

(2) 質 問 表

THE PRELIMINARY STUDY
ON
POWER TRANSMISSION
AND
DISTRIBUTION NETWORK PROJECT FOR HARARE AND BULAWAYO
IN
THE AREA
OF
THE REPUBLIC OF ZIMBABWE

QUESTIONNAIRE

JULY 1990

PRELIMINARY STUDY TEAM
OF
JAPAN INTERNATIONAL COOPERATION AGENCY

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1. SOCIOECONOMIC SITUATION IN ZIMBABWE

INR : (in the report)

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
1-1. Maps of Zimbabwe	1-1-1. Maps of Zimbabwe on an appropriate scale	o	1-1
1-2. Population	1-2-1. Past records of population by regions (for the latest 10 years)	o	1-4
	1-2-2. Past records of immigration and emigration (for the latest 10 years)	o	1-9
	1-2-3. Forecasts of population by regions	-	1-2 (1982)
1-3. Economic Situation	1-3-1. Past records of economic indices (for the latest 10 years)		
	(a) Gross domestic product (GDP) by sectors		1-5
	(b) Gross national product (GNP)		1-6
	(c) National income		
	(d) Government revenue and expenditure	o	1-7
	(e) Balance of trade		
	(f) Export and import by type of commodities		
	(g) Balance of international payment		1-8
	(h) Outstanding foreign debts		
	(i) Foreign currency reserves		1-13
	(j) Consumer price index		
	(k) Wholesale price index		
	(l) Exchange rate		
	(m) Employment by sectors		
	(n) Unemployment ratio		

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
1-3-2.	Past records of energy production and consumption by type of energy resources (for the latest 10 years).	o	INR 1985
1-3-3.	National socioeconomic development plan	o	1-14 5-9 5-7
1-4.	Other Information		
1-4-1.	Meteorological data of the project site		
	<ul style="list-style-type: none"> (a) Temperature (b) Relative humidity (c) Rainfall (d) Rainy season (e) Seismic intensity (f) Max. wind velocity and wind pressure (g) IKL (Isokeraunic level) (h) Numbers of stroke to the ground 	o	1-15
1-4-2.	Ground condition of the project site		
	<ul style="list-style-type: none"> (a) Land elevation (b) Soil (c) Rivers 	o	1-1
1-4-3.	Available port nearest from the Project site		
	<ul style="list-style-type: none"> (a) Port name and country (b) Unloading capacity (c) Seasonal restriction for unloading 	o	

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
1-4-4.	Inland transportation from port to site		
(a)	Limitation of carrying capacity by weight and dimension	o	-
(b)	Recommendable contractor for inland transportation		
(c)	Market prices of carriage		
1-4-5.	Labour cost		
(a)	Daily working hours and wages	o	1-8
(b)	Premium payment for holiday and overtime work		
1-4-6.	Market price	o	1-8

2. GENERAL INFORMATION ON ELECTRIC POWER SUPPLY IN ZIMBABWE

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
2-1. Organization of Electric Power Supply	2-1-1. Administrative organization of electric power supply	o	INR
	2-1-2. Organization of ZESA	o	2-1 2-2
2-2. Year Books of ZESA	2-2-1. Annual report of ZESA	o	2-3 2-4
	2-2-2. Financial statement of ZESA	o	2-3 2-4
2-3. Electric Power Tariff Structure	2-3-1. Electric power tariffs of ZESA	o	2-6
2-4. Present Status of Electrification	2-4-1. Present status of electrification in terms of village (town) and/or household (population) (with indication for each Project area)	o	INR

