FE
FOUNDATION ENGINEERING
Services Limited
Geotechnical Consultancy, Construction Quality Assurance Specialists
RC. 142630

Office:
174, Western Avenue, Iganmu,
P. O. B. 2100, LAGOS.

Telephone: LAGOS 801770-2, 835393
Telegrams: FOUNDENG, EBUTE-METTA
Cables: FOUNDATIONS, LAGOS
Telex: 26979 OR 26988.

MESSRS YACHIYO ENGINEERING CO. LIMITED

PROPOSED PROJECT FOR RURAL ELECTRIFICATION
AT KALSHINGI CITY, GOMBE STATE,
FEDERAL REPUBLIC OF NIGERIA

REF.: S.10903/JUNE, 2000

REPORT ON SUBSOIL INVESTIGATION

Carried Out By:-

FOUNDATION ENGINEERING SERVICES LIMITED,
P. O. BOX 2100,
LAGOS.

FE

MESSRS YACHIYO ENGINEERING LIMITED

PROPOSED PROJECT FOR RURAL ELECTRIFICATION

AT KALSHINGI CITY, GOMBE STATE,

FEDERAL REPUBLIC OF NIGERIA

REPORT ON SUBSOIL INVESTIGATION

1. INTRODUCTION

Further to your letter of award reference YEC-BRG-FDN01 dated 18th May 2000, Foundation Engineering Services Limited carried out a subsoil investigation at Kashingi city in Akko Local Govt. area of Gombe State for the above proposed project. The purpose of the investigation was to provide data on subsoil conditions for foundation design.

The following is our report on the investigation.

2. SCOPE OF INVESTIGATION

2.1 Site Work

The site work was carried out on 2nd and 3rd June, 2000. The defined scope of site work required comprised 1 No. shell and auger borehole put down to the specified 10.0m depth as requested by yourselves and the survey of the boring position to determine

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the height above mean sea level (MSL) with reference to an established bench mark.

A pilcon Wayfarer 1500 rig with B.S. 5930 shell and auger percussion boring techniques was used to bore through the soil deposits. Both disturbed and undisturbed soil samples were taken and standard penetration tests (SPT) carried out at regular intervals of 1.0m depth as appropriate.

An area map showing kalshingi city is presented as Figure 1 while a site plan (based on the sketched site layout drawing provided by the client) indicating approximate position of the borehole as selected by yourselves and set out by ourselves is presented as Figure 2.

Borehole log giving details of the strata encountered at the site is presented as Figure 3.

All depths referred to in this report are below ground surface at the time of the investigation and are approximate.

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2.2 Laboratory Testing

Laboratory tests relevant to the engineering objectives of the investigation were Scheduled on selected samples retrieved from the borehole. The tests were carried out in general accordance with B.S. 1377; 1990. "Method of Test for Soils for Civil Engineering Purposes"; Parts 1 - 9 unless otherwise stated. The results are presented in tabular and graphical forms in the Appendix.

The following tests were carried out:-

3 No.	Particle size distribution by wet sieving
3 No.	Hydrometer Analysis
2 No.	Natural moisture content
2 No.	Quick Undrained Triaxial compression test on 38mm diameter undisturbed sample
2 No.	Unconfined Compression Test on 38mm diameter undisturbed sample
5 No.	Atterberg limit determination on material passing 425 micron sieve
1 No.	Chemical Analysis of soil samples for hydrogen ion concentration (pH) and soluble sulphate content

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2 No. One-dimensional oedometer consolidation Test diameter compressibility characteristic. In calculating the coefficient of consolidation (Cu) "The square root of Time fitting" method was adopted.

3.0 GEOLOGY OF THE SITE

The site is generally flat, uncultivated dotted with few trees and flowers near a school compound. The 1:2,000,000 Geological Map of Nigeria compiled by the Geological survey of Nigeria, 1974 Edition, indicates that the site is underlain by sandstone, siltstone, shale and ironstone of Gombe sandstone grownup of the cretaceous period. The results of the investigation are generally concordant with the overburden soils associated with the description of the site geology.

4.0 SUBSOIL AND GROUNDWATER CONDITIONS

Details of the subsoil strata encountered during boring are given on the borehole log. However, the subsoil sequence may then be generally summarised as follows:-

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Depth Below Ground Level (m)		Generalised Strata Description
From	To	
Ground Level	1.25	Stiff slightly sandy (cmf) silty CLAY
1.25	7.0	Very stiff/Hard silty CLAY with fragment of concretion/ claystones
7.0	10.0 (Borehole Termination)	Predominantly concretion (Hardpan/Ironstone)

*Variations in strata thickness and depths away from the borehole are likely.

Groundwater seepage was not encountered in the borehole during the period of investigation. However seasonal variations in groundwater level may occur, with possible development of perched water table within the clayey or indurated layers during or immediately after the wet seasons.

5.0 LABORATORY TEST RESULTS

Particle size analysis carried out on 3 No. samples of the overburden clayey deposits gave the range of gravel fraction to be 1% to 7%, sand 34% to 41%, silt and clay 39% to 50% by weight.

Detailed results are presented on the summary sheet and graphically on the particle size distribution curves in the Appendix.

The index properties of the clayey deposits were investigated by means of Atterberg Limits tests. The natural moisture content (W) ranged between 10% and 15%, Liquid Limit (WL) ranged from 43% to 51%, Plastic Limit (WP) was indicated to range between 14% and 22% while the Plasticity Index (IP) was 25% to 35%. These results indicate high plasticity.

The liquidity index (IL), equals to the moisture content (W) minus plastic limit (WP) divided by Plasticity Index (IP), for the various samples tested was computed. A normally consolidated clay has a moisture approaching the liquid limit with a Liquidity Index tending to unity, while an over consolidated clay has a moisture content around the plastic limit with a liquidity index of approximately zero or negative. The 5 No. samples considered gave IL values of between -0.342 and -0.111. These indicate the clay to be over-consolidated.

Shear strength of the encountered cohesive deposits was investigated by means of quick Undrained Triaxial Compression Test and Unconfined Compression Test on undisturbed samples. The

Undrained Cohesion (Cu) was indicated to range between 250 and 300 kN/m^2 while the angles of internal friction (Øu) varied between 8 and 10 degrees. The unconfined compression test was indicated to range between 334 kN/m^2 and 452 kN/m^2. These results indicate the clays to be generally very stiff/Hard consistency.

For these deposits the bulk wet density varied between 2.09 and 2.26 Mg/m^3.

Deformation characteristics of the clayey deposits was determined in an oedometer apparatus. The coefficients of consolidation (Cv) and compressibility (Mv) at various overburden pressures are presented on the summary table. The results indicate that the clays are of low compressibility. The graphs of voids ratio/log of effective pressure relationship for the samples tested are presented in the Appendix.

The aggressiveness of the soil deposits to concrete was assessed by the determination of hydrogen ion concentration (pH) and soluble sulphate content of 1 No. sample The pH value was 6.0 indicating slightly acidic conditions, while the water soluble sulphate content was indicated to be very low (0.005 gr/litre).

From the survey work carried out at the boring position (Borehole 1).

The following values are tabulated below in table 1.

Station	Starting Point and Height above the Mean Sea Level (MSL) (m)	Distance Covered (m)	Height of Boring Station above Mean Sea Level (MSL) (m)	Height of Temporary Bench Mark (m)
Kalshingi City	Trig. Station ML 302 483.104m	12	390.552	TBM1 = 392.552

Note: More detailed survey report is presented in the Appendix.

6.0 FOUNDATION DISCUSSION

6.1 Design Details

It is understood that it is proposed to install a transformer of about 12 ton (120 kN). No further details have been made

available to us. However, for the purpose of this report, we have assumed a maximum overall ground loading of 60 kN/m^2.

The following comments and recommendations are based on the borehole log and on the results of the laboratory tests.

6.2 Shallow Foundation

The results of in-situ and laboratory test carried out indicate the presence of stiff to very stiff sandy within the top 1.0m to 2.0m depth within which a shallow foundation can be set.

However, it is recommended that reinforced concrete strip or pad foundation may be adopted for supporting the structure at the site. The foundation should not be less than 1m wide and set at not shallower than 1m depth in order to avoid problems of seasonal moisture variations/erosion and on undisturbed virgin stiff to very stiff/Hard sandy clay.

As a guide, it is estimated that the net allowable bearing pressures that may be imposed at different founding depths are as shown in Table 2 below.

These Figures have taken into consideration the relief provided by the overburden assumed to be removed above the founding level.

Founding Depth (m)	Allowable bearing Pressure (kN/m^2)
1.0	120
1.50	220
2.0	240

Table 2. Estimated Allowable Pressure for shallow Foundation.

6.3 Settlement

Settlement of strip or pad foundations constructed to the standards, loading and depths stated above is estimated to be less than 20mm with differential settlement not exceeding half the total settlement.

6.4 Foundation Preparation

The base of the foundation excavation must be carefully probed and inspected for soft pockets which, if encountered, must be completely removed and replaced with well compacted relatively dry lean mix concrete or the excavation taken deeper.

Immediately after preparation, the foundation level must be protected with a blinding layer of concrete as the soil may loosen if left exposed or if ingress of water is allowed.

Backfilling to the sides of the foundation should be placed to ground level as soon as possible following casting of the foundation. Backfilling of excavations around completed foundations should be with suitable material placed in thin layers not exceeding 200mm thickness and compacted to a high standard.

7.0 GENERAL

The subsoil conditions are indicated to be slightly acidic, with negligible concentrations of soluble sulphates. Ordinary Portland cement may therefore be used for buried concrete but a rich, dense mix is recommended.

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We strongly recommend that the design and construction of all foundation and earthworks be carried out in accordance with a good engineering practice as embodied in recognised Codes of Practice such as the British Standards Institution's B.S. 8004: 1986, Code of Practice for Foundations and B.S. 6031: 1981, Code of Practice for Earthworks.

We trust you find the contents of this report of assistance and assure you of our best attention at all times.

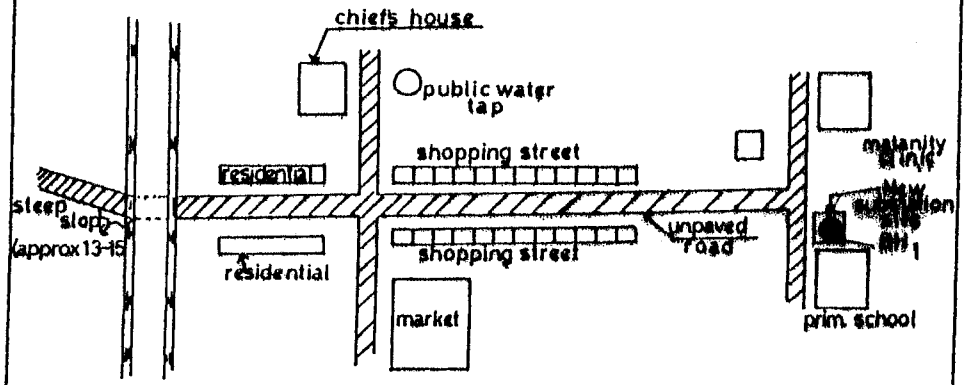
Philip C. Nwamu,
Chief Geologist.

