資料－5　フィールドレポート

BASIC DESIGN STUDY
FOR
ATOLL ISLAND ELECTRIFICATION PROJECT (Phase II)
IN
THE REPUBLIC OF MALDIVES

FIELD REPORT

AUGUST 1995

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1. Introduction

In order to build mutual understanding by the JICA Basic Design Study Team (hereinafter referred to as "the Team") for Atoll Island Electrification Project (Phase Ⅱ) (hereinafter referred to as "the Project") and Maldives Electricity Board (hereinafter referred to as "MEB") on the technical and engineering aspects, implementation schedule and work share for the Project, this Field Report was prepared by the Team based on the results of field surveys and discussions with officials concerned of MEB as well as MEB's requests.
However, all the items and components described in this report will be decided after further studies in Japan. And the draft final report will be submitted to Maldivian side around the end of October, 1995 as stated on the Minutes of Discussion signed on 10th of August, 1995.

2. Design Conditions

The following conditions shall be considered for the basic design of the Project.

2.1 Climatic and Site Conditions

The following data source from some meteorological data 1966-1991, Department of Meteorology Male' shall be adopted to the Project.

(1) Altitude of the sites	Approximately 1 m from sea level.		
(2) Ambient temperature	Maximum	34.1 ℃	(for AC.design:32.0℃)
	Minimum	17.2 ℃	
	Average	28.0 ℃	
(3) Wind : Velocity	Maximum	31.9 m/sec	
	Average	4.9 m/sec	
: Direction	Spring	W to E	Wet monsoon
	Summer	W to E	Wet monsoon
	Autumn	W to E	Wet monsoon
	Winter	NE to SW	Dry season
(4) Relative humidity	Annual mean	95 %	
(5) Rainfall	Annual mean	1,943.0 mm	
	Month mean	162.0 mm	
	Day maximum	175.9 mm	
	One hour Max.	10.0 mm	
(6) Seismic acceleration	Nil		
(7) Thunder days	34 times/year		
(8) Soil bearing capacity	10 tons/m2(assumed)		
(9) Under ground water level	50 cm below ground level		

2.2 Power Supply Conditions

(1) Power Demand Forecast

Power demand forecast of subject islands up to year 2000 is given in the following table. (As of Aug. 1995) (kW)

Island	No, of Household as of Jul'95	Demand/per Household (W/house)	1995	1996	1997	1998	1999	2000
Hulhudhoo/Meedhoo	789	230	181	200	220	242	266	292
Hithadhoo	1,345	250	336	370	407	448	492	542

(Note-1) Demand of one household includes public facility's demand.
(Note-2) Demand increase ratio per one year is assumed as 10% up to year 2000.
(Note-3) It can be judged that the total capacity of existing generators (4 x 160kW) in Hithadhoo is enough for demand in year 2000.

(2) Type of Generators	Diesel Engine Generator (continuous type)
(3) Number of DEG set	2 sets for normal operation and 1 set for stand-by
(4) Fuel system	
1) Fuel	Diesel oil (Same as Phase I Project)
2) Main oil storage tank capacity	Enough for one month operation(30 days)
3) Day tank capacity	One tank for 3 DEG enough for 10 hours operation
(5) Electrical system	
1) Generating system	3 phase, 4 wire, 415/240 V, 50 Hz
2) Distribution system	3 phase, 4 wire, 400/230 V, 50 Hz (Supply voltage to the consumers)
3) Control system	AC 200/100 V and DC 24 V
(6) Neutral earthing system	Direct earth for 400 V lines and fuel storage tank. (Lightning protection will be earthed separately.)
(7) Allowable voltage drop for distribution lines.	Maximum 7.5 % according to standard in UK

2.3 Design standards to be applied

The following standards shall in principle be applied to the Project.

(1) Noise level	JEAC or equivalent
(2) Exhaust gas	Relevant Japanese standards
(3) Civil and building works	AIJ or equivalent
(4) Generating facilities	JIS, JEM, JEC, or equivalent
(5) Electrical panels	JIS, JEM, JEC, or equivalent
(6) Distribution facilities	British Standards or equivalent

3. Generating Facilities for Hulhudhoo/Meedhoo Island

3.1 Outline drawings for Major Facilities

Outline drawings for major generating facilities are attached as follow;

(1) Site layout plan	See Attachment-1
(2) One line diagram	See Attachment-2
(3) Fuel flow diagram	See Attachment-3
(4) Power House Layout	See Attachment-4

3.2 Diesel Engine Generator(DEG)

(1) Diesel Engine	
1) Operating duty	Continuous
2) Capacity	150 kW (203.94 PS)
3) Revolution	1,500 rpm
4) Type	Indoor
5) Fuel	Diesel oil
6) Starting method	DC starting motor
(2) Generator rating	
1) Operating duty	Continuous
2) Capacity	187.5 kVA
3) Type	Synchronous
4) Frequency	50 Hz
5) Revolving speed	Same as diesel engine
6) Rated voltage	415/240 V
7) Power factor	0.8 (lagging)
8) Connection	Wye(Y), neutral shall be directly earthed

DISEMD

9) Excitation	Brush-less type
10) Synchronizing	Auto and Manual

3.3 Fuel system

(1) Fuel flow diagram	See Attachment-3
(2) Main oil storage tank	Approximately 75 m3 (for one month operation)
(3) Day tank capacity	Approximately 1.0 m3 (for 10 hours operation)
(4) Oil transfer pump	2 sets (1 set for stand-by) of 40 l/min. (Pump capacity shall be capable of transferring fuel into a day tank within five minutes per a 200 liter drum can.)
(5) Transfer system from a main tank to a day tank	Automatic control system by level switch installed in a day tank.
(6) Handy pump	One set with 5 m hose
(7) Piping	To be installed on the ground (Aerial or in trench)
(8) Oil/Water separator	To be provided on the common delivery line of fuel transfer pump
(9) Composition of Fuel	Same as Phase I Project

Item	Unit	Value
Specific Gravity (60 F°C)	-	0.82 - 0.89
Kinematic Viscosity (40°C)	Stokes(CST)	1.80 - 5.00
Pour Point	°C	9
Flash Point	°C	60
Sulfur Content	wt %	1.0
Water Content	Vol.g	0.05
Ash Content	wt.g	0.01
Calorific Value	kj/kg	42,700

3.4 DC Power Supply System

Common DC 24 V system shall be supplied for the following equipment and systems

(1) Starter of DEG

(2) Control source for a generator control panel

(3) Power source for the communication facility

3.5 Workshop Equipment, Tool, Spare Part, etc.

(1) High frequency radio equipment

1 set of base station and 6 sets of handy talkies shall be provided for each site as same as Phase I Project.

