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Département de DAKAR

RÉPUBLIQUE DU SÉNÉGAL
1/5000

Région du CAP VERT

LAC YOUI
FEUILLE 81-254

Département de DAKAR

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DAGOUDANE-PIKINE

Yeumbeul

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DAGOUDANE - PIKINE
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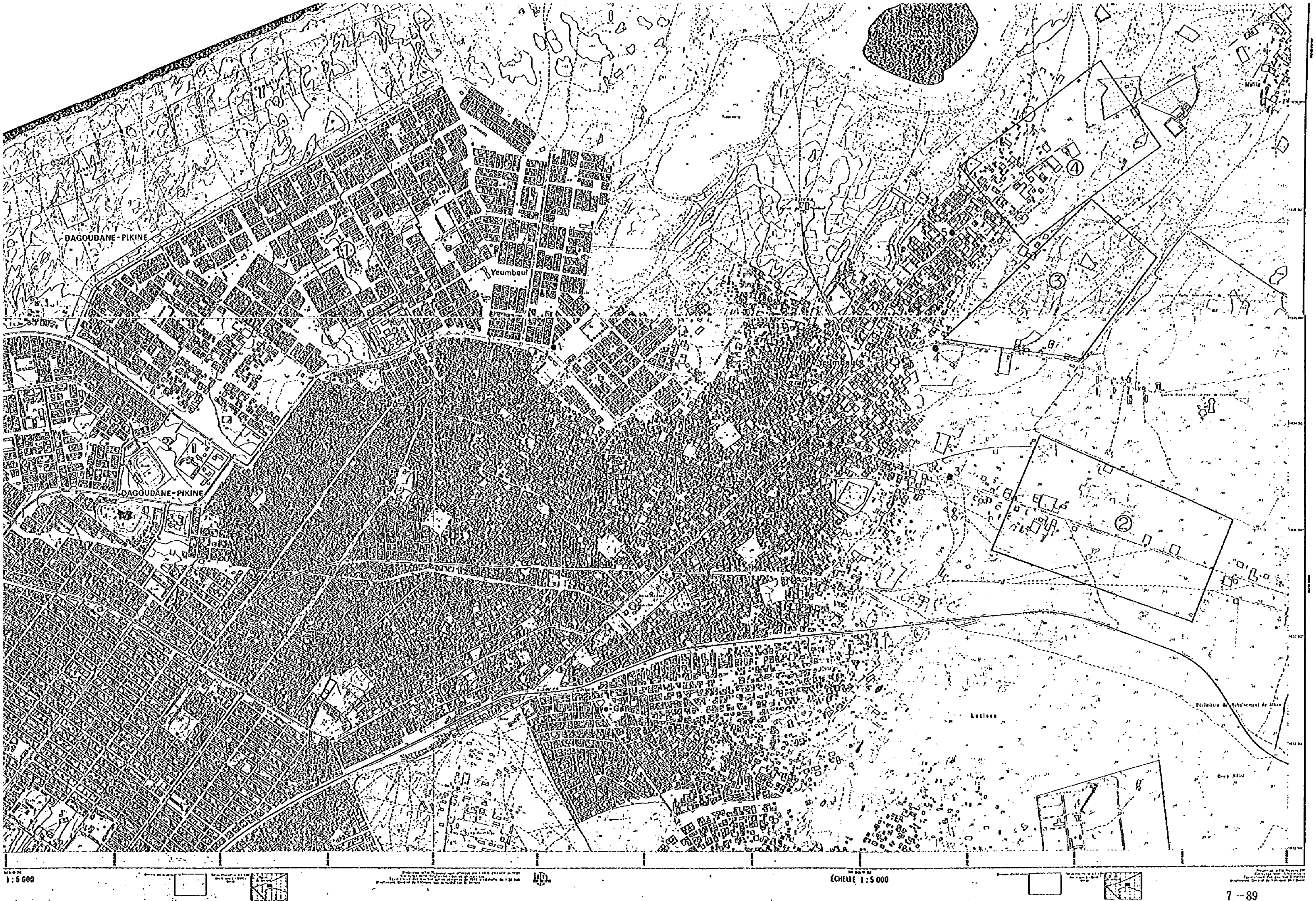
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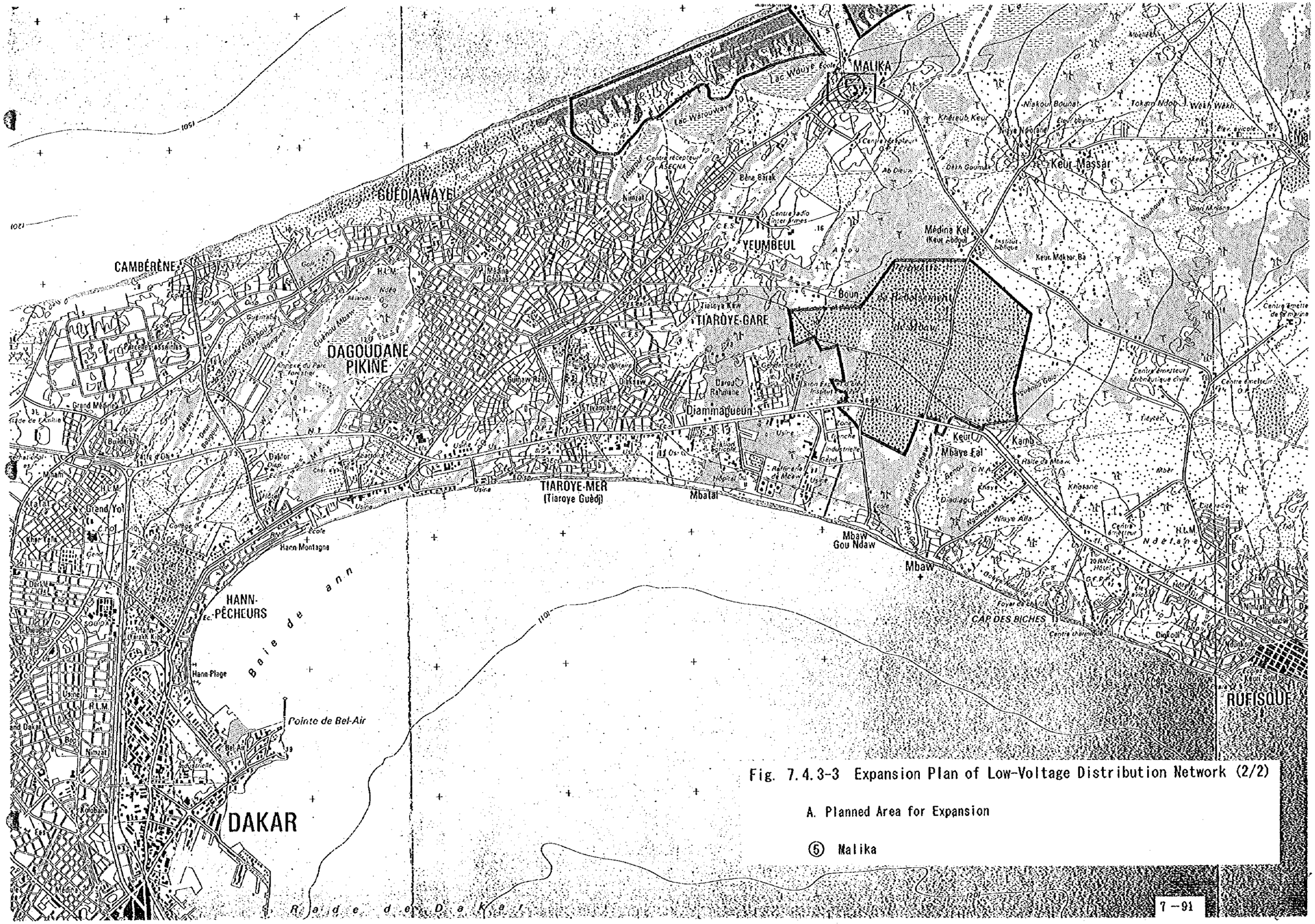

