FEASIBILITY STUDY REPORT
ON
RURAL ELECTRIFICATION
IN
NORTH-EASTERN STATE OF NIGERIA

1975 JUNE

JAPAN INTERNATIONAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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PREFACE

In March 1974, the Government of the Federal Republic of Nigeria made a request to the Government of Japan for the dispatch of some experts to study the rural electrification in her North-Central State and North-Eastern State.

In compliance with the Government's decision to meet the request, Japan International Cooperation Agency sent a team comprising four experts headed by Mr. Tatsuo Watanabe of the Tokyo Electric Power Company, Inc. from October 2, 1974 to February 7, 1975. During the above period, the team carried out technical survey and collected necessary informations and also exchanged views with the Nigerian official concerned.

I sincerely hope that this report prepared by the team will contribute to the advancement of the electrification project in Nigeria, and I wish to avail of this opportunity to express my deep appreciation to the officials of both their Federal and State Governments of Nigeria for the cooperations and warm hospitalities extended to the expert-team during their stay in Nigeria.

June 1975

Sinsaku Hogen
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

June , 1975

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency

Drar Mr. Hogen:

The report presented to Nigeria here on has been a final conclusion on feasibility study which was drawn up by the survey team dispatched from the Japan International Cooperation Agency (refers to the former Overseas Technical Cooperation Agency) due to the request from the Federal Republic of Nigeria Government in regard to feasibility study for planning rural electrification in the areas of North-Central and North-Eastern States. The report also includes our advice for state-wide electrification to the North-Central States, and includes designs and specifications additionally required by the North-Eastern State Government.

During the stay of the survey team in Nigeria, the team has carried out research and survey activities as follows.

To begin with, the survey team has negotiated with the both state government staffs, staffs of the National Electric Power Authority (hereafter, refers to as NEPA), and relative staffs of the Japanese Embassy on the spot regarding how to research and survey at this moment, and regarded firmly as an essential organization in response to team activities has to be the both state governments mentioned above.

Recognizing the above matter, the team negotiated the purpose of research and survey and how to carry it out with the executive staffs of both the Ministry of Economic Planning and the Ministry of Works and Housing of the both states.

In compliance with the preparation as mentioned above, field survey in respective towns was carried out based upon relative data collected throughout the state government concerned, NEPA, and others with our best effort.

Getting touch with the structure of the final results surveyed and the contents of the final report, they have been involved in the so-called "Interim Report" which was approved by the both parties at the intermediate reporting conference getting together with the executive staffs of the both states, staffs of the Japanese Embassy on the spot, and out team members.

Such being the case, we, the survey team members, are deeply expecting that, in every aspect, this final report would greatly contribute to the encouragement of rural electrification in the both states in that the report was drawn up in compliance with the survey and recognition as mentioned so far.

In presenting this final report to Nigeria, on behalf of all the team members, I'd like to express our deepest appreciation for the heart-felt and kindest helps and assistances incessantly extended by the relative staffs of Nigeria and Japan as well as the relative persons individually cooperated with the team during the stay period of the team in Nigeria and up to the time of completing the final report after our coming home.

Very faithfully yours,

Tatsuo Watanabe

Tatsuo Watanabe

Team Leader
Survey Team for the Rural Electrification of the North-Central and North-Eastern State of Nigeria.

CONTENTS

I. FOREWORD

1. BAKCGROUND OF RURAL ELECTRIFICATION SURVEY AND DETACHMENT OF SURVEY TEAM FOR RURAL ELECTRIFICATION

The Government of Federal Republic of Nigeria is now making a great effort to modernization of the country and welfare improvement in the livelihood of the nation.

Each state has not only been striving to expand the roads, medical facilities, water supply facilities and to universalize education, but orienting to grow up their economy by encouragement of industrialization in the state as well in order to cope with the above-mentioned national policy.

State government concerned has a strong intention it is indispensable to supply electric power for solving the social atmosphere and for growing up its national economy, and that it is of importance to electrify the residential areas of the state from the viewpoint of social service so as to level up the living atmosphere of the nation.

In Nigeria, the National Electric Power Authority (hereafter refers to as NEPA) has been founded as a power supply organization of which purpose has been for nation-wide power supply. NEPA has been making its best to encourage rural electrification, but it has been in a real situation unable to respond enough the request of state government suggested to satisfy a growth rate in power demand running more than twenty per cent. In consequence, each state government has a plan to encourage rural electrification individually for solving this problem of importance.

Under such background, the North-Central and North-Eastern State Governments have presented the offer to the Japanese Government through the Federal Ministry of Economic Development and Reconstruction regarding technical cooperation for rural electrification in their areas.

In compliance with this offer, the Japanese Government has determined to despatch a survey team with four staffs headed by Mr. Watanabe, the team leader, the Tokyo Electric Power Company, Incorporated, Power System Operation and Maintenance Department.

The members of this survey team comprised the following, all employees of the Tokyo Electric Power Co., Inc.:

Tatsuo Watanabe	:	Power System Operation and Maintenance Dept.
Nobuchika Inoue	:	Power Sales Dept.
Akira Tanaka	:	Power Sales Dept.
Haruo Kawada	:	Power System Operation and Maintenance Dept.

2. PURPOSE AND RESPONSIBILITY OF SURVEY TEAM

Prior to forwarding actual activity of the survey team, the team has recognized its purpose, mission, and principle on the plan and design as follows in common with the responsible staffs of the both state governments.

2.1 PURPOSE

The North-Eastern State has already carried out rural electrification in the four towns and also has been planning it in a lot of other towns successively.

In several towns of them, they have required the survey team to cooperate technically in carrying out feasibility study for electrification, and additionally have required design and specifications.

2.2 RESPONSIBILITY OF SURVEY TEAM

The survey team has determined to carry out as follows in the towns undermentioned.

1) Assessment of Demand Forecast.

2) Survey and Plan for Power Supply Facilities.

3) Design and Specification for Power Supply Facilities.

The names of towns concerned are as follows:

Damaturu, Darazo, Jama'are, Ningi, Monguno, Michika, Dadin-Kowa, Shira, and Tafawa Balewa.

In addition, Kumo was exempted from the first plan for the reason why the preparation for electrification was forwarded by NEPA, and Geidam and Mallam Fatori, for the sake of convenience of transportation and accommodation.

2. 3 PRINCIPLE OF PLAN AND DESIGN

1) It shall be fundamental that electrical facilities are to be equivalent to the power demand foreseeable in 1985. On the other hand, it is needed a diesel electric generator has to be extended in the midst of the above period, and that a power distribution line has also to be newly installed for taking the load of which site is indefinite.

2) The original standard and specification shall be complied those of NEPA currently available.

3. SITUATION OF TEAM ACTIVITY

3. 1 MEMBERS WHO OFFICIALLY PARTOOK WITH THE TEAM

1) North-Central State

Ministry of Economic Planning and Rural Development.

Mr. I Inuwa	Permanent Secretary
Mr. Z. A. Oloruntoin	
Mr. J. De-Ganga	

Ministry of Works and Housing

Mr. G. A. Yarson	: Chief Electrical and Mechanical Engineer
Mr. R. J. Patel	: Principal Electrical Engineer
Mr. E. A. Andow	: Executive Electrical Engineer Zaria . Counter Part
Mr. A. Yakubu	: Liaison Officer (Lagos)

2) North-Eastern State

Ministry of Economic Planning and Political Division.

Mr. U. G. Galtenari	: Permanent Secretary
Mr. M. L. Mukhtar	:

Ministry of Works and Housing

Mr. A. S. Kumar	: Chief Electrical and Mechanical Engineer
Mr. M. Kagu	: Principal Electrical Engineer
Mr. U. M. Sa'ad	: Counter Part
Mr. A. Abubakar	: Liaison Officer (Lagos)

3.2 MEMBERS WHO COOPERATED WITH THE TEAM

NEPA

Mr. E. O. Ilmoka : Assistant General Manager

Mr. B. A. O. Rdesanya : Manager, Commercial Department

Federal Ministry of Mines and Power

Mr. O. B. Edun : Electrical Inspectorate Division

In addition, the district officers of NEPA at Kaduna and Maiduguri have also taken care of arranging necessary data.

The survey team has got aerial photographs through the arrangement of Mr. M. F. Anderson, Surveyor General, Ministry of Land and Survey, Bauchi, North-Eastern State.

Table I-1 OUTLINE OF SCHEDULE IN NIGERIA

Period	Number of week allocated	Place of sojourn	Breakdown of main jobs carried out	Name of towns surveyed at the site
October 1974	2	Lagos	Getting contact with the staffs concerned Laying hold of the situation Getting contact with the state authorities concerned Acquiring of data	
	1	Kaduna Maiduguri	Visiting with the state government concerned for greeting Consulting with the persons concerned for preparations	
	1	Lagos	Acquiring of data Preparing of materials for site surveys	
November 1974	1	Kaduna	Preparing for site surveys Site surveys	 Kachia
	2	Katsina Daura Funtua Zaria	Rural site surveys	Jibiya, Maiadua, Musawa, Kankara, Shika, Kudan, Hunkuyi, Makarfi, Soba,

Period	Number of week allocated	Place of sojourn	Breakdown of main jobs carried out	Name of towns surveyed at the site
November 1974	2	Kaduna.	Site survey Contacting for summarization Arrangement of materials for site surveys	Zonkwa
December 1974			Acquiring of data Preparing to start to the North-Eastern State.	
	2	Bauchi Azare Potiskum	Acquiring of aerial photograph Rural site surveys Inspecting of the situation on electrified works	Tafawa Balewa, Dadin Kowa, Darazo, Ningi, Jama'are, Shira,
	3	Maiduguri	Site surveys Arrangement of materials for site surveys	Damaturu, Monguno, Michika,
January 1975			Acquiring of data Contacting for summarization Preparing to come back to Lagos	
	2	Lagos	Arranging of the interim report Conference for the interim report Preparing to come home	
February 1975			Coming home	

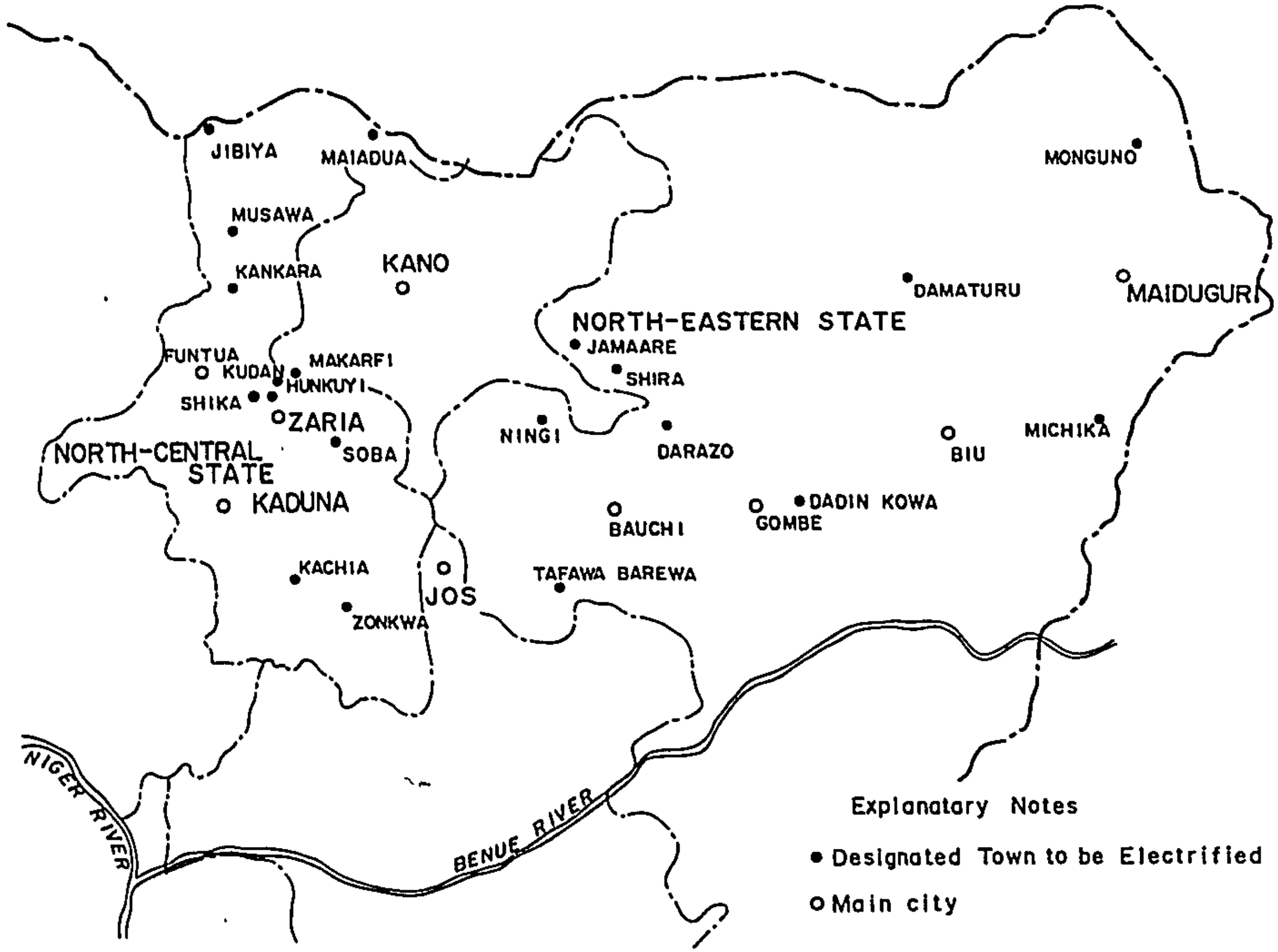


Fig. I-1 TOWNS DESIGNATED TO BE ELECTRIFIED

II. PURPORT AND RECOMMENDATIONS

1. STRUCTURE OF THE REPORT

The structure of the report consists of the following three volumes.

Volume "Feasibility Study Report":

This volume corresponds to the statement of surveyed results and records in which the survey in towns pointed out, power demand forecast, plan and design of facilities, etc. are stated on the key-points as to how to consider, how about the survey results, and what process to be applied, etc.

When making use of the Volumes general and individual specification, or carrying out the same kind of survey activity hereafter, this Volume will grow available as a sort of manual.

In addition, in this Volume, the statement has been partly seen in common with the North-Central and North-Eastern States, so that the structure has some blank pages.

Volume "General Specification":

In this volume, the common parts of technical specifications which are able to be used repeatedly have been involved when rural electrification was carried out by diesel generation as a power source.

Volume "Individual Specification":

In this volume, the design papers have been dealt assembly at this moment concerning the towns pointed out in electrifying them with diesel generation, so that getting the volume together with the Volume "General Specification", this volume has grown as complete designs and specifications. In consequence, putting general conditions together with bid conditions, etc., orders are able to be issued.
In connection with the design papers, we print numerical tables only. Accordingly, regarding the drawings, they can be dealt with by way of making the reprintings from the originals which have been sent.

2. PURPORT AND CONCLUSION

Regarding the volume "Feasibility Study Report", we would like to mention the outline.

2.1 SURVEY OF THE TOWNS DESIGNATED FOR ELECTRIFICATION

Town survey for electrification has been carried out as follows.

1) The following data have been secured beforehand and confirmed at the site.

   i) Present situation of each town to be surveyed and information from the state government in regard to a future plan.

   ii) Aerial photographs or maps of towns to be surveyed.

2) Carrying out site surveys of towns, new informations and necessary data have been looked for.

Through these ways, the survey team secured the demand forecast of towns to be surveyed and the necessary data for the plan and design of facilities to be electrified. Moreover, concerning the power transmission route for above towns to be electrified, it has been dealt to the extent of economic evaluation applicable dependent on the current situation.

2.2 DEMAND FORECAST

1) The power demand forecast has been carried out under the survey results of each town by way of the forecasting process dependent on the following three data.

i) Survey results on real situation in already electrified towns.

ii) Statistical data of already electrified towns secured from NEPA.

iii) Process which were available in several cases of survey for electrification carried out in the past.

In the meantime, the demand forecast has been carried out a little more intensively than usual for the reason why it has been in the period of economic fluctuation at present and rapid economic growth will be foreseeable hereafter.

2) We have estimated the maximum demand in 1985 as follows under the demand forecast.

in the case of big towns	Damatsuru	(805 kW)
	Darazo	(795 kW)
	Jama'are	(733 kW)
in the case of intermediate towns	Michika	(635 kW)
	Ningi	(631 kW)
	Monguno	(508 kW)
in the case of small towns	Dadin Kowa	(391 kW)
	Tafawa Balewa	(332 kW)
	Shira	(220 kW)

The average in between these towns has run to 561 kW. The average demand per customer is 0.89 kW which is smaller than 2.5 kW (in 1972), the nation-wide. This fact has brought us that in such rural towns, enough load has not been grown up yet. The breakdown of the load has been at present occupied at 45 - 75 % to the whole with the load of public facilities such as for education, medical treatment, and water supply, etc.

On the other hand, we have forecasted the universalization at 23%, but this rate has brought us our judgement that an electric tariff payment to the present whole income has occupied at a high rate of about 10% (45 kWH ₦3.1) at ordinary houses and has to be payed in block every month.

In consideration of the fact that power demand is dreadfully high in industrialized, commercialized and electrified towns, a low electric rate policy may bring more increase in consumer's contracts, we think.

2.3 PLAN OF FACILITIES AND ITS DESIGN AND SPECIFICATION

The plan of facilities shall be, in principle, equivalent to power demand ten years after, and the facilities themselves shall be designed and specified under to the standard of NEPA and criteria of Nigeria.

a) Power Sources

Diesel power stations shall have four diesel electric generators and be on synchronized operation system, and also have enough capacity which is able to operate the system even if one generator is shut down. The number of generators which is constructed for the first time shall be able to take the power demand up to three to four years ahead. In the station building, enough space to erect a generator at one rank higher in capacity has been provided and flexibility has been furnished equivalent to the increase in power demand more than forecasted.

b) Distribution System

Voltage of high tension power distribution lines in towns shall be at 11 kV inconsideration of the situation of being electrified with either diesel generation or transmission lines.

Designs and specification for sustaining materials determine, in principle, to use Nigerian-made concrete poles together with wooden-poles, as the case may be. Looking at the power demand forecast, the load of which place is outstanding hasn't been designed yet. Even in small towns of which power distribution can be dependent upon low voltage only, the constitution at high and low voltage has been applied for the feasibility to future expansion.

3. RECOMMENDATION

3. 1 ACTUAL PRACTICE OF CONSTRUCTION WORK

The design drawings and specifications of the Volumes "General and Individual Specification" have been published under the survey results of our team and the requested points from the state government staffs concerned.

However, in the following regards, careful consideration needs to be paid in carrying out construction works.

1) Minimum capacity of diesel electric generators has been, however, set up at 75 kW (for Shira), this setting-up has been dependent upon an idea, in which universality and common feature exist when considering electrification program of many towns planned by the state government.

   On the other hand, when the state government does not consider there is such universality and common feature in electrification program, it is favorable to unify the capacity of diesel electric generators at 115 kW modified from 75 kW. In this case, the change in the items concerned with the Volumes "General and Individual Specification" needs to be modified.

2) Seeing that the present roads from Bauchi to Tafawa Balewa are a seasonal track and have been attended with difficulty to transport main materials for construction works and fuel for daily use, it seems to be advisable to start to construction works after completion of the tarred roads which are now under construction.

3) Monguno looks like having a land adjustment plan. Seeing that the plan and design for rural electrification was carried out at this moment along the present line of houses on a street, adjustment of the period for electrification to be carried out and some review on the distribution system are needed with an inspection on the land adjustment plan of it.

4) In Dadin Kowa, a substation of NEPA is expected to be constructed very near there, so it needs to be checked to electrify them from the above power source substation.

3. 2 CONSTRUCTION WORKS SCHEDULE IN THE FUTURE

Seeing that the transmission system of NEPA is being expected to become perfect gradually in such a case as a 132 kV transmission line which will be nearly constructed in the state area, we think it better that some of towns, which will be electrified in future, should be planned to be connected with the grid system because there many be the town area where it is near to the NEPA transmission system

In planning a still better rural electrification in the future, positive inspection should be required from such a viewpoint.

III. SURVEY OF THE TOWNS DESIGNATED FOR ELECTRIFICATION

The survey team surveyed the towns desingated for electrification to estimate the demand and to design the facilities by taking the following steps.

1. DESIGNATION OF TOWNS FOR ELECTRIFICATION

1) The state government designated the towns to be electrified under the present plan mainly from the following viewpoints.

i) Politically important towns:

Administratively important principal towns in which Administrative Headquarters (Development Area Headquarters or Local Authority Headquarters) and District Headquarters are located, and towns with special facilities such as educational facilities.

ii) Industrial towns:

Towns which are important for transportation, commerce, industrialization and agriculture.

iii) Population:
Towns with population of over ten thousands.

iv) Others:
Towns which are easy to be electrified having power sources in the vicinity, etc.

2) The survey team consulted with the state government on whether the towns were included within the "Countrywide Electrification Project" which had recently been ordered by NEPA for installation, and whether it was possible to investigate within the limited time, and the towns to be investigated were decided upon mutual agreements.

2. GENERAL SURVEY OF THE TOWNS

1) The investigation of the present conditions of each town and of various projects.

In order to grasp the characteristics of each town, the size, the population and the existence of facility, planning projects and various data were obtained from the Ministry of Economic Planning and from the Ministry of Work and Housing of the State Government, prior to conducting the field study.

2) Aquisition of maps and sketches

The maps and sketches which were to be used for designing facilities within the towns and in the transmission lines were obtained through Ministry of Land and Survey.

i) Firstly, the existence of maps (1/3,000 - 1/10,000 which are necessary for designing within the towns, and 1/50,000 for designing transmission lines) was checked.

ii) Secondly, the existence of aerial photographs (1/3,000 - 1/10,000) was checked.

iii) When microfilms of aerial photographs were found, they were projected by an enlarging machine and hand-copied.

iv) The outlines of towns and the roads were sketched from aerial photographs of 1/25,000 - 1/50,000, when there were not any aerial photographs of larger size. In addition, enlarged photographs of 1/5,000 were obtained from the original films of aerial photographs of 1/10,000 - 1/40,000 provided by the Air Survey Section of Federal Survey of Federal Ministry of Works and Housing, though it was after the survey.

3. FIELD SURVEY OF EACH TOWN

1) Decision on the field survey plans

i) Schedule:

One or two days per town. One day was spent for intermediate processing of data for every couple of towns surveyed.

ii) Transportation:

One or two passenger cars and one truck were supplied by the State Government.

iii) Personnel:

Four persons of the investigation team, one counterpart of the State Government, one messenger boy, two drivers (with a boy). One officer of the town and one guide at the time of investigating the town.

iv) Place of accommodation: Hotels, catering rest houses, etc.

2) Investigation on the outline of the town

On arriving at the town designated to be electrified, the survey team received explanations from the head of the town using a list of tables concerning the present conditions of the town, main buildings and projects expected in the future. (See Table III-1)

Table III-1 TOWN LIST

1. State Name
2. Town Name
3. Priority
4. Survey Date.
5. Classification of Town (Include projected).
   (1) Political
      - Administrative Headquarters
      - Development Area Headquarters
      - Local Authority Headquarters
      - District Headquarters

(2) Industrial

- o Agricultural Town
- o Industrial Town
- o Commercial Town
- o General Town

(3) Traffics

- o Main Route Town or Trade Route Town
- o Other Town.

(4) Others

- o Major Border Town
- o Towns Near Major Town
- o Other Town.

6. Population

7. Main Building List (Incluue Proposed or Decided Consumers)

Main Offices

- o Government Office
- o Local Authority Office
- o District Office
- o Other Main Office

Educational Facilities

- o University
- o Secondary School or Teacher's Training College.
- o Primary School
- o Others

Medical Facilities

- o Hospital
- o Health Centre
- o Dispensary
- o Others

Public Utilities

- o Council Hall or Town Hall
- o Court
- o Prison
- o Police Station
- o Library or Reading Room
- o Post Office (Agency)
- o Mosque
- o Church

Water Supply

- o Pump House

House and Residence

- o Emir's Palace
- o Chief's House
- o Officer's Staff Residence
- o Guest House
- o Police Barrocks
- o Hotel

Industry and Others

- o Market
- o Big Factories
- o Local Factories
- o M. O. W. Yard
- o Others

8. Existing Generators (Including Small ones)

3) Investigation on Principal Demand

Based on the list explained by the head of the town, location of main buildings, size of the demand, areas with high demand density and location of sizable proposed consumers were checked and confirmed.

In addition, future plans to enlarge secondary schools and health centres etc. which may become sizable loads after the electrification, and the capacity and the load of the existing generators were investigated.

4) Preparation of sketches

i) When sketches obtained from maps, aerial photographs and microfilms were available, the outline of the town, new areas and the distance were confirmed by driving and walking, and the main landmarks were recorded.

ii) When sketches concerning the town were not available, sketches of the town were prepared by taking the following steps. Firstly, the existence of main roads and branches, the main landmarks and the outline of the town were confirmed and the steps for the survey were decided. Then one of the members sketched freehand confirming the direction by means of a magnet. Another member measured the distance between the centers of the roads by a range finder, a tape-measure and also supplementarily by pacing and by an automobile hodometer

iii) The following main landmarks were recorded on the sketches.

- o direction (showing the north),
- o principal roads and branch roads where distribution lines may pass,
- o the outline of the town, o main buildings, main houses,
- o hills, rivers, ponds, railroads, etc.,
- o existing distribution lines, o location of diesel power plants.

iv) Finally, the conditions of the town were recorded in more than ten photographs.

5) Selection of the location of power station and of the routes of the distribution lines.

i) The proposed sites for the power station were selected so as to locate them in the center of the load, to make transportation of instruments and fuel feasible, and to minimize the effect of noise.

ii) Investigation necessary for laying out the route of the lines was undertaken so that the distribution lines might be supplied from the center of the load, that there would be enough space for installing transformers and that deforestation might be minimized.

4. THE RESULT OF THE INVESTIGATION OF THE TOWNS

The towns to be electrified were studied by the above methods and the results are shown in the Table III-2 and the details are shown in Table Annex.

Table III-2 TOWN LIST (North-Eastern State)

1. Town Name	DAMATSURU	DARAZO	JAMA'ARE	NINGI	MONGUNO	MICHIKA	DADIN KOWA	SHIRA	TAFAWA BALEWA
2. Population (1976 Estimate)	17,100	17,300	18,400	11,000	14,800	16,300	13,100	10,400	10,400
3. Survey Date	27th 12, 1974	13th 12, 1974	17th 12, 1974	16th 12, 1974	28th 12, 1974	31st 12, 1974	12th 12, 1974	19th 12, 1974	11th 12, 1974
4. Classification of Town									
(1) Political	Dev. H. Q. Dis. H. Q.	Dev. H. Q. L. O. H. Q.	Dev. H. Q. L. O. H. Q.	Dev. H. Q. L. O. H. Q.	Dev. H. Q. L. O. H. Q.	Dis. H. Q.	Dis. H. Q.	Dis. H. Q.	Dis. H. Q.
(2) Industrial	Agric. Comm.	Agric. Comm.	Agric. Comm.	Agric. Comm.	Agric.	Agric. Comm.	Agric.	Agric. Comm.	Agric.
(3) Traffic	Main Route	Main Route	General Route	Main Route	General Route	Main Route	Main Route	Main Route	General Route Railway
5. Priority	High	High	High	High	High	High	High	Low	Low
6. Main Loads									
(1) Town Area Future Load Growth 1 - 5th 5 - 10th	High High	Medium High	Medium Medium	Medium Medium	Low Medium	Medium High	Low Medium	Low Low	Low Low
(2) Extension Area (Gov.) (Others)	G. R. A. One Area	G. R. A. L. O. A.	G. R. A. L. O. A.	G. R. A. L. O. A.	G. R. A. -	- Two Areas	- One Areas	- -	- One Area
(3) Secondary School (Permanent) Number of Student (1974)	(P)	Existing 152	(P)	(P)	Existing 50	Existing	(P)	-	(P)
Other Big School Number of Student (1974)	(P) T. T. C.	-	(P) T. T. C.	(P) T. T. C.	-	-	-	-	-
(4) Health Centre	(P)	Existing	Under construction	(P)	(P)	(P)	(P)	-	-
(5) Water Supply	(P) Bore Hole	(P)	-	(P) River	- -	- -	- -	- -	- -
(6) Others	-	Agric. Training Centre	-	Tiffi	-	-	-	-	-

NOTE: Dev. - development area L. O. - local authority Dis. - district H. Q. - headquarters L. O. A. - local authority residencial area
Agric. - agricultural Comm. - commercial G. R. A. - government residential area (P) - proposed
T. T. C. - teachers' training college.