3. ELECTRIC POWER DEMAND AND SUPPLY IN ZIMBABWE

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
3-1. Past Records of Electric Power Demand and Supply	3-1-1. Past records of energy consumption, contract capacity and number of customers by tariff categories (for the latest 10 years)	o	3-5 (1989) 2-7
	3-1-2. Past records of demand-supply balance (for the latest 10 years)		
	(a) Installed capacity of each power plant	o	3-6 (1990)
	(b) Available capacity of each power plants		
	(c) Peak demand of ZESA		
	(d) Peak demand imported to or exported from ZESA		
	(e) Peak demand exported from ZAMBIA/SOUTH AFRICA and other countries		
	(f) Energy supply of ZESA		
	(g) Energy imported to or exported from ZESA		
	(h) Energy exported from ZAMBIA/SOUTH AFRICA and other countries		
	3-1-3. Monthly peak demand (in the latest year)	o	3-6
	3-1-4. Daily load curves of a week by month (in the latest year)	o	3-1 (holiday) 3-2 (weekday)

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
3-1-5.	List of existing big customers (to mark the customers in the Project areas with "x")		
	(a) Customer name	o	3-7
	(b) Location		
	(c) Contract capacity		
	(d) Peak load		
	(e) Products		
3-2.	Latest Forecasts of Electric Power Demand and Supply		
	3-2-1.	o	5-7 (peak only)
	Forecasts of energy consumption and number of customers by tariff categories		
	3-2-2.		
	Forecast of demand-supply balance		
	(a)	o	5-2 5-11
	Installed capacity of each Power Plants		
	(b)		
	Available capacity of each power plants		
	(c)		
	Peak demand of ZESA		
	(d)		
	Peak demand to be imported to or exported from ZESA		
	(e)		
	Peak demand to be exported from ZAMBIA/SOUTH AFRICA and other countries		
	(f)		
	Available energy generation		
	(g)		
	Energy supply of ZESA		
	(h)		
	Energy to be imported to or exported from ZESA		
	(i)		
	Energy to be exported from ZAMBIA/SOUTH AFRICA and other countries		

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
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3-2-3. List of expected big customers (to mark the customers in the Project areas with "x")

- (a) Customer name
- (b) Location
- (c) Contract capacity
- (d) Peak load
- (e) Products
- (f) Expected year

o

5-12

3.3. Updated Power Development Programme

3-3-1. Programme of power plant expansion until 2010

o

3-8

3-3-2. Programme of transmission line expansion associated with above

4. ELECTRIC POWER FACILITIES IN ZIMBABWE

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
4-1. Power Plants	<p>4-1-1. List of existing, on-going and planned power plants (to mark the power plants in the Project area with "x")</p> <p>(a) Type (hydro, oil thermal, diesel, etc.)</p> <p>(b) Plant name</p> <p>(c) Location</p> <p>(d) Installed capacity</p> <p>(e) Available capacity</p> <p>(f) Hourly generation data of each plant for the latest one week</p> <p>(g) Constants for all existing/on-going/planned connecting transformers to be filled in the attached table 1.</p> <p>(h) Constants for all existing/on-going/planned generators to be filled in the attached table 2.</p> <p>(i) Date of commissioning</p> <p>(j) Manufacturer of major equipment</p> <p>(k) Availability</p> <p>(l) Maintenance days per year</p>	o	INR
4-2. Transmission Lines	<p>4-2-1. List of existing, on-going and planned transmission lines (to mark the lines in the Project area with "x")</p> <p>(a) Voltage</p> <p>(b) Section name</p> <p>(c) Section length</p> <p>(d) Number of circuit</p> <p>(e) Conductor or cable</p> <p>(f) Support</p> <p>(g) Date of commissioning</p>	o	INR

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
4-2-2.	Existing and on-going/planned transmission system diagram single line diagram and tables of line constants to be filled in the attached table 3	o	4-2
4-2-3.	Power flow diagram for the latest one week	o	3-3 (holiday) 3-4 (weekday)
4-2-4.	Grounding system of transmission lines	o	INR
4-2-5.	Protective system of transmission lines	o	INR
4-3-1.	List of existing, on-going and planned substations (to mark the substations in the Project area with "x")	o	4-1 5-5 5-7
(a)	Voltage	o	INR
(b)	Substation name	o	-
(c)	Location (on a map)(with indication of boundary of service area for distribution substation)	o	-
(d)	Installed capacity (fulfill attached table 1 for connection transformers)	o	-
(e)	Date of commissioning	o	-
(f)	Hourly or on-specific-time data of load by each substation for the latest one week	o	-
(g)	Power factors at peak/off-peak hours specified by each distribution substation	o	5-2
(h)	Existing/on-going/planned phase-modifiers	o	-