Fig. 7.4.3-3 Expansion Plan of Low-Voltage Distribution Network (2/2)

A. Planned Area for Expansion

⑤ Malika


Ndinate
Dagoudane
Nabilere
Grande Mosquée
Poste Yoff Centre
Ecole
Mbenguene
Ndeugagne
Route de Tonbor
Vers L'AEROPORT DE YOFF
ROUTE DE MATERNITE


Ndinate
Dagoudane
Ecole
Poste Téléphone
Layene
Ngaparou
Ndiafene
Grande Mosquée
Poste Tell Centre
Mbenguene
Ndeugagne
ROUTE DE MATERNITE
VERS DAKAR
ROUTE DU GRAND CIMETIERE

Route de Tongor

Vers L'AEROPORT DE YOFF

Ndinate

Dagoudane

Frigo

Poste Mariage Yoff

Ecole

Nord Terre

Grande Mosquée

Poste Yoff Centre

Mbenguene

ROUTE DE HANNITE

Ndeugagne

Branche Ouest de L' Autoroute

Fig. 7.4.4-1 Existing Low Voltage Distribution Network (1/3)
(Toff Village)
Scale 1 : 2,000

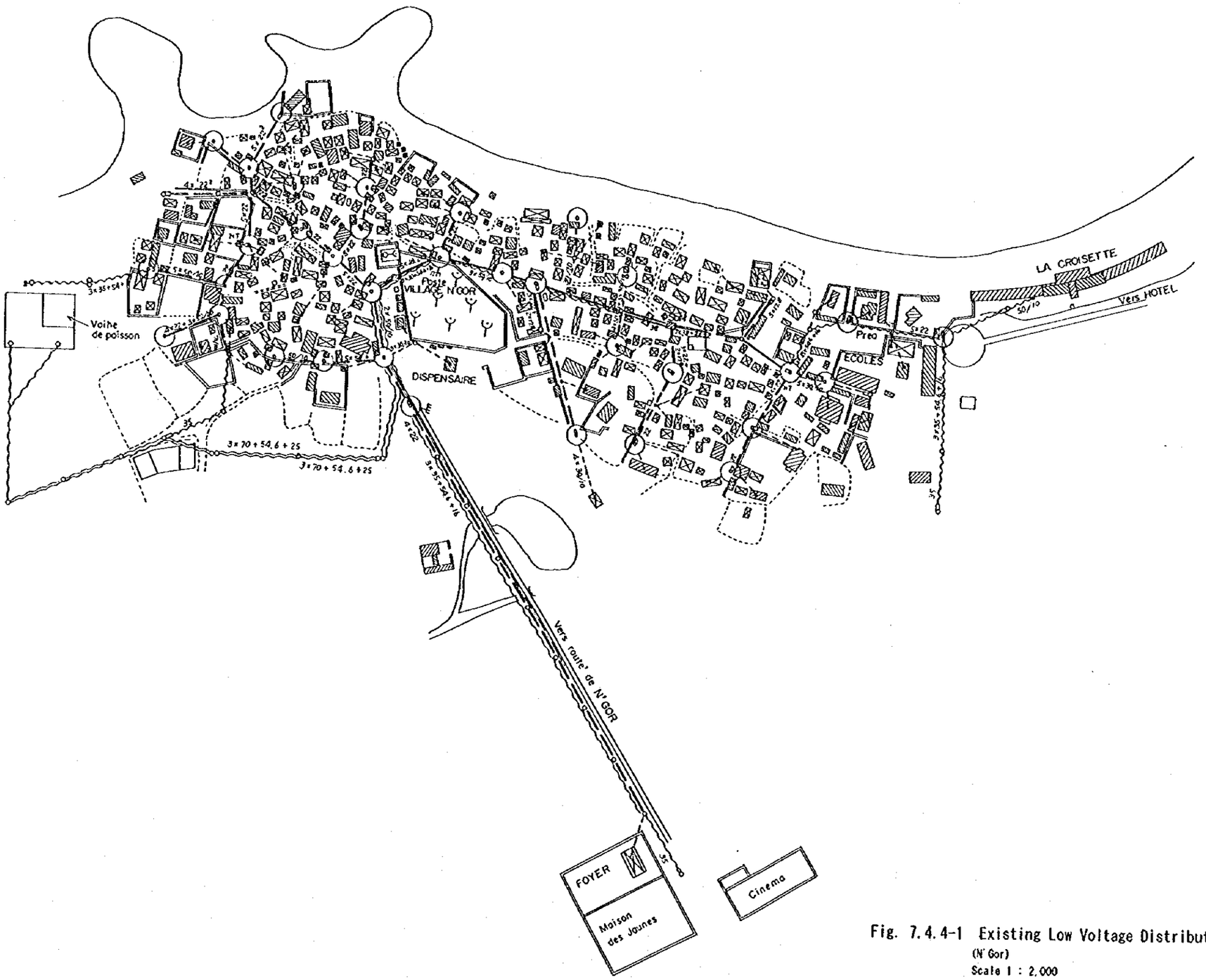

Fig. 7.4.4-1 Existing Low Voltage Distribution Network (2/3)
(N'Gor)
Scale 1 : 2,000


GENDARMERIE
Dispensaire
Poste Africa Sonom
Mairie
Cinema
Poste Ouakam Village
Poste Ouakam Khor
OUAKAM


