TANESCO DISTRIBUTION ENGINEERING INSTRUCTION MANUAL

9TH EDITION

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LIST OF ABBREVIATIONS

ABBREVIATION/TERM	MEANING OR DEFINITION OF THE TERM
AAC	All Aluminum Conductor
ABC	Aerial Bundled Conductor
ATV	Asset Transfer Voucher
AMR	Automatic Meter Reading
AAL	All Aluminum
ACSR	Aluminum Conductor Steel Reinforced
Al	Aluminum
AR	Auto- re-closer
a.c	Alternating Current
BA	Billing Accountant
BS	British Standard
BS EN	British Standards European
CAIDI	Customer Average Interruption Duration Index
CAIFI	Customer Average Interruption Frequency Index
CE	Construction Engineer
CM	Credit Meter
CWO	Capital Works Order
CSD	Customer Service Department
CRB	Contractors Registration Board
CT	Current Transformer
CAP	Chapter
CP	Concrete Pole
C/S	Cycles Per Second
Coy Sec	Company Secretary
Cu	Copper
CS	Customer Service
DA	District Accountant
D1	Domestic customer
DB	Distribution Board
DOF	Drop Out Fuse
DCM	Dough moulded Cut out
DC	Direct Current
DM	District Manager
DMD(D&CS)	Deputy Managing Director (Distribution and Customer Service)
DMD(T)	Deputy Managing Director (Transmission)
DS	Disconnect Switch
DSN	Distribution System Nomenclature
DT	Distribution Transformer
DP	Distribution Pillars
ELB	Electricity Licensing Board
ELD	Earthed Line Design
EHV	Extra High Voltage
ELCB	Earth Leakage Circuit Breaker
FTC	Fuse Tube Carrier

GPS	Global Position System
GMT	Ground Mounted Transformer
GL	General Ledger
HV	High Voltage
HF	High Frequency
HP	Horse Power
HRC	High Rupture Capacity
HDCC	Hard Drawn Copper Conductor
HORPC	Head Office Revenue Protection Committee
HSC	House Service Cut-out
Hz	Hertz
IIS	Installation Inspection Section
IEE	Institution of Electrical Engineers
IEC	International Electrotechnical Commission
IID	Installations Inspection Department
ILD	Insulated Line Design
IEEE	Institute of Electrical and Electronics Engineers
IMT	Indoor Mounted distribution Transformer
IR	Insulation Resistance
kV	Kilo Volt
kW	Kilo Watt
kVA	kilo Volt Ampere
kWh	Kilo Watt hour
LV	Low Voltage
LUKU	Lipia Umeme Kadri Unavyotumia
LPU	Large Power User
LT	Low Tension
LA	Lightning Arrester
LBS	Load Break Switch
ME	Maintenance Engineer
MV	Medium Voltage
MU	Metering Unit
MAS	Meter Advice Slip
MO	Manager Operations
MOV	Metal Oxide Varistor
MCOV	Maximum Continuous Operating Voltage
MRC	Meter Reading Card
MCCB	Moulded Case Circuit Breaker
MCB	Miniature Circuit Breaker
MDs	Managing Director's
NC	Net Cost
NTL	Non-Technical Loss
OF	Order Form
OV	Over Voltage
OLTC	On Load Tape Changer
O&M	Operation and Maintenance

PE	Principal Engineer
PpM	Pre-paid Meter
PPM	Programmable Polyphase Meter
PME	Principal Maintenance Engineer
PSSCA	Power Supply Service Contract Agreement
Pf/PF	Power Factor
PVC	Polyvinyl Chloride
PMT	Pole Mounted Transformer
PT	Potential Transformer
PG	Parallel Groove
PM	Pole Mounted
PC	Porcelain Clad Cut out
RCM	Reliability Centered Maintenance
R&M	Repair & Maintenance
RCD	Residual Current Device
RCM	Reliability Centred Maintenance
RCRO	Regional Customer Relation Officer
RHRO	Regional Human Resources Officer
RM	Regional Manager
RV	Rated Voltage
RPE	Revenue Protection Engineer
RMU	Ring Main Units
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SE	Senior Engineer
SMS	System Master Station
S/L	Service line
SPN	Single Phase and Neutral
SPU	Small Power User
SPDU	Small Power Distribution Units
SIV	Stores Requisition/Issue Voucher
SLAF	Service Line Application Form
SLQF	Service Line Quotation Form
SRV	Stores Return Voucher
SPU	Small Power User
SMD	Senior Manager Distribution
SB	Split Bolt
S/S	Substation
SR	Sectionalizes
SRA	Senior Revenue Accountant
STE	Specific Temporary Employee
TANESCO	Tanzania Electric Supply Company Limited
T1	Tariff 1
T2	Tariff 2
T3	Tariff 3
TPN	Three Phase and Neutral

TDEI	TANESCO Distribution Engineering Instruction
TOV	Temporary Over Voltage
TT	Earthing System
TN	Earthing System
TBU	Transmission Business Unit
VT	Voltage Transformer
WP	Wooden Pole

INTRODUCTION

Engineering Instruction Manual is the guideline for those who undertake day to day activities in the Directorate of Distribution and Customer Services.

The main activities are: Safety issues, Planning and Design, Construction, Maintenance and Operation, Service line application and connection, Accounting Instruction and Regulations about customer services.

This manual shall be in force immediately after inception by EWURA. After having passed through legal procedures and been endorsed by EWURA, this manual shall become a bylaw of the company. EWURA shall be responsible for overseeing adherence to laid down instructions by the company management.

The stake holders of this Engineering Instruction Manual are: Company Management, Engineers, Technicians, artisans, and linesmen who undertake various distribution works. Other stakeholders are Company Auditors, Engineering Committee, Directorate of Generation,Transmission (grid substations) surveyors, accountants, IT department, Company Legal department, Ministry of Energy and Mineral, Rural Energy Agency- REA, customers and the general public.

The document has been prepared by the group of company engineers from Distribution and Customer Services Directorate and other departments.

The Engineering Instruction Manual is the revised (9th Edition) version of former Engineering Instruction. This 9th edition has been set up quite different from the former Engineering Instruction.

Whereas the former Engineering Instruction was giving guidelines to limited engineering disciplines namely: service line application charges and construction, street light, financial regulation on CWO, a little bit of Safety Issues, Customer premises inspection, the new manual takes much more deeper approach in covering all distribution engineering disciplines as follows:

- Health Safety and Switching and Work Procedures: Safety Issue has been emphasized very much as the company is still undergoing cultural change in making every employee upper and lower echelons to accept safety at work places as life prerequisite to everybody.
- Planning and Design has been introduced in this manual for the first time. Planning Engineers up to this moment are engaged with service line works. We are going to have all of construction works of any nature to be designed. For the first time the company is going to conduct planning for distribution network: by conducting load forecast, load flow analysis and applying GIS technology to the regions at large. The company has already purchased software for these works.
- Construction works shall come from simply carrying out works depending on individual knowledge to planned, designed and properly constructed works according to laid down standards. Project financial viability shall no longer be calculated based on only anticipated annual revenue and total installed power capacity (and being tested only for one year) but we shall adopt NPV (Net Present Value) analysis based on the following factors: total project cost, Life Cycle cost (maintenance cost, cost of losses, and cost of undelivered energy due to scheduled and unscheduled outage), load demand and anticipated annual revenue. Testing for financial project viability shall be spread over a period of seven years.

- Maintenance work shall evolve from simple R&M Work Order opening for Repair works (attending breakdowns) to more elaborated maintenance based on inspection report, planned preventive maintenance with measurable output based on distribution performance indices such as SAIDI, SAIFI, CAIDI and CAIFI. It is all about Reliability Centred Maintenance – RCM which puts forward system reliability requirement of power supply and customer needs.RCM includes prevention and corrective maintenance. It is expected that soon the company shall purchase software for maintenance activities. The software addresses supply and single system equipment reliability. The company also is expected to realize importance of system performance condition based through inspection and measurements
- Quality of power supply is introduced for the first time. This new approach for the system has picked up internationally in 1980s.Here we are enlightening our engineers and the management on the role of the company as far as Power Quality is concerned. That both utility and customers contribute to power quality problems but the company should strive to clear its side and that the company shall have to learn and adopt international standards on power quality.
- About new connections, customers with small dedicated transformers to be metered on the HV side irrespective of the tariff category. Although losses on say 50kVA transformer is very little, but taking hundreds of such transformers scattered in the system, and summing up their cost of losses per year the result is high
- Rural Electrification department is expected to make big technological changes in collaboration with REA in promoting affordable service connectivity through low cost design for rural electrification initiative.
- Technical loss reduction has been approached by merely collecting reports about units generated, units exported, units used in company premises and finally units sold, and lost. The company is going to address measures and strategies to reduce losses.
- Through this document, much attention shall be put on distribution construction cost and how to reduce it.

This manual shall assist Regional Managers in writing proper job descriptions for their engineers.

The list for new approach is somehow long but it also include include as well as the Demand Side Management which is also crucial undertaking for the company.

DEFINITIONS

The following definitions shall be used:

APPARATUS: All equipments, in which electrical conductors are used, supported, or of which they may form a part.

FOREMAN: A person qualified by technical knowledge and experience and selected by the Work Management/ Work Supervisor to be responsible for the personal safety at the place of work.

OPERATIONS MANAGEMENT: A person or department responsible for operation, planning of operation and issuing of necessary instructions.

OPERATION ORDER: A document of a format defined in these rules, specifying the action to be taken for work, outages and switching.

OPERATIONAL PERMIT: Confirmation by the holder of the Permit to Work that the apparatus/ lines concerned have been released for operation, with the changes specified in the document.

OPERATIONS SUPERVISOR: A person nominated by the operational Management to be responsible for switching in a specified area, system or plant.

PERMIT TO WORK : Confirmation by the Switching Supervisor that the apparatus or lines has been released for work, that safety precautions have been taken to the extent set out in the document and that these precautions will be maintained until an operational Permit is issued by the holder of the Permit to Work.

SWITCHING: The apparatus of circuit breakers, disconnectors/isolators or other means of making and breaking an electric circuit and or/ the application and removal of earthing.

SWITCHING OPERATOR: A person who carries out switching as per order.

SWITCHING SUPERVISOR: A person selected by the operational Management to manage switching

WORKER: A person who takes part in the work, under the supervision of a Foreman.

WORK MANAGEMENT: A person or department that plans the work orders its execution and issues the necessary instructions for its executions.

WORK SUPERVISOR: A person selected by the Work Management to be responsible for the execution of the work.

REVENUE PROTECTION: General term combining all efforts aimed at ensuring that the **difference** between distributed energy and the energy sold is at the minimum level possible.

REVENUE PROTECTION UNIT: Name applied to a Technical Section which is responsible with implementation of revenue protection matters, especially in assurance of metering reliability at customer points.

SMALL POWER USERS (SPU): Single or three phase domestic or commercial user metered on whole current credit or prepaid meter. These are also known as Tariff 1 customers.

LARGE POWER USERS (LPU) LV: is a Three-phase Low-Voltage (LV) connected commercial or industrial users, metered through current transformer (CT) operated meters. These are also known as Tariff 2 customers.

LARGE POWER USERS (LPU) HV: Three-phase High Voltage (HV) either at 11kV or 33 kV connected commercial or industrial users, metered through current transformers (CTs) and potential transformers (PTs). These are known as Tariff 3 customers.

SPECIAL CONTRACTS CUSTOMER: Three-phase High-Voltage (HV) at either 220 kV or 132 kV connected Industrial or Bulk Power Users metered through current transformers (CTs) and potential transformers (PTs). These customers have **Special Tariffs**

TEST METER: Testing instrument installed at metering system of customer premises, to verify the accuracy of the existing meter.

ENGINEERING INSTRUCTION NO. TDEI-O1

HEALTH AND SAFETY

This instruction complies with Occupational Health and Safety Act, 2003; Electricity Act of 2008 cap.131, Fire and Rescue Act of 2007, Employment and Labour Relations Act 2004 and all related regulations. Managing Director, Deputy Managing Directors, Senior Managers, Managers, Head of Departments, Heads of Sections Supervisors/foreman and every employees are responsible for health and Safety at the company workplaces.

1.1 The prime responsibility for Safety and Health remains to be under the Managing Director and members of the Management of the company and that any accusation in the course of company business which prosecutes member of the management shall not prevent a further prosecution of the company.

1.2 Every employee has to observe Health and Safety policy and follow up all directives in order to ensure health and safety promotion in the company and to all employees in general. Refer and observe Health and Safety policy statement of generating, transmitting and distributing electrical power to consumers but executing all these activities safely. All works whether new construction or maintenance shall be carried out after conducting pre-job discussion where through it risk assessment is also done.

1.3 Health and Safety rules, regulations, working procedures, directives and other company management statements contained in the comprehensive health and safety manuals mentioned below have legal value, and shall be used to create Safe, healthy and friendly working environment in the company, to safeguard the assets of the company, to protect the environment in which we work and live and finally to minimize loss and maximize the profit. The manuals shall be read and understood by every employee. All working staff must have access to the Health and Safety Rules manuals as listed here below:

1.3.1 Operating safety rules and regulations.
1.3.2 Health and safety policy.
1.3.3 OSHA policy for understanding National health and safety directives.

1.4 Disciplinary action will be taken to any employee violating Safety and Health regulations/rules and procedures in accordance with the Company's disciplinary procedures such as termination, demotion, reprimand and fine.

1.5 Health and Safety issue shall be one of the company key performance indicators which direct the company to have no accident. This implies that the Deputy Managing Directors, Senior Managers, Managers and Regional/Plant Managers shall oversee the health and safety in the company in particular areas of responsibility.

1.6 Regional/plant managers or divisional managers shall submit preliminary report of any incident of an accident occurring in their company workplaces to Manager Safety -Head Office within twenty four hours and a complete detailed report revealing the root cause within fourteen days.

1.7 Regional/plant managers or divisional managers shall ensure that company infrastructure is inspected

periodically and take immediate rectification steps if anomalies are found in the systems.

1.8 Safety department shall be consulted in purchasing of materials, uniforms and must participate in inspection of safety gears and working materials before being used to monitor and control quality for health and safety promotion.

1.9 Safety of the public buildings must be inspected and tested during power connection and commissioning. The premises' wirings have to be inspected as per recommended period for safety insurance in order to avoid property loss.

1.10 Fire protective equipment shall be supplied to every company premises and positioned at strategic places. They must be timely serviced in the period of one year. The premises must also be fumigated in the same period.

1.11 Company management shall ensure compliance to standardized design, construction, and line materials and maintenance works for good quality of workmanship and safety at large.

1.12 Managers shall ensure that all employees are protected at their work places against excessive noise, less Air (Oxygen), less light, excessive heat (temperature) and observe Ergonomic matters for promotion of their health. Noise limit to be 85dB, Air to be at an average of 21%, level of light not below 200 lux and working heat in offices, power stations and substation buildings with temperature of not above 28°C. Employees must work in a good environment to get rid of ergonomic problem where office furniture must be properly and well designed for use. Recommended space of occupancy per person is approximately to be **$3.7m^2$** or **$11m^3$.**

1.13 DMD (T), DMD (D&CS), Company Sec and Regional managers shall make sure that transmission and distribution lines way leave are free from any object and that trace clearance is conducted from time to time. In the same reason no any structure will be electrified if it is found within the way leave corridor. Such structures shall be demolished according to laid down procedures. To meet the mentioned conditions the rules observe different width of way leave corridor depending on voltage levels.

1.13.1 11 kV 5m, that is 2.5m on each side from the centre line.
1.13.2 33 kV 10m, that is 5m on each side from the centre line.
1.13.3 66 kV 20m, that is 10m on each side from the centre line.
1.13.4 132 kV 40m, that is 20m on each side from the centre line.
1.13.5 220 kV 60m, that is 30m on each side from the centre line.
1.13.6 330 kV 80m, that is 40m on each side from the centre line.
1.13.7 400 kV 80m, that is 40m on each side from the centre line.

1.14 Regional/Plant Manager shall ensure maintenance of the systems is timely done to eliminate anomalies as unmaintained systems are the major source of accidents.

1.15 Regional Managers shall ensure that employees and materials including poles and equipment are transported in different vehicles when going to worksites.

1.16 Regional Managers and divisional managers shall ensure that equipment/machineries including transformers are crated when required to be transported to avoid unnecessary loss due to damage.

1.17 All works whether new construction or maintenance shall be carried out after conducting pre-job discussion where through it risk assessment is also done.

1.18 Switching and other operations in Company's networks must be done following proper and recommended procedures, safety rules and regulations where proper switching Management/sequences must be strictly observed. Any employee violating these rules and procedures shall face disciplinary actions. Employees shall follow rules and regulations concerning permits request/receipt as stipulated in operating safety rules and regulations manual when performing different activities in the networks.

1.18.1 Permit to Work – PTW
1.18.2 Sanction for Test – SFT
1.18.3 Limitation of Access – LOA
1.18.4 Hot Line Order – HLO.

1.19 Regional/Plant Manager and Manager Transport and supplies shall ensure all company vehicles/motorcycles are properly and timely maintained and all drivers must strictly observe all driving rules.

1.20 INSTRUCTIONS FOR SWITCHING LV AND HV SYSTEMS FOR THE PURPOSE OF CARRYING OUT WORKS

Procedures for switching and work have been ignored by those carrying out the works and the result has been frequent accidents which most of them result in fatal incidents. The instructions given here below cover the necessary procedures for safe switching before the work is started.

1.20.1 PLANNING

1.20.1.1 Careful planning is necessary to achieve safety. The work Management/ Work Supervisor and the Operations Management/ Operation Supervisor must cooperate in this planning.
1.20.1.2 Clear rules must be established for the division of work between the Switching Supervisor, Switching Operator, Foreman and Workers during switching and work.
1.20.1.3 All apparatus must be marked so that they can be identified. Cubicles and switches must have clear markings indicating the circuits to which they belong. All poles in overhead lines should be marked wherever the risk of confusion could arise.

1.20.2 RESPONSIBILITY FOR SWITCHING AND WORK

1.20.2.1 The Management of the company should determine the responsibilities of the persons who regardless of their status should perform different duties related to safety during switching and work.
1.20.2.2 The Operations Management shall issue the necessary instructions for switching and ensure that Operation Orders are issued and Switching Supervisors are selected.
1.20.2.3 The Operations Management can select an Operations Supervisor and specify his area of responsibility.
1.20.2.4 The Operations Supervisor is responsible for switching and operations within a specified area, voltage system or plant. The Operations Supervisor can either be the Switching Supervisor

himself, or he can appoint a Switching Supervisor for certain switching operations within his area of responsibility.

1.20.2.5 The Work Management shall plan and issue instructions for the work and, in cooperation with the Operations Management, plan the necessary outages.

1.20.2.6 Within the Work Management, the Work Supervisor is responsible for the execution of the work and for selecting persons who have the necessary knowledge for the work to be executed. The Works Supervisor appoints the Foreman, if he does not act as such himself.

1.20.2.7 The Switching supervisor is responsible for the switching in his area. The switching Supervisor shall issue an Operation Order if that is not done earlier by some other person or department.

1.20.2.8 The switching Supervisor can do the switching himself or with assistance of a Switching operator.

1.20.2.9 The foreman is responsible for the personal safety at the place of work. The foreman shall be at the location during the whole period of the work.

1.20.2.10 A person who performs a task single-handed is also regarded as a Foreman

1.20.3 DIVISION OF WORK

The following are divisions of work intending for planning and execution of switching and work on dead equipment when the work management, Work supervisors are different persons. Two or more functions can be held by one person, depending on circumstances.

1.20.3.1 PLANNING

1.20.3.1.1 The Work Management plans the work and the necessary outages.

1.20.3.1.2 The Work Supervisor plans the execution of the work, appoints the Foreman, decides the necessary disconnections and issues special safety regulations for the work.

1.20.3.1.3 The Operations Management plans the outages and switching, and issues the operation orders and appoints the Switching Supervisor

1.20.3.2 ACTION BEFORE WORK

1.20.3.2.1 The Switching Supervisor orders the necessary switching or executes it himself, and hands over the Permit to Work to the Foreman.

1.20.3.2.2 The Foreman waits for the Permit to Work – if he is not responsible for the switching himself and takes the necessary safety precautions at the place of work.

1.20.3.3 ACTION DURING WORK

The Foreman is responsible for the personal safety during the execution of the work.

1.20.3.4 ACTION AFTER WORK

1.20.3.4.1 The Foreman hands over an Operational Permit to the Switching Supervisor, if a Permit to work has been issued.

1.20.3.4.2 When the Switching Supervisor has all the Operational Permits, he orders the necessary switching or executes it himself.

1.21 SWITCHING AND WORK ON SYSTEM VOLTAGE UP TO 1000V (LOW VOLTAGE SYSTEM)

1.21.1 ISOLATION FOR WORK

1.21.1.1 Equipment or line shall be in such a way that it cannot become live from any direction.

1.21.1.2 Isolation shall be carried out by means of an isolating device which is safe for the person who does the switching and which gives a sufficient isolation.

1.21.1.3 Isolation shall be carried out in such a way that a visible isolation gap is created or by a switching device with reliable position indication.

1.21.1.4 Switching shall be planned.

1.21.2 PROTECTION AGAINST ENERGIZING THE CIRCUIT DURING WORK

1.21.2.1 After isolation, the isolation device shall be tagged. Tagging means that a "WORK IN PROGRESS" tag is placed in a conspicuous location.

1.21.2.3 Switches, isolators or the like shall be locked, if possible.

1.21.2.4 Fuses and contact pieces that have been removed shall be stored so that they are not accessible to unauthorized persons.

1.21.2.5 These measures shall be maintained during the whole period of the work and shall be carried out by the Switching Supervisor.

1.21.3 TEST FOR VOLTAGE AND EARTHING

1.21.3.1 Test for voltage

1.21.3.1.1 After a section on which work is to be carried out has been isolated and all apparatus has been locked and tagged, a test for voltage shall be made to check that the section is dead.

1.21.3.1.2 The test shall be made by approved voltage tester.

1.21.3.2 EARTHING

The equipment or line shall be earthed – unless an exception has been specified. After isolation, locking and testing for voltage, and before the beginning of the work.

1.21.3.2.1 Exceptions from the earthing demands are when work is to be carried out on underground cables, cables in ducts or the like where there is no connection to overhead lines and when work is to be carried out on pedestals, enclosed distribution boards or enclosed switch gear.

1.21.3.2.2 An approved earthing device shall be used for earthing.

1.22 SWITCHING AND WORK ON SYSTEM VOLTAGE ABOVE 1000V (HIGH VOLTAGE SYSTEM)

1.22.1 Isolation for Work

1.22.1.1 Equipment or line shall be isolated in such a way that it cannot become live from any direction.

1.22.1.2 Isolation shall be carried out by means of an isolating device which is safe for person doing the switching and which gives sufficient isolation.

1.22.1.3 Switching shall be planned and performed in accordance with written instructions – an operation order.

1.22.1.4 If the Switching Supervisor and the Foreman is the same person, he shall take the same action for the isolation as Switching Supervisor would be responsible to take.

1.22.2 SWITCHING SUPERVISOR

The Switching Supervisor shall:
1.22.2.1 Check and confirm the receipt of the Operation Order.
1.22.2.2 Ensure that the measures specified in the Operation Order are carried out
1.22.2.3 Receive Proof of Readiness (oral or written)
1.22.2.4 Issue a Permit to Work

1.22.3 SWITCHING OPERATOR

The Switching Operator shall:
1.22.3.1 Check and confirm the receipt of Operation Order
1.22.3.2 Carry out the switching ordered by the Switching Supervisor
1.22.3.3 Submit Proof of Readiness (oral or written)

1.22.4 FOREMAN

The Foreman shall:
Check and confirm receipt of the Operation Order.

1.22.5 SWITCHING ORDERS

1.22.5.1 Oral switching orders are given if an Operation Order has been received by the personnel
1.22.5.2 Written switching orders are given if an Operation Order has not been received by the personnel
1.22.5.3 The Operation Order could consist of written instructions for disturbances or routine switching
1.22.5.4 Switching shall be carried out in the sequence specified in the written instructions

1.22.6 PROTECTION AGAINST ENERGIZING THE CIRCUIT DURING WORK

Locking means that a mechanical devise is used to prevent operation of the equipment. This is normally done by locking the operating device and tagging it with a "**WORK IN PROGRESS"** location. The following measures for protection against energizing the circuit during work shall be carried out, on receipt of a special order by the person who carries out the switching or by the Switching Supervisor who does the work himself:

1.22.6.1 A hand operated disconnector shall be locked and tagged with a "WORK IN PROGRESS" tag.

1.22.6.2 A disconnector which is operated by means of a special tool, e.g. an operating rod shall be tagged with a "WORK IN PROGRESS" tag placed in a conspicuous location.

1.22.6.3 A motor-driven disconnector shall be mechanically blocked to prevent unintentional operation and it shall be locked and tagged with a "WORK IN PROGRESS" tag. In relevant cases the control circuit shall be isolated so WORK IN PROGRESS tag shall that remote control is impossible.

1.22.6.4 Draw – out apparatus shall be in the disconnected position and locked. A “WORK IN PROGRESS” tag shall be placed in a conspicuous location.

1.22.6.5 A “WORK IN PROGRESS” tag shall be placed at fuses and contact pieces. Fuses and contact pieces that have been removed shall be store so that they are not accessible to unauthorized persons.

1.22.6.6 Check carefully that the isolation point has adequate physical separation and that unintentional shunting is prevented, if isolation for work is carried out by removing jumper conductors.

1.22.6.7 These measures shall be maintained during the whole period of the work.

1.22.7 PROOF OF READINESS

Written proof of readiness shall be issued in the following cases:

1.22.7.1 When disconnector is locked after operation or after checking of the operational status.

1.22.7.2 When draw-out apparatus is locked in the disconnected position.

1.22.7.3 When fuses and contact pieces are removed and locking has been carried out.

1.22.7.4 When jumper conductors are removed for work.

1.22.7.5 When earthing is applied.

Written Proof of Readiness, for locked apparatus and applied earthing, handle over to the Switching Supervisor by the Operation Supervisor, means that the operational status of the network shall be maintained until the Proof of Readiness is cancelled.

Written Proof of Readiness is cancelled either by a written cancellation message or at the same as an order for new switching with the apparatus.

1.22.8 PERMIT TO WORK

A Permit to Work is issued after the equipment or line has been isolated and all necessary locking has been executed. Disconnections which are normally open shall also be locked and tagged during the work.

1.22.8.1 Written Proof of Readiness for earthing which has been applied on the order of the Switching Supervisor must be received before the permit to work is issued.

1.22.8.2 A Permit to Work shall be issued in writing and shall include information about the isolated apparatus or lines and the earthings applied. The boundaries shall be stated, e.g. by designation of disconnectors or the like, for wok in stations or on lines with sectionalizing disconnectors or branches.

1.22.8.3 The Switching Supervisor shall inform the Foreman from which direction the section could be made live, if the section is not earthed at all supply points.

1.22.9 TEST FOR VOLTAGE AND EATHING

1.22.9.1 TEST FOR VOLTAGE

1.22.9.1.1 After a section on which work is to be carried out has been isolated and all apparatus has been locked and tagged, a test for voltage shall be made to check that the section is dead, unless an exception has been specified. The test shall be made by means of an approved voltage tester or, if advisable, as spark test.

1.22.9.1.2 The exception from the test for voltage is for switchgear with an enclosure which is safe for the personnel, even if live equipment should accidentally be earthed.

1.22.9.1.3 A voltage tester or a spark test can be used only to test that the apparatus is not energized with service voltage

1.22.10 EARTHING

1.22.10.1 The apparatus or line shall be earthed after isolation, locking and test for voltage and before the beginning of the work.

1.22.10.2 Sequence of operations: isolation – locking; test for voltage; earthing; work.

1.23 TRAINING

Manager safety shall coordinate and ensure that training/seminars regarding identification Techniques of rotten and new poles, new construction and maintenance works, HV&LV switching certification course, general health and safety including medical surveillance to employees and STEs is frequently conducted at least once per year to promote health and safety in the company and among the employees at large. Any employee shall undergo medical examination before and after employment engagement.

1.23.1 Due to importance of safety issues while carrying out distribution networks company management shall ensure that all newly engaged engineers and technicians undergo 18 months mandatory rotational training. Training programme shall include 3 months at TTS whereby at the end of the programme, they shall be assessed on the knowledge acquired on switching and work.

1.23.2 Special training on switching regulation shall be conducted for Supervisors and Foremen on interval of three years.

1.23.3 The Company Management shall see to it that Supervisors and Foremen have different remuneration packages from those whom they supervise in order to have effective and efficient supervision at work sites.

1.23.4 Newly employed engineers and technicians shall undergo a mandatory training on switching procedures two years after completion of 18 months training after when they can qualify to become Authorized and Senior Competent Persons respectively.

1.23.5 Long time employed engineers and technicians shall qualify as Authorized and Senior Competent Persons only after having attended Switching course.

1.23.6 A Foreman shall be a person with a minimum of form four education or VETA graduate with Trade Test Grade One or Competent Based Education Training Level Four. Foreman must undergo training on Switching Procedures specifically meant for foremen after when he must qualify for Competent Person in switching matters. With working experience of not less than four years and above one can become a foreman.

1.23.7 Newly recruited linesman with little knowledge and experience should not be allowed to carry out other works apart from hole excavation, conductor carrying (only at ground level), pole loading/off loading on truck and pole erection using ropes under strict personal supervision. This also applies as well to the specific task employees.

1.24 PLANNNG, DESIGN AND CONSTRUCTION

Good system planning is necessary in order to have customer satisfaction in terms of reliability, quality and security of power supply. Planning should also accommodate future demand without difficulties. Safety requirement for the entire distribution network depends very much on system design and construction standards. Systems with substandard means of construction are very much prone to frequent outages and long outage duration. Good planning, design and construction are prerequisite for power supply reliability, power quality and safety of personnel working in the system and general public. Maintenance cost and cost of losses will be controlled depending on system planning, design and construction standards.

1.24.1 PLANNING

Regional planning engineer shall make sure that regional short and long term plans are available. Manager Planning and Design /Regional Manager/Planning Engineers shall make sure that in long range planning judgments are made based on:

1.24.1.1 Load forecasting.
1.24.1.2 Plans for exploitation
1.24.1.3 Changes in the overlying network
1.24.1.4 Load flow analysis: Calculation of voltage drops, load currents and short circuit currents
1.24.1.5 Inspection reports

1.24.2 Regional planning engineer should understand sources of information for planning strategies such as:

1.24.2.1 Customers
1.24.2.2 Land owners
1.24.2.3 Central or local government authority
1.24.2.4 REA for rural electrification programme
1.24.2.5 Maintenance Engineer

1.24.3 Regional Planning Engineer and Regional Maintenance Engineer should work together to improve distribution network efficiency by addressing issues of: distribution technical loss reduction, voltage drop along LV and HV system, system overload, system low power factor, phase unbalance, network configuration for safety switching during normal and emergency works and reduction of power outages by making proper technical and economical decision on:

1.24.3.1 Optimal interconnection of the feeders
1.24.3.2 Series capacitors, shunt capacitors, and voltage regulators
1.24.3.3 Reinforcement of existing lines
1.24.3.4 Constructing new distribution lines
1.24.3.5 Extension of transformer capacity in existing in Primary or Secondary substations.
1.24.3.6 Construction of new Primary or Secondary substations.
1.24.3.7 Question of raising or not raising voltage level from 11kV to 33kV.
1.24.3.8 To introduce Ring Main Unit system whenever possible to the distribution network work with many T-offs (laterals).
1.24.3.9 Manager Planning and Design /Regional Manager/Planning Engineers shall make sure that network planning strategies will be facilitated if some general guidelines are followed (as in 1.24.3.9 bellow) :

1.24.4 Decided established policy about:

1.24.4.1 Quality of supply (National Standard of Power Quality)
1.24.4.2 Design criteria for overhead lines and underground cables also selection of materials and equipment
1.24.4.3 Network layout
1.24.4.4 Environmental considerations
1.24.4.5 Technical parameters
1.24.4.6 Economical parameters
1.24.4.7 Existing laws and regulations
1.24.4.8Construction standards.

1.25 DESIGN

For any line (LV or HV) to be constructed, Regional Manager and Planning Engineer shall make sure that the proposed line route is properly surveyed and pole schedule is made available and that the route is chosen based on technical, economical, safety and environmental issues.

1.25.1 Regional Planning Engineer shall calculate Power Demand of the proposed project based on:
1.25.1.1 Demand factor or,
1.25.1.2 Diversity factor or,
1.25.1.3 Load factor or,
1.25.1.4 Coincidence factor or,
1.25.1.5 Utilization factor or
1.25.1.6 After Diversity Maximum Demand factor (ADMD).

1.25.2 Regional Planning Engineer shall select suitable size of conductor based on technical and economic criteria as listed below:

1.25.2.1 Selection of conductor size is made depending on economic current density (J in A /m^2) from handbooks. Calculated Power demand is divided by J, to get the conductor size. Another alternative is to select conductor size from the known company's standardized list of conductors which has to be tested compared depending on:

1.25.2.1.1 The maximum power transfer capacity
1.25.2.1.2 The conductor cross- section area should be such as to minimize the initial capital cost of the capitalized cost of loses i.e. conductor size is tested against line losses.
1.25.2.1.3 The conductor cross section area is tested against short circuit current (symmetrical three phase short circuit to earth).The main consideration is that conductor must not lose a significant amount of tensile strength due to annealing.
1.25.2.1.4 The choice of conductor from mechanical point of view depends upon external loading: wind speed and ambient temperature, internal characteristics: modulus of elasticity, thermal, thermal expansion and creep.
1.25.2.2 Using the selected conductor impedance, calculated apparent demand power, the line loss and voltage drop is calculated to see how much the selected conductor size can contribute to these parameters (power loss and voltage drop).

1.25.3 OVERHEAD LINE DESIGN

1.25.3.1 MECHANICAL DESIGN

1.25.3.1.1 Regional manager /Planning Engineer shall make sure that the mechanical design of the system must not only be adequate to sustain normal stress and strain but must safely sustain them during abnormal conditions. And that the minimum design criteria which define the following must be observed:

1.25.3.1.2 Clearance between conductors and surrounding structures for different operating voltages and under different conditions

1.25.3.1.3 Strength of materials and safety factors used in proposed structure

1.25.3.1.4 The probable loading imposed on conductors and structures based on climatic conditions.

1.25.3.2 ELECTRICAL DESIGN

For design of the line, Regional Planning Engineer shall apart from calculating and selecting conductor size be able to carry out selection of Voltage level, insulators, conductors, voltage control gears, capacitor banks, voltage regulators, and different types of line switches, protective control gear and transformers

1.25.3.2.1 The transformer size in kVA is calculated using calculated power demand and power factor.

1.25.3.2.2 Every regional office shall have several single line diagrams showing distribution network of the whole region, of separate districts and of grid substation or power station. Also single line diagrams of primary and secondary substations showing fault level of each substation and transformer and line characteristics.

1.25.3.2.3 Planning Engineer shall make a single line diagramme for LV network for new project by showing phase connection sequence for each new single phase customer to be connected in order to have phase balance. The drawing shall also show entire LV network showing expected voltage profile of each LV feeder emanating from transformer substation. Voltage drop profile shall be shown cumulatively from the transformer substation. For design purpose the last pole along the LV feeder shall be with voltage drop of ± 4%.

1.25.4 CONSTRUCTION WORKS

DMD (D&CS) / MO/ Principal Distribution / Principal Maintenance Engineer/ RM / Planning /Construction Engineer / Maintenance Engineer / DM shall make sure that overhead lines (LV and HV), underground cables, transformer substations (pole and ground mounted) and service line drops construction, and maintenance works are supervised by well trained and experienced supervisors and foremen, and that linesmen and temporary employees are trained.

1.25.4.1 DMD (D&CS) /SZM/RMs shall make sure that working gangs (manpower) are staffed in accordance to real work force requirement and that departmental organization chart reflect today's real change in engineering and technological requirement in order to meet customer needs.

1.25.4.2 Regional Manager/ Construction/ Maintenance Engineers / District Manager/ Construction and Maintenance Supervisors and Foremen shall make sure that the following areas in construction and maintenance are closely supervised in order to get rid of substandard and poor workmanship in the distribution network:

1.25.4.3 Hole excavation shall be made with right depth in accordance to the pole height. Pole shall not be erected in the middle of the hole. Excavated soil shall be compacted around the pole and no soil will be left lumped around the pole.

1.25.4.4 Proper pole size in accordance with design calculation shall be used.

1.25.4.5 Construction of pole mounted transformer substation shall be in accordance with Construction Manual while observing transformer bed height from ground level, safe distance from HV jumpers to LV feeders emanating from transformer substation, and neat wiring of LV cables. Substation shall be constructed in such a way that it shall be possible and safe to work on the transformer while transformer HV fuses are removed (without switching off the main feeder), also emergency gang shall be able to work safely on LV feeder jumpers on substation and lame leg transformer poles without switching off the main feeder.

1.25.4.6 Construction of H- pole structure and plinth for ground mounted transformer shall be in accordance with Construction Manual.

1.25.4.7 Substation fence shall be constructed to standard civil works, proper gate with standard padlock shall be provided.

1.25.4.8 Proper substation earthing and fence earthing shall be made to correct earthing impedance values.

1.25.4.9 Mounting of HV cable of any size shall be made on H- structure

1.25.4.10 Danger/Hatari plate, barbed wire, pole number plate shall be properly fixed on the poles. If the old pole is removed during maintenance work, Danger / Hatari plate, barbed wire, pole number plate shall be fixed on the new pole.

1.25.4.11 The LV line route length from transformer substation shall depend on calculated loading (based on ADMD method) of the line during the initial design. Even if there is no software for the calculation, this is easily performed using excel programme.

1.25.4.12 Maximum number of poles on the distribution mains shall depend on the size of conductor, its power handling capacity, thermal capacity, power losses and voltage drop on the last pole along the distribution mains all these parameters are calculated during line design exercise.

1.25.4.13 Depending on calculated load during line design, trunk of the LV lines (distribution mains) can be single or two or three phase and size of conductor will depend on power handling and thermal capacity of the conductor, power losses and voltage drop at the terminal point of the line.

1.25.4.14 Maximum number of poles on spur lines shall be treated as in Part 1.25.4.12 above. Different poles along the main trunk from where loads are tapped are taken as load nodes where voltage profiles, losses between spans are shown.