Base station; 3 channels shall be programmed:

Ch.1 146.375 MHz
Ch.2 146.400 MHz
Ch.3 146.425 MHz

(2) Workshop equipment and Maintenance tool

- 1 lot of workshop equipment same as phase I Project shall be provided for Hulhudhoo/ Meedhoo site.
- 1 lot of diesel engine maintenance tool same as phase I Project shall be provided for Hulhudhoo / Meedhoo site including tacho-meter.
- 1 lot of maintenance tool for electrical equipment same as phase I Project shall be provided.
- 1 set of meggaer tester, DC dielectric insulation tester for 11kV and transformer insulation oil tester shall be provided.

(3) Spare Parts
- Spare parts for diesel engines, generators and Panels same as phase I Project shall be provided.
- Air filters of DEG shall be provided for 2 years.

4. Distribution facilities for Hulhudhoo/Meedhoo and Hithadhoo Islands

Major equipment and materials to be provided for the power stations and power distribution networks for Hulhudhoo /Medhoo and Hithadhoo islands shall be as follows:

4.1 Step-up transformer

In order to minimize the voltage drop of distribution networks, a step-up transformer and its auxiliaries shall be provided to the power stations.

Specifications for main equipment are as follows:

(1) Step up transformer

1) For Hulhudhoo/Meedhoo	Capacity	400kVA
	Voltage	415V/11kV
	Connection	△-△
	Type	Outdoor type
	Cooling	Oil and natural cooling
2) For Hithadhoo (to be supplied and installed by MEB)	Capacity	750kVA
	Voltage	415V/11kV
	Connection	△-△
	Type	Outdoor type
	Cooling	Oil and natural cooling

(2) LV panel for step-up transformer

1) For Hulhudhoo/Meedhoo	1 pc	ACB for 400kVA transformer with all protection system
	1 pc	V-meter with selector switch
	1 pc	A-meter with selector switch
	3 pcs	Indication lamps with fuses for incoming.
	3 pcs	Indication lamps with fuses for outgoing
	1 lot	busbar
2) For Hithadhoo (to be supplied and installed by MEB)	1 pc	ACB for 750kVA transformer c/w all protection and CT's
	1 pc	V-meter with selector switch
	1 pc	A-meter with selector switch
	3 pcs	Indication lamps with fuses for incoming
	3 pcs	Indication lamps with fuses for outgoing
	1 lot	busbar

(3) HV and LV outgoing panels

1) For Hulhudhoo/Meedhoo	1 lot	Details are shown in Attachment-5
2) For Hithadhoo (to be supplied and installed by MEB)	1 lot	Details are shown in Attachment-6

4.2 Distribution Substation

In order to step-down the voltage from 11kV to 415/240V, equipment and materials for distribution substations (DS) will be provided by Japanese side. Installation of such equipment and materials including civil works and construction of shed will be carried out by MEB. Each DS will consist of the following equipment :

(1) HV fuse box	1 set	1 x 11kV power fuse. Self-standing weather proof type

(2) Transformer	1 set	Voltage ; 11kV/415/240V Connection ; △-Y
(3) LV distribution board	1 set	Refer to Attachment-5 and 6

4.3 Local distribution panel

In order to distribute 1- phase 230V and /or 3 phase - 400 V power to consumers, Local distribution panels will be provided by the Japanese side. Installation of local distribution panels including civil works shall be carried out by MEB. Each local distribution panel will consist of the following equipment :

(1) Type and structure of case — Outdoor wall flush mounted type made by fiberglass reinforced polyester(FRP).

(2) Rated voltage — 400/230 V (Supply voltage to consumers)

(3) Components

1) Incoming circuit breaker with ELR (setting 0.03-10A, timer 0-0.5sec.)	1 set
2) Outgoing circuit breaker (1 pole 20 A)	15 set
3) Outgoing circuit breaker (3 poles 30 A)	1 set
4) Space for future outgoing circuit breakers (3 poles 30 A)	space for 2 sets
5) Jumper terminal to next local distribution board	1 set
6) Internal wiring	1 lot
7) Space heater and it's auxiliaries	1 set
8) Earthing rod	1 set

4.4 Household Panels

(1) Scope of supply — Maldivian side will provide all the household panels for the Project prior to the completion of the construction by the Japanese Side.

(2) Component

The household panel consist of following equipment and materials. Household panels for public facilities, commercial facilities, factories, etc. will be designed and supplied by MEB.

1) Disconnecting switch with fuse	1 set
2) Watt-hour meter	1 set
3) ELCB (30 mA)	1 set
4) Socket Outlet (3 phase. BS type)	3 set
5) Wooden panel board	1 set
6) Wiring	1 lot

4.5 Power distribution cable

(1) 11kV distribution cable

In order to feed 11kV power to the distribution substations (DS), 11kV distribution cable shall be buried under the ground (approx. 75 cm deep) from the power station to the DS. Main specifications of 11kV distribution cable shall be as follows;

1) Insulation voltage	AC 11kV
2) Specifications	XLPE insulated, metal armored and PVC sheathed copper conductor cable (to be conformed to IEC or BS .)
3) Color identified	According to BS (3 cores)

(2) Main distribution cable

Main distribution cable shall be buried under the ground (approx. 75 cm deep) from the main distribution board installed in the power station and DS to the local

distribution panels.
Main specification of the cables as follows;

1) Insulation voltage	AC 600/1000 V
2) Specification	PVC insulated, metal armored and PVC sheathed copper conductor cable (to be conformed to IEC or BS 6346.)
3) Color identified	Red, yellow, blue and black (4 cores)

(3) Branch distribution cable
Branch distribution cable shall be provided and buried under the ground (approx. 75 cm deep) from the local distribution panels to the household panels by MEB prior to the completion of the construction by the Japanese Side.
Main specification of the cables shall be as follows :

1) Insulation voltage	AC 600/1000 V
2) Specification	PVC insulated, and PVC sheathed copper conductor cable (shall be conformed to IEC or BS.)
3) Color identified	Black and White (2 cores)
4) Minimum size of cable	6 mm2 as MEB standard

(4) Accessories

1) Underground warning tape	100 micron polyethylene and 15 cm wide for main distribution lines.
2) Cable fault locator	1 set for each site.
3) PVC conduit pipe	1 inch size for protection of cables between ground level to household panels will be provided and installed by MEB.