GENDARMERIE
Dispensaire
Mairie
Cinema
Poste Bouaké
Poste
Ouakam Village

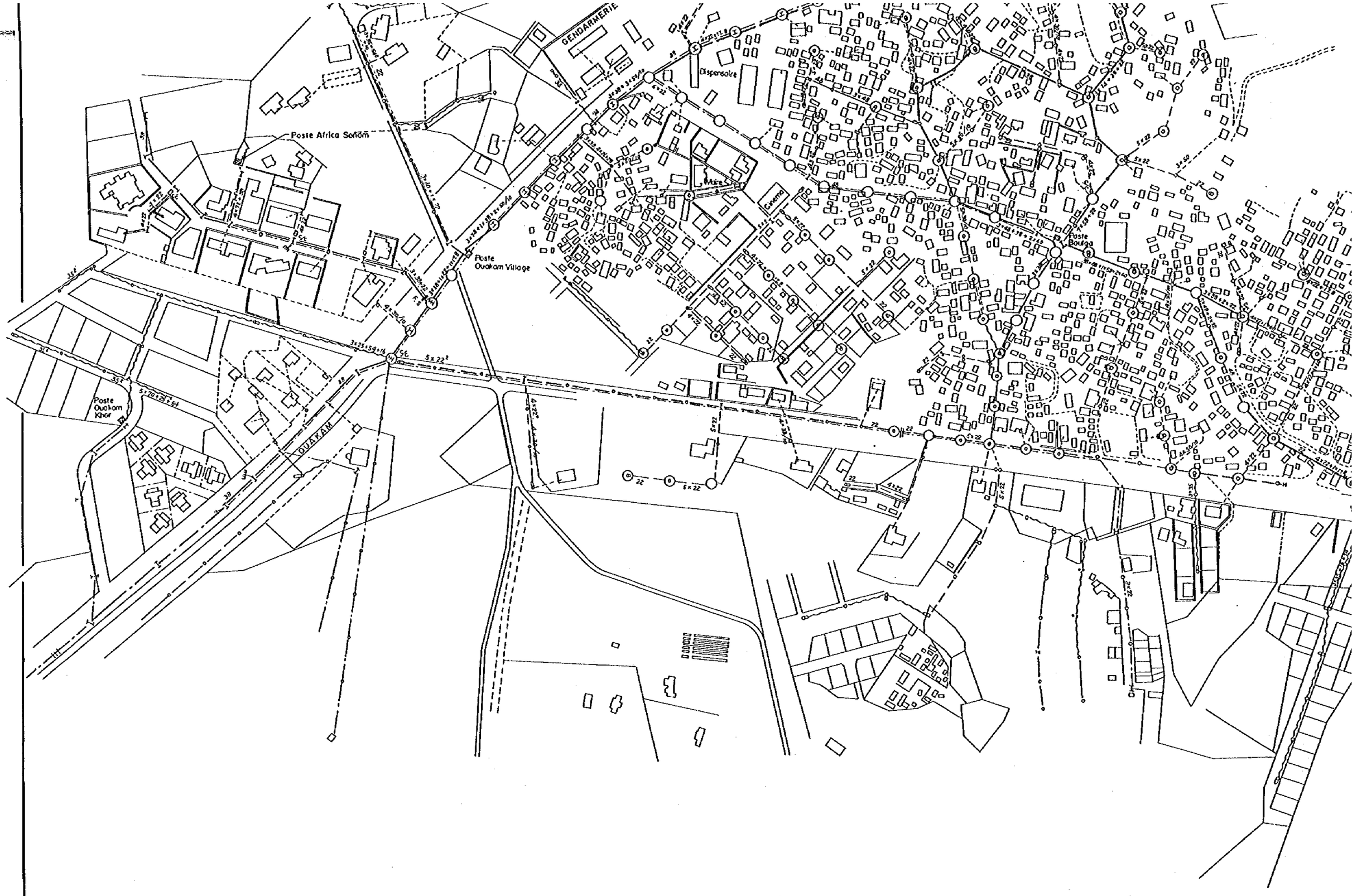
GENDARMERIE
Poste Africa Soñôm
Poste Ouakam Village
Poste Ouakam Khor
OUAKAM
Mairie
Cimetière
Poste Bouaye

Fig. 7.4.4-1 Existing Low Voltage Distribution Network (3/3)
(Ouakam)
Scale 1 : 2,000

CHAPTER 8

PRELIMINARY DESIGN

CHAPTER 8 PRELIMINARY DESIGN

8.1 Power Generating Facilities

The diesel generating plant under this Project is to be installed in the C-I building at the Bel-Air Power Station, and it will therefore be essential to establish an economically favorable design to assure the maximum possible efficiency in its operation in conjunction with the existing facilities at the Power Station. As the new generators are to cover the base load of the Dakar Electricity Grid System, it will be important to design a power generation system suited for long-term continuous operation and offering high supply reliability.

8.1.1 Use of Existing Facilities

The main existing facilities units capable of being used in the execution of this Project are as follows.

(1) Power Generation Building

The diesel generator set (5 MW x 2) under this Project will use part of the C-I buildings for installation next to the existing diesel generator set (5 MW x 2).

(2) Fuel Storage Tank

The existing heavy oil and the diesel oil storage tanks are as listed below and will be used also for supplying the new diesel plant with fuel oil.

Heavy oil tank	1,000 m^3 x 3
Diesel oil tank	30 m^3 x 1

The heavy oil storage capacity of the existing tanks thus totals 3,000 m^3, a amount equivalent to 15 days' consumption for the existing power station. The storage tanks are replenished through a pipeline from the Senegal Oil Refinery Corporation's Tanks located near the Port of Dakar. There is therefore no problem in maintaining a stable supply of oil as the installed tank capacity is fully adequate. Consequently,

there is no need to build additional new tank installations.

(3) Cooling Water Tank

Cooling water for the new diesel power generating plant will be supplied from a newly installed cooling water tank (purified water tank), built after the removal of the existing one. The existing purified water tank has a capacity of 235 m^3 per cycle and is capable of producing 5 m^3 of purified water per hour. The purified water is temporarily stored in the tanks below and thence supplied to the cooling water system.

Under normal operating conditions, purified makeup water is supplied to the condensers of the existing steam generator plant at a rate of approximately 3 m^3/h. The initial priming volume charged into the cooling water system of the new diesel generator plant is in the order of 10 m^3. This amount will be fed from the purified water tank to be newly installed. The purified water requirement under normal operating conditions is small, amounting to only about 1 m^3/day.

(4) Steam

Because of the small steam requirement of only approximately 0.5 t/day, the steam used for heating the heavy oil feed system to the new diesel generating unit will be fed from the existing C-II auxiliary 7 kg/cm^2 g steam line.

(5) Ancillary Electrical Facilities

1) Substation facilities

Step-up transformers will be installed in the old steam turbine building (C-II), and connected to 30 kV bus bar through power cable, 30 kV circuit breakers and disconnecting switches.

2) Station service power source

Station service power source (AC, 380/220 V) only for this power plant will be secured by connecting a newly installed transformer

to the 6.6 kV bus bar.

