



ELECTRICITY MANAGEMENT SERVICES LIMITED

4, Dar Es Salem Crescent, Off Aminu Kano Crescent, Wuse II, Abuja, FCT

INSPECTION REPORT OF JOS-MAKURDI 330KV DC OVERHEAD TRANSMISSION LINE

Your letter No NIPP/TRX/2041/2014 dated 28th November, 2014 on the above subject matter refers. Please be informed that the Inspection/Test of Makurdi – Jos 330KV (DC) OHTL with the associated Makurdi 330/132/33KV substation and 330KV line bays extension at Jos was carried out between 8th and 14th December, 2014. The following persons were present for the exercise;

a. Electricity Management Services Limited (EMSL) Officials:

- | | | |
|------|---------------------------|------------------------------|
| i. | Engr. T.T Aliyu | Head (TS & IS) |
| ii. | Engr William C. Metieh | SA (Technical) - MD's Office |
| iii. | Engr. Mustapha Baba Umara | SA Tech (HMSP) |
| iv. | Engr. Usman Momoh | Ag AIE (Abuja) |
| v. | Engr. Gideon Nanjwan | AIE (Jos) |
| vi. | Mr Baba David Danlami | Engineer 1 (Jos) |

b. Consultant (Colenco Consulting Limited):

- | | | |
|----|-------------------|------------------------|
| i. | Engr. Ibe Odo Uma | Colenco Representative |
|----|-------------------|------------------------|

c. TCN Officials:

- i. Engr. Emma Akpa PM (T) Apir Works Centre
- ii. John B Kuminyawo
- iii. Hillary C. Attah
- iv. Julius A. Oboh AM (System Operation)
- v. Vitalis C. Ihome SM (System Operation)
- vi. Edwin N. Ike AM (System Operation)
- vii. Jean Loius Nnamchi

d. Contractor (North China Power Engineering Co Ltd) Officials:

- i. Sun Ziyu Project Manager
- ii. Zhou Ping Substation Electrician
- iii. Leo Ge Administrator
- iv. Hu Kai Bin Project Administrator

2. Project Details and Objective

2.1. Contract Details

Client	NDPHC
Consultant	Colenco Consulting Limited
Contractor	North China Power Engineering Co Ltd.

2.2. Project Description

2.2.1. Makurdi – Jos 330kV DC OHTL	
Total length	286 KM
No of Circuit	Two (2)

No of Conductor per Phase	Two (2)
No of Spacers per Phase/Span	6/7/8
No of Dampers per Phase/Span	4/6
Conductor Type	ACSR
Conductor Size	350mm ²
Phase Configuration	Vertical
Earth Wire Type	Copper (Substation); Galvanized Steel (Earth Shielding System)
OPGW	Galvanized Steel with embedded Optic Fibres
Type of Support	Lattice Galvanized Steel Towers
Type of Foundation	Grillage/Concrete Pad & Chimney
Rated Voltage	330KV
Insulator Type	Disc Assemble (Glass)
No of Insulators per Phase	20/22

2.2.2. Makurdi 330/132/33KV Substation

- i. 330KV interconnecting bays with associated protection (V.Ts, C.Ts, Line Isolator, Breaker, etc.) Schemes for the incoming Ugwuaji 330KV DC OHTL, outgoing Jos 330KV DC OHTL, 132KV interconnecting bays and with their associated protection schemes
- ii. 1 x 150 MVA, 330/132/33KV Power T/F
- iii. 1 x 60 MVA, 132/33KV Power T/F
- iv. Control Room with Control & protection Equipment Therein
- v. 1 x 75 MVar Shunt Reactor
- vi. 1 x 300 KVA, 33/0.415KV Station Service T/F



2.2.3. Jos 330/132/33KV Substation

- i. 330KV bays extension
- ii. 1 x 150 MVA, 330/132/33KV Power T/Fs
- iii. 1 x 60 MVA, 132/33KV Power T/Fs

2.3. Project Objective

The purpose of this project is to link and/or interconnect Benue and Plateau States with 330KV National Grid System, while having the North-South loop of the 330KV Grid System.