4.6 Street Lighting
Street lighting fixtures including photo-cell switches, anchor bolts, foundations, branch cables for them from local distribution panels, etc. shall be designed and supplied by MEB.

5. Power House Building

Descriptions of the Power house building to be constructed by the Japanese side at Hulhudhoo/Meedhoo island shall be as follow. Layout drawing is attached in Attachment-4

5.1 Rooms (Total floor area shall be approximately 200 m2)
(1) Diesel Engine Generators room (DEG)
(2) Control room
(3) Engineers room
(4) Battery room
(5) Spare parts store
(6) Workshop
(7) Entrance
(8) Toilet
(9) Kettle

5.2 Specifications
(1) Structure

1) Foundation, Ground floor slab, Column,	Reinforced concrete
2) Roof	Steel truss + Steel corrugated sheet with insulation

3) Wall	Local coral brick (200mm, 100mm)
(2) Finishing	
1) Wall	Cement mortar + EP
2) Floor (Control R. Engineers R.)	PVC tile
3) Floor (Other rooms)	Cement mortar steel trowel
4) Windows and doors	Aluminum, steel (outside) or wood
(3) Building services	
1) Air-conditioning	Control room and Engineers room
2) Ventilation	All other rooms
3) Rain water collection and supply system	1 lot
4) Well water supply system	1 lot
5) Drainage system with a septic tank	1 lot

6. Office building

An office building to be constructed at Hulhudhoo/Meedhoo island will be designed and constructed by MEB.

7. On-the-Job Training (OJT)

OJT for operation and maintenance (O & M) shall practically be carried out by the Japanese Contractor during the implementation period of the Project. MEB shall assign engineers and technicians to OJT in order to transfer the operation and maintenance technique of DEG sets. OJT program will contain the following items.

(1) O & M plan of DEG set including maintenance schedule, data log and document control.
(2) O & M procedure of DEG set.
(3) O & M execution and practical training for know-how of DEG set.

8. Tentative Implementation Schedule

The Project may be executed in two(2) stages. Attachment-7 shows a tentative idea of implementation schedule for the Project on condition that Japan's Grant Aid is extended to the Project.

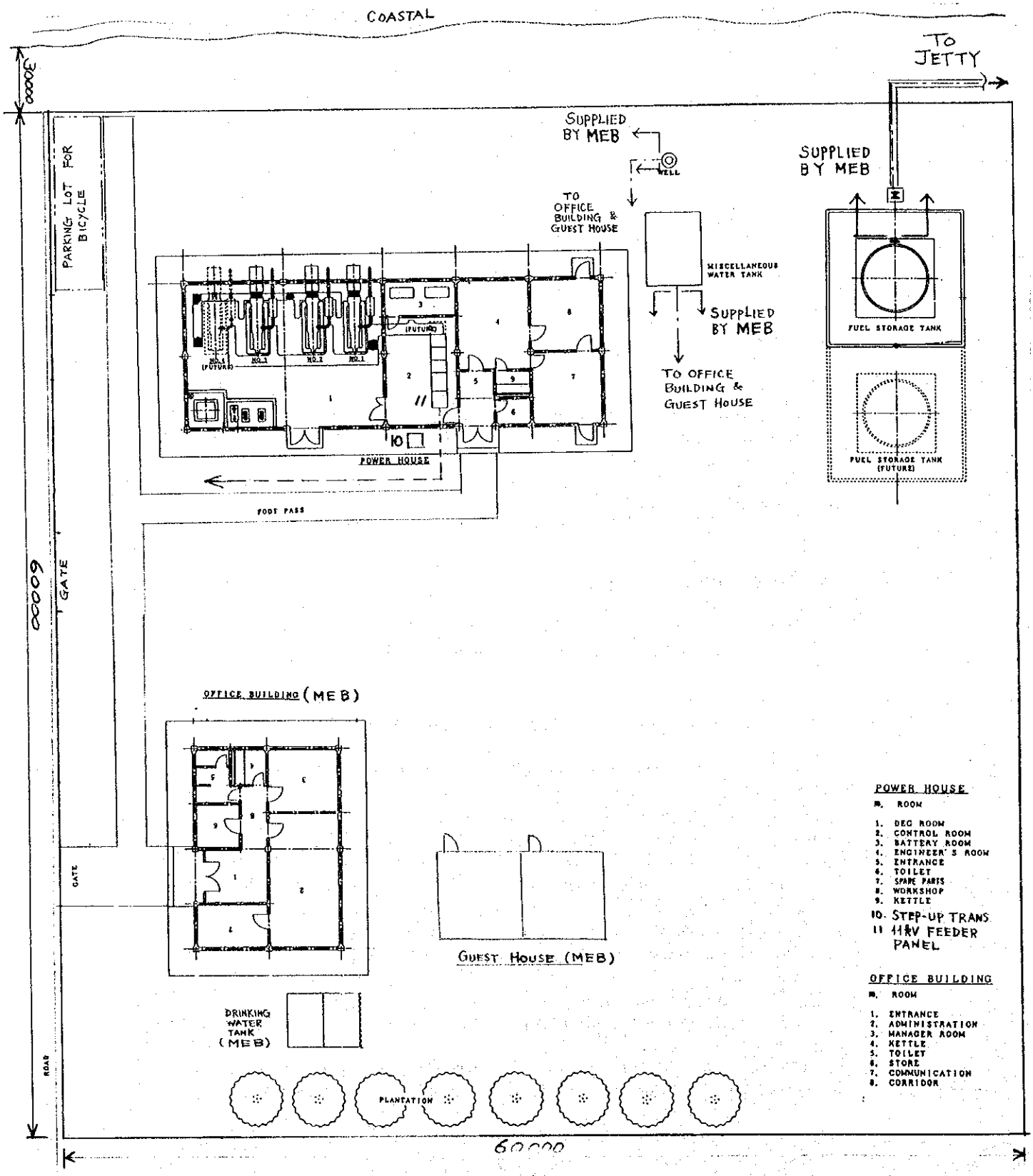
9. Work Share between Japanese side and Maldivian side

Undertakings by the Government of Maldives are described in the Minutes of Discussions (M/D) for the Project signed on 10 th August 1995.
In addition to the above, the following measures shall be taken by the Maldivian side and the detailed work share between Japanese side and Maldivian side is shown Attachment-8 on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

(1) To relocate the existing DEG sets in Hithadhoo island to the new power house which will be constructed by MEB.
(2) To provide topographical survey maps for the Project site.
(3) To take necessary measures to expedite the approval for execution of the Project by the Government of Maldives.
(4) To provide a bench mark at the sites.
(5) To facilitate proper arrangement for inter transportation of the facilities and equipment for the Project.
(6) To provide the disposal places of the surplus soil during the construction period.
(7) To bear the cost for the fuel and the lubrication oil during commissioning.