Prince Wale Ajayi-Fajomodu,
Managing Director.

FOUNDATION ENGINEERING SERVICES LIMITED,
P. O. BOX 2100,
LAGOS.

REF.:S10903/JUNE, 2000.

FIG. 2



Proposed Project For Rural Electrification
At Kalshingi City, Gombe State.

LOCATION MAP

KEY

:- Borehole Postion.

(S10903)

Foundation Engineering Services Limited

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FIG. 3

BOREHOLE LOG

LOCATION : PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE

JOB No : S10903

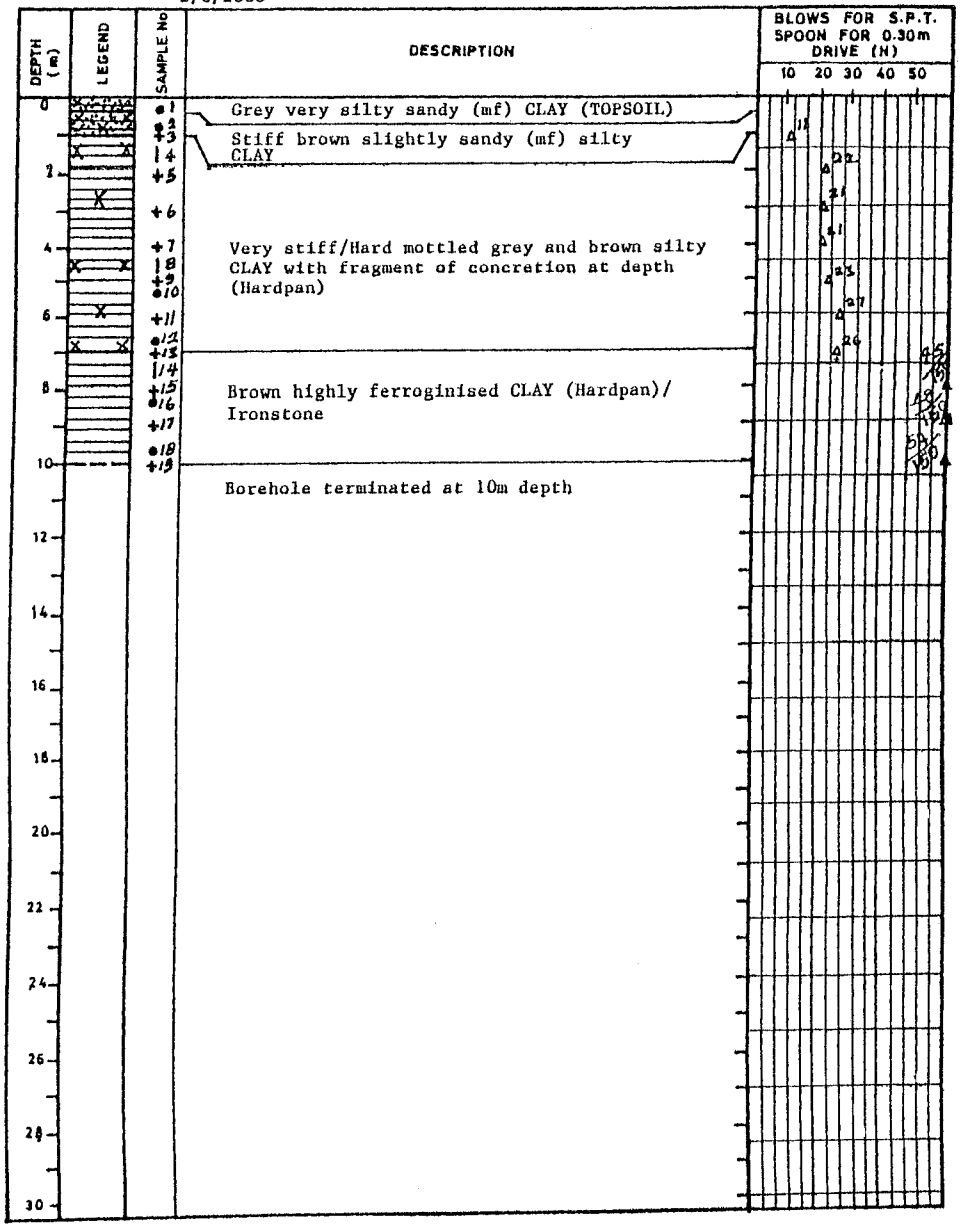
BOREHOLE DIA : 0.20m & 0.15m

DATE (Start) : 2/6/2000

BOREHOLE No : 1 (KALSHINGI)

GROUND LEVEL : 390.552m (ABOVE MSL)

GROUND WATER : DRY



FOUNDATION ENGINEERING SERVICES LTD

Summary of Laboratory Test Results.

LOCATION: PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI CITY, GOMBE STATE

CONTRACT No: S10903

SHEET:- 1 OF 1

BOREHOLE/ SAMPLE No.	TYPE	DEPTH m	PARTICLE SIZE DISTRIBUTION % PASSING 2·00 mm	425 µm	63 µm	2 µm	NAT M.C % dw	ATTERBERG LIMITS LL % dw	PL % dw	PI % dw	γdB Mg/m³	S.G.	QUICK UNDRAINED TRIAXIAL TESTS dia (mm) type	σ3 kN/m²	Cu kN/m²	φu deg	LAB VANE Su kN/m²	OEDOMETER CONSOLIDATION STRESS RANGE kN/m²	Mv m²/MN	Cv m²/yr	pH	SO3 (s) gr/litre	SO3 (w) pp 10⁵	Unconfined Compressive Strength (kN/m²)
1/3	D	1.0	99	85	58	46	14	51	20	31														
1/4	U	1.5					11	41	14	27	2.09		38					50-100	0.107	3	6.0	0.005		334
														100	250	10		100-200	0.105	3				
														200				200-400	0.082	2				
1/5	D	2.0	99	91	62	50	15	57	22	35														
1/9	U	4.5					10	43	15	25	2.26		38					50-100	0.103	3				452
														100	300	8		100-200	0.091	3				
														200				200-400	0.073	3				
1/11	D	6.0	83	67	49	39	15	48	20	28														

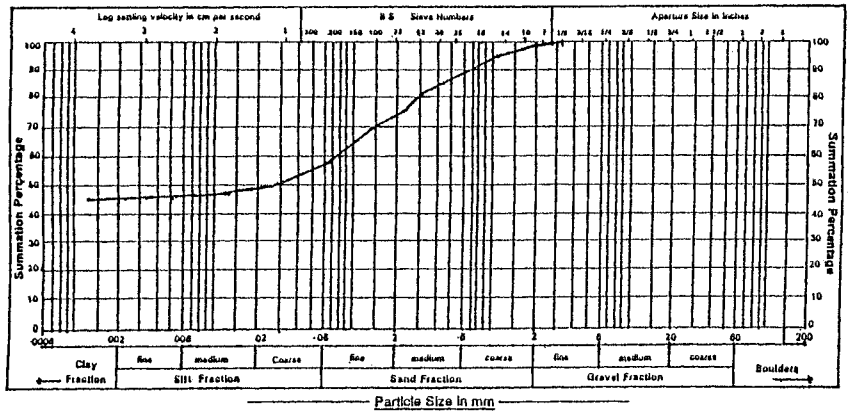
PARTICLE SIZE DISTRIBUTION

CONTRACT: S10903 PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE

DATE: JUNE, 2000

BOREHOLE/SAMPLE NO: 1/3 DEPTH: 1.0m

LOSS ON PRETREATMENT: -

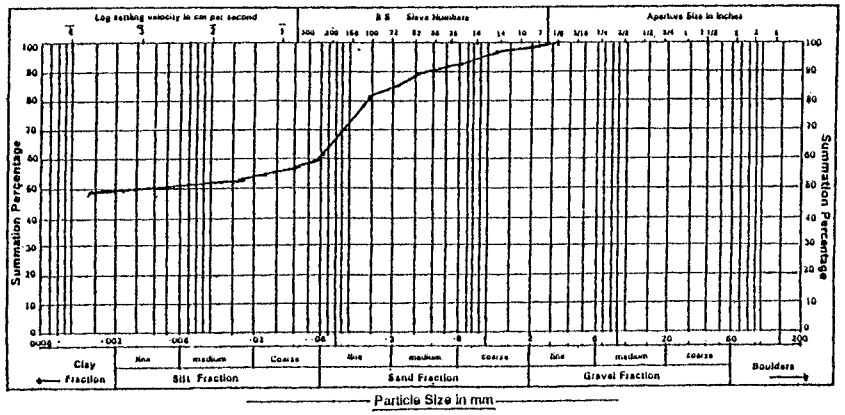


CONTRACT: S10903 PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE

DATE: JUNE, 2000

BOREHOLE/SAMPLE NO: 1/5 DEPTH: 2.0m

LOSS ON PRETREATMENT: -



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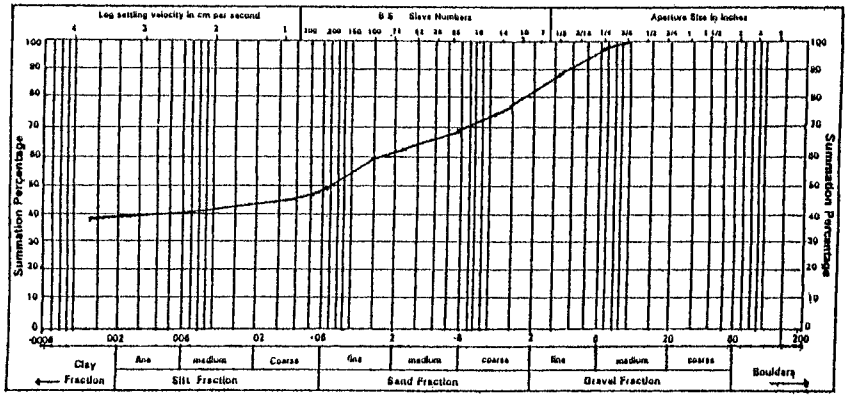
PARTICLE SIZE DISTRIBUTION