IV. DEMAND FORECAST

1. BASIC PHILOSOPHY

1) We investigated on the towns to be electrified to estimate the demand and, grasped the present conditions of the towns and the actual situations of various projects now being proceeded. In addition, we obtained various materials of value from NEPA and investigated on the present conditions of the towns already electrified. Also, supplementarily, we referred to T. Ingledow (1970), and Merz and Mclelan (1970), which are the rural town electrification program reports consisting mainly of data in the growth period of 1960's and Gapac (1973), Motor Columbus (1973), which are the enforcement program reports.

2) Based on these results, load requirement was estimated as follows.

   Further, due to the recent new trends that the state government is putting hand on its priority policies to expand public facilities of educational, medical, water service, roads and offices, electrification to help these purposes are being urged. By electrifying the town, construction of factories is to be encouraged, which brings forth an expectation for the development of the town and for the improvement of the living standard and productivity. The income of the public is expected to increase, which will result in higher distribution of electricity. The demand was estimated taking these things fully into consideration.

3) Thus, the demand was estimated to be rather on a higher side, but it is hoped that the reliability of the estimation shall be improved by checking it at the stage of construction and by checking the regular load after electricity is supplied.

2. METHODS OF ESTIMATION

2.1 ITEMS ESTIMATED

Estimation was made for the following items.

1) Maximum demand

   In order to decide the output of generators, the capacity of transformers and the organization of distribution systems.

2) Number of consumers

   In order to estimate kWH sales and installation expenses.

3) Energy consumption (sales)

   In order to grasp the actual power demand, the expenditure and the income from the sales.

2.2 ESTIMATION OF DEMAND

We estimate power demand from actual existing undertaking data and other considerations as following chart.

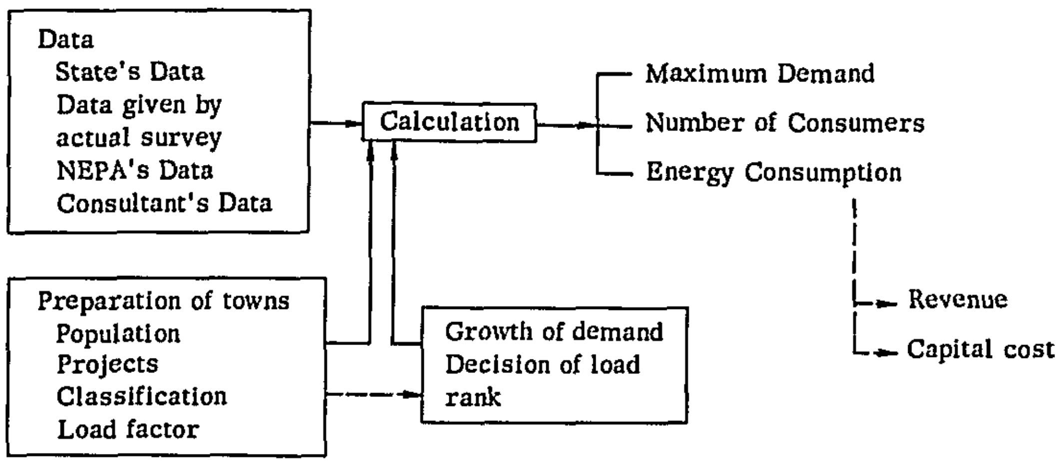


Fig. IV-1 Estimation of Power Demand

2.3 CLASSIFICATION OF LOAD

The breakdown of load by each town is as follows.

1) Existing town area where the demand for electrification is made up of many small consumers.

2) Government residential area, local authority residential area and the extension area developed by the town.

3) Boarding educational facilities such as secondary schools and teacher's colleges.

4) Medical facilities like rural health centers with about 35 beds.

5) Water supply for towns, hospitals and agricultures.

6) Other big loads.

7) Street lightings.

8) Miscellaneous

2.4 THE YEARS FOR WHICH THE DEMAND IS ESTIMATED

We estimated the demand for the following years.

Starting year 1976

Estimate years .... Every year from 1976 through 1985

The estimation was made for each of the following breakdowns of the load

1) Existing load .... from 1976 through 1985

2) Those under construction and those to be constructed in the near future .... from 1976 through 1985

3) Proposed load

   Extension area .... from 1978 through 1985

   Educational facilities ... from 1976 through 1985

   Health centers .... from 1978 through 1985

   Water supply .... from 1978 through 1985

4) Not yet proposed

   Educational facilities ... from 1981 through 1985

   Health centers .... from 1983 through 1985

   Water supply .... from 1983 through 1985

2.5 THE GROWTH OF DEMAND

The growth rate of the demand in the towns already electrified has actually been accerelated to around 20%. Therefore we have postulated that the demand increases annually at a fixed rate rather than the constant annual addition to the load as presently conducted by the state.

2.6 POPULATION

The growth of the population after 1976 is assumed to be 3.5%, which consists of the regular population growth of 2.9% and the expected growth by electrification of 0.6%.

2.7 ESTIMATION OF DEMAND FOR EACH TOWN

The results of demand estimation was obtained by adding the amount for each breakdown of the load. Also in the calculation the following points were considered.

1) Distribution lines will be connected to the consumers who have their own generators before the electrification.

2) As to the maximum demand, we assumed that the distribution loss would offset the diversity factor and it was not taken into consideration.

3) Projects with big factory loads are decided after the electrification, and therefore the installed capacity of the power station and of the distribution lines are to be estimated in accordance with the demand after the construction is completed. Thus the demand for these loads was not estimated.

3. ESTIMATION FOR EACH BREAKDOWN OF THE LOAD

3.1 EXISTING TOWN AREA

1) General description of the load

The categories of the predicted power demand are contained in the presently administered charging system, i.e., residential, small commercial and industrial groups:

i) Residential:

The inhabitants of the town are mostly engaged in agriculture composing a low income class. Standard families with seven members and with three or four rooms are selected for electrification. While the current costs for lighting lamps are ₦2.1 per month (7 kobo/day), the electricity charge will amount to ₦3.1 (45 kWH).

Assuming the income of a family to be ₦30 a month, the electricity charge corresponds to 10% of the income. In addition, connection fees and indoor service construction fees are expensive and these must be paid in a lamp sum for each month, rendering the burden still heavier. Consequently, a fairly large number of consumers may give up installing electricity, although the number of consumers will increase with the improvement of personal income. Thus, except for the public facilities, the consumers will mainly consist of officers, traders, merchants, big farmers, etc., who receive relatively high income.

As to the load peak, evening peaks are expected because consumption will be limited only to lighting for some time for the prices of electric appliances are expensive for the income.

ii) Commercial:

Consumers will mainly consist of public facilities and shops which are opened at evening.

iii) Industrial:

Small local factories use gasoline engines for generators, and the fuel requirements are usually 2ℓ/H below 3 kVA and 3.8 /H for 5 kVA. When electrified, the cost of electricity will be around the same or less, and there will be less noise. Therefore, the electrification is expected to proceed except within the farming fields where there is no power source. The consumption of electricity will be during the daytime and the effect on the evening peak demand will be small.

Under these circumstances of the town, the following points are to be considered as the factors to help judge the future development.

i) Politics:

If the town is politically important as the town is the centre of the wider area or important town in the State, various facilities will be planned, many person will visit or stay, then the town will be prospered, and income of the individual shall be rapidly increased so the growth rate of load will be very high as well.

ii) Transport:

The most important transport method is by road. Towns near the important road crossing, therefore, tends to have more traders and marchants shall be accelerated to increase in these towns.

iii) Industry:

These towns are almost all agricultural towns where people will use the smaller size of motor (2-3 kW at most 10 kW) for their factories such as local sugar cane factories or cotton seed factories etc.

iv) Special load:

Town area load increase shall be expected where hospital, secondary school etc. are established.

v) Merchants and shops:

We studied the towns which had been already electrified main consumers for electricity consist of shops or houses of big merchants and traders except public facilities.

vi) Houses:

As the electrification will start from some permanent buildings and big houses in each towns we made these houses as important check point.

2) Demand (kW)

i) Calculation

demand (kW) = average kW per consumer x number of consumers

ii) Average kW per consumer 0.3 kW

Since large demands for supply is expected in the first and the second years after the electrification, the average kW per consumer was assumed to be 0.35 kW and 0.32 kW, respectively, with reference to Ingledow Report.

Note 1: The number of kW per consumer will increase as consumers purchase new appliances. On the other hand the increase in the number of consumers invites the decrease in the demand rate and also the new consumers will come from the low income class. Therefore no growth is predicted in the general average.

Note 2: The average kW per consumer of 0.3 kW was assumed to belong to the "medium" in the rankings of the towns and the "high" was assumed to be medium plus 10% and the "low" medium minus 10%. Also the ranking of high, medium and low for each town was predicted by dividing the future developments into the short term (1 - 5 years) and the long term (5 - 10 years) with reference to the actual conditions of the towns previously explained in the general description of the load.

Short term (1976-1980): merchants, shops, houses and special loads which represent the present state of the towns.

Long term (1981-1985): politics, transport, industry and special loads which predict future development of the towns.

Refer to Table III-2 for the ranking of each town surveyed.

3) Number of consumers

i) Calculation

Number of consumers = average number of consumers per population x population $(1 + \text{annual growth ratio})^n$

ii) Average number of consumers per population: 21.8×10^{-3}

Also by the same reason expressed in 3.1.2) ii), 12.8×10^{-3} and 18.0×10^{-3} were assumed for 1976 and for 1977, respectively.

iii) Annual growth rate after the third year: 8%

The details are as follows:

population growth	2.9%	3.5%
new consumer growth after electrification	0.6%	
new request to electrification increase of personal income increase of commercial and industrial consumers others		4.5%

iv) The above figures belong to the medium in the ranking of the town. The "high" is medium plus 20% and the "low" is medium minus 20%.

v) n ; the number of years after the electrification - 2

For the first and the second year, n is supposed to be 0.

4) Energy consumption (kWH sales)

i) Calculation

kWH sales (kWH) = consumption per consumer per year x number of consumers $(1 + \text{annual growth ratio})^n$

ii) Consumption per year: 750 kWH

Note 1: By the same reason expressed in 3.1-2) ii), the amount was assumed to be 400 kWH for 1976 and 700 kWH for 1977.

Note 2: The above figures belong to the "medium". The "high" is medium plus 10% and the "low" is medium minum 10%.

iii) Number of consumers See 3.1.3)

iv) Annual growth rate: 3%

Note: The town belongs to the "medium" in the ranking. The "high" is medium plus 10% and the "low" is medium minus 10%.

v) n ; the number of years after the electrification - 2.

For the first year and the second year, n is assumed to be 0.

3.2 EXTENSION AREAS

1) General description of the load

Public facilities like offices, courts, guest houses, police stations, officers' houses and police barracks comprise the main consumers. Many of them are now being proposed or being constructed and they will make up a new urbane district. As a whole, many of them will be private houses.

According to the survey of the towns already electrified, the appliances which are used in individual loads are those highly electrified such as lighting, water heaters, refrigerators, air conditioners, fans, cookers, washing machines, etc. Therefore, the monthly charge for electricity to be paid amounts to around ₦20.

From this figure, we assumed the maximum load per consumer to be 8 kW in G. R. A. (Government Residential Area) and 5 kW in other areas and the calculation was made with the demand ratio of 0. 6.

2) Demand (kW)

i) Calculation

demand (kW) = average kW per consumer x number of consumers

ii) Average kW per consumer

G. R. A.	4. 8 kW
other areas	3 kW

Note: By the same assumption expressed in 3. 1-2) ii), no growth is predicted.

3) Number of consumers

The growth of consumers will be as follows:

G. R. A.	3 x number of year after installation
other areas	2 x number of year after installation

4) Energy consumption (kWH sales)

i) Calculation

$$\text{kWH sales (kWH)} = 365 \times \text{demand} \times \text{load factor} \times \text{hour} \times (1 + \text{annual growth ratio})^n$$

ii) Demand — See 3. 2. 2)

iii) Load factor x hour

Since electricity will be used for 24 hours a day, we assumed that the total load factor per day is 0. 21 with 0. 1 x 12 hours for the day, 0. 7 x 5 hours for evenings and 0. 05 x 7 hours for the night.

iv) Annual growth rate

Note: Identical as with that of the existing town area.

v) n ; the number of years after the electrification - 1.

3.3 EDUCATIONAL FACILITIES

1) General description of the load

Secondary schools and teachers' colleges are now being constructed urgently under the educational policies of the state.

Table IV-1 NUMBER OF STUDENTS PER SCHOOL
(Secondary School and Teachers College)

Item	1968	1969	1970	1971	1972	1973	1974
N. E. State. Number of Students per 1 School	230	223	211	239	243	266	332
Growth percentage		△ 3	△ 5	3	2	9	25
N. C. State. Number of Students per 1 School	191	235	246	267	306	430	N. D.
Growth percentage		23	5	9	15	41	-

Table IV-2 SUMMARY OF BIG SCHOOL
(Example of Surveyed Town)

1974

Classification of School		Capacity of Generator kVA	Peak Load kVA	Number of Students 1974	Number of Students 5 years Estimate	Note
A	S. S.	N. O. N.	N. O. N.	140	1000	
B	S. S.	65.7	7	350	1000	New school
C	T. S. S.	138	N. D.	650	1000	
D	G. S. S.			510	1500	
E	S. S.	65	55	550	N. A.	some classrooms are not electrified
F	W. T. C.	25	N. D.	330	700	
G	G. S. S.	25	N. D.	270	N. A.	
H	S. S.	25	25	450	800	Generator will be changed to bigger one soon
I	S. S.	N. O. N.	-	300	N. A.	
J	S. S.	N. O. N.	-	50	N. A.	
K	S. S.	5	N. D.	150	N. A.	

Note: N. D. : no data N. A.: no answer N. O. N. : no existing

These educational facilities can be divided into school load which includes offices, classrooms, water supply, dining rooms and dormitories for all students and residence load which includes residence for main staffs and teachers.

The residence is highly electrified to guarantee the living for the teachers who work in secluded areas. Electricity for lighting is now supplied by a small generator for about two hours in the early morning and for about five hours in the evening, but many places suffer from insufficient supply because of the rapid increase in the number of students and teachers.

2) Demand (kW)

i) Calculation

demand (kW) = kW per student x number of students

ii) kW per student 0. 12 kW

Note: Judged from the data actually collected in the field investigation.

iii) Number of students

1) Already electrified schools

Number of students = number of students at 1974 x $(1 + \text{annual growth rage})^n$

Note 1: annual growth rate 0. 1 (10%)

2: maximum number of students 1,000

This figure is assumed to be the upper limit.

ii) Schools not yet electrified

Number of students at 1976 = 1. 5 (number of students at 1974 + 50 x 2) x $(1 + \text{annual growth rate})^n$

Note: The number of students after the electrification is assumed to be 1. 5 times of the existing number, since the improved equipment is predicted to bring about the increase in the number.

iii) Proposed schools

The number of students was assumed to be 150 for the first year, 250 for the second year and 300 for the third year with the annual growth rate identical with that in 1).

iv) n : the number of years after the electrification - 1

3) Number of consumers (for reference)

The residential load in the school load forms the consumers to whom the distribution lines are connected after the electrification. Since rapid increase in the number of students is predicted in the future, the number of consumers is assumed to be 0. 04 for one student with reference to the actual conditions shown in Table III-3.

Table IV-3 NUMBER OF TEACHERS PER NUMBER OF STUDENTS (Secondary School and Teachers College)

	1968	1969	1970	1971	1972	1973	1974
N-E State	0. 050	0. 058	0. 057	0. 049	0. 049	0. 047	0. 045
N-C State	0. 063	0. 053	0. 053	0. 053	N. D.	0. 024	N. D.

4) Energy consumption (kWH sales)

i) Calculation

kWH sales (kWH) = 365 x demand x load factor x hour x $(1 + \text{annual growth ratio})^n$

ii) Demand See 2)

iii) Load factor x hour

Since electricity will be used for 24 hours a day, we assumed that the total load factor per day is 0.3 with 0.2 x 12 hours for the day, 0.8 x 5 hours for evenings and 0.1 x 7 hours for the night.

iv) Annual growth rate 3%

Note: Identical with that of the existing town area

v) n : the number of years after the electrification - 1

3.4 MEDICAL FACILITIES

1) General description of the load

In the towns investigated rural health centers are now being constructed urgently. The content of the load is offices, wards, machine equipment rooms, dining rooms, residence for main staffs, doctors and nurses, and water supply. Residence is highly electrified. In a certain newly established hospital, they are planning to expand medical equipments like sterilizers to three times as much as the existing equipment. With a load of 6 - 10 kW for an X-ray apparatus, the peak will be five to six times as much as the existing one in many equipment. Therefore it is required to construct electric equipments with sufficient capacity. Electricity is now supplied by generators of 50 - 100 kVA for a limited period of hours, but after the electrification it will be switched to round the clock operation. Water supply for medical facilities is included in that of the town.

2) Demand (kW)

i) Calculation

demand (kW) = demand at the third year $(1 + \text{annual growth rate})^n$

ii) Demand at the third year 45 kW

The demand at the first year and the second year is assumed to be 25 kW and 35 kW since the rapid increase in load is predicted from the actual conditions of the towns investigated.

iii) Annual growth rate: 0.1

The figure was assumed from the predicted increase in the number of beds in the state.

iv) n : the number of years after the electrification - 3.

3) Number of consumers (for reference)

Doctors, a part of clerks and nurses will make up the consumers. From the present conditions, we assumed the number to be six at the beginning stage. It was also assumed that the number will increase in accordance with the demand.

4) Energy consumption (kWH sales)

i) Calculation

kWH sales (kWH) = 365 x demand x load factor x hour x (1 + annual growth ratio)^n

ii) Demand See 2)

iii) Load factor x hour

The total load factor was assumed to be 0.51 with 0.6 x 11 for the day, 0.8 x 5 for evenings and 0.2 x 8 for the night.

iv) Annual growth rate 13%

Note: Identical with that of the existing town area

v) n : the number of years after the electrification - 1

3.5 WATER SUPPLIES

1) General description of the load

Water is now supplied from wells and rivers and carried by hand or by trucks. After the electrification water will be pumped up by motors and supplied individually for use in towns, hospitals, plant fields and livestock ponds by reservoir tank systems or by continuously pressurized systems.

The load of the electricity is predicted based on the reservoir systems in which peaks appear in a short time. Initially, calculation was made with the operating time of 3 hours per day, and with the height of the water pumped up 10 meters above the ground and 10 meters below the ground making the total height of 20 meters. Electricity for the water supply is mainly used in daytime and usually it will not affect the peak demand. Since the worst case of the evening operation was foreseeable, it was calculated as an evening load.

2) Demand (kW)

demand (kW) = kW for towns + kW for hospitals + kW for others

i) kW for towns

The volume of water used was estimated as per capita water consumption x population + losses and the corresponding capacity of electric motors (initially with an operating time of 3 hours a day) was estimated.

o per capita water consumption

In a rural town where water supply has already begun, the actual record of the volume of water used per person per day is 1 - 2 gallons (0.0045 m^3 - 0.009 m^3)

at the beginning stage of the supply. However, rapid increase in use will double the consumption in 4 - 5 years, and so it is estimated to be 5 gallon/day (0. 023 m^3/day) with some margin.

o losses:

Loss in the water supply was estimated to be 100% of the minimum volume of water required.

o correlation between the volume of water required and the output of electric motors:

The following correlation which is generally used was adopted.

Output of electric motors	Volume of water pumped per minute	Volume of water for three hours
3. 73 kW	0. 6 m^3	110 m^3
5. 6	0. 9	160
7. 46	1. 4	250
11. 2	2. 1	380
15	3. 0	540
20	4. 1	740
25	5. 5	990
30	7. 0	1, 260
40	9. 0	1, 620
50	12. 0	2, 160
75	17. 0	3, 060
100	23. 0	4, 140
150	32. 0	5, 760

ii) kW for hospital

After the field investigation, it was estimated to be 15 kW, since the required volume of water is 500 m^3 for the initial operating time of three hours per day.

iii) kW for other use

The figures were assumed to be identical with those in town areas.

3) Number of consumers

This was estimated to be one for each purpose for which water is used.

4) Energy consumption (kWH sales)

i) Calculation

kWH sales (kWH) = (kW for town use + kW for other uses) x 3 x $(1 + \text{annual growth rate})^n$ + kW for hospitals x 3 x $(1 + \text{annual growth rate})^n$

ii) Annual growth rates

for town and other uses	0. 2
for hospital use	0. 1

iii) n : the number of years after the electrification - 1

3.6 STREET LIGHTINGS

1) General description of the load

Main roads, shopping streets and much crowded areas shall be equipped with street lightings for the evening and night time illumination and to provide the low income class with the benefit of electrification which they still can not enjoy. Street lightings could use mercury lamps, sodium lamps, fluorescent lamps or incandescent lamps. We have, however, decided to use fluorescent lamps because of their low capacity and costs.

2) Demand

i) Calculation

demand = kW per street light x number of street lighting x m.

ii) kW per street light 0.06 kW (0.03 kW x 2)

Note: The power factor was not taken into consideration.

iii) Number of street lights

Individual estimation on each town

3) m. 1 (1 - 5 years), 1.5 (5 - 10 years)

3) Energy consumption (kWH)

i) Calculation

kWH = demand x N x 3.65

ii) n : (consumption hour per day) 12

from 6.00 p.m. through 6.00 a.m.

3.7 OTHER LOADS

The contents of the demand were investigated respectively and then decided were made.

4. RESULTS OF THE ESTIMATION

1) We estimated the maximum demand, number of consumers, and energy consumption of the towns surveyed by the method of demand forecast.
The results are shown in Table IV-4. The details are listed in Table Annex.

2) In order to comprehend the changes, summary of the demand forecast is given in Table IV-5. Further, the changes for a period of 10 years are shown in Fig. IV-2, for a typical city of Darazo with many public facilities and for Monguno with much general demand.

3) As a result, the load will remarkably increase due to the increase in the number of public facilities like educational facilities, but the maximum demand is still pretty small even ten years later and is below 1,000 kW. The average demand per consumer is 0.69 kW in 1976 and 0.89 kW in 1985 against 2.5 kW in the whole Nigeria.

As to the breakdown of the load, public facility loads like those for the educational facilities, medical facilities and water supply account for about 70% of the total load. The percentage of the electrified households will be 23% for the family of seven and considerable number of consumers will continue to use oil lamps. This is because the connection fee and the charge of electricity are still expensive and because the payment must be done in a lump sum. On the other hand, momentary saturation of loads of new facilities is observed in large towns and demand can be excited when personal income becomes higher. Thus, the future subject of importance to be considered is to help the low income class.

Besides this, high reliability in electrification will invite active electrification in both agriculture and industry thus exciting the demand and the development of the towns, which will lead again to the increase in demand.

Table IV-4 DEMAND FORECAST

Maximum Demand: kW
kWH Sales : 10^3 kWH

Town Name	Item	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Damatsuru	Max. Demand	208	280	421	474	522	568	622	677	738	805
	No. of Consumer	295	416	513	567	612	653	717	786	862	943
	kWH Sales	343	621	972	1,161	1,346	1,532	1,752	1,992	2,263	2,634
Darazo	Max. Demand	252	301	397	440	487	551	606	666	721	795
	No. of Consumer	263	359	434	474	514	567	623	685	752	824
	kWH Sales	591	804	1,028	1,187	1,362	1,567	1,796	2,057	2,344	2,665
Jama'are	Max. Demand	213	285	336	379	422	471	521	621	675	733
	No. of Consumer	271	381	461	503	546	593	653	700	760	822
	kWH Sales	449	736	917	1,057	1,206	1,383	1,571	1,845	2,078	2,353
Ningi	Max. Demand	136	191	313	358	401	536	489	534	581	631
	No. of Consumer	190	268	334	366	398	433	471	511	555	598
	kWH Sales	202	352	628	768	917	1,063	1,214	1,384	1,567	1,776
Monguno	Max. Demand	119	151	217	248	282	319	353	436	471	508
	No. of Consumer	173	239	295	318	342	371	402	437	472	511
	kWH Sales	214	332	542	654	775	884	1,005	1,189	1,344	1,517
Michika	Max. Demand	177	207	277	312	349	397	438	541	586	635
	No. of Consumer	288	378	457	497	542	592	649	712	778	851
	kWH Sales	259	451	696	826	965	1,095	1,245	1,483	1,669	1,894
Dadin Kowa	Max. Demand	72	104	163	191	217	241	264	338	364	391
	No. of Consumer	147	209	259	280	301	327	354	385	417	450
	kWH Sales	123	239	432	525	622	712	805	963	1,090	1,232
Shira	Max. Demand	34	45	50	53	56	78	94	184	202	220
	No. of Consumer	107	151	182	194	206	227	246	272	292	312
	kWH Sales	44	105	127	139	151	214	262	468	560	657
Tafawa Balewa	Max. Demand	70	99	116	129	141	156	171	276	302	332
	No. of Consumer	121	172	207	223	238	255	273	305	324	347
	kWH Sales	122	225	283	323	361	411	462	697	822	955
Total	Max. Demand	1,281	1,663	2,290	2,584	2,877	3,317	3,558	4,273	4,640	5,050
	No. of Consumer	1,855	2,582	3,142	3,422	3,699	4,018	4,388	4,793	5,212	5,658
	kWH Sales	2,347	3,865	5,625	6,640	7,705	8,861	10,112	12,078	13,737	15,683

Fig. IV-2 EXAMPLE OF LOAD TRANSITION

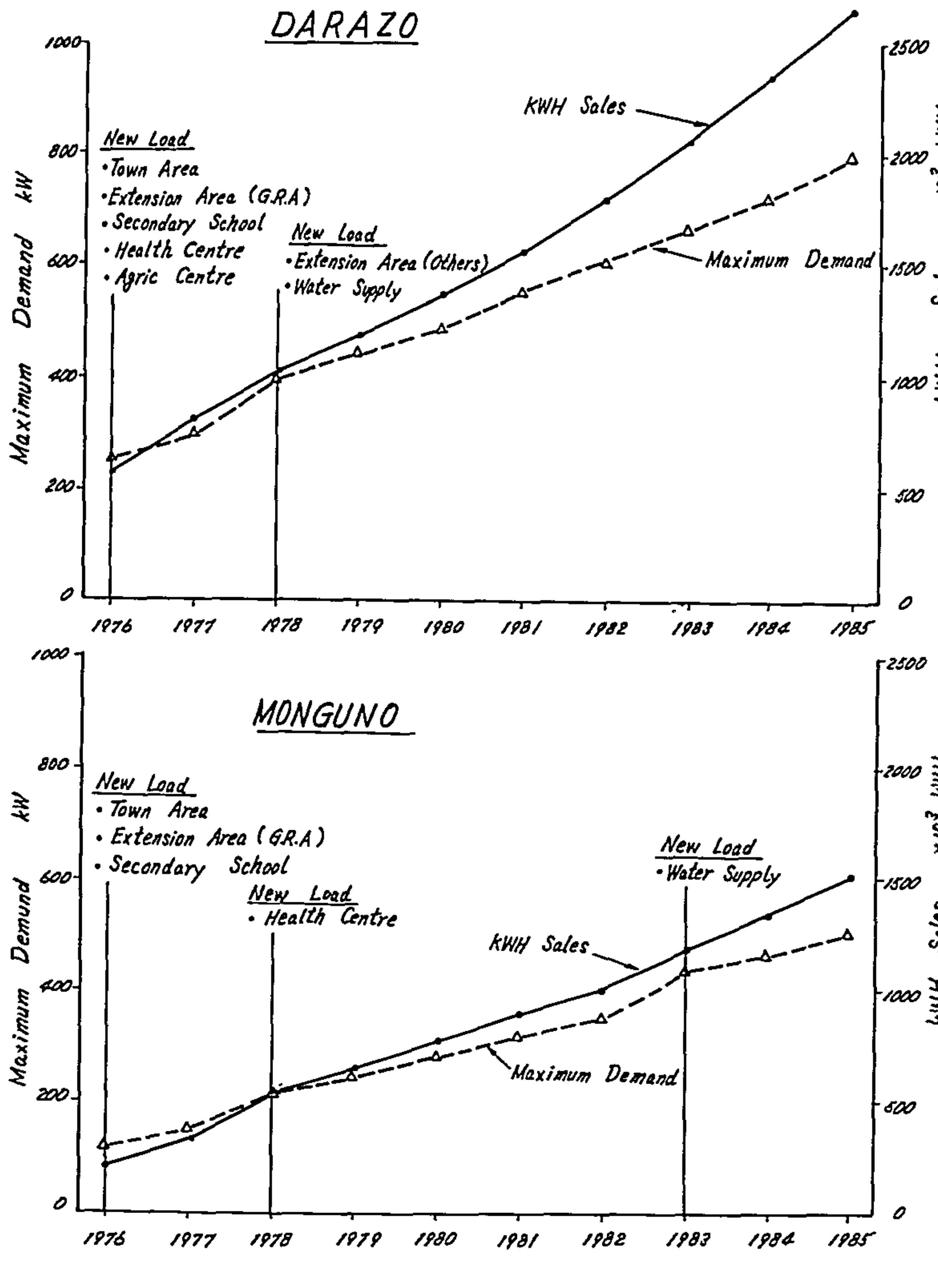


Table IV-5 SUMMARY OF DEMAND FORECAST

		1976	1985
Maximum Demand			
Maximum Demand per town (kW)	Max.	252	805
	Min.	34	220
	Ave.	142	561
Average Demand per consumer (kW)		0.69	0.89
Average Demand per person (W)		10	26
Number of Consumers			
Average Number of Consumers per town		206	629
Average Percentage of Electrification (%)		10.0	23.2
Energy Consumption			
Average kWH Sales per Consumer per year (kWH)		1264	2770
Load Factor		0.21	0.35
Average Population per Town		14.3	19.0

V. SUMMARY OF INSTALLATION PLAN DESIGN AND SPECIFICATIONS

1. GENERAL

In compliance with existing power systems in Nigeria, the installation plan, design and specifications are considered to ease construction, operation and maintenance of the project.