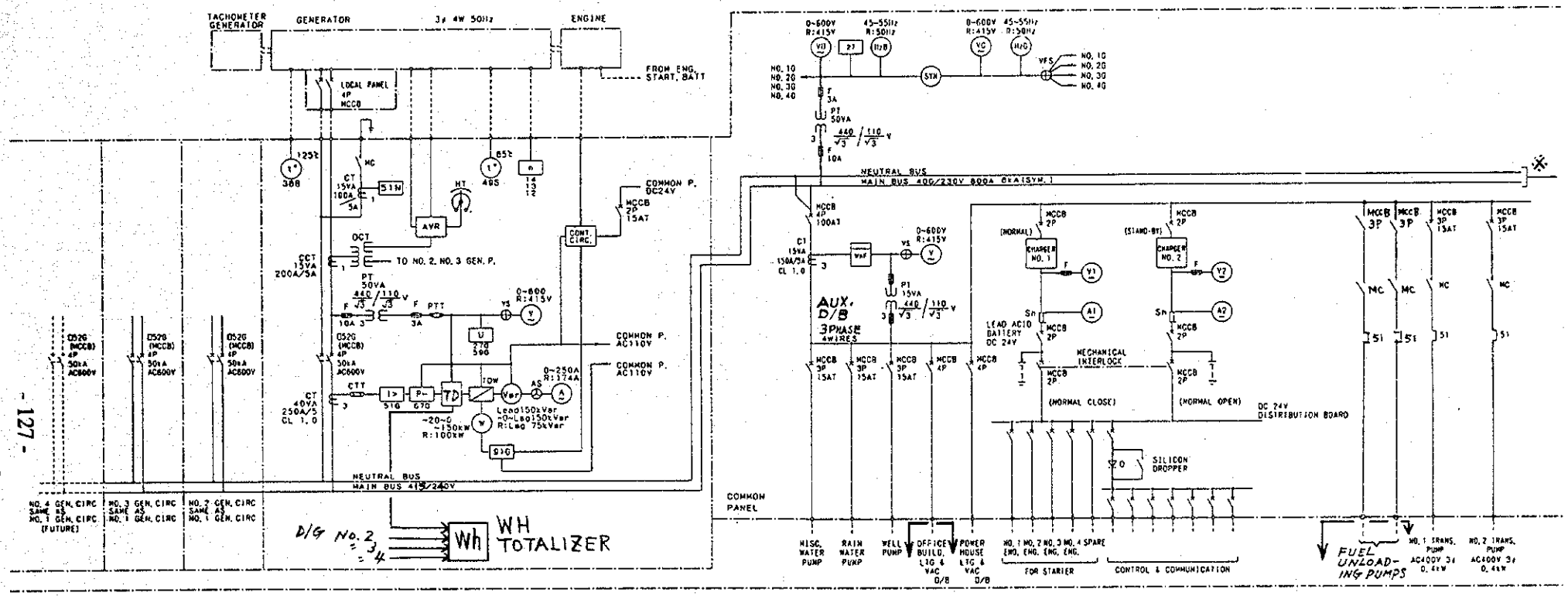
Attachment-1

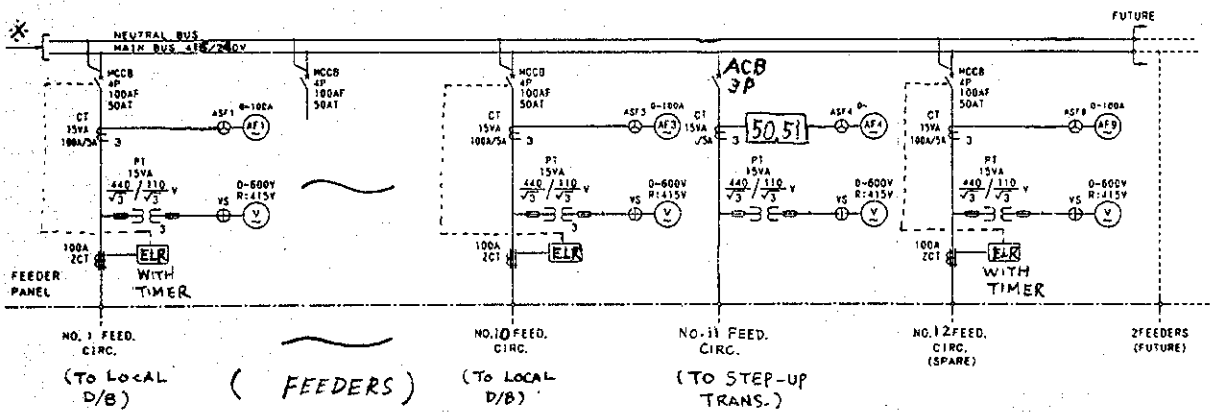
Site Layout Plan for Hulhudhoo/Medhoo Power Station