1.25.4.15 For safety reason for the personnel working on emergency customer calls, combined type of construction (LV and HV conductors on the same pole) shall have conductors carried on HV poles only. Injecting LV poles in the midspan shall be considered as dangerous construction and therefore prohibited.

1.25.4.16 Stay work shall be designed, all mechanical forces calculated and pole top stay make off and stay block properly positioned and tensioned.

1.25.4.17 Proper standard stay blocks shall be used (treated wooden stay block, locally made concrete stay block, or steel plate).

1.25.4.18 Tension meters shall be used while stringing conductors.

1.25.4.19 In order to minimize voltage sags, voltage swells and internal overvoltage caused by loose connections along the lines and at transformer substation, all HV connections of the jumper joints, midspan joints, joints at substations, LV network joints and jumpers up to service line

terminations shall be solidly connected by applying proper termination preferably using crimping tools.

1.25.4.20 Disconnection / Reconnection team shall not disconnect unpaid account by severing any part of service line instead they shall find another conducive and safe way of doing so.

1.25.4.21 Number of poles distribution MV main line and its laterals shall be based on design results

1.25.4.22 Conductor size on distribution MV main line and its laterals shall be based on the design results

1.25.4.23 Span lengths shall not be of fixed measurements especially for MV distribution system where spans can be of 50, 100, 120, 150 even 200m depending on purpose of design e.g. low cost design.

1.25.5 POOR WORKMANSHIP ON TERMINATION

Poor workmanship on termination on HV, LV and service connections contribute to outages to customers, internal over voltage that damage customer properties, low voltage, voltage sags, and distribution losses. Therefore incomplete newly constructed or maintenance works shall not be commissioned unless the following are observed:-

1.25.5.1 This applies to works being commissioned with all jumper joints wrapped, transformer LV line outlets directly connected.

1.25.5.2 If at all the only available solution during commissioning is to wrap the joints, then the Regional Manager shall put in writing the reason why jumpers should be wrapped, and why transformer LV side should not be terminated.

1.25.5.3 Regional Manager's statement showing when materials for proper work shall be available, the statement shall be addressed to Senior Zonal Manager and SMD for follow up of final commissioning. In order to make good all defects noted during commissioning the works order number for a project in question shall not be closed until those defects (wrapped jumpers) are corrected.

1.25.5.4 For the contracted construction works where the company takes part as project supervisor or engineer, the engineer appointed by the region/head office to supervise such works shall have competency and experience in construction and supervision works, be acquainted with FIDIC (Yellow Book for electrical works) regulations and thoroughly read and understand the tender document for the work he/she is going to supervise

1.25.5.5 SMD/ Manager Rural Electrification/ Regional Manager / Regional Engineer shall make sure that the appointed engineer is given the terms of reference of the work he/she is going to supervise.

1.25.5.6 Supervising Engineer shall appoint a competent supervisor or foreman who shall always be at site with the Contractor. He/she shall be responsible to note all anomalies in the work carried by the contractor and report those anomalies to the Engineer on daily basis. But the site supervisor or foreman will not interfere with or talk to contractor. Engineer shall report those anomalies during the weekly site meeting or if the anomalies are of serious nature then the issues shall be discussed on the same day.

1.25.5.7 Leaning LV and HV poles, pole mounted transformer structure and any line structure are regarded as A NEAR MISS in safety terms, therefore, RM/ Construction/ Maintenance Engineer / DM shall make sure that leaning equipment are attended promptly whenever they are reported.

1.26 DISTRIBUTION COST REDUCTION

Unlike other departments in the company, Distribution Department is engaged in investing for new projects for new expansion, maintenance and system reinforcement every year. Due to this fact distribution cost: construction of lines, transformer substations and service line costs should be optimum so as to enable least cost investment in order to have affordable electricity services to the customers.

1.26.1 DMD /SMD /RM shall work hard to see that optimum cost of construction for the distribution undertakings is achievable by doing the following:

1.26.2 Making sure that any project or work is designed and tested for technical and economical viability. And that with any project or work there must be two variants to choose the viable from.

1.26.3 To see that over design for sizes of conductors, poles, transformers and other equipment is avoided.

1.26.4 Standardized sizes of conductors for LV distribution mains shall be 35, 50, 95, 100, 120 mm^2 AAC PVC, ABC for LV lines and 25, 50,100,120,150mm^2 ACSR or AAAC for HV lines.

1.26.5 Standardized sizes of poles are 11 and 12m medium or stout (depending on design and size of conductor). Use of 13m stout pole is overdesign and shall not freely be used unless for special terrains where line has to cross deep valleys. For LV poles we have 9m only, 10m pole is for transformer substation lame leg.

1.26.6 Standardized sizes of transformers shall go down from 50kVA three phase to 25, 15, 10 and 5 KVA single or three phase other higher scale three phase is 50, 100, 200, 300 (315), 500 KVA. Size of transformer will depend on calculated diversified load demand and not total capacity (nominal or rated capacity) of the premises to be electrified.

1.26.7 Manager Electrification shall make sure that the cost of rural electrification is made affordable by:

1.26.8 Establishing service line charges for Ready Board installation (the stock of ready boards has overstayed in the company stores without a solution).

1.26.9 Establishing cheaper means of metering system for rural residential and other single phase customers.

1.26.10 Establishing standard service line conductor sizes including lead in wire in accordance with different estimated demand load categories (existing practice is 2x25mm2 AAC OHL and 16mm^2 copper conductor).

1.26.11 To enhance low cost design already adopted by REA that is 33 or 11kV single phase two conductor system with single phase transformers for rural expansion projects. In this design, single phase motors with a maximum rated power of 7kW will be in use. Above that, three phase converter will be used in order to connect three phase motors.

1.26.12 SWER System (Single Wire Earth Return System) may be adopted for even lower cost design purpose. Manager Electrification shall be aware on technical and safety advantage or disadvantage of this system and shall advice the company accordingly on how to overcome the bad side of SWER.

1.26.13 In order to make sure that massive single phase rural electrification does not contribute much to technical loss to the distribution system, Manger Electrification/ Manager Planning/Regional

Manager shall make sure that all lines (even those already commissioned) are equipped with means of voltage regulation, power factor correction and automation whenever it viable.

1.26.14 RM/ Panning Engineer shall make sure that LV line shall be designed and a single line diagram of the distribution transformer network showing single phase connection sequence of each customer to a particular phase shall be given to the contractor (this avoids lumping of service lines anyhow on one phase which results to phase unbalance).This applies the same to other works carried out by the company.

1.26.15 RM/Planning Engineer shall make sure that all rural electrification proposals sent to REA are well documented by the region.

1.26.16 Proposed route line surveyed and pegged

1.26.17 Line design showing load demand of every settlement are shown proposed laterals to other settlement are shown, conductor size and loading of the whole line and voltage drop profile along the line also must be shown.

1.26.18 Design of transformer capacity, LV distribution network including service lines are shown.

1.26.19 Considering reliability of supply, design for fuses and or autoreclozers, sectionalizers LBS are included.

1.26.20 For voltage regulation: possible use of series capacitors, pole mounted voltage regulators and shunt capacitors for power factor correction.

1.26.21 Lines constructed on single phase two wire system shall not remain the same indefinitely, Planning Engineer shall monitor line loading trend, that when it shall be justified for three phase system then a third conductor shall be added, the same shall apply to SWER system.

1.26.22 For introduction of “new technology” in the system (actually this is about long time familiar applications by other utilities elsewhere in the world, we need not to test them but just to apply) the following procedures should be followed:

1.26.23 This is only when it is intended to introduce new application and replace old one at a massive scale for example introducing dry type transformer to counteract transformer oil theft, this means replacing almost all distribution transformers of most vulnerable towns or regions.

1.26.24 The proposal of the new introduction shall first be tabled before the Corporate Engineering Committee for scrutiny and after that it shall be presented to the Management for deliberations.

1.26.25 The proposal shall give details of necessary information showing what is needed.

1.26.26 Show the priorities in that field of application e.g. our priority in the field of technical loss is to reduce losses in the lines rather than in transformers.

1.26.27 Show other alternatives

1.26.28 Show the extent of application is it for the entire system or part of it. Also show time frame how long it will take to be accomplished.

1.26.29 Show how the application will be evaluated.

1.26.30 Show the expected cost. Present detailed Cost / Benefit analysis of the proposal.

1.26.31 SMD shall emphasize on the following priorities:

1.26.31.1 Technical loss reduction on 33,11,0.4/0.23kV lines up to service line terminations.

1.26.31.2 Frequent outages with long outage durations.

1.26.31.3 Loose connections on 33, 11, 0.4/0.23kV lines up to service line terminations.

1.26.31.4 Many rotten and leaning poles in the distribution system.

1.26.31.5 Distribution network automization.

1.26.31.6 Long extended feeder lines covering wide areas with many long laterals.

1.26.32 DMD (D&CS) shall endeavor to see that procurement of line materials, working tools and equipment are purchased direct from manufacturers or first line (main) suppliers.

ENGINEERING INSTRUCTION NO. TDEI 02
RELIABILITY OF POWER SUPPLY AND DISTRIBUTION NETWORK MAINTENANCE

INTRODUCTION

Reliability is the degree of performance of the elements of bulk electric system that result in electricity being delivered to customers within accepted standards and in the amount desired.

Reliability may be measured by the frequency, duration, and magnitude of adverse effects on the electric supply. Electric system reliability can be addressed by considering basic and functional aspects of the electric system adequacy and security.

Maintenance is one aspect, which should not be ignored at all. Strategic maintenance planning taking a higher view of how maintenance dovetails with other activities and events that impact of reliability will enable optimum utilization of the assets which will go a long way in providing reliable supply to consumers.

Maintenance costs and cost of losses are vital factors in deciding cost of energy. When a company has higher maintenance cost and cost of losses, the Regulator shall not allow the company to increase energy tariff unless those costs are reasonably reduced.

2.1. PERSPECTIVES ON RELIABILITY

2.1.1. The customer perspective

SDM/ MO/RM/PME shall make sure that service curtailments to customers are kept to minimum by:

2.1.1.1 Carrying out routine distribution network inspection
2.1.1.2 Carrying out condition based preventive maintenance works based on inspection reports
2.1.1.3 Having proper maintenance planning and scheduling and having maintenance budget based on inspection findings.
2.1.1.4 Making sure that the region adopts Reliability Centred maintenance (RCM) policy which is driven by concerns about the effects of customer interruptions.
2.1.1.5 Making sure that power supply outage frequency, power supply outage duration and extent of power supply outage (number of customers affected by every single power supply outage) are kept to minimum by carrying out effective distribution maintenance by: timely replacing old equipment, addressing overload issues, conducting trace clearance, installing line switches, and applying distribution network automation.

2.1.1.6 Adopting strategies to reduce interruption indices as follows:
2.1.1.6.1 Reduction of number of outages by:
2.1.1.6.1.1 Conducting preventive maintenance rather than breakdown maintenance.
2.1.1.6.1.2 Monitoring critical component like transformers. Avoid overloading of lines and transformers.
2.1.1.6.1.3 Employ better quality equipment. Quality assurance department shall have better knowledge by being equipped with up-to-date testing tools.
2.1.1.6.1.4 Preventive replacement of components which have reached the end of their useful life (pole replacement,reconductoring)
2.1.1.6.1.5 Tree trimming and periodical trimming of vegetation to prevent contact with conductors.
2.1.1.6.1.6 Protection against animals making contact with conductors.

2.1.1.6.2 Reduction of outage durations by:
2.1.1.6.2.1 Distribution network automization
2.1.1.6.2.2 System reconfiguration
2.1.1.6.2.3 Line sectionalization for quick fault tracing
2.1.1.6.2.4 Faster emergency gang response, reliable means of transport, radio communication increase of number of gangs and emergency service centres.

2.1.1.6.3 Reduction of number of customers affected by outage by:
2.1.1.6.3.1 Reconfiguration of distribution network,(interconnections, having shorter feeders, installing RMUs)
2.1.1.6.3.2 Installing more protective elements (fuses, autoreclosers, sectionalisers, remote operated disconnectors, earth fault throwers).

2.1.1.7 Making sure advance notice about planned outage is well communicated to customers

2.1.2 Utility Perspectives

From planning point of view frequency and duration of interruptions together with extent of outages (number of customers affected by outages) shall be recorded by Maintenance/Planning Engineer on daily basis (Daily Power Supply Status Report) and the recorded data shall be used by the regions to calculate the distribution systems performance indices such as: SAIDI, CAIDI, SAIFI, CAIFI etc.

2.1.2.1 MO/ Principal Engineer shall make sure that corporate distribution system performance indices are computed by making average of all regions.
2.1.2.2 The distribution system performance indices shall be the Distribution Maintenance Key Performance Indicators (KPIs) of each region.
2.1.2.3 In order to compute distribution system performance indices the following data should be known: number of feeder outages, feeder outage duration, number of customer served (customer base of the region or district) and number of customers affected by each feeder outage. Due to these requirements the regions must arrange to make known number of customers (and tariff category of each customer) per feeder.

2.1.2.4 From planning philosophy point of view, there is Reliability index-based design: The distribution system needs to be planned, designed and maintained with particular attention to interruption prevention.

2.1.2.6 For feeder design, there is an increase in reliability in going from radial to ring main systems. Therefore Regional Managers shall strive to make feeder interconnection in the cities, municipalities even in the townships.
2.1.2.7 Another choice in feeder design is between laying feeders underground or using overhead feeders. Underground system improves reliability. Overhead design is much less costly but more vulnerable to natural hazards (wind, lightning, flooding, vehicles hitting poles, trees touching the lines etc.) DMD(D&CS)/SMD/SZM shall endeavour to start planning for underground system especially for parts of the cities.
2.1.2.8 SMD/SZM shall make sure that circuit breakers, autoreclosers, sectionalisers, remote controlled disconnectors, dropout fuses and load break switches should intensively be used on feeders (especially long radial feeders) for protection and switching purposes.
2.1.2.9 From design stage Reliability of supply must be kept in mind that any line should be constructed with thought of having feeder automation.

2.1.2.10 DMD (D&C) shall make sure that suitable software for RCM and Component Reliability are made available for simulation of system outages and distribution component failure rate.

2.1.2.10.1 Failure rate and outage time of different components vary considerably depending on factors operational age and manufacturer (or supplier for items like wooden poles).

2.1.2.10.2 SMD shall make sure that the company has acquired knowledge about the reliability of individual components in the distribution component. This is about acquiring Modern Asset Management Methods which require information about component reliability.

2.1.2.11 In order to introduce cultural change of the company towards maintenance of the distribution network, SMD /MO / PME shall institute the following to the regions:

2.1.2.11.1 To enhance maintenance activities by conducting training to maintenance personnel.

2.1.2.11.2 To make sure head office maintenance team pays visits to all regions every year in order to do the following:

2.1.2.11.2.1 Scrutinize distribution network inspection reports: showing how frequent inspection is carried out, showing maintenance plans and scheduling on monthly; quarterly and annual basis.

2.1.2.11.2.2 Check the volume and quality of maintenance works carried out based on site inspection reports.

2.1.2.11.2.3 Check the daily branch maintenance work.

2.1.2.11.2.4 Check adequacy of line materials (the priority given by the region to maintenance works through material allocation out of existing branch stock)

2.1.2.11.2.5 Make sure regions are properly computing maintenance cost on monthly basis (maintenance cost consists of cost of materials, cost of labour and transport plus cost of undelivered energy due to shut down for planned or unplanned system outage),monthly, quarterly and annual maintenance costs should be shown separately for preventive and corrective works and finally the total

2.1.2.11.2.6 Verify correctness of all reports and make random inspection of the system.

2.1.2.11.2.7 To see to it that distribution system regional maintenance plans aim at improvement of the distribution system performance indices, technical loss reduction and improvement of power quality.

2.1.2.11.2.8 Check safety awareness of maintenance engineer, maintenance supervisors, maintenance foremen and linesmen about switching regulation and discussion before work.

2.1.2.11.2.9 Hold meeting with regional management committee and discuss the findings as a result of regional visit.

2.1.2.11.2.10 The outcome of the meeting shall be forwarded to SMD (copy to SZM and Zonal Engineering Committee) for further action.

2.2 DISTRIBUTION MAINTENANCE WORKS THAT ADDRESS SYSTEM LOSS REDUCTION

2.2.1 What are losses

2.2.1.1 Losses arise as we deliver power through our networks to meet customer loads. Conductors present resistance to the power flow. This causes voltage drop or loss of volts as currents pass through the networks and ultimately converts a fraction of electrical energy. Some power is dissipated or lost as heat in the conductors.

2.2.1.2 Losses are intrinsic to the process power delivery. They cannot be eliminated in any economical or practical way, what we need to do is to control or reduce them to a least damaging or economical optimum level.

2.2.1.3 Losses arise in network conductors, and in network transformers. Transformer loss are divided in : Load (copper) losses, and No load (iron) losses

2.2.2 LOSS REDUCTION MEASURES

Loss reduction on a power distribution system cannot be achieved in a simple programme. It requires a wide range of measures spanning all areas of distribution activity and spread over a large number of usually small projects.

2.2.1 Experience shows that the majority of the losses on HV and LV systems are attributed to:

2.2.1.1 Much extended lines with small size of conductors

2.2.1.2 Overloaded lines

2.2.1.3 Lines with low power factor,

2.2.1.4 Unbalanced load: presence of negative and zero sequence currents raise losses,

2.2.1.5 Overloaded distribution transformers and feeder pillars,

2.2.1.6 Poor quality of line construction: wrapped conductor joints,

2.2.1.7 Inappropriate service line conductor connections issue of corrosion as a result of direct jointing of copper and aluminum or wrapped joints.

2.2.2 RM/PE/SE/RPE/ CE/ ME/DM shall make sure that correct engineering measures are taken in distribution network planning, design, construction, operation and maintenance.

2.3 MAJOR STRATEGIES TO OPTIMIZE LOSS PERFORMANCE OF NETWORKS

RM/ PE/SE/RPE/CE/ ME/DM shall strive to do the following works in the distribution network:

2.3.1 To optimize Network loading, both in terms of optimal sectionalizing and load balancing across phases. Optimal sectionalization relates to balancing load across interconnected feeders to minimize total losses.

2.3.2 To install shunt or series capacitor (switched or not switched) to reduce reactive power flows, improve power factor and improve voltage.

2.3.3 To carry out network upgrading by reconductoring and constructing new transformer substations for load release and voltage improvement.

2.3.4 To consider Voltage conversion to reduce load currents in the network

2.3.5 To apply economically optimal design – optimum sizing of conductors and transformers for new construction and maintenance works.

2.3.6 To correctly install transformer substation at load centre.

2.3.7 To replacing high impedance power transformers

2.3.8 To manage distribution transformer load.

2.3.9 To reduce the primary and secondary conductor loading.

2.3.10 To reduce problems of low voltage to customers

2.3.11 Plan to install line voltage regulators along much extended feeder lines to improve power factor, reduce voltage drop, decrease current and hence increase power handling capacity of the line. This is much cheaper than considering other solutions, e.g. changing voltage level, building secondary substation, changing conductor sizes etc. It reduces corporate investment costs.

2.3.12 Plan to create interconnections. Interconnection of feeders eases system operations during emergency and planned switching. Interconnection can also solve problems with voltage drops and overloading of lines, and it reduces losses in the network and thereby giving economic benefit

2.4 EMERGENCY SERVICES

Emergency works also known as Temporary Breakdowns (TBs) shall be carried out either as Live Line works or works carried on dead line or equipment. Breakdown that involve service lines conductor and jumpers, and restoring blown out fuses can be carried out as live line works provided rubber gloves are used, safety distance is observed and work is carried out under personal supervision by the experienced and competent foreman.

2.4.1 Emergency Engineer / Emergency Supervisor / Emergency Foreman shall make sure that all other types of supply breakdowns works shall strictly be attended while line or equipment is made dead and all procedures for switching and work for either HV or LV system are followed.

2.4.2 RM/ Engineers / DM/ Technicians/Supervisors shall see to it that no short cut for switching procedure shall be entertained, any staff found omitting switching procedures or making shortcut shall immediately be dismissed from the work (always staff at work site do think that applying earthings is a cause for unnecessary delay, and that a work that takes some few minutes is not dangerous).

2.4.3 Following rampant fatal accidents involving STEs while carrying out works of emergency and maintenance nature, RM/SE/PE/ME/DM shall make sure that no STE is engaged in Emergency works.

2.4.4 RM/RCRO/RHRO/DM shall arrange for training of all emergency and other front desk staff on proper methods of handling customers during day to day discharge of their duties.

2.4.5 All staff who will fail to properly handle customers as per the Company policy and Customer Service Charter shall be disciplined accordingly and replaced.

2.4.6 RM/SE/PE/DM/ RHRO together with Manager Safety shall work together to conduct training on safety issues to all staff engaged in Emergency Services.

2.4.7 Any employee found to be seeking for “kick back” from a customer in order to render emergency service to that customer shall be committing act of bribery and shall face serious disciplinary actions.

2.4.8 Emergency Engineer shall be responsible for the follow up of all works (findings) referred by emergency team to other departments so as to be able to give the correct answer of the outcome to the customer.

2.4.9 RM/SE/PE/ME/RPE/CE/DM shall make sure that all Emergency works referred to Construction, Maintenance or Planning Departments or any complaints from the customer concerning low voltage, frequent outage, overvoltage, supply disturbances, long time unattended supply problem and company line or equipment posing threat to life and property shall be treated with high priority and written report shall immediately be sent to the affected customer showing him/her how the problem is being or has been or will be solved.

2.4.10 Maintenance Engineer shall collect all power outage report from Emergency Desk on daily basis.

2.4.11 Emergency offices set up shall be standardised throughout the Company (one stop shops).

2.4.12 Leaning LV and HV poles, pole mounted transformer structure and any line structure are regarded as A NEAR MISS in safety terms and should be reported as emergency case, therefore, RM/ Construction/ Maintenance Engineer/DM shall make sure that leaning equipment are attended promptly whenever they are reported. But the work shall be carried out by Construction / Maintenance gang.

2.5 EMERGENCY SERVICE GANGS

2.5.1 Emergency services must be customer service (CS) oriented.

2.5.2 A Senior Staff (Engineer/Supervisor) for large Regions and a supervisor / Foreman for smaller Regions and Districts will be in charge of the emergency desk. He will record all incoming data, extract data from an emergency foreman in the field, and compile the data in a useful manner for analysis, and will carry out subsequent follow up.

2.5.3 There will be an emergency cupboard with fast moving spares, fuses, line taps, binding wire, bolts & nuts, line connectors etc. It will also have tools & testing equipment, torches, sport lights etc.RM/DM/EM shall keep proper records of all materials in stock, and record and replenish the materials used during an emergency.

2.5.4 Emergency gang will draw fast moving spares from the cupboard and sign for them. They will have to account for their use upon finishing the shift. The Emergency Engineer/ Emergency Supervisor will inspect the emergency gang tool box before they take off to ensure that all tools and equipment are available. If some of the tools/equipment is not available, he will borrow from the emergency cupboard and make a report to the Regional Manager, who will take steps to replenish the gang's tools.

2.5.5 Emergency records shall be sorted out on weekly and monthly basis so as to determine the problematic areas and appropriate action will be taken to avoid repetitive complaints from customers. The records shall be sorted out by Emergency/Maintenance/Planning Engineer who will also evaluate the quality of the work of the emergency staff. Staff showing poor workmanship will not be allowed to do emergency works. The outcome of the sorted out records shall be presented to the Regional Management and further to the Zonal Engineering Committee for deliberation.

2.5.6 DMD (D&CS) shall make sure that Emergency gangs in the regions are fully equipped with standard working tools and equipment, means of transport, radio communication, safety gears and those emergency desks are computerized.

ENGINEERING INSTRUCTION NO. TDEI- 03

QUALITY OF POWER SUPPLY

Power quality is defined as any problem manifested in voltage, current, or frequency deviations that result in failure or misoperation of customer equipment. Actually it is the quality of voltage that is being addressed in many cases.

Power supply system can only control the quality of voltage; it has no control over the currents that particular loads may draw. Therefore, the standards in the power quality area devoted to maintaining the supply voltage within certain limits.

Types of disturbances in the distribution network include Harmonics, Sags, Swells, Overvoltage, under voltage, Voltage Unbalance, Waveform Distortion, Flicker and others.

3.1 INTRODUCTION TO SOURCES OF ELECTRICAL DISTURBANCE

3.1.1 Harmonics are a regular distortion of the voltage waveform often caused by the power supplies of electronic equipment. It can cause over heating in transformers, building wiring, and motors.

3.1.2 Harmonic distortion evaluation are currents produced by non linear loads, it can interact adversely with the utility system. The interaction often gives rise to voltage and current harmonic distortion observed in many places in the system.

3.1.3 To limit both voltage and current harmonic distortion, several standards propose to limit harmonic current injection from end users so that harmonic voltage levels on overall power system will be acceptable if the power system does not inordinately accentuate the harmonic currents. This approach requires participation from both customers and utilities.

3.1.4 Conventional solutions are: passive filters, surge suppressors, motor- generator sets, static VAR compensators, Uninterruptible Power Supplies (UPS), Ferro resonant transformers, and line power conditioners. Whereby - Passive Filters: Prevent customer site harmonics from getting to the distribution or transmission system, they are cheap, simple, and un-powered, but they need tuning and Active filters mitigate harmonic by producing harmonics currents equal to those in the load current, shunting them away, they are more. robust, but expensive, consume much power, and create high electromagnetic interference

3.1.5 Large industrial and commercial customers must have adequate protection to safeguard their equipment and installation. They shall not cause unwanted tripping of the utility supply. It is essential that industries with high demand capacity installation are monitored and checked for proper switching requirement. Should there be a fault within an industry's installation; the industry should automatically be disconnected without causing feeder outage.

3.2 SOURCES OF ELECTRICAL DISTURBANCE

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.2.1 All distribution substations must be adequately maintained with desirable protective device on the primary and secondary sides as per laid down standards, and satisfactory loading should be ensured.

3.2.2 Power disturbances that cause threat to the smooth operation of electrical equipment are kept to minimum. When power falls outside of the acceptable operating zone, it makes the electronic equipments operate incorrectly and shortens the equipment life.

3.2.3 Customers are protected from other sources producing excessive distortion on the supply and damaging equipment or causing inconvenient malfunctions. The problems are addressed by maximum levels of harmonic voltages which are allowed on the supply, maximum distorting current that household appliance can draw and maximum distorting current that industrial installation can draw.

3.2.4 Any actions taken by individual customers that worsen the quality of power supply are promptly reported. Such actions include wrong use of electricity, like use of high rated welding sets in a strictly residential area.

3.2.5 Disturbances by over/under voltage are controlled periodically by conducting distribution network inspection, patrol and with use of infra red camera to collect data for maintenance works...

3.2.6 Where new customers are connected to the distribution system, ascertain that the network performance does not deteriorate beyond the specified limits and impact negatively on other customers. The transformers and distribution mains are adequately rated and do not give rise to voltage sags.

3.2.7 OLTC on grid & primary substations is auto-controlled.

3.2.8 Customer Service Department (CSD) shall solicit and encourage new customers to safeguard installation against unwanted spikes and dips through setting up and installation of protective gadgets for precautionary protective measures on their internal distribution system.

3.2.9 Common disturbances that affect electronic equipments such as voltage sags, swells, spikes, over/under voltages, HF and Harmonics, blackouts and interruptions are analyzed on both utility side and customers in order to minimize to acceptable level. (Refer International Standards)

3.2.10 Power sags are reduced by replacing aging power lines and cables, transformers are inspected and maintained, trimming surrounding trees, performing diagnostic tests to locate potential problems within the distribution lines and equipment by installing and upgrading lightning protection.

3.2.11 Voltage and frequency regulation requirements are specified in terms of the allowed maximum deviation from the standard. The standard LT and MV distribution system voltage and permissible variation is as follows:-

Table 2: Nominal Medium and Low Voltage Levels and permissible variations

Voltage	**Standard Nominal**	**Permissible Limits**
0.4 kV	0.4 kV	± 5 %
11 kV	11 kV	± 10 %
33 kV	33 kV	± 10 %

3.1.12 Frequency standard is maintained at a nominal value of 50 Hz, and the permissible variation is ± 2.5% of the nominal value. This is taken care of by the generation and grid control center.

3.3 ELECTRIC MOTORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that all industrial electric motors shall be provided with means of starting and stopping, the latter placed so as to be easily operated by the person in-charge of the motor.

3.3.1 ELECTRIC MOTOR CONTROL

SMD /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.3.1.1 Every Electric Motor is provided with control apparatus as specified below:

3.3.1.1.1 Means to prevent automatic re-starting after a stoppage due to a drop in voltage or over load tripping or failure of supply.

3.3.1.1.2 Means of isolation is suitably placed and connected so that all voltages may thereby be cut off from the motor and all apparatus, including any automatic Circuit Breaker, used therewith**.** If this means of isolation is installed adjacent next to the motor, another alternative provision must be provided for the primary means of isolation to be locked in the off position.

3.3.1.1.3 It is acceptable that a single means of isolation may be provided for whole group of motors and associated control apparatus where for the purpose of carrying out inspection or other work on any individual motor in the group or on the control apparatus directly associated with such motor.

3.3.1.1.4 Every motor having a rating exceeding 5kW (7HP) shall be three phase connected and be provided with control apparatus and motor starters incorporating a suitable device to limit excessive starting current and provide protection against injurious transient over current and voltages including protection against spikes and single phasing.

3.3.1.1.5 Maximum permissible starting current for motors are as follows:-

Number of phases	Rating kW	Starting Capacity
1	0 – 1.5	7 times full load current
3	0 – 2.0	7 times full load current
3	Over 2 – 10	4 times full load current
3	Over 10 – 100	2 times full load current
3	Above 100	As directed by the Company

Table 3.1: Maximum permissible starting current for motors

3.3.1.2 Strict adherence to IEE regulations on industrial wiring and in particular to the motor starting limitations shall be maintained.

3.3.1.3 Installation Inspector should understand motors with capacities which are allowed to be started direct on line (DOL) (usually less than 10kW motors). Various methods used to reduce currents and torque for the purpose of smooth starting, that is: Star – Delta starting, autotransformer starting, starting via chokes or resistors, multistage starting, starting using electronic soft starter and starting using frequency inverters.

3.4 INDUSTRIAL POWER TRANSFORMERS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.4.1 Industrial power transformers connected to the system shall be a three phase type such as not to cause imbalance on system HV, MV or LT, service voltage. It is prerequisite that prior approval is obtained for all equipments intended to be connected to the system.

3.4.2 Use of two single phase to phase transformers connected as “Open Delta” or “V-Connected” transformer should be monitored, such that connection results in center phase shall not over load the system by giving rise to voltage sinking and higher voltage on the outer two phases, as it generates disturbance to adjacent customers.

3.5 ARC WELDING

SMD /SZM /Zonal Principal Distribution & Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that Arc welding machines in residential areas, should not be allowed, because it causes voltage dips, fluctuation and surge generation in the system.

3.6 CIRCUIT BREAKER

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that the MV and HV rated circuit breaker in use shall be for pre-strike and re-strike free. The surge caused by faulty circuit breaker has tremendous deteriorating effects on the quality of electricity supply. It produces huge, intolerable voltage spikes. Prior approval of utility must be obtained before bringing such equipments for connection on to the utility MV or HV system.

3.7 STEEL ROLLING MILL & FABRICATING INDUSTRIES

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:-

3.7.1 All steel industries must be connected through their own transformers at medium voltage and be restricted to the use of three phase equipment so as not to cause unbalanced voltage on the system.

3.7.2 Basing on the Company power quality standards, monitoring shall be done to ensure power quality at consumers metering point.

3.7.3 If a customer has low power factor below 0.9 shall be given six (6) months notice to correct the power factor; failure to comply the customer shall pay surcharge power factor (p.f.) penalty according to the Company schedule of costs.

3.8 SURGE ARRESTORS

3.8.1 SELECTION OF SURGE ARRESTOR

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that General principles of application of surge arrestors, referring to IEC and other international standards current in force, are applied during selection, installation, and servicing of surge arrestors, taking into account the specific features of the power supply system.

3.8.1.1 RATED VOLTAGE

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.8.1.1.1 The rating arrestor voltage should be near to and not less than the highest power frequency line-to-earth voltage to which the arrestor may be subjected to. The rated arrestor voltage is the power frequency voltage at which the arrestor is capable of interrupting power flow current after operation under the conditions laid down in IEC 99-4.

3.8.1.1.2 A system is designated as "**effectively earthed**" if the voltage - to - earth of the sound phase or phases during the occurrence of an earth fault does not exceed a factor of 0.8 (80%) of the normal line-to-line voltage. This factor of 0.8 is termed as the **coefficient of earthing**.

3.8.1.1.3 The system is designated as "**non - effectively earthed**", and co-efficient of earthing = 1. Nevertheless, variations in characteristics may occur in a system, and the maximum phase-to-earth power-frequency voltage at the point of installation of the arrestor should be determined as far as possible.

3.8.1.2 RATED DIS-CHARGE CURRENT

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.8.1.2.1. The discharge current / rating of an arrestor must have an adequate margin over the maximum surge current which can be discharged at the end of overhead lines to which the arrestor is connected.

3.8.1.2.2. The selection of an arrestor must be governed by economic consideration. In general, the more expensive arrestor of higher current rating gives better protection because of its lower dis-charge residual voltage, and its use is therefore justified at more important supply points.

3.8.2 POINTS OF INSTALLATION OF SURGE ARRESTORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.8.2.1. Surge Arrestors must be installed preferentially at points at which a single line terminates in a transformer or in a switch or circuit breaker.

3.8.2.2. As a rule, a surge Arrestors should not, be installed away from a protected equipment.

3.8.2.3. Surge Arrestors must be installed at a sub- station connected to a line with unearthed cross-arms. Line construction to horizontal configuration is subjected to much higher lightning voltage and is

therefore in greater need of protection by a surge arrestor than a station connected to a line with earthed cross-arms.

3.8.3 INSTALLATION OF SURGE ARRESTORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.8.3.1. An arrestor should be installed close to the equipment to be protected, and the distance between the arrestor and the equipment should be kept as short as possible. The distance from earth side of the arrestor to the earth must be kept as short as possible as well.

3.8.3.2. All MV switchboards must be protected against incoming surge through provision of LA on the emanating feeder cables.

3.9 SWITCHGEAR

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that Switch-gears should be installed near transformers and arrestors installed to protect the latter.

3.10 EARTHING

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that the Surge Arrestor's earth lead must take the shortest possible route, and a transformer tank should be connected to the same earth system as the arrestor.

3.11 SERVICING OF SURGE ARRESTORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.11.1 Surge arrestors should be regularly inspected and periodically cleaned to remove surface deposits, especially in areas subject to pollution.

3.11.2 Arrestor insulator surface needs to be cleaned and surface leakage needs to be eliminated before the Megger test is carried out. Care must be taken to use similar rated Megger Instrument while carrying out Megger test, as 1000 volts m Megger values cannot be compared with 100 volts Megger values. Megger Test – results should be evaluated by comparing them with previous tests or tests on similar arrestor units.

3.11.3 If a surge arrestor for one phase is punctured, the surge arrestors must be removed from all three phases and replaced. The removed surge arrestors are checked, and, if found usable, returned to stores for use elsewhere. Ensure that arrestors that are used together are of a similar brand; otherwise, the performance of the three phases may differ due to the different characteristics of the arrestors.

3.12 RECOMMENDED SURGE ARRESTORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that the following recommendations for installing arrestors and cables assume only one overhead line connected at each cable end. Arrestors are not required if at either end more than one line is connected or if the cable is tied from the overhead line.

	Unearthed Line		Earthed Line	
Voltage	**Cable Length**	**Number of Arrestors**	**Cable Length**	**No. of Arrestors**
33kV	Up to 3,000m	One only	Up to 150m	One only
	Over 3,000m	Nil	Over 150m	Nil
11kV	Up to 3,000m	one at each end	Up to 150m	One only
	Over 3,000m	one only	Over 150m	Nil

Table 3.2: Recommended Arrestors Installation to Unearthed and Earthed Lines

3.13 CONDUCTOR JOINTS, CLAMPS, INSULATORS, AND LINE SWITCHGEAR

This section of Engineering Instruction provides general information on conductors and cables in use, tension and non-tension joints, insulators, and LV and MV line switchgear. The information contained can be further clarified through the office of SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager where possible, the equipment in use has been shown on sketch.

Technical staff should update themselves on new product through various standards updates and publications

3.13.1 REQUIREMENT OF JOINTS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.13.1.1. The conductivity of the joint should not be less than that of an equivalent length of the conductor. Joints should be capable of carrying maximum fault current without failure or deterioration for the time required for the protective system to operate. A satisfactory joint is the one which, when tested for temperature rise test, gives results similar to the results obtained on the conductor or cable without any joint.

3.13.1.2. The efficiency of a joint is measured through the rise in temperature. The higher the temperature rise, the poorer the joint. In other words, the contact resistance of the joint shall be as low as possible. This applies for both tension and non-tension joints.

3.13.1.3. The mechanical strength of the conductor tension joint shall not be less than 25% of the breaking load of the conductor, where as non-tension joints are not designed for tension of any type.

3.13.1.4. NON TENSION JOINTS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.13.1.4.1. Bolted Joints

3.13.1.4.1.1 Two clamps should be used for high voltage line jumpers at angle and section poles, for low voltage neutral jumpers, and for all jumpers of conductor of size 100 sq mm or above.

3.13.1.4.1.2 All joints involving Aluminium surfaces must be brushed and cleaned before jointing.

3.13.1.4.1.3 Only correct size of bolted PG clamps, compression PG clamps, or line taps are used, and sufficient tightening pressure is applied so as to grip the conductor firmly. Use the right size of ring spanner to achieve tightening.

3.13.1.4.1.4 In case of Bimetallic SB or PG connectors, ensure that the Al conductor is on top and the Cu conductor at the bottom position such that moisture or water runs from Al to Cu conductors or sections. Ensure that the separating tong piece between Al and Cu for SB connectors is in place.

3.13.1.4.1.5 Conductors required for jumper from the Main line to transformers or from section to section on the LV and MV lines should be selected carefully and need to be of the correct size, type of tubes (Lugs), and compression dies.

3.13.1.4.1.6 A Bi-metallic lug must be applied for jointing overhead ACSR line to a pole mounted substation transformer terminals.