1.1 SYSTEM CHARACTERISTICS

Frequency	50 Hz	
Generating voltage	415/240 V	
High voltage	33 kV (for transmission line) 11 kV (for transmission and distribution lines)	
Low voltage	415/240 V	
Insulation level for high voltage line		
BIL (peak)	75 kV	
One-minute power frequency withstanding voltage (r. m. s.)	35 kV	
Grounding system	415/240 V	Multi-grounding common neutral system
	11 kV	Non-grounding system

1.2 STANDARDS

Planned design and installation practice comply with the Recommendations of International Electrotechnical Commission (I. E. C.) and the Laws of the Federation of Nigeria and Lagos (Chapter 57).

1.3 COORDINATION OF INSULATION

In order to provide economy for system cost, the coordination of insulation is much severer for series devices (insulator, line switches, power cables) which give influence to the customers in wide area, and the grade of the coordination is lowered to some extent for devices to be operated in parallel (distribution transformers, capacitors and so on) which may give rather local influence at operation failure.

Devices of lower insulation are protected by arrestors. Individual unit of diesel engine generators is protected by surge absorbers.

1.4 PROTECTIVE COORDINATION

In order to limit influence of a device failure to a very local area, by disconnecting the device in failure quickly from the system, close coordination must be provided for operating time of fuse-free breakers and relays in diesel power station and drop-out fuses and switches in substation.

1. 5 SHORT-CIRCUIT STRENGTH

The short-circuit strength of 11 kV system is determined by impedance of devices such as diesel generator, transmission line and step-down transformer. At present, the diesel electric generator provides a comparatively small short-circuit capacity, but in future, when the power will be supplied from transmission line, the short-circuit capacity of power source will be able to reach some 50 MVA. Therefore, a 50 MVA short-circuit strength must be given to the 11 kV system.

1. 6 CLIMATIC CONDITION

The design and installation practice for all devices comply with requirements in tropical zone.

1. 7 SELECTION OF DEVICES AND MATERIAL

1) Construction materials are selected, as much as practical, for ease of procurement and supply.

   Example: Supporters - concrete poles made in Nigeria.

2) An emphasis is placed on interchangeability and compatibility so that spareparts for maintenance are effectively reduced.

   Example: Unit capacity of diesel generators - 346 kW, 229 kW, 115 kW, 75 kW

   Wire size - 50 mm^2, 100 mm^2

2. POWER SOURCE

2. 1 POWER SOURCE SUPPLY SYSTEM

2. 1. 1 General

In electrification of rural towns by a 11 kV distribution system, either of the following power source systems would be possible:

1) A diesel power station in individual town.

2) Extention of transmission line from existing, under construction or planned NEPA's grid.

However, the towns which will be planned to be electrified in this report are for apart from NEPA's grid, so the towns will be electrified by isolated diesel generation.

2.1.2 Individual Diesel Power Station Plan

Assuming that the power is supplied from individual diesel power station installed in each town, capacity and number of generators can be determined as follows:

a) Conditions to Determine Capacity and Number of Generators

1) In capacity, type of diesel engine generators have to unified for ease of construction, operation and maintenance. The type and capacity of diesel engine generators comply with the NEPA unified capacity standards. (Note 1)

The capacity of generators is limited to the following:

346 kW 229 kW 115 kW 75 kW (Note 2)

Note 1: In this report, the capacity of generators is selected from NEPA's Unified Standards, but, in order to assure freedom of device selection at actual procurement, it seems feasible that certain allowance (some -10% to +15%) may be given to the capacity of generators.

Note 2: The 75 kW generator is not listed in NEPA's Unified Standards, but, the small power generator seems advantageous, by the following reason, for use in towns for which very small load is foreseen.

- o At starting of system operation, some towns such as Hunkuyi or Shipa seems as small as 30 to 40 kW. If a 115 kW generator is selected, the small load will make the initial investment excessively large and operation efficiency will be lowered because of the excessively low load rate.
- o Estimated future load in these towns, 10 years after, will range 150 to 260 kW. If 115 kW generators are installed, excessive investment will be seen in the final installation which would be 115 kW x 4 = 460 kW. (The 75 kW generators would make the final capacity appropriate as 75 kW x 4 = 360 kW.)

2) Considering the ease of operation, interchangeability of devices and common use of spare parts, the capacity of diesel engine generators in a station is unified to the same type. The power house is designed to be capable of installing additional diesel engine generators of 1-rank larger, or to ensure replacement of generators with these larger generators, considering a possibility that the customers demand may exceed the forecasted load.

3) Considering overall conditions, such as reliability, economy and technical condition, generators is operated in parallel, as given in V-2. 1.2 e).

4) It is our principle to make the final number of installation to 4 generators per plant. Even when the estimated load for 1985 is covered by 3 engine generators, the power house is designed to be capable of installing 4 generators considering the possibility that the future load demand may exceed the estimated one.

5) Reliability design

Since diesel engine generator is a rotary machine, periodical inspection, at comparatively short intervals, is essential to expect high-performance for a long period of time. (Note 1) For this purpose, number of generators in power station is determined so that a generator is left as a stand-by machine. The stand-by machine is no only operated at the perildical inspection, but, operate when a generator failure occured in the station.

Note 1: For the periodical inspection, a diesel engine generator will have to be stopped for 3 weeks at every 6000 hr. operation (approximately every 8 months, when continuously operated).

b) Decision of Diesel Electric Generator Capacity

Capacity of diesel generator is determined for each station, as given below:

- o Final installation at 1985 - 4 generators.
- o Capacity of station - capable of covering the estimated final load (P_{10} .... load in 1985) in 10 years later.
- o Employed reliability design - 2. 1. 2-a)-5)

From these conditions, capacity required for a diesel engine generator (P_{GO}) is given as follows:

$$P_{GO} = \frac{P_{10}}{4 - 1}$$

Basing on the calculated value for P_{GO}, capacity of generator is selected from the closest one in the Unified Standard capacities in 2. 1. 2-a)-1). (Note 1)

Note 1: When determining actual diesel generator capacity (P_G) for the calculated capacity (P_{GO}) from the Unified Standards (346 kW, 229 kW, 115 kW and 75 kW), a generator having 1-rank larger capacity should be selected, if the calculated value for P_{GO} exceeds one of the standard generator capacity, even some kilowatts. However, the load estimated in this report is an accummulation of individual load (schools, hospitals and so on), and diversity factor and economy must be taken in consideration. In some cases, actual load in future can be smaller than the estimated one. Therefore, a generator is selected from the Unified Standards, until the calculated P_{GO} exceeds 120% of rated capacity for the generator.

In case, 1.2×346 kW (415 kW) $\geq P_{GO} > 1.2 \times 229$ kW (= 275 kW), a 346 kW generator is selected.
Similarly, the selection will be as follows:

$1.2 \times 229 \geqq P_{GO} > 1.2 \times 115$ kW (138 kW) .... 229 kW

$1.2 \times 115 \geqq P_{GO} > 1.2 \times 75$ kW (90 kW) .... 115 kW

$1.2 \times 75 \geqq P_{GO}$ .... 75 kW

c) Decision of Number of Diesel Electric Generators

The number of generators to be installed at starting of operation (1976) is determined as follows, so that the load in the 2nd year (P_2 ..... load in 1977) may be covered (see Note 1) and reliability design in 2. 1. 2-a)-5) may be satisfied.

$3 \geqq \frac{P_2}{P_G} > 2$ 4 generators are installed.

$2 \geqq \frac{P_2}{P_G} > 1$ 3 generators are installed.

$1 \geq \frac{P_2}{P_G} > 0$ 2 generators are installed.

P_G : Capacity of a diesel engine generator determined in item b) above and selected from the Unified Standards.

Note 1: In some of the present estimate of loads, the estimated load for the 3rd year (1978) increases greatly from that for the 2nd year (1977) by scheduled increase of load in public facilities (secondary schools, hospital and water supply). However, most of these scheduled public facilities are not under construction, and some deviation in date of completion seem feasible. It leads to an excessive investment, if generators are installed in 1976 so that they will cover the currently estimated load in these public facilities to be completed in 1978. It will be sufficiently in-time, if expansion of diesel generator plants may be started when starting of construction of these public facilities is made much clearer. Therefore, the initial number of diesel engine generators is determined basing on the load estimated for 1977.

d) Result of Examination

Table V-1 CAPACITY AND NO. OF DIESEL ELECTRIC GENERATORS

	Capacity			No. of generators at starting			No. of generators in 1985
	Load in 1985 (P_{10} (kW))	$P_{GO} = \frac{P_{10}}{4-1}$ (kW)	Final capacity (kW)	Load in 1977 P_2 (kW)	No. of generators ($\frac{P_2}{P_G}$)	No. of generators	
Damatsuru	805	268	229	280	1.22	3	4
Darazo	795	265	229	301	1.31	3	4
Jama'are	733	244	229	285	1.24	3	4
Ningi	631	210	229	191	0.83	2	4
Monguno	508	169	229	151	0.66	2	4
Michika	635	212	229	207	0.90	2	4
Dadin Kowa	391	130	115	104	0.90	2	4
Shira	220	73	75	45	0.60	2	4
Tawara Balewa	330	110	115	99	0.86	2	4

Note : No. of generators in 1985 $P_{10} \geq 2P_G$ ...... 4 generators

$P_{10} \geq 1P_G$ ...... 3 generators

e) Merits Obtained from Parallel Running Generators of the Same Capacity

In a conventional approach, generators were not operated in parallel, but a generator was operated at peak load time, and the other generator was operated for off peak service. As shown in calculation below, however, the parallel running of generators of the same capacity has the following merits and it recommended for this project:

- o Number of generators can be reduced.
- o Saving in equipment investment.
- o Simplyfied operation technique.

Example of calculation:

Assuming that the required power can be supplied from non-failure generators, in case of failure of the maximum capacity's generator, calculation shown below gives merits for parallel running of generators (of the same capacity).

Table V-2

		Xth year	X +αth year
Demand	At peak load	200 kW	400 kW
	At off peak load	100 kW	200 kW
Conventional method	Capacity and No. of generators	200 x 1 100 x 2 400	400 x 1 200 x 1 100 x 2 800
			(Addition of a 400 kW generator in (X +α)th year.)
	Operation mode At peak load	200 x 1 (100 x 2)	400 x 1 (200 x 1 + 100 x 2)
	At off peak load	100 x 1 (100 x 1 and 200 x 1)	200 x 1 (100 x 2 and 400 x 1)
Method of parallel running of same generators	Capacity and No. of generators	200 x 2 400	200 x 3 600 (Addition of a 200 kW generator in (X +α)th year.)
	Operation mode At peak load	200 x 1 (200 x 1)	200 x 2 (200 x 1)
	At off peak load	200 x 1 (200 x 1)	200 x 1 (200 x 2)

Generator in ( ) is a spare machine.

As seen in the table, the parallel running of the same generators can reduce number of required generators in Xth year and (X +α)th year. It also saves total capacity. It is our conclusion that the separate operation of peak load generator and off peak generators will lead to excessive investment.

2.2 BASIC DESIGN FOR DIESEL POWER STATION

2.2.1 One Line Diagram

The basic connection system is those shown in Fig. Annex-1 (One Line Diagram) and Table Annex-2 (Ratings of 415 V bus, fuse free breakers, knife switches and current transformers).

The basic design for this system includes the following:

- o Parallel operation of diesel electric generators at 415 V bus.
- o 11 kV transmission from 415 V bus, through step up transformer.
- o Provision for separated 415 V emergency feeder.

2.2.2 Diesel Power House

Diesel power station shall be designed taking into consideration the matter described hereafter. Standard type design of diesel power station, which is minimum requirement for the station, is stated in the attached Fig. Annex-2.

a) Location of Diesel Power Station

The proposed preliminary locations of each power station is mentioned in each attached town map. The exact location of each station shall be decided through discussion with the Government.

Location of each diesel power station will be so selected so as to satisfy the following conditions.

1) to be located close to the area of load center.

2) to be located at a sufficient distance away from houses to prevent noise trouble.

3) to be located near the main load to enable machinery and fuel transportation.

b) Site Area of the Power Station

About 1600 m^2 of the site area of the standard type design includes the necessary area for future extension of diesel power house.

In case that a local administration office or other required building is provided, the site area mentioned above shall be increased. The actual site area may adjusting accordingly as the situation demands due to site surveying/investigation.

c) Area and Location of Power House

A sufficient area shall be kept free on the D/G room side for future power house extension.

d) Outline of Site Preparation

The stations shall be constructed on additional soil placements which will be added to the natural soil level to prevent rainwater from causing any damage. All station sites shall be with proper drainage methods (e. g. ditches, etc.) to prevent rainwater from causing any damage.

e) Outline of Power House

The power house shall consists of at least C/G room, control room, office, wash room, store room and battery room. D/G room shall be of pre-fabricated steel structure and service area shall be of reinforced concrete structure.

f) Fuel Storage Tanks

The fuel storage tanks shall be located so as to allow easy access of tank filling by oil trucks. Concrete oil fences or dikes shall be provided around oil tanks to prevent fuel flow out in case of accident.

2.2.3 Electrical Devices

a) Step up Transformer

1) Conditions to determine transformer capacity

i) Since the transmission system voltage is unified to 11 kV, a step up transformer (415 V/11 kV) is installed in each diesel power station.

ii) As shown in the one line diagram, (Annex-1), the step up transformer receives power output of diesel electric generators operated in parallel on the 415 V bus. At commissioning, each power station has a step up transformer. This system is much more advantageous than the 11 kV parallel system in which a step up transformer will be installed for each generator and transformer outputs (11 kV) are operated in parallel, in the following terms;

Reduced special high tension circuits (11 kV), and improved safety.
Reduced number of step up transformers which improves economy of system.

iii) Capacity of step up transformer must match capacity of diesel electric generators to be operated. Power factor of 11 kV distribution system is assumed as 0.85. An overload operation, at 110% for several hours, is affect the service life of transformers, provided that the overload is removed within several hours. Therefore, assuming that full power operation of diesel electric generators end within several hours, capacity of step up transformers is set to allow 110% overload operation for several hours.

Capacity of step up transformers

- A power station with 3 x 229 kW generators

  $229 \times 3 \times \frac{1}{0.85} \times \frac{1}{1.1} = 735$ (kVA) 1 x 700 kVA transformer is used.

- With 2 x 229 kW generators

  $229 \times 2 \times \frac{1}{0.85} \times \frac{1}{1.1} = 490$ (kVA) 1 x 500 kVA transformer is used.

- With 2 x 115 kW generator

  $115 \times 2 \times \frac{1}{0.85} \times \frac{1}{1.1} = 246$ (kVA) 1 x 300 kVA transformer is used.

- With 2 x 75 kVA generator

  $75 \times 2 \times \frac{1}{0.85} \times \frac{1}{1.1} = 160$ (kVA) 1 x 200 kVA transformer is used.

2) Reliability design

The transformer is a stationary device which ensures higher reliability than diesel generator, thus, at commissioning and early stage of operation, each diesel power station will have a step up transformer. The step up transformer must be protected well from thunder (by arrestors) and from short-circuit failure (by circuit breakers). Should the transformer or other series device fails to operate, power supply must be continued, to the minimum extent, through a low voltage emergency feeder. This emergency feeder is not operated in normal cases, and terminals from power station and from feeder must be left opened. In an emergency case, these terminals are connected to supply the emergency power. Handling of this connection must comply with the V-3. 1. 2-b), and must be operated cautiously.

In proposed final situation, the power will be supplied to 2-11 kV feeders from two step up transformers. In case of a transformer failure, the power will be supplied from live transformer to the 2-feeders (see Fig. V-1).

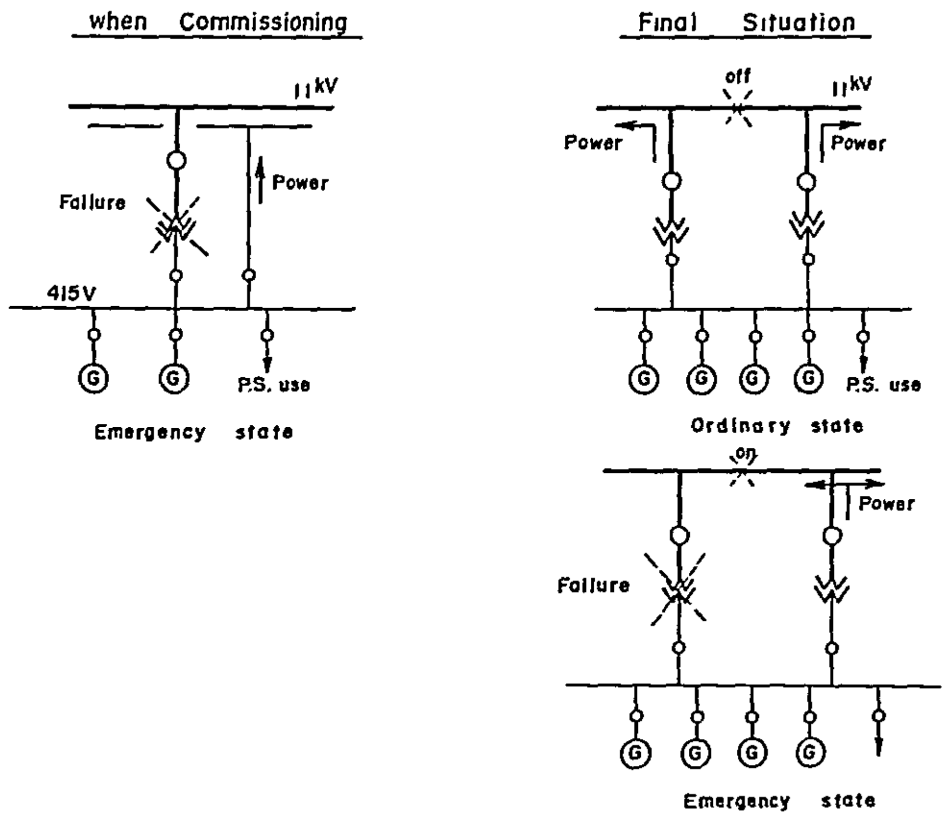


Fig. V- 1

3) Result of Examination

Table V-3 CAPACITY OF STEP UP TRANSFORMERS

	Capacity at commissioning (kVA)
Damatsuru	700
Darazo	700
Jama'are	700
Ningi	500
Monguno	500
Michika	500
D. Kowa	300
Shira	200
T. Balewa	300

b) Fuel System

1) Basic composition

i) As shown in Fig. Annex-3, a daily service tank is prepared for each diesel generator, and two outdoor storage tanks is installed.

Note: Considering inspection, two storage tanks is required for each station.

ii) In addition to the fuel transfer pump, a magnetic valve is installed to prevent leakage of fuel to daily service tank and to return overflown fuel to storage tank with a return pump.

2) Selection of storage tank capacity

Capacity of storage tank is selected so that fuel required for the possible load in 1985, for 15 days with two tanks.

Calculation formula

- o Fuel - low calory fuel (10,200 kcal/kg)
- o Average fuel consumption of engine - 0.170 kg/PSH
- o Average engine efficiency - 0.92
- o Specific density of fuel - 0.98
- o Daily power consumption in 1985 - H_{10} (kWH)
- o Required tank capacity per a tank - V_T (m^3)
- o Conversion factor for PSH and kWH - $\frac{1}{0.7355}$

The power consumption to be generated daily is given as:

$$H_{10} \times \frac{1}{0.92} \times \frac{1}{0.7355} \text{ (PSH)}$$

Volume of fuel required daily, is:

$$0.170 \times H_{10} \times \frac{1}{0.92} \times \frac{1}{0.7355} \text{ (kg)}$$

Required volume for V_T (m^3) is given as:

$$V_T = \frac{1}{2} \times 0.170 \times H_{10} \times \frac{1}{0.92} \times \frac{1}{0.7355} \times \frac{1}{0.98} \times \frac{1}{1000} \times 15$$

$$= 0.00192\, H_{10} \text{ } (m^3)$$

3) <u>Result of Examination</u>

Table V-4 CAPACITY OF FUEL STORAGE TANK

	Power consumption per day (kWH)	Necessary Tank capacity V_T(m^3)	Tank to be installed (m^3)
Damatsuru	7291	14.00 x 2	15 x 2
Darazo	7275	13.97 x 2	15 x 2
Jama'are	6424	12.33 x 2	15 x 2
Ningi	4848	9.31 x 2	10 x 2
Monguno	4141	7.95 x 2	10 x 2
Michika	5171	9.93 x 2	10 x 2
D. Kowa	3363	6.57 x 2	10 x 2
Shira	1796	3.45 x 2	5 x 2
T. Balewa	2616	5.02 x 2	10 x 2

c) Pneumatic Starting System

1) Basic composition

i) The electric diesel generators may be started by either of cell-motor or pneumatic (compressed air) starter. Considering reliability, ease of operation and so on, the pneumatic starter system is used.

ii) As shown in Fig. Annex-4, system composition common to plants includes the following:

- o Two air compressors driven by electric motor and an auxiliary air-compressor driven by a small diesel engine in emergency case (when the whole plant system is in failure).
- o A storage air tank (capacity of this tank is equal to that of unit air tank for individual diesel engine).

Each diesel engine has an air tank (unit tank). Capacity of this tank is sufficient to start mated diesel engine three times or more, without any supply of external air.

d) Cooling System

1) Basic composition

i) Since proposed site for diesel generating plant will not always be supported with ample fresh water, the proposed cooling by radiator system will be suitable because the system can cool diesel engine with small quantity of water.

ii) As shown in the cooling system diagram, Fig. Annex-5, hot water exhausted from engine is returned to the upper tank of radiator, and cooled by a blower fan while it passes through capillary in the radiator. The heat exchange effect lowers water temperature but a temperature rise occurs in the cooling air, thus, the radiator has to be installed close to air exhaust port so that the hot air may be directly exhausted to open air.

e) Lubrication System

1) Basic composition

As shown in Fig. Annex-6, lubricant oil is forced to circulate by a lubricant pump driven by crank shaft. The oil is supplied to parts of engine through an oil cooler and a filter.

f) DC Power System

1) Basic composition

A DC power system for protection and control is composed of the following devices:

- o Battery
- o Battery charger
- o Emergency DC generator
- o DC distribution panel

Connection of the DC power system is as shown in Fig. Annex-7.

2) Battery

Considering the recovery characteristics after discharging, alkaline batteries are suitable for the protection and control purpose. However, the alkaline batteries have critical thermal characteristics, thus, the battery room should be ventilated well.

3) Battery Charger

The power is charged into the battery by a silicon rectifier which float-charges the batteries.

4) Emergency DC Generator

Considering the worst case in which all diesel electric generators in a plant may lose normal functioning, by any reason, and the failure may continue long exceeding service capacity of alkaline batteries, a small engine generator (approximately 2 kW) is installed in each plant.

3. DISTRIBUTION

3.1 DISTRIBUTION SYSTEM PLANNING

3.1.1 High Voltage Distribution

a) Choice of Voltage

The demand of electricity of the towns estimated in this survey is approximately 800 kW for a large town in the year 1985. Judging from the capacity of power distribution and other items, we shall adopt 11 kV three-phase three-wire nongrounding system as the distribution voltage which is commonly used in Nigeria for the ease of operation and maintenance of facilities and for the economy of construction.

b) System Design

We recommend a radial system since the demand is estimated as described above, and initially only one circuit of high voltage feeder shall be used. At the time when diesel generators are to be added, two step-up transformers and two feeders shall be constructed to improve reliability; isolators shall then be set to individual feeding points and in between.

c) Choice of Conductor

All aluminum conductors are recommended from the viewpoint of material properties. Price of aluminum is cheaper than that of copper and all aluminum conductors are the most favoured type for use in construction of relatively short span distribution systems. In addition, all aluminum conductors have an advantage of having a homogeneous quality, and easier to joint and clamp when compared with A. C. S. R. As to the cross-section area of the conductor, we recommend 50 mm^2, which is larger than the minimum size prescribed by the Laws of Federation of Nigeria and Lagos, Chapter 57, and is easily available on the market. This size, however, is larger than that which can handle the permissible current for the maximum load of 1985, and smaller one may be used from the point of view of voltage drop.

3.1.2 Low Voltage Distribution

a) Choice of Voltage

The voltage for the low voltage distribution of a country is determined by the historical reasons of the country. We shall adopt 240/415 V three-phase four-wire multiple grounding system which is most commonly used system in Nigeria.

b) System Design

The low voltage system shall use a radial system. In order to increase the reliability of supply for economical reasons, two or three feeders shall be extended from transformer depending on the condition of the route, and one or two connections shall be made possible between individual feeding points and between adjacent distribution lines so that in case of a line failure, switch over of the distribution line is possible using sound lines, and in case of inspection and other instances, the area of blackout is made as small as possible. For the transmission in a reverse direction through an interconnection, it is necessary to make it clear to open the circuits on the other side without fail by taking appropriate maintenance procedures. Each feeder shall be three-phase four-wire system throughout to respond to the demand of three-phase 415 V that may arise from any point on the route.

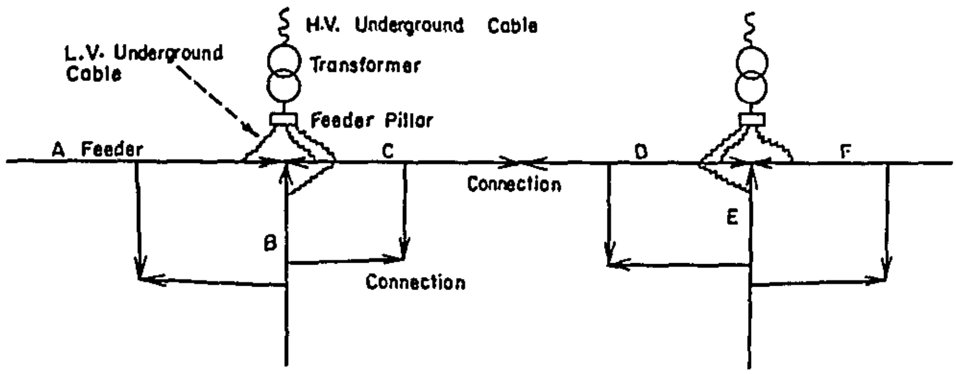


Fig. V-2 L.V. DISTRIBUTION SYSTEM

c) Choice of Conductor

For the reasons stated previously, all aluminum conductors are recommended from the viewpoint of the material property. The nominal cross-section area of all aluminum conductor shall be 50 mm^2 or 100 mm^2.

3.1.3 Line Routes

Routes of the overhead distribution lines shall be selected upon consideration of the following items:

1) The line routes shall be either on vacant lands along the road or on the side of the road. If the routes are selected on the vacant lands along the road or on the road side even for cases of only 11 kV distribution lines, future increase in the demand can be met by simply extending the low voltage lines or by adding transformers and low voltage lines. Then the construction of poles and high voltage lines will be unnecessary, which gives econimic advantage to this method.

2) The arrangement of the line routes shall be simple and there shall be no interwinding of the routes.

3) Connections between the routes and the future extension of the routes and switchovers should be easy. In practice this is realized by using the same side for a particular road.

4) Crossing the road center lines shall be minimized.

5) Approach to places where woods grow densely shall be avoided as much as possible.

6) Routing on roads that are overflowed in the rainy season shall be avoided.

3. 1. 4 Length of Span

The maximum length of span should be less than 50 m within a township according to the Laws of Federation of Nigeria and Lagos, Chapter 57; we have however adopted an average span of 40 m for the ease of setting up service lines and for less requirement on the strength of supports. For transmitting to remote demand locations from the town (the center of the demand) by high voltage, the average span shall be 80 m so that when the demand increases in future with the expansion of the town, one pole may be added to each span so that the service shall be possible as in the town.

3. 1. 5 Supports

The supports shall be mainly concrete poles, but wooden poles may also be used. 10 m poles shall be the standard for high voltage lines or for poles supporting both high and low voltage lines, and 8 m poles for low voltage lines. For towns in which extension area's demand will definitely add in the near future, 10 m poles shall be set for the lines to the extension area with only low voltage lines and spare the upper portion for the future use of high voltage lines, even though only the low voltage lines are required at the present time.