Attachment-2

One line Diagram of DEG

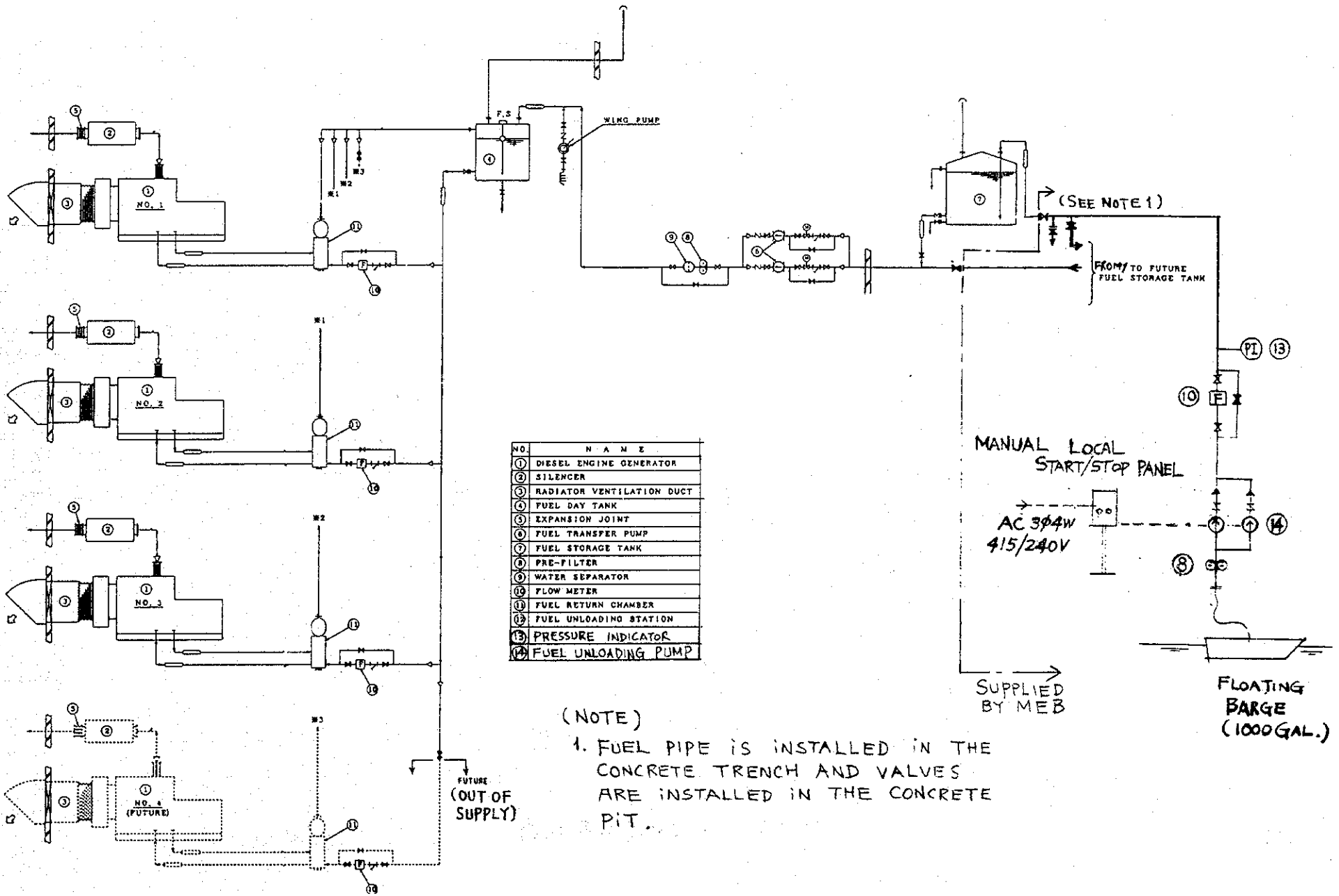




(NOTE)
SHOWS MEB SUPPLY

Attachment-3

Fuel Flow Diagram



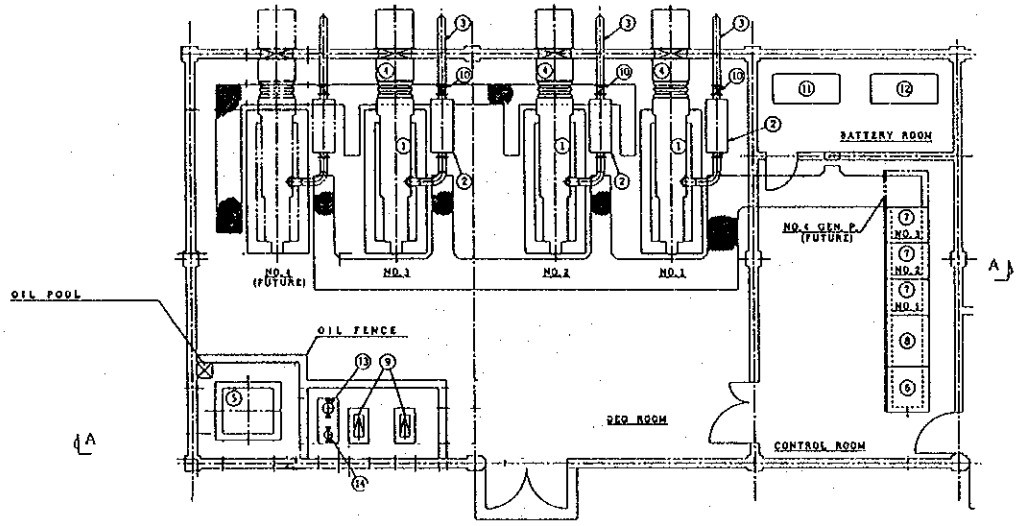
NO.	NAME
①	DIESEL ENGINE GENERATOR
②	SILENCER
③	RADIATOR VENTILATION DUCT
④	FUEL DAY TANK
⑤	EXPANSION JOINT
⑥	FUEL TRANSFER PUMP
⑦	FUEL STORAGE TANK
⑧	PRE-FILTER
⑨	WATER SEPARATOR
⑩	FLOW METER
⑪	FUEL RETURN CHAMBER
⑫	FUEL UNLOADING STATION
⑬	PRESSURE INDICATOR
⑭	FUEL UNLOADING PUMP