3.13.1.4.1.7 Where jumpers have to be connected first to Drop out Fuse (DOF), the jumpers should be properly matched for connection to the overhead ACSR, and the remaining jumpers to the transformer could be of copper, since the transformer and the DOF are designed to take CU jumpers.

3.13.1.4.2. Binding joints

Use of substandard binding joints is prohibited as it results in the conductor snapping off the holding insulator on to the ground, on to the D-irons holding the Bobbin insulator, or on the cross arm for MV lines.

3.13.1.4.2.1 Bobbin & Shackle LT insulators

Soft Aluminium binding wire should be used to bind the conductors to the low voltage line insulators. At intermediate and angle positions, the conductor is bound on the side of the insulator nearest the pole so that if it gets drifted, it will remain in the clevis and not fall on the ground. Binding arrangement is shown in the attached Appendix 3.5 of this Engineering Instruction.

3.13.1.4.2.2 Pin and Post Insulator

The conductor should be wrapped with soft Aluminium tape before being fitted in the stirrups. On straight line positions, the conductor is bound in the top groove of the insulator. At angle positions, the binding is done on the side groove so that the insulator, not the binding, takes the conductor's lateral pull. Binding arrangement is shown in the attached appendix 3.5 of this Engineering Instruction. Preformed binding stirrup which does not require binding wire can as well be used in place of normal stirrup.

3.13.1.5 TENSION JOINTS

Tension joints should withstand the conductor tension, provide mechanical strength to withstand the conductor pull and maintain sag at all temperature.

3.13.1.5.1. Conductor Tension Joints

3.13.1.5.1.1 The conductor's mid span tension joints should be compression type, where as for dead ends and sections, they could be bolted or compression types. Ensure that an AAL or ACSR mid span joint with a married joint shall not be used, as such joints may work only on Hard Drawn Copper Conductor (HDCC).

3.13.1.5.1.2 Aluminium mid span conductor splice tubes must be with oxidation inhibiting and contact enhancement grease to prevent corrosion of the conductor and improve contact resistance. If the splice does not have this grease, ensure that it is applied before compression. It is essential that the surface of the conductor is free from Al oxides. Clean the conductor surface with Al wire brush before making a joint.

3.13.1.5.2 Bolted Tension Clamps

The entrance curvature of the clamp must be of correct size if the conductor vibrations are to be gradually damped out. These are designed so as to minimize vibration failures. Aluminium tape must be applied on the conductors when using bolted tension clamps with Aluminium conductors. The conductor should be wrapped with Aluminium tape from the approach to the remote end of the bolted section.

3.13.1.5.3 Compression Dead end clamps

The compression tool/machine must be kept properly. Only trained technicians/linesmen have to carry out such joints.

3.13.1.5.4 Compression Joints

3.13.1.5.4.1 For both non-tension and tension compression joints, it is important to ensure that correct die and connector is applied for the conductor in use and that the joint is efficiently compressed by a trained operator.

3.13.1.5.4.2 Compression tools together with the die sets must always be kept in their carrying cases when not in use. The tools are kept under the direct custody of the respective mains supervisors in the Region.

3.13.1.5.4.3 The requirement of cleaning the Aluminium conductor before joining should be observed in compression joints. Ensure that all the splices/sleeves and Al PG connectors are filled with the proper grease/compound.

3.13.1.5.5 Bimetallic Joints

3.13.1.5.5.1 All copper, Aluminium joints and Bimetallic PG clamps shall be arranged such that water cannot run from Copper to Aluminium. Tinned brass split bolt connectors, with a tinned separating tongue between the conductors, covered with water-inhibiting grease, and protected.

3.13.1.5.5.2 Before making bimetallic connector joints, the conductors shall be cleaned by different brushes. If a copper conductor brush is used on an Aluminium conductor, copper particles will be deposited on the Aluminium conductor and will subsequently corrode it. The Aluminium conductor shall always be on top of copper conductor to avoid water with copper salts from flowing on to the Aluminium conductor.

3.14 INSULATORS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.14.1 MV Dropout Cutouts

3.14.1.1 Care must be taken to ensure that the correct 'Fuse Tube Carrier' (FTC) is used on the DOF assembly, and that it is of same type and manufacturer. Wrong FTC may render the DOF inoperative.

3.14.1.2 The fuse link must be securely and correctly tied inside the fuse carrier by an experienced staff, and it ought to be correctly tensioned.

3.14.2 LV Mounted Cut-out

3.14.2.1 Care must be taken to ensure that the correct cable termination is carried out on the PC or DMC cut outs to avoid high contact resistance which would result in heating and damaging the cable.

3.14.2.2 The cause of blown out HRC fuse links must be investigated and action taken. Fuse replacement must be carried out by an experienced technician with a correct fuse rating according to the transformer size and proper mounting of the slotted tags on the fuse carrier needs to be ensured.

3.15 OVERHEAD LINES EARTHING AND SUBSTATION

There are several standard Medium Voltage (MV) overhead line construction practices followed by electrical utilities. These are classified under the categories of Insulated Line Design (ILD) and Earthed Line Design (ELD). MV and LV - ILD is constructed on insulated poles.

3.15.1 MV- ILD CONSTRUCTION MV & LV LINES

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:-

3.15.1.1 All stays except those on poles carrying earthed equipment shall be insulated for the MV or LT voltage. The vertical height of any stay insulator shall be at least 3 meters from ground level.

3.15.1.2 If wooden stay insulators are used, arcing horns must be used to divert the arc away from the surface of the wooden stay insulator.

3.15.1.3 Stay on poles carrying earthed equipment shall be left un-insulated. The stay is bonded together with pole mounted equipment.

3.15.2 WOOD POLE CONSTRUCTION - WISHBONE BRACKET

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:-

3.15.2.1 The steel work shall be bonded behind the earth-wire stroke bolt and behind the pole bolts holding the insulator cross-arm by a 10 sqmm single core galvanized steel wire.

3.15.2.2 Where the continuous earth wire is made on earth strokes, the bonding wire shall be made off on to the continuous earth wire.

3.15.2.3 The bonding wire shall be continued down the pole at intervals not exceeding five spans. It shall be wound around the butt of the pole at least six times and stapled.

3.15.2.4 Stays shall be made off above the top cross-arm, ensure contact between the stay and steel cross arms and stay insulators are not required.

3.15.3 STEEL POLE CONSTRUCTION MV LINES

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.15.3.1 Cross-arms do not require any additional bonding but the pole has to be bonded to the continuous earth wire.

3.15.3.2 Stays need to be made off above the top cross-arms, and stay insulators shall not be fitted.

3.15.4 CRADLE GUARDS FOR MV AND LV LINES

SMD /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that the cradle guard must be connected at both ends to the continuous earth wire, if provided, or to efficient earth electrodes.

3.15.5 STEEL POLE CONSTRUCTION: LV LINE

SMD /SZM /Zonal Principal Distribution/Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that Poles shall be earthed by means of a continuous overhead earth wire run from pole to pole, and a bond-wire from the continuous earth-wire fastened under the clamp holding the earth-wire "D" irons. Stay shall be left un-insulated.

3.15.6 WOODEN POLE CONSTRUCTION: LV LINES

SMD /SZM /Zonal Principal Distribution /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.15.6.1. Stays shall be insulated by one stay insulator at a vertical height of not less than 3 meters.

3.15.6.2. Where LV conductors are run on poles carrying H.V. conductors, an earth wire shall be run above the LV conductors. In this case the "D" irons shall be bonded behind the "D" iron pole bolts with 10 sqmm galvanized steel wire.

3.15.7 DISTRIBUTION TRANSFORMERS

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.15.7.1 The neutral point of the transformer LV winding is earthed via an insulated copper earthing cable of not less than 16 sqmm in size. The earth lead is brought down through an isolating neutral earth link to an independent earth electrode well clear of the transformer tank and other earthed or live metal.

3.15.7.2 The earth wire must not be bolted to any metal for support without adequate insulation. This is to ensure that the neutral may be completely isolated electrically for test. The size of the connection shall not be less than 16 sq. mm copper or equivalent.

3.15.7.3 Electric supply stations and plants generating/supplying at medium voltages, the earth resistance should not exceed 1.0 ohms and the ground grid will be designed in accordance with IEE regulations.

3.15.7.4 Resistivity of the earth varies dependent upon its composition as indicated in table below:

	Resistance in ohms		
Type of soil	Minimum	Average	Maximum
Ashes, Cinders, brine waste	1.9	7.6	22
Clay, shale, gumbo, loam	1.1	13	53
Same but with sand and gravel	3.3	50	433
Gravel, sand, stones little clay or loam	19.2	300	1460

Table 3.3: Resistivity of Earth depending on Composition

However, the ground resistivity for various kinds of soil and concrete is given in the table below.

Type of ground	**Ground resistivity (ohms-metre)**	
	Range of values	**Average values**
Boggy ground	2 -50	30
Adobe clay	2- 200	40
Silt and sand – day ground, humus	20 - 260	100
Sand and sandy ground	50 – 3,000	2,00 (moist)
Peat	〉 1,200	200
Gravel (Moist)	50 – 3,000	1,000 (moist)
Stony and rocky ground	100 – 8,000	2,000
Concrete: 1 part cement + 3 part sand	50 - 300	150
Concrète: 1 part cément + 5 parts gravel	100 -8,000	400

Table 3.4: Ground Resistivity for Various Kinds of Soil and Concrete

3.15.7.5 The transformer tank and other steel work must be connected to an earth electrode at least 8 meters from the electrode where the transformer neutral is connected. There must be a galvanic separation between the two earthing system pits.

3.15.7.6 Where two or more transformers are connected in parallel, only one neutral point must be earthed at one time to minimize circulating currents.

3.15.7.7 A suitable earth mat shall be provided at the operating position for ground mounted transformers with distribution pillars. The earth mat shall be bonded to the tank earthing.

3.15.7.8 A similar earth mat shall also be provided at the operating position of 11KV ring main units or other similar ground mounted outdoor switchgear.

3.15.8 POLE MOUNTED EQUIPMENT

SMD /SZM /Zonal Principal Distribution Engineer /Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

3.15.8.1 The steel work of all poles carrying equipment such as disconnect switches, load break switches, sectionalizers, series capacitors, circuit breakers, cable boxes, and autoreclosers shall be earthed.

3.15.8.2 An earthing lead bonded to the steel work earthing shall be run from the operating handle and formed into an earth mat at the operating position.

3.15.9 POWER STATION AND SUBSTATION SWITCHBOARD

Zonal Principal Distribution & Transmission Engineer /Principal Engineer /Planning Engineer /District Manager shall ensure that Two efficient and independent earth connections shall be provided and connected in parallel, to which shall be connected all frames, instrument cases, and other non-current carrying metal parts.

3.16 EARTH TESTING AND INSPECTION

Zonal Principal Distribution & Transmission Engineer /Principal Engineer /Planning Engineer /District Manager shall ensure that:

3.16.1 All earthing shall be tested at least twice a year (i.e. during rainy and dry seasons) and the necessary measures shall be taken to ensure that the earth resistance is suitably low. The earth wires and earth leads shall be inspected regularly to ensure that they are intact and effective. Desired values of transformer neutral earthing resistance are tabulated below.

Distribution Transformer Neutral Earthing	
Transformer Size	Neutral Earth Resistance (ohms)
50	1
100	1
150	2.5
200	2.5
315	2.5
500	2.5
750	2.5
Steel Structure, Line Switchgear and Arrester Earthing	
Steel Structure	5 to 7 ohms
Lightning Arrester	5 to 7 ohms
Line Switchgear	5 to 7 ohms

Table 3.5: Distribution Transformer Neutral Earthing

ENGINEERING INSTRUCTION NO. TDEI 04

SYSTEM EXPANSION AND NEW CONNECTION

4.0 PROCEDURES FOR CARRYING OUT CAPITAL WORKS ORDER FOR DISTRIBUTION SYSTEM EXPANSION

In order to facilitate and maintain technical control on the extension of the distribution system, all service line projects involving Low Voltage (LV) extension, Medium Voltage 11 or 33 kV line extension and establishment of distribution transformer of either 33/0.4 or 11/0.4 kV, require the procedures below to be followed.

All prospective applicants shall process the SLAF for the service line. The SLAF has to be accompanied by the installation drawing showing total installed capacity.

PRE/SE/PE shall compute the installed capacity of the applicant's request and then calculate the load demand. Estimates are prepared to arrive at the costing figure for issuance of quotation. The customer's acceptance and confirmed acknowledgement in writing must be obtained.

4.1 LPU-LV and MV TYPE CWO PROJECTS

4.1.1 All consumers shall follow procedures for acquiring Service Line; the SLAF shall be accompanied with a site survey drawing.

4.1.2 A single line schematic drawing is prepared to indicate the surrounding area network system data, like size of conductors of LT and MV lines, voltage drops, maximum and minimum loading of MV lines, nearest distribution transformer, loading at the primary substation, any obstacles that have to be overcome, and all other pertinent particulars relevant to the project.

4.1.3 PE shall prepare estimates showing material, labour, supervision, and transport costs and CWO application form.

4.1.4 PE shall Work out consumption for the new prospective customer, and compute the anticipated annual revenue income.

4.1.5 PRE/PE/SE shall assess the project and the power consumption of consumer and endorse the CWO application form.

4.1.6 For Increase in Capacity of Transformer, PRE/PE/SE shall ensure that a schematic circuit drawing with all parameters and capacity of existing distribution transformer is submitted with the CWO. Specify where the transformer is intended to be removed from. Transformer is a delicate and costly piece of equipment; it should be handled and stored with precaution measures Transformer movement is accompanied with an Asset Transfer Voucher (ATV).

4.1.7 For a New Distribution Transformer Substation, all required relevant documents shall be attached with the CWO, together with details on why a new substation is required, whether for load relief, for connecting more customers, for prospective LPU customers, or for improving system reliability and loss reduction. Indicate whether the project was foreseen and budgeted or whether it is an emergency measure for a sensitive new consumer of Public interest.

4.1.8 For LPU - LV type Dedicated Transformer, ensure that with the CWO, all relevant necessary supporting documents are appended. Note that such customers are quoted for full cost.

4.1.9 For LPU- MV type CWO Project, all projects involving 11 or 33 kV line extensions as service lines are liable to calculations for charging full capital contribution. Ensure that all required documents pertaining to the project are appended to the CWO application, like estimates and capital contribution cost, existing schematic circuit drawing with all parameters and capacity of existing primary 33/11 kV

distribution transformer capacity, MV feeder loading, and capability for additional load increase. Note that such customers are quoted for full cost.

4.2 DISTRIBUTION LINES EXTENSION FINANCIAL VIABILITY

4.2.1 All projects involving MV line extensions and/or establishment of pole mounted or ground mounted distribution substations will be liable to calculations to determine financial viability. The capital cost for such services are 100% paid for by the customer for the dedicated lines otherwise will pay for capital contribution basing on the financial viability calculated. However, to arrive on a priority base as to which project is carried out first, such calculation is useful.

4.2.2 For electrification of a group of customers in a location where a distribution line does not exist, before embarking on the project, financial viability of the project must be evaluated.

4.2.3 Proper study of the project and detailed estimates for the cost of the project will be made. Also the anticipated annual revenue will be made as detailed as possible.

4.2.4 The Planning Engineer shall calculate the expected maintenance and operation costs of the proposed project for each year up to seven years.

4.2.5 The Planning Engineer shall as well calculate expected costs of losses and of undelivered energy due to outages for each year up to seven years.

4.2.6 With anticipated annual revenue for first, second, third up to seventh year taken as cash inflow (with positive values), and costs in (a) and (b) above, as cash outflows (with negative values),Net Present Value (NPV) for each year is computed

4.2.7 When the NPV is less than zero the project is not viable. And when NPV is equal or greater than zero the project is viable. The test for project viability is carried out for each year up to seven years.

4.2.8 NPV analysis shall be calculated as described in Appendix 4.8

4.3 PROCEDURES FOR SERVICE LINE CONNECTION

The purpose of this section of Engineering Instruction is to ensure that service lines to new consumers are properly constructed, electricity supply is safely connected, metering system is installed and GPS coordinates are recorded, prepaid consumers are on respective SMS system, and opening of consumer account number for billing purposes is prompt and correct.

Service line means any Electricity Supply line through which energy is supplied or intended to be supplied by the Company to Consumer.

Distributing mains means a portion of any mains to which a service line is intended to be connected, and the size of the conductor has to be an insulated All Aluminium Conductor (AAC) or Aerial Bundled Conductor (ABC) with a minimum of cross section area of 35mm^2 and above.

4.3.1 It is the obligation of the Company to construct and maintain distribution mains especially in the surveyed areas so as to make sure that standard construction practice is observed in order to have: lines with very few sections (few line joints), uniform conductor sizes, avoiding unnecessary use of stay materials and keeping good workmanship.

4.3.2 Prospective customer may pay for the extension of distribution mains, when the company has no budget for distribution mains extension in the particular area during the time of prospective customer's request. Such a person shall be entitled to reimbursement by the company as stipulated in Part IV Tariffs and Charges, section 8, (a), (b), (c) and section 9 of Electricity Act 2008.

4.3.3 Service lines can be connected to a consumer either from distribution mains or directly from the premises of the company.

4.3.4 Service lines can be connected from the same point of the distribution mains to a group of consumers on the same premises or on adjoining premises. Where pole is required due to clearance or way leave matter, the standard S/L (30m) shall incorporate a pole.

4.3.5 The standard service line according to electricity Act 2008 (Cap 131) Regulation 2011 No. 2, is defined as " a Service line not exceeding thirty meters in length in the nearest tapping point from distributing main line to the point of metering at the customer premises". The service line conductor size shall depend on the loading of the premises to be supplied with the electricity and the conductor type can either be AAC to Copper or AAC and ABC only. This service shall either be Single Phase and Neutral (SPN) or Three Phase and Neutral (TPN) type and at supply voltage of 230 ±5% Volts SPN or 400 ±5% Volts TPN.

4.3.6 Other non-standard service lines could either be on Low Voltage (LV) supply at 230/400 volts, Medium Voltage (MV) supply at 11/33kV, or High Voltage (HV) supply at 66/132/220 kV as follows:

4.3.7 The LV service line categorized as **Small Power User (SPU)** is either Single Phase and Neutral (SPN) or Three Phase and Neutral (TPN). This service is limited to maximum of **63 - 100 amperes**. Meter rating is either 10-60 or 20-100 amps.

4.3.8 Another type of LV service line categorized as **Large Power User (LPU) LV Service** is 400 Volts TPN supply not exceeding 630 amperes.

4.3.9 The MV or HV service line, which is also categorized as **LPU supplied at LV or at MV**, caters for demand of 500 kVA and above.

4.3.10 Any Customer who owns a transformer shall also be metered at the primary side of the transformer.

4.3.11 Any Customer who is connected to a dedicated line (LV or HV) shall be metered at the point where that dedicated line shall emanate from.

4.3.12 The SPU and LPU with LV service are mandatory protected with adequately equipped distribution board on the consumer side as per requirement to the latest edition of "IEE Wiring Regulation BS 7671". The point of supply from overhead mains, service overhead lines, service cable, service cut-out and the meter is owned by the utility.

4.3.13 The LPU of LV and MV connected service is mandatory protected with proper negotiated protective switchgear owned by the consumer for safe utilization of LV and MV electricity service. The point of supply from overhead/cable mains up to the metering system are owned by the Company.

4.3.14 For low cost purposes, Service line connection in rural areas may be extended up to 50m instead of the standard 30m. When this need arises, the conductor to be used shall be a minimum of $10mm^2$ concentric copper cable or equivalent size of ABC/ AAC. The service line connection shall be limited to loads not exceeding 60A equivalent to 12kW at a power factor of 90%.

4.3.15 For Low cost purposes, Service lines may be connected to supply premises where Small Power Distribution Units (SPDU) also known as Ready Boards have been used in place of normal internal

wiring system provided they have passed the company's recognized standards and specifications. The conditions where Ready Boards will be allowed are for the installations in kiosks, rural areas residential houses with not more than two rooms.

4.3.16 All consumers with power demand above 17 kW shall be connected with three phase supply. The connected load is determined from nominal rating of appliances/equipment as declared at time of service line application.

4.3.17 For grass thatched houses, customers shall fix a metal pipe which is curved at the end where conductor enters at first from the pole to the house. The curved end does not allow rain drops from flowing through the inside of a hollow pipe. The pipe shall be supported at the point of contact with the thatched roof by mortar. A pipe shall be at a height of at least one meter from the roof level. The other end of the pipe ends at the point where the meter or ready board is installed.

4.4 GUIDELINES TO CUSTOMER FOR SL APPLICATION

4.4.1 Visit Regional/District Office to purchase SLAF from the CSD and take it for completion by the contractor if new service is desired.

4.4.2 The customer or appointed contractor submits the dully filled SLAF, installation completion certificate, and installation drawings, which are checked and registered.

4.4.3 The customer is given a definite date for collection of a survey technician to go and make a connection diagram from the existing mains conductors or from the Transformer to the consumer's premises.

4.4.4 Customers shall deal with appropriate Company Offices and obtain official documents after official transaction. The Company shall not be responsible for any damage/loss to customer as a result of un-official dealing with anyone outside the respective Company Offices.

4.4.5 SMSM/RM shall ensure in liaison with the Communications section of the Company that from time to time they educate customers on the connection procedures.

4.4.6 RM shall ensure that RHRO/RCRO/DM from time to time educate staff on proper procedures of handling and guiding customers on connection procedures. Staff, who will mishandle customers or collaborate with conmen (vishoka), shall immediately face the Company's appropriate disciplinary actions.

4.4.7 It is important that all customers abide by the procedures laid down by the company when they are seeking any company services so that they may not be cheated by anyone. If the customer lacks information, it is advisable that he approaches the *RCRO* for guidance, rather than depending on un-official sources.

4.5 DRAWING PREPARATION

4.5.1 The survey technician will complete his job within one day. If the drawing shows that the line can be constructed, Quotation and Order forms will be issued to the customer by PE/CE/DM, If on the other hand, the customer site details show that the area needs an extension of HV and/or LV lines, or has way leave problems, or has low voltage problems, he/she has to be informed.

4.5.2 In order to comply with the wiring regulations, the contractor has to do the following, after having carried out installation of wires, fittings and apparatus:

4.5.2.1 Draw installation drawing using the standard drawings and symbols stipulated in the latest IEE wiring regulation.

4.5.2.2 Inspect and test the installation and submit test results together with SLAF tests to indicate earth loop impedance, earth electrode resistance, insulation resistance, method of protecting against electric shock, and other relevant tests as per requirement of latest IEE Regulation.

4.5.2.3 The drawing inspection certificate and installation completion card are kept by the company as permanent records of the installation for any future reference or work on the installation.

4.6 METER POSITIONING

4.6.1 The meter shall be outside on the street side of the building. The consumer shall offer sufficient protection to the metering device and shall be held responsible for security of the metering.

4.6.2 If it is absolutely necessary for the meter to be installed inside a building, the lead-in wire shall pass through a steel conduit to the meter position. The meter position shall be as near as possible to the service line bracket. A weather proof box shall be installed near the bracket if necessary. The consumer shall extend his tail wire to the meter position chosen by the Company.

4.6.3 For group SL, the Contractor's responsibility is to carry out the entire wiring from the incoming 300 or 630 amps service cut-out to the tail wires for connection to the energy meter. The tail wire from the customer's distribution board is connected to the energy meter by the Company upon successful inspection and testing of the installation

4.6.4 The lead-in wire for standard SPN and TPN shall be easily visible from the house bracket to the meter position.

4.7 VITAL CONDITIONS

4.7.1 Buildings within the way leave of MV or HV electric lines shall not be connected to the electricity supply.

4.7.2 The consumer shall make a copy of the building plan available for drawing the electrical installation layout on it. The Company shall decline to connect the power if a proper drawing is not submitted.

4.7.3 The Company shall only connect power supply to electrical installations carried out by duly licensed wiremen under the direct supervision of a duly licensed electrical contractor.

4.7.4 New connection, change in tariff, increase in consumption, or extension to existing installation requires a SLAF if processed similarly to new SL. An Installation Inspector has to confirm the capacity and safety of installation, tariff has to be subsequently determined, and a deposit has to be paid.

4.7.5 Change of property ownership will require new SLAF, and shall incorporate particulars and details pertain to the change of ownership.

4.7.6 Modified electrical installation must be re-inspected and re-tested by a licensed and competent electrical contractor. All installation must be inspected and re-tested.

4.7.7 Addition or alterations, temporary or permanent, shall not be made to the existing installation without notifying the Company through the electrical contractor carrying out such work, who needs to submit an Inspection Certificate. Immediate notification must be given to the Company in writing if any addition or modification is made to the installation, or if power exceeds the load declared. Any addition or modification not notified to the Company shall be deemed to be done at the consumer's own risk as to damages and legal action.

4.8 GENERAL REQUIREMENT

4.8.1 The installation inspection staff has to play a diligent role and ensure inspection is done fairly without any prejudice. The MAS is raised and forwarded to CE/PE/DM for necessary approvals before submitting the same to SRA/BA/DA.

4.8.2 The installation's inspection staff are responsible for ensuring that sufficient details about the location of the consumer's premises are recorded properly on the SLAF, PSSCA, and Meter Advise Slip(MAS) in order to enable any other staff of the Company to locate the consumer premises with ease when need arises.

4.8.3 In case of modifications or extensions to existing installations and separation of installations, the consumer will purchase new SLAF, submit additional installation drawings, and complete a new installations completion form accordingly before submitting the same to PE/DM for action. Installations Inspector will visit the consumer premises to re-inspect and re-test the installations. Furthermore, the installations inspector shall shift the existing meter position to a more suitable location if necessary to ensure that the meter is safe and can be reached easily by meter readers and that the lead-in cable is easily visible from the pole bracket to the meter position. Meter separation is treated as new installation. The Power Supply Agreement section of the SLAF is appraised to accommodate all changes made.

4.8.4 RM/DM shall cross check to ascertain that all completed Service Lines have meters and shall examine all service line completion certificates.

4.8.5 SRA/BA/DA will compile records and details of new consumers connected on a monthly basis, and shall ensure that the list of names and accounts recorded matches with list of names and accounts billed.

4.8.6 In case of any mismatch CE/PE/DM shall ensure that all consumers in respective meter reading route get an individual bill and shall request evidence of previous payments for record purposes. These details shall be forwarded to SRA/BA/DA who will take appropriate measures.

4.8.7 PRE/SE/PE/DM will arrange to carry out SL works on a first-come, first-served basis. All efforts should be made to complete each SL started within a period as per customer service chatter

4.8.8 The Contractor's Installation Drawings should be neatly drawn on durable paper, as the drawings will be kept inside the SLAF folder as a permanent record of the consumer's electrical installation. During Installation Inspection, wiring drawings will be checked, and if there are no discrepancies, the next phase of inspection will be carried out

4.9 RESPONSIBILITIES FOR DOCUMENTATION APPROVAL

The following is the procedure for approving documents during the process of connection of new service lines. PE/DM shall approve survey drawings:

4.9.1 30m S/L Order forms shall be signed by Planning Engineer/District Manager;

4.9.2 Order Forms for S/L above 30m, WPs and CWOs shall be signed by Principal and Senior Engineers for classes A and B respectively and by RMs in class C regions District Managers shall sign S/L above 30m only.

4.9.3 The SIVs for service lines within 30m shall be approved by Principal Engineer/Senior Engineer/District Managers;

4.9.4 SIVs for service lines above 30m, WPs, CWOs and R&Ms shall be approved by by Principal and Senior Engineers for classes A and B respectively and by RMs in class C regions District Managers shall sign S/L above 30m only.;

4.9.5 Occasionally approving officers shall be required to visit and check samples of the above works.

4.10 STANDARD SEVICE LINE CHARGE

4.10.1 The standard charge applicable shall be available at the office of SMD. The SMD will circulate new charges applicable whenever changes occur.

4.10.2 The prospective consumer will be charged for the service line payments in one (full) or part payment. Construction will be done after full payment.

4.10.3 The SPU consumer using credit meter shall pay a deposit as shall be invoiced by the Company as a security for any amount due or becoming due to the Company in respect of the power supply.

4.10.4 Deposit will not be charged for LUKU Meters

4.10.5 For LPU of LV or MV service, workout deposit shall be based on load factor (LF) of 80%, for 24 hours operations and 60% for LPU customers operating for less than 24 hours; applicable power factor (PF) shall be 90%. The kVA demand charge and the anticipated units consumed shall be priced to form the minimum deposit. Any deposit update shall be well recorded for future references.

4.10.6 Permanent Employees of the Company will not pay deposit for their personal domestic consumption.

4.11 SERVICE LINE CHARGES

Standard Service charges shall be provided to the customer; however the charges will be reviewed from time to time.

4.11.1 UNDERGROUND SPN AND TPN SERVICE LINE

4.11.1.1 This type of service will be charged to the consumer at cost of the material plus 10% overhead charges. Work will be carried out under Service Line Works Order.

4.11.1.2 However, Low Voltage Service Line Cables shall be of armoured cable type.

4.11.1.3 Whenever necessary and when the customer desires so, he/she shall supply the cable up to the metering point and the meter shall be installed at the beginning of the cable on the power source side.

4.11.2 SERVICE LINE IN PRIVATE LANDS

4.11.2.1 If a service line route length in private land exceeds 30 meters, such a service line will be charged to the consumer at cost plus 10% overhead charges. But before the payment is effected, i.e. before the **ORDER FORM** is issued to the applicant, a written way leave agreement for the private land has to be obtained. The work will be carried out under Service Line Works Order.

4.11.2.2 There shall not be an extension service line or distribution mains from the private land plot.

4.11.3 GROUP SERVICE LINE

4.11.3.1 These are overhead service lines for supply to blocks of flats, residential housing schemes, offices, etc. Customer will purchase SLAF and process it as new connection.

4.11.3.2 All works beyond the metering point shall be carried out under Contract Work Order and charged at cost plus 10% overhead charges and plus 25% contract charges.

4.11.4 TEMPORARY SERVICE LINE

4.11.4.1 Customer shall start with purchase of a new SLAF and follow the procedures for SPU standard service line of SPN or TPN. Temporary service line will be charged at cost of the material plus 10% overhead charges and plus 25% contract charges.

4.11.4.2 Upon terminating contract for temporary service line, all materials are recovered and returned to stores to be charged at half price if the temporary service line has been used for up to 7 years. If used for over 7 years, the materials will be regarded as used up.

4.11.4.3 When converting a temporary service line to a permanent service line, the refund (if any) should be calculated as if the temporary service line is being removed. This amount is refunded less the charges for a new service line.

4.11.5 STAFF RATE

Company staff shall be charged at staff rate as agreed upon by the management for either single or three phase service line. The charges shall be 25% of the current existing charges without meter deposit for both 1 phase and 3 phase meters. Only one house per staff is allowed to be connected at staff rate.

4.12 STORES REQUISITION ISSUE VOUCHERS (SIV)

4.12.1 For standard LV SPU service line, individual SIV is raised per customer.

4.12.2 For group service connection of common service line with larger cable size, one SIV is acceptable. However, each service line must be accompanied by an individual SLAF. If only one SLAF is submitted, it will be considered as one service line and may need the LPU – LV service line approach, and a metering chamber will be used.

4.12.3 Similarly, one SIV is raised for materials required for LPU of MV service line type. Left over materials are all returned to stores by delivery note pending raising of stores return voucher (SRV) by Stores officer.

4.13 INSPECTION AND METER INSTALLATION

4.13.1 Inspection and testing of the consumer's installation shall be carried out in the presence of the respective Electrical Contractor. If the inspection and testing of the installation are successful, the CE/PE will fill in the SL completion certificate and ensure that the agreement section of the SLAF is duly completed and signed.

4.13.2 For standard SL, For LV&MV LPUs, a pre-arranged date is required for the meter installation at site. If the contractor is not present, a second notice will be issued, the Contractor shall within

seven (7) days respond in writing to RM as when he/she shall be available and if the contractor is not available for the second time, Power will not be connected until the contractor has shown up.

4.13.3 If the service line requires upgrading of existing system e.g. a new transformer, or new LV mains, these works are completed prior to working on the service line. The tapping of power on the LV side of the transformer or from LV mains is carried out after installation and connection of the Metering Cabinet and checking of customer installation. The same applies for LPU – MV service: the tapping at the MV supply mains is done at the end.

4.13.4 For LPU of MV or HV service supply, the contractor must perform all tests to prove the dependability and health of the switchgear protective circuits and adequacy of protection scheme. It is the Company's duty to ensure that all such large MV and HV services are adequately installed and protected for safe operation of the power system.

4.13.5 If customer's installation is defective and does not qualify for connection, the customer is informed of the defects. After correction of the defects, power supply connection may proceed.

4.13.6 For LPU – LV or MV service, and SPU of SPN and TPN, contractor must be present before the Metering System can be installed. The LV or MV side connection at tapping point is carried out only upon successful completion of inspection and testing of the installation of metering system. Should the inspection and testing of the installation be unsuccessful (does not comply with the wiring regulations), the electrical contractor will be required to rectify the defects and pay a fine as indicated in the schedule of payments before the installation is re-inspected and re-tested. RM should be notified of the anomalies, and a copy of the same should be retained inside SLAF folder for office records. The electrical contractor's name and his/her registration number shall be sent to EWURA and CRB for further follow-ups.

4.13.7 All protective relay settings must be declared in writing together with other pertinent commissioning tests carried out by the contractor. These are required to be forwarded to the RM in time for submission to the relevant departments in Transmission and Distribution Business Units for study and evaluation when at site.

4.14 HANDLING OF METER ADVICE SLIP (MAS) LUKU FORM

4.14.1 The meter advice slip/LUKU form controls the movement of the meters and changes in consumer's accounts. Hence, this document shall be handled with maximum security and care. All MAS/LUKU FORM in the region shall be registered at the office of the Revenue Accountant, who will sign for their receipt and distribute them to the sections required for action.

4.14.2 At the end of each month, SRA/BA/DA shall indicate all MAS actioned and returned to the originating office in the register. Un-actioned MAS/LUKU form shall be sent to the Regional Manager who will take the appropriate measures. The SRA/BA shall be held responsible for any loss of MAS or MAS/LUKU form not actioned within the period specified in the company's routine schedules.

4.14.3 RM/DM will ensure that all records of the service lines are available for any consumer queries that may arise. In case any consumer record is not readily available in the register, severe disciplinary action shall be taken against those responsible.

4.15 INSPECTION AND TESTING OF ELECTRICAL INSTALLATION OF CONSUMERS

4.15.1 GENERAL REQUIREMENT

By Electricity Act, 2008 sec 26(1), conditions under which supply may be denied, the Licensee, that is TANESCO Company, shall not be compelled to give energy to any premises unless the Company is reasonably satisfied beyond any doubt that the service lines, fittings, and apparatus therein are in good order and condition.

4.15.2 INSTALLATION TESTING

4.15.2.1 Every installation shall on completion and before being energized is inspected, tested, and proved to have conformed to the Company regulation and IEE Wiring Regulation BS7671 of the latest edition.

4.15.2.2 Diagrams, charts or tables, or an equivalent form of information shall be made available to persons carrying out the inspection and testing. The information has to show: -

4.15.2.3 Type and composition of circuits and devices performing functions of protection isolation and switching and their locations.

4.15.2.4 The coordination between protective devices for automatic disconnection, earthing arrangements, and the value of relevant impedance of the circuits concerned is such that during the earth fault, the magnitude and duration of the voltage that develops between simultaneously exposed and extraneous conductive parts do not cause danger.

4.15.2.5 Existing installations shall be routinely checked and tested for compliance as per regulations..

4.15.3 INSTALLATION COMPLIANCE

The installation must be provided with the following:

4.15.3.1 Labels to indicate the purpose of the switchgear and control gear.

4.15.3.2 Warning notes to the presence of the voltage in excess of 250V.

4.15.3.3 Labels on distribution boards.

4.15.3.4 Indelible and durable notice on distribution board for periodic inspection and testing.

4.15.3.5 "Safety electrical connection - do not remove" notices at earth electrodes and bonding points.

4.15.3.6 "For equipment outdoors" notices where applicable.

4.15.3.7 All additional installations carried out in the premises of any consumer for the purposes of the supply of energy to such consumer that alter the capacity and character of the installation must be reported to the Company before connecting them to the Company's supply.

4.15.4 VISUAL INSPECTION AND TESTING

4.15.4.1 Carry out visual inspection and testing on the ensured dead circuits and verify that the entire electrical equipment installation is in compliance to the requirement of latest IEE wiring regulation.

4.15.4.2 Only after ascertaining that the equipments installed are in compliance with the IEE requirement should final testing shall proceed.

4.15.5 **VISUAL INSPECTION**

4.15.5.1 Visual inspection shall be carried out to verify that the equipment is in accordance with the standards, correctly selected and erected, and are not visibly damaged so as to impair safety.

4.15.5.2 The equipment or wiring is suitably rated to withstand additional rating due to the reactive demand and has the capacity to withstand overloads under short circuit condition to allow the timely protective device to operate.

4.15.5.3 The electrical and barrier protective measures are sufficiently incorporated.

4.15.5.4 The wiring colour codes must comply with the current standard codes.

4.15.6 **TESTING**

4.15.6.1 Carry out installation testing in the following sequential order and prepare a report on the findings: -

4.15.6.2 Continuity of ring final circuit conductors, continuity of protective conductor (including supplementary equipotential bonding), and every protective conductor shall be separately tested.

4.15.6.3 Check for earth electrode resistance value and proper Protection by Electrical separation, and carry out insulation resistance test with Insulation Tester

4.15.6.4 The Insulation Resistance (IR) test voltage up to 500V DC shall be applied for installations rated up to 400V, an IR test voltage up to 1,000V DC shall be used for installations rated above 400V up to 5000V.

4.15.6.5 When the insulation resistance is measured with all fuse links in place, all switches closed, all poles or phases of the wiring electrically connected together, the insulation resistance to earth shall not be less than 1 MΩ.

4.15.6.6 Where equipment is disconnected for the above test, the equipment shall be tested separately and the insulation resistance shall not be less than 0.5 MΩ.

4.15.6.7 Test and check that the earth protective wire will not, under any condition, get connected with the neutral. The wiring regulation calls for the TT system where there is no direct connection between live parts and earth, and the exposed conductive parts of the installation are earthed separately and not through the company neutral. This check is carried out for both SPU and LPU.

4.15.6.8 Check for proper and adequately rated provision of Residual Current Device (RCD) for protection against earth leakage. It is a prerequisite of the Company and the IEE regulation BS 7671 for the TT system.