3. 1. 6 Voltage Drop

Since the voltage drop on the low voltage lines will be within 5% at the consumer's main switchboard, the voltage drop as a rule shall be distributed such that it is 4. 5% for the low voltage feeder and 0. 5% for the service line. The voltage drop (per phase) is expressed by the following equation if the load conditions are balanced for each phase, and if the load is the same for all poles:

$$V = \frac{Re\,\ell\,I\,(n-1)}{2000} \quad (V)$$

where Re: equivalent resistance, (Ω/km)
I : phase current, (A)
n : number of service poles.
ℓ : length of the span (m)

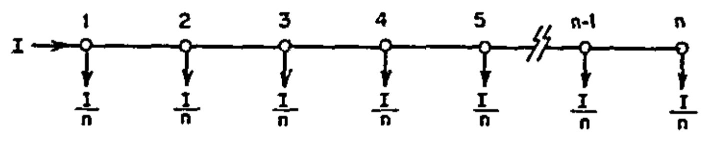


Fig. V-3

The possible number of spans to be serviced is given by n-1, and the possible service length by ℓ(n-1). As an example, the number of spans and the length for the currently planned system with a 100 KVA transformer, voltage drop limit of 4. 5%, wire cross-section of 50 mm^2 (0. 604Ω/km), and span length of 40 m will be as shown in Table V-5 for the cases of two feeders and three feeders.

Table V-5

Number of L. V. feeder	Number of span n - 1	Sercive length $\ell(n - 1)$
2	12	480
3	19	760

The facility shall be constructed taking these numbers as the standards.

3. 1. 7 Demand Forecast and Supply Facilities

a) The existing town areas shall be considered the sum of the electricity demand of existing town area, town area demand for the water supply, and the street lighting and planned the supply facility to serve the entire area.

b) The existing schools shall be supplied by individual transformers, but those proposed or to which decisions are made for construction but uncertain of the sites are excluded from the planning of the facility construction. These shall be supplied by extending the high voltage lines when concrete decisions are made for construction.

c) Existing health centers shall also be supplied by individual transformers together with water supply as in the case of schools. Those proposed or decided but with uncertain sites shall be supplied when concrete decisions are made.

d) The water supply for agriculture and others shall be supplied when concrete decisions are established.

e) Street lighting shall be administered for the main streets and its demand shall be added to the demands of the existing area and of the water supply.

f) For other demands, large demands shall be supplied by specific transformers, and small loads by nearby transformers.

g) For the demand of each town, refer to the note in the table of demand forecast.

3. 2 DESIGN

The designs of the system planning stated in 3. 1 are materialized as in the following. When 33 kV is to be introduced for the high voltage, basic designs for 11 kV can be normally used by changing only those facilities which are affected by the change of the voltage (cables, transformers, insulators, drop out fuse switches, arresters, etc.), clearances and crossing etc.

3. 2. 1 Poles

As a rule concrete poles shall be used. Wooden poles may be used when concrete poles are difficult to obtain under the circumstances, or when those are economically less expensive.

a) Length and Strength of Poles

The standard length of the high voltage poles and the low voltage poles shall be as described below. These are set upon consideration of the future extension of housing to higher levels and addition of facilities such as TV antennas. For the strength of the poles, the followings shall be the standards upon consideration on the economy of the support structure, average span length, and the conductors used.

High voltage poles and poles supporting both high and low voltage lines	10 m, design load 300 kg
Low voltage poles	8 m, design load 150 kg

b) Pole Types and Loading Condition

1) The basic pole types are as shown below:

Intermediate pole	up to 5°
Angle pole	up to 20°
	up to 45°
Tee-off pole	
Terminal pole	

Section poles shall be erected at least at an interval of 1.5 km for lines extended for several kilometers.

2) Wind pressure

The wind pressure on poles shall be assumed to be 146.5 kg/m^2 (30 lb/sq foot) of plane surface and 87.9 kg/m^2 (18 lb/sq foot) of diametrical plane of a cylindrical surface.

In case of compound structures (H-Poles) the wind pressure on the leeward-side members can be reduced to one-half of the wind pressure on the windward-side members.

c) Safety Factor

The safety factor for each support structure shall be two point five (2.5) for concrete poles and four (4) for wooden poles, over the calculated crippling-loads of the structure.

d) Concrete Poles

In the southern part of Nigeria some prestressed and one reinforced concrete pole factories are working and some of them already supply NEPA and some states with concrete poles. Concrete poles produced in Nigeria shall be used as much as possible.

e) Wooden Poles

In Nigeria the usual species for wooden poles are the Opepe, Teak and Idigbo.
The basis for the preparation of wooden poles is "the specification for wood poles (Nigerian Standards Organization)".

Table V-6 POLE DIMENSIONS FOR CLASSES AND SPECIES

Pole Class			Ex:H.	V. H.	H	M	L	V. L.	Ex:L.
			Extra Heavy	Very Heavy	Heavy	Medium	Light	Very Light	Extra Light
Load Applied 61 cm from Top (KN)			24. 5	20. 0	15. 6	11. 1	8. 9	6. 7	5. 3
Minimum Top Diameter (cm)			22. 9	20. 3	17. 8	15. 2	14. 0	12. 7	10. 2
Pole Length (m)	Butt to Ground Line (m)	Species	Minimum Pole Diameter 1. 52 m from Butt (cm)						
8. 54	1. 52	ID	34. 9	32. 4	29. 8	26. 7	24. 8	22. 9	20. 9
		OP	28. 6	26. 7	24. 8	22. 2	20. 3	18. 4	17. 1
		TE	26. 7	24. 8	22. 9	20. 3	19. 1	17. 1	15. 9
10. 06	1. 84	ID	36. 8	34. 3	31. 8	28. 6	26. 0	24. 1	22. 2
		OP	29. 8	27. 9	27. 3	23. 5	21. 6	19. 7	18. 4
		TE	28. 6	26. 7	24. 1	21. 6	20. 3	19. 7	17. 1

Abbreviation: ID - Idigbo; OP - Opepe; TE - Teak.

f) Attachment of Fittings

The provision of holes for the attachment of fittings is given in the detailed drawing in the Fig. A-8, A-9, A-10.

g) Cross-arms

The material to be used for cross-arms has been fixed for each pole-type and is specified in the drawings in the Fig. A-8, A-9, A-10.

The size and the strength of cross-arms (including the distance between phases) for long spans shall be determined by the Contractor on the conditions of wind pressure, etc. as previously stated in V-3. 2. 1-b) and V-3. 2. 2-b).

h) Accessories

Each pole shall be equipped with the pole number, danger warning sign, and a preventive device against pole climbing. Reference should be made to Fig. A-11 for details.

i) Galvanization

All steel parts including tie straps, bolts, nuts, washers, cross-arms etc, shall be galvanized by the hot-dip process after all shearing, sawing, drilling, punching, bending and machining are completed.

j) Stay Wires

Stay wires shall be equipped when the load exceeds the design load of 300 kg for high voltage poles and for poles supporting both high voltage and low voltage lines, and 150 kg for low voltage lines.

Flying stay wires shall be considered when the interference from the traffic etc, is expected. The safety factor for the stay wire shall be greater than 2. 5.

k) Foundation

When the safety factor of over 2. 5 is difficult to realize because of the ground condition, foundation of the support structure should be strengthened.

3. 2. 2 Conductors

a) Cross-section

For high voltage lines, all aluminum conductor of nominal area 50 mm^2 (Ant) is recommended. For low voltage lines, all aluminum conductors of nominal area 50 mm^2 (Ant) and 100 mm^2 (Wasp) are recommended.

The following table gives the technical data of the chosen conductors.

Table V-7 TECHNICAL DATA FOR ALL ALUMINUM CONDUCTORS

Code name	Nominal aluminum area	Equivalent copper area	Stranding wire diameter	Approximate overall diameter	Total area	Weight	Nominal breaking load	Maximum D. C. resistance at 20°C
	mm^2	mm^2	mm	mm	mm^2	kg/km	kgf	ohm/km
Ant	50	32. 3	7/3. 10	9. 3	52. 8	145	846	0. 5419
Wasp	100	64. 5	7/4. 39	13. 2	106. 0	290	1632	0. 2702

b) Mechanical Design of Conductor

1) The following basic assumptions shall be used for the design temperatures.

minimum temperature	5°C
maximum temperature	65°C
average temperature	25°C

2) The wind pressure shall be as follows after the Laws of the Federation of Nigeria and Lagos.

inside towns	58. 6 kg/m^2 (12 lb/ft^2)
outside towns	87. 9 kg/m^2 (18 lb/ft^2)

c) Sagging

The maximum stresses are given at minimum temperature with wind load and the maximum sags at maximum temperature without wind load. It is recommended to the stringing work so that the maximum stresses on lines shall be less than 8 kg/mm^2.

d) <u>Clearances and Crossings</u>

The definite clearances at maximum sag given in the following table are kept:

Table V-8 CLEARANCES AND CROSSINGS

Item	0.4 kV		11 kV	
	m	ft.	m	ft.
Bare conductor to ground level across streets and roads	5.80	19	5.80	19
Bare conductor to ground level along streets and roads	5.19	17	5.49	18
Bare conductor to ground level in places inaccessible to vehicular traffic	4.58	15	4.88	16
Bare conductor to any part of a fence, wall, building or other structure upon which a man may stand or against which ladder may be placed.	3.05	10	3.05	10
Over-head line phase centres	0.21	2/3	0.76	2½
Vertical clearance between different voltage on the same support. 11 kV and L. V.	-	-	1.22	4

The horizontal clearance shall be kept not only at maximum sag but also at conductor deflections due to wind.

e) <u>River Crossings</u>

The distance between maximum conductor sag and high water level shall be provided by the Chief Electrical Inspector.

f) <u>Railway Crossing</u>

Before erecting an overhead electric line across a railway, a permission must be obtained from the Nigerian Railway Authority. Overhead crossings shall be used for the most part, but underground crossings shall also be considered as an alternative.

g) <u>Crossing Post and Telegraph Lines</u>

The minimum clearance between the nearest conductors of the overhead line and a P & T line shall be in vertical and horizontal direction not less than 2.44 m (8 feet) for 11 kV and 1.22 m (4 feet) for 0.4 kV This minimum clearance is to be kept under the most unfavourable operating conditions.

For cases not mentioned in this chapter "The Laws of the Federation of Nigeria and Lagos", Chapter 57 (Electricity) shall apply.

3.2.3 Insulators

As a standard, insulators for 11 kV lines shall be pin type insulators for intermediate poles, angle poles and some of the tee-off poles; and disc type insulators for some of the tee-off poles and terminal poles. For the insulation of lines, the following shall be used as the standards, with a little higher insulation level for disc type insulators:

Table V-9 TECHNICAL DATA

		Pin type	Disc type
Power frequency withstand (one-minute)	dry	75 kV	78 kV
	Wet	50 kV	45 kV
Impulse withstand		95 kV	105 kV

Bindings shall be employed for pin type insulator and four bolt clamp shall be employed for disc type insulator. Low voltage insulators shall be the single groove type shackle insulator.

The following table gives the main characteristics low voltage insulator.

Table V-10 TECHNICAL DATA

Dry flashover	23 kV
Wet flashover	11 kV

3.2.4 Substation

1) A substation shall consist of a ground-mounted transformer which shall be installed outdoors.

2) A ground-mounted transformer shall be surrounded by a fence 2 m high and equipped with a lockable door.

3) H-poles shall be used for substations, and the H. V. lines shall be anchored by tension insulators on steel cross-arms.

4) Lightning arresters, drop-out fuse switches, cable heads, etc. shall be mounted on iron supports.

5) Standard lightning arresters shall be designed against 10 kA, and fuses against 50 MVA.

6) The terminal of transformer shall be cable joint type.

7) Transformers shall be mounted on the foundations.

8) Three feeders shall be provided for four wire low voltage overhead lines.

The low voltage distribution feeder pillar shall be mounted at operation height on foundation.

Each pillar shall contain:

3 fuse sets	3 phases and a neutral for overhead line feeders.
1 fuse set	3 phases and a neutral for input cable from transformer.

To facilitate the control of transformer loading, ammeters, voltmeters, and power meters equipped with maximum indicators shall be installed.

3.2.5 Transformers

a) Type

The transformers shall be of the three-phase, oil-immersed, naturally cooled, outdoor type for tropical climate.

b) Capacity

To meet the demand of the next decade and for the ease of maintenance, the standard transformers to be used in the present project shall be of the ground mounting type with capacity of 100 kVA and 200 kVA rather than the pole mounting type of lesser capacity of 50 kVA etc., which need maintenance work on the pole.

c) Technical Data

1) High voltage winding — 11 kV ± 2 x 2.5%
in delta connection, tap changing at off-load

2) Low voltage winding — 415/240 V at full load and cos ϕ = 0.9, in star connection, with neutral brought out and sized for rated current.

3) Vector group for distribution transformers — Dy 11

4) Frequency — 50 Hz

5) Impedance voltage — 4%

6) Material of windings — copper

7) Maximum ambient temperature — 40°C

8) Maximum hot spot temperature rise — 55°C

3.2.6 Underground Cables

Underground distribution is generally used when it is impossible to set up overhead lines as restricted by laws, or instructed by the road management officials as well as for lines in places of importance, busy streets, government office areas and other business building areas. Underground cables have the advantage of improving city beautification, reliability of supply in case of general calamities such as storms, lightnings or fires, and of improving the safety of equipments and persons. On the other hand, they have demerits of having higher construction costs, taking longer times for the recovery of accidents, etc.

In this project, underground cables shall be used for the following with main emphasis on personal safety:

(1) outgoing lines from diesel power plants

(2) high voltage lines to substations and low voltage outgoing lines from them

(3) service lines for high voltage consumers.

The conductor shall be copper wire, and use paper insulated cables or C. V. cables for H. V. and P. V. C. insulated cables for L. V.

3. 2. 7 Lightning Arrester

Thunderstorms may occur at any time of the year, but they are most frequent and most violent at the beginning of the rainy season. They are accompanied by heavy rain and by strong winds that sometimes cause much damage. The velocity of these thunderstorms may exceed 120 km/h.

For this reason, we shall install lightning arresters in the following locations to cope with the lightning damage.

(1) feeding points from diesel power plants

(2) substation poles

(3) service poles for high voltage consumers

(4) at every 500 m on the distribution lines

3. 2. 8 Street Lighting

Street lighting shall be equipped on every pole in the main streets with heavy passenger traffic. The electric system shall use exclusive lines, and the lighting loads shall be connected between the exclusive lines and neutral line. As a rule, switching shall be operated within the feeder pillar. The size of the exclusive lines shall be the same as that of the low voltage main lines to prevent accidents which may occur due to the differences in sagging.
A minimum illuminant of 1 lux shall be guaranteed on the ground.

3. 2. 9 Earthing

a) The Neutral of Low Voltage System

The earthing for the L. V. neutral conductors shall be made at the supply points (of transformers), at every terminal, and at every 200 m along the routes of the distribution lines.

b) Lightning Arrester

The arrester shall be earthed by means of an independent earthing-lead and earthing rod. The rod of arrester shall be placed not less than 2 m from any other earthing rod.

c) Steel Works

All steel works shall be required to be earthed.

d) Transformer

The cases of all transformers shall be earthed.

e) Earthing Leads

Earthing leads shall be copper and cross-section shall be not less than 25 mm^2. Earthing lead shall be protected from mechanical damage by wooden capping for a distance of 3 m above ground level and 15 cm below ground level.

f) Earth Resistance

In all cases, the valve of earth resistance shall not exceed 10 ohms for distribution system.

4. SUMMARY OF EQUIPMENT PLAN

According to aforementioned plan and design for power source and distribution system, equipment plan for individual town is summarized as shown in Table V-11.

Design for diesel power station and distribution system is shown in the maps of each town.

Table V-11 SUMMARY OF FACILITIES

	Power Source			Distribution System			
	Diesel electric generator (kW)	Step-up transformer (kVA)	Substation (kVA)	Length of H.V.lines (km)	Length of H.V.+ L.V.lines (km)	Length of L.V.lines (km)	Length of street lighting lines (km)
Damatsuru	229 x 3	700 x 1	200 x 1 100 x 3	-	2.3	10 6	1.7
Darazo	229 x 3	700 x 1	100 x 5	2.8	1.6	4.3	0.7
Jama'are	229 x 3	700 x 1	100 x 3	-	1 0	5.1	1.2
Ningi	229 x 2	500 x 1	200 x 1 100 x 3	0 7	2.0	9.0	1 2
Monguno	229 x 2	500 x 1	100 x 3	0.6	1.8	8.5	1 1
Michika	229 x 2	500 x 1	100 x 4	1.6	2 0	9.2	0.9
Dadin Kowa	115 x 2	300 x 1	100 x 3	0.5	1.4	8 0	1.2
Shira	75 x 2	200 x 1	100 x 1	-	0.3	4.6	0.6
Tawafa Balewa	115 x 2	300 x 1	100 x 1	-	0.5	4.2	0.3

Table Annex 1-1

D A M A T S U R U

I. Town: Damatsuru

II. Population

A.	1963	11,723
B.	1973 (Estimate)	15,709
C.	1976 (")	17,100

III. Classification of Town

A.	Political	-	Development Area Headquarter District Headquarter
B.	Industrial	-	Agricultural Town Commercial Town
C.	Traffic	-	Main Route Town

IV. General Information

This town is situated at an important road junction. The Maiduguri-Bauchi-Jos road and Gombe-Damatsuru-Gashua-Geidam road crosses together here. This town is also a development area headquarter. It has a secondary school and large scale farming scheme, A health centre will be built.

V. Priority: High

VI. Survey Date: 27th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1)	Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2)	Future Load Growth Rank	
a)	1st Year - 5th Year	High
b)	5th Year - 10th Year	High

Details:

Politic	High
Transport	High
Industry	Some
Special Loads	None (4 Proposed)
Merchants, Shops	Some
Houses	Medium

2. Extension Area

1) Government Residential Area

D. O. Office, house and some houses

2) Commercial Area

B. Special Load

1. Secondary School (Proposed: site decided)
2. Teachers Training College (Proposed)
3. Health Centre (Proposed)
4. Water Supply (Proposed: bore hole)

VIII. Isolated Existing Generating Sets

A. Small Generators

1. Secondary School
2. Hotel
3. Police Station (Charge Office)
4. Petrol Station

IX. Main Building and Establishments List

A. Main Offices
- Development Area Office
- District Office
- Treasury

B. Education Facilities
- Teachers College (Proposed)
- Secondary School (Temporary building)

C. Medical Facilities
- Health Centre (Proposed)
- Dispensary
- Maternity
- Leprosy

D. Public Utilities
- Court
- Police Station
- Prison (Lock up)
- Library
- Post Office
- Mosque
- Church

E. Water Supply
- Bore Holes (Proposed)

F. Houses and Others
- D. O. House
- District Head House
- D. E. House
- Police Barracks
- Guest House
- Hotels (Small)
- Personal Houses

G. Industry and Others
- Market
- Veterinary
- Cooperative Office
- " Store
- " Consumer Shop
- M. O. W. Yard
- Street Lights

DEMAND FORECAST

DAMATSURU

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			17.1	17.7	18.3	18.9	19.6	20.3	21.0	21.7	22.5	23.3	
Maximum Demand (kW)	Existing Town Area		102	129	148	162	174	184	202	221	243	266	No.1 100 kVA, No.2 100 kVA No.3 100 kVA
	Extension Area	G.R.A.	62	77	91	107	120	134	149	163	178	197	No.4 200 kVA
		Others	6	12	18	24	30	36	42	48	54	60	
		Sub Total	68	89	109	130	150	170	191	211	232	257	
	Education Facilities	S.S.	18	30	36	40	43	48	53	58	64	70	
		T.C.	18	30	36	40	43	48	53	58	64	70	
		Sub Total	36	60	72	80	86	96	106	116	128	140	
	Health Centre				25	35	45	50	55	61	67	74	
	Water Supplies	Town Area			25	25	25	25	25	25	25	25	No.1, No.2, No.3
		Agric. etc.			25	25	25	25	25	25	25	25	
		Health Centre			15	15	15	15	15	15	15	15	
		Sub Total			65	65	65	65	65	65	65	65	
	Street Lights		2	2	2	2	2	3	3	3	3	3	
	Total		208	280	421	474	522	568	622	677	738	805	
Number of Consumers	Existing Town Area		263	369	448	491	527	558	612	671	735	806	
	Extension Area	G.R.A.	13	16	19	22	25	28	31	34	37	40	
		Others	2	4	6	8	10	12	14	16	18	20	
		Sub Total	15	20	25	30	35	40	45	50	55	60	
	Education Facilities	S.S.	8	13	15	17	18	20	22	24	27	29	
		T.C.	8	13	15	17	18	20	22	24	27	29	
		Sub Total	16	26	30	34	36	40	44	48	52	58	
	Health Centre				6	8	10	11	12	13	14	15	
	Water Supplies	Town Area			1	1	1	1	1	1	1	1	
		Agric. etc.			1	1	1	1	1	1	1	1	
		Health Centre			1	1	1	1	1	1	1	1	
		Sub Total			3	3	3	3	3	3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		295	416	513	567	612	653	717	786	862	943	
	Number of New Consumers		295	121	97	54	45	41	64	69	76	81	
kWH Sales (kWH) x 10^3	Existing Town Area		112	280	368	417	462	505	573	649	735	892	
	Extension Area	G.R.A.	114	146	178	213	249	286	328	370	416	474	
		Others	11	23	35	48	62	77	92	109	126	144	
		Sub Total	125	169	213	261	311	363	420	479	542	618	
	Education Facilities	S.S.	47	80	99	113	125	144	164	185	210	237	
		T.C.	47	80	99	113	125	144	164	185	210	237	
		Sub Total	94	160	198	226	250	288	328	370	420	474	
	Health Centre				111	161	213	243	276	315	356	405	
	Water Supplies	Town Area			27	33	39	47	57	68	82	98	
		Agric. etc.			27	33	39	47	57	68	82	98	
		Health Centre			16	18	20	22	24	26	29	32	
		Sub Total			70	84	98	116	138	162	193	228	
	Street Lights		12	12	12	12	12	17	17	17	17	17	
	Total		343	621	972	1161	1346	1532	1752	1992	2263	2634	
Revenue (₦) x 10^3	kWH Sales		17.2	30.6	42.7	50.4	57.7	65.0	74.1	84.1	95.7	111.9	
	Connection Fee		0.6	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	
	Total		17.8	30.8	42.9	50.5	57.8	65.1	74.2	84.2	95.9	112.1	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-2

D A R A Z O

I. Town: Darazo

II. Population

A.	1963	11,937
B.	1973 (Estimate)	15,875
C.	1976 (")	17,300

III. Classification of Town

A.	Political	-	Development Area Headquarter Local Authority Headquarter
B.	Industrial	-	Agricultural Town Commercial Town
C.	Traffic	-	Main Route Town (Bauchi - Maiduguri)

IV. General Information

This is an important transit town being on the Maiduguri - Bauchi-Jos road. This town is an important agricultural centre, with a secondary school, a rural health centre, an agricultural institute and a livestock improvement and breeding centre.

V. Priority: High

VI. Survey Date: 13th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1)	Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2)	Future Load Growth Rank	
a)	1st Year - 5th Year	Medium
b)	5th Year - 10th Year	High

Details:

Politic	High
Transport	High
Industry	Few Local Factories
Special Loads	3 (1 Proposed)
Merchants, Shops	Some
Houses	Medium

2. Extension Area

1) Government Residential Area

D. O. Office	D. O. House (Under construction)

2) Local Authority Area
Area Decided

B. Special Load

1. Secondary School

a) Consumption	Office
(Evening Load)	Classrooms
	Staff's Residences
	Students Quarters
b) Future Load Growth	High
Number of Students	152 (Now)
	500 (Five Years Estimate)

Existing staff's quarters is only three houses.
More five houses are under construction.

2. Health Centre

a) Consumption	Main Building, Wards
	Staff's Residences
(All Day Load)	Nurses Quarters
	Water Supply
b) Future Load Growth	High

More load due to medical instruments, will be needed.
But main load is residential and wards.

c) Staff's and Nurse	
Residence	11 Houses
d) Evening	6 hours
Morning	2 hours

3. Water Supply (Proposed)

4. Agricultural Training Centre

1) Consumption	Main Building
(Evening Load)	Staff's Quarters
2) Future Load Growth	Medium

Only four buildings and residences

VIII. Isolated Existing Generating Sets

A. Health Centre	2 Sets
65.7kVA (94.6AMP)	400/200
Peak Load 40A	(Evening)

B. Health Centre (Water supply)
2 Sets
16.25kVA (23.4AMP)

C. Secondary School
5kVA (8AMP)

D. Small Generators

1. Secondary School (Principal house)
1.5kVA

2. Agriculture Training Centre
about 2kVA

IX. Main Building and Establishments List

A. Main Offices
- ° Development Area Office
- ° District Office

B. Education Facilities
- ° Secondary School
- ° Farm Training Centre
- ° Primary School

C. Medical Facilities
- ° Health Centre
- ° Clinic
- ° Dispensary
- ° Maternity Centre

D. Public Utilities
- ° Court
- ° Police Station
- ° Reading Room
- ° Postal Agency
- ° Mosque
- ° Veterinary Office
- ° Agricultural Store (Proposed)
- ° Motor Park (Proposed)

E. Houses and Others
- ° D. O. House (Under construction)
- ° District Head House
- ° Police Barracks
- ° Guest House
- ° Personal Houses

F. Industry and Others
- ° Market
- ° M. O. Agriculture Office
- ° Street Lights

DEMAND FORECAST

DARAZO

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			17.3	17.9	18.5	19.1	19.8	20.5	21.2	21.9	22.6	23.4	
Maximum Demand (kW)	Existing Town Area		77	100	113	122	132	159	174	191	210	230	No.1 100 kVA No.2 100 kVA
	Extension Area	G.R.A.	43	58	72	86	101	115	130	144	158	173	Present No.2 future 200 kVA
		Others			6	12	18	24	30	36	42	48	
		Sub Total	43	58	78	98	119	139	160	180	200	221	
	Education Facilities	S.S.	46	50	55	61	67	74	82	90	100	109	No.3 100 kVA
		T.C.											
		Sub Total	46	50	55	61	67	74	82	90	100	109	
	Health Centre		50	55	61	67	74	81	89	98	108	119	No 4 100 kVA
	Water Supplies	Town Area			25	25	25	25	25	25	25	25	
		Agric. etc.			25	25	25	25	25	25	25	25	
		Health Centre	15	15	15	15	15	15	15	15	15	15	
		Sub Total	15	15	65	65	65	65	65	65	65	65	
	Agric. Training Centre		20	22	24	26	29	32	35	41	45	50	No.5 100 kVA
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		252	301	397	440	487	551	606	666	721	759	
Number of Consumers	Existing Town Area		221	311	377	407	440	482	528	579	635	696	
	Extension Area	G.R.A.	9	12	15	18	21	24	27	30	33	36	
		Others			2	4	6	8	10	12	14	16	
		Sub Total	9	12	17	22	27	32	37	42	47	52	
	Education Facilities	S.S.	19	21	23	26	28	31	34	38	42	46	
		T.C.											
		Sub Total	19	21	23	26	28	31	34	38	42	46	
	Health Centre		11	12	13	14	15	17	19	21	23	25	
	Water Supplies	Town Area			1	1	1	1	1	1	1	1	
		Agric.etc.			1	1	1	1	1	1	1	1	
		Health Centre	1	1	1	1	1	1	1	1	1	1	
		Sub Total	1	1	3	3	3	3	3	3	3	3	
	Agric Training Centre		1	1	1	1	1	1	1	1	1	1	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		263	359	434	474	514	567	623	685	752	824	
	Number of New Consumers		263	96	75	40	40	52	56	62	67	72	
kWH Sales (kWH) x 10^3	Existing Town Area		88	218	283	315	350	396	448	508	575	651	
	Extension Area	G.R.A.	79	110	141	173	208	246	286	326	369	416	
		Others			11	23	35	48	62	77	92	109	
		Sub Total	79	110	152	196	243	294	348	403	461	525	
	Education Facilities	S.S.	119	133	151	173	195	222	254	287	328	369	
		T.C.											
		Sub Total	119	133	151	173	195	222	254	287	328	369	
	Health Centre		223	252	288	326	371	418	473	537	609	691	
	Water Supplies	Town Area			27	33	39	47	57	68	82	98	
		Agric.etc.			27	33	39	47	57	68	82	98	
		Health Centre	22	24	26	29	32	35	39	43	47	52	
		Sub Total	22	24	80	95	110	129	153	179	211	248	
	Agric Training Centre		52	59	66	74	85	96	108	131	148	169	
	Street Lights		8	8	8	8	8	12	12	12	12	12	
	Total		591	804	1028	1187	1362	1567	1796	2057	2344	2665	
Revenue (₦) x 10^3	kWH Sales		23.3	33.5	41.2	47.4	54.0	62.1	71.0	80.8	92.1	104.5	
	Connection Fee		0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		23.8	33.7	41.4	47.5	54.1	62.2	71.1	80.9	92.2	104.6	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-3

J A M A ' A R E

I. Town: Jama'are

II. Population

A.	1963	12,600
B.	1973 (Estimate)	16,886
C.	1976 (")	18,400

III. Classification of Town

A.	Political	-	Development Area Headquarter Local Authority Headquarter
B.	Industrial	-	Agricultural Town Commercial Town
C.	Traffic	-	General Route Town

IV. General Information

This is an old and historic town. It is also both a local authority and development area headquarters. A health centre will be built.