CONTRACT: S10903 PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE

DATE: JUNE, 2000

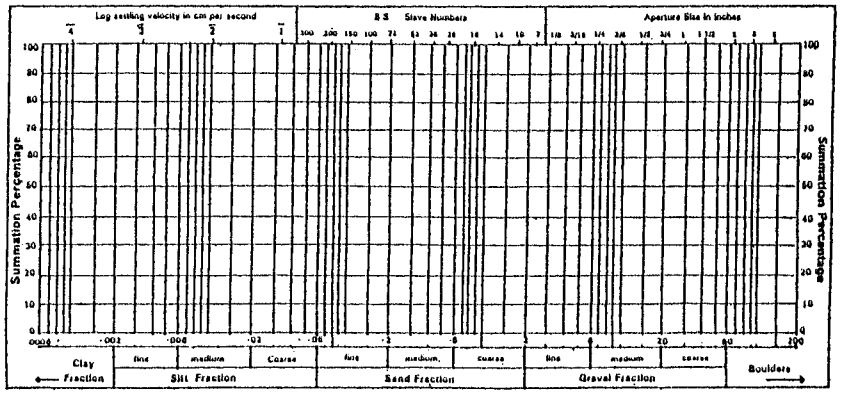
BOREHOLE/SAMPLE NO: 1/11 DEPTH: 6.0m

LOSS ON PRETREATMENT: -



CONTRACT: DATE:

BOREHOLE/SAMPLE NO: DEPTH: LOSS ON PRETREATMENT:



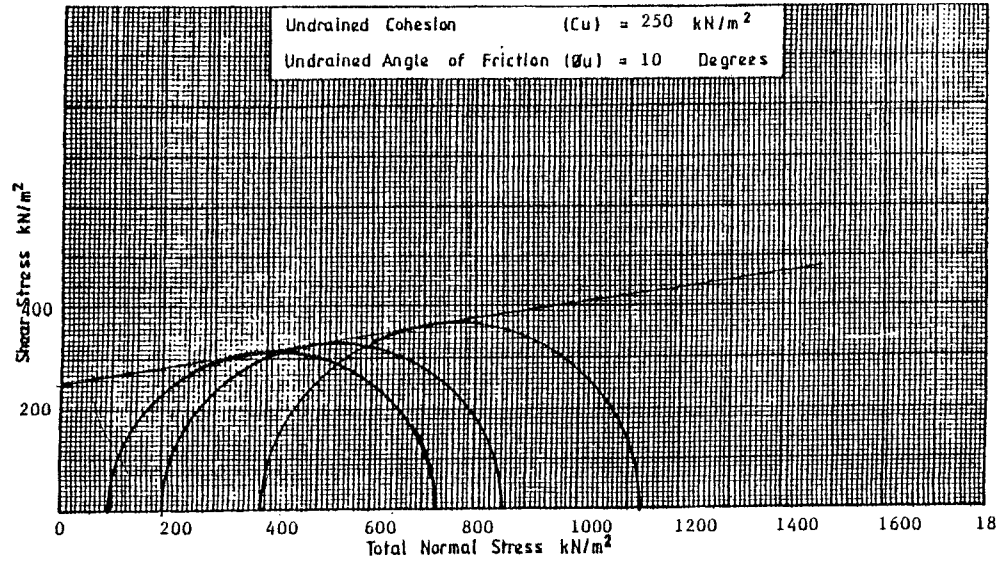
FOUNDATION ENGINEERING SERVICES LTD. FIG. A3

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

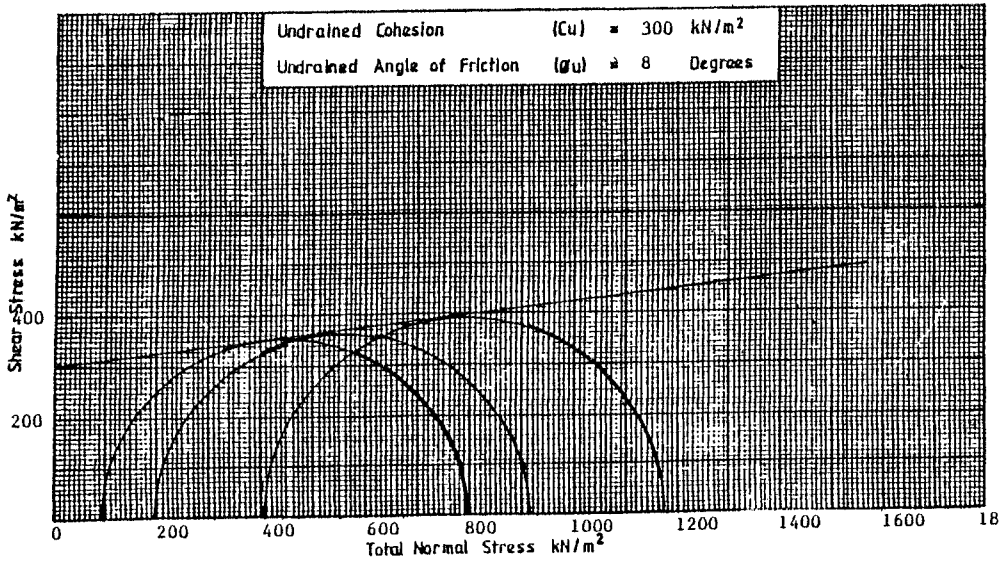
MOHR CIRCLES DIAGRAM

LOCATION. PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE
JOB No S10903
DATE OF TEST JUNE, 2000

BOREHOLE No 1
SAMPLE No. 4
DEPTH 1.5m



BOREHOLE No. 1 SAMPLE No. 9 DEPTH 4.5m



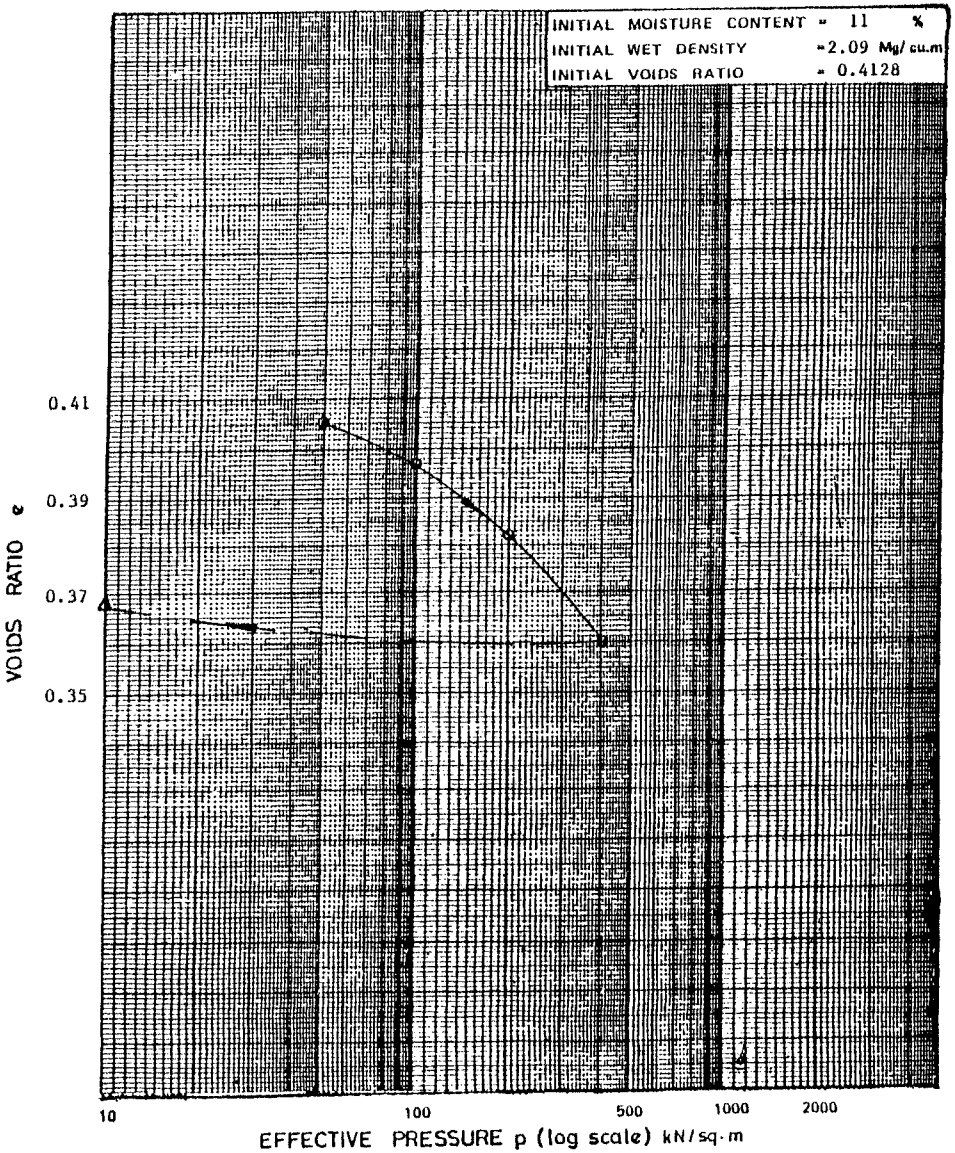
FOUNDATION ENGINEERING SERVICES LTD. FIG. A4

CONSOLIDATION TEST

(e - log p curve)

LOCATION. PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE
JOB No S10903
DATE OF TEST JUNE, 2000

BOREHOLE No. 1
SAMPLE No. 4
DEPTH. 1.5m



FOUNDATION ENGINEERING SERVICES LTD. FIG. A5

CONSOLIDATION TEST

(e - log p curve)