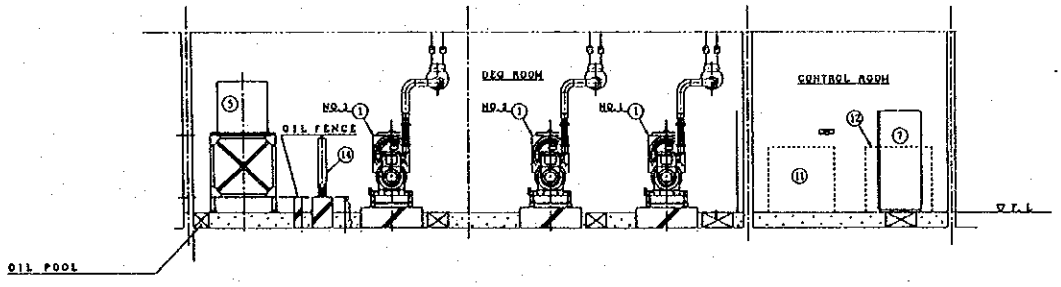
(NOTE)

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

Attachment-4

Power House Layout Plan



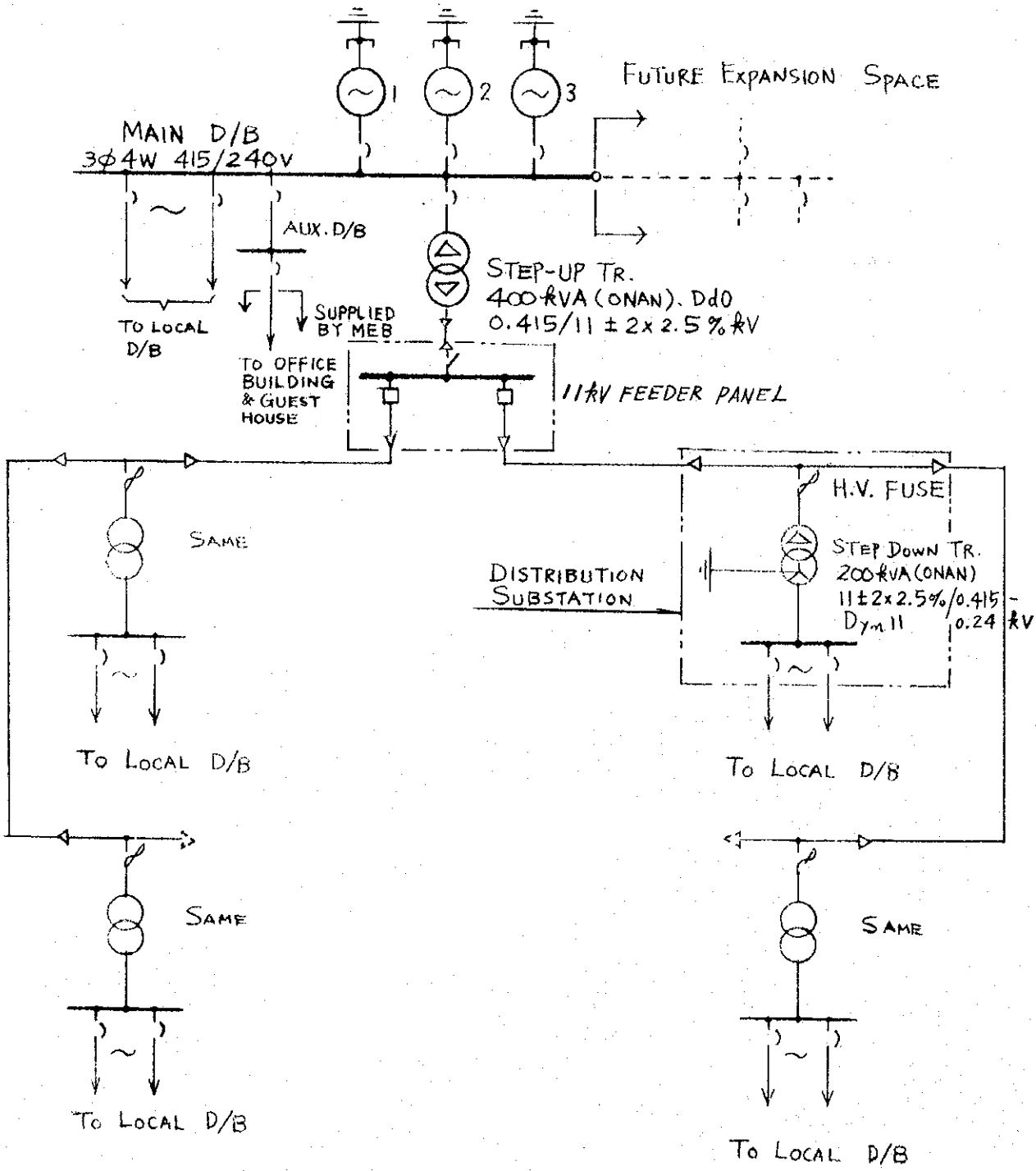


SECTION A-A S=1/50

NO.	NAME
①	DIESEL ENGINE GENERATOR
②	SILENCER
③	EXHAUST GAS PIPE
④	RADIATOR VENTILATION DUCT
⑤	FUEL DAY TANK
⑥	FEEDER PANEL
⑦	GENERATOR PANEL
⑧	COMMON PANEL
⑨	FUEL TRANSFER PUMP
⑩	EXPANSION JOINT
⑪	BATTERY
⑫	BATTERY (STAND-BY)
⑬	PRE-FILTER
⑭	WATER SEPARATOR