4.15.6.9 Check for the provision of circuit isolation against short circuit and over load condition.

4.15.7 **INSULATION OF SITE BUILT ASSEMBLIES**

4.15.7.1 The site built assemblies shall be tested to verify that the insulation resistance or insulating enclosures can withstand the same test voltages as factory built assemblies.

4.15.7.2 Where protection against electric shock is provided by Safety extra low voltage or by electrical separation, the electrical separation of the separated circuits shall be inspected or tested.

4.15.8 **PROTECTION AGAINST DIRECT CONTACT**

Protection against direct contact by barriers or enclosure provided during erection shall be verified to show that the barriers afford a degree of IP2X or IP4X for factory and site built assemblies.

4.15.8.1 IP2X: No contact can be made with ingress of solid body's ≥ 12.5 mm in diameter (e.g. Human fingers/ 800mm).

4.15.8.2 IP4X: No contact can be made with ingress of solid body's ≥ 1.0 mm diameter (wire ≥ 1 mm in diameter) or 1 mm thick.

4.15.8.3 Insulators of non conducting floor and walls:

4.15.8.3.1 Resistance measured between three points on the flow and walls to the main protective conductor must not be less than 50 KΩ for normal supply voltage.

4.15.8.3.2 Where insulator of extraneous conductive part is used to prevent contact, the insulation must withstand 2 kV with leakage currents not exceeding 1mA.

4.15.9 **POLARITY**

It shall be verified that, all fuses, circuit breakers, and other single pole control devices are connected in the phase conductor only, and that the wiring has been correctly connected to socket outlets and power outlets. Note that centre-contact bayonet and Edison type screw lamp holders have their outer or screwed contacts connected to the neutral conductor.

4.15.10 **RESIDUAL CURRENT DEVICE**

4.15.10.1 The time taken by the residual current device to trip at rated tripping current shall be verified and shown not to exceed the delay time declared by the manufacturer of the device.

4.15.10.2 Where the device has a rated tripping current not exceeding 30 mA (to reduce the risk of shock due to direct contact), the tester must be set for a fault current of 250 mA and the device must break the circuit within 40ms.

4.15.10.3 Voltage operated earth leakage circuit breakers ceased to meet the wiring regulations. All new installations shall use residual current device. Where an RCD is in use, it shall fulfil the following:

$R_a I_a \leq 50$ V Where: R_a is the sum of the resistances of the earth electrodes and protective conductors connecting it to the exposed conductive part. I_a is the current causing the automatic operation of the protective device within 5 seconds.

4.15.11 **CONNECTION OF SUPPLY**

Before connection of supply, the Electrical Contractor should submit an inspection certificate together with drawings, charts, and tables with information on the installation as per the above mentioned requirements. **Appendix 4.5** attached shows an inspection certificate.

4.15.11.1 The Installations Inspection Department will carry out the inspection and testing, and if the outcome is satisfactory, the IID will accept the installation completion certificate from the Contractor and arrange to connect the supply to the installation.

4.15.11.2 The Installations Inspection Department will also carry out routine inspection of existing consumers' installations.

4.15.11.3 The owners of the installations and their electrical contractors will be informed of the discrepancies found in their installations, and will be given appropriate notices requiring them to rectify their installations before disconnection. The Installation completion form and inspection certificates in **appendix 4.5** as attached.

4.15.11.4 A guideline on the common discrepancies found in installations is shown in **appendix 4.6**.

4.16 TYPES OF SERVICE LINES

4.16.1 TEMPORARY SUPPLY

4.16.1.1 For standard temporary supply as SPU with SPN or TPN, applicable charge shall be as per normal SL charges including energy deposit.

4.16.1.2 For LPU with LV or MV supply, the customer is charged as per actual costs plus 10%. Costs for the following metering items should also be included for LPU MV supply: LV Metering Cabinet, specified Meter and Test Terminal Block. For LPU MV supply the following metering equipment should be included: The Outdoor Metering Unit (CT/VT Unit), Enclosed Metal clad Load Break Switch, Test Terminal Block, specified Meter. Deposit shall be computed as per LPU of permanent type depending on the declared required demand. Apply load factor of 60% and power factor of 90% to arrive at the energy consumption. Total deposit payable is for one month and both capacity as well as energy is charged. Any deposit update shall be well recorded for future references.

4.16.1.3 All materials used for temporary supply **shall be** forfeited upon completion of contract Energy deposit shall be refunded upon payment of the final account.

4.16.2 CONVERSION OF SPN TO TPN - INCREASED CAPACITY

4.16.2.1 In case a consumer requires a single phase service line to be converted to a three phase service line, the consumer shall be charged at half the rate for a similar new three phase connection.

4.16.2.2 If the size of the service line conductor is to be increased due to increase in load, the consumer shall be charged for a new connection with the large conductor size less the charge of a similar new connection with smaller conductor size. Such works will be carried out under service line works orders.

4.16.3 SEPARATION OF WIRING FOR EXTRA METER.

4.16.3.1 For prospective consumers who require extension, separate meters, or wish to extend the wiring in the existing installation, the following procedures apply:-

4.16.3.2 The customer starts with the purchase of a new SLAF and processes it as a new installation.

4.16.3.3 The service line wires and lead-in wires are checked to ensure that they are of adequate capacity.

4.16.3.4 Meters for different tariffs shall have separate lead-in wires. Meter boards, cut outs, and installation shall be physically separated by a Masonic wall if possible.

4.16.3.5 Charge for separation of installation for a SPN consumer in which a new lead in cable, meter board, cut out, and meter are installed at the cost of a new service line connection charge for SPN standard service.

4.16.3.6 Charges for separation of installation for TPN consumer in which a new lead in cable, meter board, cut out, and meter are installed at the cost of a new service line connection charge for TPN standard service.

4.16.3.7 No separation of installation arrangement is allowed for TPN supply with lead-in wire over 16 sqmm in size. Such arrangement will require a new survey for determining capacity of the existing service and requires a completely fresh start.

4.16.4 **SERVICE LINE OVER 50 SQMM**

4.16.4.1 Prospective consumers shall not be given service of conductor size greater than 50 sqmm from public supply mains. Such consumers are taken as LPU of LV service or group service connection. Such a customer is connected from a transformer installed nearest to his premises with a suitable lead in cable.

4.16.4.2 Depending on the load, service line may require over 50 sqmm or extension of MV line and establishment of distribution transformer. Service line over 50 sqmm may involve extension of MV line and establishment of a new distribution transformer, depending on results of a financial viability analysis.

4.16.5 **SPECIAL CONNECTIONS**

4.16.5.1 RM/DM shall make maps showing LV distribution lines in all areas of his jurisdiction. They shall also make the necessary plans for extending the LV lines in various areas.

4.16.5.2 Special consideration shall be given to those prospective consumers who cannot wait until the LV mains in their areas are established or reinforced according to the distribution system plans.

4.16.5.3 Consumers described above shall pay for the full cost of extension of the LV mains and service line. The extended network shall remain to be the property of the Company up to the meter installation point.

4.16.5.4 To ensure that such cases are limited to the minimum, RM/DM shall get details of power requirements to all important or sensitive prospective consumers in the region and carry out planning to establish or reinforce LV mains in the corresponding areas and include the same in the annual LV mains construction budget.

4.16.6 **NEW SPU SERVICE LINE FOR SPN OR TPN**

4.16.6.1 The Prospective Consumer, his/her Electrical Contractor, shall arrange to pay the initial designated amount and collect the Service Line Application Form (SLAF) from the company's Regional/District office at the Customer Service Department (CSD).

4.16.6.2 The SLAF is duly filled and completed in all respect by the customer or his appointed contractor. The contractor completes the section required and clearly inserts the CRB and EWURA registration number. The completed SLAF is submitted together with Consumer Installation drawings to the Planning Engineer, who ensures that all details are filled in properly and entered into a register. The Planning Engineer receives stamps, and signs the SLAF and drawings. The prospective consumer is given a survey date appointment.

4.16.6.3 The Installation Inspection Section (IIS) gets the SLAF, and customer's installation drawings. Planning Engineer shall visit the site and carry out the following tasks so as the SLAF to be considered complete:-

4.16.6.4 Make an accurate drawing showing the applicant's premises, the distribution mains, and the distribution primary substation transformer spare capacity from which the supply is to be connected. Record details of conductor size, pole number, capacity of the existing distribution substation, and distance of applicant's premises from the nearest existing overhead distribution mains. Check the voltage at the tapping point to ensure that it is within acceptable limits.

4.16.6.5 Ensure that the drawing connects the applicant to a transformer or feeder located in the same billing zone as the location of his/her premises. Record GPS coordinates of the meter location in the premises. Check that the location of the applicant's premises does not interfere with LV, MV, and HV way leave.

4.16.6.6 Give the applicant standard "Service Line Quotation Form (SLQF) and Order Form (OF)" if there are no problems with the proposed service line work. If there are way leave or other problems, give the applicant Service Line Connection Problems Form and keep copies of the form for office records.

4.16.6.7 Planning Engineer/ District Manager shall maintain all drawings and quotation in the SLAF folder. This is a standard service line, and costing is a fixed amount but subjected to change from time to time.

4.16.6.8 Planning Engineer/District Manager shall open Service Line Works Order, and ensure that all materials for the SL are included and carry out the project. Upon completion of the service line, the following needs careful handling:-

4.16.6.9 Planning Engineer/District Manager shall ensure that SL completion form is completed, get the MAS/LUKU installation form raised, ensure that installation department mounts the cut-out, and terminate lead in cable followed with meter installation. Do not let the customer terminate the tail cable from his distribution board on his own - this is done by the utility installation team only.

4.16.7 Planning Engineer/District Manager shall get the Installation Inspection Section (IIS) to carry out audit of the service line, lead-in cable, and service cut-out with meter, and test consumer's installation. Loop impedance for earthing must be checked. The consumer's installation must conform to the requirement of IEE regulation and residual current protective circuit should be installed.

4.16.8 Planning Engineer/District Manager shall ensure proper installation of meter and sealing system for the meter. The meter terminal cover should be proficiently installed and sealed.

4.16.9 Planning Engineer/District Manager shall ensure that the consumer has signed the agreement section of the SLAF and initial meter reading is carried out and recorded on the MAS.

4.16.10 PRE/PE/SE should ensure that the SLAF and MAS/LUKU installation forms are submitted to SRA/BA not later than the second day after meter installation.

4.16.11 RFO/RA should ensure that the new account is opened not later than the second day after receipt of the MAS and include the new customer in the meter reading roster.

4.16.12 For prepaid meter (LUKU), the meter dispenser is registered on line on the same day of receiving the MAS/LUKU installation form at the regional SMS station so that customer can purchase units when required. Get the SMS controller to include the meter at all vending stations.

4.16.13 PRE/PE/SE should submit the service line completion report complete with labour and transport recharge not later than the second day after the date of completion.

4.16.14 PRE/PE/SE should ensure that the service line works order is closed within four (4) working days after the date of receipt of the service line completion report.

4.16.15 For Meter Separation or repositioning of the existing service line and metering system, the following guidelines shall apply:

4.16.15.1 The consumer is required to fill another SLAF, the project is treated similarly to a chargeable works order

4.16.15.2 In general, meter separation and/or repositioning will require new SLAF to be purchased and filled in. Such cases are treated similar to New Service Line. All outstanding bills must be paid before meter separation.

4.16.15.3 For group standard service line, the utility incoming cable must be appropriately rated and terminated on larger cut-out, say 300/630 amperes, indoor type. The cut-out connects to the bus bar chamber, and all service or lead in cable emanates from the bus bar to the individual cut-outs and meters. All service distribution system is provided on the ground floor in a room exclusive to utility service.

4.16.15.4 The contractor must process several SLAF depending on the number of individual service line required. Otherwise, the service is considered as LPU – LV service and a metering cabinet to meter as group is required.

4.16.15.5 For group SL or service line requiring use of materials in excess to the standard service line with fixed charge, a CWO must be obtained for carrying out the work.

4.16.15.6 For group service where the contractor has carried out all internal distribution, a CWO is still required based on company estimates. Note that such installation may require only the service cable, but the company is equally responsible for maintenance of the distribution up to the metering point.

4.16.15.7 Similarly, where a transformer is required to supply group LV services as above and the transformer is mounted within the complex where supply is required and the contractor procures and installs all equipment to make connections easier, SLAFs must accompany the installation diagrams, depending on the meters required.

4.16.15.8 The cost for entire installation and distribution up to point of metering is refundable, based on company estimate. The transformer and all company in use network up to metering point becomes the property of the company.

4.16.15.9 Note that in case the installed transformer capacity is not utilized, the Utility has the right to emanate LV feeder service to neighbouring customers.

4.16.15.10 The refund cost is based on utility estimates and not what the contractor claims, unless prior approval of the costing was agreed upon. Note that in this case, the transformer is the property of Utility, and if under-utilized, additional service may be taken out to neighbouring new consumers. Conversely, should the transformer fail, the utility is obliged to replace it at no cost to the consumer.

4.16.16 NEW LPU - LV SERVICE LINE

4.16.16.1 The Prospective Consumer, his/her Electrical Contractor, shall arrange to pay initial designated amount and collect a SLAF from the Company's Regional office at the Customer Service Department (CSD).

4.16.16.2 The SLAF form shall be duly filled and completed in all respect by the customer, his/her appointed contractor, or his/her representative. The contractor will indicate the intended kVA demand utilization, and it shall not exceed 630 amperes.

4.16.16.3 The prospective consumer's contractor shall complete the section required and clearly insert the Contractors Registration Board (CRB) and EWURA registration number.

4.16.16.4 The duly completed SLAF is submitted together with customer's installation drawings to the CSD head, who ensures that all details are filled in properly and entered into a register. The CSD receives stamps, and signs the SLAF and drawings. The prospective consumer is given a survey appointment.

4.16.16.5 The Installation Inspection Section (IIS) will get the copy of the preliminary applications and customer's installation drawings. Competent Staff from the CSD will visit the site and carry out the following tasks:

4.16.16.5.1 Make an accurate drawing showing the applicant's premises, the LV distribution mains, and distribution transformer capacity, the nearest MV feeder mains available capacity and the distribution primary substation transformer spare capacity from which the supply is to be connected. Record details of conductor size, pole number, capacity of the existing distribution substation, distance of applicant's premises from the nearest existing overhead LV/MV distribution mains and all other relevant technical information. Check LV voltage at the tapping point to ensure that it is within acceptable limits.

4.16.16.5.2 Ensure that the drawing connects the applicant to a transformer or feeder located in the same billing zone as the location of the applicant's premises. Check that the location of the applicant's premises does not interfere with LV, MV and HV way leave clearance.

4.16.16.5.3 Prepare complete material estimates for the service line and quote the LPU applicant with a "Service Line Quotation". If there are way leave obstacles associated with the service line, these should be clearly indicated on the service line quotation.

4.16.16.6 Note that LPU service is paid for 100% by the consumer, including the cost of upgrade of distribution transformer substation, the establishment of a new substation, extension of distribution mains, service line, and cable, and the cost of a metering cabinet for 300 or 630 amperes, as necessary.

4.16.16.7 The LPU of LV service shall not exceed demand above 630 amperes. The standard metering chamber capacity for LPU with LV service is either 300 or 630 amperes.

4.16.16.8 Arrange for capital works order for the establishment of transformer substation, extension of the Mains Distribution, or up-grade of the distribution transformer capacity. This CWO application authorization is obtained as per current financial regulations.

4.16.16.9 The distribution mains or transformer substation is created, and service line construction is carried out.

4.16.16.10 All customer drawings and other documentation are kept inside the SLAF folder under the custody of CSD.

4.16.16.11 The Installation Inspection Section (IIS) shall carry out audit of service line and lead-in cable, extension of LV mains and the newly installed or up-rated distribution transformer installation and consumer's installation. Adequate protective circuit against earth fault and short circuit should conform to the requirement of IEE regulation.

4.16.16.12 Upon completion of the service line, the following needs careful handling:-

4.16.16.13 Ensure CWO and SL completion form is completed and closed. Materials left over should be handed over to stores.

4.16.16.14 Raise MAS and get the LPU - LV metering cabinet installed and tested by competent staff, do not let ignorance prevail. If necessary, get assistance from MLPU for installation of PPM meter to avoid huge NTL. Ensure that proper installation of power meter, sealing system, and pad locking for the metering cabinet is observed.

4.16.16.15 The consumer shall sign a Power Supply Service Contract Agreement (PSSCA).

4.16.16.16 PRE/PE/SE shall ensure that the SLAF and MAS are submitted to RFO/RA not later than the second working day after meter installation.

4.16.16.17 RFO/RA shall ensure that the new account is opened not later than the second working day after receipt of the MAS and include the new customer in the meter reading roster/list.

4.16.16.18 All milling machines, garages, workshops, restaurants, bakeries and similar light commercial customers with three phase connections shall be categorised in the billing system and closely monitored.

4.16.16.19 PRE/PE/SE; shall submit the service line completion report complete with labour and transport recharge not later than the second working day after the date of completion.

4.16.16.20 RFO/RA; shall ensure that the service line works order is closed within four (4) working days after the date of receipt of the service line completion report.

4.16.16.21 When on load, PRE/PE/SE; shall ensure that the meter is re-tested and verified seven days after installation.

4.16.16.22 For repositioning of the existing service line and metering system or increase in demand capacity, the following guidelines apply:-

4.16.16.23 The consumer is required to have another SLAF, which shall be treated similar to a New Service Line if it involves extension or change of service wires or a new service cable. The meter chamber may require replacement because of limitation of the circuit breaker capacity and current transformer ratio. A new service cable or new transformer may be required.

4.16.16.24 If the above activity does not require any extension or replacement of service wire and service cable, and if the same meter chamber could cover the increase in capacity, there shall be no

extra cost. Nevertheless, the customer is still required to get SLAF and indicate the load requirement.

4.16.16.25 If the existing service system suffices the increase in load but requires metering system to be changed from 300 to 630 amps, the cost of the new metering cabinet is charged and the old metering cabinet is returned to stores.

4.16.16.26 In general, meter repositioning or load increase will require new SLAF accompanied by load requirement. Such cases are treated similar to New Service Line. The consumer shall pay for the cost of repositioning the meter if such reposition is effected upon his request; including but not limited to repositioning as a result of maintenance of the premises.

4.16.17 NEW LPU LV- MV SERVICE LINE

4.16.17.1 For LPU of MV service, the prospective customer shall notify the company in writing his/her power supply requirement. The intended demand and the possibility of supplying the required power must be negotiated with Regional Manager and forward to a SZM/SMD for information and future planning input.

4.16.17.2 The Prospective Consumer, his Electrical Contractor, shall arrange to pay the initial designated amount and collect SLAF from the company's Regional office at the Customer Service Department (CSD).

The SLAF form shall be duly filled and completed in all respect by the customer, his appointed contractor. The contractor will indicate the intended kVA demand utilization.

4.16.17.3 The demand and utilization in this category needs careful deliberation. There is a definite limit to the capability of supply at LV service, and it is negotiable. For MV supply, the prospective capacity shall be forwarded to SZM/SMD for onward deliberation with the management.

4.16.17.4 The prospective consumer's contractor shall complete the section required and clearly insert the CRB and EWURA registration number.

4.16.17.5 The duly completed SLAF is submitted together with the customer's installation drawings to the CSD head, who ensures that all details are filled in properly and entered into a register. The CSD receives stamps, and signs the SLAF and drawings. The prospective consumer is given a survey date appointment.

4.16.17.6 The IIS will get a copy of the preliminary applications, installation completion form, and customer's installation drawings. Competent Staff from the CSD will visit the site and carry out the following tasks:

4.16.17.6.1. Make an accurate drawing showing the applicant's premises, the available capacity of the nearest MV feeder mains and the spare capacity of the distribution primary substation transformer from which the supply is to be connected. Record details of conductor size, pole number and distance of applicant's premises from the nearest existing overhead MV 11 and 33 kV distribution mains. Get information on the voltage level at the proposed tapping point to ensure that it is within acceptable limits.

4.16.17.6.2. Ensure that the drawing connects the applicant to a MV feeder located in the same billing zone as the location of his premises.

4.16.17.6.3. Check that the location of the applicant's premises does not interfere with LV, MV and HV way-leave clearance.

4.16.17.7 The complete material estimates shall be prepared for the MV line extension and service line. The LPU with MV service line type applicant is quoted with “Service Line Quotation”. If there are way leave obstacles associated with the service line, indicate them clearly on the service line quotation.

4.16.17.8 Upon acceptance of the offer, arrange for capital works order for the construction of MV mains extension and service line. The CWO application authorization is obtainable from RM/SMZ/DMD (D&CS).

4.16.17.9 The MV main is extended followed with provision of MV SL construction. All works are carried out only upon establishment of CWO. Upon completion of the project, ensure closing of the CWO within the period of five (5) working days from the date of completion through issuance of a completion certificate for the project.

4.16.17.10 All drawings and the quotation shall be maintained in the SLAF folder. Upon completion of the service line, the following needs careful handling:

4.16.17.10.1 Return all excess materials to stores through stores return voucher and get IIS to carry out line audit and inspection.

4.16.17.10.2 Get the LPU - MV metering Unit system (MU) installed and ensure that proper installation of power meter, sealing system, and pad locking for the MU marshalling box is observed.

4.16.17.10.3 The MV metering system is installed by competent staff from the SMSM. The meter shall be checked by the experts from the office of SMSM to prevent huge NTL.

4.16.17.10.4 The Installation Inspection Section (IIS) shall carry out audit of MV mains line, service line, lead-in power cable, and consumer’s installation. Note that MV supply service may require services from TBU. On the lower voltage side, ensure that adequate protective circuit against earth fault and short circuit conforms to the requirement of the latest IEE regulation. In commissioning of MV & LPU installation it should be Mandatory that Electrical Workshop staff, Meter Workshop staff and Protection staff are tripartite involved.

4.16.17.10.5 The consumer shall sign a Power Supply Service Contract Agreement (PSSCA).

4.16.17.10.6 Ensure MAS is processed and the account and initial meter readings is recorded. When on load, get the meter tested and verified.

4.17 SERVICE LINE ACQUISITION AND CONSTRUCTION

4.17.1 For the standard service line, LV insulators/ ABC accessories and fittings shall be used at the pole and at the house bracket. The overhead line is extended to the point of metering with lead-in wire of which the size will depend of the customer’s load

4.17.2 It is important that the connections between the copper and aluminium wires are properly made with bimetallic connectors.

4.17.3 The service line bracket is made of a galvanized pipe or a bent galvanized angle iron bracket or D-iron directly anchored to an agreed place on the building. The attached appendix and drawings include galvanized pipe and angle iron brackets for both single and three phase service lines. Where ABC conductors are used, specified anchors typically pig tail hook and strain clamp shall be used instead of the service bracket and its accessories.

4.17.4 All new service lines shall be extended from the distribution mains and not from existing service lines.

4.17.5 If a customer opts to pay for the extension costs, the subsequent customers will compensate the first customer.

4.17.6 The reinforcement and extension works reaching up to 30 meters from the prospective consumers premise will be carried out under Capital Works Order.

4.17.7 From the first pole to the distribution main, the conductor size shall preferably be 50 sqmm or 100 sqmm AAC or equivalent, depending on the load density and the number of prospective consumers who are likely to be connected to the distribution main extension.

4.17.8 Where the house is more than 20 m from public land, the pole shall be placed at the edge of public land. The distribution main shall end at the boundary of the public land. All supply line in private land meant exclusively for supply to the consumer shall be considered as private service line. No further extension of the line from a private land to another plot shall be made.

4.17.9 Use of TPN supply shall be discouraged and not allowed if total load does not exceed 60 amperes as installed capacity.

4.17.10 Note that standard service is restricted to the whole current energy meter. The available energy meter for whole current measurement has been standardized as 10-60 amperes for SPN or 20-100 amperes for TPN. The meter terminal entry can accommodate cable size up to 35 sqmm.

4.17.11 Regional Managers will review on monthly basis the progress of all service line construction within the region. PRE/SE/PE/DM, shall explain SLs that have not been completed on time in accordance with CSC. RM will compile a list of all such pending SLs, ascertain the availability of the necessary materials, and seek advice from SZM/SMD on the best line of action.

4.17.12 An up-to-date audit is required to show construction progress of standard service lines.

4.17.13 The progress of all service lines of CWO type, LV SPU, LV LPU, and MV LPU will be shown separately and reasons for delay.

4.17.14 Arrangements should be made to reconstruct/repair/re-arrange existing service lines with abnormal or substandard construction in the vicinity of new service lines.

ENGINEERING INSTRUCTION NO. TDEI- 05

STREET LIGHTING

There is no standard street light system practiced in the company. All street light works are done on contract and as per actual costing plus 25% overheads. All LT distribution network, new and extensions to current network are built as four-wire system without the fifth switch wire for street lighting.

The street light agreement which the Utility offers to individual City or Township authorities throughout the country is based on this section of Engineering Instruction.

5.1 METHOD OF ERECTION OF STREETLIGHTS

SMD /SMSM /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

5.1.1 For request of mounting on Company's poles, construction works will be carried out and charged as per actual cost plus 25% as contract price. If the Client provides the materials, costing is computed as if materials are bought locally, i.e. store's handling charge plus the 25% on contract price. Alternatively, Township Authority shall construct the street lights at own cost and using its own manpower and the Company should only be involved in commissioning of the line including metering.

5.1.2 If the Company poles do not have the fifth switch wire as switch wire, this is erected at actual cost plus the 25% on contract price.

5.1.3 For streetlights to be mounted on township authority poles, the Company will erect poles, lay underground cable or install overhead or another type of switch wire, and install bracket and fittings (provided by Authority) under Contract Works Order, for which payment is to be made before work commences. The town authority will supply all nonstandard materials.

5.1.4 For carrying out the activities listed above in section 5.2.3, the street light authority shall provide the actual material costing include on it other overhead, as per purchas**e** invoic**e.** This total costing shall be used to determine 25% additional contract pricing.

5.1.5 If costing is not available, prepare estimate and costing according to market value for the material required or supplied and work out the 25% contract price for erection.

5.2 MV/LV LINE EXTENSION AND SUBSTATION

SMD /SZM /Zonal Principal Distribution & Transmission Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

5.2.1 Where it is necessary to extend the MV/LV Line and/or erect a distribution transformer substation as Pole Mounted Transformers (PMT) or Ground Mounted Transformers (GMT) type for establishing an LV supply for street lighting installations, the work will be carried out and charged at actual cost plus 25%. Provided the size of distribution transformer does not exceed 50 KVA, the applicable monthly charge is based on kWh consumption based on tariff T1.

5.2.2 Where the transformer required for use by the street light authority is above 50 kVA and includes other public customers, the street light authority shall pay for the cost of establishment of 50 kVA capacity. The applicable tariff still remains as T1.

5.2.3 The city or town authority is required to fill in SLAF depending on the number of service points required. The authority shall be provided with a quotation for power supply service.

5.2.4 Only upon the acceptance of the quotation in writing and upon full down payment for the total cost is the work initiated.

5.2.5 Applicable tariff is T1 or T2 depending on the unit's consumption and capacity required. One point delivery of capacity bigger than 50 kVA must be examined carefully; it must not create higher voltage drops and render street lights in operative during voltage sag.

5.3 METERING.

SMD /SMSM /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

5.3.1 A proper outdoor type metering chamber shall be installed and a billing account opened for street lighting, as with any other consumer. All other regulations on power supply requirement will be applicable.

5.3.2 A special, weather-proof metering chamber shall be installed. The cost of such a chamber and the cost of the meter is fully paid for by the street light authority. Where applicable, the use of prepaid metering system will be applied, provided the metering does not call for demand charge.

5.3.3 The cost for provision of metering chamber and switching facility is charged as per actual plus contract of 25%.

5.3.4 If the installation has been carried out by a contractor, relevant ENGINEERING Instructions for connectivity shall be followed. The installation shall be tested and inspected. The contractor's electrical installation completion certificate and testing report is a pre-requisite.

5.4 BILLING

SMSM /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

5.4.1 Units consumed will be determined and billed under tariff T1 or T2 depending on the demand and energy consumption.

5.4.2 The units consumed will be determined from the meter reading.

5.4.3 Bills will be prepared in duplicate. The original will be forwarded to the City/Municipal/Township Authorities, and the duplicate will be retained by the Branch office.

5.5 REPAIR AND MAINTENANCE CHARGES

SMD /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall ensure that:

5.5.1 Units consumed while carrying out maintenance on streetlights should be charged to the City/Municipal/Township Authorities account. It implies that the meter is in working condition during the maintenance.

5.5.2 Replacement of switch-wire brackets on Company's poles will be carried out and charged as set out in the Street Lighting agreement contract.

5.5.3 All maintenance and repair work or any other work on street lights on City/Township Authority's poles will be carried out by the council. In case the council wishes to employ the Company, it will so be done at cost plus 25% overheads under Contract Works Order for which payment will be made before the work is done. All maintenance on the Company poles if done by the council shall be supervised by the Company. Supervision provided by TANESCO in maintaining street lights mounted on company poles should be paid for. The charges shall be 25% of the maintenance project cost.

5.6 CONTRACT AGREEMENT WITH CITY AUTHORITY

SMD /SZM /Zonal Principal Distribution Engineer /Regional Manager /Principal Engineer /Senior Engineer /Planning Engineer /District Manager shall negotiate with City/Municipal/Town Council and have a signed agreement.

The attached appendices are a typical contract agreement to be negotiated with City/Municipal/Town Council.

ENGINEERING INSTRUCTION NO. TDEI-06

METERING LARGE POWER USERS AND DISTRIBUTION SYSTEM

The purpose of this Engineering Instruction is to ensure that Large Power Users, feeders, regional/districts and/ or areas boundaries and distribution substations are accurately metered.

Feeder Metering is when the metering facilities are installed at the Primary substation where the feeder originates.

Boundary metering is when the metering facilities are installed at the boundary of different TANESCO Regions/Districts areas for the purpose of establishing the total units distributed in that particular area.

Distribution substation metering is when the metering facilities are installed at the secondary substation in order to establish units distributed to customers connected to that particular substation.

6.1 LARGE POWER USER METERING

6.1.1 Metering is the means by which the service provided by the Company to the consumer is quantified and measured. The meter thus plays a crucial role in the billing of electricity to the consumer and has therefore been referred to as the "Cash Register" of the company.

6.1.2 It is necessary that meters register correctly in the interest of fairness to both the Company service provider and the consumer. Metering accuracies therefore concern all.

6.1.3 The Large Power Users (LPUs) have high kVA demand and consume a colossal amount of energy. They are the prominent source of our revenue generation. Absolute care must be taken to block all possible sources leading to high Non Technical Loss (NTL).

6.1.4 This Engineering Instruction is intended as guideline for appropriate and accurate metering of LPU supplied on Low Voltage (LV) at 0.4 kV, Medium Voltage (MV) at 11kV or 33 kV, and High Voltage (HV) at 66 kV, 132 kV or 220 kV service lines.

6.1.5 For LPU on LV service, the consumer's metering system is carried out through the use of metering class current transformer located on LV incoming supply.

6.1.6 For LPU on MV or HV service, a combination of both current and Voltage transformers of metering class, which are located on the MV or HV primary side, are used.

6.1.7 All LPU are metered with Programmable Polyphase Meter (PPM)-AMR, which has the facility for historical data capture for the past consumption and some engineering functions like reversal of phase sequence, reversal of CT polarity, change of CT and PT ratio, consumer power factor, kVAr consumption, and automatic capture of meter reading at 24.00 hours on last day of the month.

6.2 INITIAL PREPARATIONS

6.2.1 After the receipt of the application for service connection as per Engineering Instruction TDEI-04, the Regional Manager shall scrutinise the contents of the power requirement and work out the calculated anticipated kVA demand, calculate revenue income, and compute the rate of return for the investment.

6.2.2 In order to have fair way of determining who to connect first, the financial viability of the project must be worked out, and the project with the highest rate of return is given first priority. If several projects have a similar rate of return, the first come first served approach shall be used. Due consideration shall be given to the projects of public interest.

6.2.3 The Regional Manager shall forward the application to the Senior Zone Manager who will further forward to Deputy Managing Director -Distribution and Customer services if the power requirement needs installation of a transformer of capacity equal to or greater than 500 KVA or if the consumer's demand necessitates MV service and power metering.

6.2.4 Deputy Managing Director -Distribution and Customer services shall allocate the proper metering system depending on the type of service to be provided.

Regional Manager shall ensure that the allocated size of metering system for installation is the one recommended for use.

6.2.5 For LPU with LV service, the LV metering cabinet will be required for installation. The PPM -AMR meter is installed by Construction/Planning Engineer

6.2.6 For LPU with MV service, Metering Units (MU) of service rating of either 11kV or 33 kV will be allocated. The PPM-AMR meter is installed by competent staff from meter workshop (Meter Engineer).

6.2.7 For LPU with HV service, the metering system is negotiated (if company cannot provide metering system) and the contractor for the HV service construction will provide the metering system, which must have a prior approval of Deputy Managing Director -Distribution and Customer services

6.3 SPECIFICATION OF LPU - LV, MV & HV METERING

6.3.1 The specification for the LPU – LV service metering cabinet is available at the office of Senior Manager Distribution

6.3.2 The metering cabinets are standard products in use and readily available in stores. It is imperative that these metering cabinets are procured exclusively by the company for the purpose of product standardisation and to minimize risks that could trigger high Non Technical Losses (NTL).

6.3.3 MV metering units of 11 kV or 33 kV, with a range of multiple CT ratios, are also a standard stock item and are readily available. It is imperative that these MV rated MU are procured by the company for purposes of product standardisation and to minimize risks that could trigger high NTL.

6.3.4 Senior Zonal Manager need to be vigilant and monitor the prospective power customers who are coming up in the next 12 months period so that earlier arrangements for the procurement of LPU metering system can be carried out in a timely manner.

6.3.5 Should there be a case of non-availability of the LV metering cabinets and MV metering units, prior approval is required from the Deputy Managing Director -Distribution and Customer Services before the customer can order one on behalf of the Company.

6.3.6 In case the procurement of the metering system is being processed by the consumer, the final drawings and technical offer shall be approved by the office of Deputy Managing Director -Distribution and Customer services. Specification of LV Metering cabinets, MV Metering Units, and PPM-AMR energy meter are readily available at the office Senior Manager Distribution A copy of the document can be obtained as and when required.

6.3.7 If the meters are not available in TANESCO stores, the customer can order them together with the Metering System. The cost incurred will be excluded from the cost estimate. Final drawings and technical offer must be approved by Deputy Managing Director -Distribution and Customer services and the meter must be verified and sealed at the company’s meter workshop.

6.3.8 When a customer is authorised to procure the complete metering system for LV, MV, or HV service, the entire metering system becomes the property of Company.

6.3.9 Senior Manager Sales and Marketing shall ensure that the metering system procured by the contractor conforms to the company's specification and standards as far as accuracy and sealing features are concerned, and that risk of causing NTL is totally at the ZERO level.

6.4 INSPECTION & TESTING OF LPU - METER INSTALLATION

6.4.1 After the customer has completed installation of his switchgear and other electrical equipment, he/she shall inform the Company when the power will be required.

6.4.2 The customer shall submit to the Regional Manager Specifications and test results of electrical equipments including switchgear and transformers before power connection, and also the Company's service to test the electrical installation is required.

6.4.3 The customer shall also submit to Company installation drawings for the entire commercial/factory installation showing both the physical layout and the schematic electrical connection. The Regional Manager will forward these details to Senior Zone Manager office for study, deliberation and approval.

6.4.4 The office of Senior Zone Manager will study the installation drawings and will arrange to have the installation inspected and tested. If the drawings are not satisfactory, the Electrical Contractor will be required to submit revised drawings.

6.5 LPU LV METERING

6.5.1 For installation of LPU with LV service, the metering cabinet shall be installed by Construction/Planning Engineer.

6.5.2 The metering cabinets shall be delivered to Regional Manager with the meter already tested and programmed at the Meter Workshop.

6.5.3 Regional Manager shall ensure that all payments have been carried out, the consumer is ready for power connection, MAS has been raised, consumer deposits and other relevant obligations have been completed, and the Power Supply Service Contract Agreement (PSSCA) has been signed.

6.5.4 The completed Agreement Form and the MAS will be given to Senior Revenue Accountant/Billing Accountant who will open up the appropriate account and keep the documents in Safe Custody.

6.5.5 The metering systems shall be adequately sealed and pad locked with tamper proof padlocks approved by the office of Senior Manager Sales and Marketing.

6.6 LPU MV METERING

6.6.1 For installation of LPU with MV service, Senior Manager Sales and Marketing/Senior Zone Manager shall carry out the following tasks:

6.6.1.1 Costing for testing of the consumer's MV or HV switchgear and other associated electrical equipments.

6.6.1.2 Electrical Workshop and Meter Department Staffs shall test the switchgear and the metering system.

6.6.2 The Meter Department Staff together with the Electrical Workshop and Protection staffs shall test the metering panel/metering unit to ensure that the metering system conforms to the company's metering standards.

6.6.3 All relay settings are worked out, adapted, and ensured for proper coordination with the protective settings at our feeding end. Company feeder protection shall not operate for a fault at the consumer's end. There shall be sufficient time grading.

If testing is successful, power will be connected.

6.6.4 Shall ensure that all connected electrical equipments are declared and that none shall cause harm or impair the company's quality of supply. Where a problem is suspected the customer shall be advised and only commission the service when convinced that the intended service connection will not cause any deterioration to quality of supply.

6.6.5 Shall ensure that all payments have been carried out, the consumer is ready for power connection, MAS has been raised, consumer deposits and other relevant obligations have been completed and the Power Supply Service Contract Agreement (PSSCA) has been signed.

6.6.6 The completed Agreement Form and the MAS will be given to Senior Revenue Accountant/Billing Accountant who will open up an appropriate account and keep the documents in Safe Custody.

6.6.7 Get the metering systems adequately sealed and pad locked with the tamper proof padlocks. The metering system must be safe against any conduct leading to NTL.

6.6.8 The Principal Engineer Meter workshops need to ensure that all seals are in position and that the metering system is safe against any malpractice leading to NTL.

6.6.9 Regional Manager shall ensure that all defunct or temporary service lines and metering points on the premises are removed within a month of commissioning of the new supply.

6.6.10 After commissioning of power supply, Regional Manager shall check for proper operation of the metering system, and carry out an on-load check at a later stage.