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
(i)	Distributed power and power factor (phase angle) at system peak of typical weekday to be filled in the attached table 4	o	-
(j)	Manufacture of major equipment	o	INR
(k)	Protective system for distribution lines	o	INR
4-4. Distribution Network	4-4-1. Statistical data of existing, on-going and planned distribution facilities	o	2-3
	(a) Circuit length of distribution lines by voltage levels	o	4-4
	(b) Number of M.V. feeders by voltage levels	o	4-5
	(c) Number and capacity of transformers installed on distribution lines	o	4-5
	4-4-2. Grounding system of distribution networks	o	INR
	4-4-3. Protective system of distribution networks, type of section switches, etc.	o	5-31
4-5. Telecommunication Networks	4-5-1. Existing, on-going and planned telecommunication facilities	o	INR
	(a) Media (Radio, PLC, Cable, etc.)	o	INR
	(b) Frequency	o	INR
	(c) Number of channels	o	INR
	(d) Telecommunication network diagram	o	INR

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
4-6. Load Dispatching System	4-6-1. Existing, on-going and planned load dispatching system	o	INR
4-7. Electric Power System Faults	4-7-1. Electric power system fault records in terms of frequency, duration and number of consumers affected (in the past five years)	o	2-3 2-4 2-5 5-28
	(a) Power plants (b) Transmission lines (c) Substations (d) Distribution Networks		
4-8. Reliability Target of ZESA	4-8-1. Reliability target in terms of frequency and duration per consumer	-	INR

5. DATA AND INFORMATION ON THE PROJECT

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-1. Background of the Project	5-1-1. Existing data, study reports and relevant information on the Project including 5 year plan and long range plan for land use and electrification	o	5-1 5-2 1-14
5-2. Socioeconomic Situation in the Project Areas	5-2-1. Maps of each Project area on an appropriate scale with clear indication of project boundary	o	5-5 5-7
	5-2-2. Past records of population in each Project area (for the latest 10 years)	o	1-4
	5-2-3. Forecasts of population in each Project area	-	-
	5-2-4. Past records of GDP (for the latest 10 years)	-	-
5-3. Electric Power Demand and Supply	5-3-1. Past records of energy consumption, contract capacity and number of customers by tariff categories in each Project area (for the latest 10 years)	o	2-3 2-4
	5-3-2. Forecasts of energy consumption and number of customers by tariff categories in each Project area	o	5-11
	5-3-3. Past records of peak demand at substations (for the latest 10 years)	o	5-2 5-10

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-3-4.	Daily load curves by month at substations in each Project area (in the latest year)	o	5-3 5-4
5-3-5.	Latest hourly records of distribution feeders of typical load in each Project area	o	5-17
5-3-6.	Number of waiting customers by customer categories in each Project area	o	5-12
5-3-7.	Present status of electrification in each Project area and target for each Project areas	o	INR
5-4-1.	Transmission system diagram in the Project areas	o	5-13 5-14 5-15
5-4-2.	Location map showing substations and transmission line routes in the Project areas	o	5-5 5-7
5-4-3.	Single line diagrams and layout drawings of substations in the Project areas	o	5-23 5-24 5-25 5-26
5-4-4.	Distribution network diagram in the Project areas		5-13 5-17 5-20 5-14 5-18 5-21 5-15 5-19 5-22