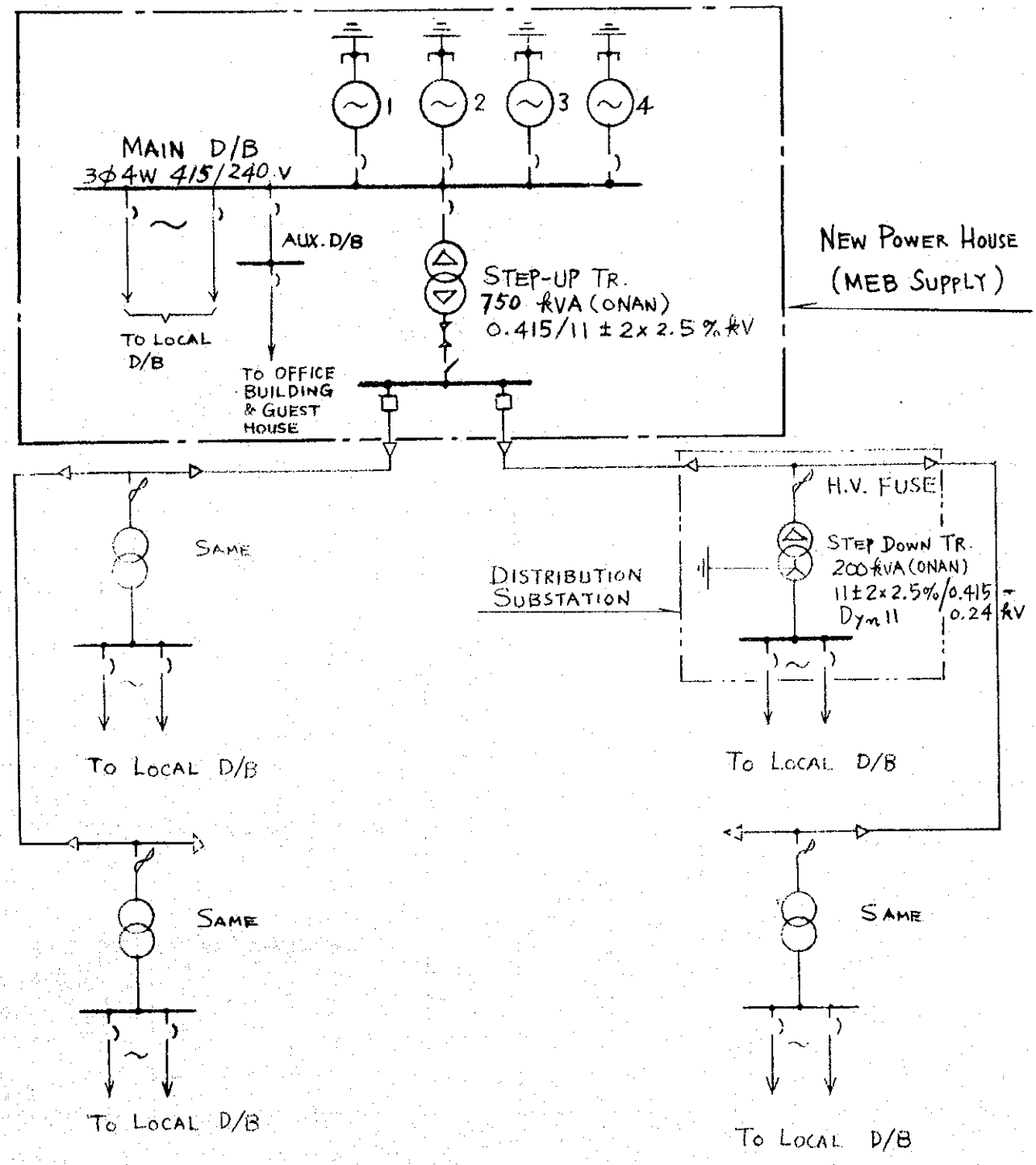
Attachment-5

One line diagram of distribution networks in Hulhudhoo/Meedhoo island



Attachment-6

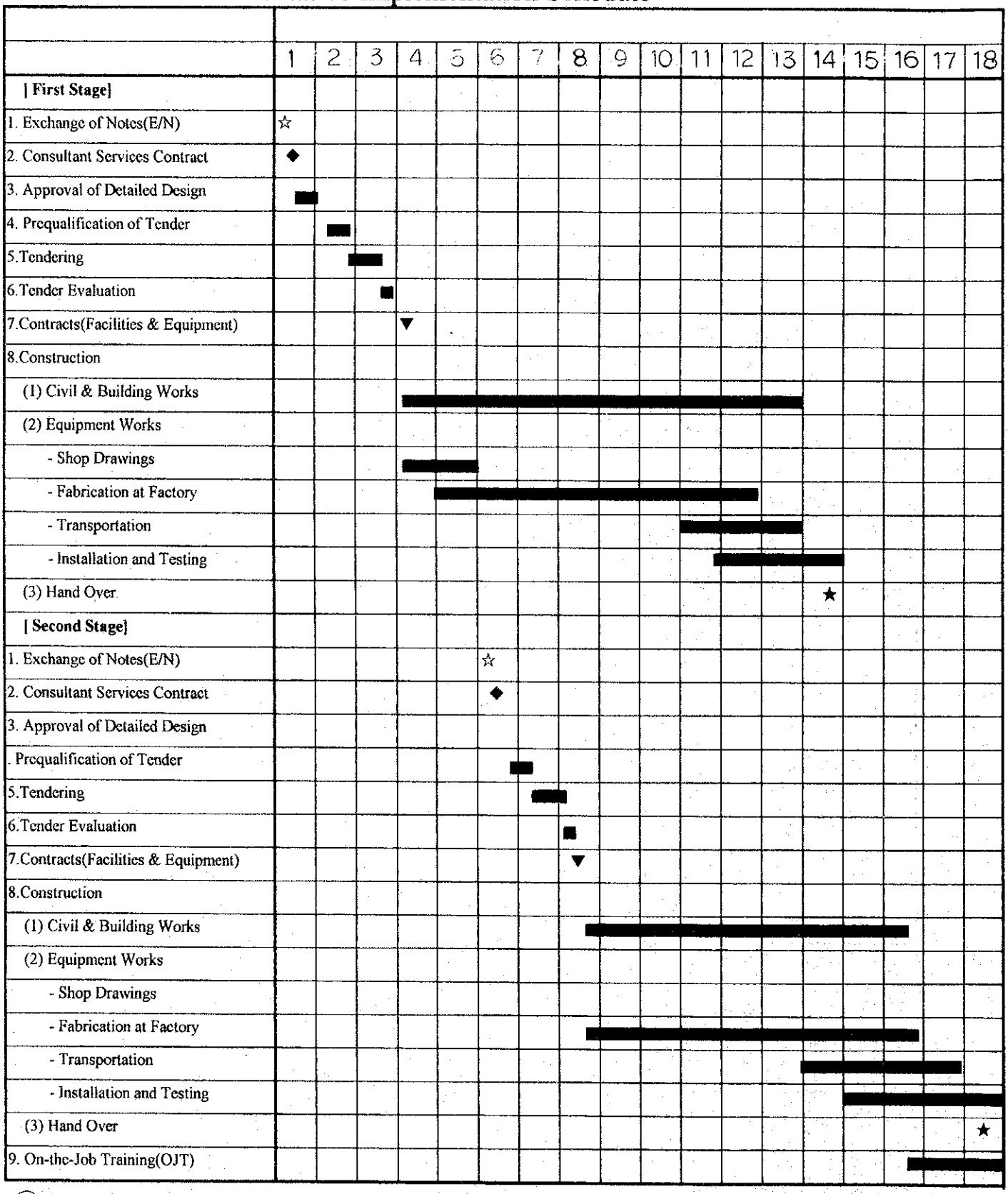
One line diagram of distribution networks in Hithadhoo island



Attachment-7

Atoll Islands Electrification Project(Phase II) in the Republic of Maldives

Tentative Implementation Schedule



Attachment-8

WORK SHARE

Maldivian side has requested and the Team has confirmed that work items and working shares between Japanese side and Maldivian side described in the following table for smooth and effective implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project. Maldivian side has confirmed that works of Maldivian side shall be executed in accordance with proper schedules to meet the requirements of the Japan's Grant Aid.