2.4. Summary of Observations & Recommendation

S/NO.	PROJECT AREA	OBSERVATION	PICTORIAL ILLUSTRATIONS	RECOMMENDATIONS
1.	Tower structures and Foundations	<p>The 330KV DC Makurdi – Jos OHTL were seen supported on towers made of galvanized steel lattice construction. Each of the tower legs were firmly erected on rectangular concrete foundation (bases). Anti-vandals (specially made) bolts and nuts were used for fixing the tower members. Also the step bolts used for the erection of the tower were still in position at the time of our inspection visit</p> <p>The following were also observed;</p> <p>i. The integrity of the</p>	 	<p>i. In order to prevent easy climbing access by vandals, all the step bolts below the anti-climbing devices should be removed from position as advised</p> <p>ii. The contractor is expected to demonstrate the integrity of the anti-vandals bolts and nuts used in the construction of the towers</p> <p>iii. All tower location within visible erosion</p>

anti-vandals bolts and nuts used were not adequately demonstrated by the contractors.

ii. Some chimneys were observed completely buried and there was also indication of water retention at the tower legs (T133, T160, T208, T288, T529)

iii. Loose nuts and bolts were observed on some towers (T217, T655 – Leg “B”)

iv. On some towers, improvised holes for fixing of anti-climbing devices were not adequately treated against rust (T246, T277)

v. Excavations for laterite observed occurring in close proximity to some towers (T20, T36, T529)

vi. Some of the bolts and nuts used for fixing the earthing conductors on the tower legs were observed rusting (T234)



prone areas along the entire transmission route length, should be provided with erosion control measures

iv. All observed loose bolts and nuts on the towers should be re-tightened

v. Improvised holes for fixing of anti-climbing devices should be treated against rust using zinc-oxide paint as supposed to the aluminum paint employed

vi. All excavation works within the vicinity of the towers should be stopped and towers already affected by excavations need to be protected by barriers/embankment

vii. All rusting/non-galvanized bolts and nuts for fixing earth wire conductors to the tower legs should be replaced

2. Materials of line conductors, Earth conductors and other fittings

The materials employed for the line conductors are aluminum re-enforced with steel (ACSR) of code name "Bisson" having a cross-sectional area of 350mm². The earth conductor for the towers were of the type galvanized steel, with the cross-sectional area of 104mm²

The following were also observed;

- i. The OPGW link to T8 was disconnected
- ii. All conductors of the two circuits were joined at some points between towers (T285 and T286), thereby creating a point of possible failure in the future



- i. The OPGW link to T8 tower should be reconnected to the tower
- ii. The joined points of the conductors should be carefully observed for sign of un-stranding and this should be avoided in subsequent projects. TCN should also be notified of the locations for close monitoring when the lines are put to use

3. Anti-climbing Devices, Danger notices/Plates, Anti-vandals etc.

Anti-climbing devices and danger plates have been provided/fitted on all the towers from Makurdi to Jos as per design. However, it was noticed that the already fitted phase identification plates for the two circuits were done on the cross-arms and they are not readily visible. Aerial identification plates were seen provided on the overhead transmission towers at intervals of about 10 towers apart, these are also not readily visible. Other observations are;

- i. Disparity of phase identification observed on tower (T240)
- ii. Considering the existence of a major Nigerian Airforce base in Makurdi, there were no aerial marker balls on the transmission lines.



- i. The phase indication should be adjusted to ensure right sequencing/order
- ii. Aerial marker balls should be fitted on the uppermost conductors of the transmission lines
- iii. The phase identification plates should be lowered for better visibility

4. OHTL Stabilization Facilities From thorough inspections and checks, insulators, spacers, vibration dampers and corona rings were provided and properly erected except we noticed loose dampers on tower (T277) which may have the tendency of coming in contact with the nearest conductor spacer.



The loose dampers should be re-tightened to avoid possible archings when in contact with the spacers.

5. 330KV OHTL Status The tensioning of the 330KV OHTL at some sections were observed not uniformly executed as can be seen from conductors imbalance (mismatch) per phase at the span between towers (T248 and T249) (red phase conductors of circuit 2), also between towers (T249 and T250).



These conductors mismatch should be corrected to achieve the required tensioning uniformity.

6. Line Trace and Access Road

The terrain traversed by the 330KV DC OHTL is a difficult one with abundant visible gulleys, heavy vegetation, swampy areas, hills and mountains, built-up areas; refer to areas between towers (T45 and T52, T160 and T161, T173 and T174, T252 and T253, T266 and T267, T275 and T279, T554 and T555, T652 and T654, T671 and T672) etc.

Contrary to the contractors claim on provision of motorable access earth road along the OHTL route, it was discovered that the access road has been overtaken by shrubs, cultivated farm lands, vegetation encroachments etc.



