construction period as much as possible.

(3) Special Points to Note Regarding Construction Work

The power house construction work on Hulhudhoo/Meedhoo Island is expected to face certain restrictions due to the lack of the necessary infrastructure for such work. It is, therefore, necessary to note the following points because of these restrictions and also because of the Project's nature as a grant aid project.

1) The selection of the construction method and construction machinery should be carefully made because of the limited scope for using heavy machinery.
2) The DEG installation work will be simultaneously conducted with the finishing work for the power house building to strictly meet the contracted completion date and, therefore, special attention should be paid to work safety. (It is likely that the construction and installation work will be simultaneously conducted on different levels with some workers working above others.)
3) The sites for temporary facilities and the stock yard which are essential for the construction work should be selected in locations where the existing houses and social welfare facilities, etc. will not be adversely affected by these temporary facilities.
4) In the case of any work requiring the felling of standing trees, etc., the acceptability of the time and duration of such auxiliary work must be confirmed with the MEB and the confirmed time and duration must be strictly adhered to.

3-1-3 Scope of Works

The division of work between the Japanese side and the Maldives side is shown in Table 3-1-1. With regard to the office building attached to the new power house on Hulhudhoo/Meedhoo Island, the need to construct the office building is less urgent that the power house building as possible alternatives exist, including the renting of a private house for its use as an office building. Consequently, the construction of this particular office building has been eliminated from the scope of the Japanese work and has been added to the list of items to be arranged by the Maldives side.

Household distribution boards have also been eliminated from the scope of the Japanese work because of their almost sufficient availability leaving only a small quantity of those required as additions, the cost of which can be easily met by the Government of the Maldives.

As the low voltage distribution cables (from outdoor local distribution board to each house) are essential materials for realizing the benefits of the Project within the

construction period, and technical coordination must be done when connecting them to the local distribution board, these cables will be within the scope of Japanese side.

As for street lighting facilities, both islands have some street lighting facilities, however, most of it is deteriorated, worn and its safe use is questionable. As a result, street lighting facilities along major roads passing public facilities in this project (approx. 6km on both islands) at a 40m interval will be installed as within the Japanese scope of work.

Table 3-1-1 Work Share for Japanese Side and Maldivian Side

(Hulhudhoo/Meedhoo Island) (1/2)

Work Items	Japanese Side	Maldivian Side
1. Diesel Engine Generating Facilities		
(1) Diesel Engine Generator (DEG)	Supply and installation	
(2) Auxiliary equipment for DEG	Supply and installation	
(3) Electrical equipment for DEG	Supply and installation	
(4) Main and daily fuel oil tank(s) and fuel supply line(s) (1-month stock)	Supply and installation	
(5) Main fuel oil tank for future (3 months-stock)		Supply and installation
(6) Grounding system within the Power Station (P/S)	Supply and installation	
(7) Workshop equipment installed in P/S	Supply only	Installation
(8) Communication equipment installed in P/S	Supply only	Installation
(9) Maintenance tools for DEG and auxiliaries	Supply only	Stock
(10) Spare Parts for DEG and auxiliaries	Supply only	Stock
(11) Operation & Maintenance Manuals for DEG	Supply and Explanation	Keep and Study
(12) On-the-Job Training (OJT) for O&M techniques for DEG	Execution	Attend
2. Power distribution networks		
(1) Step-up transformer with LV panel	Supply and installation	
(2) 11kV outgoing feeder panel	Supply and installation	
(3) Distribution substations (DS)	Supply only	Installation
(4) Main distribution panels to be installed in P/S	Supply and installation	
(5) Main Power distribution cables	Supply only	Installation
(6) Branch Power distribution cables	Supply only	Installation
(7) Local distribution boards	Supply only	Installation
(8) Grounding materials for local distribution board	Supply only	Installation
(9) Household pancls		Supply and installation
(10) Street lightings	Supply only	Installation
3. Construction of Civil and building works		
(1) Power house building	Construction	
(2) Oil tanks and Equipment foundations	Construction	
(3) Office building and the site plantation		Design and Construction
(4) Rain water collection & supply system for the Power house building	Construction	
(5) Rain water collection & supply system for the Office building		Design and Construction
(6) Well and well water supply system	Construction	Construction inside Office
(7) All furniture and curtain		Supply
(8) Site Leveling, Boundary fence, Entrance gate and Access road		Design and Construction
(9) Electricity for construction	Construction	
(10) Water supply & drainage for construction	Construction inside the site	Construction to the site
(11) Telephone for construction	Construction inside the site	Construction to the site