V. Priority: High

VI. Survey Date 17th December, 1974

VII. Main Load

A. Residential and Small Commercial Load.

1. Existing Town Area

1)	Consumption (Evening Load)	Small Consumers Small Shops, Houses, Street Lights
2)	Future Load Growth Rank	
a)	1st Year - 5th Year	Medium
b)	5th Year - 10th Year	Medium

Details:

Politic	High
Transport	Medium
Industry	Few Local Factories
Special Loads	1 (2 proposed)
Merchants, Shops	Some
Houses	Medium

2. Extension Area

a) Government Residential Area:
Now under construction

b) Local Authority Area:
Area is decided.

B. Special Load

1. Health Centre:
Under construction, only 300m from town area

2. Secondary School (Proposed)
   Site not yet decided

3. Teachers Training College (Proposed)
   about 3 km from Jama'are

VIII. Existing Generating Sets

1. 2 Private small generators

IX. Main Building and Establishments

A. Main Offices
   ° Central Offices
   ° Agricultural Extension Office
   ° Field Secretariat

B. Education Facilities
   ° Teachers Training College (T.T.C.)(Temporary)
   ° T.T.C. (Proposed)
   ° Secondary School (Temporary)
   ° Secondary School (Proposed)
   ° 2 Primary Schools

C. Medical Facilities
   ° Medical and Health Office
   ° Health Centre
   ° Dispensary
   ° Medical Store

D. Public Utilities
   ° Court
   ° Police Station
   ° Prison (Lock up)
   ° Council Hall (in palace)
   ° Town Hall
   ° Library
   ° Mosque
   ° Church

E. Houses and Others
   ° Emir's Palace
   ° D. O. House
   ° Councilor's House
   ° Police Barracks (Proposed)
   ° 3 Guest Houses
   ° Agricultural Officers Residence
   ° Rest House
   ° Hotel
   ° T.T.C. Staff's Quarters
   ° Personal House

F. Industry and Others
   ° Market
   ° N.T.C. (Nigeria Tobacco Company)
   ° Agirc. Store
   ° Co-operative Store
   ° Motor Park (Proposed)
   ° Farm Centre (Proposed)
   ° Bakery
   ° Street Lights

DEMAND FORECAST

JAMA'ARE

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10³)			18.4	19.0	19.7	20.4	21.1	21.8	22.6	23.4	24.2	25.0	
Maximum Demand (kW)	Existing Town Area		83	106	120	130	140	152	164	177	191	206	No.1 100 kVA No.2 100 kVA
	Extension Area	G.R.A.	43	58	72	86	101	115	130	144	158	173	Present No.2 future 200 kVA
		Others			6	12	18	24	30	36	42	48	
		Sub Total	43	58	78	98	110	139	160	180	200	221	
	Education Facilities	S.S.	18	30	36	40	43	48	53	58	64	70	
		T.C.	18	30	36	40	43	48	53	58	64	70	
		Sub Total	36	60	72	80	86	96	106	116	128	140	
	Health Centre		35	45	50	55	61	67	74	81	89	99	No.3 100 kVA
	Water Supplies	Town Area								30	30	30	No.1, No 2
		Agric. etc.								30	30	30	
		Health Centre	15	15	15	15	15	15	15	15	15	15	No.3
		Sub Total	15	15	15	15	15	15	15	65	65	65	
	Street Lights		1	1	1	1	1	2	2	2	2	2	
	Total		213	285	336	379	422	471	521	621	675	733	
Number of Consumers	Existing Town Area		236	331	401	433	468	505	545	589	636	687	
	Extension Area	G.R.A.	9	12	15	18	21	24	27	30	33	36	
		Others			2	4	6	8	10	12	14	16	
		Sub Total	9	12	17	22	27	32	47	42	47	52	
	Education Facilities	S.S.	8	13	15	17	18	20	22	24	27	29	
		T.C.	8	13	15	17	18	20	22	24	27	29	
		Sub Total	16	26	30	34	36	40	44	48	54	58	
	Health Centre		8	10	11	12	13	14	15	17	19	21	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre	1	1	1	1	1	1	1	1	1	1	
		Sub Total	1	1	1	1	1	1	1	3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		271	381	461	503	546	593	653	700	760	822	
	Number of New Consumers		271	100	80	42	43	47	60	47	60	62	
kWH Sales (kWH) x 10³	Existing Town Area		89	227	206	330	368	406	453	508	562	626	
	Extension Area	G.R.A.	79	110	141	173	208	246	286	326	369	416	
		Others			11	23	35	48	62	77	92	109	
		Sub Total	79	110	152	196	243	294	348	403	461	525	
	Education Facilities	S.S.	47	80	99	113	125	144	164	185	210	237	
		T.C.	47	80	99	113	125	144	164	185	210	237	
		Sub Total	94	160	198	226	250	288	328	370	420	474	
	Health Centre		156	206	236	268	306	346	393	444	502	575	
	Water Supplies	Town Area								33	39	47	
		Agric. etc.								33	39	47	
		Health Centre	18	20	22	24	26	29	32	35	39	42	
		Sub Total	18	20	22	24	26	29	32	107	117	136	
	Street Lights		13	13	13	13	13	20	20	20	20	20	
	Total		449	736	917	1057	1206	1383	1571	1845	2078	2353	
Revenue (₦) x 10³	kWH Sales		19.1	31.2	38.8	44.3	50.3	57.3	65.1	75.1	84.7	95.3	
	Connection Fee		0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		19.6	31.4	39.0	44.4	50.4	57.4	65.2	75.2	84.8	95.4	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-4

N I N G I

I. Town: Ningi (Include Tiffi Town)

II. Population

A.	1963	7,486
B.	1973 (Estimate)	10,031
C.	1976 (")	11,000

III. Classification of Town

A.	Political	-	Development Area Headquarter Local Authority Headquarter
B.	Industrial	-	Agricultural Town Commerical Town
C.	Traffic	-	Main Route Town

IV. General Information

This is an old and historical town. It is along a main road that links Kano with Bauchi, Jos, and the southern part of North Eastern State. Thus, it is a very important transit centre. It is also both a local authority headquarter and a developemnt area headquarters. A health centre is now under construction.

V. Priority: High

VI. Survey Date: 16th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1)	Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2)	Future Load Growth Rank	
a)	1st Year - 5th Year	Medium
b)	5th Year - 10th Year	Medium

Details:

Politic	High
Transport	High
Industry	Few Local Factories
Special Loads near the Town	1 (2 Proposed)
Merchants, Shops	Some
Houses	Low

2. Extension Area

1) Government Residential Area
It is under construction.

2) Local Authority Area
   Site is decided.

3. Tiffi

   Two towns consisting of the new and the old are situated at 1 mile from the centre of Ningi. Consequently, the load of the towns is estimated with only some houses and street lightings. The population is 3,910 (1973 estimate).

B. Special Load

1. Teacher's College (Proposed)
   Site is already decided.

2. Secondary School (Proposed)

3. Health Centre

   Now, it is under construction in new Tiffi Town.

VIII. Isolated Existing Generating Sets

1. Small Genertor

IX. Main Building and Establishments List

A. Main Offices
   - Central Offices
   - D. O. Office

B. Education Facilities
   - Teacher's College (Proposed)
   - Secondary School (Proposed)
   - 3 Primary Schools
   - Islamiya School

C. Medical Facilities
   - Health Centre (Under construciton)
   - Maternity
   - Leprosy
   - Verterinary
   - Dispensary
   - Education Office

D. Public Utilities
   - Court
   - Court (Proposed)
   - Police Station
   - Prison
   - Prison (Proposed)
   - Council Hall
   - Town Hall
   - Reading Room
   - Postal Agency
   - Mosque
   - Church

E. Water Supply
   - Pump House (Proposed)

F. Houses and Others
   - Emir's House

- Councillor's House
- D. O. House
- 3 District Head Houses
- Police Barracks
- 2 Guest Houses
- Village Head House (Old Tiffi)
- Personal Houses

G. Industry and Others

- Local Authority Works Department
- Ministry of Agriculture Office
- Market
- Motor Park
- Store (Proposed)
- Slaughter House
- Street Lights

DEMAND FORECAST

NINGI

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			11.0	11.4	11.8	12.2	12.6	13.4	13.9	14.4	14.9	15.4	
Maximum Demand (kW)	Existing Town Area		49	63	72	78	84	91	98	106	114	123	No.1 100 kVA No.2 100 kVA
	Extension Area	G.R.A.	43	58	72	86	101	115	130	144	158	173	No.3 200 kVA
		Others			6	12	18	24	30	36	42	48	
		Sub Total	43	58	78	98	119	139	160	180	200	221	
	Education Facilities	S.S.	18	30	36	40	43	48	53	58	64	70	
		T.C.	18	30	36	40	43	48	53	58	64	70	
		Sub Total	36	60	72	80	86	96	106	116	128	140	
	Health Centre				25	35	45	50	55	61	67	74	No.4 100 kVA
	Water Supplies	Town Area			20	20	20	20	20	20	20	20	No.1, No.2
		Agric. etc.			20	20	20	20	20	20	20	20	
		Health Centre			15	15	15	15	15	15	15	15	
		Sub Total			55	55	55	55	55	55	55	55	
	Tiffi		7	9	10	11	11	12	13	14	15	16	No.4
	Street Lights		1	1	1	1	1	2	2	2	2	2	
	Total		136	191	313	358	401	536	486	534	581	631	
Number of Consumers	Existing Town Area		141	198	240	259	280	302	326	352	380	410	
	Extension Area	G.R.A.	9	12	15	18	21	24	27	30	33	36	
		Others			2	4	6	8	10	12	14	16	
		Sub Total	9	12	17	22	27	32	37	42	47	52	
	Education Facilities	S.S.	8	13	15	17	18	20	22	24	27	29	
		T.C.	8	13	15	17	18	20	22	24	27	29	
		Sub Total	16	26	30	34	36	40	44	48	54	58	
	Health Centre				6	8	10	11	12	13	14	15	
	Water Supplies	Town Area			1	1	1	1	1	1	1	1	
		Agric.etc.			1	1	1	1	1	1	1	1	
		Health Centre			1	1	1	1	1	1	1	1	
		Sub Total			3	3	3	3	3	3	3	3	
	Tiffi		23	31	37	39	41	44	48	52	56	59	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		190	268	334	366	398	433	471	511	555	598	
	Number of New Consumers		190	78	66	32	32	35	38	40	44	43	
kWH Sales (kWH) x 10^3	Existing Town Area		51	134	175	195	218	240	263	298	332	370	
	Extension Area	G.R.A.	79	110	141	173	208	246	286	326	369	416	
		Others			11	23	35	48	62	77	92	109	
		Sub Total	79	110	152	196	243	294	348	403	461	525	
	Education Facilities	S.S.	47	80	99	113	125	144	164	185	210	237	
		T.C.											
		Sub Total	47	80	99	113	125	144	164	185	210	237	
	Health Centre				111	161	213	243	276	315	356	405	
	Water Supplies	Town Area			22	26	32	38	45	55	65	78	
		Agric.etc.			22	26	32	38	45	55	65	78	
		Health Centre			16	18	20	22	24	26	29	32	
		Sub Total			60	70	84	98	114	136	159	188	
	Tiffi		6	15	18	20	21	24	25	27	29	31	
	Street Lights		13	13	13	13	13	20	20	20	20	20	
	Total		202	352	628	768	917	1063	1214	1384	1567	1776	
Revenue (₦) x 10^3	kWH Sales		9.9	17.2	26.3	31.6	37.2	42.7	48.6	55.2	62.1	71.1	
	Connection Fee		0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		10.3	17.4	26.4	31.7	37.3	42.8	48.7	55.3	62.2	71.2	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-5

M O N G U N O

I. Town: Monguno

II. Population

A. 1963	10,119
B. 1973 (Estimate)	13,559
C. 1976 (")	14,800

III. Classification of Town

A. Political	-	Development Area Headquarter Local Authority Headquarter
B. Industrial	-	Agricultural Town
C. Traffic	-	General Route Town

IV. General Information

Monguno is an old town and a development area headquarter. Streets may be reconstructed next year. There is also a primary school and a secondary school. A health centre will be built in the 1975-80 plan period. A health centre is a small hospital with 28 beds.

V. Priority: High

VI. Survey Date: 28th December, 1974

VII. Main Load

A. Residential and Small Commerical Load

1. Existing Town Area

1) Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2) Future Load Growth Rank	
a) 1st Year - 5th Year	Low
b) 5th Year - 10th Year	Medium

Details:

Politic	High
Transport	Medium
Industry	Few Local Factories
Special Load	1 (1 Proposed)
Merchants, Shops	Some
Houses	Medium

2. Extension Area

1) Government Residential Area
Another side of the main road, there are D. O. Office, residences and other one house.

B. Special Load

1. Secondary School

a)	Consumption (Evening Load)	Office Classrooms Staff's Residences Student's Quarters
b)	Future Load Growth	Very High
	Number of Students	about 50 (Now)

Not yet electrified

2. Health Centre (Proposed)

VIII. Isolated Existing Generating Sets

A. Small Generator — Secondary School 1 (Principal house)

IX. Main Building and Establishments List

A. Main Office
- ° Development Area Office
- ° Local Authority Development Area Office
- ° District Head Office
- ° Local Authority Sub-treasury

B. Education Facilities
- ° Secondary School
- ° Primary School

C. Medical Facilities
- ° Health Centre (Proposed)
- ° Dispensary
- ° Maternity

D. Public Utilities
- ° Court
- ° Prison (Lock up)
- ° Council Hall
- ° Mosque

E. Houses and Others
- ° D. O. House
- ° 3 Guest Houses
- ° Hotel (Small)
- ° Personal Houses

F. Industry and Others
- ° Market
- ° M. O. W. Yard (Proposed)
- ° Veterinary
- ° Street Lights

DEMAND FORECAST

MONGUNO

Item			1976	1977	1978	1979	1980	1981	1992	1983	1984	1985	Note
Population(10³)			14.8	15.3	15.8	16.4	17.0	17.6	18.2	18.8	19.5	20.2	
Maximum Demand (kW)	Existing Town Area		47	62	70	74	79	95	102	110	119	128	No.1 100 kVA No.2 100 kVA
	Extension Area	G.R.A.	43	58	72	86	101	115	130	144	158	173	Present No.3 future 200 kVA
		Others											
		Sub Total	43	58	72	86	101	115	130	144	158	173	
	Education Facilities	S.S.	28	30	34	37	41	44	49	54	60	66	No.3 100 kVA
		T.C.											
		Sub Total	28	30	34	37	41	44	49	54	60	66	
	Health Centre				25	35	45	50	55	61	67	74	
	Water Supplies	Town Area								25	25	25	No.1, No.2
		Agric. etc.								25	25	25	
		Health Centre			15	15	15	15	15	15	15	15	
		Sub Total			15	15	15	15	15	65	65	65	
	Street Lights		1	1	1	1	1	2	2	2	2	2	
	Total		119	151	217	248	282	319	353	436	471	108	
Number of Consumers	Existing Town Area		151	213	258	274	292	315	340	367	396	428	
	Extension Area	G.R.A.	9	12	15	18	21	24	27	30	33	36	
		Others											
		Sub Total	9	12	15	18	21	24	27	30	33	36	
	Education Facilities	S.S.	12	13	14	16	17	19	21	23	25	28	
		T.C.											
		Sub Total	12	13	14	16	17	19	21	23	25	28	
	Health Centre				6	8	10	11	12	13	14	15	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre			1	1	1	1	1	1	1	1	
		Sub Total			1	1	1	1	1	3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		173	239	295	318	342	371	402	437	472	511	
	Number of New Consumers		173	66	55	23	24	29	31	35	35	43	
kWH Sales (kWH) x 10³	Existing Town Area		49	129	168	184	201	221	249	276	317	343	
	Extension Area	G.R.A.	79	110	141	173	208	246	286	326	369	416	
		Others											
		Sub Total	79	110	141	173	208	246	286	326	369	416	
	Education Facilities	S.S.	73	80	93	105	120	132	152	172	197	223	
		T.C.											
		Sub Total	73	80	93	105	120	132	152	172	197	223	
	Health Centre				111	161	213	243	276	315	356	405	
	Water Supplies	Town Area								27	33	39	
		Agric. etc.								27	33	39	
		Health Centre			16	18	20	22	24	26	29	32	
		Sub Total			16	18	20	22	24	80	95	110	
	Street Lights		13	13	13	13	13	20	20	20	20	20	
	Total		214	332	542	654	775	884	1005	1189	1344	1517	
Revenue (₦) x 10³	kWH Sales		10.2	16.0	23.0	27.0	31 5	35.8	40.6	47.2	53.2	60.4	
	Connection Fee		0.3	0 1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		10.5	16.1	23.1	27.1	31.6	35.9	40.7	47.3	53.3	60.5	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-6

M I C H I K A

I. Town : Michika

II. Population

A. 1963	11,182
B. 1973 (Estimate)	14,986
C. 1976 (")	16,300

III. Classification of Town

A. Political	-	District Headquarter
B. Industrial	-	Agricultural Town Commercial Town
C. Traffic	-	Main Route Town (Maiduguri - Mubi)

IV. General Information

This is an important town in Northern Sardeuna Province which is next to Mubi, Provincial Capital. It is a commercial town in which there is a secondary school. The road from Maiduguri to Mubi is under construction, crossing through the town.

V. Priority: High

VI. Survey Date: 31th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1) Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2) Future Load Growth Rank	
a) 1st Year - 5th Year	High
b) 5th Year - 10th Year	High

Details:

Politic	High
Transport	Medium
Industry	Few Local Factories
Special Loads	1 (1 Proposed)
Merchants, Shops	Many
Houses	High

2. Extension Area

2 District Extension Areas
New Town Area.
0,8 km from Michika

B. Special Load

1. Secondary School

a)	Consumption (Evening Load)	Office Classrooms Staff's Residences Student's Quarters
b)	Future Load Growth Number of Students	High 300 or more (Now)

Now 4 houses have been electrified and two houses are under construction.

2. Health Centre (Proposed)

VIII. Isolated Existing Generating Sets

A. Secondary School
3 kW

B. Small Generators
Traders' Houses Some

IX. Main Building and Establishments List

A. Main Office
- District Office

B. Education Facilities
- Secondary School
- 4 Primary Schools

C. Medical Facilities
- Health Centre (Proposed)
- Dispensary
- Maternity
- Leprosy

D. Public Utilities
- 2 Courts
- Court . (Proposed)
- Police Station
- Prison (Lock up)
- District Council Hall
- Postal Agency
- Post Office (Proposed)
- Mosque
- Church

E. Water Supply
- Dam for Water

F. Houses and Others
- District Head House
- Police Barracks
- Guest House
- Rest House
- 2 Hotels
- Persoanl Houses

G. Industry and Others
- Market
- Veterinary
- Agric. Office
- Cooperative Stores (Proposed)
- Motor Park
- Street Lights

DEMAND FORECAST

MICHIKA

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			16.3	16 9	17.5	18.1	18.7	19.4	20.1	20.8	21.5	22.3	
Maximum Demand (kW)	Existing Town Area		73	94	107	115	124	149	164	180	197	215	No.1 100kVA No.2 100kVA
	Extension Area	G.R.A.											
		Others			6	12	18	24	30	36	42	48	
		Sub Total			6	12	18	24	30	36	42	48	
	Education Facilities	S.S.	43	48	53	58	64	70	77	84	92	102	No.4 100kVA
		T.C.											
		Sub Total	43	48	53	58	64	70	77	84	92	102	
	Health Centre				25	35	45	50	55	61	67	74	
	Water Supplies	Town Area								30	30	30	No.1, No.2, No.3
		Agric. etc.								30	30	30	
		Health Centre			15	15	15	15	15	15	15	15	
		Sub Total			15	15	15	15	15	75	75	75	
	New Area (1)		30	32	35	38	41	44	48	52	56	60	No.3 100kVA
	New Area (2)		30	32	35	38	41	44	48	52	56	60	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		177	207	277	312	349	397	438	541	586	635	
Number of Consumers	Existing Town Area		209	293	355	383	414	453	496	544	596	653	
	Extension Area	G.R.A.											
		Others			2	4	6	8	10	12	14	16	
		Sub Total			2	4	6	8	10	12	14	16	
	Education Facilities	S.S.	18	20	22	24	27	29	32	35	38	43	
		T.C.											
		Sub Total	18	20	22	24	27	29	32	35	38	43	
	Health Centre				6	8	10	11	12	13	14	15	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre			1	1	1	1	1	1	1	1	
		Sub Total			1	1	1	1	1	3	3	3	
	New Area (1)		30	32	35	38	41	44	48	52	56	60	
	New Area (2)		30	32	35	38	41	44	48	52	56	60	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		288	378	457	497	542	592	649	712	778	851	
	Number of New Consumers		288	90	79	40	45	50	57	63	66	73	
kWH Sales (kWH) x 10^3	Existing Town Area		82	203	264	294	328	370	419	475	538	609	
	Extension Area	G.R.A.											
		Others			11	23	35	48	62	77	92	109	
		Sub Total			11	23	35	48	62	77	92	109	
	Education Facilities	S.S.	111	128	146	164	187	210	238	268	302	345	
		T.C.											
		Sub Total	111	128	146	164	187	210	238	268	302	345	
	Health Centre				111	161	213	243	276	315	356	405	
	Water Supplies	Town Area								33	39	47	
		Agric. etc.								33	39	47	
		Health Centre			16	18	20	22	24	26	29	32	
		Sub Total			16	18	20	22	24	98	107	126	
	New Area (1)		28	55	69	78	86	94	106	118	130	143	
	New Area (2)		28	55	69	78	86	94	106	118	130	143	
	Street Lights		10	10	10	10	10	15	15	15	15	15	
	Total		259	451	696	826	965	1095	1245	1493	1669	1894	
Revenue (₦) x 10^3	kWH Sales		14.5	25.0	34.1	39.6	45.5	51.5	58.5	68.0	76.6	86.7	
	Connection Fee		0.6	0.2	0.2	0 1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		15.1	25.2	34.3	39.7	45.6	51.6	58.6	68.1	76.7	86.8	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-7

D A D I N   K O W A

I. Town: Dadin Kowa (Include Tunga)

II. Population

A. 1973 (Estimate)	12,000
B. 1976 (")	13,100

III. Classification of Town

A. Political	-	District Headquarter
B. Industrial	-	Agricultural Town
C. Traffic	-	Main Route Town (Bauchi - Biu)

IV. General Information

This town is situated at one of the most fertile areas in Nigeria. Consequently, it will be an agricultural/industrial estate which will be set up around the area. Already there is a tomato factory therein and there is also a possibility that a textile factory may be eventually established.

V. Priority: High

VI. Survey Date: 12th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1) Consumption (Evening Load)	Small Consumers Houses Street Lights
2) Future Load Growth Rank	
a) 1st Year - 5th Year	Low
b) 5th Year - 10th Year	Medium

Details:

Politic	High
Transport	Medium
Industry	Some
Special Loads	None (3 Proposed)
Merchants, Shops	Few
Houses	Low

2. Extension Area

One area

B. Special Load

1. Secondary School (Proposed)

Site is not yet decided.

2. Water Supply (Proposed)

3. Textile Factory

   As it is not proposed yet, so not included in the demand forecast.

VIII. Isolated Existing Generating Sets

   A. Small Generator

IX. Main Building and Establishments List

   A. Main Office
      ° District Office

   B. Education Facilities
      ° Secondary School (Proposed)
      ° Primary School

   C. Medical Facilities
      ° Dispensary
      ° Veterinary

   D. Public Utilities
      ° Court
      ° Police Station
      ° Library
      ° Mosque

   E. Water Supply (Proposed)

   F. Houses and Others
      ° District Head House
      ° Guest House
      ° Hotels (Small)
      ° Personal Houses

   G. Indsutry and Others
      ° Market
      ° M. O. Agriculture
      ° Cotton Market
      ° Store
      ° Store (Kanti or Tasha)
      ° Street Lights

DEMAND FORECAST

DADIN-KOWA

Item			1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			13.1	13.6	14.1	14.6	15.1	15.6	16.1	16.7	17.3	17.9	
Maximum Demand (kW)	Existing Town Area		41	55	62	70	77	84	91	98	106	114	No.1 100 kVA, No.2 100 kVA No.3 100 kVA
	Extension Area	G.R.A.											
		Others	12	18	24	30	36	42	48	54	60	66	
		Sub Total	12	18	24	30	36	42	48	54	60	66	
	Education Facilities	S.S.	18	30	36	40	43	48	53	58	64	70	
		T.C.											
		Sub Total	18	30	36	40	43	48	53	58	64	70	
	Health Centre				25	35	45	50	55	61	67	74	
	Water Supplies	Town Area								25	25	25	No.1, No.2, No.3
		Agric. etc.								25	25	25	
		Health Centre			15	15	15	15	15	15	15	15	
		Sub Total			15	15	15	15	15	65	65	65	
	Street Lights		1	1	1	1	1	2	2	2	2	2	
	Total		72	104	163	191	217	241	264	338	364	391	
Number of Consumers	Existing Town Area		134	189	228	243	259	280	302	326	352	380	
	Extension Area	G.R.A.											
		Others	4	6	8	10	12	14	16	18	20	22	
		Sub Total	4	6	8	10	12	14	16	18	20	22	
	Education Facilities	S.S.	8	13	15	17	18	20	22	24	27	29	
		T.C.											
		Sub Total	8	13	15	17	18	20	22	24	27	29	
	Health Centre				6	8	10	11	12	13	14	15	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre			1	1	1	1	1	1	1	1	
		Sub Total			1	1	1	1	1	3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		147	209	259	280	301	327	354	385	417	450	
	Number of New Consumers		147	62	50	21	21	26	27	31	32	33	
kWH Sales (kWH) x 10^3	Existing Town Area		44	115	149	163	179	198	219	246	274	306	
	Extension Area	G.R.A.											
		Others	22	34	47	60	75	90	106	122	140	159	
		Sub Total	22	34	47	60	75	90	106	122	140	159	
	Education Facilities	S.S.	47	80	89	113	125	144	164	185	210	237	
		T.C.											
		Sub Total	47	80	99	113	125	144	164	185	210	237	
	Health Centre				111	161	213	243	276	315	356	405	
	Water Supplies	Town Area								27	33	39	
		Agric. etc.								27	33	39	
		Health Centre			16	18	20	22	24	26	29	32	
		Sub Total			16	18	20	22	24	80	95	110	
	Street Lights		10	10	10	10	10	15	15	15	15	15	
	Total		123	239	432	525	622	712	806	963	1090	1232	
Revenue (₦) x 10^3	kWH Sales		10.2	12.1	18.5	21.8	25.4	29.1	32.7	38.4	43.3	48.9	
	Connection Fee		0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		10.5	12.2	18.6	21.9	25.5	29.2	32.8	38.5	43.4	49.0	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College

2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-8

S H I R A

I. Town: Shira

II. Population

A. 1963	7,100
B. 1973 (Estimate)	9,514
C. 1976 (")	10,400

III. Classification of Town

A. Political	-	District Headquarter
B. Industrial	-	Agricultural Town Commercial Town
C. Traffic	-	Main Route Town

IV. General Information

This town is along a main road and serves as a small trading centre. This is the district headquarter of the largest district in Katagum Division.