8.1.2 Removal Facilities and New Installation

(1) Removal Facilities Inside of C-I Building and Outside

The existing facilities listed blow shall be removed at the cost and expenses of SENELEC prior to the installation of new facilities. This removal work will be required as the existing facilities is liable to obstruct and hinder the installation work for new facilities.

1)	Inside	De-mineralized water tank 30 ton	3 Nos.
2)	Inside	Pipings, heat exchangers	1 lot
3)	Outside	De-mineralized water tank 40 ton	3 Nos.
4)	Outside	Residual oil incinerator	1 lot

(2) Installation of New De-mineralized Water Tank

The de-mineralized water tank(s) with enough capacity will be installed at the cost of SENELEC.

8.1.3 Preliminary Design Drawings

Relevant drawings for preliminary design are as follows.

Fig. 8.1.3-1	Arrangement of C-I building
Fig. 8.1.3-2	Removal facilities
Fig. 8.1.3-3	Fuel oil system
Fig. 8.1.3-4	Steam system
Fig. 8.1.3-5	Cooling water system

8.1.4 Preliminary Design Conditions

The following conditions have been established for the design of the diesel generating facilities.

(1) Climatic Conditions (Meteorological Office of Dakar City 1984 - 1993)

The climatic conditions at the Project Site (Dakar City) are given as follows.

Atmospheric temperature:	Maximum	38.2°C
	Maximum (average)	27.3°C
	Minimum	12.6°C
Humidity :	Maximum	92%
	Minimum	62%
	Average	76%
Rainfall :	Annual average	569 mm
	Hourly Maximum	205 mm
	Monthly average	183 mm
	Rainy season	June - Oct.
Wind :	Wind direction (in dry season)	Northwest
	Wind direction (in rainy season)	Southeast
	Maximum wind velocity	30 m/sec
Lightning:	Average incidence per year	26 days (mainly in the rainy season)
Sand dust:	Incidence in a year	60 days (Mainly in the dry season)

No allowance needs to be made for seismic activity (earthquakes) in the design.

(2) Fuel Composition

Tables 8.1.4-1 (1/2 ~ 2/2) show the composition of fuel currently being used at the Bel-Air power station.

(3) Cooling Water Analysis

The cooling water currently being used at the Bel-Air power station is obtained by treating main supply water in a de-mineralizing plant and has the following analysis.

Item	Unit	Cooling water (Treated water)	Remarks
pH	-	7.8 (13.8°C)	Data Feb. 7, 1995
Electric conductivity	μmho/cm	17.0 (25°C)	
M alkali level	$mgCaCo_3/l$	2.0	
COD	mgO/l	Less than 1	
Total hardness	$mgCaCo_3/l$	1.75	Calculated value
Calcium hardness	$mgCaCo_3/l$	1.6	
Magnesium hardness	$mgCaCo_3/l$	0.15	
Fe	mg/l	Less than 0.05	
Mn	mg/l	Less than 0.05	
SO_4	mg/l	Less than 5	
Cl	mg/l	Less than 0.4	
SiO_2	mg/l	Less than 0.2	
Langeria index		-3.6	<0: Corrosive water >0: Water causing scale deposition

(4) Applicable Standards

The following Japanese and international standards shall apply for the specifications and testing of the performance, materials, and quality of the materials.

Japanese Industrial Standards (JIS)
Japan Electric Industry Association Standards (JEM)
Japan Electric Cable Industry Standards (JCS)
Standards of International Electrotechnical Commission (IEC)

8.1.5 Preliminary Plan

(1) Diesel Generator Power Station Data

The diesel generator equipment shall be subject to the following performance, service conditions and control methods.

1) Rated output of power station;
10 MW (5 MW x 2)

2) Fuel consumption rate;
193 g/kWh (Power generation end)

3) Station service consumption rate;
3.5%

4) Starting method;
Pneumatic starting system using compressed air

5) Engine start operation;
Two start methods available: Manual start by operating a switch on the control panel and manual start by operating a switch on the local control panel

6) Engine stop operation;
Two stop methods available: Manual stop by operating a switch on the control panel and manual stop by operating a switch on the local control panel. In addition, automatic emergency stop by the operation of a protective device and remote emergency stop from the control room are possible.

7) Start and stop of ancillary equipment;
Two start/stop methods available: Automatic start and stop as well as manual start and stop by operating a switch on the local control panel.

8) Supervisory control method;
Remote supervisory control from the control panel and/or the control room to monitor failure and operating conditions.

9) Speed control system;
Speed of the engine can be controlled automatically or manually from the control room and local control panel.

10) Cooling method
While cooling water is used for cooling, the engine itself is cooled with primary cooling water and the air coolers, lubricant coolers and clean-water coolers with secondary cooling water. The secondary cooling water is recycled through radiators.

11) Heating of fuel oil;
Heating with steam

12) Air intake;
Outdoor air intake

13) Exhaust method;
Exhaust to the external atmosphere through exhaust stack fitted with silencers.

(2) Site and Arrangement Plan

The main equipment will be installed in the existing C-I building and the adjoining outdoor site.

1) General arrangement

The land area required for the project and the arrangement of the main equipment will be as follows.

Land area required		Approx. 1300 m^2 (Indoor)
		Approx. 300 m^2 (Outdoor)
Equipment Arrangement		
	In C-I Building:	Diesel engine
		Generators
		Air compressors
		Operating and control panels
		Station service transformer
		DC power supply units
		Fuel oil facility
		Lubricant oil facility
	Outdoor (Outside C-I):	Cooling water facility
		Air intake and exhaust facility
		Fuel oil tank
	C-II Control Room:	Remote monitoring panel

2) Important considerations for equipment arrangement and installation

a. Foundations for diesel generators

Underneath the planned locations for the diesel generator foundations, a concrete tunnel of approx. 1.5 m depth has been built underground to release the ash from the existing boilers. The tunnel shows signs of minor amounts of spring water. It can therefore be assumed that spring water might rise in those locations if the foundations are excavated to a greater depth. For this reason, the diesel generators need to be arranged by using an anti-vibration installation method with a common support plate by taking care that the concrete foundation will not become exceedingly large. There are no existing foundations in this locations. The soil condition at the planned location is marked primarily by sandy ground and the plans have to be made on the basis of a bearing capacity of 10 tons/m^2.

b. Arrangement of diesel generator

To permit the effective utilization of the C-I building and the existing overhead travelling crane, it will be essential to select an optimum arrange by allowing for the spacing of the support pillars of the building and the crane position.

c. Package support plate

In order to reduce the on-site installation work and the piping work and to shorten the construction period, installation shall be carried out using a package support plate, with the fuel oil and lubricant as well as the cooling water equipment packaged on a single integral support plate. The pipes are also to be shipped ready for installation in the plant precincts.

d. Air filters

Because of the considerable presence of sand and dust in the air, means will be required to prevent sand/dust from entering the engine interior through the air supplied for combustion. For this purpose, inertia filters and oil bath filter are to be installed providing a sand/dust removal capability in the air intake chamber.

e. Exhaust stack

Exhaust gases from the engines shall be discharged from exhaust stack fitted with silencers. The exhaust stack are to be installed near the site boundary and the exhaust outlet holes shall face a direction opposite that of the adjacent buildings.

f. Anti-noise measures

The main noise sources of diesel generator are diesel engine itself and air intake and exhaust equipment. For the air intake noise, air intake silencers and an air intake chamber are to be provided. For the exhaust noise, exhaust silencers are to be used. These silencing units will reduce the noise to a level not causing any problem. For the noise from the diesel engines themselves, however, the economically most effective solution would be to raise the noise barrier wall between the generator building and the neighboring houses and to repair the damaged parts of the existing building.