(Hithadhoo Island) (2/2)

Work Items	Japanese Side	Maldivian Side
1. Diesel Engine Generating Facilities		
(1) Diesel Engine Generator (DEG)		Re-installation of the existing facilities
(2) Auxiliary equipment for DEG		
(3) Electrical equipment for DEG		
(4) Main and daily fuel oil tank and fuel supply line		
(5) Earthing system within the Power Station (P/S)		
(6) Workshop equipment installed in P/S		
(7) Communication equipment installed in P/S		
(8) Maintenance tools for DEG and auxiliaries		
(9) Spare Parts for DEG and auxiliaries		
(10) Operation & Maintenance Manuals for DEG		
(11) On-the-Job Training (OJT) for O$M techniques for DEG		Execution
2. Power distribution networks		
(1) Step-up transformer with LV panel	Basic Design	Supply and installation
(2) 11kV outgoing feeder panel for	Basic Design	Supply and installation
(3) Distribution substations (DS)	Supply only	Installation
(4) Main distribution panels to be installed in P/S		Supply and installation
(5) Main Power distribution cables	Supply only	Installation
(6) Branch Power distribution cables	Supply only	Installation
(7) Local distribution boards	Supply only	Installation
(8) Grounding materials for local distribution board	Supply only	Installation
(9) Household panels		Supply and installation
(10) Street lightings	Supply only	Installation
3. Construction of Civil and building works		
(1) Power house building		Design and Construction
(2) Oil tanks and Equipment foundations		
(3) Office building and the site plantation		
(4) Rain water collection & supply system for the Power house building		
(5) Rain water collection & supply system for the Office building		
(6) Well and well water supply system		
(7) All furniture and curtain		
(8) Site Leveling, Boundary fence, Entrance gate and Access road		
(9) Electricity for construction		
(10) Water supply & drainage for construction		
(11) Telephone for construction		

3-1-4 Consultant Supervision

In accordance with Japan's grant aid system, the Consultant will organise a project team to conduct the detailed design and work supervision, taking all the basic design principles into consideration. At the work supervision stage, the Consultant will dispatch engineers to the Maldives when such dispatch is deemed necessary in light of the Project's progress to supervise the work and to witness the inspection of the completed facilities. The Consultant will also dispatch an mechanical engineer to the Maldives for a period of approximately two months prior to the completion of the Project to supervise the equipment installation work and to witness the inspection of the completed installations.

(1) Basic Principles Regarding Work Supervision

The Consultant will adopt the following principles to fulfill his responsibility to supervise and guide the Contractor in view of the punctual and safe completion of the Project-related work within the planned period. The scope of work for the Consultant is shown in Table 3-1-2.

Table 3-1-2 Scope of Work for Japanese Consultant under the Project

(1) Pre-Construction Stage	Detailed Design Study Preparation of Tender Documents Execution of Tender on Behalf of Project Implementation Body Evaluation of Bids Assistance for Contract Negotiation and the Contract
(2) Construction Stage	Work Supervision Inspection and Instruction Preparation of Reports

1) Schedule Control

a) The Consultant shall ensure that the Contractor always checks the progress of the manufacture, delivery and installation of the equipment and construction work against the original plan to ascertain the state of work progress.

b) The Consultant shall control each work item on a daily, weekly and monthly basis so that the Contractor adheres to the contracted work schedule.

2) Quality Control

a) The Consultant shall confirm that the specifications and quality of the equipment and materials meet those specified in the detailed design documents.

b) The Consultant shall witness the quality inspection, inspection of the construction method used and various performance tests in connection with the installation, piping, wiring and various connection work on-site.

3) Safety Control

a) All workers involved in the Project will be made aware of the importance of accident prevention measures and the Contractor will be instructed to train local supervisors to foresee safety hazards.

b) Constant inspection of the construction machinery will be emphasised to prevent accidents.

c) The Consultant shall provide the necessary guidance for the Contractor to prevent any accident or damage involving persons, existing buildings and/or existing facilities by vehicles and construction machinery, etc. operating on the Project sites. The actual measures to be introduced by the Contractor should include a low speed limit and others.

(2) Work Supervision System

The system to supervise the actual construction and installation work and the involvement of the related organizations are shown in Fig. 3-1-1.