The line trace should be properly and adequately maintained and secured. Appropriate procedures need to be put in place by the Contractor to ensure clear access along the entire route.

All erosion prone areas should be adequately backfilled and compacted.

7. 330KV OHTL Crossings Observations also revealed that there were no railway lines crossings along the trace of the 330KV DC OHTL. However, the line crosses Benue river between towers (T37, T38 and T39) and it also crosses existing 33KV, 11KV and 0.415KV OH lines at many locations. It also crosses some major roads. At all these crossings, statutory safety clearances were maintained throughout the lines route. Other observations are seen as in appendix II



- i. The 330KV OHTL passes over buildings between towers (T24 – T25), (T33+1 – T34), (T231 – T232), (T232 – T233), (T263 – T264), (T653 – T654), (T671 – T672)



- i. All existing structures within the right of way of the transmission line should be demolished.
- ii. The contractor should liaise with the respective distribution companies to ensure that all channel irons of the 33/11KV lines at the crossings of the 330KV OHTL are appropriately earthed.

8. Earthing System/Earth Tests Carried out

Two methods of earthing system in addition to the grounding sky wire were adopted. Namely;

- Counterpoise earthing
- Individual tower legs earthing

In both cases, physical earth connection to the tower legs was seen and visible. The results of the random earth resistance measurement tests for the tower legs were as recorded in appendix III



The contractor should carry out further earthing improvements for all earthing resistance above 10 Ω

9. Makurdi 330/132/33KV Substation

North China Power Engineering Co Ltd. Pre-commissioning engineers proved the integrity of the Makurdi 1 x 150 MVA, 330/132/33KV substation by executing and demonstrating the following functional tests in our presence (EMSL engineers) where practicable;

- i. Remote/manual and automatic operations of all isolators and circuit breakers
- ii. Operation of all earthing switches
- iii. Relay injection simulation test to verify differential, overcurrent and earth fault protection schemes were not demonstrated
- iv. Tripping of circuit breakers in response to actuation of Bucholz relay and



- i. The contractor should carry out relay injection simulation test to verify differential, overcurrent and earth fault protection schemes in the presence of EMSL engineers
- ii. Likewise, the tripping of circuit breaker in response to actuation of Bucholz relay and transformer pressure release valves

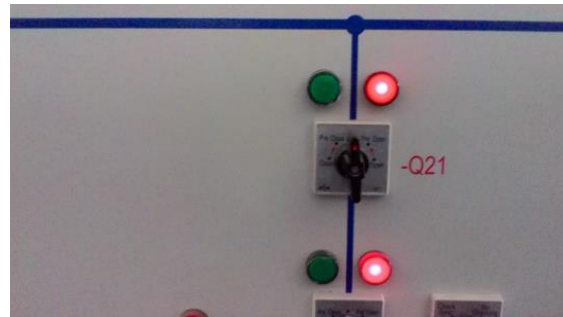
transformer
pressure release
valves were not
demonstrated

Further observations within
the substation and control
room revealed the following;

- i. The ugwuaji 330KV
DC lines run over
the substation. This
is a potentially very
dangerous design
as non-isolated live
lines will be
running over a
supposedly dead
station when the
breakers are in
open position
- ii. On the main
substation control
panel, clockwise
rotation of
operating switches
turn off the
respective
substation devices
whilst anti-
clockwise direction
turns them on. This
is against normal
practice/standard



- iii. The running of
ugwuaji 330KV DC
lines over the
substation is unsafe.
A diversion to clear
the substation is
recommended



- iv. The control panel
switches should be
re-wired to conform
to standard, which is
clockwise to "ON"
and anti-clockwise to
"OFF"

-
- of clockwise ON and anticlockwise OFF
- iii. On the main substation control panel, the indicators are Green when the substation equipment is ON and RED when the equipment is OFF. This is against standard practice and design of having indicators to be RED when the units are ON, and GREEN, when the units are OFF. It was observed that in the main substation, local indicators on the Circuit Breakers show RED on CLOSE and GREEN on OPEN, which is directly opposite to what happens in the Control room. This is confusing and unsafe