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-4-5.	Location map showing M.V. distribution line routes, MV switches and M.V./LV transformers in the Project areas	o	5-27
5-4-6.	Distribution network facilities in each Project area by substation		
(a)	Number of M.V. circuit breakers and M.V. feeders by substations	o	2-3
(b)	Circuit length of M.V. distribution lines		2-4
(c)	Number and capacity of M.V./L.V. transformers		
(d)	Circuit length of LV distribution lines		
(e)	Number of M.V. switches		
5-5.	Electric Power System Faults in the Project Area		
5-5-1.	Electric power system fault records in terms of frequency duration and number of consumers affected in each Project area (in the past five years)	o	2-3 2-4 2-5
(a)	Transmission lines		5-28
(b)	Substations		
(c)	Distribution networks		
5-6.	Laws, Regulations, Codes and Standards electric power facilities installation	o	- Electric wiring regulation 196 o - British standard
5-6-1.	Laws, regulations, codes and standards on electric power facilities installation		
(a)	Transmission line		
(b)	Substation		
(c)	Distribution network		

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-7. Design Criteria of ZESA	5-7-1. Design criteria of ZESA (a) Transmission line (b) Substation (c) Distribution network	-	5-29
5-8. Specification of Main Materials and Equipment	5-8-1. Specification of transmission line materials (a) Support (b) Conductor (c) Cable (d) Insulator	-	INR
	5-8-2. Specification of substation equipment (a) Transformer (b) Circuit breaker	-	INR
	5-8-3. Specification of distribution line materials and equipment (a) Support (b) Conductor (c) Cable (d) Insulator (e) Transformer (f) Switch	-	INR

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
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5-9.	Construction Costs of Lately Installed Electric Power Facilities Similar to the Project	5-9-1.	Construction costs of lately installed facilities similar to the Project, with the detailed breakdowns including materials and installation costs
			<ul style="list-style-type: none"> (a) 330 kV overhead line (b) 330 kV underground line (c) 132 kV overhead line (d) 132 kV underground line (e) 330 kV substation of each type (f) 132 kV substation of each type (g) 33 kV substation (h) 88/33/11 kV switching station (i) 33 kV overhead line (j) 33 kV underground line (k) 11 kV overhead line (l) 11 kV underground line (m) 11 kV/LV transformer (n) LV overhead line (o) LV underground line
		o	5-30

5-10.	Locally Available Materials and Equipment and Costs	5-10-1.	Locally available materials and equipment and costs
			<ul style="list-style-type: none"> (a) Transmission line materials (b) Substation equipment and materials (c) Distribution line materials and equipment
		o	INR

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-11. Local Contractors	5-11-1. List of contractors specialized in electric power facilities construction, civil works, building construction, transportation, etc.	-	INR
	(a) Name (b) Speciality (c) Experiences		
5-12. Operation and Maintenance of Electric Power Facilities	5-12-1. Organizations for operation and maintenance (a) Transmission line (b) Substation (c) Distribution network (d) Telecommunication network	o	2-1
	5-12-2. Manuals for operation and maintenance (a) Transmission line (b) Substation (c) Distribution network	-	-
	5-12-3. Operation and maintenance costs (a) Transmission line (b) Substation (c) Distribution network	o	o

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-13. Fixed Cost and Variable Cost of On-going/Planned/Candidated Plants	5-13-1. Fixed cost For each plant: (a) Construction cost (without interest during construction) (b) Construction period (c) Disbursement schedule (d) Fixed O/M cost (\$/kW-year) (e) Life cycle (years) (f) Residual value (%)	0	-
	5-13-2. Variable cost		
	For each plant:		
	(a) Fuel price (\$/bbl) (b) Heat content (MBTU/bbl) (c) Heat rate (MBTU/MWh) or Thermal efficiency (%) (d) Variable O/M cost (%) (e) Station use rate (%)	0	-
5-14. Energy Loss	5-14-1. Loss rate for the latest 10 years (a) Power plant (station use) (b) Transmission line (c) Substation (d) Distribution line	0	2-3

ITEMS	DATA AND/OR INFORMATION	AVAILABILITY	REMARKS
5-14-2.	Loss rate at each project area for the latest 10 years	o	2-3
	(a) Power plant (b) Transmission line (c) Substation (d) Distribution line		
5-15. Major Projects which Affect System Operation	5-15-1. Contents of the projects	o	5-12
	(a) Time schedule (b) Project name (c) Location (d) Peak load (e) Kind of business (f) Loading condition (g) Power factor (h) Voltage flicker condition (i) Independent generator and capacity		
5-16. Power II Project	5-16-1. Scope	o	INR
	(a) Indication of effect on this project (b) Programme and progress		
	5-16-2. Maps indicating above		
	5-16-3. Relevant data		
	(a) Feasibility report (b) Design report (c) Technical specification		