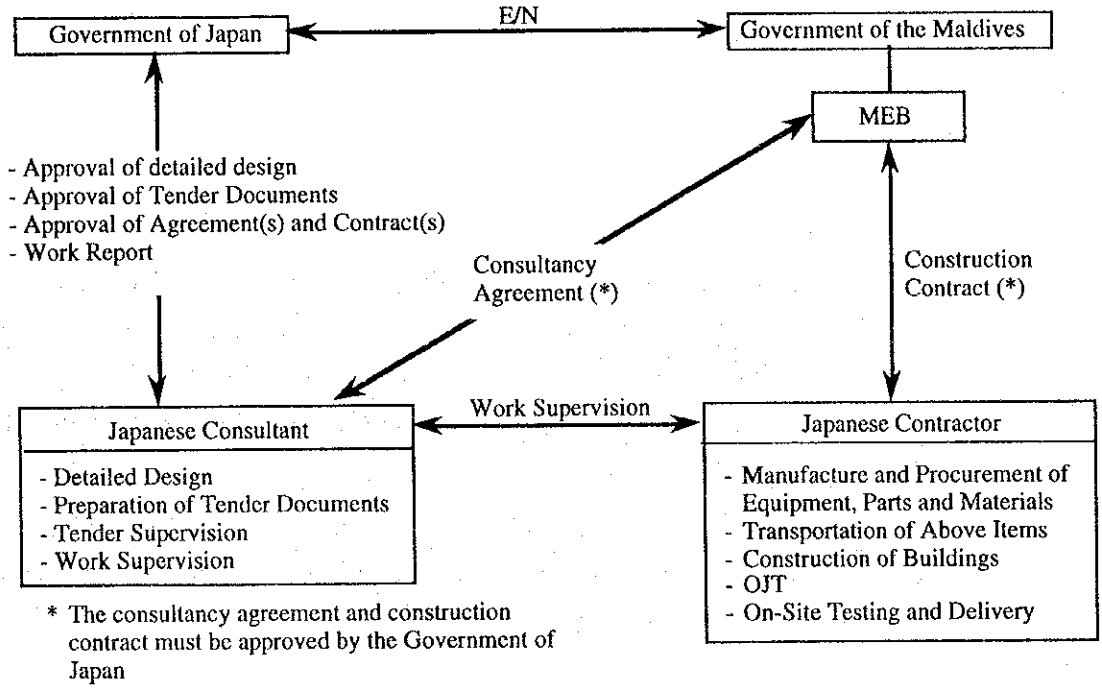


Fig. 3-1-1 Project Implementation and Work Supervision System

(3) On-Site Supervisors from the Contractor

The Contractor will be required to smoothly manage the joint work with Maldive or third country construction companies (subcontractors) and to provide appropriate technical guidance for these subcontractors in view of completing the construction of the buildings and the procurement and supply of the equipment and materials to meet the demands specified by the detailed design documents. The dispatch of supervisors with experience of similar projects is desirable to provide such smooth management and technical guidance and also to ensure a high quality of the completed work. Given the planned scope of the work under the Project, the Contractor will be required to dispatch the following full-time, on-site supervisors.

- One site manager : Responsible for the general supervision of all aspects on on-site work and OJT.
- Mechanical Supervisor : Responsible for providing guidance on equipment installation and schedule control.

In addition to the above full-time supervisors, it will be necessary for the Contractor to dispatch engineers who are specialised in building and civil

engineering, equipment installation and testing/calibrating, etc., in accordance with the actual progress of each type of work.

3-1-5 Procurement Plan

(1) Supply Sources

The construction equipment and materials to be used for the Project are not manufactured or produced in the Maldives. While some imported items are available, it will be difficult to ensure punctual supply or quality. Consequently, all equipment and materials, except coral blocks and diesel oil, will be imported from Japan or third countries.

The supply sources shown in Table 3-1-3 have been decided, taking into consideration the required standards, specifications, quality, production volume, stable supply prospect, delivery time and prices.