6.6.11 All customers with their own or dedicated transformers regardless of transformer size shall be metered at the primary side of the transformer.

6.7 LOCATION OF METERING SYSTEM

The consumer shall be made aware of the fact that he /she–is accountable and responsible up to the metering point, and is answerable for any meter meddling. An agreement (PSSCA) shall be signed, where the customer is made fully accountable to the well being of the metering system, and position the metering system such that it is easy for the company to get access for meter reading.

6.7.1 METER INSTALLATION AND COMMISSIONING

6.7.1.1 METER INSTALLATION.

Any energy meter shall be installed by a **competent staff**. Any installed metering system shall be at ZERO NON-TECHNICAL LOSS

Before meter installation, the Meter /Construction/Planning Engineer shall make sure that, the customer's installation is technically inspected and complies with the following important things:

6.7.1.1.1 The application card (SLAF) and other documents are reviewed clearly and is filled in completely.

6.7.1.1.2 Fully payment has been completed for connection

6.7.1.1.3 Position for meter installation is acceptable, safe, visible, accessible and traceable
6.7.1.1.4 Meter shall be installed when power supply is disconnected for safety of person and property
6.7.1.1.5 Meter /Construction/Planning Engineer shall have a correct and required meter, installation instruments, proper seals, and data collecting instruments, safety gears and commission sheet in hand for installation
6.7.1.1.6 All connection made and that which will be introduced until to finish installation, proper clamps shall be used.
6.7.1.1.7 Meter /Construction/Planning Engineer shall inspect and test functionality of the meter and fill in the inspection and functionality test form (Appendix 6.1)

6.7.1.2 Small Power Users

For New Single phase and three phase connection, especially LUKU meters must be installed outside the customer's premises and lead- in cable must be visible, traceable from bracket and shall be concentric

Also any meter removal or replacement at the customer's premises shall follow part 6.10.3 below. For a new connection, meter removal or replacement SMS LUKU meter form shall be applied

In case of AMR meters the following should be observed:

6.7.1.2.1 Network availability and communication strength at the site must be observed
6.7.1.2.2 Meter shall be installed at the electric pole
6.7.1.2.3 Lead in cable from meter to customer's load must be far away from main LT line
6.7.1.2.4 SIM card must be available for meter connectivity

6.7.1.1 Large Power Users

For large power users, meter shall be installed in the Company's meter box or LV metering cabinet, secured with security switch and antenna.

Metering system for T2 and T3 customers shall be carefully protected (e.g. properly earthed), CT and VT ratios shall be in proportional with customer's load

Test terminal block MUST BE installed with meter for meter testing activities and other use.

For T2 customer the LV metering cabinet shall be installed at safe, visible and accessible, while the Lead in cable from transformer shall be visible and traceable.

For T3 customer, metering system (meter with meter box and metering unit) shall be installed at the electric pole, at safe H-pole or safe designed structure for metering purpose and :

6.7.1.1.1 On meter installation Correct CT and VT ratios with tapping and connection shall be observed
6.7.1.1.2 Test Terminal Block (TTB) must be open and not shorted
6.7.1.1.3 Modem is installed and with SIM Card properly to the meter
6.7.1.1.4 Observe the communication signal strength if it is acceptable (Above 8dB)

6.7.2 METER COMMISSION

After all above have been completed, Meter/Construction/Planning Engineer have to communicate online with AMR Center Head Office or Zone office for connectivity and registration to AMR System, with the following important information:

6.7.2.1 Name of customer and other details of customer

6.7.2.2 Type of customer (Commercial or Residential) or is the customer of T2 or T3

6.7.2.3 Meter number and other details of meter, with modem number
6.7.2.4 The size of CT and VT ratios tapped
6.7.2.5 SIM Card number
6.7.2.6 Meter/Construction/Planning Engineer shall test functionality of the meter and fill in the inspection and functionality test form (see Appendix 6.1)

6.7.3 After meter has been connected and registered, then Meter/Construction/Planning Engineer must have the following acceptable testing instruments in hand for commissioning, Current and Voltage meter, Phase sequence meter and also Standard test meter if required.

6.7.4 If all physical measurements observed are the same with that seen online (AMR System), Meter/Construction/Planning Engineer shall make sure:

6.7.4.1 Meter Terminal cover is fixed properly and tightened
6.7.4.2 Door switch and Metering unit cables are properly connected
6.7.4.3 Switch for LV cabinet or meter box door and Metering unit switches are activated
6.7.4.4 Proper sealing and padlock are used

6.7.5 On completion of all above, Meter/Construction/Planning Engineer shall fill in the commission form as the data will be collected at site and will be filled at site (See Appendix 6.3)

6.7.5.1 MAS Raising Note shall be filled and submit to respective region if meter is installed by Meter workshop staff. Construction/Planning Engineer from region will fill M A S straight and submit to Regional Manager and Regional Revenue Accountant or Billing Accountant for opening customer's account (see Appendix 6.2)

6.8 MAINTENANCE OF THE METERING SYSTEM

6.8.1 The metering system is the property of company and therefore should be maintained and replaced by company as and when need arises. The Regional Manager shall ensure that maintenance and verification of metering is carried out at least once a year or whenever deemed necessary.

6.8.2 The Company has the responsibility of ensuring that the consumer(s) installation/equipment is in a good state and worthy of being connected or continued to be connected to the Company's System. Therefore, while servicing the metering panel, the consumer's switch-gear shall be checked and inspected to see that they are in good condition. Otherwise, the consumers are obliged to maintain the installation in sound and safe working condition.

6.8.3 The Consumer shall not work on or maintain the metering system. This shall always be sealed and maintained by the company.

6.9 BOUNDARIES AND SUBSTATIONS METERING

6.9.1 Competent Engineer from meter workshop shall install metering facilities to all TANESCO Regions/Districts boundaries and Medium Voltage (MV) feeders.

6.9.2 Construction/Planning Engineer shall install metering facilities to all secondary substations and ensure that all MV feeders are metered.

6.9.3 Principal Engineer/Senior Engineer/Planning engineer/District Manager shall ensure that all boundary meters are read on monthly basis and use the readings for computation of the distributed/imported units using three months moving average including the current month.

6.9.4 Using the moving average of units distributed, Principal Engineer/Senior Engineer/Planning engineer/District Manager shall compare with the units sold in order to calculate the losses.

6.9.5 Principal Engineer/Senior Engineer/Planning engineer/District Manager shall use readings from secondary substations for analysis of losses in the area of supply, transformer loading and phase imbalance.

6.9.6 Principal Engineer/Senior Engineer/Planning engineer/District Manager/Maintenance Engineer shall take immediate measures to ensure that losses, transformer loading and phase imbalance are well addressed and corrected.

6.10 LPU, SUBSTATION, FEEDERS AND BOUNDARY METER READING

For meters other than Automatic Meter Reading (AMR) meters the following procedures shall be observed:

6.10.1 LPU, substations, feeders and boundaries meters shall be read by Principal Engineer/Senior Engineer/Planning engineer/District Managers/ Maintenance Engineer.

6.10.2 Meter Reading Record Card must be filled in during meter reading and shall be left at the meter reading point.

6.10.3 Meter Reading Cards (MRC) shall be used to capture meter readings and kept by Principal Engineer/Senior Engineer/Planning engineer/District Manager office

6.10.4 Senior Revenue Accountant/Billing Accountant shall prepare the exceptions report necessary for checking the accuracy of the billing process; doubtful readings shall be referred back to the respective Engineer who submitted the readings.

6.10.5 Any irregularity found with metering system during meter reading exercise shall be reported to Regional Manager.

6.10.6 Meters for Automatic Meter Reading (AMR) system the following procedures shall be observed:

6.10.6.1 LPU, substations, feeders and boundaries meters reading shall be downloaded from AMR system by Senior Revenue Accountant/Billing Accountant/District accountant. If any AMR meter will miss readings must be reported to AMR Centre for further request from the system

6.10.6.2 If any AMR meters from the list downloaded will not be able to get their data through the AMR system then Principal Engineer/Senior Engineer/Plan engineer/District Manager shall ensure that, readings are collected from the site.

6.10.6.3 Regional AMR Coordinator shall ensure that, the respective Customer is issued with access permit for overseeing energy consumption within seven days after power connection/commission

6.10.6.4 Any defective meter noted shall be attended within three (3) days after reporting.

ENGINEERING INSTRUCTION NO. TDEI- 07

CONSUMER PREMISES INSPECTION AND METER TEST PROCEDURE

7.1 ROUTINE CONSUMER PREMISES INSPECTION

This section of Engineering Instruction gives procedures for handling various consumer malpractices in respect to the connection of power to various consumers' premises, proper utilization of power and safety to the public. It is important that only a Senior Employee, who understands the procedures and legal requirements, should carry out the Routine Consumer's Premises Inspection and disconnection exercise. This TDEI may be read side by side with TDEI – 07 on Revenue Protection.

Routine consumer inspection shall be conducted by Engineers and Technicians only

7.1.1 CONSUMER'S INSPECTION & FINDINGS

There are several aspects being looked at during the inspection. All the flaws are contained in the Electricity Act, 2008. Some of the flaws are dealt with below.

7.1.1.1 Fittings On Utility Poles

In case a consumer's fittings or wiring or apparatus are found fixed on Utility poles or installation without the Company's consent, or if any person including consumer, is found affixing any advertisement, bill, notice or any paper against or upon or otherwise any encloser, building, substation fence in connection with electrical installation, without a consent of company or Authority such a person shall be liable for penalty. Such action is contrary to Electricity Act 2008 Sec33 part (2), (e) Compliance. The following actions shall be taken:

7.1.1.1.1 The consumer is given a notice (reasonable length of time not exceeding 14 days) to remove his fittings, wiring, or apparatus. If the notice is not heeded to, power is disconnected.

7.1.1.1.2 The consumer is fined and charged a daily penalty, as per the schedule of payment, until the consumer removes his fittings, wiring, or apparatus.

7.1.1.1.3 The Company further charges the consumer the cost of survey, inspection, and rescheduling of works, as per the schedule of payment, as well as disconnection and re-connection fees. The consumer's deposit for supply shall be revised according to the current rates.

7.1.1.1.4 The payments above are allocated to account GL 701045, while the deposit is put in GL 241000. The consumer shall also pay for the cost of any rectification required to be made on the Company's pole or installation.

7.1.1.2 **Consumer Dubiously On Wrong Tariff**

In case a consumer found dubiously on the wrong tariff, the following actions shall be taken:-

7.1.1.1.1. The consumer is disconnected immediately as per Electricity Act 2008 section 28(1) (b). The consumer has not complied with Electricity Act, 2008 section 33(3), the consumer has committed theft and is to be charged as per Regulation 9, the consumer is fined and charged a daily penalty as per the schedule of payment of this Engineering Instruction (Appendix7.1-Revenue recovery). The fine is applicable daily until such improper use of energy has stopped.

7.1.1.2.2. The consumer is charged a fine for the improper use of energy as per the schedule of payment.

The consumer is also charged the cost of survey, inspection, rectification of Account as well as rescheduling of works, disconnection and re-connection fee. These charges are allocated in account GL701045.

7.1.1.2.3. The consumer shall pay for the lost revenue, which shall be determined from the consumer's account and electric fittings and appliances installed at premises. A supplementary bill shall be raised accordingly.

7.1.1.2.4 The consumer's deposit for supply shall be revised according to the current rates, with payment being put in account GL-241000.

7.1.1.3 **Dangerous Installation**

If a consumer is found with dangerous installations or with installations not complying with the latest IEE wiring regulations and so invokes application of Electricity Act, 2008 section 26(1) (a)(b), the following actions shall be taken:

7.1.1.3.1 If the installation is found to be dangerous, the power shall be disconnected immediately.

7.1.1.3.2 If the installation is otherwise not complying with the wiring regulations, the consumer is given a notice of up to one month depending on the gravity of the discrepancy. If the consumer fails to comply with the notice, the supply shall be disconnected.

7.1.1.3.3 Power shall be restored after all the discrepancies have been rectified and after the consumer has paid the disconnection and reconnection fees and revised deposit for supply according to the current rates.

7.1.1.4 **Load Increase To Overload Metering System**

If a consumer is found to have increased the load so much as to excessively overload the meter and/or lead in wire due to additional installation of which the Company has not been informed, and hence the additional installation has not been inspected and approved by the Company, the consumer has not complied with the wiring regulations Rule 59 (2), the following actions shall be taken:

7.1.1.4.1 The consumer has also not complied with The Conditions of Power Supply as stipulated on the Service Line Application Form (SLAF) between the consumer and the Company.

7.1.1.4.2 The consumer shall be disconnected immediately for non-compliance to avoid damage to the Company's equipment.

7.1.1.4.3 The consumer shall be charged the cost of survey, inspection, rectification of Account and rescheduling of works as per schedule of payment. The consumer will also be charged the full cost of replacement of meter if found damaged, cost for increase in capacity of service line if required, disconnection/reconnection fee, cost of installation inspection and total costs of changing lead in wires or service line.

7.1.1.4.4 If the load is so big as to necessitate changing the size of the distribution line, the customer shall pay for the entire cost for reinforcing the distribution system.

7.1.1.4.5 Before supply is restored, the consumer shall enter into a fresh power supply agreement by completing a new SLAF, and if the consumer happens to be a LPU, shall sign a new PSSCA. For SPU, the new SLAF shall be signed and treated as a new customer for new service.

7.1.1.4.6 The consumer's deposit for supply shall be revised according to the current rates.

7.1.1.5 Consumers Refusing Company Workers Access to Premises for Company Work

If a consumer refuses the Company's workers to enter their premises or, after allowing them entry, does not allow them to carry out their duties, the following actions shall be taken:

7.1.1.5.1 The consumer has not complied with Electricity Act, 2008 section 13(f) and Regulation 5(2). The consumer shall be given 24 hours notice to allow works to be carried out.

7.1.1.5.2 If the notice is not heeded to, power shall be disconnected. Power shall be reconnected after allowing the workers to carry out their duties and payments of disconnection and reconnection fee.

7.1.1.6 **Consumer Found Supplying to Other Consumers**

If a consumer is found supplying to other consumers with power supplied by the Company without authority, the following actions shall be taken:

7.1.1.6.1 The consumer has not complied with Electricity Act, 2008 section 21(1) (a).

7.1.1.6.2 The consumer is disconnected in accordance with Electricity Act, 2008 28 (1)(a) (b)and 33(3) and charged a fine for reselling power without authority, as well as for the cost of survey, inspection, rescheduling of works as per schedule of charges, and disconnection and reconnection fee all as in Attachment 1(Revenue recovery) of this Engineering Instruction. The consumer shall also pay for the loss of revenue arising from the resale of power if any.

7.1.1.6.3 The supply to the consumer shall be reconnected after payment of above charges/costs by the consumer, complete disconnection of the other consumer(s) from his installation, and the consumer's commitments in writing that ~~he~~ will never supply power to other consumer(s) without Authority.

7.1.1.6.4 The consumer installation shall be re-inspected for conformity with the requirement of latest IEE Wiring Regulations.

7.1.1.6.5 The consumer deposit for supply shall be revised in accordance with the current rates.

7.1.1.7 **Consumer Property Under MV/HT Line or Within TANESCO's way leave**

If a consumer is found with a house, installation/works, or other property under the company MV/HV electric line, the following actions shall be taken:

7.1.1.7.1 The consumer shall be given a sufficient notice not exceeding three (3) months to remove his house, installation/works, or other property from under the electric line.

7.1.1.7.2 The consumer shall be disconnected and the service line completely removed.

7.1.1.7.3 Legal steps shall be taken to ensure that the property is removed from under the MV/HV line.

7.1.1.8 Consumer Found with Meter Unsuitably Positioned

If a consumer is found with a meter installed at an unsuitable position where the metering system is subjected to excessive dust, soot, fumes, or vapours, in places exposed to weathering, or in places where entry is difficult like in the stores, strong rooms, cash offices, bed rooms, or in other inaccessible places, the following actions shall be taken:

7.1.1.8.1 Investigation shall be made so as to get the name of the Staff who did the entire project. Stern

disciplinary action shall be taken against them.

7.1.1.8.2 If a consumer makes re-arrangement of his premises (i.e. by extending his building etc.) such that the location of the meter became unsuitable, inaccessible, exposed to dust, soot, fumes or ash weather the following action shall be taken:-

7.1.1.8.3 The consumer shall be given a notice of two weeks to prepare a suitable box to exclude the dust or prevent the effects of the weather, or to shift his/her main switch/tail wire end to a position according to suitable new meter position.

7.1.1.8.4 The consumer shall submit a new SLAF and follow the requirements of Step No. 1 of the form if the meter position is to be shifted.

7.1.1.8.5 If consumer fails to comply with the notice under 7.1.1.8.3 above or does not fill the SLAF section required in case where the main switch or tail wire end has been shifted, power shall be disconnected.

7.1.1.8.6 The consumer shall then be charged for the cost for survey, inspection, rectification of Accounts, rescheduling of works, shift of lead in wire and meter repositioning charges as per schedule of charges and attachments, cost of replacement of meter if found damaged, and disconnection and reconnection fees, and the consumer's deposit for supply shall be adjusted according to the current rates.

7.1.1.9 **Improper Utilization of Energy Causing Quality of Supply to Deteriorate**

If a consumer is found using electricity in a way that causes the quality of supply to deteriorate and impedes efficient supply of electricity to other consumers the following actions shall be taken:

7.1.1.9.1 Electricity is disconnected until corrective steps have been taken.

7.1.1.9.2 The consumer shall pay for the charges related to the cost of survey, inspection and rescheduling works, disconnection and reconnection fee, and the costs of increasing the capacity of the distributing mains if required in order to ensure proper supply to the other consumers, and the consumer's deposit for supply shall be revised according to the current rates.

7.1.2 ENERGY THEFT

If a consumer is found by-passing the meter, tampering with the meter, or otherwise using un-metered or improperly metered supply, or if a consumer is found using power without a power supply contract. The consumer has invoked application of Electricity Act, 2008 sections 28(1)(b), 33(3), and Regulation 7(1) and therefore the following actions shall be taken:

7.1.2.1.1 The consumer shall be disconnected immediately.

7.1.2.1.2 The consumer shall be charged with a fine for tampering or mishandling Company's property, as well as the cost of survey, inspection, rescheduling of works as per schedule of charges and attachments, cost of replacement of meter if found damaged, and disconnection and re-connection fees, and account is rectified.

7.1.2.1.3 The consumer shall pay for the lost revenue, which shall be determined from the consumer's consumption records and electric fittings and appliances installed at his/her premises. A supplementary bill shall be raised accordingly.

7.1.2.1.4 The consumer shall pay for the cost of replacing the tempered meter. This cost shall include cost of meter, labour, and transport. The consumer's deposit for supply shall be revised according to the current rates.

7.1.2.1.5 In case a consumer has occupied a house and started using the power without the power contract,

the consumer will have to fill the Agreement Form, pay the charges, pay the deposit for supply, and pay for the cost of power consumed for the period he/she occupied the house.

7.1.2.1.6 The consumer will be required to inform TANESCO as to who enabled him/her to bypass or temper with the Company property.

7.1.2.2 **Illegal Service Line**

7.1.2.2.1. If a consumer is found with an illegal service line, power supply shall be disconnected and the service line removed.

7.1.2.2.2. If the meter is installed illegally, the meter shall be removed. The consumer is charged with a fine for tampering with the Company's services, cost of survey, inspection and rescheduling of works, disconnection and reconnection fees as per schedule of payment, service line costs, and any other costs required for proper supply. The consumer's deposit for supply shall be revised according to the current rates.

7.1.2.2.3. Before supply is restored, the Company will investigate thoroughly so as to get the name of the person who enabled the consumer to get the illegal service line and meter, where applicable, in order to prevent future recurrence. If the investigations are successful, the consumer shall be charged as above and, upon payment, join a queue of new applicants. If the investigations are not successful in up to three months, the consumer shall be charged as above and join a queue of new applicants.

7.1.2.3 Restoration of power

7.1.2.3.1 The consumers shall be informed in writing (in the letter detailing the charges) that after payment, the Company will try to restore power supply as soon as it is feasible. The restoration of power supply shall not necessarily disrupt the normal working schedule of the branch.

7.1.2.3.2 In all cases, the Company shall take advantage of the power disconnection to correct any non-standard works on the Company's distribution lines/equipment at or in the vicinity of the consumer's premises,

7.1.2.4 Disconnection & Reconnection Fee

The disconnection and reconnection fee shall be as per the schedule of charges and attachments. Refer to the latest applicable fees.

7.1.2.5 The inspection fee

The Inspection fees are defined in schedule of charges and Appendix 7.1 1.

7.1.2.6 **Inspection**

Involvement of the Customer/Customer's Representative during Inspection for planned and un-planned work, Revenue Protection Engineer/Technician/Artisan shall be:

7.1.2.6.1 Introduced him/her self, backed by his/her ID card and Uniform.

7.1.2.6.2 Explaining the purpose for visiting, that you are there to confirm the meter's functionality, and that you need a member of the premise above 18 years old and with a sound mind to accompany you.

7.1.2.6.3 Carrying out the inspection and fill in information to the form as per Appendix 6.1 ~~7.1-2 or 7.1-3~~ and the customer's representative shall sign the form before leaving the premises

7.1.2.7 Periodic Inspection

Customer's premises shall be inspected periodically to access meter and installation condition such as un-reported installation additions, and leakages. A thorough inspection shall be carried out by the registered Contractor at the consumers' cost every five years and inspection report should be submitted to the Company. Customers premises installed with credit meters should be inspected at least once a year while customers installed with LUKU meters should be inspected twice a year to verify the performance of meter, zero purchase and low purchase incidences.

7.1.2.7.1 For any meters especially for AMR T1 customers disconnected remotely from Head Office/Zone office, the same list generated by Regional Revenue Accountant/Billing Accountant shall be submit to Regional Revenue Protection team for visiting the customers who did not appear for a month without any payment, to see if there is a self re-connection or whatever, report shall be written and submitted to Regional Manager and AMR Centre.

7.1.2.7.2 Also after payment of required amount is done the restoration of power supply shall not necessarily disrupt the normal working schedule of the branch.

7.2 PROCEDURES FOR METER TESTING

7.2.1 Legitimacy Of Meters

The aim of this section of Engineering Instruction is to provide guidelines for meter testing and identification of persons authorized to carry out the tests, both at field and at the company's meter workshop.

The energy meters are set to register correctly the value of the energy and power supplied at all time.

7.2.1.1 All company's Energy Meters are tested, verified, and authenticated at the Meter Workshop before dispatch to the Regions around the country (refer to TDEI 06 section 6.2). The verification carried out at the meter workshop includes meters for use as SPN and TPN for SPU customers. Also for LPU customers, power meters are set and programmed at the meter workshop. Sometimes, the power meters are programmed and set at site depending on the installation process.

7.2.1.2 Energy Meters are the Cash Registers of the company. They generate the revenue for the company. The company is fully equipped with Standard Instruments for testing and calibrating Energy Meters. The accuracy of the working standards is also being carried out at an internationally recognized meter laboratory in an absolute method.

7.2.2 Meter Validation Request

7.2.2.1 The consumers may request the Company to carry out meter verification for the purpose of validating the meter registration. The consumer shall make a down payment for carrying out such tests as per schedule of charges and attachments.

7.2.2.2 If the meter test results prove to be within the prescribed limits of error, the payment done for

testing is forfeited and no credit is given.

7.2.2.3 For meters found outside the limits of error, the consumer is refunded the cost for testing and is given a credit or debit note depending on the result of the verification.

7.2.2.4 If the consumer's meter is suspected of any non conformity, the meter shall be tested at company's own cost only upon the request of the Regional authority.

7.2.3 Authority To Test Meters

7.2.3.1 The regional installation team (Technician) shall carry out simple tests on all whole current SPN consumers' meters.

7.2.3.2 The TPN whole current meters shall be tested under the supervision of the Installation Supervisor or the Installation Superintendent, and testing results shall be verified by Principal engineer/Senior Engineer/Planning Engineer/District Manager.

7.2.3.3 All LPU Programmable Power Meters for **kWh & KVA** measurements under tariff 2, 3 and 4 shall be tested by the Meter workshop Engineer Regional Manager shall play a full, active role during such investigation.

7.2.4 Commercial, Accountant & Audit Report

7.2.4.1 Every month, the Regional Manager shall evaluate Senior Revenue Accountant/Billing accountant's report on meter reading or ledger ~~(Meter reader memorandum - see Appendix 7.2)~~ and Routine consumer inspection report from Principal/Planning/Senior Engineer/District manager.

7.2.4.2 Regional Manager shall also evaluate any other inspection reports from the directorates of internal audit as well as reports from routine inspection conducted by Revenue protection teams from Head office and Zone in the region.

7.2.5 Test Results

7.2.5.1 If the results of the test show that the meter is less than 2% fast or slow, the test fees shall be forfeited as the meter is within the acceptable accuracy limits. The consumer shall be informed accordingly as per attached letter format **Ref/ Meter Test 2, under Appendix 7.1-4**.

7.2.5.2 If the results of the test show that the meter indicates the absolute error of greater than 2%, the consumer's account shall be adjusted according to the results of the test considering previous consumption records and the test fee will be refunded. The consumer shall be informed accordingly as per attached letter format **Ref/Meter Test 3, under Appendix 7.1-5**.

7.2.5.3 If the results of the test show that the meter is more than 2% slow, the consumer account shall be adjusted according to the results of the test considering previous consumption records, and the test fee will be refunded. The consumer shall be informed as per attached letter format **Ref/Meter Test 1, under appendix 7.1-3**

7.2.5.4 The Inspected meters which are required to be replaced or removed from site to office store shall be controlled by MAS and SRV forms.

7.2.6 Test Result For LPU Tariff

For meters used for LPU under Tariff T2 and T3, the meters shall be tested by Manager Large Power User's through Revenue Protection Unit section in coordination with respective Regional Manager the Revenue Protection Engineer shall give details of the results of their findings to the Regional Manager

about revenue recovery. The results shall indicate current consumption pattern and the load, including power factor. Revenue Protection Engineer will issue proper test results which will be final and binding. The result shall be communicated in writing for onward communication to the consumer for recovery or otherwise**.** There shall be no ambiguity what so ever. Revenue Protection unit findings are the final binding results without any prejudice. The Regional Manager shall be in close liaison with the Manager Large Power User's before onward communication with the customer.

ENGINEERING INSTRUCTION NO. TDEI 08

REVENUE PROTECTION

The purpose of this section of Engineering Instruction is to ensure that revenue loss reduction is minimum as possible by carrying out metering system audit, rectifying all discrepancies noted, collection of revenue lost and service lines are installed at zero non technical loss. The Revenue Protection activities shall be carried out by dedicated units in the head office and regions in collaboration with Zonal offices, according to Electricity Act, (cap 131) the Electricity Supply Service Rules, 2013 number 49.

8.1 METER VALIDATION

Energy Meters are the Cash Registers of the Company. Thus, validating and ensuring accuracy of metering is a must, according to Electricity Act, 2008 section 31 (1) (2).

New meters procured for use in Company's system shall be validated by Meter Engineer for compliance to all relevant standards at Company's Meter Workshop, prior to issuing to regions for use. Testing percentage for any new meter consignment shall be as follows:

8.1.1 For consignment above 50,000 Meters – Testing of the random sample shall be 5%
8.1.2 For consignment below 50,000 Meters – Testing of the random sample shall be 10%.

8.1.3 All ex-site meters removed from customers shall be re-conditioned, re-calibrated, and re-sealed by Meter Engineer, before being re-used to other customers.

8.1.4 Each meter, except for single-phase pre-payment (LUKU) meter with separable base, validated at Company Meter Workshop, shall be properly sealed by meter Engineer with Meter Workshop Seals in such a way that it is impossible to gain access to the internal parts of the meter without breaking the seal after the meter is in service.

8.2 REVENUE PROTECTION UNITS AND RESPONSIBILITY

Revenue Protection Unit is part of technical sections at Zonal, Regional levels and Head Office which shall deal with implementing revenue protection issues, especially in assurance of metering integrity at customer points.

All Revenue Protection staff shall be Permanent employed with Company number. As well meter Audits shall be carried out only by competent staff with a level of Technician and above. The following shall be the unit composition of the units, demarcation of operations and respective responsibilities:

8.2.1 HEAD OFFICE REVENUE PROTECTION UNIT

The unit shall be under the Department of Large Power Users and to be comprised of competent Engineers and Technicians in regard to revenue protection issues. The unit shall be adequately equipped with up to date testing tools/instruments, evidence collection tools/instruments, communication facilities and adequate transport.

8.2.1.1 General Responsibilities Of Head Office Revenue Protection Unit (Principal Engineer Revenue Protection) shall be:

8.2.1.1.1 Carrying out meter audits to Large Power Users country wide.

8.2.1.1.2 Carrying out sample audits to Small Power Users in all regions country wide and advise the RRPUs accordingly.

8.2.1.1.3 Carrying out audits to metering systems of generation stations, grid substations and distribution feeders.

8.2.1.1.4 Conducting in-house training for Regional Revenue Protection Units.

8.2.1.1.5 Maintaining efficient and effective customer database for continuous monitoring of customer's load profiles.

8.2.1.1.6 Assisting in creation and maintaining of efficient and effective Regional Revenue Protection Units.

8.2.1.1.7 Supervising activities done by Regional Revenue Protection Unit.

8.2.1.1.8 Carrying out special assignments as given by the Manager Large Power Users from time to time.

8.2.1.2 Head Office Revenue Protection unit – Annual Work Targets shall:

8.2.1.2.1 Ensure that each year each Tariff-3 LPU customer is audited at least twice.

8.2.1.2.2 Ensure that each year each Tariff-2 LPU customer is audited at least once.

8.2.1.2.3 Ensure that meters for Grid Substations, Generation Stations and Distribution Feeders are audited at least once in every five (5) years.

8.2.1.3 Head Office Revenue Protection Committee (HORPC)

There will be a Head Office Revenue Protection Committee (HORPC). The HORPC shall report directly to the Deputy Managing Director Marketing and Customer Services.

8.2.1.4 Composition of HORP Committee

The HORPC shall constitute members of various disciplines headed by the Senior Manager Sales and Marketing as the chairperson. All Revenue Protection cases shall be reported to the committee and outcome forwarded to the Deputy Managing Director Marketing and Customer Services.

Members for the HORPC shall be:

Senior Manager (M&CS) - Chairperson

Manager Large Power Users - Secretary

Chief Financial Officer - Member

Chief Internal Auditor - Member

Chief Information Technology Officer - Member

System Analyst (LUKU) - Member

Head Office Credit Control Officer - Member

Principal Engineer Revenue Protection - Member

Principal Engineer Meter Workshop - Member

Principal Marketing Officer - Member

Manager Operations - Member

Revenue Protection Engineers (Two) - Member

Zonal Principal revenue protection Engineers - (Member)

Regional revenue protection Engineers - (Member)

Invited members (where necessary) - Member

8.2.1.4.5 HORPC Schedule Of Meetings

The HORPC should meet at least once in every month to deliberate on revenue protection activities and issues raised during the month in order to find workable solutions and monitor progress.

8.2.1.4.6 Functions of The HORPC

The Committee shall monitor all revenue protection projects throughout the country.

The HORPC forums shall ensure regular communications for detailed feedback regarding statistics of RP projects carried out by all Revenue Protection Unit at Head Office and in Regions as compiled and submitted by the Head Office Revenue Protection Unit.

The Heads of the Departments and Sections Involved in the HORPC shall be responsible for implementing the measures agreed in the forums within the time margin allocated by the forum.

8.2.1.5 Head Office Revenue Protection Reports

8.2.1.5.1. Activities Weekly And Monthly Reports

The Principal Engineer Revenue Protection shall produce reports on activities carried out by the Head Office Revenue Protection Unit every week and every month, and submits the same to the Manager Large Power Users and copied to the Senior Manager (Sales & Marketing).

8.2.1.5.2. E-mail as a means of Communication

For fast and effective communication, the weekly Head Office Revenue Protection Report will be submitted to the Manager Large Power Users and copied to Senior Manager (Sales & Marketing) via e-mail, and will be supplemented by the respective hard copy. The weekly report will be generated on every Friday or last working day for the respective week.

8.2.1.5.3. Keeping Hard Copies of Reports

The Principal Engineer Revenue Protection shall keep hard copies of all revenue protection activities for the Head Office revenue protection activities.

8.2.2 ZONAL AND REGIONAL REVENUE PROTECTION UNITS

The unit shall be under the Senior Zonal Managers and Regional Managers and to be comprised of competent Engineers, Technicians and well trained artisans in regard to revenue protection issues. The unit shall be adequately equipped with up to date testing tools/instruments, evidence collection tools/instruments, communication facilities and adequate dedicated transport.

The Zonal Revenue Protection Unit shall be headed by a Principal Engineer under the Senior Zonal Managers with not less than six (6) revenue protection teams or as may be required.

8.2.2.1 General responsibilities of Zonal and Regional Revenue Protection Units (Principal Engineer Revenue protection – Zone and Regional Revenue Protection Engineer):

8.2.2.1.1. Shall spearhead Non Technical Losses Reduction activities in the regions.

8.2.2.1.2. Shall be establishing with possible highest accuracy the level of Non Technical Losses in the regions and avail a report to the next level (Zone and Head Office) on each and every month.

8.2.2.1.3. Shall be carrying out meter inspection to all Small Power Users (D1 and T1) and detect defective meters, unbilled customers and other sources that may contribute to reducing losses to minimum levels.

8.2.2.1.4. In case of detection of defective meters or malpractice, shall be generating an elaborate audit report complete with Revenue Loss suffered by the Company

8.2.2.1.5. Shall ensure that each LUKU meter inspected operates with current Supply Group Code by requesting Key Change Token from Regional Business Application Officer whenever such discrepancy is noted.

8.2.2.1.6. Shall ensure that meter inspection is done house to house, one secondary transformer at a time feeder wise. In that process customer data must be collected transformers and feeder wise and effective customer data is established or upgraded.

8.2.2.1.7. Shall be establishing a percentage level of energy loss on every audited transformer

8.2.2.1.8. Shall be using AMR system for early detection of metering discrepancies in the region. AMR meters that will generate tamper alarms, or with suspicious load profiles shall be visited and inspected immediately.

8.2.2.1.9. Shall be using zero purchase and low purchase reports from LUKU system as a bench mark for auditing LUKU meters. LUKU meters appearing in such reports shall be attended within 30 days from the generation.

8.2.2.1.10. Shall be generating a monthly minimum and low billed customers from Hi Affinity billing system (only service charge and less than 50 units) as bench mark for auditing customers installed with credit meters. Meters with ZERO consumption appearing on the report shall be attended within 30 days from the generation.

8.2.2.1.11. Shall be fighting against GHOST vending by tallying the total units on each LUKU meter at sight against the total units vended by TANESCO LUKU system to that meter.

8.2.2.1.12. Shall be monitoring customers with Low Power Factors (PF) below 0.9 using Monthly Billing Reading from AMR system and prepare PF surcharge intent letters to respective customers.

8.2.2.1.13. Shall be referring meters requiring replacement to the Construction Engineer by using an appropriate Works order. Revenue Protection Engineer/Technician shall not install or replace any defective meters.

8.2.2.1.14. For Zonal Revenue Protection Unit, all audit reports must be submitted to Respective Regional Managers within three days for informing the customers in writing using auditing form.

8.2.2.2. Zonal and Regional Revenue Protection work targets (Principal Engineer Revenue protection – Zone and Regional Revenue Protection Engineer):

8.2.2.2.1. Shall ensure that each 3-phase Tariff 1 customers (Medium Power User) in the region is audited at least once in each and every one year.

8.2.2.2.2. Shall ensure that each 1-phase Tariff 1 customers (Small Power User) in the region is audited at least once in two consecutive years**.** That is 50% of all T1 Small Power Users Using one phase meters are audited per year.

8.2.2.2.3. Regional Manager shall ensure that all meters for distribution feeders including respective boundary meters are read each month and records are kept. Establish losses in the feeders and necessary actions shall be taken to reduce the level of losses.

8.2.2.2.4. Regional manager to shall ensure that each 3-phase Tariff -1 AMR metered customers in the Region is analyzed via AMR, Billing and LUKU systems at least once in every month.

8.2.2.2.5. Regional manager to shall ensure that each Tariff -2 Large Power User customers in the Region is analyzed via AMR, Billing systems at least once in every 21 days.

8.2.2.3. Zonal and Regional Revenue Protection office reports (Principal Engineer Revenue protection – Zone and Regional Revenue Protection Engineer):

8.3.2.3.1 Activities Weekly and Monthly Reports

The Regional Revenue Protection Engineer to shall produce reports on activities carried out by the Region Revenue Protection Unit every week and every month, and submits the same to the Regional Manager and copied to the Senior Zonal Manager and Senior Manager (Sales & Marketing).

The Zonal Principal Revenue Protection Engineer shall produce reports on activities carried out by the Zonal Revenue Protection Unit every week and every month, and submits the same to the Senior Zonal Manager and Senior Manager (Sales & Marketing).

8.3.2.3.2 E-mail as a means of Communication – Protection Activities Reports

For fast and effective communication, the weekly Regional Revenue Protection Report shall be submitted to the Senior Zonal Manager and copied to Senior Manager (Sales & Marketing) via e-mail, and will be supplemented by the respective hard copy.

For Zonal Revenue Protection unit, report shall be submitted to the Senior Zonal Manager and copied to Senior Manager (Sales & Marketing) via e-mail, and will be supplemented by the respective hard copy.

The weekly report shall be generated on every Friday for the respective week.

8.3.2.3.3 Keeping Hard Copies of Reports

The Zonal Principal and Regional Revenue Protection Engineers shall keep hard copies of all revenue protection activities for the Zonal and Regional revenue protection activities.

8.4 REVENUE PROTECTION PRINCIPLES AND PRACTICES AS SHALL BE OBSERVED BY REVENUE PROTECTION ENGINEER AND TECHNICIAN:

8.4.1 The service line shall be visible all the way from the tapping pole to the meter.

8.4.2 Service line construction and meter installation shall comply with all relevant Engineering Instructions and construction procedures.

8.4.3 Regional Revenue Protection Engineers shall be monitoring commissioning of metering systems for LPU Tariff 2 customers.

8.4.4 No load splitting and meter separation shall be done except if approved by Senior Zonal Manager.

8.4.5 Use of one mains power supply with multiple service lines and multiple meters for one multi-storeyed building shall entail to have all meters in one meter room and shall be approved by Senior Zonal Manager.