V. Priority: Low

VI. Survey Date: 19th December, 1974

VII. Main Load

A. Residential and Small Commercial Load

1. Existing Town Area

1) Consumption (Evening Load)	Small Consumers Small Shops Houses Street Lights
2) Future Load Growth Rank	
a) 1st Year - 5th Year	Low
b) 5th Year - 10th Year	Low

Details:

Politic	Low
Transport	Medium
Industry	Few Local Factories
Special Loads	None
Merchants, Shops	Some
Houses	Low

2. Extension Area

None

B. Special Load

None

VIII. Isolated Existing Generating Sets

None

IX. Main Building and Establishments List

A. Main Office
- District Office

B. Education Facilities
- Primary School
- Islamiya School

C. Medical Facility
- Dispensary

D. Public Utilities
- Court
- Police Office (Charge office)
- Council Hall
- Reading Room
- Mosque

E. Water Supply

None

F. Houses and Others
- District Head House
- 2 Guest Houses
- Judge House
- Personal Houses

G. Industry and Others
- Market
- Store
- Street Lights

DEMAND FORECAST

SHIRA

Item		Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.7	14.2	
Maximum Demand (kW)	Existing Town Area		33	44	49	52	55	59	63	67	71	76	No. 1 100 kVA
	Extension Area	G.R.A.											
		Others											
		Sub Total											
	Education Facilities	S.S.						18	30	36	40	43	
		T.C.											
		Sub Total						18	30	36	40	43	
	Health Centre									25	35	45	
	Water Supplies	Town Area								20	20	20	No. 1
		Agric. etc.								20	20	20	
		Health Centre								15	15	15	
		Sub Total								55	55	55	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		34	45	50	53	56	78	94	184	202	220	
Number of Consumers	Existing Town Area		106	150	181	193	205	218	232	247	263	280	
	Extension Area	G.R.A.											
		Others											
		Sub Total											
	Education Facilities	S.S.						8	13	15	17	18	
		T.C.											
		Sub Total						8	13	15	17	18	
	Health Centre									6	8	10	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre								1	1	1	
		Sub Total								3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		107	151	182	194	206	227	246	272	292	312	
	Number of New Consumers		107	44	31	12	12	21	19	26	20	20	
kWH Sales (kWH) x 10^3	Existing Town Area		37	98	120	132	144	156	171	187	205	224	
	Extension Area	G.R.A.											
		Others											
		Sub Total											
	Education Facilities	S.S.						47	80	99	113	125	
		T.C.											
		Sub Total						47	80	99	113	125	
	Health Centre									111	161	213	
	Water Supplies	Town Area								22	26	32	
		Agric. etc.								22	26	32	
		Health Centre								16	18	20	
		Sub Total								60	70	84	
	Street Lights		7	7	7	7	7	11	11	11	11	11	
	Total		44	105	127	139	151	214	262	468	560	657	
Revenue (₦) x 10^3	kWH Sales		3.4	6.6	7.7	8.4	9.1	11.8	13.9	20.7	24.0	27.7	
	Connection Fee		0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		3.6	6.7	7.8	8.5	9.2	11.9	14.0	20.8	24.1	27.8	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

Table Annex 1-9

T A F A W A   B A L E W A

I. Town: Tafawa Balewa

II. Population

A.	1973 (Estimate)	9,500
B.	1976 (")	10,400

III. Classification of Town

A.	Political	-	District Headquarter
B.	Industrial	-	Agricultural Town
C.	Traffic	-	General Route Town (Proposed) Railway Town

IV. General Information

This is an old town along the Kafanchan-Maiduguri rail line. It is the headquarter of the most populated district in Bauchi Emirate. A secondary school and a rural health centre have been proposed in the town. Agriculture is predominant here. It is also an important tin mining. The Bauchi-Dass-Tafawa Balewa road is under construction and will be complete three years after.

V. Priority: Low

VI. Survey Date: 11th December, 1974

VII. Main Load

A. Residential and Small Commerical Load

1. Existing Town Area

1)	Consumption (Evening Load)	Small Consumers Houses Street Lights
2)	Future Load Growth Rank	
a)	1st Year - 5th Year	Low
b)	5th Year - 10th Year	Low

Details:

Politic	Low
Transport	Medium
Industry	Mining
Special Loads	None (1 Proposed)
Merchants, Shops	Few
Houses	Low

2. Extension Area

Area is decided.

B. Special Load

Secondary School (Proposed)
Area is decided.

VIII. Isolated Existing Sets

None

IX. Main Building and Establishments List

A. Main Office
- District Office

B. Education Facilities
- Secondary School (Proposed)
- 2 Primary Schools

C. Medical Facilities
- Clinic (Big)
- Maternity (Proposed)

D. Public Utilities
- Court
- Police Station
- Council Hall
- Reading Room
- Postal Agency
- Mosque
- 2 Churches
- Railway Station (Include staff's quarters)

E. Water Supply

None

F. Houses and Others
- District Head House
- Police Barracks
- Guest House
- Personal Houses

G. Industry and Others
- Market
- Small Local Factories
- Agriculture Office
- Street Lights

DEMAND FORECAST

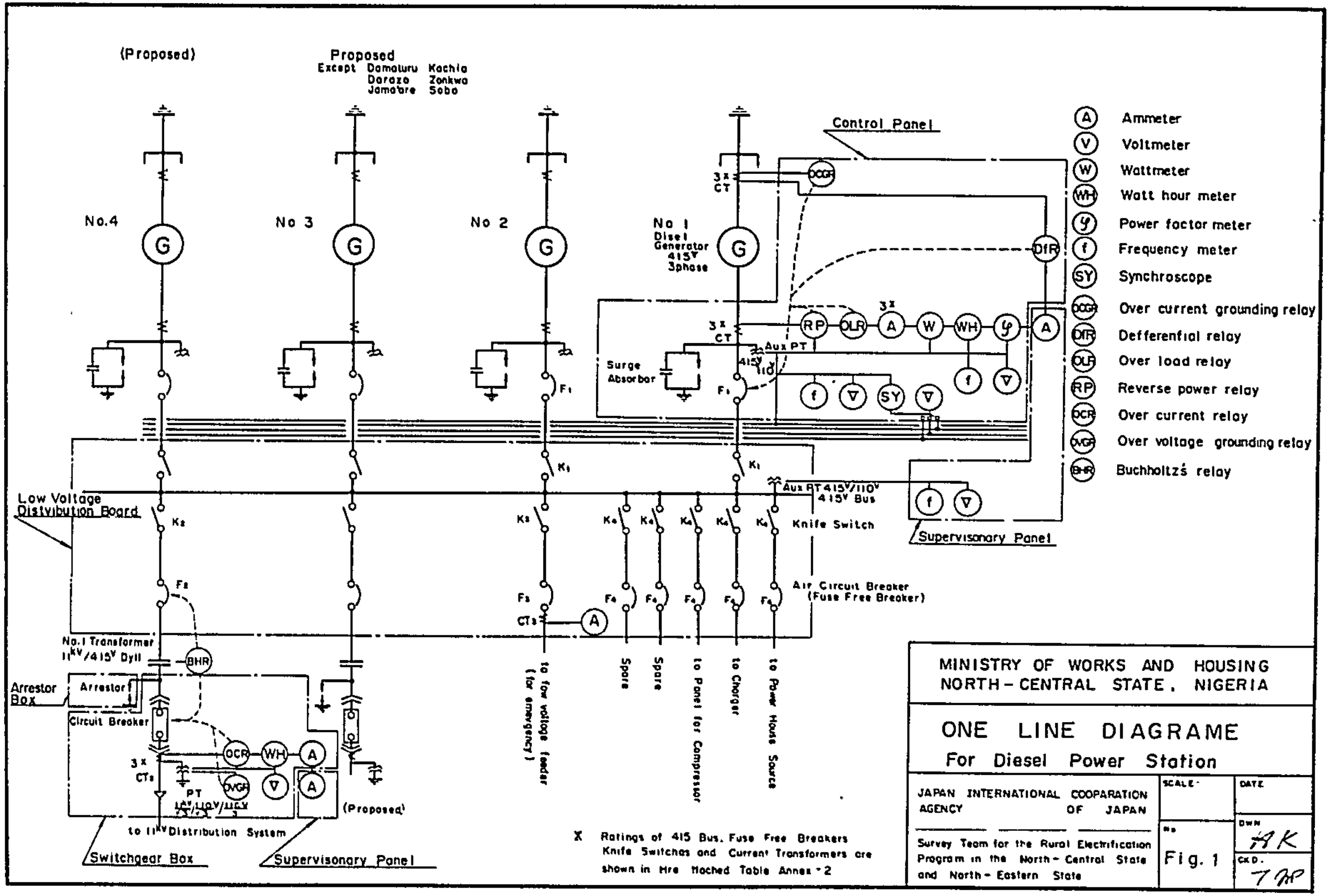
TAFAWA-BALEWA

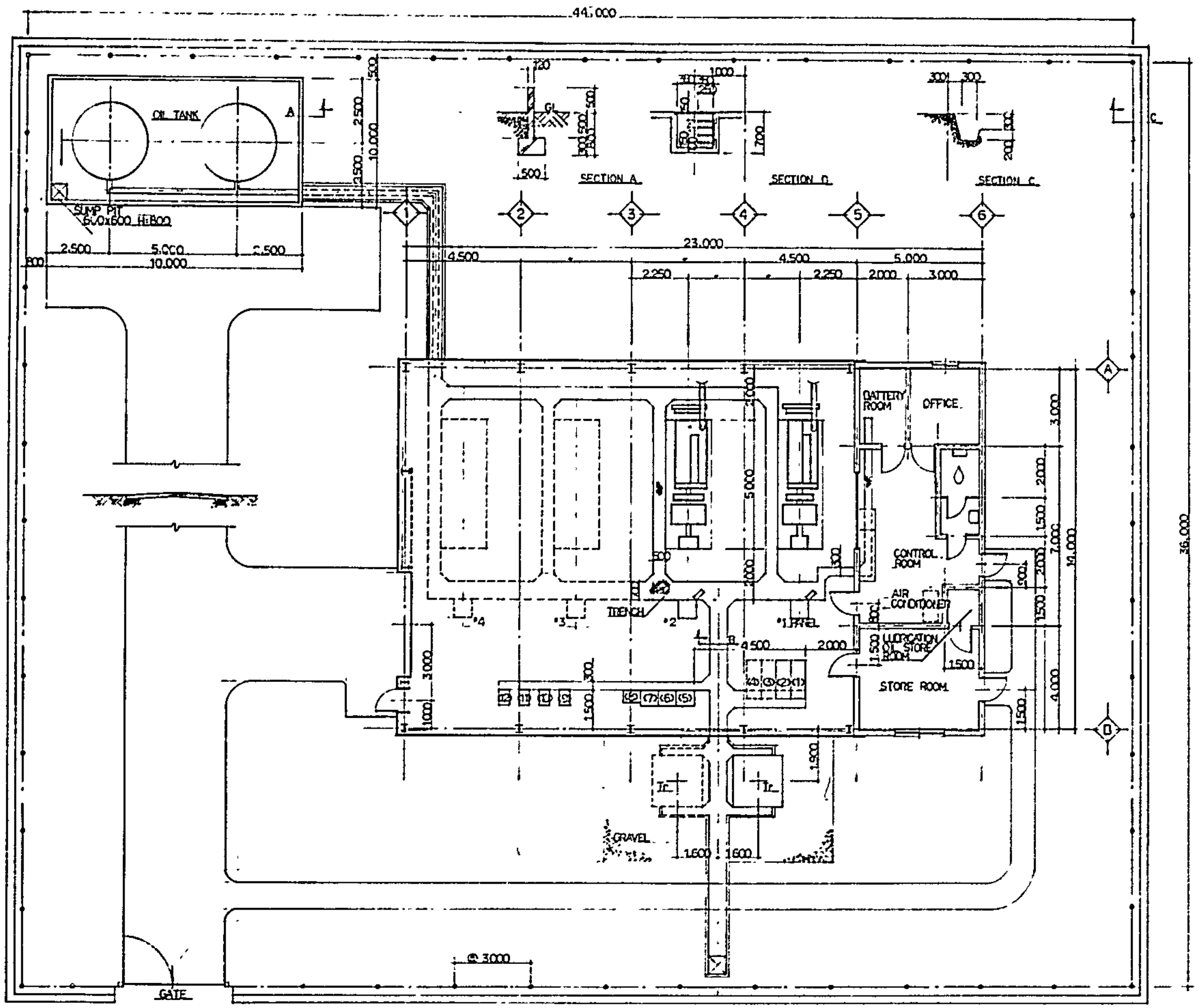
Item		Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Note
Population(10^3)			10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.7	14.2	
Maximum Demand (kW)	Existing Town Area		33	44	49	52	55	59	63	67	71	76	No. 1 100 kVA
	Extension Area	G.R.A.											
		Others	18	24	30	36	42	48	54	60	66	72	
		Sub Total	18	24	30	36	42	48	54	60	66	72	
	Education Facilities	S.S.	18	30	36	40	43	48	53	58	64	70	
		T.C.											
		Sub Total	18	30	36	40	43	48	53	58	64	70	
	Health Centre									25	35	45	
	Water Supplies	Town Area								25	25	25	No. 1
		Agric. etc.								25	25	25	
		Health Centre								15	15	15	
		Sub Total								65	65	65	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		70	99	116	129	141	156	171	276	302	330	
Number of Consumers	Existing Town Area		106	150	181	193	205	218	232	247	263	280	
	Extension Area	G.R.A.											
		Others	6	8	10	12	14	16	18	20	22	24	
		Sub Total	6	8	10	12	14	16	18	20	22	24	
	Education Facilities	S.S.	8	13	15	17	18	20	22	24	27	29	
		T.C.											
		Sub Total	8	13	15	17	18	20	22	24	27	29	
	Health Centre									6	8	10	
	Water Supplies	Town Area								1	1	1	
		Agric. etc.								1	1	1	
		Health Centre								1	1	1	
		Sub Total								3	3	3	
	Street Lights		1	1	1	1	1	1	1	1	1	1	
	Total		121	172	207	223	238	255	273	305	324	347	
	Number of New Consumers		121	51	35	16	15	17	18	32	19	23	
kWH Sales (kWH) x 10^3	Existing Town Area		38	95	121	133	145	158	173	189	207	228	
	Extension Area	G.R.A.											
		Others	33	46	59	73	87	103	119	136	154	173	
		Sub Total	33	46	59	73	87	103	119	136	154	173	
	Education Facilities	S.S.	47	80	99	113	125	144	164	185	210	237	
		T.C.											
		Sub Total	47	80	99	113	125	144	164	185	210	237	
	Health Centre									111	161	213	
	Water Supplies	Town Area								27	33	39	
		Agric. etc.								27	33	39	
		Health Centre								16	18	20	
		Sub Total								70	84	98	
	Street Lights		4	4	4	4	4	6	6	6	6	6	
	Total		122	225	283	323	361	411	462	697	822	955	
Revenue (₦) x 10^3	kWH Sales		6.1	11.9	13.2	14.9	16.4	18.5	20.7	27.4	32.9	37.8	
	Connection Fee		0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	Total		6.3	12.0	13.3	15.0	16.5	18.6	20.8	27.5	33.0	37.9	

Note: 1. G.R.A. ......Government Residential Area
S.S. ....Secondary School
T.C. ....Teachers College
2. The note represents the number of transformers and their capacities in the designing drawing of supply facilities.

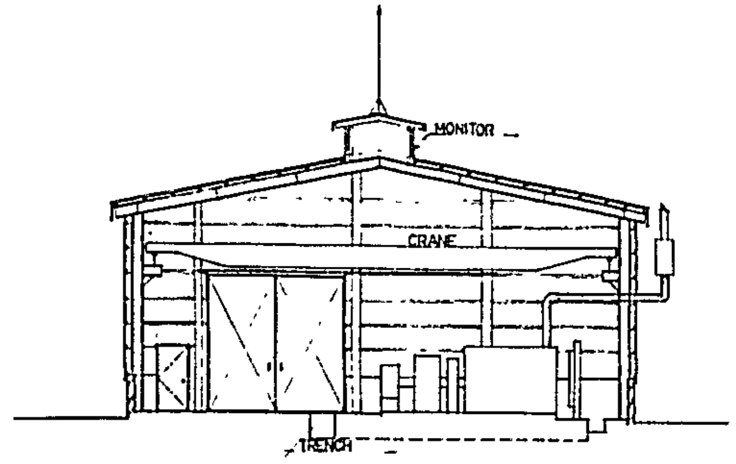
DRAWINGS

DRAWINGS


(Proposed)
Proposed
Except Damaturu Kachia Darazo Zonkwa Jama'are Sobo
No.4
No 3
No 2
No 1 Diesel Generator 415V 3phase
3x CT
Surge Absorbar
Aux PT 415V/110V
Control Panel
Ammeter
Voltmeter
Wattmeter
Watt hour meter
Power factor meter
Frequency meter
Synchroscope
Over current grounding relay
Defferenfial relay
Over load relay
Reverse power relay
Over current relay
Over voltage grounding relay
Buchholtzś relay
Aux PT 415V/110V
415V Bus
Knife Switch
Air Circuit Breaker (Fuse Free Breaker)
Supervisonary Panel
Low Voltage Distvibution Board
No.1 Transformer 11kV/415V Dyll
Arrestor Box
Arrestor
Circuit Breaker
3x CTs
PT
(Proposed)
to 11kV Distribution System
Switchgear Box
Supervisonary Panel
to fow voltage feeder (for emevgency)
Spare
Spare
to Panel for Compressor
to Chorger
to Power House Source
X Ratings of 415 Bus. Fuse Free Breakers Knife Switches and Current Transformers are shown in Hre Hached Table Annex - 2
MINISTRY OF WORKS AND HOUSING
NORTH - CENTRAL STATE, NIGERIA
ONE LINE DIAGRAME
For Diesel Power Station
JAPAN INTERNATIONAL COOPARATION AGENCY OF JAPAN
Survey Team for the Rural Electrification Program in the North - Central State and North - Eastern State
SCALE
DATE
DWN
CKD.
Fig. 1



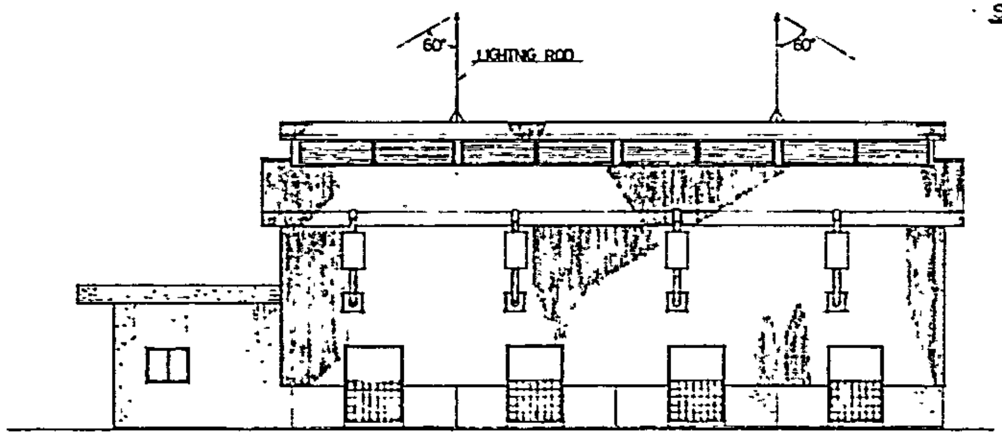
SITE PLAN



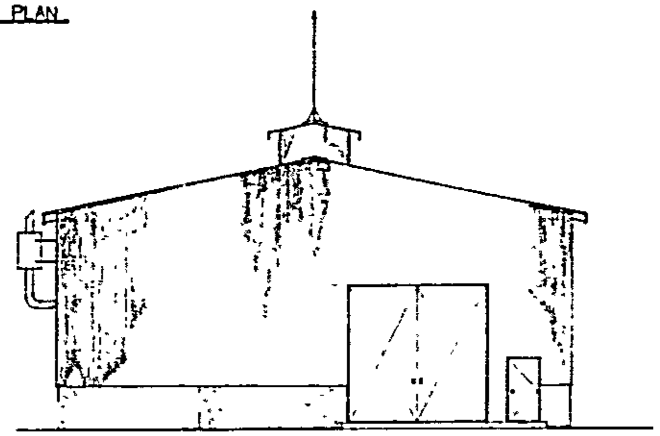
SECTION

NOTES

1. PANEL AND SWITCHING BOARD
(1) 11Kv FEEDER SWITCHING BOARD
(2) 11Kv PT, LA BOARD
(3) SPARE
(4) SPARE
(5) LT SWITCHING BOARD
(6) D.C CHARGER
(7) D.C. DISTRIBUTION BOARD
(8) D G STARTING BOARD
(9) SURPER VISION PANEL
(10) AIR COMPRESSOR A.C. MOTOR DRIVEN
(11) AIR COMPRESSOR ENGINE DRIVEN
(12) D C EMERGENCY GENERATOR



ELEVATION 1



ELEVATION 2

MINISTRY OF WORKS AND HOUSING NORTH - CENTRAL STATE, NIGERIA		
SITE LAYOUT PLAN FOR PS		
JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN Survey Team for the Rural Electrification Program In the North-Central State and North-Eastern State	SCALE	DATE
	NO. Fig.2	DWN H K CKD. T.M