Table 3-1-3 Material and Equipment Source

Material / Equipment	Source Country		
	Maldives	Japan	Third Country
Fuel Oil	○		
Sand			○
Cement			○
Gravel			○
Steel			○
Construction Materials			○
Diesel Engine Generator (diesel engine, generator, electrical systems, mechanical systems)		○	
Spare Parts for the Above		○	
Maintenance Tools for the Above		○	
Repair Equipment for the Above		○	
Distribution System			
- High voltage system			○
- Low voltage system			○
- Street lighting facilities			○
VHF Communication Station			○
Distribution Line Repair Tools			○
Construction Equipment (backhoe, dump truck, truck crane, generator, submersible pump, etc.)			○

(2) Transport Method

As mentioned in Section 3-1-2, equipment and materials will pass customs at Male Island, be transported by sea some 500km to near the island where it will have to be transferred to 3 ton barges inside of the reef.

As it will be difficult to procure a transport vessel in Maldives, and as it is punctual to keep the implementation schedule of the Project, the same transport vessel used to transport materials from Japan or third countries to Male Island will be used after clearing customs in Male Island. Therefore, the domestic transport cost from Male Island to the construction site will be born by the Japanese side.

3-1-6 Implementation Schedule

In case that the Project is extended to the implementation stage with grant aid provided by the Government of Japan, the actual procurement, construction and equipment installation will be conducted in three stages following the signing of E/N, i.e., (1) preparation of detailed design documents, (2) tender process and signing of construction contract, and (3) actual procurement, construction and installation.

(1) Basic Design

As soon as the E/N has been signed, the Japanese Consultant will conclude a consultant agreement with the Maldives side and will commence the detailed design work. Based on the Basic Design Study findings and the Detailed Design Study findings, the tender documents (specifications and detailed design drawings) will be prepared. At the beginning and end of the detailed design stage, the Consultant will have thorough discussions with the Maldives side and will then proceed to the tender process upon approval of the documents by both governments.

The detailed design work is estimated to take 3 months for the First Phase and 2.5 months for the Second Phase.

(2) Tender and Construction Contract

The Consultant will announce the tender, receive and evaluation of prequalification documents from the applicants, hold a tender explanation and

Government of the Maldives. Upon receipt of the bid prices and application documents, the Consultant will promptly examine them to facilitate a construction contract between the Government of the Maldives and a Japanese contractor. The tender will be witnessed by all applicants and representatives of related organizations. If the contents of the bid with the lowest price are assessed as being appropriate, the bid will be accepted and the bidder will conclude a construction contract with the Government of the Maldives.

The time required from tender announcement to signing of the construction contract is expected to be 1.5 months each for the First and Second Phases.

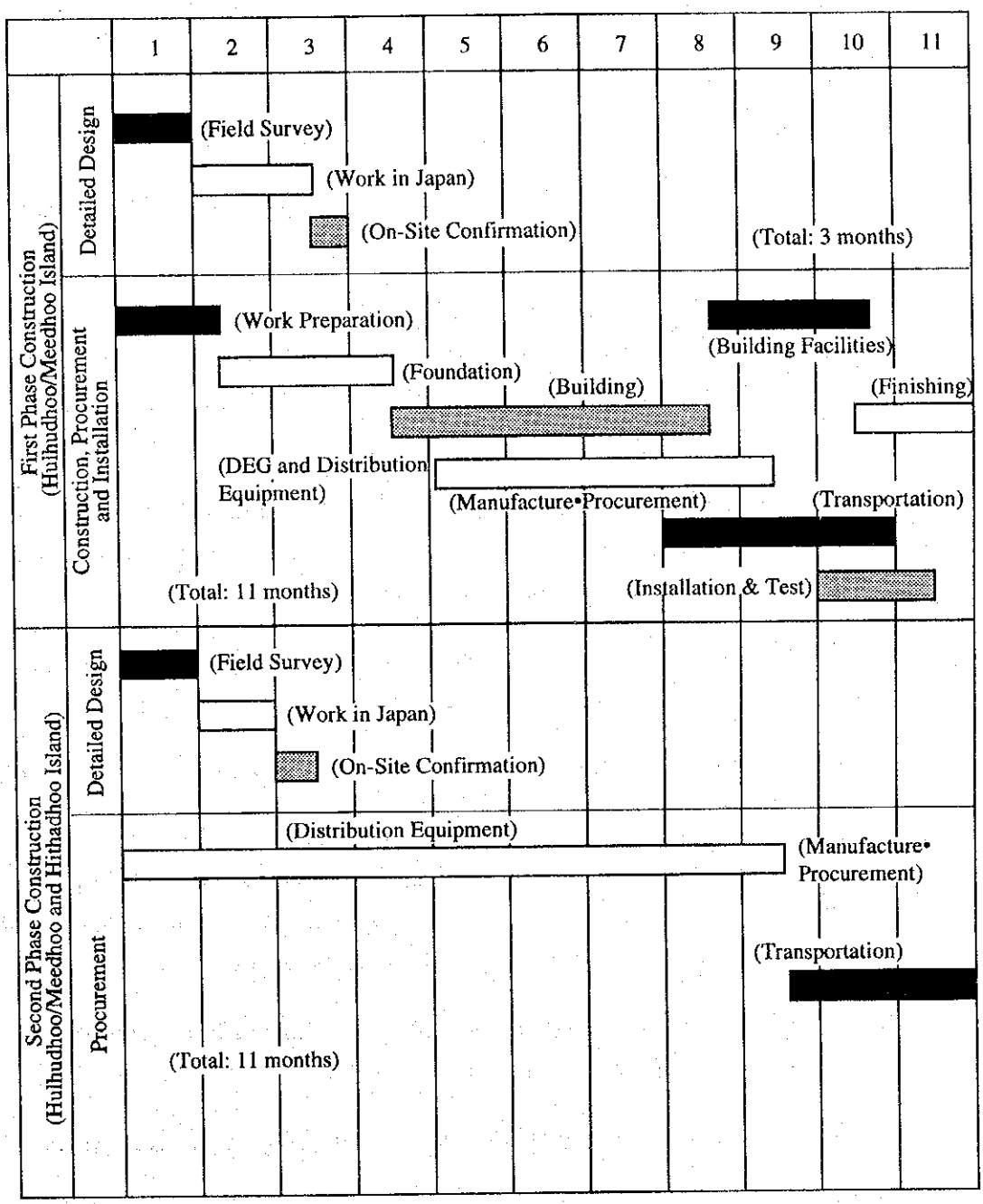
(3) Building Construction and Equipment Installation