(3) 要請書及び T/R

Telegrams: "MINFIN", HARARE
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ZIMBABWE

A/28/101/17

Reference:

CR A/28/41
MINISTRY OF FINANCE, ECONOMIC
PLANNING AND DEVELOPMENT
Munhumutapa Building
Samora Machel Avenue
Harare

5 October 1989

H.E. Mr. Ken Ikebe
Ambassador
Embassy of Japan
18th Floor - Karigamombe Centre
HARARE

Your Excellency

RE: HARARE AND BULAWAYO MASTER STUDY FOR Z.E.S.A.

The Zimbabwe Electricity Supply Authority (ZESA) intends to carry out a comprehensive distribution studies for Harare (including Chitungwiza) and Bulawayo in order to come up with practical implementation plans for distribution of electricity.

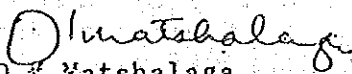
It is expected that this integrated approach will produce benefits through savings in operational costs and capital expenditure. During the execution of project distribution engineers would gain valuable training in their planning and design methods.

The cost of implementing this study is estimated at Z\$ 1.5m inclusive of hardware, software, purchase of tools and equipment, technical assistance and training.

... Please find attached a copy of the Terms of Reference for your information.

On behalf of the Government of Zimbabwe I am officially requesting the Government of Japan for financial assistance to enable ZESA to undertake this study.

Sincerely yours


O. K. Matshalaga
for: SENIOR SECRETARY FOR FINANCE,
ECONOMIC PLANNING AND DEVELOPMENT

MAB/ls

HARARE AND BULAWAYO MASTER PLAN STUDIES

STUDY TERMS OF REFERENCE

1.0. INTRODUCTION

The aim of optimized network planning and operation is the safe, dependable and economic supply of electricity to all consumers. To this end there is a need to carry out comprehensive distribution studies in the two largest cities of Harare (including Chitungwiza) and Bulawayo in order to provide ZESA management with practical implementation plans for distribution expansion to meet the rapid load growths and expected future growths.

The integrated approach to the planning of the distribution systems of Harare and Bulawayo should produce considerable benefits through both savings in operation costs and capital expenditure.

The study should provide valuable training opportunity for Distribution Engineers in their planning and design methods and generally improve the mode of system operation and maintenance procedures of a comprehensive distribution system such as that of Harare and Bulawayo.

1. OBJECTIVES

- 1.1 To review the existing system design and operational procedures and propose a programme of immediate improvements and modifications.
- 1.2 For a range of possible future load growths to the year 2010; prepare a least-cost development programme for a reliable distribution and sub-transmission network.

2. SCOPE OF STUDY

- 2.1 The studies shall cover the entire 132/33/11 kV switching stations and feeders of Harare and Chitungwiza and the 88/33/11 kV switching stations and feeders of Bulawayo as well as the interfacing systems (330 kV bulk supply substations and generating stations) of the Generation and Transmission network.
- 2.2 The studies shall incorporate the findings of the System Development Plan and Power System Stability and Transmission Network Development Plan Studies, modifying their conclusions as appropriate.