LOCATION. PROPOSED RURAL ELECTRIFICATION PROJECT AT KALSHINGI, GOMBE STATE

BOREHOLE No. 1

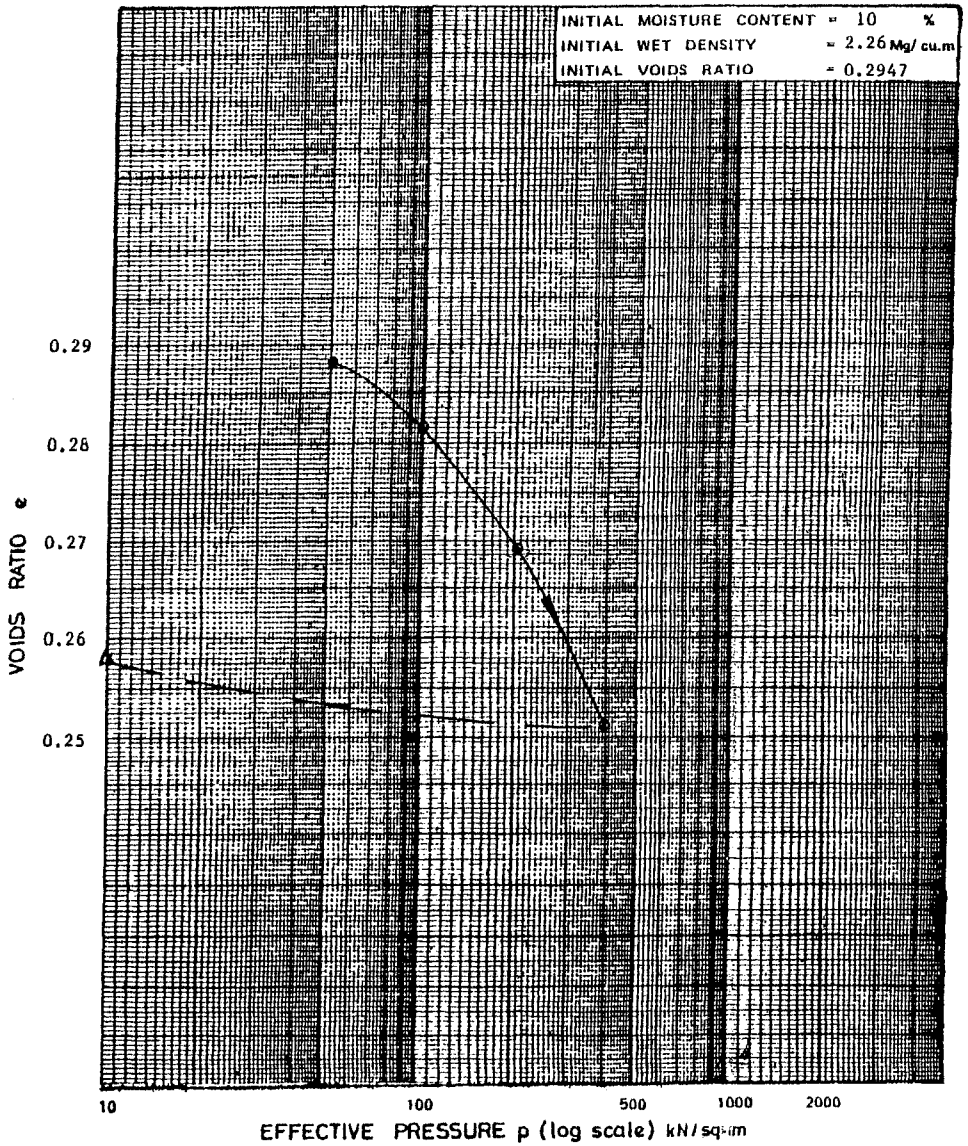
JOB No S10903

SAMPLE No. 9.

DATE OF TEST JUNE, 2000

DEPTH. 4.5m

INITIAL MOISTURE CONTENT = 10 %
INITIAL WET DENSITY = 2.26 Mg/cu.m
INITIAL VOIDS RATIO = 0.2947



FE
FOUNDATION ENGINEERING
Services Limited
Geotechnical Consultancy, Construction Quality Assurance Specialists
RC. 142630

OFFICE:
290, HERBERT MACAULAY
STREET,
SABO, YABA,
P O. BOX 2100 LAGOS
TEL: 01 - 867712, 835393.

MESSRS YACHIYO ENGINEERING CO. LIMITED

PROPOSED PROJECT FOR RURAL ELECTRIFICATION
AT DAMASAK CITY, BORNO STATE,
FEDERAL REPUBLIC OF NIGERIA

REF.: S.10904/JUNE, 2000

REPORT ON SUBSOIL INVESTIGATION

Carried Out By:-

FOUNDATION ENGINEERING SERVICES LIMITED,
P. O. BOX 2100,
LAGOS.

FE

MESSRS YACHIYO ENGINEERING LIMITED

PROPOSED PROJECT FOR RURAL ELECTRIFICATION

AT DAMASAK CITY, BORNO STATE,

FEDERAL REPUBLIC OF NIGERIA

REPORT ON SUBSOIL INVESTIGATION

1. INTRODUCTION

Further to your letter of award reference YEC-BRG-FDNO1 dated 10th May 2000, Foundation Engineering Services Limited carried out a subsoil investigation at Damasak city in Mobbar Local Govt. area of Borno State for the above proposed project. The purpose of the investigation was to provide data on subsoil conditions for foundation design.

The following is our report on the investigation.

2. SCOPE OF INVESTIGATION

2.1 Site Work

The site work was carried out between 3rd and 4th June, 2000. The defined scope of site work required comprised 1 No. shell and auger borehole put down to the specified 10.0m depth as requested by yourselves and surveying of the boring position to determine

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the height above mean sea level (MSL) with reference to an established bench mark.

A pilcon Wayfarer 1500 rig with B.S. 5930 shell and auger percussion boring techniques was used to bore through the soil deposits. Both disturbed and undisturbed soil samples were taken and standard penetration tests (SPT) carried out at regular intervals of 1.0m depth as appropriate.

An area map showing Damasak city is presented as Figure 1 while a site plan (based on the sketched site layout drawing provided by the client) indicating approximate position of the borehole as selected by yourselves and set out by ourselves is presented as Figure 2.

Borehole log giving details of the strata encountered at the site is presented as Figure 3.

All depths referred to in this report are below ground surface at the time of the investigation and are therefore only approximate.

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2.2 Laboratory Testing

Laboratory tests relevant to the engineering objectives of the investigation were Scheduled on selected samples retrieved from the borehole. The tests were carried out in general accordance with B.S. 1377; 1990. "Method of Test for Soils for Civil Engineering Purposes"; Parts 1 - 9 unless otherwise stated. The results are presented in tabular and graphical forms in the Appendix.

The following tests were carried out:-

3 No.	Particle size distribution by wet sieving
4 No.	Natural moisture content
1 No.	Chemical Analysis of soil samples for hydrogen ion concentration (pH) and soluble sulphate content.

3.0 GEOLOGY OF THE SITE (DAMASAK CITY, BORNO STATE)

The site is generally flat, uncultivated dotted with few trees. The 1:2,000,000 geological Map of Nigeria compiled by the Geological survey of Nigeria, 1974 Edition, indicates that the site is underlain by sands and clays of the chad formation, the results of the investigation are generally concordant with overburden soils associated with the description of the site geology.

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4.0 SUBSOIL AND GROUNDWATER CONDITIONS

Details of the subsoil strata encountered during boring are given on the borehole log. However, the subsoil sequence may then be generally summarised as follows:-

Depth Below Ground Level (m)		Generalised Strata Description
From	To	
Ground Level	0.15	Loose silty SAND (f) [TOPSOIL]
0.15	10.0 (Borehole Termination)	Medium dense silty SAND (f)

Variations in strata thickness and depths away from the borehole are likely.

Groundwater seepage was not encountered in the borehole. However, indications from local observations are that the groundwater level could vary approximately be between 10m and 15m depths. Seasonal variations in groundwater level will occur, with the site possibly becoming saturated to the surface in places during or following periods of wet weather.

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5.0 LABORATORY TEST RESULTS

Particle size analysis carried out on samples of the overburden silty sand gave the range of sand fraction to be 95% to 98%, silt 2% to 5% by weight. Detailed results are presented on the summary sheet and graphically on the particle size distribution curves in the Appendix.

The aggressiveness of the soil samples to concrete was assesed by the determination of hydrogen ion concentration (pH) and soluble sulphate content of 1 No. sample. The pH value was indicated to be 5.3 indicating acidic conditions, with very small soluble sulphate content (0.005 gr./litre).

From the survey work carried out at the boring position (Borehole 1).
The following values are tabulated below in table 4.

Station	Starting Point and Height above The Mean Sea Level (MSL) (m)	Distance Covered (km)	Height of Boring Station above the Mean Sea Level (MSL) (m)	Height of Temporary Bench Mark (m)
Damasak City	Trig. Station V - 1059 303.25	10.4	308.470	308.250

Note: More detailed survey report is presented in the Appendix.

6.0 FOUNDATION DISCUSSION

6.1 Design Details

It is understood that it is proposed to install a transformer of about 12 ton (120 kN). No further details have been made available to us. However, for the purpose of this report, we have assumed a maximum overall ground loading of 60 kN/m^2.

The following comments and recommendations are based on the borehole log and on the results of the laboratory tests.

6.2 Shallow Foundation

The results of in-situ and laboratory test carried out revealed the presence of a medium dense silty sand within the top 1.0m to 4.0m depth within which a shallow foundation can be set.

Foundations should be set above the water table on sand which has been thoroughly compacted using a heavy vibratory roller or plate. The allowable bearing pressure that may be imposed will be dependent on the width and depth of the foundations, the care taken in excavating and preparing the foundation level and the allowable settlement of the foundations.

As a guide, it is estimated that the net allowable bearing pressures that may be imposed at different founding depths are as shown in Table 2 below. These Figures have taken into consideration the relief provided by the overburden assumed to be removed above the founding level.

Founding Depth (m)	Allowable bearing Pressure (kN/m^2)
1.0	70
2.0	90
3.0	110

Table 2. Estimated Allowable Pressure for shallow Foundation.

However, it is recommended that a heavily reinforced concrete strip or pad foundations may be adopted for supporting the proposed structures at this site. The foundation should not be less than 1.0m wide, set on well compacted sand which has been thoroughly compacted using a heavy vibratory roller or plate and not shallower than 1.0m depth in order to avoid problems of seasonal moisture variation.

6.3 Settlement

Settlement of strip or pad foundations constructed to the standards, loading and depths stated above is estimated to be

less than 30mm with differential settlement not exceeding half the total settlement.

6.4 Foundation Preparation

The base of the foundation excavation must be carefully probed and inspected for soft pockets which, if encountered, must be completely removed and replaced with well compacted relatively dry lean mix concrete or the excavation taken deeper.

Immediately after preparation, the foundation level must be protected with a blinding layer of concrete as the soil may loosen if left exposed or if ingress of water is allowed.

Excavations in the sand should be battered to a low angle to avoid minor slip failure.

Backfilling to the sides of the foundation should be placed to ground level as soon as possible following casting of the foundation. Backfilling of excavations around completed foundations should be with suitable material placed in thin layers not exceeding 200mm thickness and compacted to a high standard.

FE

7.0 GENERAL

The subsoil conditions are indicated to be acidic, with negligible concentrations of soluble sulphates. Ordinary Portland cement may therefore be used but a rich, dense mix is recommended for buried concrete.

We strongly recommend that the design and construction of all foundation and earthworks be carried out in accordance with a good engineering practice as embodied in recognised Codes of Practice such as the British Standards Institution's B.S. 8004: 1986, Code of Practice for Foundations and B.S. 6031: 1981, Code of Practice for Earthworks.