Following the signing of the construction contract, the Contractor will commence the equipment procurement and construction work on receipt of verification from the Government of Japan. The time required for construction is estimated to be 10 months for the First Phase and 11 months for the Second Phase.

The Consultant will conduct the detailed arrangements prior to the commencement of construction work and supervise the Contractor in regard to the transportation of equipment and materials, construction methods and work schedule, etc., and will enforce schedule control and quality control to complete the entire work before the deadline stipulated in the E/N.

Table 3-1-4 shows the project implementation schedule.

Table 3-1-4 Project Implementation Schedule



3-1-7 Obligations of Recipient Country

Necessary measure to be taken by the Government of Maldives in case Japan's Grant Aid is extended are as follows;

1) To provide necessary data and information for the Project.

2) To ensure speedy unloading, custom clearance of the goods for the Project at the port and/or airport of disembarkation.

3) To accord Japanese national whose services may be required in connection with the supply of the products and the services under the verified contract(s) such facilities as may be necessary for their entry into the Republic of Maldives and stay therein for the performance of their work.

4) To meet the charge of customs duties, internal taxes and other fiscal levies which may be imposed in the Republic of Maldives with respect to the supply of the products and services under the verified contracts.

5) To bear commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.

6) To bear all the expenses, other than those to be borne by the Grant Aid necessary for the execution of the Project.

7) To assign exclusive counterpart engineers and technicians to the Project in order to transfer the operation and maintenance technique for the Project and to witness and confirm construction when inspection is carried out.

8) To maintain and use properly and effectively the facilities constructed and equipment provided under the Japan's Grant Aid.

9) To provide public electricity to the peoples of the subject islands by MEB.

10) To secure and provide cleared, embanked and leveled land as well as access road for the project site prior to the commencement of the construction by the Japanese side and to construct incidental outdoor facilities, boundary fence(s) and entrance gate(s) by the completion of the power station at Hulhudhoo/Meedhoo Island.

11) To install the equipment and materials supplied by the Japan's Grant Aid for power distribution networks in accordance with the design drawings prepared by

the Japanese side and to complete installation works within three (3) months after delivery of such equipment and materials to Hithadhoo Island.

12) To install the equipment and material supplied by the Japan's Grant Aid for power distribution networks in accordance with the design drawings prepared by the Japanese side and to complete installation works by the one month before the starting of the test operation of DEGs in Hulhudhoo/Meedhoo Island.