8.4.6 Change of Tariff shall be approved by the Senior Zonal Manager/Regional Manager.

8.4.7 The Regional Manager shall follow-up with customers on payments of monthly installments of revenue recovery and submits a progress report on revenues recovered to the Senior Zonal Manager and copy Senior Zonal Manager Sales and Marketing.

8.4.8 Customers not paying revenue recovery, or customers bleaching agreement on payment of revenue recovery installments, must be issued with a forty eight (48) hours disconnection notice after the expiry of which such customers must be disconnected forthwith.

8.5 AUDIT EXCERCISE COMPLETENESS

Protection of revenue starts right from the instant of power connection at the customer' premises also can be observed from other stake holder like Public, Employees and others as in figure 8.1 below.

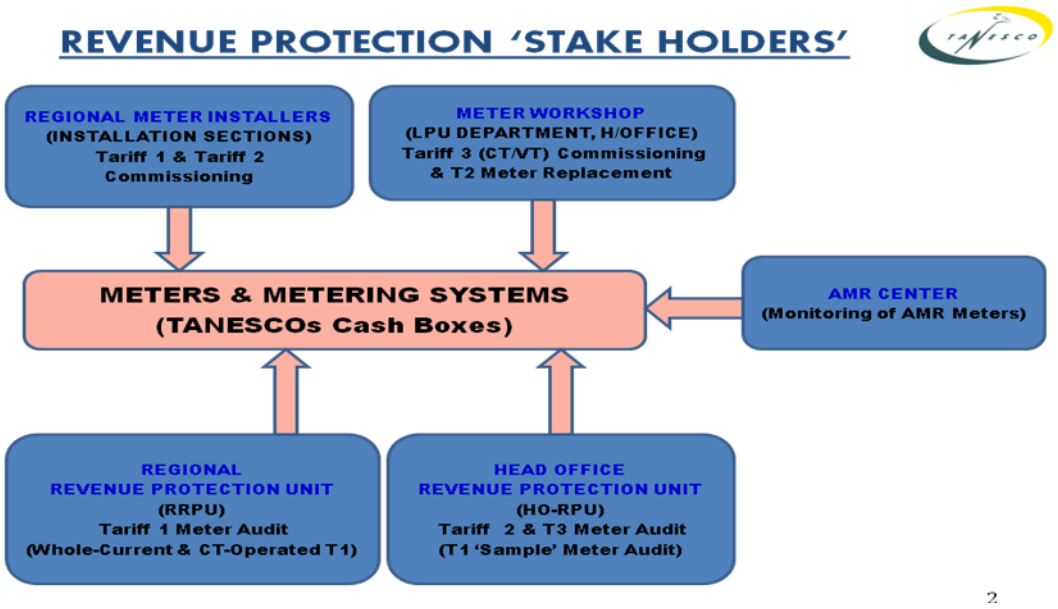


Figure 8.1: Revenue protection stake holders

8.6 METHODS OF AUDITING FOR NON TECHNICAL LOSS (NTL)

8.6.1 Remote Auditing

This is possible only to those customers installed with AMR meters and have good strength of network to link with Communication tower and AMR server. Engineer or Technician trained with AMR system shall be able to communicate with meter through computer and download different data from the meter for the purpose of load profile analysis.

8.6.2 Physical Auditing

Auditing, a group of person or team (Engineers and Technicians) shall be at customer's premises for inspection with all required tools, apparatus and other officers from different sectors other than RPU office if it is necessary. An audit exercise to be completed the following shall be done:

8.6.2.1 The customer's representative shall be present and witness the on-site meter audit, right from the beginning to the end and other officers.

8.6.2.2 Thorough inspection of the physical condition of the metering system components such as CTs, TTB, meters and wires.

8.6.2.3 Thorough visual inspection of all seals for marks or indication of tampering.

8.6.2.4 Thorough check on the condition of the service line and lead-in cable for possible energy theft.

8.6.2.5 Thorough check on the condition of the meter box, LV Metering Cabinet door and metering signal cable for potential energy theft.

8.6.2.6 Check if the meter exists in the billing/LUKU system.

8.6.2.7 Check and record the outstanding debt for the meter account.

8.6.2.8 Test and record the meter error.

8.6.2.9 If the meter error is beyond the standard limit for error, revenue loss must be computed for recovery.

8.6.2.10 Revenue Engineer/Technician shall check 'Export kWh' units are present and billed.

8.6.2.11 Revenue protection Engineer/Technician shall deduce the average power factor for the customer from downloaded meter data.

8.6.2.12 Revenue protection Engineer shall determine historical consumption of the customer as per billing/LUKU system and compare with the maximum demand/consumption.

8.6.2.13 A standard audit form must be used and must be filled fully and signed by the Revenue protection Engineer/Technicians as indicated in TDEI No. 7-1. The name of the customer's representative to be filled in if available.

8.6.2.14 Each audited meter shall be labelled by a sticker that identifies the date of last audit and the identity of the auditors.

8.6.2.15 Photos showing scenes describing the discrepancy shall be showing the date on which it was taken.

8.6.2.16 Revenue protection Engineer/Technician shall explain each procedure to the customer together with witness and if the metering system will be found tampered, illegal, bypassed or whatever for the purpose of having free electricity, power will be disconnected after completing the exercise and noted.

8.6.2.17 Each audit process must be very thorough and the evidence collected in case of discrepancy must be able to stand firm and be justified when disputed via a Court Of Law.

8.7 REVENUE RECOVERY CALCULATIONS BY REVENUE PROTECTION ENGINEER

The success of any Revenue Protection Unit is determined by their ability to be cost effective and recover as much revenue lost as possible.

There are many different ways to calculate the extent of revenue loss after confirmation of a metering deficiency or energy theft situation. Some are simplistic while others are quite complex.

8.7.1 Important Resources for Establishment Revenue Loss, the available resources shall be included all or some of the following components:

8.7.1.1. The percentage error of the meter.

8.7.1.2. Data downloaded from the meter for the case of programmable meters.

8.7.1.3. Customer's consumption history from the billing system and the associated profile.

8.7.1.4. The customer's actual maximum installed load.

8.7.1.5. Average instantaneous load during meter audit.

8.7.1.6. Appropriate Load factor applicable if the meter is for Residential or commercial use.

8.7.1.7. The appropriated audit form used to have customer's information can be found in Appendix 8.1 -1 and 8.1-2.

8.7.1.8. A form used to give alarm to customer if the customer's Account will be changed due to audit exercise done, whether is due to the request from customer or is the company suspicious see Appendix no. 7.1-3, 7.1-4 and 7.1-5.

8.7.1.9. Revenue Loss Recovery For Defective Metering System refer to Appendix 8 Scenario 1-4

8.7.2 Scenario 1 - Burnt or Damaged Meter with Known Date of Damage

If the date on which the meter got burnt is known, and if the burnt meter did not affect power availability to the customer, then:

8.7.2.1 The period for revenue recovery will be from the date on which the meter got burnt to the date of replacing a new meter.

8.7.2.2 The amount of revenue to be recovered for each month will base on the 'Average consumption for previous three (3) months'.

8.7.2.3 If the average consumption from the billing data is too unrealistic to be considered, then, the maximum installed load can be used together with the respective standard Load Factor for the kind of business to calculate the revenue lost for recovery.

8.7.3 Scenario 2 – Burnt or damaged meter, date of damage not known, no reading or meter error cannot be obtained from the meter.

If the date on which the meter got burnt is not known, and no reading or meter error cannot be obtained from the meter, and if the burnt meter did not affect power availability to the customer, then the revenue recovery shall be calculated as follows:

8.7.3.1. Customer's consumption history from the billing system must be plotted to get the consumption profile by using Spreadsheet. From the consumption profile, the point where the profile drops significantly and hold steady will pin the start point for revenue recovery.

8.7.3.2. The date of rectification of the metering deficiency will be the end date for the revenue recovery period.

8.7.3.3. Average monthly consumption to be calculated and multiplied to the number of months for which the metering system was defective.

8.7.3.4. Average daily consumption to be computed from the average monthly consumption for billing the extra days to the date of metering system rectification.

8.7.3.5. If the average consumption from the billing data is too unrealistic to be considered, then, the maximum installed load can be used together with the respective standard Load Factor for the kind of business to calculate the revenue lost for recovery.

8.7.4 Scenario 3 – Erroneous or defective metering system with known date of start of the deficiency

If the meter error is determined and the date of start of the metering deficiency is established, and if the metering deficiency did not affect power availability to the customer, then the revenue recovery will be calculated as follows:

8.7.4.1. If the average historical consumptions from the billing system are realistic with respect to the customer load from the technical point of view:

8.7.4.1.1. Period for revenue recovery will be from the date the meter became erroneous to the date of rectification of the metering deficiency.

8.7.4.1.2. Units lost to be calculated by utilizing the metering error obtained and the units registered by the erroneous meter.

8.7.4.2 If the average consumptions from the billing system are not realistic with respect to the customer load from the technical point of view:

8.7.4.2.1. Period for revenue recovery will be from the date the meter became erroneous to the date of rectification of the metering deficiency.

8.7.4.2.2. The established meter error will not be used.

8.7.4.2.3. The maximum installed load to be used together with the respective standard Load Factor for the kind of business to calculate the revenue loss to be recovered.

8.7.5 Scenario 4 - Erroneous metering with date of start of metering deficiency not establishable

If the meter error is determined and the date of start of the metering deficiency cannot be established, and if the metering deficiency did not affect power availability to the customer, then the revenue recovery will be calculated as follows:

8.7.5.1. Customer's consumption history from the billing system must be plotted to get the consumption profile by using Spreadsheet. From the consumption profile, the point where the profile drops significantly and hold steady will pin the start point for revenue recovery.

8.7.5.2. The date of rectification of the metering deficiency will be the end date for the revenue recovery period.

8.7.5.3. Units lost to be calculated by utilizing the metering error obtained and the units registered by the erroneous meter.

8.7.6 Charge of 2% Compound Interest

A Compound Interest of 2% shall be charged to payment raised due to:

8.7.6.1. Revenue loss recovery due to metering deficiencies caused by energy theft actions **done by the customer**.

8.7.6.2 Outstanding debt settlement due to deliberate non-payment of monthly electricity bills.

8.7.6.3 Interest of 2% shall not be charged to revenue loss recovery which due to metering deficiencies that are not caused by the customer.

8.7.7 Charge of Cost of Meter, Metering Unit, LV Metering Cabinet And Meter Deposit For Energy Theft Actions Leading To Damage Of Meter or Metering System Component

The customer shall be charged the cost of any item of the metering system damaged due to the customer's energy theft actions such as the cost of meter, CTs, PTs, T.T.B, H.T. Metering Unit, LV Metering Cabinet, Padlocks, Cables, and any metering system accessory damaged due to acts of energy theft by the customer.

8.7.7.1 Penalty For Interference With The Metering System, or Supplying any other Person With any Amount of The Electricity Supplied By TANESCO.

The customer shall be charged the statutory penalty for interference with the metering system, or supplying any other person with any amount of electricity supplied by TANESCO.

8.7.7.2. Charge of Labour and Transport Cost As Re-commissioning Charge For Refurbishment of Damaged Metering System Components Or Metering Deficiencies Caused By Energy Theft

Actions.

The customer shall be charged Labour and Transport Cost for refurbishing work on metering system deficiencies caused by energy theft actions done by the customer.

8.8 INSPECTION FEES FOR OFFENDERS

8.8.1 Tariff 1 Small Power User Customers

8.8.1.1 First Offence

Inspection Fee of TSh. 300,000.00 shall be charged to a Tariff 1 SPU customer found exercising energy theft for first offence.

8.8.1.2 Second Offence

Inspection Fee of TSh. 500,000.00 shall be charged to a Tariff 1 SPU customer found exercising energy theft for second offence. Also a warning letter will be issued to the defaulting customer for the second offence, that next offence, apart from other charges, the service line will be removed and that the customer shall pay cost of service line anew as well as the meter deposit, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.1.3 Third Offence

Inspection Fee of Tshs. 1,000,000.00 shall be charged to a Tariff 1 SPU customer found exercising energy theft for third offence. Apart from Inspection Fee, the customer shall not be re-connected to the system until they pay a full cost of service line and a fresh meter deposit at prevailing rates, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.2 Tariff 2 Large Power User Customers

8.8.2.1 First Offence

Inspection Fee of TSh. 2,000,000.00 shall be charged to a Tariff 2 LPU customer found exercising energy theft for first offence.

8.8.2.2 Second Offence

Inspection Fee of TShs. 4,000,000.00 shall be charged to a Tariff 2 LPU customer found exercising energy theft for second offence. Also a warning letter will be issued to the defaulting customer for the second offence, that next offence, apart from other charges, the service line will be removed and that the customer shall pay cost of service line anew as well as the meter deposit, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.2.3 Third Offence

Inspection Fee of TShs. 6,000,000.00 shall be charged to a Tariff 2 LPU customer found exercising energy theft for third offence. Apart from Inspection Fee, the customer shall not be re-connected to the system until they pay a full cost of service line and a fresh meter deposit at prevailing rates, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.3 Tariff 3 LPU Customer

8.8.3.2 First Offence

Inspection Fee of TShs. 6,000,000.00 shall be charged to a Tariff 3 or Special Tariff LPU customer found exercising energy theft for first offence.

8.8.3.2.1 Second Offence

Inspection Fee of TShs. 12,000,000.00 shall be charged to a Tariff 3 or Special Tariff LPU customer found exercising energy theft for second offence. Also a warning letter will be issued to the defaulting customer for the second offence, that next offence, apart from other charges, the service line will be removed and that the customer shall pay cost of service line anew as well as the meter deposit, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.3.3 Third Offence

Inspection Fee of TShs. 18,000,000.00 shall be charged to a Tariff 3 or Special Tariff LPU customer found exercising energy theft for third offence. Apart from Inspection Fee, the customer shall not be re-connected to the system until they pay a full cost of service line and a fresh meter deposit at prevailing rates, according to Electricity Act, 2008 section 28(1) (a) (b).

8.8.4 Load Factor

The following Table 8.1 indicates Load Factor to be used to establish Minimum Average Monthly Consumption for a customer.

S/no	Customer Category	Type of Business	Load Factor to Apply
1	Tariff 1	Residential	10% (0.10 x Total kW)
2	Tariff 1	Commercial	17% (0.17 x Total kW)
3	Tariff 2		32% (0.32 x Total kW)
4	Tariff 3		50% (0.50 x Total kW)

Table 8.1: Load Factors for Different Categories of Customers

8.9 CUSTOMER DATABASES

Establishing and Maintenance of Customer Databases at TANESCO Head Office, Zonal Offices and Regional Offices shall be managed and done by the respective Revenue Protection Units. The data base shall be used to monitor Non Technical Losses:

8.9.1 An LPU Customer Database shall be established maintained up to date at TANESCO Head Office under Manger Large Power Users.

8.9.2 Customer Data shall be arranged as per Distribution Feeder by Principal/Construction/Planning Engineer.

8.9.3 Monthly Power Book Database shall be maintained by Manager Large Power Users, TANESCO Head Office.

8.9.4 The LPU Customer Database shall be linked with the Monthly Power Book Database.

8.9.5 SPU Customer Database shall be established maintained up to date by Principal/Construction/Planning Engineer under the Zonal Office.

8.10 METER SEALS AND SEALING SYSTEMS

The main objective of sealing any device is to ensure that access to certain sensitive parts of that device is restricted. This is especially so, where energy meters is concerned, since these form the basis from which all revenue is obtained by electricity supplier. It is therefore imperative that a strict sealing procedure is established and that proper control is maintained to ensure that these procedures are strictly followed and adhered.

Seals shall be in place on each energy meter, all associated CTs, PTs, Test Terminal Block, LV metering cabinets, meter boxes, metering cubicles, metering units, and any other component of the metering system having sealing provision.

Each Meter Shall Carry Seals on the main cover to prevent being opened, this seal is applied at the Meter Laboratory. All meters when issued from Central Stores are ready with this seal. It must be ensured that meter case is sealed such that it is impossible to gain access to internal parts of meter without breaking the seal after the meter has been placed in service.

8.10.1 Responsibility over sealing facilities by Engineers or Technicians:

8.10.1.1 Any person receiving a sealing facility such as plastic or any other form of seals, sealing pliers, seal wires and ferrules, automatically accepts responsibility for the same. Therefore issuing of sealing facility shall be made in writing by proper and standard documentations.

8.10.1.2 The issuing and receiving persons shall sign in the respective documentation and the transaction shall be registered in a dedicated log book.

8.10.1.3 Lending or Borrowing of Sealing Pliers or Seals is strictly prohibited.

8.10.2 Control of Seals and Sealing Facilities

The aim of controlling of seals and sealing facilities is to provide a mechanism by which the last Engineer/Technician/Artesian has worked on a specific piece of equipment can be traced. In order that this is done, it is a requirement that all seals or sealing facility shall have unique serial numbers or identification marks clearly and indelibly marked on them.

8.10.2.1 Control of Seals and Sealing Systems

Stores shall document issuing of seals and issuing directives. The entire sealing system components in stock shall be continually audited.

8.10.2.2 Issuing of Sealing Facility Plastic Seals

Well documented stocking and issuing procedure must be followed such that the seal number can be traced right from procurement to disposal.

8.10.3 Sealing Pliers & Metal Ferrule Sealing System

8.10.3.1 Shall consist of a piece of wire made from stainless steel of several strands, a metal ferrule insert made of brass, and Ratchet Operated Sealing Pliers that shall have identifiable and unique coding engraved onto both jaws that leave the encoding embossed on the ferrule after crimping.

8.10.3.2 The Metal Ferrule shall be crimped by a pair of ratchet operated sealing pliers that are specifically designed for the task. The unique pliers' encoding embossed shall remain embossed on the ferrule.

8.10.3.3 The ferrule insert is firmly crimped onto the wire in such a way that it is impossible to remove the seal or have access into the meter without first breaking the wire or disfigurement of the ferrule.

8.10.4 Sealing Procedures

8.10.4.1 Check that the Seals contained in the plastic packet, has not been tampered and the quantity, color-coding and serial numbers contained is correct as per packing list attached on the packet.

A Disciplinary Action shall be immediately taken in cases of misuse of any type of sealing system in use or in stock. Such instances are immediately reported to the higher authority without further delays.

8.10.4.2 Sealing Pliers shall be requested from the Central Store by the Manager Large Power Users, who, in turn, shall issue by delivery note to the User of the Sealing Pliers.

8.10.4.3 The Manager Large Power Users shall make the recipient of the Sealing Pliers sign a special Sealing Pliers Log Book for confirmation of accepting the responsibility of the Sealing Pliers. The Sealing Pliers Log Book will be kept by the Manager Large Power Users.

8.10.4.4 Record of seals issued to Regions shall be made available to the Manager Large Power Users immediately after the issuance.

8.10.4.5 Handing over of Branch or Region or any other office, which entails custody of sealing pliers or packets of new or used plastic seals, from person to person, shall include handing over stock of seals, Sealing Pliers and any other Sealing Systems in stores and in use.

8.10.4.6 Each Meter Shall Be Sealed in such a way that it is impossible to gain access to the internal parts of the meter without breaking the seal after the meter is in service.

8.10.4.7 The Extended Terminal Cover shall be sealed in such a way that no access to the terminals shall be possible without the seals on the cover being broken.

8.10.4.8 If a meter is fitted with a Maximum Demand Reset Facility, the meter shall be adequately sealed that it shall not be possible to reset the meter without first breaking a seal.

8.10.4.9 As General Requirement, any equipment that makes up part of a metering system (CTs, PTs, PT-fuses and Test Terminal Block etc.) shall be sealed in such a way as to ensure restricted access to that equipment.

8.11 Regional Managers shall Ensure:

8.11.1 That a register is established, in which to record all movements of all ready numbered plastic seals.

8.11.2 That a register is established and maintained that will keep of number of sealing pliers used to seal a particular meter on any particular date.

8.11.3 The sealing registers shall be randomly audited and regularly monitored.

8.12 On-Site Inspection of Seals Removed From Metering System under Revenue protection Engineers/ Technician or Principal/Construction/Planning Engineer.

Seals removed from the metering system during meter audit shall be inspected right at site for any tamper or fraudulency. For disposal, these seals are destroyed under the supervision of the DIA directive.

8.13 Additional Security Measures for Metering Systems

Where Fraudulency is Rampant, additional measures for enhancement of metering security shall be taken, such as enclosing the metering system in chambers or reinforced steel boxes and locking with non-standard high-security pad locks. The Manager Large Power Users shall oversee such security improvement.

8.14 TRAINING OF ENEGINEERS AND TECHNICIANS

8.14.1 All Engineers and Technicians responsible in non-technical losses reduction projects and activities shall undergo adequate periodical in-house and short-term training for performance improvement.

8.14.2 Revenue Protection Engineers and Technicians shall have an intensive short-term training at least once in every two years or whenever there is a change in metering technology.

8.14.3 Meter Readers shall have intensive short-term training at least once in every five years, or whenever there is a change in metering technology.

8.14.4 The short term intensive training to be conducted by renowned expatriates or training institutions.

8.15 NON-TECHNICAL LOSSES REDUCTION CAMPAIGNS

8.15.1 Shall be a use of Mass Media for Campaign against energy theft tendencies.

8.15.2 Revenue Protection Units shall prepare documentaries on energy theft via television and radio stations.

8.15.3 Revenue Protection Units and Customer Relation Officers shall prepare warnings and alerts on TANESCOs reactions against energy theft via bill boards.

8.15.4 Customer Relation Officers shall prepare persistent mobile public address on measures taken against energy frauds. The vehicle and the public address system to be owned by Company, one in each zone. All Company's vehicles countrywide to have anti-theft campaign adverts.

8.15.5 Dissemination of Revenue Protection Leaflets to all stakeholders.

8.16 ANNUAL REVENUE PROTECTION DAY

The company shall organize an annual stakeholder get-together with revenue protection exhibition.

8.16.1 Shall involve presentation on revenue protection issues and experiences.

8.16.2 Performance of various Revenue Protection Units shall be charted and compared for rewarding the best performing teams.

8.18.3 Annual Corporate Forum On Revenue Protection to be organized shall involve all relevant stake holders. Invitations to be extended to the CTI, EWURA, Ministry of Energy & Minerals, Ministry of Trade & Industry, Technical High Learning Institutions, the Revenue Authority, and other invitees as found important. This event shall also serve to enhance campaign on anti-energy theft.

ENGINEERING INSTRUCTION NO. TDEI- 09

DEMAND AND ENERGY MANAGEMENT

9.1 Demand Side Management consisting of the management of customer consumption of electricity or the demand for electricity through the implementation of:

9.1.1 Energy efficiency technologies, management practices or other strategies in residential, commercial, institutional or government customers that reduce electricity consumption by those customers.

9.1.2. Load management or demand response technologies, management practices or other strategies in residential, commercial, industrial, institutional and government customers that shift electric load from periods of higher demand to periods of lower demand, including pump storage technologies.

9.1.3. Industrial by-product technologies, consisting of the use of a by-product from an industrial process, including the reuse of energy from exhaust gases or other manufacturing by-products that are used in the direct production of electricity at the facility of a customer.

9.2 MD /DMD /SMSM /SMD shall make sure that:

9.2.1 A Demand Side Management (DSM) policy is developed so that energy efficiency and demand responses programs are realized.

9.2.2 Establish a Demand and Energy Management Unit dealing with Management and Demand Side Programs (Refer HATCH Consultant No. H335897-0000-90-236-0003 Rev. 1 - December 30, 2010 Report).

ENGINEERING INSTRUCTION NO. TDEI- 10

DISTRIBUTION SYSTEM NOMENCLATURE

The purpose of this section of Engineering Instruction is to ensure that all Distribution Facilities such as Primary Distribution Substations, 11kV and 33kV feeders, poles, line switchgear, and distribution transformers are all uniquely numbered using a similar common system throughout the entire distribution system. All feeders are identified with abbreviations, all three phases are identified with coding, and where the system is ring fed, the feeders are phased out and coded for easy operation and paralleling.

10.1 The transmission system voltages comprised of 66, 132 and 220 kV has readily available unique nomenclature and code. The transmission system built by contractors includes numbering and feeder identification with abbreviated nomenclature. The transmission system coding and abbreviation is controlled under the jurisdiction of Transmission Business Unit.

10.2 Having a proper Distribution System Nomenclature (DSN) will enable the Utility to set up a comprehensive Database of all its distribution facilities legible to both utility staff and customers. This Database would help in identification of feeders, identification of site distances for field sketching, providing on site guidance towards faultfinding, site planning work, and routine customer service under emergency operations.

10.3 While embarking on this DSN, the Regional Manager//Principal or Senior Engineer shall ensure that the standardization as described hereafter is well instituted in his distribution network. In case of any doubt, contact the Senior Manager Distribution.

10.4 PRIMARY DISTRIBUTION SUBSTATIONS

The Regional Manager/Senior Engineer shall ensure that all Primary Distribution Substations 220/33, 132/33, 66/33 and 33/11 kV in the Region/City/Town are abbreviated as per the typical example given hereunder, worked out for Dar Es Salaam City, which is comprised of four regions. In case of any doubt, contact DMD(D&CS), SMD, SZMs and RMs. When several substations are within the same area, use substation nomenclature abbreviation suffixed with a number. For example, in Dar Es Salaam, there are three substations in line along Nyerere Road designated as FZ1, FZ2, and FZ3. Below is a typical Dar Es Salaam primary substation designation and coding.

S/No.	Substation	Code	Feeder Name
1	OYSTERBAY	OB	O1, O2……
2	MSASANI	MS	MS1, MS2,….
3	SOKOINE	SK	SK1, SK2,…..
4	CHANG'OMBE	CG	CG1, CG2,….
5	FACTORY ZONE I	FZ 1	FZ11, FZ12,…
6	KUNDUCHI	KN	KN1, KN2,…..

7	CITY CENTRE	CC	C1, C2,……
8	TEGETA (33 kV)	TG	TG1, TG2,…..
9	BAHARI BEACH	BB	BB1, BB2,…..
10	FACTORY ZONE III (11 kV)	FZ 3	FZ31, FZ32,….
11	KIGAMBONI	KG	KG1, Kg2,……
12	UBUNGO (11 kV)	UB	U1, U2,…
13	MAGOMENI	MG	MG1, MG2,…
14	MIKOCHENI	MK	MK1, MK2,…..
15	KURASINI	KR	KR1, KR2,…..
16	FACTORY ZONE II	FZ 2	FZ21, FZ22,……
17	TANDALE	TN	TN1, TN2,….
18	KARIAKOO	KA	KA1, KA2,…
19	ILALA	IL	D1, D2,…….
20	RAILWAY	RL	RL1, RL2,…..
21	MBURAHATI	MH	MH1, MH2,…..
22	TEMEKE	TE	TE1, TE2,……
23	YOMBO	YB	YB1, YB2,…..
24	TABATA	TB	TB1, TB2,…..

10.4.1 DISTRIBUTION SUBSTATION & LINE SWITCHGEAR

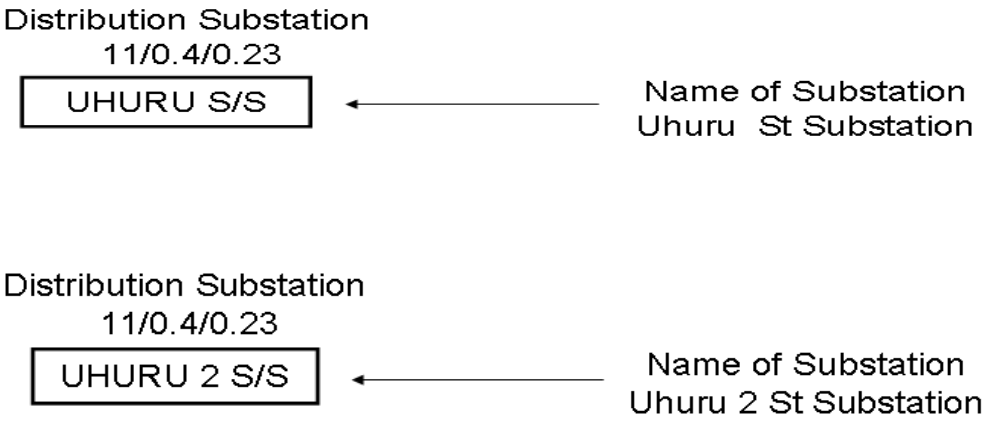
All distribution transformers (DT), pole mounted distribution transformers (PMT), ground mounted distribution transformers (GMT), indoor mounted distribution transformers (IMT), and line switchgear including Ring Main units (RMU), Auto-reclosers (AR), Disconnect Switches (DS), Load-break Switches (LBS), Sectionalizers (SR), Drop out Fuses (DOF), Distribution Pillars (DP), and other associated line switchgear are abbreviated suitably as discussed and exampled here in below.

10.4.1.1 Numbering Procedure For Distribution Substations

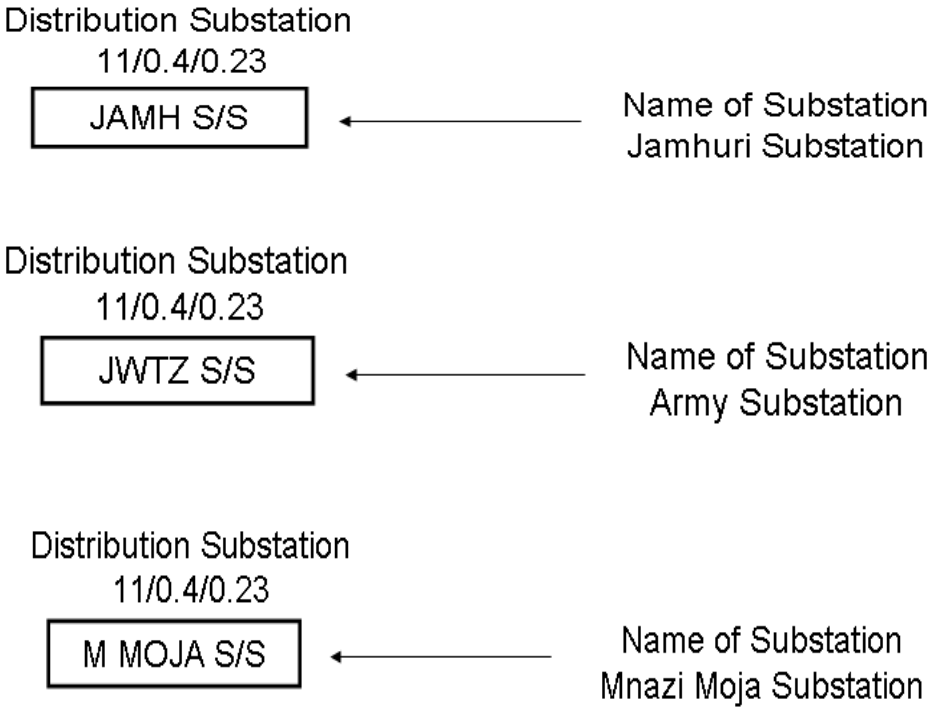
All MV pole mounted, ground mounted, and indoor type distribution substations rated 11/0.4 or 33/0.4 kV shall be given name coding. These are normally street/road names or prominent names in the area. The names shall be abbreviated in not more than five alphabet letters followed by the abbreviation for "substation." For example, the Jamhuri Street Substation is named as JAMH S/S.

The name of the feeder from which the substation is normally fed will be on the HT pole number plate.

10.4.1.1.1. The following are examples of two Pole Mounted Distribution Substations along Uhuru Street in Dar Es Salaam:



10.4.1.1.2. The following are examples of Ground Mounted Distribution Substations in Dar Es Salaam:



10.4.1.1.3. The following are examples of Pole Mounted 33/0.4/0,23 kV Substations:

10.4.1.1.5 The pole mounted substation name plates are made bigger in size compared to those for ground mounted substations. The nameplate is engraved on an Aluminum plate and is mounted at 3m from the ground level.

10.4.1.2 Numbering Procedure For Distribution Switchgear

All pole mounted as well as ground mounted distribution switchgear are abbreviated similar to the distribution transformers. There shall be no repetition of the nomenclature used for the pole or ground mounted switchgear or transformer.

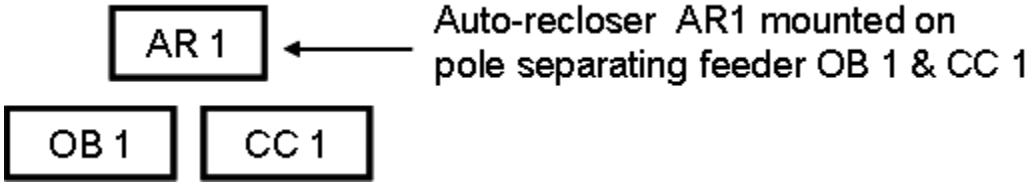
The nomenclature plate for the pole or ground mounted switchgear and distribution transformer remains as it is. If the pole has additional equipment like drop out fuse (DOF), abbreviation plate DOF is added on the pole.

10.4.1.2.1. Auto-reclosers, Sectionalizers and Load Break Switches are not mounted together with a pole mounted distribution transformer (PMT) on the same pole. Thus abbreviations for line switchgear are mounted on the pole just above the pole numbering. Use AR for auto-reclosers, use SR for sectionalizers, use LBS for load break switches, and use DS for disconnect switches.

10.4.1.2.2. If several AR, SR, DS and LBS are on the same feeder, the abbreviation is suffixed with a number, like AR 2 or SR 3 or DS 5 or LBS 5.

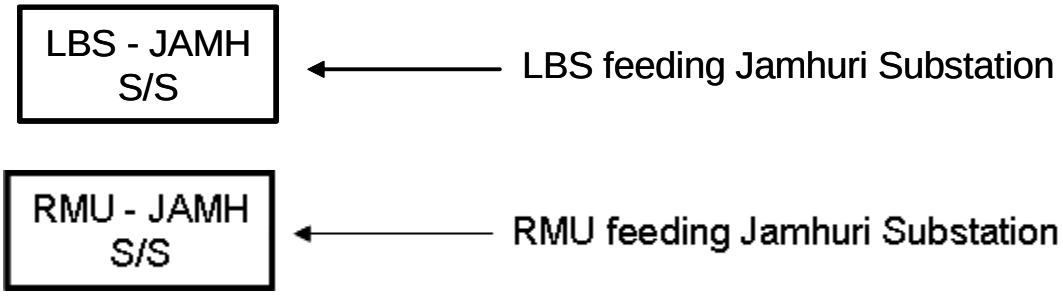
10.4.1.2.3. Where AR or SR or DS or LBS are mounted to separate 11 or 33 kV ring circuits, the pole must have two name plates showing the various feeders meeting on the pole and indicating the origin of the feeder clearly.

10.4.1.2.4 The following is an example of a line AR switchgear and two feeders meeting



10.4.1.2.5 Line Switchgear Connecting to DT

When distribution Switchgear such as LBS, RMU, DS and AR are used for connection to distribution substations or as MV service, the distribution substation or the MV service are all prefixed with the line switchgear as exampled below.



10.5 33kV FEEDER OUTLETS

10.5.1 ZPDE, RM, PE, CE, Planning Engineer and DM shall ensure that feeders are constructed as per guidelines provided hereunder. Total feeder outlets shall not exceed the available feeder circuits at the substation.

10.5.2 Maximum number of 33 kV feeders for

- 220/33kV substations - 12
- 132/33kV substations - 6
- 66/33kV substations -

10.5.3 Pole numbering shall originate from the primary substation outlet or from the power station switchgear panel board.

10.6 11kV FEEDER OUTLETS

10.6.1 Maximum number of feeders per 33/11kV substations

- 5 MVA 33/11 kV - 3
- 15 MVA 33/11 kV - 6 + 1 Bus Coupler
- 30 MVA 33/11 kV - 6 + 1 Bus Coupler

10.6.2 Pole numbering shall originate from the primary substation outlet or from the power station switchgear panel board.

10.7 0.4/0.23 kV LV FEEDER OUTLETS

10.7.1 Maximum number of circuits in a distribution substation is limited to 4, numbered clockwise from the NORTH direction.

10.7.1 Maximum number of feeders per 33/0.4 or 11/0.4 kV substation is

- 50 kVA 33/0.4 or 11/0.4 kV - 1
- 100 kVA 33/0.4 or 11/0.4 kV - 2
- 200 kVA 33/0.4 or 11/0.4 kV - 3
- 315 kVA 33/0.4 or 11/0.4 kV - 3
- 500 kVA 33/0.4 or 11/0.4 kV - 4

LV pole numbering shall originate from the respective distribution (33/0.4/0.23 and 11/0.4/0.23 kV) substations. Before numbering starts, the circuits emanating from the distribution transformer have to be numbered.

10.8 NUMBERING FOR MV & LV FEEDERS

All MV and LV Feeders emanating from the respective Primary Distribution 220/33, 132/33, 66/33, or 33/11kV or secondary distribution 33/0.4 or 11/0.4 kV substations have to be numbered, name designated, or coded.

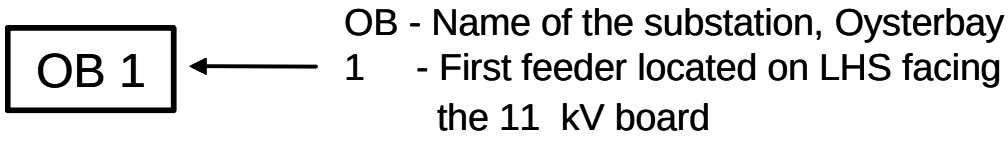
10.8.1 MV Feeder numbering

10.8.1.1 For indoor MV switchgear, feeder numbering begins with feeder No. 1 on the left side while facing the MV switchboard e.g. OB 01 must be the first feeder outlet located on the left hand side (LHS) whilst looking at the switchboard, followed by OB 2, OB 3, and so forth.

10.8.1.2 For an outdoor substation, the principal approach is similar to the indoor type switchboard. From the busbar facing toward the feeder outlets, the first feeder outlet is the one on the most left and the next one is towards the RHS.

10.8.1.3 Feeder numbering is carried out by adding a number suffix to the coded name of the substation as elaborated under section 2.

Example: Oysterbay 33/11 kV Substation



Example10.1: Tegeta 132/33 kV Substation

10.8.2 LV Feeder numbering

10.8.2.1. For 0.4 kV PMT, GMT, or IMT distribution substation, the circuits emanating from the distribution transformer have to be numbered. Circuit numbering begins with circuit 1, followed by circuit 2, and so forth, and will be done in a clockwise direction as from the Geographical North. The main circuits shall all be three phase four wire.