- v. The control panel indicators should also be re-wired to indicate RED when the units are ON and green when the units are OFF

iv. No insulation rubber mats provided for all the panels in the control room

v. A lot of the cable entries into the panels do not have cable glands, and the sealing compound used may degrade over time



vi. The contractor could not demonstrate the operation of the changeover switch/interlock between the station's 415V supply and the standby generator supply

vii. The exhaust of the generator was within the generator room

viii. Although the main 150MVA transformer oil temperatures were being indicated on



vi. Contractor to provide insulated rubber mats on all control panel floors

vii. Appropriate cable glands should be used, while all panel entries sealed to prevent rodents from gaining access to the panel

viii. Generator, main supply, changeover/interlock operation should be demonstrated prior to handing over the substation

ix. The exhaust of the standby generator should be moved out of the generator room

x. Appropriate means of monitoring transformer windings temperatures should be installed in the control room

the Control panel, there was no indication for the transformer winding temperature.

Relying on the oil temperature may not give an accurate indication of the transformer windings temperatures



- ix. Some of the labelling on the control panel are not explicit enough. On some panels the upper label indicates Jos 2- Jos 1 whilst the line diagram below indicates Jos 1- Jos 2



- x. Some bolts and nuts used on the substation gantries were found to have corroded.



- xi. The labelling in the control room should be consistent and explicit

- xii. Replace all corroded bolts and nuts with galvanized ones

xi. Most of the earth leads of the perimeter lighting columns were not properly bolted, and some bolts, nuts and washers have rusted. A drainage bar welded to the metal fence was found rusted at the point of welding. At the Makurdi-Jos feeder 1, all the metal support bars for the CVT control panel are rusted.



xii. The standby generator house was being used as storage for expanded metal, formwork, used tyres, clothes and other flammable materials. It was generally very dirty and cable trenches were still left open without covers. Cable entries not properly glanded



xiii. Tighten all bolts and nuts and coat all exposed welded joints with zinc-oxide and thereafter with aluminum paint

xiv. The generator room should be cleared of all items and left free of all storage items at all times

xiii. During the tap change operation on the 150MVA power transformer, there was severe noise emanating from the bevel gear mechanism



xiv. The red phase earthing switch on the Jos 2 feeder was difficult to operate in comparison with the rest earthing switches. The key lock was malfunctioning



xv. A relay module on the Ugwuaji line was not available, though the Contractor stated that this unit was on its way from Lagos, having been ordered earlier





xvi. The Contractor confirmed that they have sufficient spares for the control panel modules and devices.

xv. The 150MVA transformer tap changer mechanism should be serviced to prevent failure whilst operational

xvi. The red phase earthing switch on the Jos 2 feeder should be rectified

xvii. The contractor to confirm when the expected relay module is available on site

10.	Jos 330/132/33KV Substation	At the time of our inspection visit, the 1 x 150 MVA, 330/132/33KV transformer was energized. The necessary inspections of the substation was therefore not carried out	The contractor to supply the results of all the tests carried out in Jos substation before the commissioning
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11.	General Observations	<ul style="list-style-type: none"> i. During the construction of pile foundation for tower (T33), a stream was blocked. The blockage has caused flooding around the area ii. The metal doors of the control rooms are not earthed iii. The eye wash basin installed in the battery room was not safely positioned 	 	<ul style="list-style-type: none"> i. The blockage should be removed to enable free flow of the water since the pile foundation construction has been successfully executed ii. The frames of all metal doors of the control room should be earthed iii. The eye wash hand basin should be safely positioned to make it readily available in an emergency
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- iv. A review meeting was held at Makurdi substation control room. The highlights of the meeting is attached as appendix I



Conclusion

Please note that the re-inspection and certification of the project will be carried out on your compliance with the action points/recommendations of this report and the necessary payment of Inspection and Re-inspection fees in the sum of **Four Million, Six Hundred and Ninety Seven Thousand, Two Hundred and Fifty Naira (₦ 4,697,250.00) only.**

Signed by:

INSPECTING/TESTING AUTHORITY: ELECTRICITY MANAGEMENT SERVICES LIMITED -----

Date-----

APPENDIX I

REVIEW MEETINGS AFTER INSPECTION

A site meeting was held to review the entire inspection from Jos to Makurdi.