The present noise level is given as 76 dB in the vicinity of the C-I boundary wall. After completion of this project, the noise level is estimated to reach 80 dB. It will therefore be necessary to adopt suitable measures to ensure that the present noise level will not be exceeded. This may necessitate the installation of soundproofed wall, the use of sound insulation in the building and the closing of orifices.

(3) Diesel Engine Output and Generator Capacity

The ratings for the generators and the diesel engines driving the generators are as follows.

Generators	Rated output	5,000 kW
	Rated capacity	6,250 kVA
	Rated power factor	0.8 (lag)
	Number of generators	2
Diesel engines	Rated output	7,080 PS
	Number of units	2

The calculations for these rated values are as follows.

1) Engine output

Engine output is calculated using the following formula.

$$\text{Engine output: } Pe \geq \frac{P}{0.736 \times \xi G} \quad (P.S)$$

where:

Generator output: $P = 5,000$ (kW)

Horse-power conversion: $I(P.S.) = 0.736$ (kW)

Generator efficiency: $\xi G = 96(\%)$

$$Pe \geq \frac{5,000}{0.736 \times 0.96} = 7,080 \ (P.S)$$

2) Rated capacity of generator

Rated Capacity of Generator : P_G (kVA) is calculated using the following equation.

$$P_G = \frac{P}{P.f} = \frac{5,000}{0.8} = 6,250 \ (kVA)$$

where the power factor for the generators is: $P.f = 0.8$ (lag)

(4) Capacity of Station Service Transformer

Power for station service is supplied through the existing 6.6 kV bus bar so that it will be necessary to install a new 6.6 kV/380/V/220V

station service transformer.

Rated capacity of transformer will be 500 kVA, and this is estimated as follows.

The station service power consumption for the newly built diesel power generating plant is equivalent to about 3.5% of the output of the diesel generators. This is based on a total output of the diesel generator plant of 10,000 kW.

Station service load = 10,000 kW x 0.035 = 350 kW
Station service transformer capacity = 350 kW ÷ 0.85 = 412 kVA ≒ 500 kVA
(This is based on a power factor of 0.85 for the station service load.)

The values to be considered here should be 500 kVA to allow for adjustment with the existing 750 kVA station service transformer capacity in C-I and for slight load variations.

(5) Operating and Control Facilities

Operating and control facilities will be required to operate the diesel generator plant of this project in the same power system and to provide for smooth integration with the other generators. The following gives the various types of control facilities or control panels that will be required.

1) Remote supervisory control panel

This is needed for remotely monitoring the diesel generator from the existing C-II control room. The generators will be controlled under commands from the C-II control room to meet the demands of the Dakar Electric Power System.

2) Local control panel

This panel is required for controlling/operating and monitoring the diesel generators in the generator room directly. Operation and control for trial operation and maintenance of the generators is performed in the generator room itself.

3) Protective relays

To ensure the continued safe operation of the diesel generators, the protective relays will automatically prevent electric faults and/or minimize the effects of faults if they have occurred.

4) Battery and D.C. power supply panel

This control panel controls the D.C. power (battery) for operating and controlling the diesel generators and related equipment and the D.C. control circuit. The D.C. voltage shall be 130 V to coincide with the existing voltage.

5) A.C. power supply panel

This operating panel control the A.C. power source for station service required for operating the ancillary equipment. The A.C. voltage shall be a three-phase four-wire 380 V/220 V supply to coincide with the existing voltage.

(6) Circuit Breaker

The circuit breakers are used for connecting and disconnecting the diesel generator with and from the existing power system (grid). They are used on the 6.6 kV circuit. The circuit breakers shall be vacuum breaker (VCB) of an easy- maintenance and high-reliability type offering economic efficiency. The circuit breakers shall be mounted in the same control panel as the protective relays.

(7) Equipment Required

The outline specifications and quantities of the equipment required for the execution of this project are as given below.

1) Materials for facilities

a. Procurement from Japan (some items from Europe)

Item	Specification		Q'ty
A. Diesel engine and related equipment			
1. Diesel engine	Type	4 cycle, Diesel engine with air cooler	2 sets
	Rated output	7,080 p.s	
	Engine speed	750 Medium-speed	
	Over load capacity	10%	
	Starting method	Compressed-air starting	
2. Attachments to a diesel engine	Lubrication oil pump	Gear type	2 sets
	Governor		2 sets
	Super-charger		2 sets
	Air cooler	Water cooling	2 sets
3. Fuel oil device	Heavy oil transfer pump	5 m^3/h	1 set
	Heavy oil buffer tank	5 m^3	1 set
	Heavy oil filter		2 sets
	Heavy oil service tank	5 m^3	1 set
	Diesel oil transfer pump	3.5 m^3/h	1 set
	Diesel oil service tank	2.5 m^3	1 set
	Fuel oil supply pump	3.0 m^3/h	2 sets
4. Lubricating oil device	Sump tank	5.0 m^3	2 sets
	Priming pump	20 m^3/h	2 sets
	Cooler	tube type	2 sets
	Filter		2 sets
	Transfer pump	3.0 m^3/h	1 set
5. Cooling water device	Cooling water tank	500 ℓ	1 set
	Cooling water pump	65 m^3/h	2 sets
	Cooler	Tube type	2 sets
	Radiator	240 m^3/h	2 sets
	Secondary cooling water pump	240 m^3/h	2 sets
	Chemical injection device	with 50 ℓ tank	2 sets
	Feed water pump	1 m^3/h	2 sets