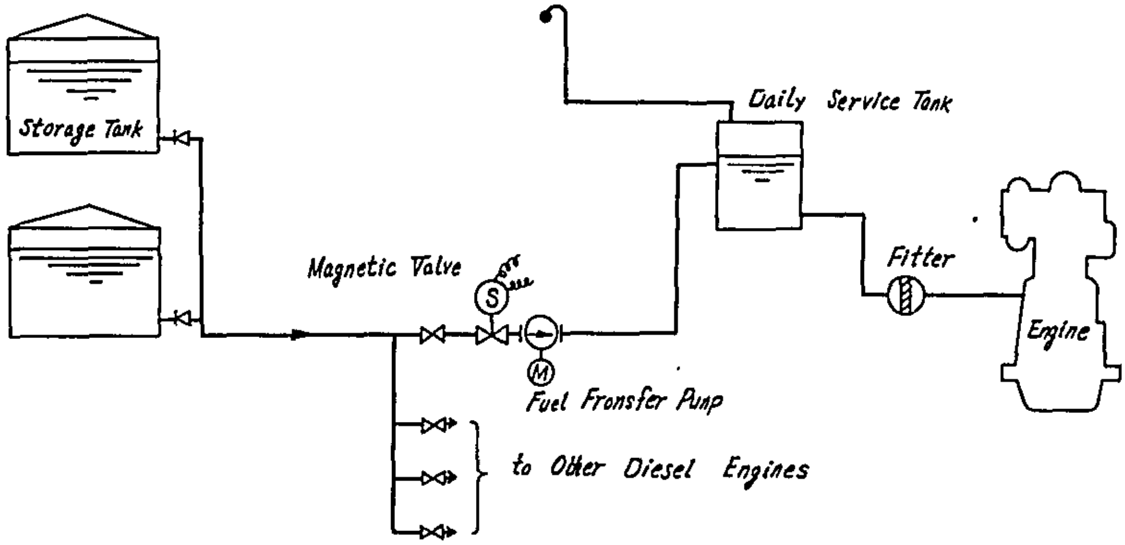


Fig. 3 SYSTEM OF FUEL

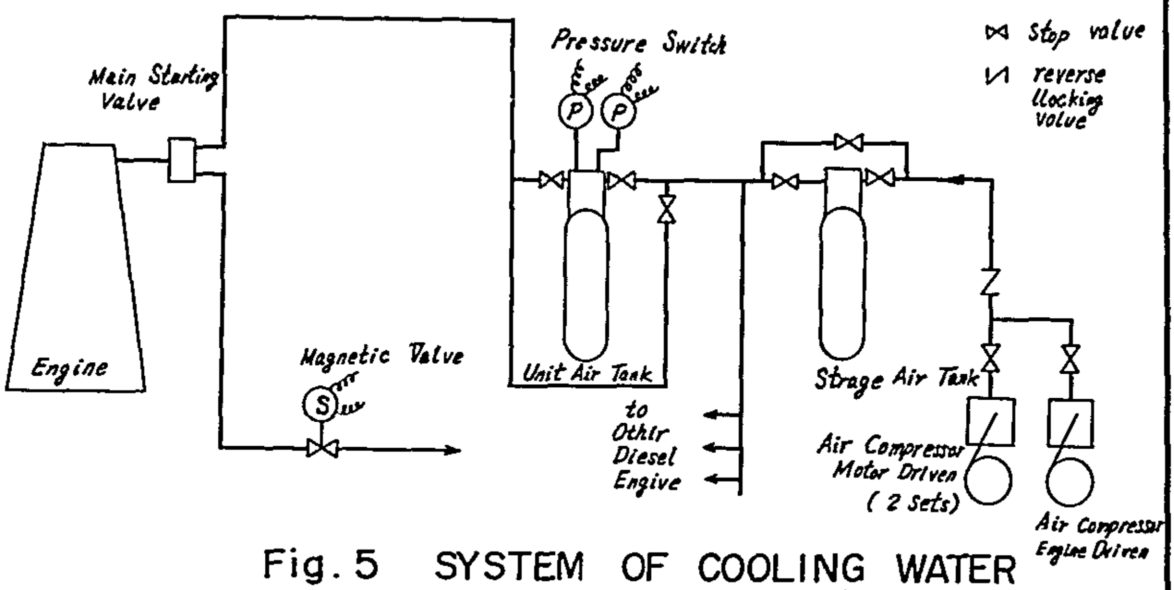


Fig. 4 SYSTEM OF COMPRESSED AIR

Fig. 5 SYSTEM OF COOLING WATER

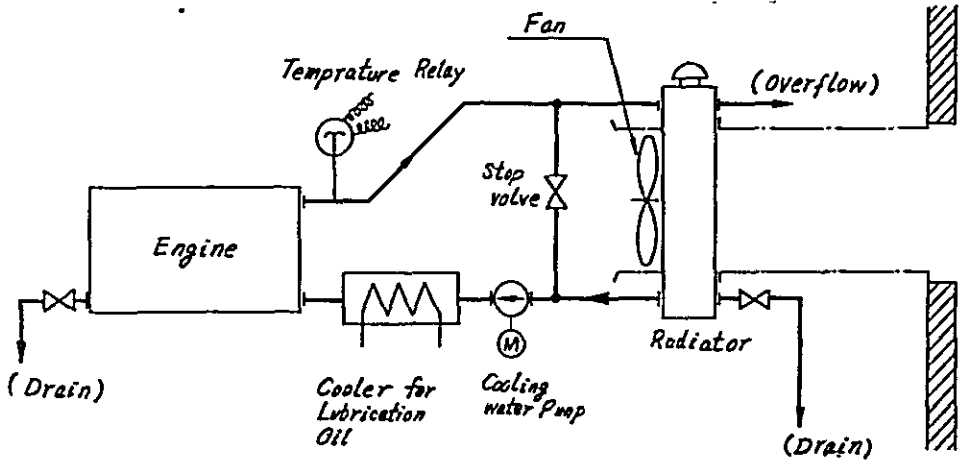


Fig. 6 SYSTEM OF LUBRICATION OIL

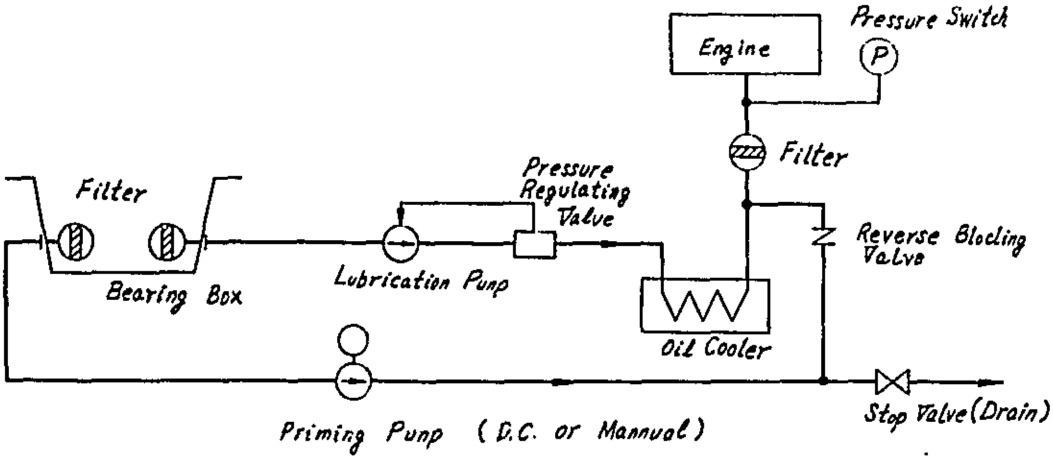


Fig. 7 SYSTEM OF D.C. SUPPLY

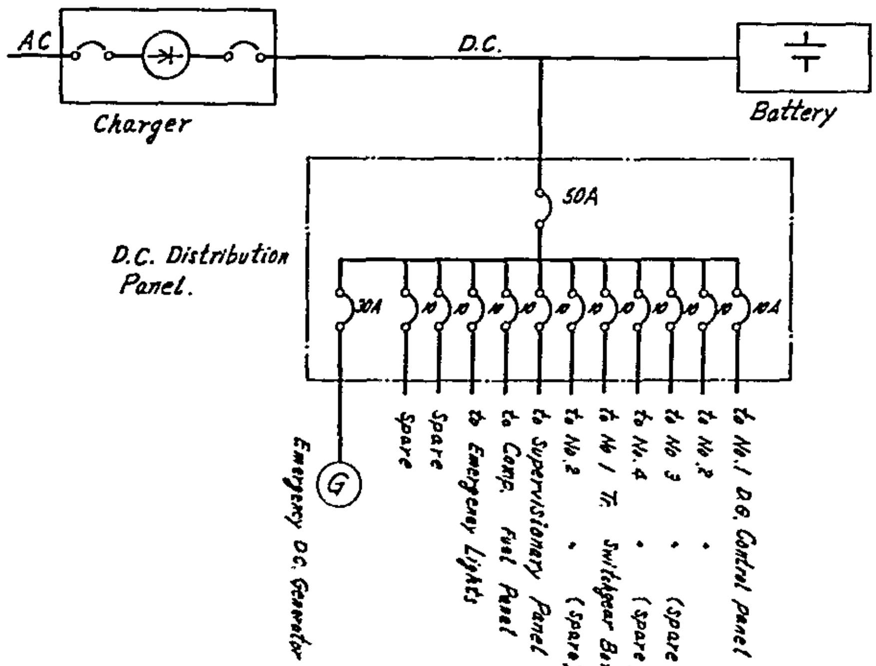
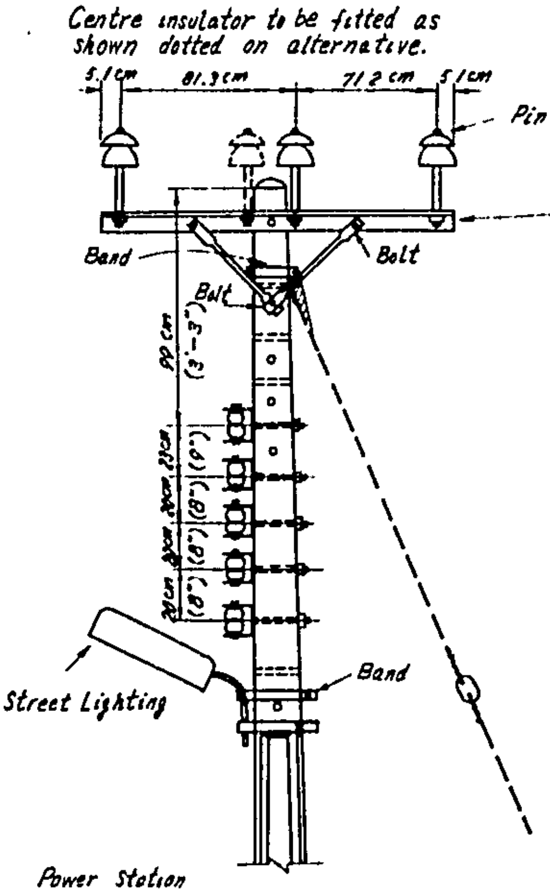
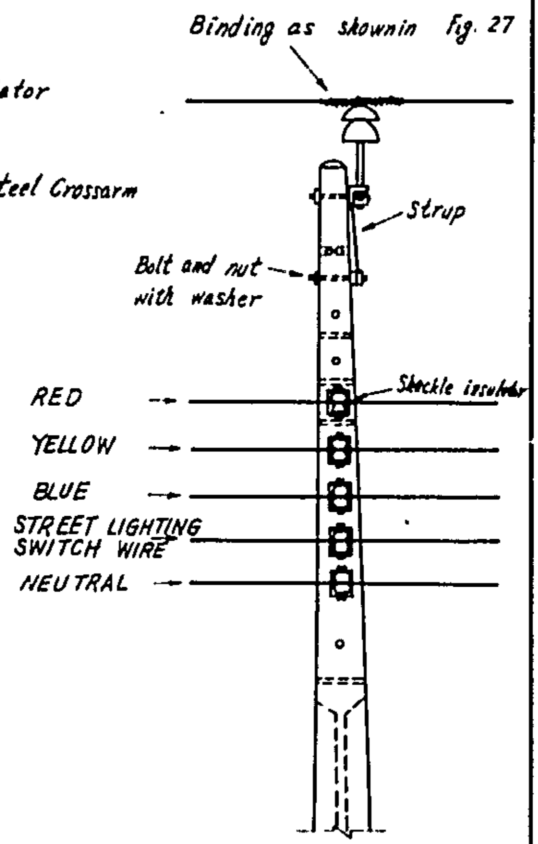
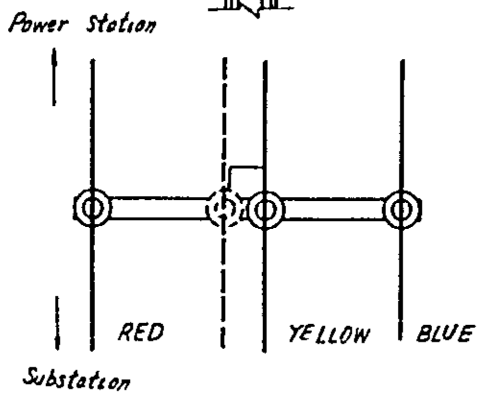


Fig. 8 INTERMEDIATE AND ANGLE POLE

(Up to 20° line deviation)





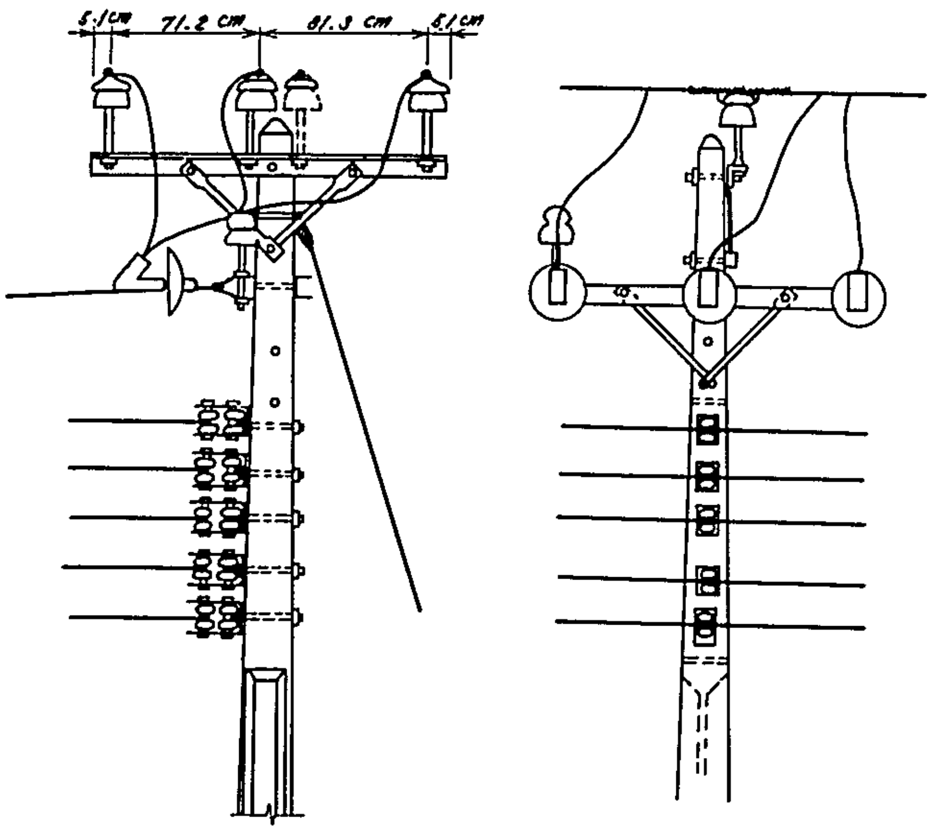


NOTE

1 This type of poles are commonly used for H.V. lines and L.V. lines and otherwise shall be applied to H.V. line only

2 The type of cross arms are either of "L" or "C" type

Fig. 9 TEE OFF POLE



NOTE *Tee Off poles shall be single pole or H pole*

Fig. 10 SUBSTATION POLE
(Terminal Pole)

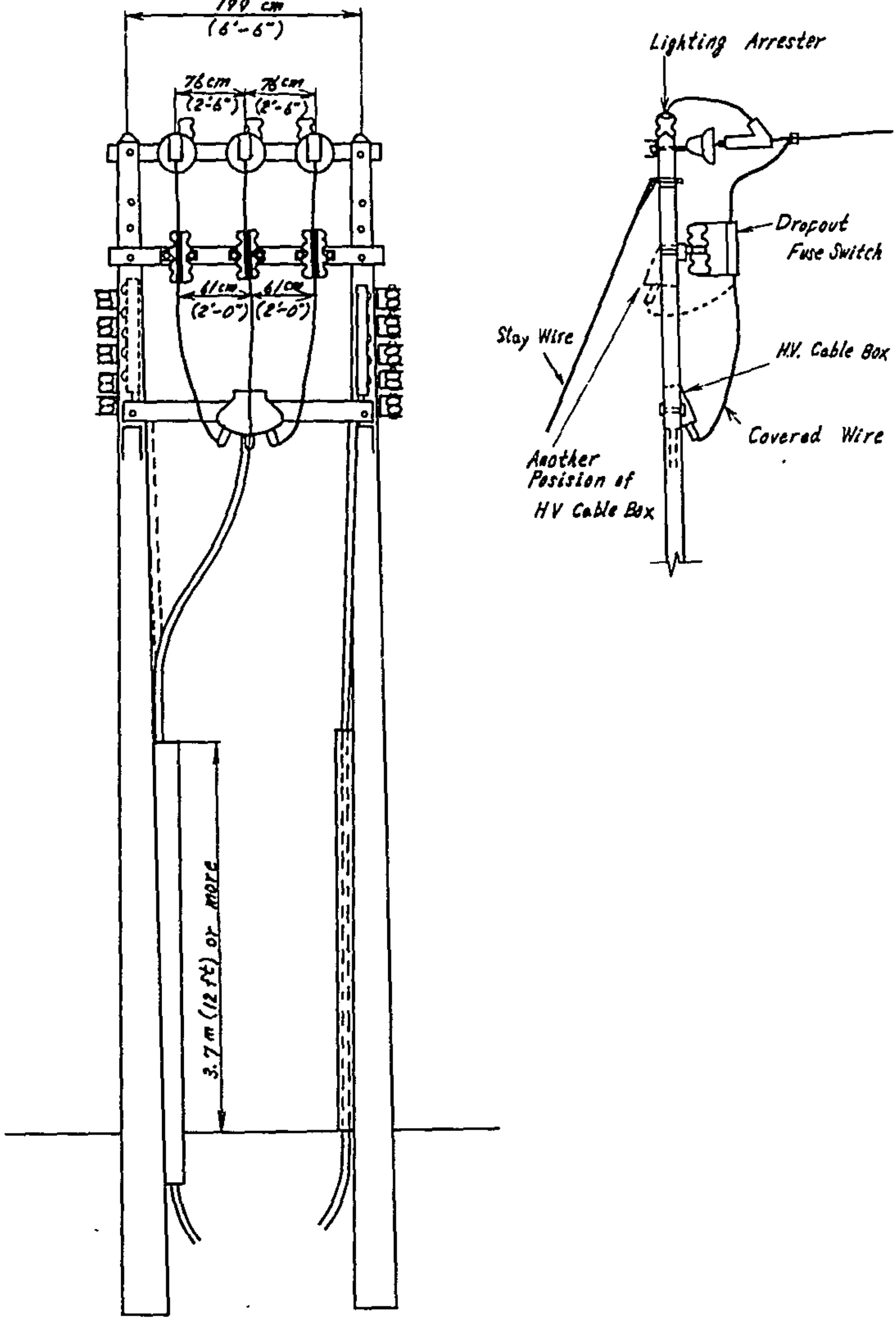
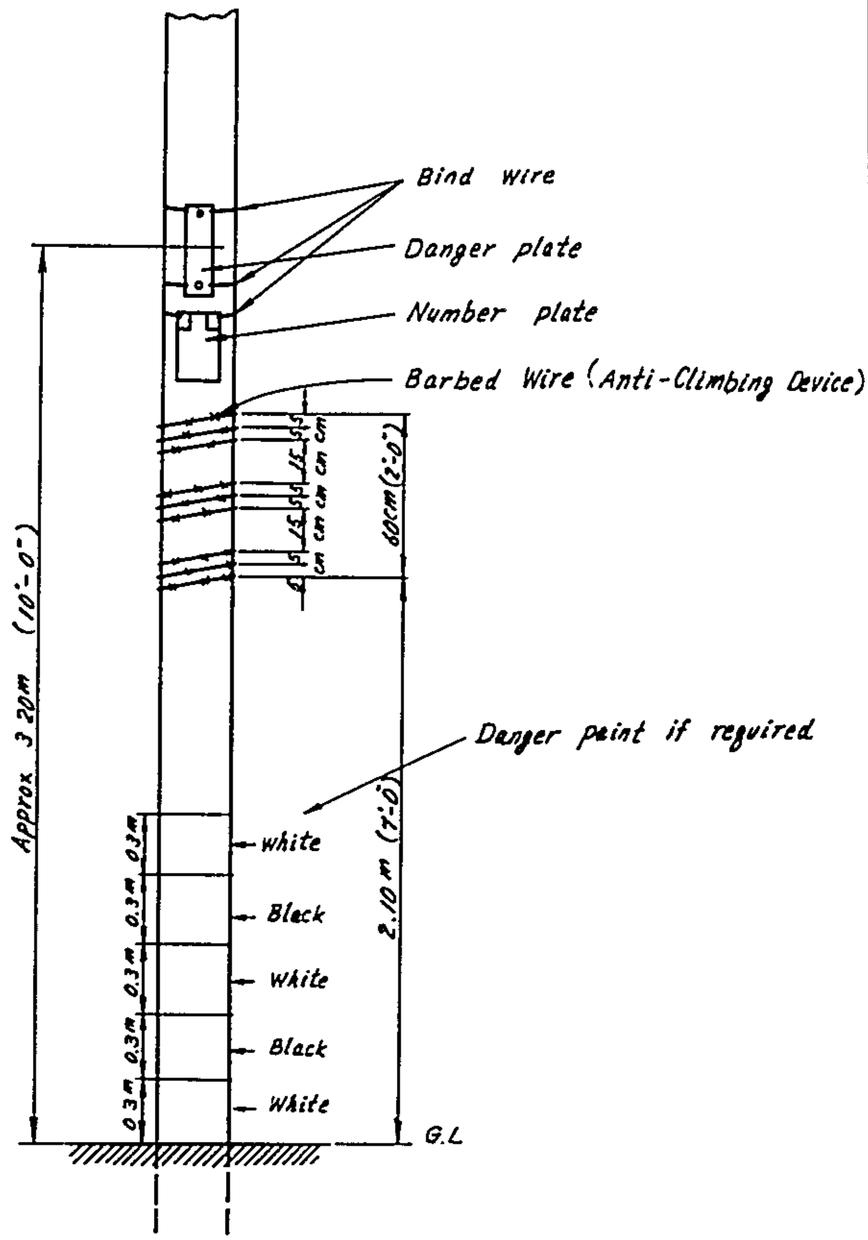
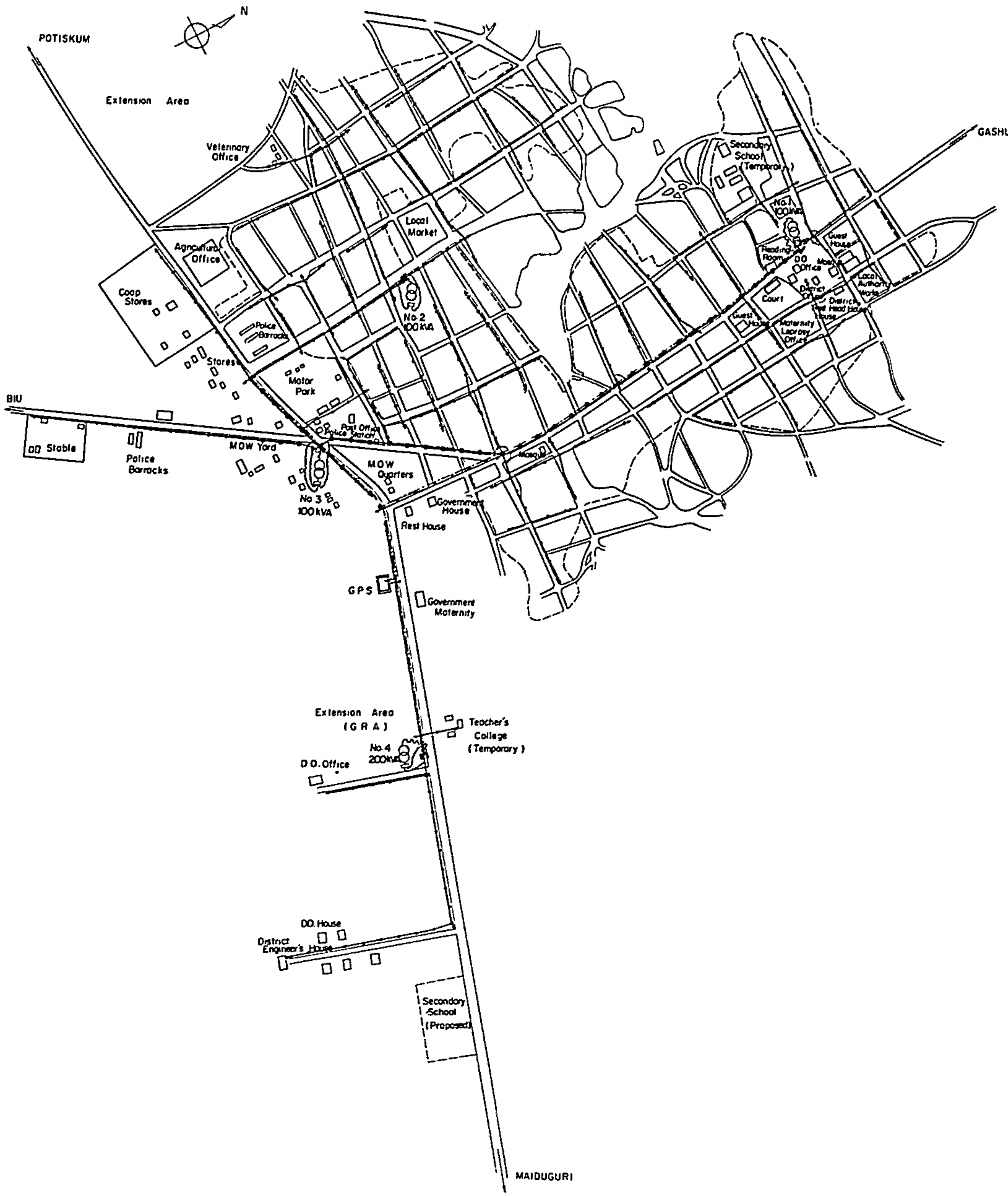


Fig. 11 ACCESSARIES OF POLE



NOTE *Anti-climbing device shall be installed at each 11 kV pole.*

DAMAIURU



NOTES

1. L.V. system shall be 3 phase 4 wire up to the end of L.V. lines.
2. The conductors of H V., L.V. and street lighting shall be all aluminium 50 mm².
3. The poles with H V. lines or dual (H V. + L.V.) lines shall be 10 m, and the poles with L.V. lines shall be 8 m.
4. H.V. insulators of intermediate and angle poles shall be mainly of pin type and H.V. insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformers and feeder pillars shall be provided at the secondary side of the transformers above-mentioned.
6. Lightning arresters shall be provided both on the primary side of transformers, at the H V. feeding points and the lines each with the interval of 500 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V. and dual (H.V.+ L.V.) construction.

LEGEND

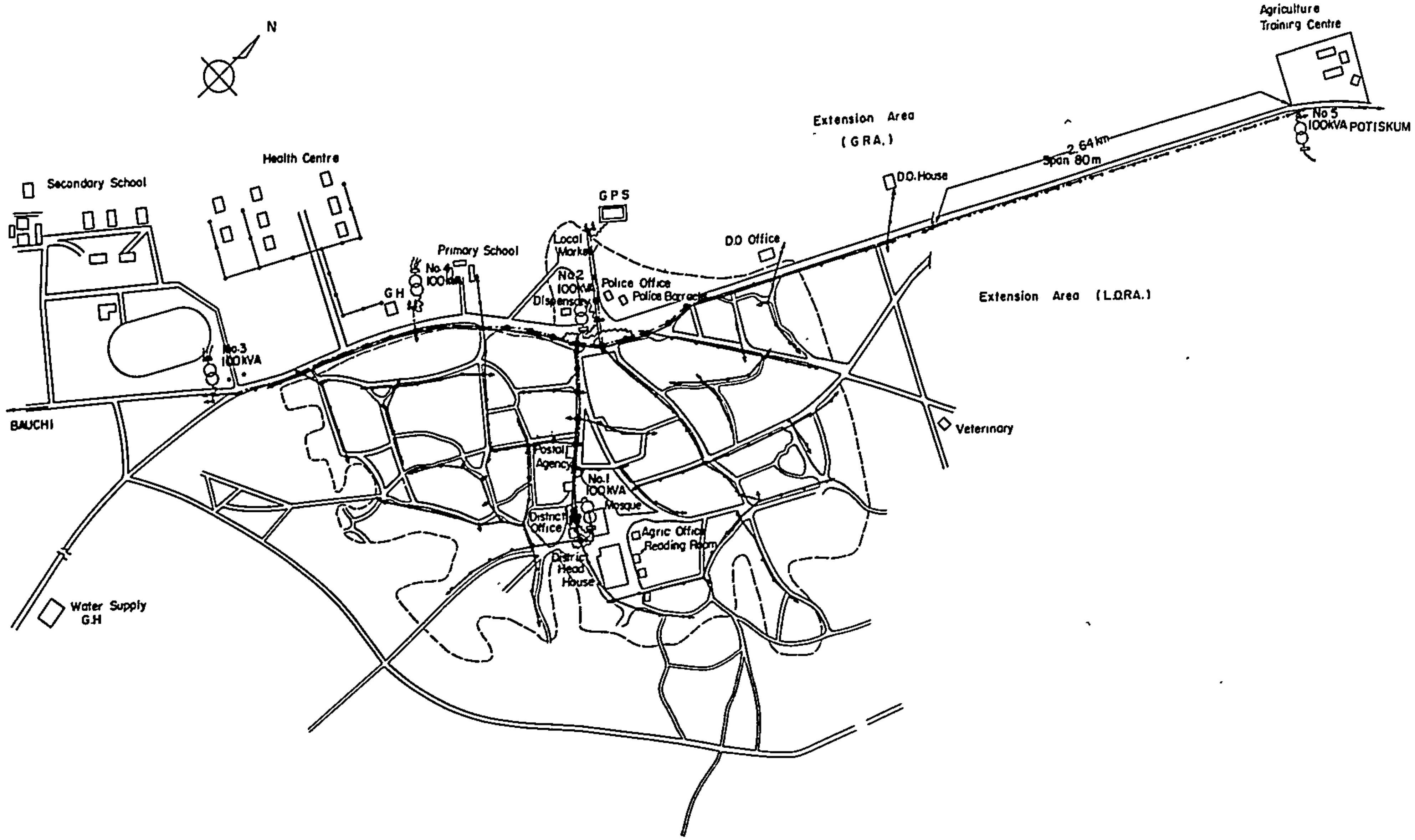
- GPS — Diesel Power Station (First Priority)
- GPS — Diesel Power Station (Second Priority)
- H. V. 3 Phase 3 Wire
- L. V. 3 Phase 4 Wire
- H. V Underground Cable
- L. V. Underground Cable
- Single Pole
- H Pole
- Pole with Street Light
- L. V. Section Pole
- Pole with Angle Stay
- Pole with Flying Stay
- Transformer and Feeder Pillar
- Existing Town Area
- Main Building (Existing)
- Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA

DAMATSURU TOWN ELECTRIFICATION

JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN	SCALE:	DATE: 10. 5. 75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State	No. NE 01	DWN: / CKD:

DARAZO



NOTES

1. L.V. system shall be 3 phase 4 wire up to the end of L.V. lines.
2. The conductors of H.V., L.V. and street lighting shall be all aluminium 50 mm².
3. The poles with H.V. lines or dual (H.V. + L.V.) lines shall be 10 m, and the poles with L.V. lines shall be 8 m.
4. H.V. insulators of intermediate and angle poles shall be mainly of pin type and H.V. insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformers and feeder pillars shall be provided at the secondary side of the transformers above mentioned.
6. Lightning arresters shall be provided both on the primary side of transformers, at the H.V. feeding points and the lines each with the interval of 500 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V. and dual (H.V. + L.V.) construction.
   Span length for only H.V. construction shall generally be 80 m, but shall not be greater than 90 m.

LEGEND

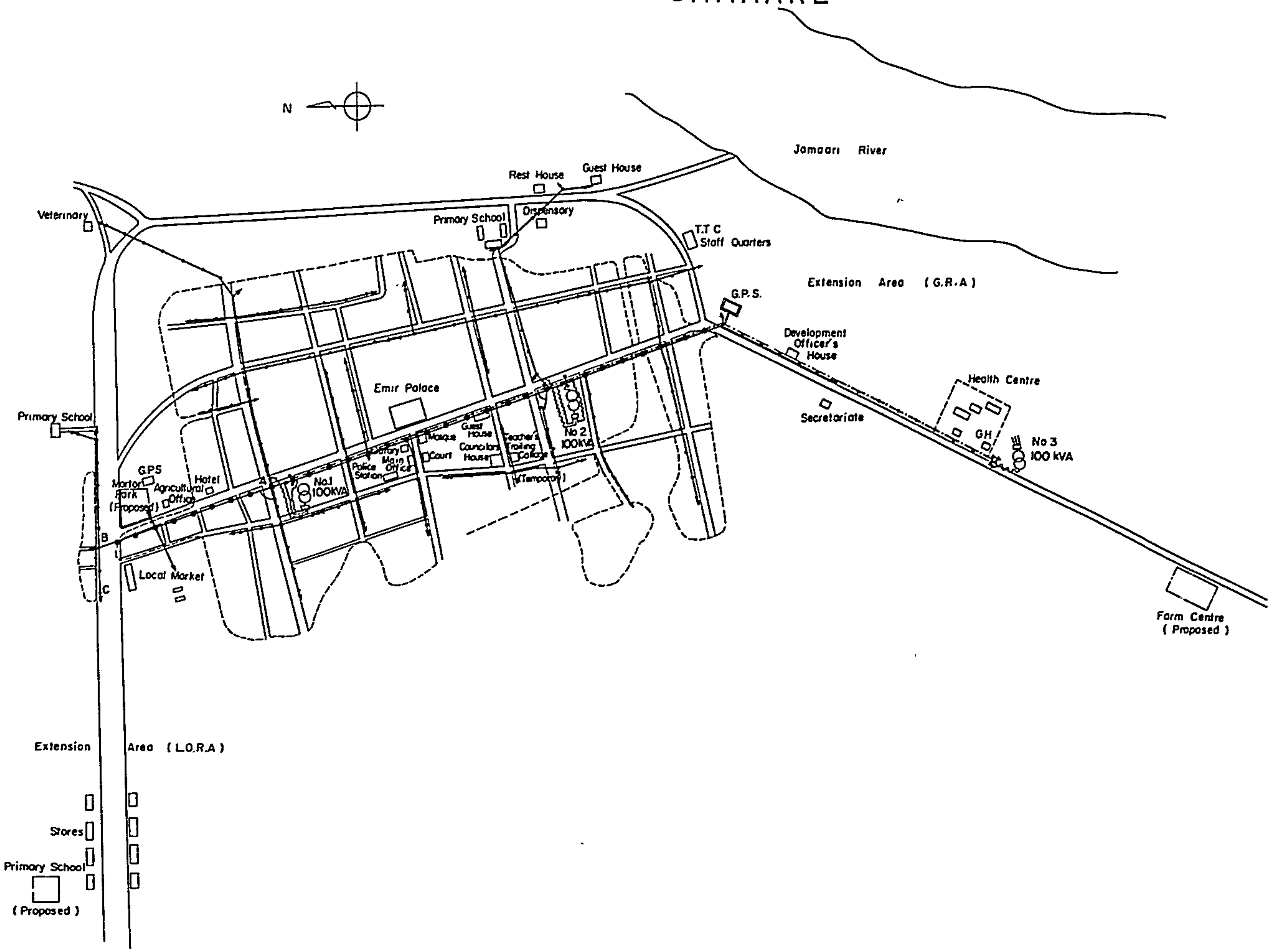
- GPS — Diesel Power Station (First Priority)
- GPS — Diesel Power Station (Second Priority)
- H.V. 3 Phase 3 Wire
- L.V. 3 Phase 4 Wire
- H.V. Underground Cable
- L.V. Underground Cable
- Single Pole
- H. Pole
- Pole with Street Light
- L.V. Section Pole
- Pole with Angle Stay
- Pole with Flying Stay
- Transformer and Feeder Pillar
- Existing Town Area
- Main Building (Existing)
- Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE. NIGERIA

DARAZO TOWN ELECTRIFICATION

JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN	SCALE	DATE 10. 5 75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State	No NE02	DWG n.I.
		CKD T.M.

JAMAARE



NOTES

1. L.V. system shall be 3 phase 4 wire up to the end of L.V. lines.
2. The conductors of H.V., L.V. and street lighting shall be all aluminum 50 mm².
3. The poles with H.V. lines or dual (H V. + L.V) lines shall be 10 m, and the poles with L.V. lines shall be 8 m. But the poles between A and B, and B and C shall be 10 m for future demand.
4. H.V. insulators of intermediate and angle poles shall be mainly of pin type and H.V. insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformers and feeder pillars shall be provided at the secondary side of the transformers above-mentioned
6. Lightning arresters shall be provided both on the primary side of transformers, at the H V. feeding points and the lines each with the interval of 500 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V. and dual (H V. + L.V) construction.