ATTENDANCE

S/NO.	NAME	ORGANISATION	DESIGNATION	E-MAIL ADDRESS	TELEPHONE
1	Engr B.U. Mustapha	Fed Min of Power –Abuja		babaumaramustapha@ymail.com	08037683488
2	Sun Ziyu	NCPE		sunzy@ncpe.com.cn	08053315348
3	Zhou Ping	NCPE		52799840@qq.com	08149841050
4	Leo Ge	NCPE		995063134@qq.com	07055886947
5	Hu Kai Bin	NCPE		hukabinjacky@163.com	07068495149
6	Qin Keven	NR		qinxw@nrec.com	
7	Engr Ibe Odo Uma	COLENCO CONSULTING LTD		beatonprojectsLtd@yahoo.com	08069569517
8	Engr Tukur Aliyu	EMSL – HQ		aliyutukur67@yahoo.com	08033493741
9	SA (Technical) – MD’s Office	EMSL – HQ		cynbil.ltd@gmail.com	08070990009
10	Engr U.O. Momoh	EMSL – Abuja		u-momoh@yahoo.com	08033494940
11	Engr Baba David Danlami	EMSL –Jos		davedanlami@yahoo.com	08065399466
12	Engr Emma Akpa	TCN		emcarrol1966@gmail.com	08032114844
13	John B. Kuminyawo	TCN (SO)		johnkuminyawo@gmail.com	08036404150
14	Hillary C. Attah	TCN (SO)		attah.hillary@gmail.com	08067799682
15	Julius A. Oboh	TCN (SO)		juloboh@yahoo.com	08051485456
16	Vitalis C. Iheme	TCN (SO)		ihemevitalisc@gmail.com	08065646780
17	Edwin N. Ike	TCN (SO)		ikeideal@yahoo.com	08060854898
18	Jean-Loius Nnamchi	TCN (AWC S/L)		nnamchiJeanloius@gmail.com	08051424216

HIGHLIGHTS OF THE MEETING

1. EMSL observed and commended the good workmanship and adherence to standards displayed at the switchyard by the contractors.
2. It was generally noted that the switchyard construction, static test and operational settings were substantially successful apart from the single earth switch on Jos 2 circuit.
3. The Client/project owners were asked to note that it was of paramount importance to complete all necessary remedial works along the Jos – Makurdi 330kV DC OHTL and also within the switchyard to ensure a healthy installation with proven integrity.
4. All the observations noted in the reports were discussed in the meeting.
5. While thanking the team for a Job well done, the contractor promised to look at all observations raised with a view to carrying out the recommendations therein.

APPENDIX II

MAKURDI – JOS 330KV DC OHTL CROSSINGS

B/W Towers	Existing 132kV	Power 33kV	O-H 11kV	Lines 0.415kV	Major Roads	Rivers	Buildings	Remarks
T6 – T7			✓	✓				
T24 – T25			✓	✓			✓	Demolish Buildings
T33+1 – T34			✓	✓	✓		✓	Demolish Buildings
T34 – T35		✓						
T35 – T39						✓		
T45 – T46					✓			
T166 – T167		✓						
T216 – T217		✓						
T230 – T231		✓			✓			
T231 – T232		✓			✓		✓	Demolish Buildings
T232 – T233		✓			✓		✓	Demolish Buildings
T263 – T264		✓			✓		✓	Demolish Buildings
T323 – T324		✓						
T324+1 – T324+2						✓		
T361 – T362					✓			
T362 – T363		✓						
T452 – T453		✓			✓			
T473 – T474		✓						
T474 – T475					✓			
T515 – T516					✓			
T554 – T555		✓			✓			
T578 – T579		✓			✓			
T595 – T596		✓						
T649 – T650	✓							
T650 – T651		✓			✓			
T653 – T654		✓			✓		✓	Demolish Buildings
T654 – T655		✓			✓			
T671 – T672		✓			✓		✓	Demolish Buildings

APPENDIX III

JOS-MAKURDI OHTL TOWER LEGS EARTH RESISTANCE READINGS IN OHMS

TOWER NUMBER	Ohms (Ω)	Ohms (Ω)		TOWER NUMBER	Ohms (Ω)	Ohms (Ω)
T2	2.79			T198	1.40	1.50
T4	4.70			T204	0.66	0.66
T5	6.40			T208	1.00	1.20
T9	0.20	0.30		T217	0.45	0.43
T10	0.56	0.55		T231	0.60	0.50
T20	3.00			T232	0.50	0.40
T24+3	0.62			T234	0.55	0.56
T27	1.00	0.97		T237	0.90	1.00
T36	0.82	0.80		T240	8.78	8.79
T39	3.36			T244	10.90	11.40
T45	0.69	0.69		T246	10.70	10.70
T52	1.06			T250	7.60	7.60
T56	0.68	0.67		T252	4.10	4.30
T63	0.69	0.69		T266	0.68	0.63
T77	0.50	0.50		T269	0.40	0.50
T87	0.90	0.80		T275	2.20	2.30
T95	0.40	0.39		T277	0.90	0.70
T101	0.39	0.39		T285	4.40	3.90
T117	0.41	0.40		T301	1.31	1.92
T133	0.24	0.23		T302	2.10	2.00
T149	0.36	0.35		T311	0.67	0.67
T160	0.45	0.44		T324	1.35	1.26
T166	0.40	0.40		T344	0.80	0.67
T173	1.51	1.80		T362	4.57	4.22