13) To install household panels including grounding system and street lightings necessary for the Project in accordance with the proper implementation schedule to meet the requirements of the Japan's Grant Aid.

14) To construct an office building including building services at Hulhudhoo/ Meedhoo power station in accordance with the proper implementation schedule to meet the requirements of the Japan's Grant Aid.

15) To construct a power house and it's auxiliary building(s) including necessary equipment foundations at MEB's Hithadhoo power station and to relocate the generating facilities including their auxiliaries from private companies before the implementation of the Japan's Grant Aid.

16) To procure and to install a fuel supply system and electrical equipment including a step-up transformer necessary for Hithadhoo power station before the implementation of the Japan's Grant Aid.

17) To utilize properly the existing generating facilities in Hulhudhoo/Meedhoo Island to another Island's electrification by the Government of Maldives.

18) To purchase necessary spare parts for the maintaining the equipment provided under the Project, by MEB's own budget, after two (2) years of the completion of the Project.

19) To take necessary measures for the prevention of the environmental pollution such as disposal of oil sludge, etc.

20) To take necessary measures for improvement of the tariff system in order to maintain the sustainable operation of the power stations at both islands.

21) To bear the cost for fuel and lubrication oil during commissioning test at Project site.

3-2 Operation and Maintenance Plan

(1) Basic Principles

Among the new facilities and equipment to be installed under the Project, the DEGs are the most important from the viewpoint of the maintenance requirement as these must be operated and maintained in a specific environment to ensure a stable supply of power to meet the demand despite constant fluctuations.

In relation to the Project, the MEB will be required to conduct the maintenance of the new generating facilities following the completion of the Project, within the above basic framework, in accordance with the operation and maintenance manuals using the relevant technologies/techniques to be transferred through the OJT provided by the Japanese contractor during the construction period.

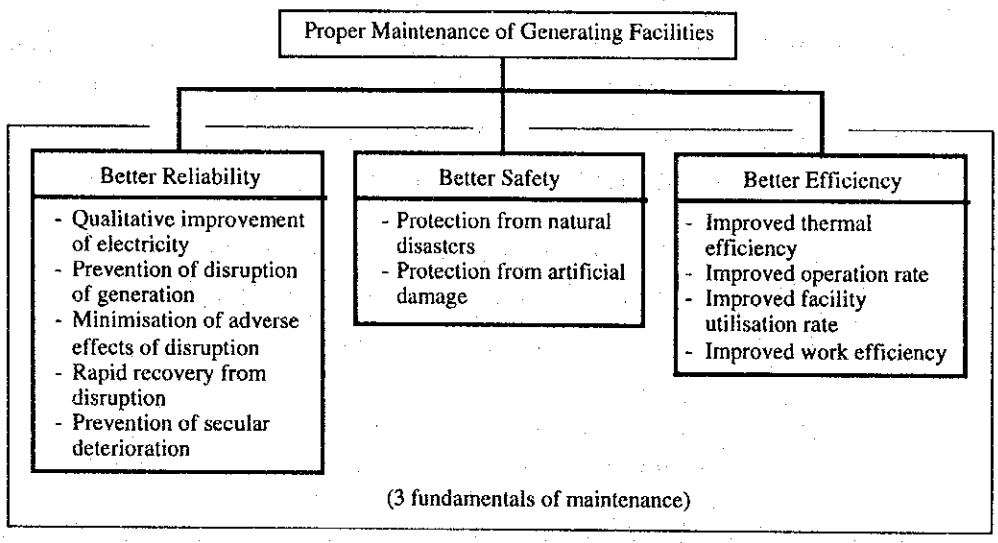


Fig. 3-2-1 Basic Maintenance Framework for Generating Facilities

(2) Regular Inspection Items

The standard subject items of regular inspection of the proposed generating facilities are listed in Table 3-2-1.