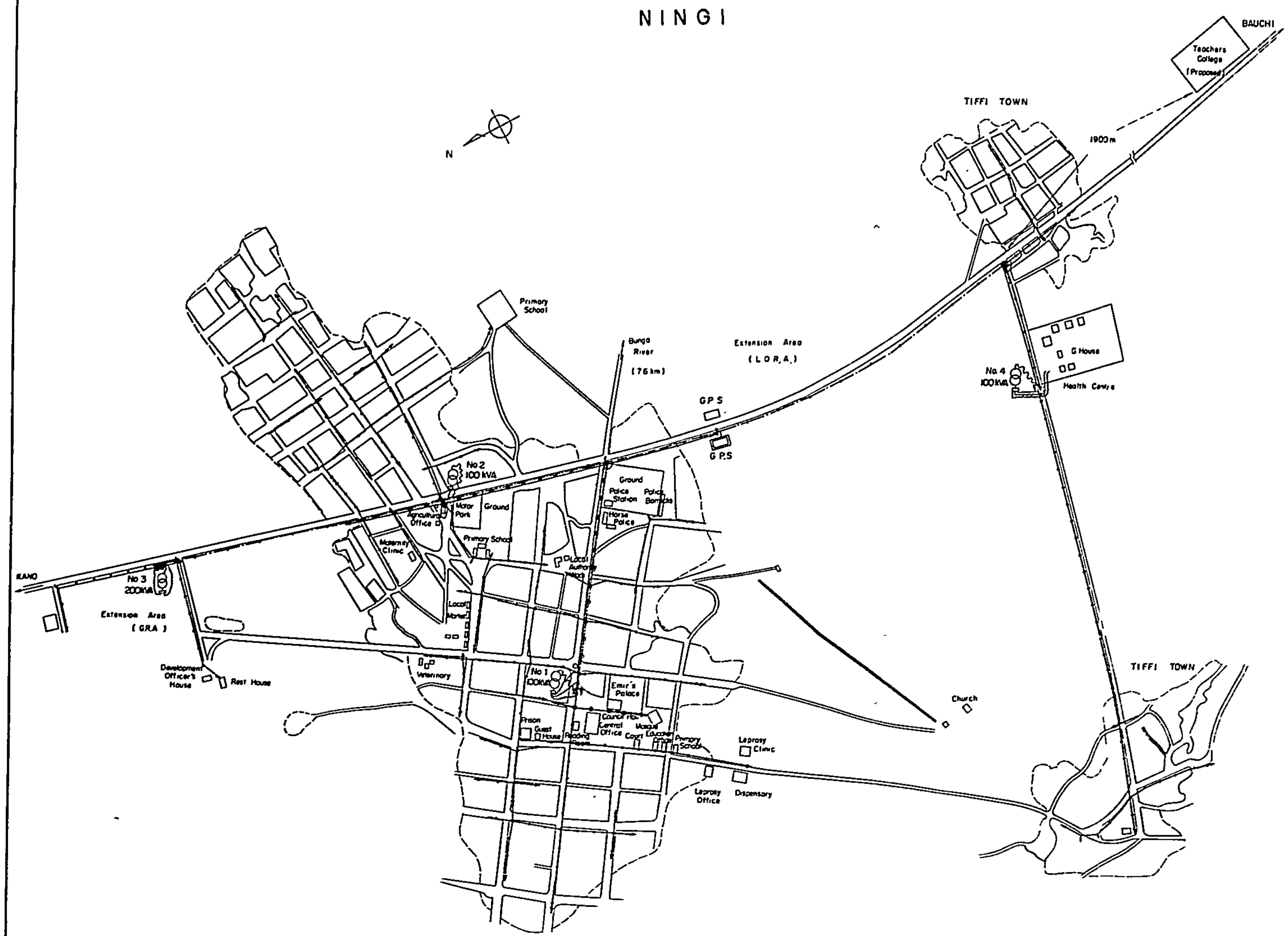
LEGEND

- GPS Diesel Power Station (First Priority)
- GPS Diesel Power Station (Second Priority)
- H. V 3 Phase 3 Wire
- L. V. 3 Phase 4 Wire
- H V Underground Cable
- L. V. Underground Cable
- Single Pole
- H. Pole
- Pole with Street Light
- L. V Section Pole
- Pole with Angle Stay
- Pole with Flying Stay
- Transformer and Feeder Pillar
- Existing Town Area
- Main Building (Existing)
- Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE. NIGERIA

JAMAARE TOWN ELECTRIFICATION

JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN	SCALE	DATE 10. 5. 75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State	No NE03	DRN [illegible] / CHD [illegible]



NOTES

1. L.V. system shall be 3 phase 4 wire up to the end of L.V. lines.
2. The conductors of H.V., L.V. and street lighting shall be all aluminium 50 mm².
3. The poles with H.V. lines or dual (H V. + L.V.) lines shall be 10 m, and the poles with L.V. lines shall be 8 m.
4. H.V. insulators of intermediate and angle poles shall be mainly of pin type and H.V. insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformers and feeder pillars shall be provided at the secondary side of the transformers above-mentioned.
6. Lightning arresters shall be provided both on the primary side of transformers, at the H.V. feeding points and the lines each with the interval of 500 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V. and dual (H.V.+ L.V.) construction.

   Span length for only H.V. construction shall generally be 80 m, but shall not be greater than 90 m.

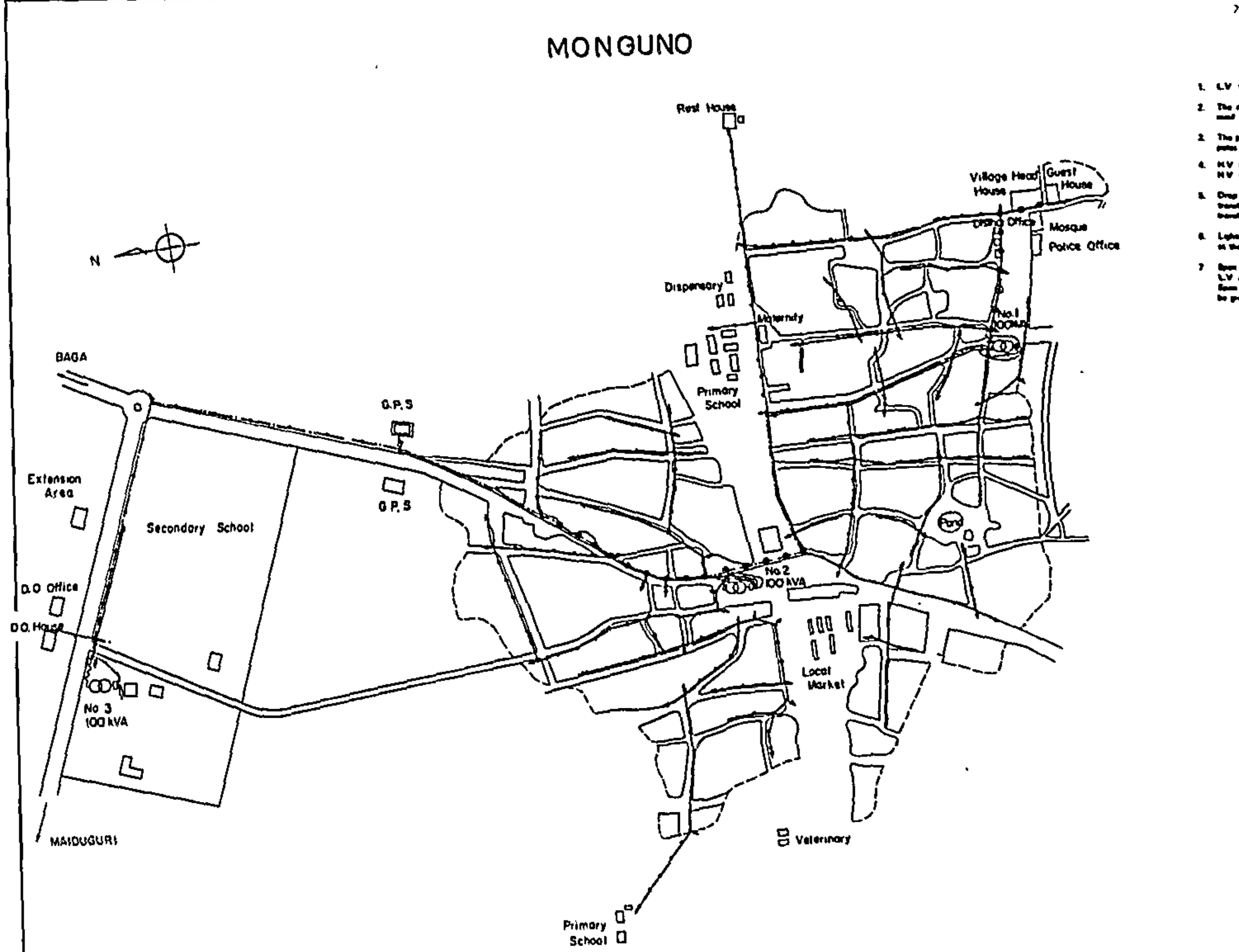
LEGEND

- GPS — Diesel Power Station (First Priority)
- GPS — Diesel Power Station (Second Priority)
- H.V 3 Phase 3 Wire
- L.V. 3 Phase 4 Wire
- H.V. Underground Cable
- L.V. Underground Cable
- Single Pole
- H. Pole
- Pole with Street Light
- L.V. Section Pole
- Pole with Angle Stay
- Pole with Flying Stay
- Transformer and Feeder Pillar
- Existing Town Area
- Main Building (Existing)
- Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA

NINGI TOWN ELECTRIFICATION

JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN	SCALE	DATE 10. 5. '75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State	No NE 04	DWN / CHD



NOTES

LEGEND

H.V 3 Phase 3 Wire

L.V 3 Phase 4 Wire

H.V Underground Cable

L.V Underground Cable

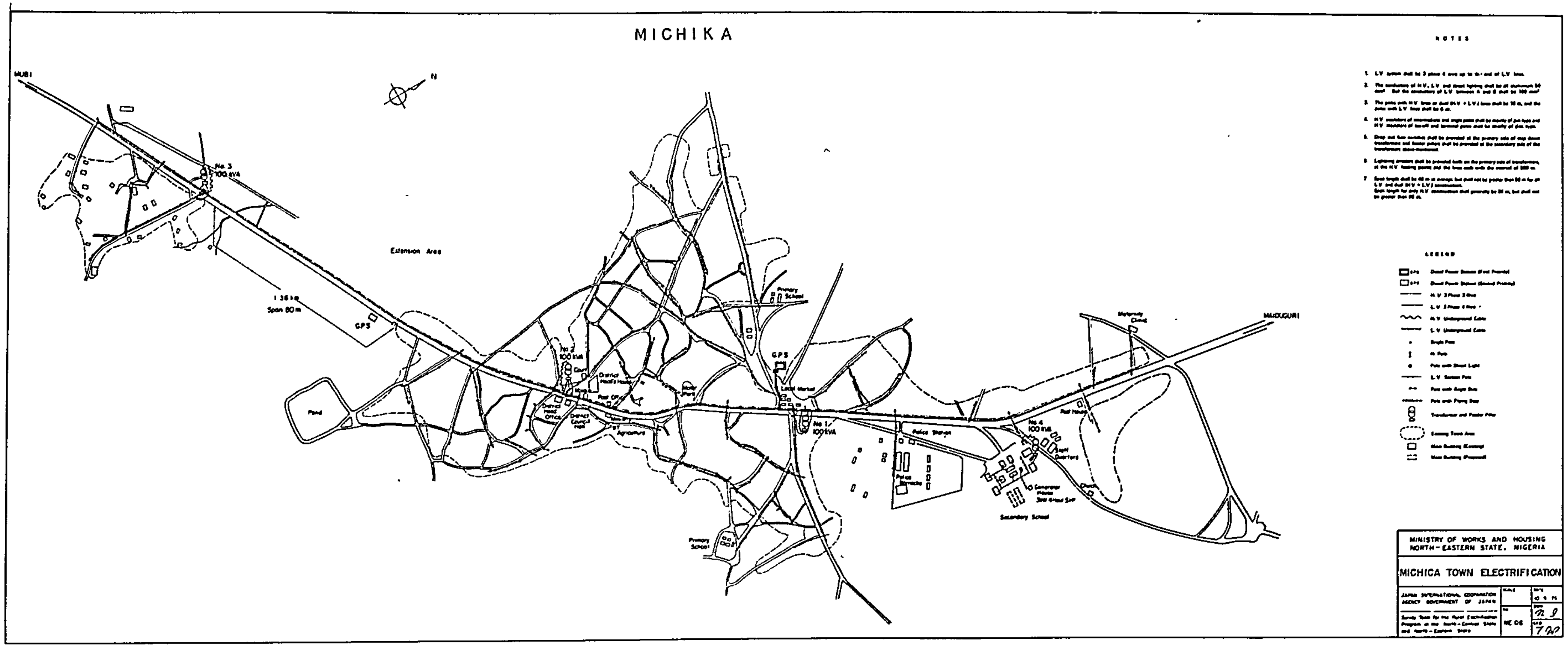
MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA

MONGUNO TOWN ELECTRIFICATION

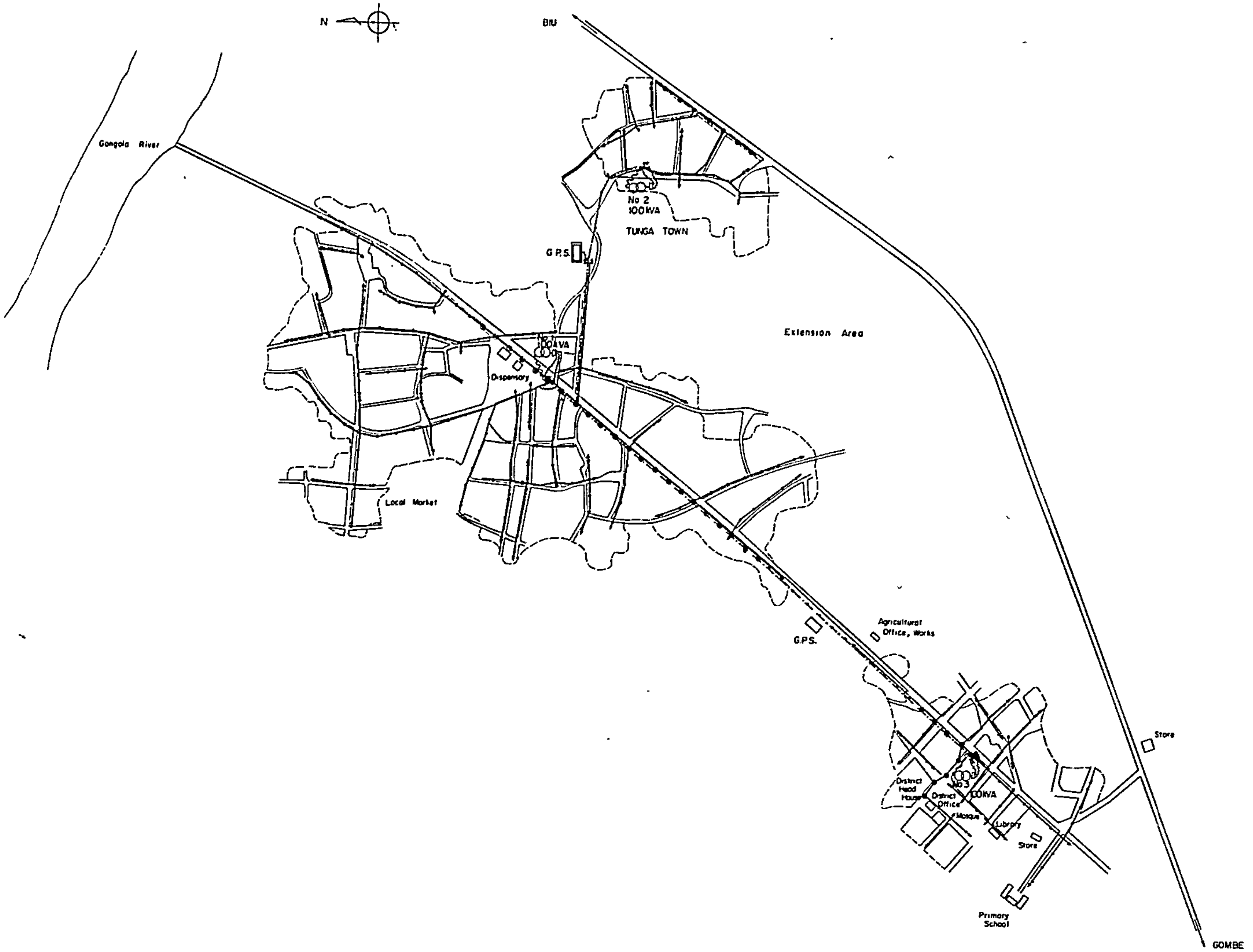
JAPAN INTERNATIONAL COOPERATION AGENCY GOVERNMENT OF JAPAN

Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State

SCALE	DATE 10 5 75
No NE 05	DRN
	CHD


MICHIKA
MUBI
N
No. 3
100 kVA
1.36 km
Span 80 m
GPS
Extension Area
No. 2
100 kVA
Court
District Head's House
Mosque
Post Office
District Head Office
District Council Hall
Agriculture
Pond
Motor Park
Primary School
GPS
Local Market
No. 1
100 kVA
Police Station
Police Barracks
Primary School
Maternity Clinic
MAIDUGURI
Rest House
No. 4
100 kVA
Staff Quarters
Generator House
Secondary School
Church
NOTES
LEGEND
MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA
MICHICA TOWN ELECTRIFICATION
NE 06

DADIN KOWA



NOTES

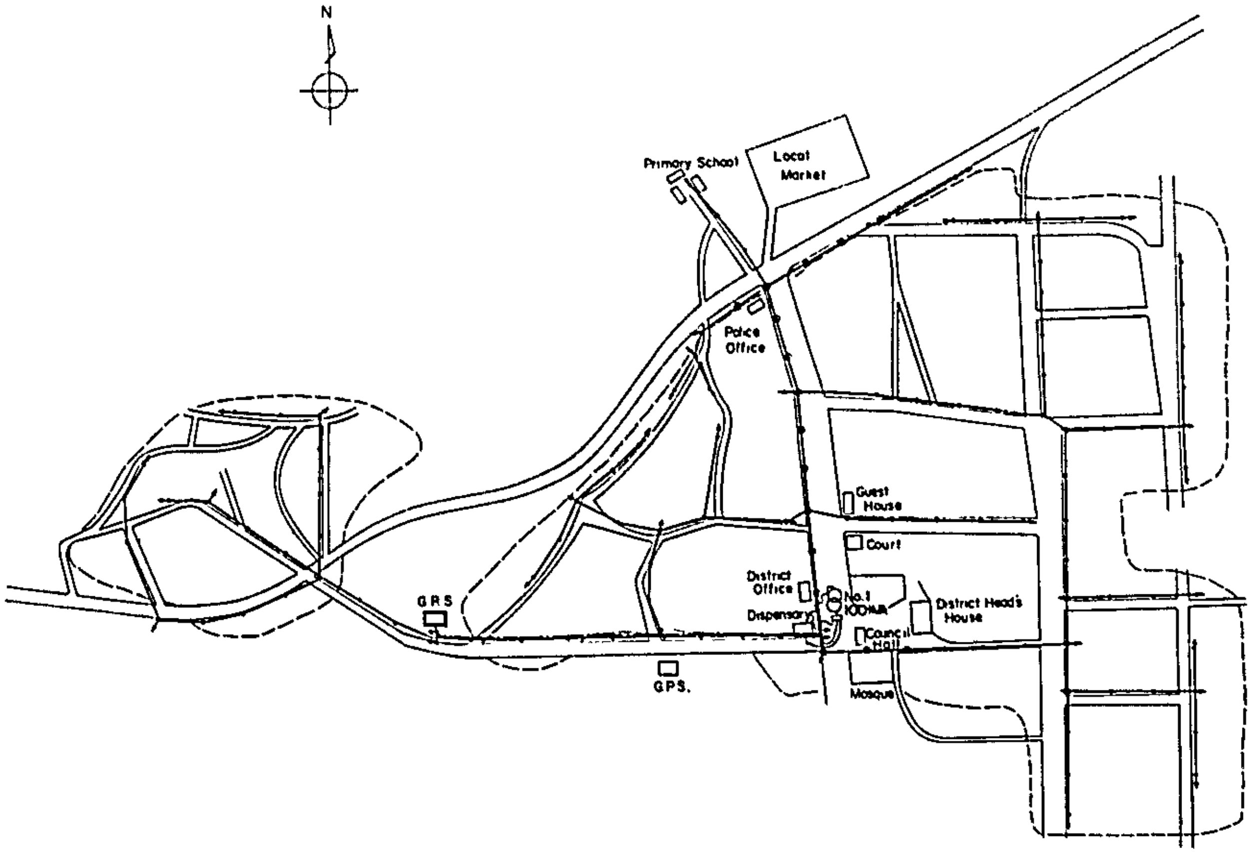
1. L.V. system shall be 3 phase 4 wire up to the end of L.V. lines.
2. The conductors of H.V., L.V. and street lighting shall be all aluminum 50 mm^2.
3. The poles with H.V. lines or dual (H.V. + L.V.) lines shall be 10 m, and the poles with L.V. lines shall be 8 m.
4. H.V. insulators of intermediate and angle poles shall be mainly of pin type and H.V. insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformers and feeder pillars shall be provided at the secondary side of the transformers above-mentioned.
6. Lightning arresters shall be provided both on the primary side of transformers, at the H.V. feeding points and the lines each with the interval of 600 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V. and dual (H.V. + L.V.) construction.
   Span length for only H V. construction shall generally be 80m, but shall not be greater than 90m.

LEGEND

G.P.S.	Diesel Power Station (First Priority)
G.P.S.	Diesel Power Station (Second Priority)
	H. V. 3 Phase 3 Wire
	L. V. 3 Phase 4 Wire
	H. V. Underground Cable
	L. V. Underground Cable
	Single Pole
	H. Pole
	Pole with Street Light
	L. V. Section Pole
	Pole with Angle Stay
	Pole with Flying Stay
	Transformer and Feeder Pillar
	Existing Town Area
	Main Building (Existing)
	Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING NORTH-EASTERN STATE, NIGERIA		
DADIN KOWA TOWN ELECTRIFICATION		
JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN	SCALE:	DATE. 10. 5. 75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State.	No. NE07	DWN: N.J. CKD: T.R.

SHIRA



NOTES

1. L.V system shall be 3 phase 4 wire up to the end of L.V lines.
2. The conductors of H.V., L.V and street lighting shall be all aluminium 50 mm²
3. The poles with H.V lines or dual (H.V + L.V.) lines shall be 10 m, and the poles with L.V lines shall be 8 m.
4. H.V insulators of intermediate and angle poles shall be mainly of pin type and H.V insulators of tee-off and terminal poles shall be chiefly of disc type.
5. Drop out fuse switches shall be provided at the primary side of step down transformer and feeder pillar shall be provided at the secondary side of the transformer above mentioned.
6. Lightning arresters shall be provided both on the primary side of transformer at the H.V feeding points and the lines each with the interval of 500 m.
7. Span length shall be 40 m in average, but shall not be greater than 50 m for all L.V and dual (H.V + L.V.) construction.

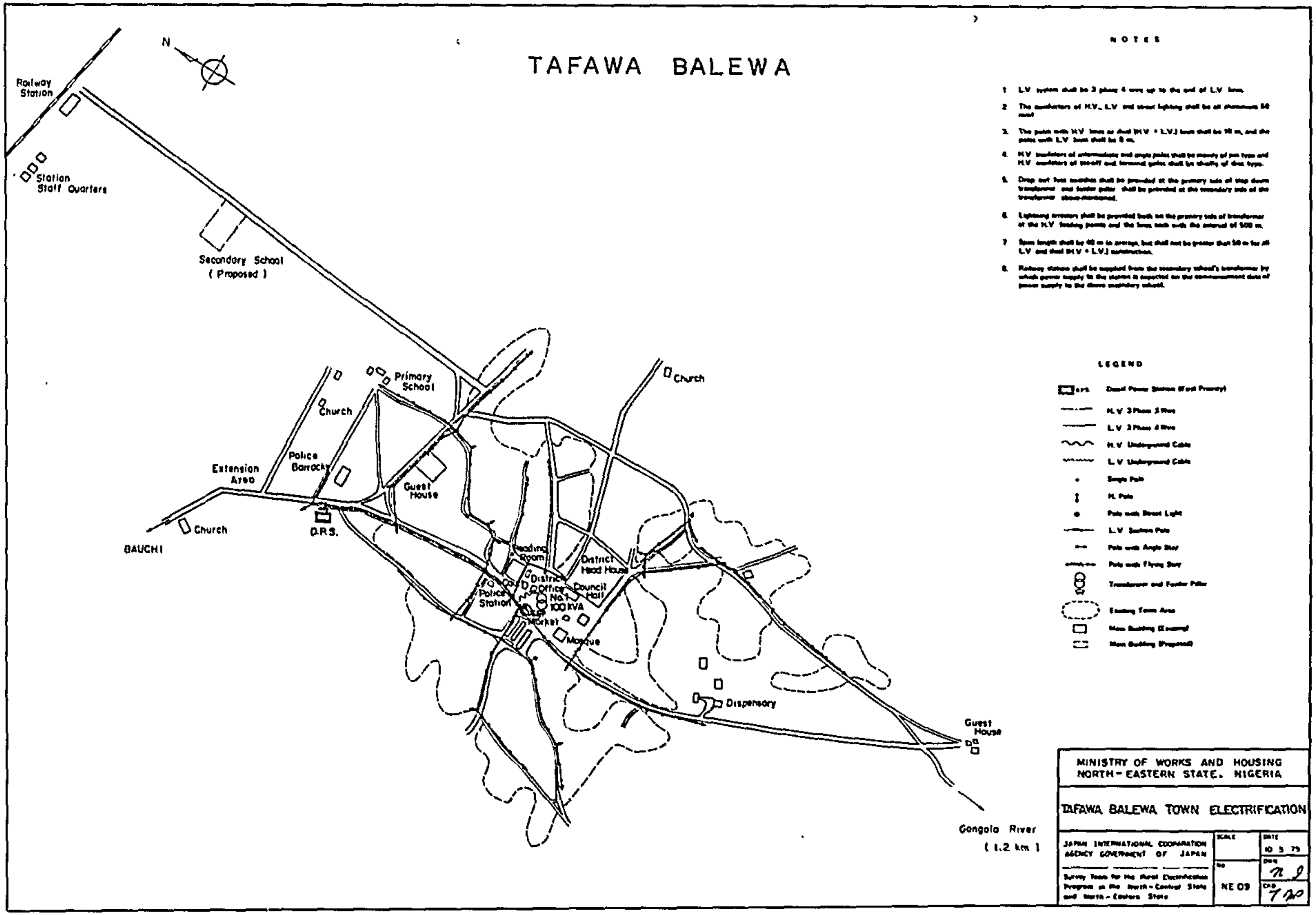
LEGEND

- DPS — Diesel Power Station (First Priority)
- DPS — Diesel Power Station (Second Priority)
- H.V 3 Phase 3 Wire
- L.V 3 Phase 4 Wire
- H.V Underground Cable
- L.V Underground Cable
- Single Pole
- H. Pole
- Pole with Street Light
- L.V Section Pole
- Pole with Angle Stay
- Pole with Flying Stay
- Transformer and Feeder Pillar
- Existing Town Area
- Main Building (Existing)
- Main Building (Proposed)

MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA

SHIRA TOWN ELECIRIFICATION

JAPAN INTERNATIONAL COOPERATION AGENCY GOVERNMENT OF JAPAN	SCALE	DATE 10 3 75
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State	No. NE 08	DWN n. J
		CHD T. Q


TAFAWA BALEWA
N
Railway Station
Station Staff Quarters
Secondary School (Proposed)
Primary School
Church
Church
Church
Church
Police Barracks
Extension Area
BAUCHI
D.R.S.
Guest House
Reading Room
District Head House
District Office
Council Hall
Court
Police Station
No. 1 100KVA
Market
Mosque
Dispensary
Guest House
Gongola River (1.2 km)
NOTES
LEGEND
H.V 3 Phase 3 Wire
L.V 3 Phase 4 Wire
H.V Underground Cable
L.V Underground Cable
MINISTRY OF WORKS AND HOUSING
NORTH-EASTERN STATE, NIGERIA
TAFAWA BALEWA TOWN ELECTRIFICATION
JAPAN INTERNATIONAL COOPERATION AGENCY GOVERNMENT OF JAPAN
SCALE
DATE
NE 09