10.8.2.2. For pole mounted distribution substations with three outlet circuits, if the substation name is, say, Ohio Street substation No. 1, the substation is named and marked as OHS1 and the first circuit is marked as OHS1-1, and so forth followed by OHS1-2 .

10.8.3 POLE NUMBERING

All poles carrying electric wires shall be numbered by engraved or punched aluminum number plates of thickness of 1mm to 2mm. The numbers shall be 2 inches in size and shall be arranged in rows. The pole number plates should contain the geographical coordinates of the pole.

10.8.3.1 Nomenclature for MV and LV Poles Numbering.

10.8.3.1.2 MV Pole numbering shall originate from the parent primary distribution substation e.g. 132/33, 66/33, and 33/11 kV substations.

10.8.3.1.3 LV pole numbering shall originate from the respective distribution transformer e.g. 33/0.4/0.23 and 11/0.4/0.23 kV substations. Before numbering starts, the circuits emanating from the distribution transformer must be numbered.

10.8.3.2 Number Plates for MV Poles

10.8.3.2.1 Row No. 1 on an MV pole number plate shall designate the name of the feeder by abbreviating the substation name in two letters and the feeder number.

10.8.3.2.2 Row No. 2 shall designate the number of the pole from the feeding substation, i.e. the 220/33, 1320/33, 66/33, 66/11, and 33/11 kV Primary Distribution Substation and 0.4/11kV Power Station, etc.

10.8.3.2.3 Row No. 3 shall designate a spur line. The spur line shall be given the street/road name abbreviated in three letters. In case there are no streets or street names, a prominent/famous name in the area shall be taken.

10.8.3.2.4 Row No. 4 shall designate the number of the spur line pole from the tapping trunk line.

10.8.3.2.5 Row No. 5 shall designate a sub-spur line that shall be named by the street name along which it runs as in row 3.

10.8.3.2.6 Row No. 6 shall designate the number of the sub-spur line pole from the tapping spur line.

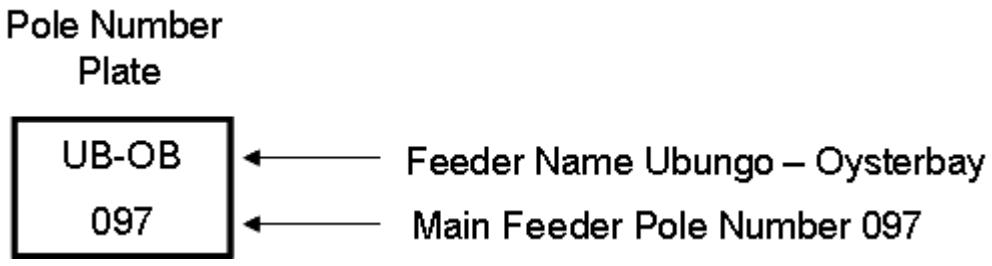
10.8.3.2.7 Row No. 7 shall designate a sub-sub-spur line that shall be named by the street name along which it runs as in row 5.

10.8.3.2.8 Row No. 8 shall designate the number of sub-sub-spur line pole from the tapping sub-spur line.

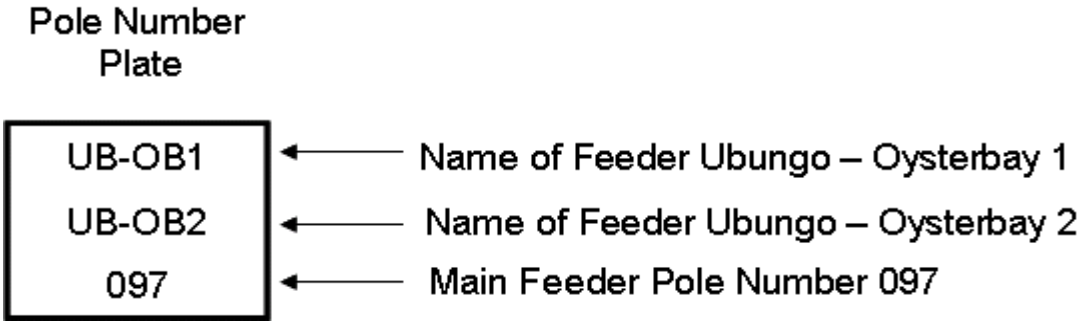
10.8.4 Chart of the MV Pole Numbering Nomenclature

ROWS	POLE NUMBER PLATE	DESIGNATION
ROW No. 1	OB4	Feeder Name
ROW No. 2	097	Main Feeder Pole Number
ROW No. 3	MRC (Street Name)	Spur-line Name
ROW No. 4	023	Spur-line Pole Number
ROW No. 5	MJM (Street Name)	Sub-spur line Name
ROW No. 6	015	Sub-spur line Pole Number
ROW No. 7	OHI (Street Name)	Sub-sub spur-line Name
ROW No. 8	005	Sub-sub spur-line Pole Number
ROW No. 9	X Y (coordinates)	GPS Position

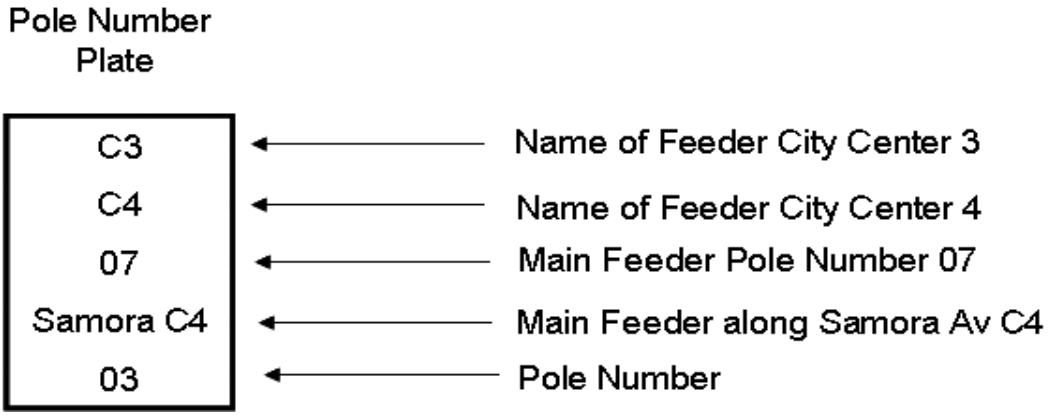
10.8.4.1 Plate example of a 33 kV main line emanating from the primary Ubungo 132/33 kV and from Kidatu 220/33 kV substations:



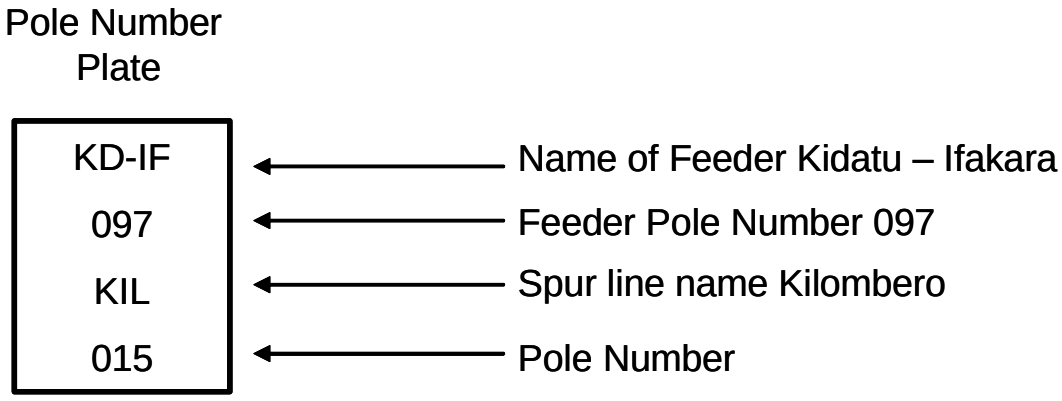
10.8.4.2 Plate example for a 33 kV double circuit line emanating from the same primary substation:



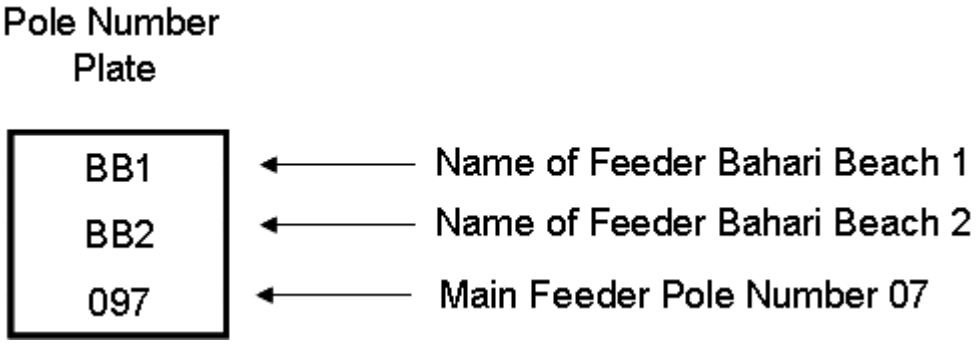
10.8.4.3 Plate example for a spur line from the main line emanating from Kidatu 33 kV busbar to Ifakara and spur line branching off to Kilombero :



10.8.4.4 Plate example for an 11 kV double circuit line emanating from the same 33/11 kV City Center primary substation and branching off from pole 07 to pole 03 along Samora Avenue:



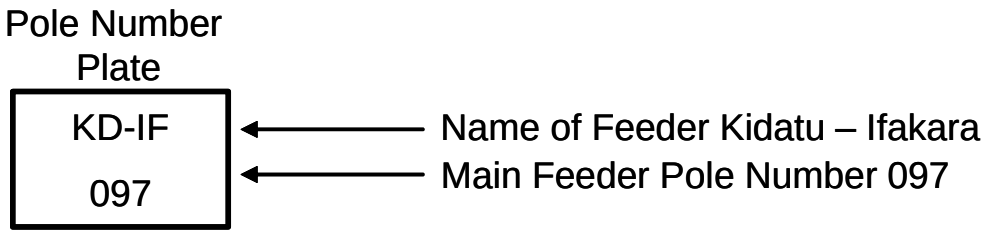
10.8.4.5 Plate example for an 11 kV double circuit line emanating from the same 33/11 kV Bahari Beach primary substation:



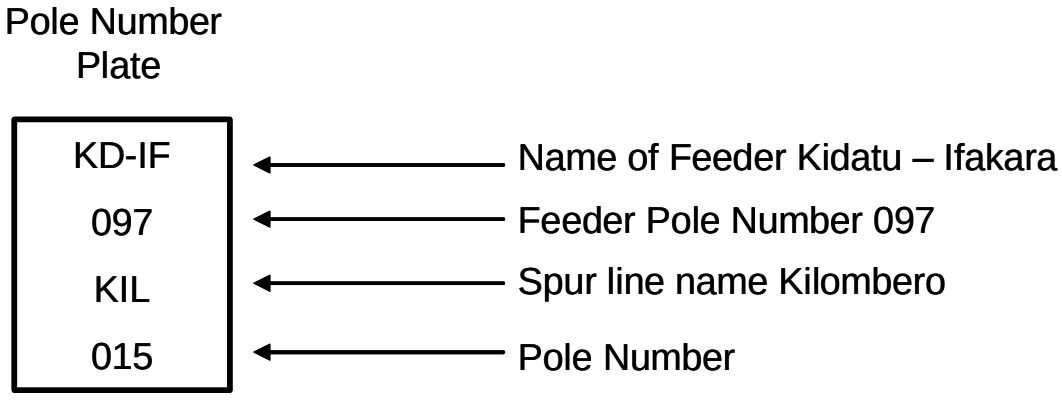
10.9 NUMBERING PROCEDURE FOR MV RURAL FEEDERS

In the case of 33kV feeders feeding only distribution substations for Rural Electrification schemes (33/0.4/0.23 kV), the 33kV feeders will be named after their destinations, and the rest of the nomenclature will be done similarly to the nomenclature discussed above.

10.9.1 Example of a pole number plate for a rural Electrification feeder:

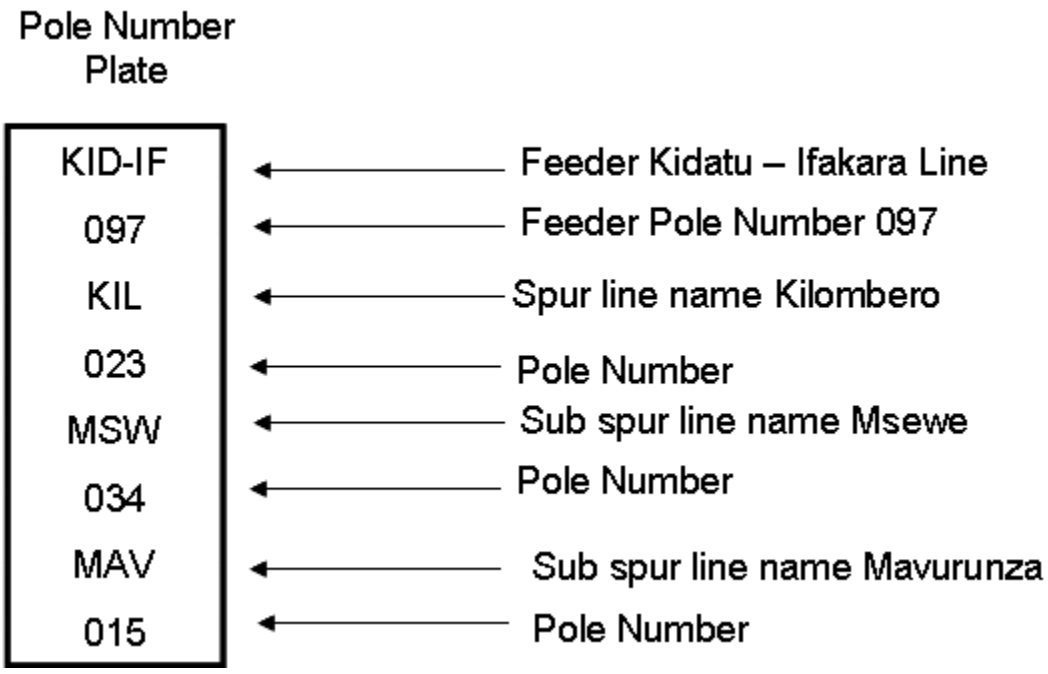


10.9.2 Example of a spur line pole number plate for rural Electrification feeders



10.9.3 Example of sub-spur line pole number plate for rural Electrification feeders

10.9.4 Example of sub-sub-spur line pole number plate for rural Electrification feeders



10.10 NUMBER PLATES FOR 33 kV POLES

10.10.1 Numbering procedure for single circuit feeders interconnecting primary distribution substations:

10.10.1.1 Row No. 1 on the MV pole shall designate the feeder name, which is named after the emanating substations (e.g. UBUNGO 132/33 kV to OYSTERBAY 33/11kV) by abbreviating them using two letters.

10.10.1.2 Row No. 2 shall designate the number of the pole from the feeding substation, i.e. the 132/33, or 66/33 kV Primary Distribution Substation, 0.4/33kV Power Station Substation, etc.

10.10.1.3 Example of a main feeder pole number plate for a single circuit feeder interconnecting primary distribution substations,

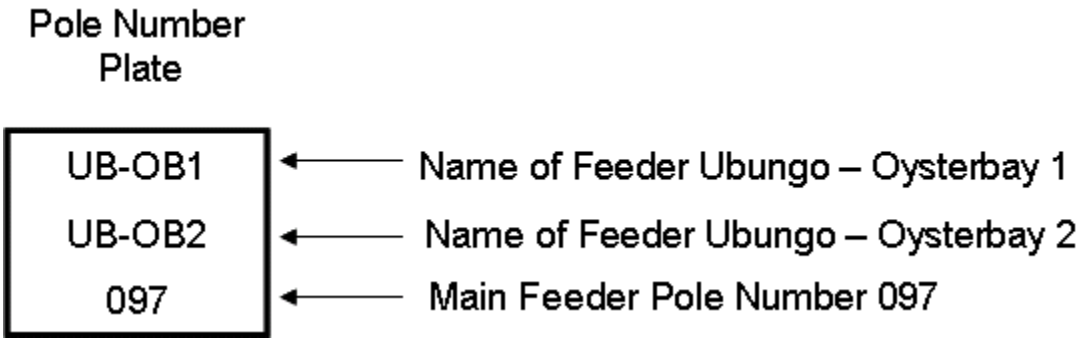
10.10.2 Numbering procedure for double circuit feeders interconnecting primary substations:

10.10.2.1 Row No. 1 shall designate the feeder on the right hand side, whereas Row No. 2 shall designate the feeder on the left hand side. The feeders shall be named after the interconnecting substations (e.g. UBUNGO 132/33 kV to OYSTERBAY 33/11kV) by abbreviating them using two letters.

10.10.2.2 Row No. 3 shall designate the number of the pole from the feeding substation.

10.10.2.3 The procedure for numbering other poles emanating from the double circuit will be the same as that for 33kV single circuits.

10.10.2.4 Example of a pole number plate for double circuit Feeders interconnecting primary substations only:



10.11 **NUMBER PLATES FOR LV POLES**

There shall only be single circuits in LV supply. There shall be only one plate for the LV poles. This plate shall be engraved or punched on detachable number plates to accommodate frequent changes in LV lines constructions.

10.11.1 The numbering shall be arranged in rows as follows:

10.11.1.1 Row No. 1 shall bear the substation name abbreviated using four letters.

10.11.1.2 Row No. 2 shall designate the number of the main circuit and the number of the pole on the main circuit. This row shall be independent of Left or Right direction.

10.11.1.3 Row No. 3 shall designate a spur circuit.

10.11.1.4 The spur circuit shall be named beginning with Left or Right direction and pole number. The Left or Right Direction of the spur circuit shall refer to the direction of the spur with reference to the main circuit from the feeding distribution substation. The spur circuit could be three phase or less.

10.11.1.5 Row No. 4 shall designate a sub-spur circuit.

10.11.1.6 The sub-spur circuit shall be named beginning with Left or Right direction and pole number. The Left or Right Direction of sub-spur circuit shall refer to the direction of the sub-spur with reference to the spur circuit from the main circuit substation. The sub-spur circuit could be three phase of less.

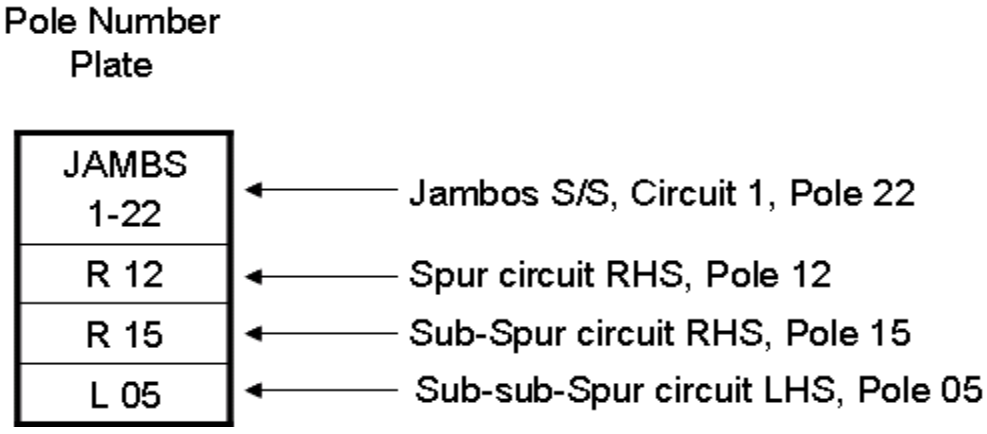
10.11.1.7 Row No. 5 shall designate sub-sub spur circuit.

10.11.1.8 The sub-sub-spur circuit shall be named beginning with Left or Right direction and pole number. The Left or Right Direction of the sub-sub-spur circuit shall refer to the direction of the sub-sub-spur with reference to the sub-spur circuit from the main circuit substation. The sub-sub-spur circuit could be three phase or less.

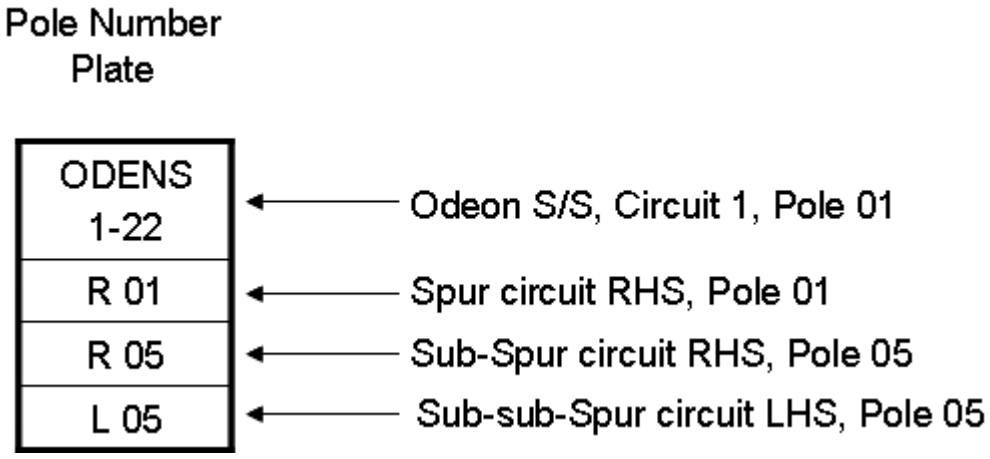
10.11.2 Descriptive Chart of L.V. Pole Numbering

ROWS	POLE NUMBER PLATE	DESIGNATION
RWO No. 1	KMRA	Substation Name
ROW No. 2	1023	Circuit No. 1 and Pole Number 023
ROW No. 3	R-15	The Spur Circuit Tees to the Right Direction From Pole Number 15 on the Main Circuit.
ROW No. 4	R-05	The Subspur Circuit Tees to the Right Direction from Pole Number 5 on the spur circuit.
ROW No. 5	L-10	The Sub-sub spur Circuit Tees to the Left Direction from Pole Number 10 on the sub spur Circuit.
ROW No. 6	R-05	The Sub-sub-sub spur Circuit tees to the right Direction from Pole Number 5 on the sub-sub spur Circuit.
ROW No. 7	L-10	The Sub-sub-sub-sub spur Circuit Tees to the Left Direction from Pole Number 11 on the Sub-sub-sub spur Circuit.
ROW No. 8	R-11	Etc.

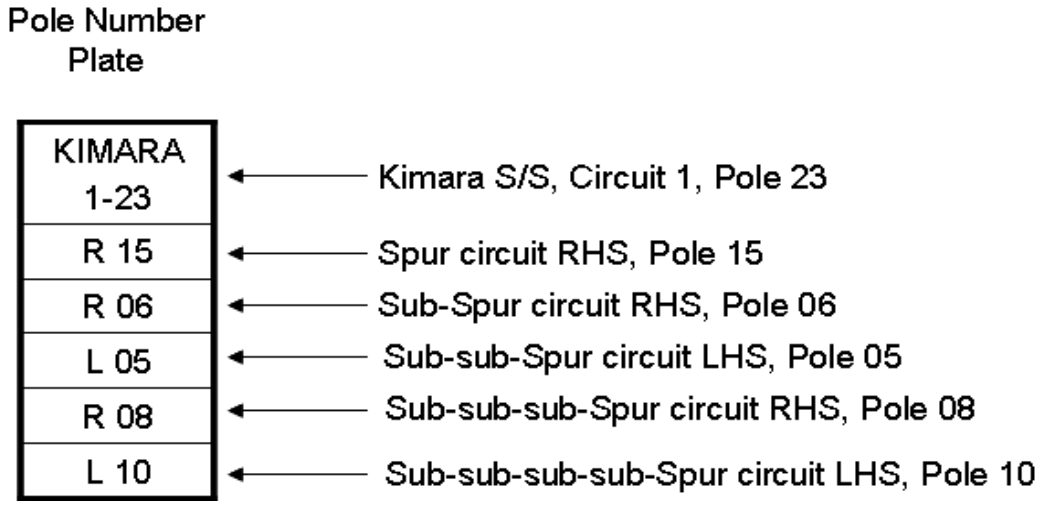
10.11.2.1 Example of LV pole numbering for 11/0.4 kV substation:



10.11.2.2 Example of LV pole numbering for MV 33/0.4 or 11/0.4 kV substation:



10.11.2.4 Example of LV pole numbering for 11/0.4 kV substation



10.12 REGIONAL NOMENCLATURE

Below are proposed substation and area coding for the remaining regions and areas of supply. These are given for demonstration only.

Region	Name of Station	Abbreviation
Tabora	Tabora P/S	TP
	Market	MT
	Nzega	NZ
Shinyanga	Shinyanga	SH
	Ibadakuli	IB
	Shinyanga P/S	SP
	Mwadui	MW
	Buliyankulu	BU
	Kahama	KA
Kigoma	Kigoma P/S	KP
	Ujiji	UJ
Mbeya	Mwakibete	MK
	Mbeya P/S	MP
	Mbeya Textile	MT
	Tukuyu	TK
	Mbozi	MB
	Kiwira	KW
	Mwakaleli	MK
	Mbeya Cement	MC
Iringa	Tagamenda	TG
	Mufindi	MF
	Sabasaba	SB

	Industrial Area	ID
Rukwa	Mpanda	MP
	Mpanda P/S	MPP
	Sumbawanga P/S	SP
Mtwara	Mtwara P/S	MT
Songea	Songea P/S	SP
Mwanza	Mwanza South	MS
	Nyakato	NK
	Sabasaba	SB

Region	Name of Station	Abbreviation
Kilimanjaro	Kiyungi	KY
	Boma La Mbuzi	BM
	Marangu	MR
	Sanya Juu	SJ
	Airport	AP
	Trade School	TS
	Same	SA
	Gonja	GO
	Nyumba Ya Mungu	NYM
	Mwanga	MW
	Kikuletwa	KK
Arusha	Njiro Hill	NJ
	Mount Meru	MM
	Themi	TM

	Unga Limited	UG
	Kiltex	KT
	General Tyre	GT
	Monduli	MO
	Usa River	UR
Dodoma	Zuzu	ZZ
	Dodoma Office	DO
Morogoro	Morogoro	MG
	Kihonda	KH
	Msamvu	MS
	Mlima Kola	MK
	Industrial	ID
	Morogoro Textile	MT
	Mzinga	MZ
	Tanzania Railway	TR
	Sokoine	SK
Musoma	Musoma	MS
	Musoma P/S	MP
Bukoba	Bukoba	BK
	Bukoba P/S	BP

Region	Name of Station	Abbreviation
Tanga	Hale	HA
	Mazinde	MZ
	Magunga	MG
	Saruji	SR
	Lushoto	LS

	Fertilizer	FT
	Steel Rolling Mill	ST
	Muheza	MU
	Bushiri	BU
	Lanzoni	LA
	Moa Mains	MO
	Marungu Mains	MR
	Kange	KN
	Maramba Mains	MA
	New Sagan	NS
	Kerenge Mlemwa	KM
	Bushiri	BS
	Korogwe	KO
Lindi	Lindi P/S	LP
Singida	Singida	SD
	Arusha Road	AR

APPENDICES

Appendix 3.1

QUALITY OF POWER SUPPLY

INTRODUCTION

Electrical disturbance is a form of distorted electrical power that comes in many shapes and sizes. Electricity as it comes from the generators at the generating power stations is smoothly flowing and is shaped like successive waves cycling up and down and up 50 times per second (50 Hz).

Distorted electricity is created by the use of electrical equipment in domestic buildings, commercial organizations, and small industries, by large power users, as well as by operational activities taking place on the utility system.

Electrical disturbances are caused by equipment interaction, such as when a large motor, large welding machine, or arc furnace starts, or by lightning strikes. Once an electrical disturbance has been caused, the wiring network carries the disturbance to other equipment, and may aggravate the disturbance, especially if there are wiring or grounding problems in the network. Finally, the disturbance reaches sensitive connected equipment, which reacts to the disturbance. Electrical disturbances interact with the system in several ways. Some types of disturbances are:-

Transients: Also known as surges or spikes, these are caused by lightning, appliances such as printers and copiers, and utility activities such as circuit breaker operation and switching in and out into faulty circuits. Transients of sufficient energy can upset computers, corrupt data, or even cause damage in other electrical equipment.

Sag: This is defined as a brief drop in the system voltage. Sags are caused by equipment such as large motor starting, arc welding, electric furnace, and air conditioning cutting in and out, as well as utility events. Sags often cause computer equipment to lock up or lose memory. This is one of the most common causes of electric problems for sensitive equipment.

Swell: This is a brief increase in the normal voltage level. Most swells are caused when a large motor is stopped. Although not generally a problem, swellings have been known to cause failure of marginal components in sensitive equipment.

Over & Under voltage: These are increases or decreases in the normal voltage that last longer than sagging or swelling. These disturbances often indicate an overloaded transformer or circuit, or inoperative on-load tap changers on a primary distribution substation power transformer.

Interruption: Also called a momentary or power outage, an interruption is generally caused by short circuits from downed trees or wires, or damaged equipment. These unsafe conditions cause a circuit breaker or fuse to trip and de-energize the circuit.

Harmonics: Harmonics are a regular distortion of the voltage waveform often caused by the power supplies of electronic equipment. Harmonics can cause over heating in transformers, building wiring, and

motors. Harmonic distortion is the change in waveform of the supply voltage from ideal sinusoidal waveform. It is caused by the interaction of distorting customer loads with the impedance of the network supply.

Major adverse effects are the heating of induction motors, transformers and capacitors and the overloading of neutrals.

Commercial loads from: office complexes, department stores (super markets), hospitals, internet data centres etc Single phase power supplies. Electronic power converter loads, adjustable speed motor drives, dc motor drives, battery chargers etc.

Industrial loads. Modern industrial facilities are characterized by the widespread application of non linear loads. These loads can make up a significant portion of the total facility loads and inject harmonic currents into the power system, causing harmonic distortion in the voltage.

Customers need to be protected from other customers producing excessive distortion on the supply and damaging equipment or causing inconvenient malfunctions. There are several standards which address this problem. The standards address three aspects of harmonics

There is issue of harmonic distortion evaluation. Harmonic currents produced by non linear loads can interact adversely with the utility system. The interaction often gives rise to voltage and current harmonic distortion observed in many places in the system.

To limit both voltage and current harmonic distortion, several standards propose to limit harmonic current injection from end users so that harmonic voltage levels on overall power system will be acceptable if the power system does not inordinately accentuate the harmonic currents. This approach requires participation from both end users and utilities.

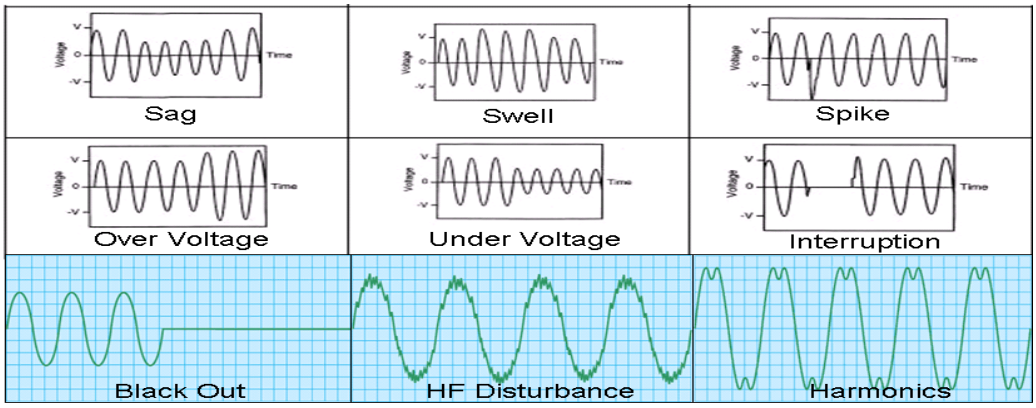
Conventional solutions are: passive filters, surge suppressors, motor- generator sets, static VAR compensators, uninterruptible power supplies (UPS), ferro resonant transformers, and line power conditioners. Different types of conventional solution address different problems:-

Passive Filters: Prevent customer site harmonics from getting to the distribution or transmission system. Passive filters are cheap, simple, and un-powered, but they need tuning.

Active Filters: Mitigate harmonic by producing harmonics currents equal to those in the load current, shunting them away. Active filters are more robust, but expensive, consume much power, and create high electromagnetic interference.

Noise: Electrical interference from equipment that radiates high frequency electrical energy such as TV/radio transmitters and cell phones. Interference can also be caused by arcing sources (switches) or switching power supplies such as those found in electronic ballasts and adjustable speed drives. This kind of noise often causes interference in control circuits.

Blackout: This is caused by utility outage due to faults occurring on the system, or due to complete grid network failure because of instability, generation failure, or transmission system fault.



SURGE ARRESTOR PHERNOMENA

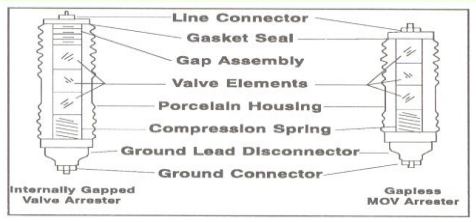
Appendix 3.2

EI 02 Surge Arresters

Lightning arrester (LA) is considered as primary protection for distribution transformer if correctly selected and installed. The selection is carried out centrally during tendering stage.

- LA is protective insurance against most surges.
- It limits momentary OV caused by lightning.
- There has been drastic design changes from gaped type LA to new gapless MOV type.
- It is applied on transformers and cables.
- OH line without earth wire is protected with LA.

- The figure shows comparison between gap and gapless type lightning arrester.
- Of latest the units are now available in silicone rubber housing, for extra safety.



1. Ensure correct mounting of the LA, it shall be close to the equipment required for surge protection.
2. All distribution transformers and cable overhead risers are protected with lightning arresters.
3. Where MV service is required, the cost for LA is also included in the estimates.
4. The LA shall work only if adequately grounded. All three terminal of Las are connected and grounded appropriately. See the MV line construction practice.