Table 3-2-1 Standard Subject Items of Regular Inspection

	Type of Inspection	Main Inspection Items/Work
Diesel Engine	daily (when in use)	- Visual external check; abnormal sound or temperature - Engine oil level - Lubricant oil pressure - Cooling water level - Fuel tank level - Leakage of oil and water - Drain deposit in Air Inlet
	every 50 hours	- Valve clearance (only first 50 hours for a new engine) - External nuts and bolts (tightening) (as above) - Engine oil (replacement) (as above) - Battery electrolyte level
	every 250 hours	- Dewatering from fuel tank - Dewatering from fuel filter - Engine oil (replacement) - Lubricant oil element (replacement) - Dewatering from lubricant oil filter - Tension of fan and dynamo driving belts - Radiator fins (cleaning) - Fan drive (greasing) - Cleaning of blower of turbocharger
	every 500 hours	- Oil filter element of governor (replacement) - Fuel filter element (replacement) - Fuel injection nozzle (readjustment)
	every 1,000 hours	- Valve clearance - External nuts and bolts (tightening) - Fuel injection timing - Air cleaner element (replacement)
	every 2,000 hours	- Air suction cooler (cleaning) - Air cleaner element (replacement)
Generator	daily (when in use)	- Visual external check; abnormal sound or temperature
	every month	- Abnormal vibration - Lubricant oil flow; oil leakage at bearings - Simple cleaning
	every year	- Insulation resistance; lead wire connectors - Auxiliary items, including space heater - Visual check and cleaning of bearings

(3) Fuel Oil Purchase Plan

The estimated annual fuel oil (diesel oil) consumption of the new DEGs on Hulhudhoo/Meedhoo Island is approximately 400 kl based on an assumed operation rate of 70%. The MEB will be required to prepare and implement a fuel oil purchase plan to ensure the undisrupted operation of these units.

(4) Spare Parts Procurement Plan

Spare parts for the DEGs are classified as standard spare parts which should be replaced in accordance with the working hours and emergency replacement parts. The Maldivian side is required to procure these spare parts in accordance with the regular inspection cycles described in Table 3-2-1. Under the Project, it is planned to purchase and stock 2 years' supply (to cover 12,000 operating hours) of spare parts, the main items of which (identified based on the regular inspection items) are listed below.

In view of this spare parts procurement plan, it will be necessary for the Maldivian side to prepare the necessary budget to procure the standard spare parts (approximately 3% of the generating facility cost) as well as emergency replacement parts within the next 2 years.

Main Standard Spare Parts

- Oil filter elements (72 sets)
- Lubricant oil filter elements (144 sets)
- Air-cleaner elements (36 sets)
- O-rings (one lot)
- Packings (one lot)
- Exhaust air valves (36 sets)
- Air-supply valves (36 sets)
- Valve springs (72 sets)
- Oil seals (one lot)
- Piston ring sets (54 sets)
- Connecting rod bolts (36 sets)
- Fuel injection nozzles (54 sets)
- Fuel injection valves (18 sets)
- Fuses (one lot)
- Lamps (one lot)

Main Emergency Replacement Parts

- Pistons (3 sets)
- Cylinder head (1 set)
- Connecting rods (between crank and piston) (3 sets)
- Fuel pump (1 set)
- Lubricant oil pump (1 set)
- Cooling water pump (1 set)
- Instruments (one lot)
- Protective relays (one lot)

(5) Electricity Tariff Plan

The MEB currently imposes an electricity charge of 1.5 Rf/kWh for atoll islands. Table 3-2-2 shows the balance sheet for the electricity supply operation of the new power house on Hulhudhoo/Meedhoo Island if the current charge is applied to the island.

As the table clearly shows, an annual operation rate of as high as 90% of the generating units (2 × 165 kW DEGs) will fail to establish self-financing operation at the current electricity tariff, making it necessary to supplement the deficit by the surplus on Male Island as in the case of the existing atoll islands to which the MEB supplies electricity. If the tariff is increased from the present 1.5 Rf/kWh to 2.0 Rf/kWh, however, the balance is expected to go into the black at an annual operation rate of 70% or more as shown in Table 3-2-3.

In the case of Hithadhoo Island (4 × 160 kW generators with one in reserve), the financial picture of operation is similar to that of Hulhudhoo/Meedhoo Island in that the balance will go into the red with the current tariff of 1.5 Rf/kWh even at an annual operation rate of 90%. Revision of the tariff to 2.0 Rf/kWh will put the operation into the black with a minimum annual operation rate of 60%.

Given the above assessment of the future financial picture of operation, the Government of the Maldives and MEB should consider revising the electricity tariff to an appropriate level in order to ensure the self-reliant development of the country's electricity sector.