Item	Specification		Q'ty
6. Compressor air device	Air compressor	25 kg/cm^2	2 sets
	Pressure air tank	800 ℓ	1 set
7. Air intake, exhaust device	Exhaust duct		2 sets
	Exhaust expansion		2 sets
	Exhaust silencer		
	Intake duct		2 sets
	Intake silencer		2 sets
	Intake filter	oil bath type	2 sets
8. Waste oil treatment device	Sludge tank	300 ℓ	1 set
	Sludge pump	0.5 m^3/h	1 set
	Sludge separation tank	3 m^3	1 set
	Oil-water pump	1 m^3/h	1 set
	Oil-water separator	1 m^3/h	1 set
	Waste oil tank	1 m^3	1 set
	Waste oil pump	1 m^3/h	1 set
9. Pipe and valve	Steel pipe, valve etc.		1 set
10. Material for construction	Steel material		1 set
B. Generator and related equipment			
1. Generator	Type : 3 phase alternative horizontal synchronized generator		2 sets
	Rated output : 5,000 kW continuous		
	Rated capacity : 6,250 kVA continuous		
	Voltage : 6.6 kV		
	Power factor : 0.8 (lag)		
	Frequency : 50 Hz		
	Insulation class : F		
	Exciting method : brushless		
	Cooling method : air cooling		
2. Transformer	Type : Oil-filled, self-cooled, with on load tap changer		2 sets
	Rated capacity : 7,500 kVA		
	Voltage : 30 kV/6.6 kV		
	Frequency : 50 Hz		
	Connection :		
	Neutral grounding:		

Item	Specification		Q'ty
3. Circuit breaker	Type	: Vacuum type	2 sets
	Voltage	: 36 kV	
	Rated current	: 1,250 A	
	Rated breaking current	: 25 kA	
	Usage	: Connect to 30 kV bus	
4. 30/6.6 kV supervision board	Type	: Indoor self-standing	1 set
	Usage	: 30 kV/6.6 kV	
5. Circuit breaker board	Type	: Indoor enclosure self-standing	2 sets
	Circuit breaker	: Vacuum circuit breaker	
	Rated voltage	: 7.2 kV	
	Rated circuit	: 1,200 A	
	Usage	: Generator circuit	
6. Station service transformer	Type	: Indoor, 3 phase, oil filled self-cooled	1 set
	Rated capacity	: 500 kVA	
	Voltage	: 6.6 kV/380V/220V	
	Frequency	: 50 Hz	
	Connection	: Δ/Y, 3 phase 4 line	
	Neutral grounding	: Solid grounding	
7. Neutral grounding device board	Type	: Indoor, enclosed type self- standing NGR 100Ω, 100A, 30 sec. with 2 disconnecting switches	1 set
8. Power fuse board	Type	: Indoor, enclosed type, self-standing	1 set
	Component	: Demand switch, power fuse etc.	
	Rated voltage	: 7.2 kV	
	Rated current	: 100A	
	Usage	: Power source for station service	
9. Exciting device board	Type	: Indoor, enclosed type, self-standing	1 set
	Usage	: Brushless type	
10. AC voltage board	Type	: Indoor, enclosed type, self-standing	1 set
	Usage	: Motor control	

Item	Specification	Q'ty
11. DC power source board	Type : Indoor, enclosed type, self-standing Usage : Power source for control circuit of power plant Rated voltage : DC 130V Battery capacity : 30 AH/5HR	1 set
12. Supervisory control board	Type : Indoor, enclosed type, self-standing Usage : Control, protection (a) remote supervisory control board 1 set (b) generator control board 2 sets (c) station service transformer control board 1 set	1 lot
13. Power cable (1)	Type : Cross-linked polyethylene insulated vinyl sheathed type Voltage : 33 kV Conductor size : Usage : 33 kV	1 lot
14. Power cable (2)	Type : Cross-linked polyethylene insulated vinyl sheathed type Voltage : 6.6 kV Conductor size : 500 mm^2 x 1 core x 6 Nos. Accessory : 1 lot, including 12 sets of cable termination materials Usage : Generator main circuit	700 m
15. Power cable (3)	Type : Cross-linked polyethylene insulated vinyl sheathed type Voltage : 600 V Conductor size : 600 mm^2 x 1 core Accessory : 1 lot Usage : Station service transformer secondary circuit	800 m
16. Control cable	Type : Vinyl insulated Voltage : 600 V Size : 22 mm^2 - 2 mm^2 10 core - 2 core Usage : Supervisory control circuit	1 set
17. Wiring material	Cable connecting material, pipes supports, etc.	1 set

b. Procurements in Senegal

Item	Specification	Q'ty
1. Sand	River sand	120 m^3
2. Gravel	Basalt	240 m^3
3. Cement	Portland cement	140 t
4. Reinforcing bar	13 mmϕ	40 t

2) Maintenance equipment

Essential for assuring the long-term performance and availability of the diesel generators under this project is to ensure that adequate stocks of spare parts, consumables, and tools are kept to meet the needs for repairing or replacing in case of equipment wear, deterioration, aging and failure. These probability of such problems occurring increases proportionally with the time of plant service (operation) and is related to the operating and maintenance skills and know-how of the plant management and control personnel.

As stated in section 3.6.(1), there are no problems in terms of the level of operating and maintenance know-how. The requirements for spare parts, consumables and tools and the relevant quantities of the stocks to be kept are given below.

a. Requirements

i) To maintain power services, a fast response is needed to remedy equipment fault and it is therefore necessary to keep a constant stock of spare parts in view of the structure of the equipment.

ii) Because of the geographical location of the project site, it would be difficult to obtain the necessary parts in an emergency.

iii) Because of the economic reason of the party managing the plant, it would be difficult for the plant operator to arrange for the keeping of major stocks of spares, consumables and tools immediately from the start of operation.

b. Main stock items and quantities

i) Items wearing and deteriorating at a rate proportional to the service time (number of hours of operation) of the equipment.

Cylinder cover related parts	Packages, O rings, etc.	2 generators
Suction valve related parts	Roto-caps, valves, springs, etc.	2 generators
Exhaust valve related parts	Valve stems, sleeves, valves, springs, etc.	2 generators
Fuel injection valve related parts	Nozzle caps, O rings	2 generators
Piston related parts	Piston rings, oil rings, etc.	2 generators
Connecting rod related parts	Crank pin bearings, bolts	2 generators
Main bearings		20 sets
Fuel injection pump related parts	Valves injection pumps, etc.	2 generators
Supercharger related parts	Bearings	2 generators
Air cooler related parts	Packings	2 generators
Starting air valves	Packings	2 generators
Other valves, pipes, bearings	Packings	2 generators

These quantities of parts are required for replacement at the overhaul performed after the diesel generators have completed their initial 8,000 hours of operation (approximately 1 year's operation).

ii) Items required for repair or replacement due to lack of functional performance as a result of long-term operation

Pressure switches	for 2 generators
Temperature switches	for 2 generators
Thermometers	for 2 generators
AVR (Automatic voltage regulator for the generators)	1 set

Control equipment related parts, relays, timers, coils, etc.	1 set

iii) Items with a fixed service life and requiring replacement at the time of regular inspection

Fuses for control circuits and indicator circuits	1 set
Display lamps for indicator circuits	1 set

iv) Tools required for disassembling and assembling of machines and for replacement of parts

- Machinery/equipment related tools:	
Spanners	1 set
Screw drivers	1 set
Wrenches	1 set
Pliers	1 set
Suspending fixtures	1 set
Tools for installing and removing valves	1 set
Tools for installing and removing bearings	1 set
Tools for installing and removing piston rings	1 set
Tools for installing and removing connecting rods	1 set
Tools for cylinder liners	1 set
Tool boxes	1 set
Gauges, pincers etc.	1 set
- Power equipment related tools:	
Tools for checking breakers	1 set
Plugs for testing relays	1 set
Measuring equipment for testing relays	1 set
Measuring equipment for testing control units	1 set
Hooks	1 set

8.2 Distribution Line Facilities

8.2.1 Basic Items

(1) Applicable Standards

For the design of the distribution facilities hereunder, the following standards shall essentially apply.