We trust you find the contents of this report of assistance and assure you of our best attention at all times.

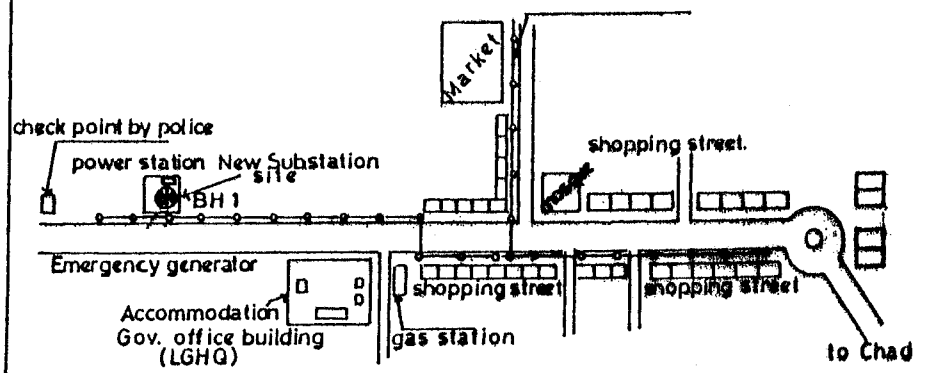
S. Adekoya,
Civil Engineer.

Prince Wale Ajayi-Fajomodu,
Managing Director.

FOUNDATION ENGINEERING SERVICES LIMITED,
P. O. BOX 2100,
LAGOS.

REF.:S10904/JUNE, 2000.

FIG. 2



Proposed Project For Rural Electrification At Damasak City, Borno State.

LOCATION MAP

KEY

⊕ :- Borehole postion.

(S10904)

Foundation Engineering Services Limited.

FOUNDATION ENGINEERING SERVICES LTD

BOREHOLE LOG

LOCATION : PROPOSED RURAL ELECTRIFICATION PROJECT AT DAMASAK CITY, BORNO STATE
JOB No : S10904
BOREHOLE DIA : 0.15m
DATE (Start) : 3/6/2000

BOREHOLE No : 1 (DAMASAK CITY)
GROUND LEVEL : 308.478m (ABOVE MSL)
GROUND WATER : NOT ENCOUNTERED

DEPTH (m)	LEGEND	SAMPLE No	DESCRIPTION	BLOWS FOR S.P.T. SPOON FOR 0.30m DRIVE (N) 10 20 30 40 50
0		1	Loose light brown silty SAND (f)	10
2		2 3 4 5 6 7 8 9 10 11 12	Medium dense brown silty SAND (f)	18 17 15 14 19
6		13 14 15 16 17 18 19 20 21	Medium dense grey silty SAND (f)	17 23 30 27
10			Borehole terminated at 10.0m depth	
12				
14				
16				
18				
20				
22				
24				
26				
28				
30				

FOUNDATION ENGINEERING SERVICES LTD

Summary of Laboratory Test Results.

LOCATION: PROPOSED RURAL ELECTRIFICATION PROJECT AT DAMASAK CITY, BORNO STATE

CONTRACT No- S10904

SHEET :- 1 OF 1

BOREHOLE/ SAMPLE No.	TYPE	DEPTH m	PARTICLE SIZE DISTRIBUTION % PASSING 2·00 mm	425 µm	63 µm	2 µm	NAT M.C. % dw	ATTERBERG LIMITS LL % dw	PL % dw	PI % dw	γd Mg/m³	S.G.	QUICK UNDRAINED TRIAXIAL TESTS dia (mm) type	σ3 kN/m²	Cu kN/m²	φu deg	LAB VANE Su kN/m²	OEDOMETER CONSOLIDATION STRESS RANGE kN/m²	Mv m²/MN	Cv m²/yr	pH	SO3 (s) gr/litre	SO3 (w) pp m	COMMENTS OTHER TESTS
1/3	D	1.0	100	97	5		10																	
1/4	D	1.5					13																	
1/10	D	4.5	100	97	2		21														5.3	10.005		
1/21	D	10.0	100	97	4		18																	

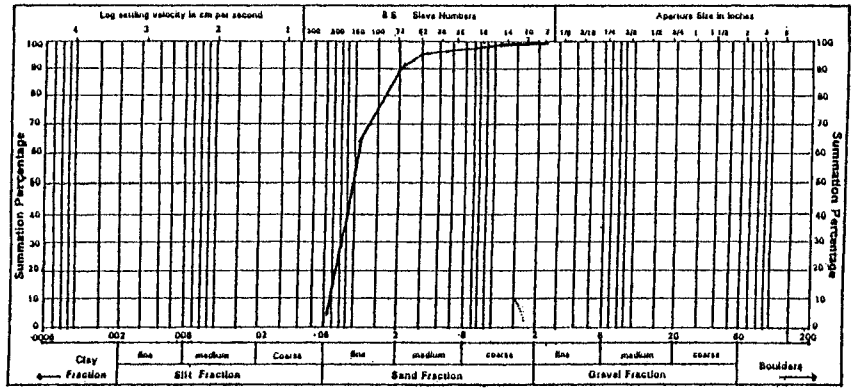
PARTICLE SIZE DISTRIBUTION

CONTRACT: S10904 PROPOSED RURAL ELECTRIFICATION PROJECT AT DAMASAK CITY, BORNO STATE

DATE: JUNE, 2000

BOREHOLE/SAMPLE NO: 1/3 DEPTH: 1.0m

LOSS ON PRETREATMENT: -

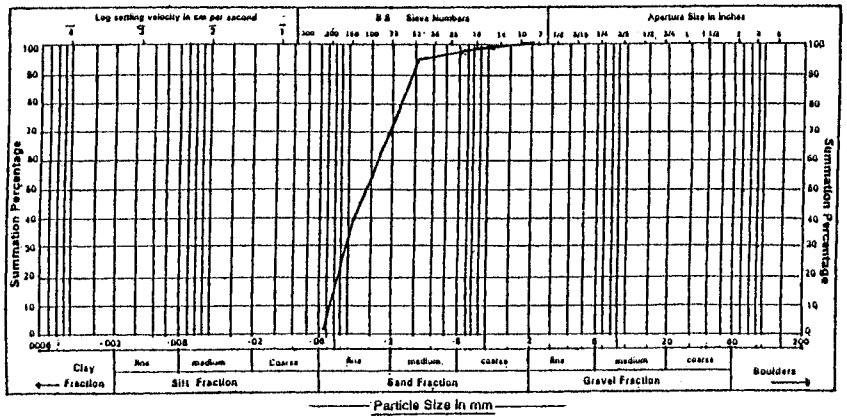


CONTRACT: S10904 PROPOSED RURAL ELECTRIFICATION PROJECT AT DAMASAK CITY, BORNO STATE

DATE: JUNE, 2000

BOREHOLE/SAMPLE NO: 1/10 DEPTH: 4.50m

LOSS ON PRETREATMENT: -



FOUNDATION ENGINEERING SERVICES LTD.

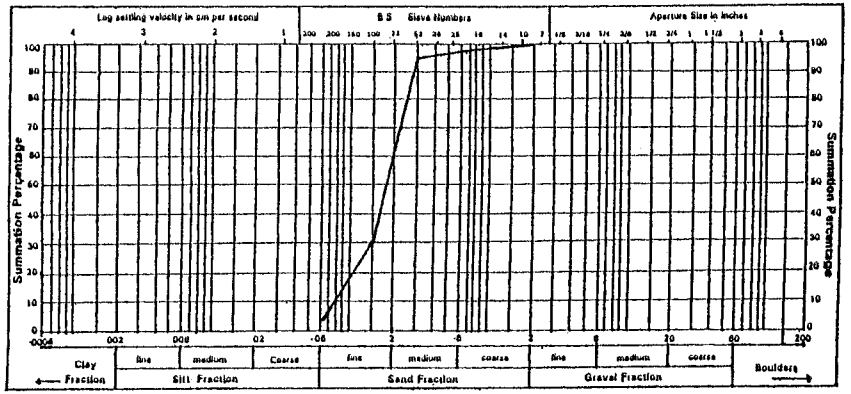
PARTICLE SIZE DISTRIBUTION

CONTRACT: S10904 PROPOSED RURAL ELECTRIFICATION PROJECT AT DAMASAK CITY, BORNO STATE

DATE: JUNE, 2000

BOREHOLE/SAMPLE NO: 1/21 DEPTH: 10.0m

LOSS ON PRETREATMENT: -

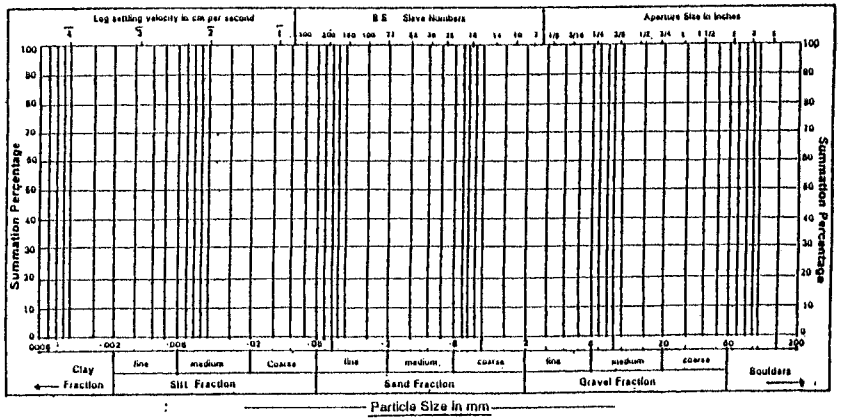


CONTRACT:

DATE:

BOREHOLE/SAMPLE NO: DEPTH:

LOSS ON PRETREATMENT:



資料－６　需要電力想定

新設33kV送電線ルートの想定最大需要電力予測

基礎データ	Basic Data	計画～5年間	6年目～10年目	11年目～15年目
		(first 5 yrs)	(second 5 yrs)	(third 5 yrs)
① 年間電力需要増加率	①Annual Increasing Ratio (100 % base)			
A: 計画対象地域	A: Project Area	1.100	1.050	1.030
B: 既存電化地域	B: Already Electrified Area	1.050	1.030	1.030
② 需要率	②Demand Factor	0.5		

(本計画施設の供用開始年) (Commencement of Operation)　　(想定計画対象年度) (Target year of the Project)　　(Unit: kW)