Work Items	Japanese Side	Maldivian Side
1. Diesel Engine Generating Facilities for Hulhudhoo/Meedhoo		
1.01 Diesel Engine Generator(DEG)	Supply and Installation	
1.02 Auxiliary equipment for DEG	Supply and Installation	
1.03 Electrical equipment for DEG	Supply and Installation	
1.04 Main and daily fuel oil tank(s) and fuel supply line(s) (1-month stock)	Supply and Installation	
1.05 Main fuel oil tank for future(3 months-stock)		Supply and installation
1.06 Grounding system within the Power Station(P/S)	Supply and Installation	
1.07 Workshop equipment installed in P/S	Supply only	Installation
1.08 Communication equipment installed in P/S	Supply only	Installation
1.09 Maintenance tools for DEG and auxiliaries	Supply only	Stock
1.10 Spare Parts for DEG and auxiliaries	Supply only	Stock
1.11 Operation & Maintenance Manuals for DEG	Supply and Explanation	Keep and Study
1.12 On-the-Job Training (OJT) for O & M techniques for DEG	Execution	Attend
2. Power distribution networks for Hulhudhoo/Meedhoo and Hithadhoo		
2.01 Step-up transformer with LV panel for Hulhudhoo/Meedhoo	Supply and installation	
2.02 Step-up transformer with LV panel for Hithadhoo	Basic design	Supply and installation
2.03 11kV outgoing feeder panel for Hulhudhoo/Meedhoo	Supply and installation	
2.04 11kV outgoing feeder panel for Hithadhoo	Basic design	Supply and installation
2.05 Distribution substations (DS)	Supply only	Installation
2.06 Main distribution panels to be installed in P/S at Hithadhoo		Supply and Installation
2.07 Main Power distribution cables	Supply only	Installation
2.08 Branch Power distribution cables		Supply and Installation
2.09 Outdoor distribution boards	Supply only	Installation
2.10 Grounding materials	Supply only	Installation
2.11 Household panels		Supply and Installation
2.12 Street lightings		Supply and Installation
3. Construction of Civil and building works for Hulhudhoo/Meedhoo		
3.01 Power house building	Construction	
3.02 Oil tanks and Equipment foundations	Construction	
3.03 Office building and the site plantation		Design and Construction
3.04 Rain water collection & supply system for the Power house building	Construction	
3.05 Rain water collection & supply system for the Office building		Design and Construction
3.06 Well and well water supply system	Construction	Construct. inside Office
3.07 All furniture and curtain		Supply
3.08 Site Leveling, Boundary fence, Entrance gate and Access road		Design and Construction
3.09 Electricity for construction	Construction	
3.10 Water supply & drainage for construction	Construction inside the site	Construction to the site
3.11 Electricity and telephone for construction	Construction inside the site	Construction to the site

資料－6　参考資料リスト

様式第１号

平成 7 年 9 月 6 日作成

資料リスト（収集資料）

主管部長	文書管理課長	主管課長	情報管理課長	技術情報課長

地域	南西アジア	調査団名又は専門家氏名	地方環礁島嶼化計画(フェーズII)	調査の種類又は指導科目	基本設計調査	作成部課	国際事業部
国名	REPUBLIC OF MALDIVES	配属機関名	八千代エンジニヤリング(株)	現地調査期間又は派遣期間	1995年7月31日～1995年 9月 3日	担当者氏名	小宮 雅嗣

番号	資料の名称	版型	ページ数	オリジナルコピーの別	部数	収集先名称又は発行機関	寄贈・購入（価格）の別	取扱区分	利用表示
1	AN INTRODUCTION OF REPUBLIC OF MALDIVES	B4	11	オリジナル	1	MINISTRY OF INFORMATION AND CULTURE, REPUBLIC OF MALDIVES	購入		
2	MALDIVES : A GLOBAL VIEW	B5	108	オリジナル	1	THE DEPARTMENT OF INFORMATION AND BROADCASTING, MALDIVES	〃		
3	The Maldives Diary 1995	A4	184	オリジナル	1	GOVERNMENT OF REPUBLIC OF MALDIVES	〃		
4	EMPLOYMENT REGULATION OF THE REPUBLIC OF MALDIVES JANUARY 1994	A4	15	オリジナル	1	MINISTRY OF PLANNING HUMAN RESOURCES AND ENVIRONMENT, MALDIVES	〃		
5	CONTRACT OF EMPLOYMENT	A4	6	オリジナル	1	GOVERNMENT OF REPUBLIC OF MALDIVES	〃		
6	SUSTAINABLE Human Development Constraints, Plans and Strategies	A4	120	オリジナル	1	〃	寄贈		
7	Priority Development Requirements	A4	53	オリジナル	1	〃	〃		
8	VILLINGILI Island Development Plan	A4	101	コピー	1	UNDP & HABITAT	〃		
9	AIR QUALITY AND NOISE IMPACTS OF MALDIVES ELECTRICITY BOARD NEW DIESEL-POWERED ELECTRIC GENERATOR FACILITIES	A4	111	コピー	1	ASIAN DEVELOPMENT BANK	〃		
10	NATIONAL ENVIRONMENT ACTION PLAN	A4	65	コピー	1	MINISTRY OF PLANNING AND DEVELOPMENT, MALDIVES	〃		
11	NATIONAL DEVELOPMENT PLAN 1994-1996	A4	257	コピー	1	MINISTRY OF PLANNING, HUMAN RESOURCES AND ENVIRONMENT, MALDIVES	〃		

図書館提出用

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