T178	1.26	1.29		T387	3.42	5.59
T187	0.75	0.75		T394	2.80	2.44

TOWER NUMBER	Ohms (Ω)	Ohms (Ω)		TOWER NUMBER	Ohms (Ω)	Ohms (Ω)
T402	4.09	3.61		T515	13.60	25.30
T413	8.57	3.52		T516	1.87	8.03
T422	8.81	8.96		T517	9.80	7.10
T437	11.20	4.10		T529	11.50	12.20
T444	9.07	7.00		T534	22.70	16.40
T453	9.90	19.70		T551	2.40	1.60
T465	2.76	6.34		T555	7.10	7.96
T472	2.13	7.79		T570	3.90	5.20
T476	3.58	7.35		T578	9.00	8.50
T487	4.78	7.04		T581	1.94	7.10
T489	6.10	7.60		T594	11.8	16.10
T493	10.70	6.40		T595	6.10	7.10
				T603	1.86	0.93

REMARKS: Contractor should please take steps to improve the earthing on those towers with earth resistance readings that are above 10 Ω .

APPENDIX IV

EARTH RESISTANCE READINGS [OHMS Ω] IN MAKURDI SUBSTATION

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Standby Generator	0.67Ω	0.56 Ω
Steel Support for OH water tank	0.68	0.67
Street Light column by generator house	0.68	0.68
Steel structure for generator diesel tank	0.67	0.71
Lighting Column by main gate	0.22	0.23
Lighting column by security gate house	0.21	0.22
Lighting column by Control room	0.33	0.33

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Switchyard fence Point 1 [Back fence]	0.14	0.15
Switchyard fence Point 2 [Back fence]	0.19	0.20
Switchyard fence Point 3 [back fence]	0.17	0.20
Switchyard fence Point 4 [Side fence – north]	0.12	0.15
Switchyard fence Point 5 [Side fence – south]	0.17	0.23
Switchyard fence Point 6 [Side fence – east]	0.13	0.22
Floodlight by side fence [north]	0.18	0.18
Floodlight by side fence [south]	0.32	0.31

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Control room earthing protection	0.14	Point 1: Point 2: - 0.15 Point 3: - 0.16 Point 4: - 0.15
132KV Switchyard		
Floodlight column 1	0.19	0.18
Floodlight column 2	0.20	0.21

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
330KV Switchyard		
Transformer body		0.13
Earthing transformer support		0.14
CVT support		0.13

Floodlight column 3	0.13	0.15
Floodlight column 4	0.13	0.14
Gantry	0.13	0.13
33KV Switchyard		
33KV Isolator support	0.12	0.13

LA support		0.13
Gantry facing 132KV switchyard		0.13
Gantry facing 330KV transformer		0.12
Circuit Breaker support		0.11

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Incomer from 330KV Station Gantry		
CA Support		0.12
Gantry		0.11
CVT Support		0.13
Wave Trap support		0.11
Isolator support		0.11

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Makurdi – Jos Feeder 1		
CA Support		0.13
Gantry		0.13
CVT Support		0.14
Wave Trap support		0.13
Isolator support		0.14
Floodlight 1	0.21	0.21

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
33KV Switchyard		
33KV Isolator support	0.12	0.13
Floodlight column 1	0.21	0.21
Floodlight column 2	0.21	0.20
Lightning Arrestor Gantry	0.18	0.17
33KV VT support	0.17	0.17
33KV Busbar support	0.17	0.17
33KV Circuit Breaker support	0.17	0.17

ITEM /AREA DESCRIPTION	EARTH LEAD	EQUIPMENT BODY
Makurdi – Jos Feeder 2		
CA Support		0.12
Gantry		0.11
CVT Support		0.12
Wave Trap support		0.12
Isolator support		0.12
Floodlight 2	0.21	0.20