年	Year	2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
年平均増加率	Annual Increasing Ratio	既存/潜在需要	想定最大電力												
		(Total Load)	(Estimated Demand)												
1. ナサラワ州	**1. Nassarawa State**														
ラフィア市	Lafia city	5,100		5,355	5,623	5,904	6,199	6,509	6,834	7,176	7,391	7,613	7,842	8,077	8,319
アドギ町	Adogi town	544		571	600	630	661	694	729	765	788	812	836	862	887
ドマ町	Doma town	544		571	600	630	661	694	729	765	788	812	836	862	887
オビ町	Obi town	408		428	450	472	496	521	547	574	591	609	627	646	666
※ アウェ町	***※Awe town***	***515***	***258***	***283***	***312***	***343***	***377***	***415***	***456***	***502***	***527***	***553***	***581***	***610***	***640***
※ ケアナ町	***※Keana town***	***757***	***378***	***416***	***458***	***504***	***554***	***609***	***670***	***737***	***774***	***813***	***853***	***896***	***941***
合計	Total	7,868	636	7,625	8,041	8,482	8,948	9,442	9,966	10,520	10,861	11,212	11,576	11,952	12,341
2. バウチ州	**2. Bauchi State**														
リネムケダグ町	Linem Ketag town & etc.	1,632		1,714	1,799	1,889	1,984	2,083	2,187	2,296	2,365	2,436	2,509	2,585	2,662
ダジン町	Dajin town	136		143	150	157	165	174	182	191	197	203	209	215	222
ダス町	Dass town	544		571	600	630	661	694	729	765	788	812	836	862	887
タファワバレア町	Tafawa Balewa town	408		428	450	472	496	521	547	574	591	609	627	646	666
※ ボゴロ町	***※Bogoro town***	***420***	***210***	***231***	***254***	***279***	***307***	***338***	***372***	***409***	***429***	***451***	***473***	***497***	***522***
合計	Total	3,140	210	3,087	3,253	3,428	3,613	3,809	4,017	4,236	4,371	4,511	4,655	4,805	4,959
(参考)	(For Reference only)														
3. ゴンベ州	**3. Gombe State**														
クモ町	Kumo town	408		428	450	472	496	521	547	574	591	609	627	646	666
デバハベ町	Deba Habe town	408		428	450	472	496	521	547	574	591	609	627	646	666
ダディンコワ町	Dadin Kowa town	1,700		1,785	1,874	1,968	2,066	2,170	2,278	2,392	2,464	2,538	2,614	2,692	2,773
※ カッシンギ町	***※Kalshingi town***	***445***	***222***	***244***	***269***	***296***	***325***	***358***	***394***	***433***	***455***	***477***	***501***	***526***	***553***
合計	Total	2,961	222	2,886	3,043	3,208	3,384	3,569	3,765	3,973	4,101	4,233	4,370	4,511	4,657
(参考)	(For Reference only)														
4. ボルノ州	**4. Borno State**														
マグメリ町	Magumeri town	680		714	750	787	827	868	911	957	986	1,015	1,046	1,077	1,109
グビオ町	Gubio town	680		714	750	787	827	868	911	957	986	1,015	1,046	1,077	1,109
※ ダマサク町	***※Damasak town***	***1,838***	***919***	***1,011***	***1,112***	***1,223***	***1,345***	***1,480***	***1,628***	***1,790***	***1,969***	***2,068***	***2,171***	***2,280***	***2,394***
合計	Total	3,198	919	2,439	2,611	2,797	2,998	3,215	3,450	3,704	3,940	4,098	4,262	4,434	4,612
本計画地の合計	***Grand Total of Project Sites***	***3,973***	***1,987***	***2,185***	***2,404***	***2,644***	***2,909***	***3,199***	***3,519***	***3,871***	***4,154***	***4,362***	***4,580***	***4,809***	***5,050***

備考:

(1) ※は、本計画対象地を示す。

(2) 想定最大電力=既存/潜在需要 X 需要率

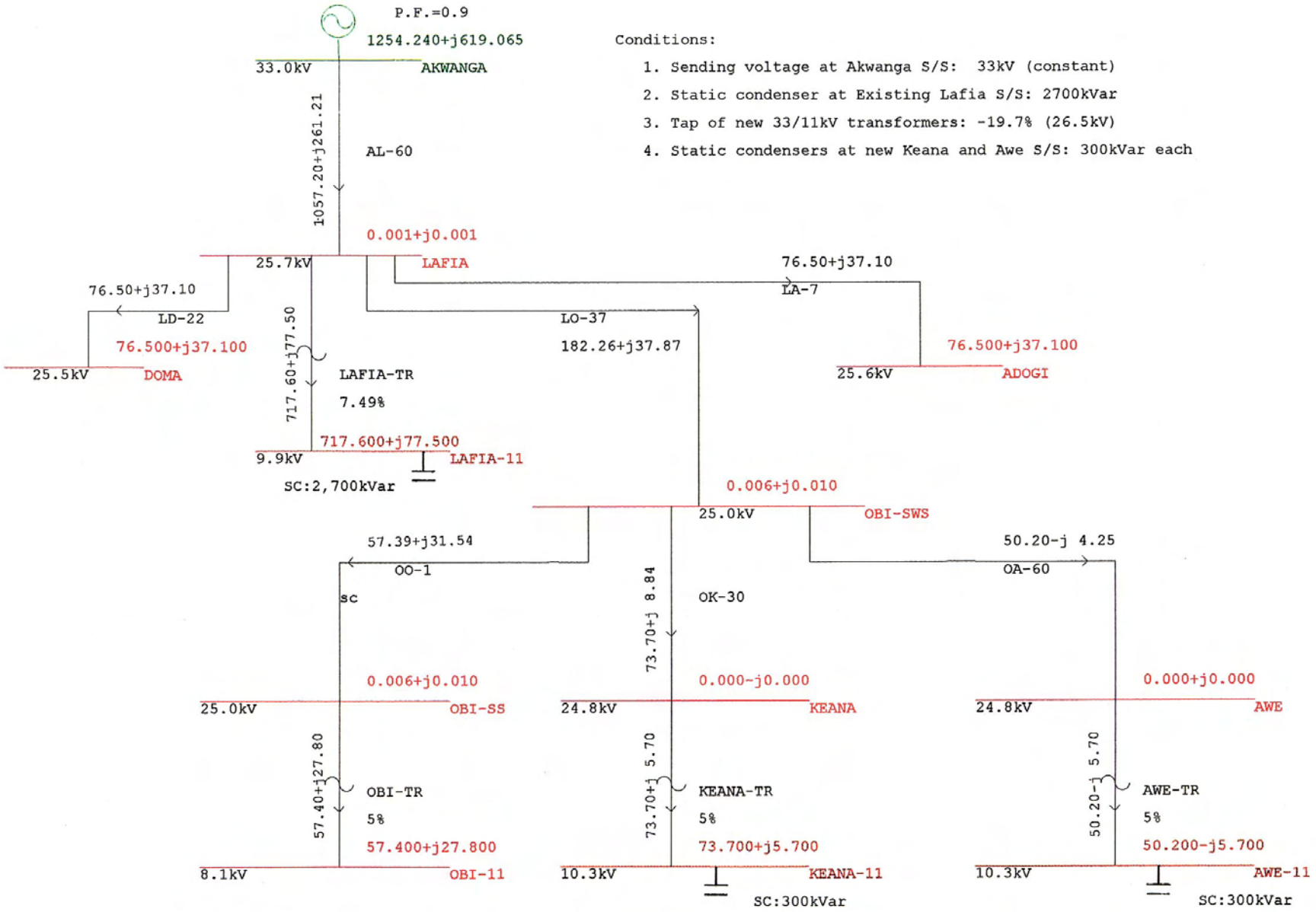
Remarks:

(1) ※ shows the Project sites.

(2) Estimated Demand = Total Load x Demand Factor

資料－７　電圧降下の検討

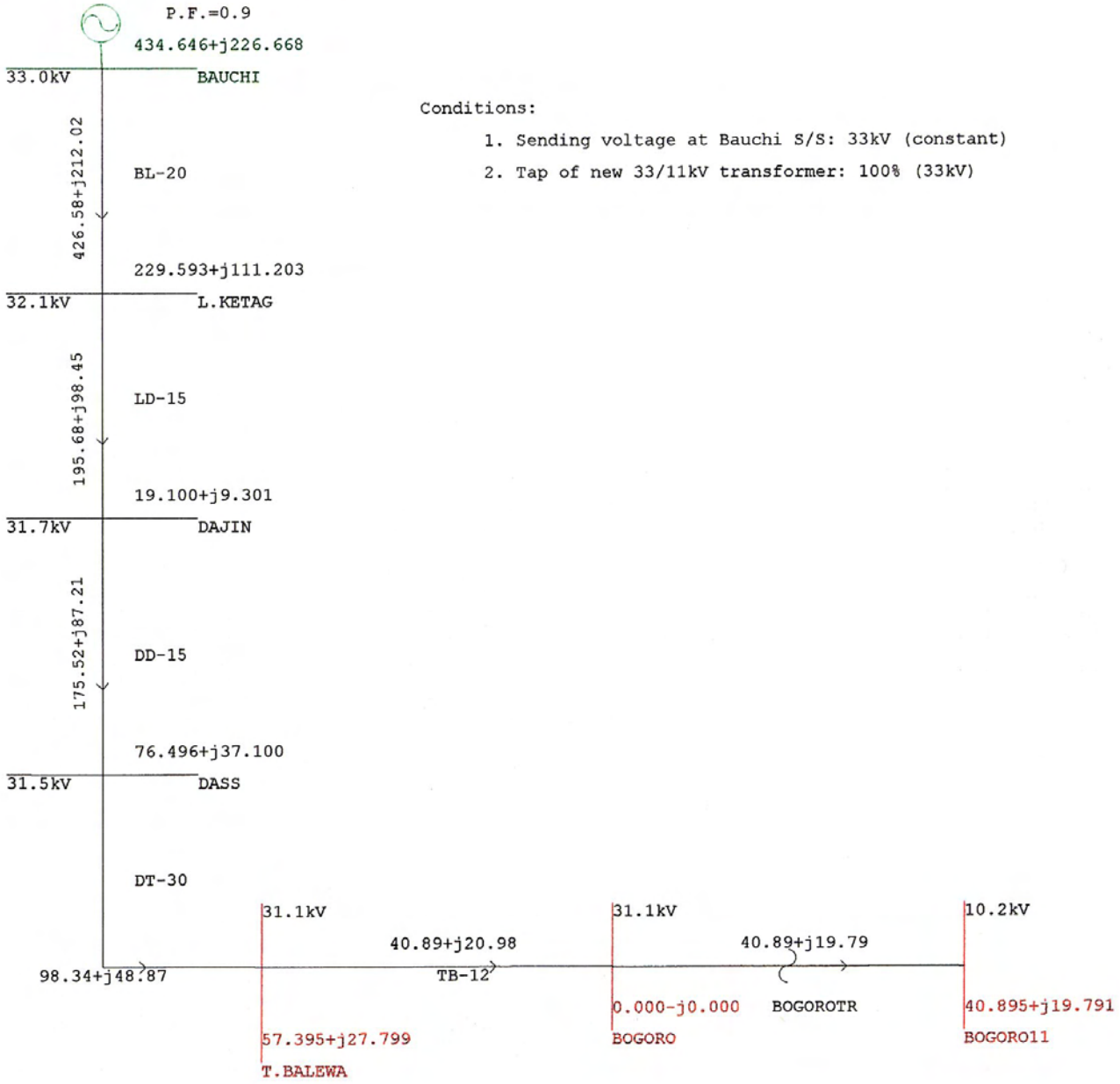
Study Result on Voltage Drop at Keana and Awe Towns in Nassarawa State in 2007 year