Table 3-2-2 Estimated Revenue and Expenditure for Operations at the Hulhudhoo/Meedhoo Plant (1.5Rf/kWh)

Item	Unit	Annual Operating Ratio				
		50%	60%	70%	80%	90%
I. Revenue						
1. DEG capacity (165kW × 2)	kW	330	330	330	330	330
2. Annual operating hours	hr	4,380	5,256	6,132	7,008	7,884
3. Total power generated	kWh	1,445,400	1,734,480	2,023,560	2,312,640	2,601,720
4. Load in power station	%	5	5	5	5	5
5. Transmission power loss	%	10	10	10	10	10
6. Total power sold	kWh	1,228,590	1,474,308	1,720,026	1,965,744	2,211,462
7. Average rate (home, public)	Rf/kWh	1.5	1.5	1.5	1.5	1.5
8. Revenue from sales	Rf	1,842,885	2,211,462	2,580,039	2,948,616	3,317,193
II. Expenditure						
1. Fuel oil	Rf	925,056	1,110,067	1,295,078	1,480,090	1,665,101
2. Lubrication oil	Rf	72,270	86,724	101,178	115,632	130,086
3. Cooling water	Rf	0	0	0	0	0
4. Salary	Rf	300,000	300,000	300,000	300,000	300,000
5. Maintenance	Rf	458,824	458,824	458,824	458,824	458,824
6. Management	Rf	36,858	44,229	51,601	58,972	66,344
7. Depreciation	Rf	1,019,608	1,019,608	1,019,608	1,019,608	1,019,608
8. Total expenditures	Rf	2,812,616	3,019,452	3,226,289	3,433,125	3,639,962
III. Operating Balance	Rf	-969,730	-807,990	-646,240	-484,509	-322,769

Conditions assumed:

(1) The electricity rate is the same as the rate MEB charges on other atolls, 1.5Rf/kWh.
(2) Internal consumption rate and transmission power loss are hypothetical.
(3) Fuel oil cost was set at 3.2Rf/ℓ.
(4) Lubrication oil cost was set at 25Rf/ℓ.
(5) Rain water will be used for cooling therefore the cost is 0.
(6) Oil consumption rate was set as follows:
    Fuel oil : 0.2 ℓ/kWh
    Engine oil : 0.002 ℓ/kWh
(7) Salary was calculated based on 25 workers at the actual cost of labour in the Naifal Island (Phase I Project).
(8) Maintenance costs were estimated at 3% of the total equipment cost (approx. 130 million yen)
(9) The management cost was set at 2% of revenue from electric rates.
(10) The depreciation was calculated on a 15 year power station life with 0% remaining value, and a capital cost of approximately 130 million yen.
(11) Exchange rate was set at 1Rf = 8.5 yen.

Table 3-2-3 Estimated Revenue and Expenditure for Operations at the Hulhudhoo/Meedhoo Plant (2.0Rf/kWh)

Item	Unit	Annual Operating Ratio				
		50%	60%	70%	80%	90%
I. Revenue						
1. DEG capacity (165kW × 2)	kW	330	330	330	330	330
2. Annual operating hours	hr	4,380	5,256	6,132	7,008	7,884
3. Total power generated	kWh	1,445,400	1,734,480	2,023,560	2,312,640	2,601,720
4. Internal consumption	%	5	5	5	5	5
5. Transmission power loss	%	10	10	10	10	10
6. Total power sold	kWh	1,228,590	1,474,308	1,720,026	1,965,744	2,211,462
7. Average rate (home, public)	Rf/kWh	2.0	2.0	2.0	2.0	2.0
8. Revenue from sales	Rf	2,457,180	2,948,616	3,440,052	3,931,488	4,422,924
II. Expenditure						
1. Fuel oil	Rf	925,056	1,110,067	1,295,078	1,480,090	1,665,101
2. Lubrication oil	Rf	72,270	86,724	101,178	115,632	130,086
3. Cooling water	Rf	0	0	0	0	0
4. Salary	Rf	300,000	300,000	300,000	300,000	300,000
5. Maintenance	Rf	458,824	458,824	458,824	458,824	458,824
6. Management	Rf	49,144	58,972	68,801	78,630	88,458
7. Depreciation	Rf	1,019,608	1,019,608	1,019,608	1,019,608	1,019,608
8. Total expenditures	Rf	2,824,902	3,034,195	3,243,489	3,452,783	3,662,077
III. Operating Balance	Rf	-367,721	-85,579	196,563	478,705	760,847

Conditions assumed:

(1) The electricity rate was set at 2.0Rf/kWh.

(2) Other conditions are the same as Table 3-2-2.