- Japanese Industrial Standards (JIS)
- Standard of the Japanese Electrotechnical Committee (JEC)
- Japan Electric Association Code (JEAC)
- Japanese Cable Makers Association Standard (JCS)
- Standards of the International Electrotechnical Commission (IEC)
- Normes Francaises (NF)
- Electricite de France (EDF)
- Union Technique de l'Electricite (UTE)

(2) Ambient Conditions

Ambient climatic conditions are as stated in section 8.1.4.

a. Height above sea level : 1,000 m or less

(3) Conductor Height

Minimum conductor height above ground of overhead distribution lines shall be as follows.

	30 kV	6.6 kV	Low voltage
Ordinary location	6.0 m	6.0 m	5.0 m
Across road	8.0 m	8.0 m	6.0 m

(4) Wind Load

The wind loads on strung wires and supports shall be as follows.

a. Strung wires 480 (Pa)
50 (kg/m^2)

b. Supports 480 (Pa) (Round shape)
50 (kg/m^2)

Note: (kg/m^2 = 9.80665 Pa)

(5) Safety Factor

The safety factors for the materials concerned shall be as follows.

a. Supports
- Wooden poles : 3.0 (at the time of erection)
- Concrete poles : 2.0
- Steel-pipe poles: 2.0

b. Conductors : 2.5

c. Stay : 1.5

(6) Insulation Design

While it is not possible in practice to exclude the risk of flashover completely due to lightning, the principle to be applied shall be that "flashover shall not take place as a result of internal overvoltage generated in the system".

1) Required dielectric strength of insulators for switching surge

a. Nominal voltage (kV)	33
b. Maximum allowable voltage (kV)	36
c. Voltage to ground peak value (kV)	29.4
d. Switching surge multiple	3.3
e. Switching surge peak value (kV)	97.0
f. Insulation drop coefficient	1.1
g. Required dielectric strength of insulator (kV)	106.7

2) Minimum insulation clearance

The minimum insulation clearance is the one which can withstand

both switching surges and short-time overvoltage.

a. Nominal voltage (kV)	33
b. Maximum allowable voltage (kV)	36
c. Voltage to ground peak value (kV)	29.4
d. Switching surge multiple	3.3
e. Switching surge peak value (kV)	97.0
f. Required withstand voltage (kV)	106.7
g. Required clearance (cm)	18
h. Minimum insulation clearance (cm)	20

3) Insulation clearance in abnormal conditions

Insulation clearance in abnormal conditions is checked for maximum allowable voltage of the system by applying the commercial frequency wet withstand voltage characteristics of standard rod gap at the presumed maximum wind velocity. The required clearance, known as the "Insulation Clearance in an Abnormal Condition" is as follows.

a. Nominal voltage (kV)	33
b. Maximum allowable voltage (kV)	36
c. Maximum allowable voltage to ground (kV)	20.8
d. Required withstand voltage (kV)	22.9
e. Insulation clearance in an abnormal conditions (cm)	9

4) Minimum insulation clearance between phases

The minimum insulation clearance between phases is the one which can withstand switching surges occurring between phases, whose values are as follows.

a. Nominal voltage (kV)	33
b. Maximum allowable voltage (kV)	36
c. Voltage to ground peak value (kV)	29.4
d. Phase to phase surge multiple	5.3
e. Phase to phase surge peak value (kV)	156
f. Insulation drop coefficient	1.1

g.	Required withstand voltage between phases (kV)	171.4
h.	Minimum insulation clearance between phases (cm)	30

8.2.2 Replacement of Circuit Breakers

(1) Substations Due for Replacement

The oil circuit breakers which has now become obsolete will be replaced with gas (SF6) circuit breakers at the following distribution substations. In this connection, consideration shall also be given to the need for the removal of the existing equipment in the substations and for the modification of the installation site.

- Centre Ville
- Universite
- Aeroport Yoff
- Thiaroye

(2) Required Quantities

The required quantities of the circuit breakers in the individual substations concerned for the each rating shall be listed below. Table 8.2.2-1 gives the ratings for the circuit breakers in the substations for each feeder.

Name of Substation	7.2 kV/ 630 A	7.2 kV/ 1,250 A	36 kV/ 630 A	Total
Centre Ville	5	-	2	7
Universite	5	-	2	7
Aeroport Yoff	1	2	2	5
Thiaroye	2	-	-	2
Total	13	2	6	21

(3) Circuit Breakers

The circuit breakers to be used for the replacement work under the present schedule shall comply with the following specification summary. The specification of 22 kV circuit breakers is shown in the following

as reference because 22 kV circuit breakers are installed in the existing 6.6 kV system as seen in the Table 7.4.1-1.

a. Rated voltage	(kV)	7.2	7.2	24	24	36
b. Insulation level	(kV)	60	60	125	125	170
c. Rated frequency	(Hz)	50	50	50	50	50
d. Rated current	(A)	630	1,250	630	1,250	630
e. Rated breaking current	(kA)	12.5	12.5	12.5	12.5	12.5
f. Rated recovery voltage	(kV)	12	12	41	41	62
g. Rated making current	(kA)	e. x 2.5				
h. Operating sequence		0-3min-CO-3min-CO				

8.2.3 Improvement of Medium Voltage Distribution Lines

(1) Outline of Work

Figs. 7.4.2-1 and -2 show the sections due for improvements on the feeders. The overhead distribution lines thus selected shall be improved to enhance the reliability of power supply from the distribution facilities and provide the conditions necessary to meet the demand of the consumers for a stable and high-quality electricity supply. The followings is an outline of the construction work.

Construction work for the improvement of existing 6.6 kV overhead distribution line with 30 kV underground cable.