Conditions:

1. Sending voltage at Akwanga S/S: 33kV (constant)
2. Static condenser at Existing Lafia S/S: 2700kVar
3. Tap of new 33/11kV transformers: -19.7% (26.5kV)
4. Static condensers at new Keana and Awe S/S: 300kVar each

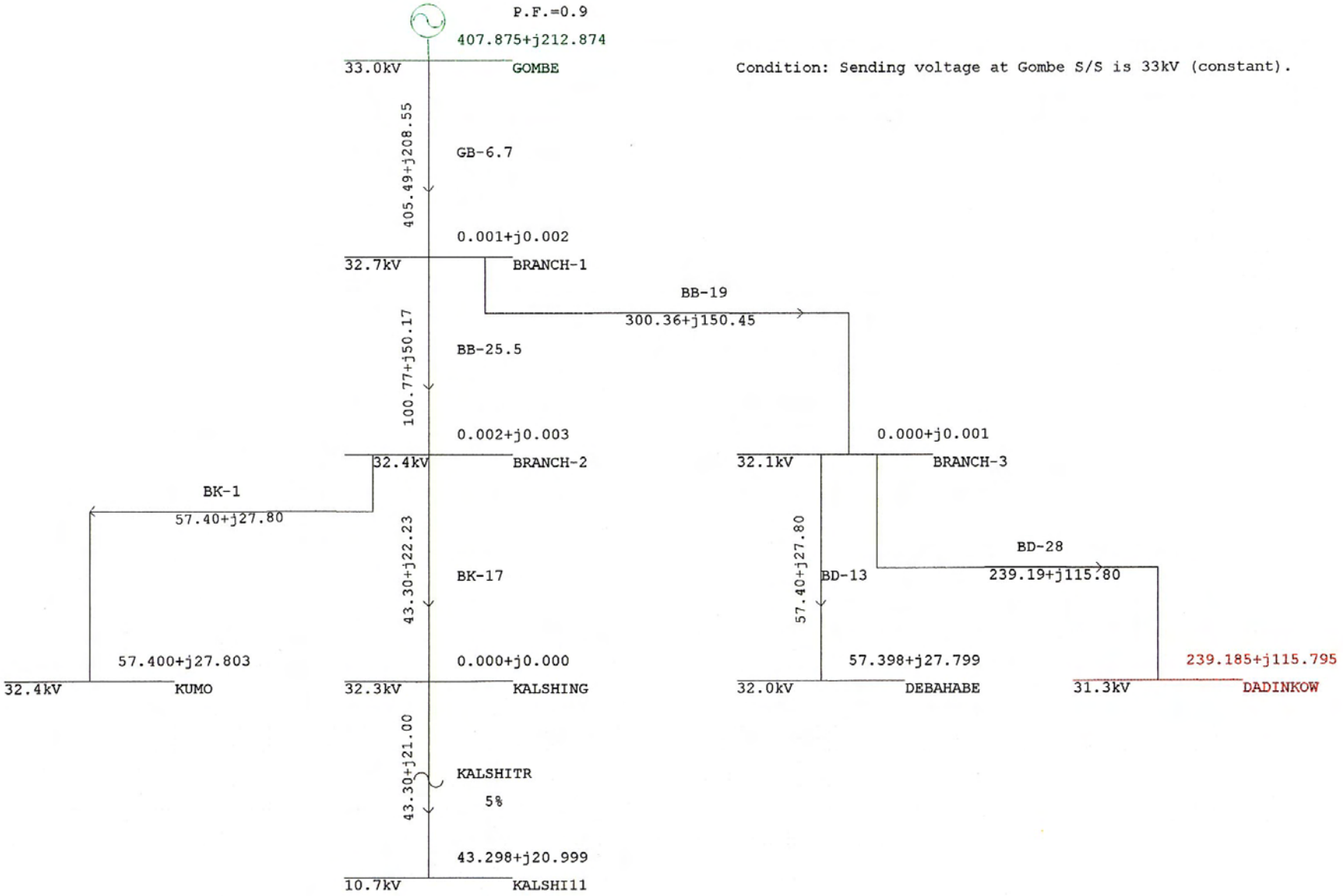
Study Result of Voltage Drop at Bogoro Town in Bauchi State in 2007 year



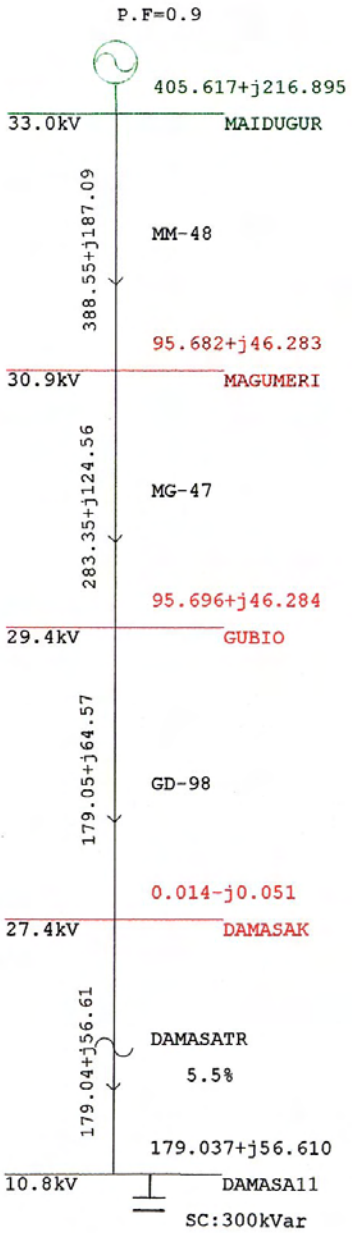
Conditions:

1. Sending voltage at Bauchi S/S: 33kV (constant)
2. Tap of new 33/11kV transformer: 100% (33kV)

Study Result of Voltage Drop at Kalshingi Town in Gombe State in 2007 year



Study Result of Voltage Drop at Damasak Town in Borno State in 2007 year



Conditions:

1. Sending voltage at Maiduguri S/S: 33kV (constant)
2. Tap of new 33/11kV transformer: -16.7% (27.5kV)
3. Static condenser at new Damasak S/S: 300kVar

資料－８　技術指導に係わる活動計画

1．技術指導の必要性

「ナ」国内で実施されている通常の 11kV 配電線工事は、本計画の実施機関である電力鉄鋼省（FMPS）が、国家電力公社（NEPA）へ入札図書等作成等の技術協力を仰ぎつつ、国内入札を経て「ナ」国内の電気工事会社へ工事請負発注する方式がとられている。同 11kV 配電線工事は、「ナ」国が推進する全国地方電化プログラムによって全国的に広がっており、その工事件数も多いことから、FMPS、NEPA 及び国内電気工事会社は、類似の送・配電網の建設経験を持ち、必要な機材、要員も保有しており、通常の 11kV 配電線据付工事には特段の困難さは見受けられない。

しかしながら、本計画は、我が国の無償資金協力で実施されるため、その工事工期は短く、業者契約から引渡しまで、第 1 期工事：約 12 ヶ月、第 2 期工事：約 14 ヶ月、第 3 期工事：約 16 ヶ月と想定される。同工期内で、日本側工事である 33kV 送電線及び 33/11kV 変電所の建設を完了させ、更に、日本側が調達し「ナ」国側が建設する 11kV 配電線工事（配電線路長：第 1 期工事　約 11.2km、第 2 期工事　約 7.1km、第 3 期工事　約 13.5km）を完了させる必要がある。

また、現在の「ナ」国による 11kV 配電線工事は、同国政府予算の執行状況に応じて、工事発注を実施しているものである。このため FMPS 及び NEPA は、本計画の様に日本側工事と整合性をとりつつ、短工期で工事を遂行するための監理技術は十分に保有していないと想定される。

上記から本計画において、「ナ」国側の実施する 11kV 配電用資機材の据付工事について、工事計画立案時から、日本のコンサルタントが派遣する技術者により、FMPS の工事監理担当技術者に対して、施主としての品質・工程・安全管理等の助言を行い、同 FMPS 技術者が、NEPA の技術者を通じて、その工事請負会社の施工状況を確実に把握しつつ、安全に工事を遂行し、工程を遵守する様に指導する必要がある。また、同技術指導を通じて、「ナ」国側工事と日本側工事との整合性を取りつつ、本計画全体の所定工期内にその達成目標を確実に発現出来るようにすることが肝要である。

更に、本計画対象地域は、「ナ」国内の広範囲な地域に広がっているため、各地域毎に FMPS 及び NEPA の担当支部局が異なり、地域により工事監理能力に格差を生じることが懸念されるが、当該技術指導によって、各計画対象地域で統一された工事監理体制を確立する必要がある。

2．活動目的

活動目的は、当該 11kV 配電線の据付工事期間中における適切な施工監理技術の移転とする。

3. 期待される効果

本ソフトコンポーネントの導入による期待される効果は、以下の通りである。

・無償資金協力制度の所定工期内（単年度工事）で、日本側工事と「ナ」側工事が完了し、効果の発現が確実となる。

・同一地域内において、11kV 配電線工事（「ナ」側負担）と 33kV 送電線工事（日本側負担）とが平行して実施され、かつ請負工事業者が異なる複合工事に対する総合監理技術が移転される。

・2つの FMPS 支部局並びに3つの NEPA 支部局に勤務する施工管理要員に品質・工程・安全管理技術を移転できる。

4. 活動内容

(1) 派遣要員の選定

本計画は、5つの計画対象地域の工事を3期に分けて実施されるが、各期毎の工事を監理する FMPS および NEPA の担当支部局は以下に示すとおり、各地域により異なっている。

このため、コンサルタントによる当該工事の施工監理の技術指導には、各期の先方側据付工事の工程に合わせ、各計画対象地域（5 サイト）に 1 名ずつ類似プロジェクトの経験を持った電気技術者（配電担当）を派遣するものとする。