3. CONTENTS OF STUDIES

- 3.1 Review of the present reliability standards as well as operation and maintenance procedures, suggesting improvements for a more efficient use of the present system.
- 3.2 Develop detailed spatial load forecasts by sector, tariff category and geographical distribution. The forecasting methodologies must be capable of being used, updated and expanded by ZESA personnel.
- 3.3 Define for the given load forecasts, alternative development scenarios of equivalent reliability and demonstrate the robustness of the development programmes to variations in economic, technical and financial factors.
- 3.4 Investigate and evaluate demand management opportunities, assessment of cross-elasticity of demand with respect to paraffin, candles, coal and firewood for low income consumers.
- 3.5 Calculate, (for selected cases in five - year periods), load flows to determine power flows, losses and voltage conditions under alternative normal and emergency network configurations.
- 3.6 For a range of loading conditions, carry out short circuit and stability studies (transient and steady-state) and provide recommendations on substation fault levels, design fault levels, system and operational configurations, protection settings, earthing methods and insulation co-ordination.
- 3.7 Carry out a loss reduction study and recommend an investment programme to reduce losses.
- 3.8 Make recommendations and advise on locations and sizes of future substations and feeders, including standardised switchgear and transformer ratings.
- 3.9 Using the discounted cash flow method, net present value or other equivalent evaluation method, determine and recommend the least-cost development programme. The study should provide the detailed financial requirements on a yearly basis for the first ten years of the study horizon. Financial costs must be broken down in local and foreign currencies.
- 3.10 Investigate the need or otherwise, of subsidizing connection and house wiring costs and / or including these in the cost of property (and hence payable in installments)
- 3.11 Investigate the current public lighting standards and requirements for Harare, and make recommendations on improvements.

3.12 Highlight major projects (for example the railway electrification) and account for them in recommendations for system improvement.

4.0 INPUTS FROM ZESA

4.1 ZESA will provide access to information, data and drawings already available and which are relevant to the studies.

4.2 DATA INPUT

Data input to the network planning programmes should be via a digitizing system that can accept maps of various scales. Emphasis should be on the production of single line electrical maps of sufficient geographical accuracy to allow current system planning rather than detailed mapping of all facilities. The digitizing system should have at least the following facilities:

- o Continuous mapping facility with retrieval by window coordinate or primary substation.
- o Data base able to store:
 - Circuit types and layout
 - Primary substation transformers
 - Feeder regulators and capacitors
 - Switches
 - Protective devices
 - Basic system costs and economic parameters
 - Loads in various forms

5.0 REPORTS FROM CONSULTANTS

5.1 An initial report summarizing the methodology to be used, availability of data, relevance of individual studies, organization and schedule of study work shall be presented within 2 months following the contract signing. The report should include a work program so that ZESA can work out periods for staff assignment accordingly.

5.2 An interim report containing the findings in brief with any important and urgent recommendations, plans for balance work etc., shall be provided within 4 months of the commencement of the studies.

5.3 A final report showing all works performed, data collected and the recommendations made, including investment programme, drawings, diagrams, results of study, calculations etc. shall be submitted within 8 months following the commencement date. The final report should include an assessment of the staff trained.

5.4 An actual bill of quantities and specifications to be

provided for immediate use in tender documents.

6.0 GENERAL

6.1 TECHNOLOGY TRANSFER & TRAINING

A team of ZESA personnel shall be associated during the entire period of the study. Necessary training shall be imparted to them so that ZESA will be in a position to update the findings in future. Towards this, the computer hardware and software employed for studies shall be provided to ZESA and ZESA's personnel duly trained in their use.

6.2 DATA AND INFORMATION

All data and information collected for purposes of the studies shall all be handed over to ZESA, suitably documented. These shall become ZESA's property with full freedom to use for whatever purpose.

6.3 REPORTS

The initial report shall be submitted in 15 copies, the interim report in 15 copies and 50 copies of the final report shall be submitted. In addition, 50 copies of an "Executive Summary" shall be submitted. The report text shall also be provided in a machine readable format.

7.0 ADJUDICATION OF TENDERS

Evaluation will be based on the following weighting factors:

(a) Firm's experience	20%
(b) Quality of personnel	30%
(c) Work programme and study methodology	30%
(d) Training and technology transfer	20%

8.0 REQUIREMENTS OF CONSULTANTS

Consultants should have experience in the application of the integrated approach to distribution planning as described above and use of software that implement the method. A knowledge of the basic fundamentals through research or other analytical studies should be demonstrated through past references of similar master plan studies.