		Line Length (m)	Postes to be newly constructed	Postes to be modified
a.	Feeder Dispensaire	2,150	5	5
b.	Feeder Dag. Pikine	800	1	2
c.	Feeder Fann	350	1	1
d.	Feeder Rte de Rufisque (1)	5,800	2	2
e.	Feeder Rte de Rufisque (2)	6,300	4	4
f.	Feeder Dag. Pikine	1,700	2	3
g.	Feeder Batterie Yoff	2,000	2	2
h.	Feeder Labo Pocherie	2,900	6	7
i.	Feeder Yeumbeul (1)	300	1	2
j.	Feeder Yeumbeul (2)	750	1	2
	Total	23,050	25	30

(2) Routes

Fig. 8.2.3-1 (1/3 ~ 3/3) show the distribution line routes due for improvement work covering the following feeders.

- Feeder Dispensaire
- Feeder Fann
- Feeder Batterie Yoff

(3) Distribution Lines and Circuit Configuration

All of the existing overhead distribution lines selected under this project shall be replaced with underground cables. At the improvement work of distribution lines, π-connection shall be employed for the lead-in to the distribution poste, as a rule. Depending on the route selected and on economic reasons, it may be possible that T-connection will be chosen. The choice of T-connection will necessitate, however, the installation of cable junction boxes at the junctions.

(4) Underground Cables

Generally, the principle shall be that the same type of cables shall be

used as those that are currently being employed on the existing facilities. In this context, it is anticipated that the Torsade cables with aluminum conductors shall be used according to the EDF (HN 33 S 23) specifications. The outline specifications and allowable current for the cables considered for use on this project are presented below.

			3x95+25	3x150+25	3x240+25
a.	Voltage	(kV)	12/20	12/20	12/20
b.	Outer diameter of conductor	(mm)	11.9	14.8	19.0
c.	O.D. after twisting together	(mm)	74.5	81.5	90.0
d.	Weight	(kg/m)	3.7	4.6	5.9
e.	Allowable current	(A)	230	295	385

(Conditions for calculating the allowable current)

- Soil temperature : 30 °C
- Thermal resistivity of soil: 100 °C • cm/W

(5) Cable-Burying Method

Fig. 8.2.3-2 shows the cable-burrying method. If the cables are to be laid underneath pedestrian walkways (pavements), the cables shall be buried directly in the ground. If the cables are to be laid underneath roads or road crossings the cables shall be laid in conduits to protect the cables against the load acting upon them from above as a result of vehicular passage.

(6) Transformer Capacity

Expect where the existing transformers are to be used, the newly erected medium/low voltage transformers shall have the following capacities.

- 160 kVA
- 250 kVA
- 400 kVA

(7) Distribution Postes

Same type of distribution poste currently used by SENELEC will be employed, and pole-mounted poste is not considered. Fig. 8.2.3-3 shows the typical type of existing distribution poste.

8.2.4 Expansion of the Low Voltage Distribution Network

(1) Outline of Work

The low voltage distribution network at the following locations shall be expanded to provide power supply to consumer which are currently not served with electricity.

	Land Area Concerned (ha)	30 kV Underground Cable (km)	Distribution Lines (km)	Distribution Postes (Nos.)
a. Madieng-Khary-Dieng	40	1.2	10	2
b. Route de Boune	50	0.6	12.5	1
c. Route de Marine	40	0.8	10	2
d. Route de Malika	40	3.0	10	2
e. Malika	50	0.5	12.5	1
Total	220	6.1	55.0	8

Fig. 8.2.4-1 shows the housing estate construction plan for Madieng-Khary-Dieng.

(2) Distribution Lines

a. Medium voltage distribution lines

The underground cables will be employed for the medium voltage distribution lines which will supply the power to the distribution poste in the locations scheduled for the expansion of the low voltage distribution lines. It is presumed that Torsade cables will be used similarly to section 8.2.3. Their size will be 95 mm^2 and the voltage of distribution lines will be 30 kV.

b. Low voltage distribution lines

The low voltage distribution lines running from the distribution postes to the individual consumers use preassembled cables (in other words, insulated cables) for the overhead lines. The supply voltage to the individual consumers is B2 (380/220 V) system. In the project area, the following two types of cables are specified: the main lines with a cross-section of 70 mm^2 and the branch lines with one of 35 mm^2.

- 3 x 35 + 1 x 54.6 + 1 x 16 .... (a)
- 3 x 70 + 1 x 54.6 + 1 x 25 .... (b)

The preassembled cables conform to the following outline description.

	Outer diameter (mm)				Weight (kg/km)	Resistance at 20 deg C (ohm/km)	
	Conductor		Insulated conductor				
	Conduc-tor	Light-ing	Conduc-tor	Light-ing		Conduc-tor	Light-ing
(a)	6.8	4.6	10.2	7.1	713	0.868	1.91
(b)	9.7	6.0	13.3	8.7	1,102	0.443	1.20

(3) Supports

1) Selection criteria

The concrete poles, wooden poles and H-section steel are employed as supports of existing overhead distribution lines. The effects due to salt contamination are taken into account, it is assumed here that the employment of tubular steel poles is considered. The following comparison critically assesses the various types of poles, that is, the wooden, concrete and steel poles. In this comparison, the wooden poles form the basis of reference.

	Wooden Poles	Concrete Poles	Steel Poles
a. Life	1	Approx. 2.5	Approx. 2
b. Salt resistance	Satisfactory	Superior	Satisfactory
c. Weight.	1	Approx. 2	Approx. 0.7

Note: (Wooden poles : Treated poles)
(Tubular steel poles: Hot-dip galvanized)

It is clear from the above comparison that the weight of the steel poles is lower than that of the wooden poles and it would therefore be possible to erect them without the use of special vehicles. They also offer a service life equal to that of the distribution lines themselves so that it would not be necessary to replace the supports during the service life of the distribution lines. For the reasons, it has been assumed that steel poles will also be used.

The fittings (including in particular, tension clamps, suspension clamps, and connectors) shall be equivalent to those currently being used by SENELEC.

2) Standard span length

The standard span length of low voltage distribution lines will be 40 m.

3) Length of supports

To keep the minimum clearance above ground and considering the common stringing of telephone lines on the supports, two kind of supports such as 10 m for trunk lines and 9 m for branch lines will be employed. The design load shall be considered as being 300 kg and the angular load shall be supported by the stay.

4) Specifications

The tubular steel poles are planned for employment as supports and are required to meet the following specifications.

		9 m	10 m
a.	Overall length (mm)	9,000	10,000
b.	Weight (kg)	160	216
	(Top materials)		
c.	Length (mm)	4,830	5,330
d.	Outer diameter (mm)	140	165
e.	Thickness (mm)	4.5	4.5
	(Bottom materials)		
c.	Length (mm)	4,500	5,000
d.	Outer diameter (mm)	165	190
e.	Thickness (mm)	5	5.3

(4) Number of Feeders

The number of feeders of distribution postes will be 3 - 4 as standard.

(5) Miscellaneous

The underground cables and the burrying method in the ground, the distribution postes and the medium/low voltage equipment shall be in accordance with Section 8.2.3.