	FMPS	NEPA
(1) 第1期工事（アウェ町及びケアナ町）	ジョス支部局	アブジャ管理事務所 （ラフィア事務所）
(2) 第2期工事		
1）ボゴロ町	ジョス支部局	ジョス管理事務所 （バウチ事務所）
2）カッシンギ町	ジョス支部局	ジョス管理事務所 （ゴンベ事務所）
(3) 第3期工事（ダマサク町）	マイドゥーグリ支部局	ヨラ管理事務所 （マイドゥーグリ事務所）

(2) 派遣技術者の現地指導内容と技術指導の所要期間

本計画の目的である適切な施工監理技術の移転を達成するために、主な指導内容を①総合/詳細計画立案の指導②工事開始段階における実施準備及び監理指導、並びに③工事完了段階における監理指導及び総合評価とする。

同派遣技術者による具体的な指導内容は、次の表-1 に示すとおりである。なお、当該派遣技術者による指導体制及び派遣期間は、上記指導内容の各段階毎に要員を適宜派遣するスポット管理方式にて行うこととする。表-2 に各期毎の派遣期間を示す。

表-1 派遣技術者の指導内容

ステップ	指導項目
1. 総合/詳細計画の立案指導	(1) 配電ルート確認調査 （電柱位置、電柱種類、配電用変圧器の配置等） (2) 計画工程表作成指導 （監理要員計画、日本側工事との工程調整、等） (3) 工事資機材数量表作成指導 （日本側調達資機材の確認、「ナ」国側が準備する仮設用資機材の管理等） (4) 工事業者との契約手続きに関する助言 (5) 工事業者からの提出図書（施工図等）の照査業務に関する指導 (6) 415V 配電資機材の調達・工事計画策定状況の確認
2. 工事開始段階における実施準備及び監理指導	(1) 日本側調達の資機材搬入検査立会に関する指導 (2) 工事監理指導 （安全管理、品質監理、工程監理、資機材納入管理及び報告書作成等） (3) 日本側工事（変電所及び 33kV 送電線工事）との必要な調整事項の指導 （施工場所及び仮設用地の確認調査、停電計画、日本側工事 OJT 参加要員の管理等） (4) 日本側施工業者による模範的な施工管理技術の説明
3. 工事完了段階における監理指導及び総合評価	(1) 現地試験立会の指導 （415V 及び 11kV 配電線路の試験、日本側変電所との接続工事確認を含む） (2) 竣工検査立会の指導 (3) 工事完了までの工事監理体制の評価 (4) 運転・維持管理上の留意点の整理・指導

表-2　技術指導工程表

	月	1	2	3	4	5	6	7	8	派遣期間
第1期工事	アウェ町	ステップ1（両サイト共通） （計画・準備期間）		ステップ2 （工事期間）			ステップ3			3ヶ月
	ケアナ町	（計画・準備期間）		ステップ2	（工事期間）		ステップ3			2ヶ月
									第1期工事　計	5ヶ月
第2期工事	ボゴロ町	ステップ1（両サイト共通） （計画・準備期間）		ステップ2	（工事期間）	ステップ3				2．5ヶ月
	カッシンギ町			（計画・準備期間）			ステップ2	（工事期間）	ステップ3	2ヶ月
									第2期工事　計	4．5ヶ月
第3期工事	ダマサク町	ステップ1 （計画・準備期間）		ステップ2	（工事期間）	ステップ3				3ヶ月
									全期合計	12．5ヶ月

■ :技術指導期間

□ :先方工事期間

5. 派遣期間中の監理

コンサルタントは、派遣期間中に下記監理業務を実施する。

(1) 技術者派遣期間中の指導状況について、当該技術者が上記各指導段階毎に作成する指導報告書（先方工事の進捗状況報告を含む）を照査し、JICA へ報告する。

(2) 先方工事完了前の竣工・引渡検査に立会い、研修成果の確認を行う。

－以上－

資料－９　参考資料リスト

収集資料リスト

調査名　　ナイジェリア連邦共和国地方電化計画基本設計調査団

番号	名　称	形態 図書・ビデオ・地図 ・写真等	ｵﾘｼﾞﾅﾙ･ｺﾋﾟｰ	発　行　機　関	発行年
1	NEPA in Brief	図書	ｺﾋﾟｰ	NEPA	1999 年
2	Year 2000-2002 Rolling Plan & the Year 2000 Capital Budget	図書	ｺﾋﾟｰ	NEPA	1999 年
3	Nigerian Economic Policy 1999-2003	図書	ｵﾘｼﾞﾅﾙ	National Planning Commission	1999 年
4	Review of the Nigerian Economy 1998	図書	ｺﾋﾟｰ	Federal Office of Statistics	1999 年
5	Local Government in Nigeria	図書	ｵﾘｼﾞﾅﾙ	I. B. Bello-Iham	1996 年
6	Annual Report 1998	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1999 年
7	The Statistical Profile of Nigerian Women 1997	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1997 年
8	National Accounts of Nigeria 1981 to 1996	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1997 年
9	The Consumer Price Index 1995-1997	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1998 年
10	Socio-Economic Profile of Nigeria 1996	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1996 年
11	Report of the National Listing of Establishments (1997)	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1997 年
12	Poverty Profile for Nigeria 1980-1996	図書	ｵﾘｼﾞﾅﾙ	Federal Office of Statistics	1999 年

資料－１０　事前評価表（無償資金協力）

事前評価表（無償資金協力）

1. 対象事業名

ナイジェリア連邦共和国　地方電化計画

2. 我が国が援助することの必要性・妥当性

(1) 「ナ」国は、1999年の民政移管後、オバサンジョ大統領が来日するなど友好関係が増している。また、2001年1月に森首相が「ナ」国へ訪問するなど緊密な関係強化を図っている。

(2) 「ナ」国は、1970年代に大規模なインフラストラクチャーの開発を行ってきたが、国家財政の8割以上を原油に依存する経済体質と1980年代の放漫な経済運営により、国家財政の巨額の赤字と累積債務に直面し、一人当たりのGNPは310US$（1999年、世界銀行）まで低下している。このため、伝統的産業である農業は崩壊し、国内消費向けの農業生産にも大きな打撃となった。また、国家財政の悪化は、電力等の重要なインフラストラクチャーの整備・改修を遅らせる要因となっており、特に地方部でその整備が遅れている。

(3) 2010年を目標年次とした「ナ」国の最上位国家開発計画（VISION 2010）では、石油依存体質脱却のための農業生産性向上、全国民へ裨益するインフラ整備並びに生活水準向上を重点課題として揚げている。特に電力セクターについては、地方部の低い電化率（34%）を2003年までに60%まで向上させることを目標としている。

3. 事業の目的等

本計画は、「ナ」国が1989年から実施している全国地方電化プログラムに基づいて、同国の重要な地方政府庁所在地及び地域開発上重要な地方農村地区であるにも係わらず電化されていない町の内、優先度の高い5町を対象に、電化に必要な33kV送電線路網及び11kV配電線路網を整備することを目的とする。

4. 事業の内容

(1) 対象

地名	人口（万人）
ナサラワ州アウェ郡アウェ町	1.70
ナサラワ州ケアナ郡ケアナ町	2.08
バウチ州ボゴロ郡ボゴロ町	0.95
ゴンベ州アッコ郡カッシンギ町	1.10
ボルノ州モバール郡ダマサク町	4.00
合計	9.83

(2) アウトプット

1) 地方電化プログラムにおける電化率の向上
2) 地方行政の体制確立（地方行政庁事務所等）
3) 公共サービスの向上（保健医療・基礎教育・給水事業等）
4) 住民生活の向上（照明・家電）
5) 地域産業振興の促進（農業・商業）

(3) インプット

1) 33kV送電線（総線路長　約349km）及び変電所用資機材（5ヶ所）の調達及び据付

2) 11kV配電用資機材（総線路長　約31.8km）及び予備品並びに工具の調達

3) ソフト・コンポーネント

「ナ」国側負担工事範囲の11kV配電線据付工事に対するコンサルタント派遣技術者による施工監理技術の指導

(4) 総事業費：　約32.88億円

(5) スケジュール

1) 第1期工事：　2000年11月から約15.5ヶ月

2) 第2期工事：　2001年6月から約17.5ヶ月

3) 第3期工事：　2002年6月から約19.5ヶ月

(6) 実施体制

1) 先方実施機関：　電力鉄鋼省電力検査局（FMPS）

2) 運転・維持管理：　国家電力公社（NEPA）

5. 成果の目標

(1) 電化率の向上

「ナ」国の未電化LGHQ所在町121町の3.3%にあたる４町及び未電化の開発上重要な町472町の0.2%（1町）が電化される。

(2) その他の社会的効果

・ 医療面において、電力を要する医療機器等が常時使用可能となり、近代的な保健医療サービスを受けられるようになる。

・ 教育面において、照明器具を用いた夜間学習はもとより、パソコン等の電力を利用した教材を活用することにより、効率的な学習（特に科学教育、基礎的職業訓練）が可能となる。

・ 産業面において、脱穀機、電動工具、電動ミシン等の電力利用設備導入による農業及び小規模工業（鍛冶屋、製縫業等）の近代化・効率化の普及に寄与する。

6. 外部要因リスク

(1) 先方側実施機関による計画・施工体制の確立

・ 本計画の日本側工事工程に併せた、「ナ」国側負担範囲の11kV配電線用据付工事及び415V低圧配電線資機材調達・据付工事を行うための施工チームの結成。

・ 本計画のソフト・コンポーネントで実施する施工監理技術（工程計画、要員計画、資機材購入計画等）の技術移転教育及び日本側工事期間中のOJTに参加する技術者の迅速な選定。

(2) NEPA管理事務所の設置及び職員の確保

・ 各計画対象地域に、本計画完了までに当該電力施設の運転・維持管理及び需要家へのサービスを行うための管理事務所の設置。

・ 当該電力施設供用開始後の運転・維持管理体制の確立。

(3) 電力料金徴収体制の確立

・ 全需要家への個別の積算電力量計の設置

・ 検針の徹底等公平な電気料金徴収体系の確立。

7. 今後の評価計画

(1) 事後評価に用いる成果指標

各計画対象地域の電化率（%）

地　名	2001年	2002年	2003年	2004年
ナサラワ州アウェ郡アウェ町	0	100	100	100
ナサラワ州ケアナ郡ケアナ町	0	100	100	100
バウチ州ボゴロ郡ボゴロ町	0	100	100	100
ゴンベ州アッコ郡カッシンギ町	0	100	100	100
ボルノ州モバール郡ダマサク町	0	0	0	100

(2) 評価のタイミング

1) ソフト・コンポーネント実施時

2) 瑕疵検査時