Appendix 3. 3

Lightning Arresters on Distribution Network

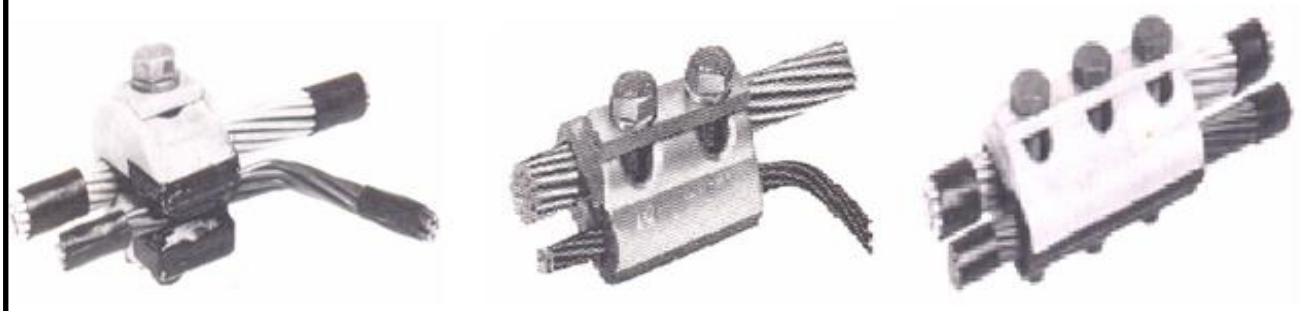
Appendix 3.4

Non-tension Type Joints

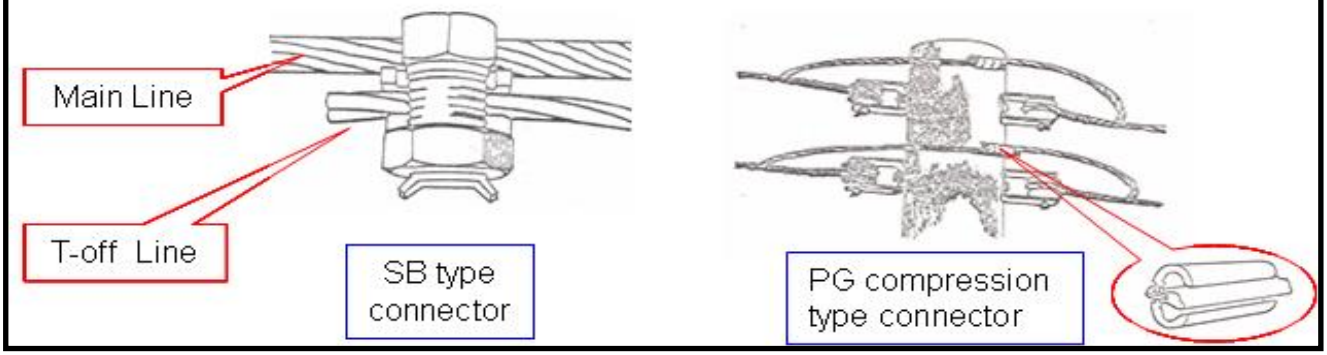
{Courtesy Tyco, Dulmison, BICC}

1. Non-Tension type, Parallel Groove, 1 bolt, 2 bolts and 3 bolts AL-AL Connectors

2. Non-Tension type, Parallel Groove, 1 bolt, 2 bolts and 3 bolts CU-AL connectors



3. Non-Tension type SB and PG connectors

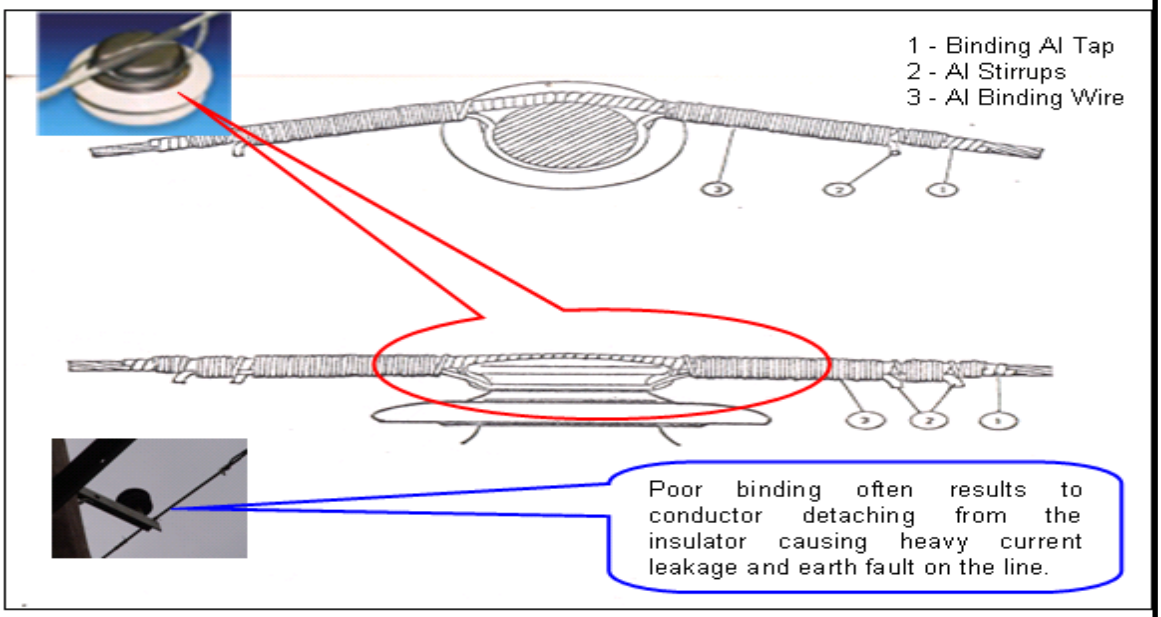


Appendix 3.5

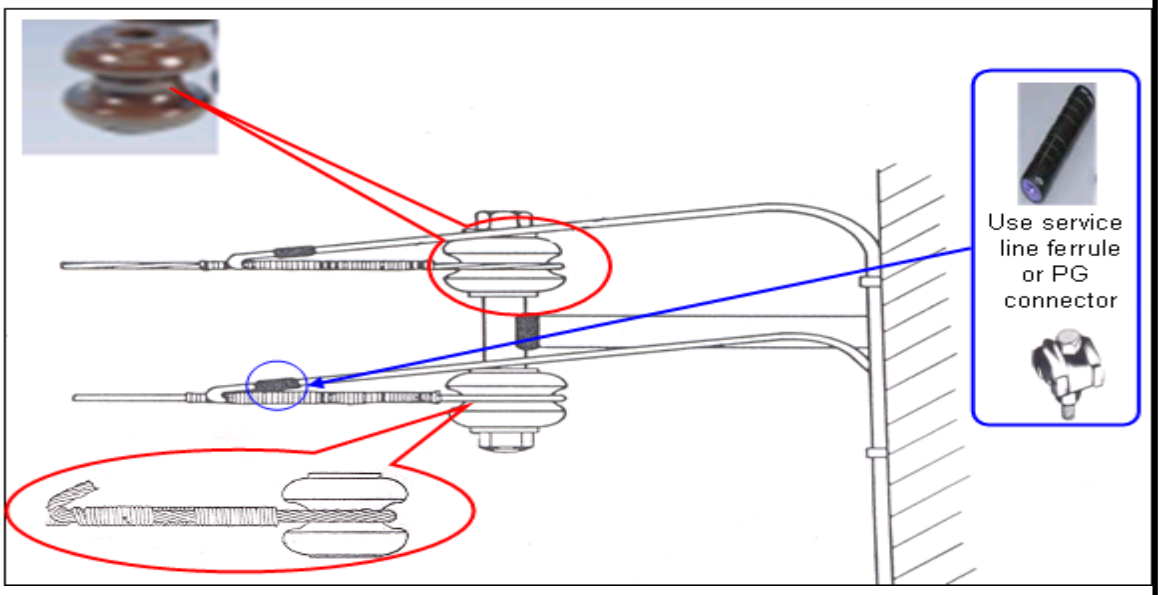
Non-tension Type Binding Joints

{Courtesy Tyco, Dulmison, ESI}

1. Non-Tension, Pin Insulator Binding.



2. Non-Tension, Service Binding Binding.

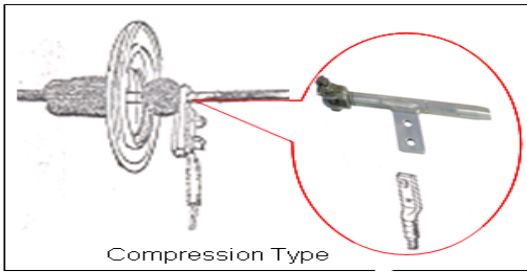


Appendix 3.6

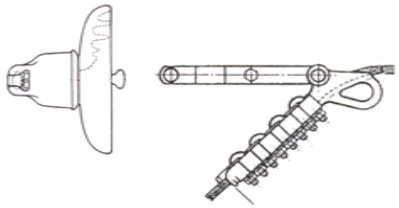
Tension Type Conductor Joints

(Courtesy Tyco, Dulmison)

Dead end or Section MV ACSR conductor termination



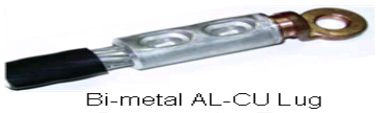
Compression Type



Bolted Type

Compression Type Mid Span
AL - AL Conductor Joint

Compression Type
AL Lug



Bi-metal AL-CU Lug
Compression Type

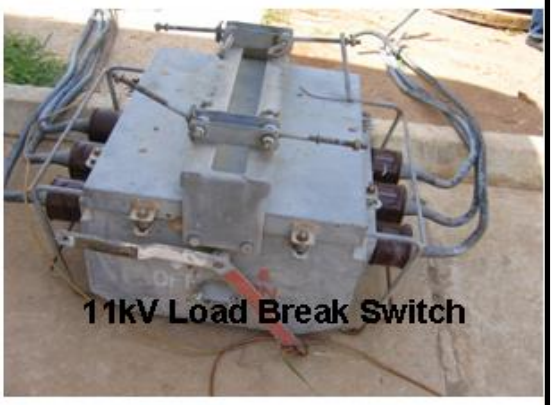
Bi-metal AL-CU Tube
Compression Type

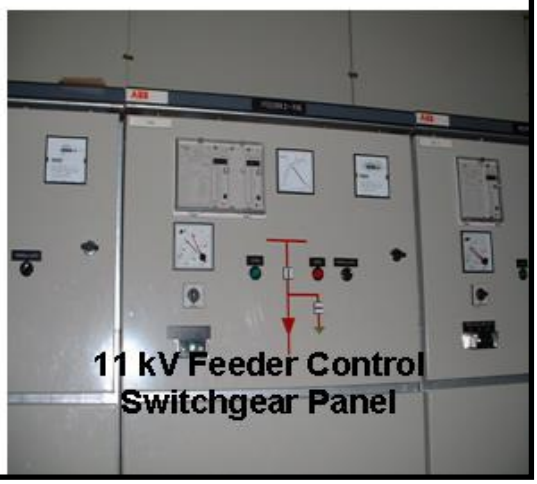
Mechanical and Hydraulic
Compressors

Appendix 3.7

MV Line Switchgear

{Courtesy ABB, NGK, Tyco, S&C}





Appendix 4.2

EARTH FAULT LOOP IMPEDANCE

1. Where HRC fuses are used for distribution circuit protection and for Sockets outlets, the maximum earth fault loop impedance 'Zs' for 0.4 seconds disconnection time is:

1.1 For HRC Fuses To BS 88 Part 2 and 6

Fuse Rating (A)	6	10	16	20	25	32	40	50
Earth Fault Loop Impedance Z_s (ohms)	8.8	5.33	2.82	1.85	1.5	1.09	0.86	0.63

1.2 For HRC Fuses to BS 1361

Fuse Rating (A)	5	15	20	30	45
Earth Fault Loop Impedance Z_s (ohms)	10.9	3.43	1.78	1.20	0.60

1.3 For HRC Fuses to BS 3036

Fuse Rating (A)	6	10	16	20	25
Earth Fault Loop Impedance Z_s	10.0	2.67	1.85	1.14	0.62

1.4 For HRC Fuses to BS1362

Fuse Rating (A)	13
Earth Fault Loop Impedance Z_s	2.53

2. Where a miniature circuit breaker is used for distribution circuit protection, for 230 volts to earth and for 0.4 seconds disconnection time for socket outlets, the maximum earth fault loop impedance 'Z_s' is:

2.1 For MCB type 1 to BS 3871

MCB Rating (A)	5	10	15	20	25	30	40	50
Earth Fault Loop Impedance Z_s (ohms)	12	6	4	3	2.4	2	1.5	1.2

2.2 For MCB type 2 to BS 3871

MCB Rating (A)	5	10	15	20	25	30	40	50
Earth Fault Loop Impedance Z_s (ohms)	6.86	3.43	2.29	1.71	1.37	1.14	0.86	0.69

2.3 For MCB Type 3 to BS 3871

MCB Rating (A)	5	10	15	20	25	30	40	50
Earth Fault Loop Impedance Z_s (ohms)	4.8	2.4	1.6	1.2	0.96	0.80	0.60	0.48

3. For a final circuit supplying only stationary equipments, a disconnection time of 0.5 seconds is permitted. Where HRC fuses are used for distribution circuit protection, the maximum earth fault loop impedance 'Zs' is:

3.1 For HRC Fuses to BS 88 Part 2 and 6

Fuse Rating (A)	6	10	16	20	25	32	40	50
Earth Fault Loop Impedance Z_s (ohms)	2.48	1.48	0.83	0.55	0.43	0.34	0.26	0.19

3.2 For HRC Fuses to BS 1361

Fuse Rating (A)	5	15	20	30	45
Earth Fault Loop Impedance Z_s (ohms)	3.25	0.96	0.55	0.36	0.18

3.3 For HRC Fuses to BS 3036

Fuse Rating (A)	5	15	20	30	45
Earth Fault Loop Impedance Z_s (ohms)	3.25	0.96	0.63	0.43	0.24

3.4 For HRC Fuses to BS 1362

Fuse Rating (A)	13
Earth Fault Loop Impedance Z_s (ohms)	0.75

3.5 For MCB Type 1 to BS 3871

MCB Rating (A)	5	10	15	20	30	40	50	63
Earth Fault Loop Impedance Z_s (ohms)	2.5	1.25	0.83	0.63	0.42	0.31	0.25	0.2

3.6 For MCB Type 2 to BS 3871

MCB Rating (A)	5	10	15	20	30	40	50	63
Earth Fault Loop Impedance Z_s (ohms)	1.43	0.71	0.48	0.36	0.24	0.18	0.14	0.11

3.7 For MCB Type 3 to BS 3871 &Type C to BS EN 60898

MCB Rating (A)	5	10	15	20	30	40	50	63
Earth Fault Loop Impedance Z_s (ohms)	1	0.5	0.33	0.25	0.17	0.13	0.10	0.08

4. Sizes of tinned copper wire for use in semi-enclosed fuses

Nominal current of fuse (A)	3	5	10	15	20	25	30	45	60	80	100
Nominal diameter of wire (mm)	0.15	0.2	0.35	0.5	0.6	0.75	0.85	1.25	1.53	1.8	2.0

Appendix 4.3

CHECK LIST FOR INITIAL VISUAL INSPECTION AND COLOUR CODE

4.4.1 Carry out Visual inspection for the following items:-

4.4.2 Selection of conductors for current rating capacity and voltage drops, connection of conductors, and colour coding identification.

4.4.3 Connection of single pole devices for protection and switching in phase conductors only, and correct connection of socket outlets and lamp holders.

4.4.4 Presence of fire barriers and method of protection against direct contact through provision of:

- Insulation for live parts
- Barriers or enclosures
- Obstacles
- Placing out of reach.

4.4.5 Appropriate devices for isolating and switching.

4.4.6 Labelling of circuits, fuses, and terminals, and danger Notice, Warning notices, and relevant Diagrams.

4.4.7 Selection of equipment and protective measures appropriate for possible external influences.

4.4.8 Danger and warning notices, diagrams, safety and rescue procedures in case of electric shock.

4.4.9 Check and observe for the following colour codes.

4.4.10 Protective including earthing conductor : Green and Yellow insulated

4.4.11 Phase of a.c single phase circuit : Red (or Yellow or Blue)

4.4.12 Neutral of a.c single phase circuit : Black

4.4.13 Phase R of 3-phase a.c. circuit : Red

4.4.14 Phase Y of 3-phase a.c. circuit : Yellow

4.4.15 Phase B of 3-phase a.c. circuit : Blue

4.4.16 Positive of DC 2 wire circuit : Red

4.4.17 Negative of DC 2 wire circuit : Black

Appendix 4.5

INSTALLATION COMPLETION FORM

{THIS FORM TO BE COMPLETED BY THE CONTRACTOR FOR}

{WIRING INSTALLATION AND AUGUMENTATION}

To: From:

TANESCO Contractor

Address	Name: P.O.Box: Region: Phone - Land Line: Phone - Mobile:

I certify that the installation detailed on this card has been inspected in accordance with Cap 131 supp 57, subsidiary legislation Rule 44, and that to the best of my knowledge and on behalf of the customer, the installation summarized in the drawings / schedules attached complies with those regulations currently obligatory at the date for the work.

Electrical Installation Premises: Customer's Name: P.O.Box: Region:

Visual Inspection

Method of Earthing Earthing resistance ohms

Insulation resistance Test:

Between conductors Conductor to earth ohms

Earth fault loop impedance

Earth Leakage Current Protection Device installed:

Type Rating volts,

Tripping Earth leakage current mA

The installation will be ready for connection on date

I recommend that this installation will be further inspected after an interval of not more than years.

DETAILS OF INSTALLATION

1. Description of premises Residential, Commercial, Industrial, Charity Institution

2. Number of Lighting Points Tungsten Lamps

3. Discharge Lamps

4. Number of Socket outlets 2 A 5 A

5. Other socket outlets NO/Amps

6. Domestic Appliances (kW) Cooker

7. Water Heater

8. Refrigerator

9. Washing Machine

10. Air Conditioner

11. Deep Freezer

12. TV/Video sets

13. Others

Office equipment

14. Photocopy Machines No

15. Typewriter Machine No

16. Central A/C No

17. Others

Other Appliances for General Industrial use

18. Motor No

19. Welding Machines No

20. Electrical Heaters No

21. Others

22. **Total Load kW**

FOR OFFICE USE ONLY

1. **SERVICE LINE WORKS**

Service Line No

Name of Foreman/Linesman assigned

Signature & Coy No

Engr/Supr who approved the Service Line

Signature & Coy

2. **INSTALLATION WORKS**

MAS number Date Opened

Voltage at consumer premises Vo

Meter Number Meter type

Meter Type SPN / TPN/ Prepaid / Credit

Power Meter kWh/kVA

Meter Size CT Ratio T Ratio

Make All intact (YES/NO)

Installation approved by (Name)

Designation Signature

Name of Contractor present during inspection & License Number

Name

3. **NOTE THE FOLLOWING**

Testing and inspection will be carried out under the supervision of Electrical Installation Supervisor / Superintendent / Mains Superintendent / Mains Engineer / Assistant Regional Manager / Regional Manager / Area Manager

INSPECTION CERTIFICATE

I CERTIFY that the electrical installation at ----------
---------- has been inspected and tested, in accordance with the Regulations for Electrical Installations (IEE Wiring Regulation BS 7671 of latest edition) and that the results are satisfactory in the respects mentioned below, except as indicated in the comments below.

I RECOMMEND that the installation be further inspected and tested after an interval of not more than _____ Years. (The installation shall normally be inspected and tested after 5 years, 3 years for agricultural premises, one to three years for caravan installations, and 3 months for temporary or construction site installations).

Items Inspected or Tested:

(i) Type of earthing arrangements: T N ☐ T T ☐ I T ☐

(ii) Over current protective devices _____ Poles_____ A

(iii) Residual current device(s)_____ A _____ mA

(iv) Prospective short-circuit current at the origin _____ kA

(v) Earth electrode resistance _____ ohms

(vi) Earth fault loop impedance at the origin _____ ohms

(vii) Insulation resistance between live and earth _____ ohms

(viii) Insulation resistance of each item to earth _____ ohms

(ix) Insulation resistance of the fixed installation _____ Mohms

(x) Continuity of ring final circuit conductors ☐

(xi) Continuity of protective conductors and equipotential bonding ☐

(xii) Protection against direct contact or barrier ☐

(xiii) Protection against direct contact, by insulation level ☐

(xiv) Presence of protective earth conductor ☐

(xv) Operation of Residual current device ☐

(xvi) Protection against direct contact, by enclosures IP2X ☐ or IP4X ☐

(xvii) Polarity of single-pole devices ☐

(xviii) Method of protection against indirect contract by coordination of protective devices for automatic disconnection, earthing arrangements, and relevant impedance of circuits to ensure automatic disconnection. (During earth fault, the magnitude and duration of voltage between simultaneously accessible and extraneous conductive parts do not cause danger).

(xix) Protection against indirect contact by measures other than automatic disconnection.

(xx) Condition of flexible cables and cords, switches, plugs and socket outlets (visual inspection).

(xxi) Sizes of live conductors and their methods of installation in relation to design currents of circuits and to the operating currents of overcurrent protective devices.

(xxii) Equipments tested include/do not include portable equipment.

(xxiii) Comments(if any) and Departure from the Regulation:-

COMMENTS

_____

_____

_____

_____

Contractor's Stamp, Signature, and Details

Contractor's Name_____

Company's Name_____

E.L.B Registration _____C.R.B Registration _____

Location_____

P.O. Box _____

Region _____

Appendix 4.6

COMMON DISCREPANCIES FOUND IN INSTALLATIONS

Here are some common discrepancies found in installations, with reference to BS 7671, 1992 edition

(i) Installations are not carried out by professional authenticated contractors (120-03-01)

(ii) The installation workmanship is poor, and non standard materials have been used. The material used can not carry the demand required whilst the equipment are connected and energized (130-01 and 02).

(iii) Conductor insulation is poor and not adequately safeguarded against abrasion and corrosive atmosphere (130-02-04).

(iv) Sufficient protective measures against fatal accidents in case of short circuits are not provided. These protective measures must be at strategic points to isolate supply (130-03-01).

(v) The installation is missing protection against earth leakage (130-04).

(vi) Earth rod is completely buried (542-04-02).

(vii) The earthing lead 'Protective Conductor' to the earthing point is so exposed that it can be touched or damaged mechanically. (543-03-01).

(viii) Earthing electrode resistance and Earth Fault Loop Impedance is too high (413-02-16).

(ix) The circuit breaker used is a voltage operated ELCB instead of a current operated RCD (413-02-19).

(x) There are provisions for use of equipment with metallic frame works but no RCD is installed (471-08-01).

(xi) Additions and alterations, temporary or permanent, made to an existing installation cause an overload to the installation and to the utility equipment (130-09-01).

(xii) The number of points connected to a circuit shall not cause overloading to the protective circuit and the cables (314-01-03).

(xiii) The installation is so haphazardly done that maintenance is difficult (341-01-01)

(xiv) All exposed conductive parts to be protected must be connected to the main terminal earth, as a requirement of TANESCO and TT system (413-02-18).

(xv) Socket outlets and lighting points are mixed up in the final sub circuits (314-01-01).

(xvi) The Installation work is not complete; hence, no test is carried out (711-01-01).

(xvii) Number of connected points in lighting circuits, socket outlet circuits, etc., exceeds the required numbers (314-01-03).

(xviii) Cables for extra low voltage circuits are mixed with those carrying medium/high/extra high voltages in one enclosure (528-01-01).

(xix) The live parts in a distribution board are easily accessible without any tools required to open a door covering the board (413-03-08)

(xx) The Insulation resistance between conductors, conductors to neutral, conductors to earth, or neutral to earth is low (613).

(xxi) Insulation resistance of site built assemblies and equipment is too low (613).

(xxii) The installation is connected to public supply before the supply authority's certification. (611-01).

(xxiii) Jointing of conductors is not done property (there are unsoldered twist connections, there are un-sleeved bare connection, there is a pealed part of the conductor left out of the enclosure etc.) (527-02-03)

(xxiv) No means of isolation is provided at the beginning and end of an installed long supply cable (476-01-02).

(xxv) The space factor of the conductors and cables installed in trunkings, conduits, and cable trenches respectively is exceeded, which impairs maintainability (529).

(xxvi) The cables used to supply Agricultural Installation (damp and corrosive areas) and heat treatment areas are not appropriate as per regulations (522-03)

(xxvii) The position of the bare overhead bus bars is too dangerous (412-05-02).

(xxviii) The method of Installation and type of protective measures used do not fulfil requirements of regulations e.g. sockets are not wired in ring mains, there is an excessive number of sockets in a radial circuit, etc. (521).

(xxix) The electrical layout drawing presented differs from the actual wiring (514-09).

(xxx) Colour code and identification of cores is not observed (514-06).

(xxxi) The heights from floor level at which the accessories and fittings are fixed are not correct (553-01-06).

(xxxii) The clearances from fixed reference objects to fittings and accessories are not correct for cooker switch (476-01-03).

(xxxiii) The single core cables should be clipped, cleated, or installed in conduits or trunkings so as to obtain mechanical protection (521-03).

(xxxiv) Flexible cables supplying distant fixed equipment like water heaters should be replaced by normal (non-flexible) cables (522-02).

(xxxv) Ends of conduits or trunking with sharp edges should be treated in such a way that the cables do not suffer from abrasion (521-04).

(xxxvi) Metal works of public water and gas services are used as earth electrode (542-02-04).

(xxxvii) The Earthing arrangement used is not in compliance with the requirements of the TT system (542-01-04)

(xxxviii) All exposed and extraneous conducting parts in a TT earthing system should be bonded and earthed (413-02-18).

(xxxix) For the TT system, automatic disconnection of the circuits due to earth fault, any fault in sockets, or fixed equipment should occur within the duration stipulated by regulation (413-02-20).

(xl) Earthing of the neutral point of the installed standby generators is not effective (471-15-04)

(xli) Reduced low voltage systems should be earthed (471-04)

(xlii) There should be an earth clamp, and the earthing point should have a warning label (514-13).

(xliii) The cooker, water heater, baking furnace, or any single phase heating appliance should be controlled by a double pole switch with or without a pilot lamp (476-01-03).

(xliv) The earth wire in a ring circuit should also be run in a ring form (543).

(xlv) The switch and control gears installed in the switch room are not labeled (514-10).

(xlvi) No warning notice is present for high voltage of over 250V (514-10).

(xlvii) The RCD is missing notice for testing routinely (514-12).

METER INSTALLATION FORMS

Appendix 4.7

Customer Name & Address: P.O. Box: Region:

Ref

Date:

Dear Sir(s)/ Madame(s)

METER INSTALLATION

PREMISES:

It is now more than one month since the completion of service line construction at your premises. However, neither your contractor nor his/her bonafide representative has called our office to liaison with our Installations Department regarding Inspection, Testing and Meter Connection.

You are therefore being given a notice of one month to call to our office before the service line is removed.

Yours faithfully,

for: **TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

for: MANAGING DIRECTOR

C.C.

Contractor Name & Address:

P.O. Box:

Region:

Tanzania

Note:

Customer Name & Address:

P. O. Box:

Region:

Ref/

Date:

Dear Sir(s)/ Madame(s)

NEW CONNECTION

PREMISES:

We are in receipt of your Installation Completion Card covering wiring in the above premises. We wish to inform you that the drawing(s) showing the physical layout of the installation and the electrical connection of all fittings, sizes of wires, etc. (schematic diagram) should be submitted / show the missing details as per the attached list.

Yours faithfully,

for: **TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

for: MANAGING DIRECTOR

C.C.

Contractor Name & Address: P.O. Box: Region:	Contractor Name & Address: P.O. Box: Region:

Ref/

Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

We are in receipt of your Inspection Certificate and Installation Completion Card covering the wiring in the above premises. Following our inspection and testing, we wish to draw your attention to the discrepancies that have been reported by our Installations Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c) and as a result, the installation has not been connected to the electricity supply.

You must rectify these defects within one month from today and forward a new installation completion card to this office together with a re-testing fee of Tshs. 2,500/= before further inspection and testing can be carried out. In case of failure to comply with the notice given within one month, the service line will be removed without any further notice, and you may face suspension and inspection of your other installation works.

Yours faithfully,

for: **TANZANIA ELECTRIC SUPPLY COMPANY LIMITED**

for: **MANAGING DIRECTOR**

Cc.

Customer Name & Address: P.O. Box: Region:	The Secretary, Electrical Licensing Board P.O. Box:

Ref/

Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We have recently inspected and tested the wiring in the above premises and we wish to draw your attention to the discrepancies that have been reported by our Installations Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), but do not necessarily cover all faults which may exist in your installation. We would ask you, therefore, to seek the services of a competent licensed Electrical Contractor to rectify these defects and ensure that the installation as a whole complies with the safety requirements laid down in these Regulations.

The Electrical Contractor concerned should then fill in the Installation Inspection Certificate attached and submit it to our office together with a drawing showing the electrical layout and alterations made, if any, ready for inspection.

We regret that, unless steps are taken to rectify these defects and submission of the above documents is made within one month from the date of this letter, we shall have no alternative other than to disconnect the supply of electricity.

Yours faithfully,

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: **MANAGING DIRECTOR**

Cc.

Customer Name & Address:

P.O. Box:

Region:

Ref/ Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We have recently inspected and tested the wiring in the above premises, and we wish to draw your attention to the discrepancies that have been reported by our Installations Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), and we regret that, in the interest of safety, we have been obliged to disconnect the supply of electricity to these premises.

We recommend that you seek the service of a competent licensed electrical contractor to rectify these defects and ensure that the installation complies with the safety requirements laid down in these Regulations. The Electrical Contractor concerned should then fill the attached Installation Inspection Certificate and submit it to our office together with a drawing showing the electrical lay-out and alterations made, if any, ready for inspection. If the inspection and tests are successful, you will have to fill in a new agreement card and pay an additional deposit before power is reconnected.

The defects should be rectified and the above documents submitted within one month; otherwise, the service line will be removed.

Yours faithfully,

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: **MANAGING DIRECTOR**

Cc:

Contractor Name & Address:

P.O. Box:

Region:

Ref/ Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We are in receipt of your application for reconnection of electricity at the above premises, but before connecting the supply, we wish to draw your attention to the discrepancies that have been reported by our Installation Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), but do not necessarily cover all faults which may exist.

We regret that, until such time as these defects have been rectified and the installation as a whole complies with the safety requirements laid down in these Regulations, we are unable to comply with your request for the reconnection of the supply of electricity to these premises. However, you are given one more month to rectify the defects before the service line is removed.

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: **MANAGING DIRECTOR**

C.C.

Customer Name & Address:

P.O. Box:

Region:

Ref/ Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We have recently inspected and tested the wiring in the above premises, and we wish to draw your attention to the discrepancies that have been reported by our Installations Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), but do not necessarily cover all faults which may exist in your installation. We would ask you, therefore, to seek the services of a competent licensed Electrical Contractor to rectify these defects and ensure that the installation as a whole complies with the safety requirements laid down in these Regulations.

The Electrical Contractor concerned should then fill in the attached Installation Inspection Certificate and submit it to our office together with a drawing showing the electrical layout and alterations made, if any, ready for inspection.

We regret that, unless steps are taken to rectify these defects and submission of the above documents is made within one month from the date of this letter, we shall have no alternative other than to disconnect the supply of electricity.

Yours faithfully,

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: MANAGING DIRECTOR

Customer Name & Address:

P.O. Box:

Region:

Ref/ Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We have recently inspected and tested the wiring in the above premises and we wish to draw your attention to the discrepancies that have been reported by our Installations Inspectors as per attached list.

The defects enumerated contravene Rule Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), and we regret that, in the interest of safety, we have been obliged to disconnect the supply of electricity to the premises.

We recommend that you seek the service of a competent licensed electrical contractor to rectify these defects for you and ensure that the installation complies with the safety requirements laid down in these Regulations. The Electrical Contractor concerned should then fill the attached Installation Inspection Certificate and submit it to our office together with a drawing showing the electrical lay-out and alterations made, if any, ready for inspection. If the inspection and tests are successful, you will have to fill in a new agreement card and pay an additional deposit before power is reconnected.

The defects should be rectified and the above documents submitted within one month; otherwise, the service line will be removed.

Yours faithfully,

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: **MANAGING DIRECTOR**

Contractor Name & Address:

P.O. Box:

Region:

Ref/ Date:

Dear Sir(s)/ Madame(s)

WIRING INSTALLATION

PREMISES:

A/C No: Meter No:

We are in receipt of your application for reconnection of electricity at the above premises, but before connecting the supply, we wish to draw your attention to the discrepancies that have been reported by our Installation Inspectors as per attached list.

The defects enumerated contravene Electricity Act 2008,Cap 131 sec 31 sub 1(a-c), but do not necessarily cover all faults which may exist.

We regret that, until such time as these defects have been rectified and the installation as a whole complies with the safety requirements laid down in these Regulations, we are unable to comply with your request for the reconnection of the supply of electricity to these premises. However, you are given one more month to rectify the defects before the service line is removed.

for: TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: **MANAGING DIRECTOR**

Appendix 4.8

PRESENT VALUE ANALYSIS

A future amount of money converted to its equivalent value now has a present value (PV) that is always less than actual cash flow, because for any interest rate greater than zero, all P/F factors have a value less than 1.

For this reason, present values are often reflected to as discounted cash flow (DCF).

Besides present value (PV) and net present value (NPV) another term frequently used is present worth (PW). There are several PV analysis such as future worth, capitalized cost, payback period, life cycle costing and bond analysis.

PERFORMING NET PRESENT VALUE (NPV) CALCULATION

The NPV calculation converts all of a project's expected future cash flows into their " present values" i.e. the project's profitability.

NPV typically is calculated over a specific time period of interest e.g. 3 or 5 years. If project NPV is less than zero (NPV< 0), the project is considered to be not profitable over that time period. If project NPV is equal or greater than zero (NPV≥ 0), the project is considered to be profitable over that time period.

By definition, NPV is equal to the sum of the present values of all a projects cash flows, both negative (cash outflows) and positive (cash inflows). For simplicity cash flows are estimated on an annual basis.
The formula for calculating the NPV is:
$NPV_n = (PV_1 + PV_2 + ... + PV_n)$

Where

NPV_n = the Net Present Value of the project over n years
PV_1 through PV_n = The cash flow from each year (positive for cash inflows e.g. anticipated annual revenue from expected energy sales) and (negative for cash outflows e.g. cost of maintenance and operation, cost of losses and cost of outages for power supply projects).

The formula for calculating the Present Value for cash flow in a particular year is:

$PV_n = FV_n * PVF_{nd}$

Where

PV_n = The present Value of the cash flow from year n
FV_n = The known future value of the project cash flow in year n
PVF_{nd} = A Present Value Factor for the year (n) and the project discount rate

Preparation for NPV calculation
Before doing the NPV calculation for a project you will need the following information:
1. The investment cost (the project total cost)

2. The future cash inflows or outflows (FV) expected to occur in each subsequent year of the project.
    - Sometimes the future cash flows will be the same every year and sometime they will be irregular
    - Sometimes they will be all cash inflows and outflows. It will vary from project to project
    - From the power supply distribution projects point of view, cash flows are:
      - Inflows – annual anticipated revenue (ARR) from energy sale to the expected project customers
      - Outflows – anticipated maintenance and operation costs, cost of losses and cost of outages

If there is no Present Value table, necessary Present Value Factors can be calculated as follows:

Present Value Factor (PVF) = $\frac{1}{(1+d)^n}$

Where:

- d is the discount rate, until the year 2011 it was taken as 17% in TANESCO , but in the year 2012 it was 12.05%. The values of discount do change from time to time as it is declared by the Bank of Tanzania (BOT).
- n is the year number.

EXAMPLE FOR CALCULATING NPV.

In this example, calculated total project cost of a certain line and transformer substations is sh. 150,000,000.Anticipated annual revenues for the first and second year is sh.45,000,000. Due to increase in number of customers and total consumption, for the third, fourth, fifth, sixth and seventh years anticipated annual revenues are sh.57, 000,000; 60,000,000; 65,000,000; 65,000,000 and 66,000,000 respectively. The discount rate is given as 10%, and number of years n=7.

Our work is to find out whether this project is viable and if so, in which year does it become viable.

Year	ARR,sh.	PVF at d=10%	PV=ARR*PVF,sh.	PC,sh.	NPV=PV-PC,sh.
0				150,000,000	
1	45,000,000	0.909	40,909,500		-109,090,500
2	45,000,000	0.826	37,188,000		-71,902,500
3	57,000,000	0.751	42,824,100		-29,078,400
4	60,000,000	0.683	40,980,000		11,901,600
5	65,000,000	0.621	40,365,000		11,286,600
6	65,000,000	0.564	36,660,000		47,946,600
7	66,000,000	0.513	33,858,000		81,804,600

Let us assume that while carrying out line design, power demand has been calculated and this is what has led us to calculate AAR. Cost of maintenance and operation, cost of losses and expected cost of

undelivered energy for this line is computed (these costs are also of anticipated in nature). For this particular example and for simplicity, let us assume that the line has been constructed to standard and in most cases conductor used are very big and that losses are minimal, outages caused by this particular short line is minimal and that maintenance costs are only due to inspection/patrol (operation costs are the overhead for inspection/patrol).The costs mentioned above should have

carried negative values in the above table.

Present Value Factor (PVF) = $\frac{1}{(1+d)^n}$ is calculated for each year as

PVF = $\frac{1}{(1+0.1)^n}$ and the result is shown in the table above

To find NPV value for example in the third year we have:

NPV= (40,909,500+37,188,000+42,824,100) – 150,000,000 = -29,074,400 this means the project is not viable in first, second and third years.

For the fourth year we have:

NPV = (40,909,500 + 37,188,000 +42,824,100 +40,980,000) – 150,000,000 = 11,901,160 here NPV is greater than zero that is positive. This means the project becomes viable in the fourth year.

In general, NPV= PV – (PC + MC + CL)

Where,
NPV is net present value in our case the total cost of the project to be carried out,

PV is the present value of cash inflow which in our case is the Anticipated Annual Revenue in a year,

PC is a total project cost,

MC is cost of maintenance, where

MC = Material cost +Transport cost +Labour cost +Cost of Undelivered Energy due to outages (planned and unplanned),

CL is cost of losses

Appendix 4.9

METER TYPE AND SIZE OF SERVICE LINE

All consumers are responsible for safe custody of the energy meter and any other Company equipment installed at respective premises for the purpose of providing supply. In particular, the customer's attention is drawn to the seals affixed to the meter.

For SPU standard service line, observe the following:-

- For SPU of SPN and TPN services, credit or prepaid meters are in use. The cut out for SPN shall be standard heavy duty 60/80 Ampere rated while for TPN shall be 100 Ampere rated. All meters have extended meter terminal covers and voltage links fitted internally.
- Cut-outs and meters shall be installed outside on the street side of the building, and a weather-proof shed has to be provided as necessary.
- The service line conductor size shall depend on the loading of the premises to be supplied with the electricity and the conductor type can either be AAC to Copper or AAC and ABC only

For LPU, LV and MV Service line observe the following:-

- Size of service wire and cable is determined by expected load. Use materials prevalent and available at stores. The office of Officials mentioned in Attachment 2 must be consulted for further information concerning standard size of conductors, LV, and MV cable in use.
- Size of LV power metering chamber is 300 and 630 amperes, where as for MV metering Cabinet, this has been standardized and available in metering unit of various current transformer ratio. Contact SMD for further information. An energy and demand meter in use for LPU is the PPM-AMR

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

INSPECTION AND FUNCTIONALITY TEST FORM

METER NUMBERS: ……

METER TYPE/MAKE: ……..

CONSIGNMENT OF ……..…. METERS.

(I) SINGLE PHASE METERS……

(II) THREE PHASE METERS……

CONTRACT NUMBER: ……..……..……. REQUEST OF: ……

CLIENT: TANESCO/REA/CONTRACTOR/CUSTOMER/REGION/RPU

S/N	INSPECTION/TESTING CARRIED OUT	PASS	NOT PASSED	AT THE VALUE OF
1	LOW - VOLTAGE VARIATION			
1.1	KEY PAD FUNCTIONALITY			
2	TARIFF			
3	AT 0.5 POWER FACTOR			
4	SUPPLY GROUP CODE			
5	AVAILABLE CREDIT			
6	CUMULATIVE ENERGY			
7	LAST TOKEN PURCHASED			
8	LCD SCREEN TEST			
9	INSTATENOUS VALUES (CURRENT)			

10	INSTATENOUS VALUES (VOLTAGE)			
11	SERVER & MODEM (AMR) COMPLIANCE			
12	PLC/RF/GPRS COMMUNICATION COMPLIANCE			
13	OPEN TERMINAL COVER TRIP			
14	TRIPPING TEST			

INSPECTED BY: …….. COY NO: ……..

TITLE: …….

CHECKED BY: …… COY NO: ……..

TITLE: …….

APPROVED BY: …….. COY NO: ……..

TITLE: …….

SIGN: …….

M.A.S RAISING NOTE

Appendix 6.2

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

FROM: PRINCIPAL METER ENGINEER

TO: REGIONAL MANAGER: ……

DATE: ……

M.A.S. RAISING NOTE

A: CUSTOMER DESCRIPTION

CUSTOMER'S NAME	A/C NUMBER	PHYSICAL ADDRESS (AREA/LOCATION)

B: JOB DESCRIPTION

Replacement of Defective Meter		Replacement of Electromechanical Meter		Replacement of Meter Due To Tariff Up-Grading		Replacement of Automatic Meter Reading	
YES	NO	YES	NO	YES	NO	YES	NO

(Check/Tick the applicable option)

C: DETAILS OF REMOVED OLD METER (For Meter Replacement & Tariff Change)

METER NUMBER	SIZE

KWH:	CT RATIO =	VT RATIO =
KVA:	CT RATIO =	VT RATIO =
LAST READINGS		
Import kWh =	Export kWh =	Max. Demand (kVA) =

D: DETAILS OF NEW METER INSTALLED

METER NUMBER	**SIZE**	
	CT RATIO =	VT RATIO =
INITIAL READINGS		**DATE INSTALLED**
Import kWh =	Export kWh =	

E: PERSONNEL INVOLVED IN THE JOB

S/N	**NAME**	**COY No.**	**TITLE**	**DEPARTMENT/SECTION**
1				
2				

F: CERTIFICATION

NAME	**SIGNATURE & STAMP**	**DATE ISSUED**
	(Principal Meter Workshop Engineer)	

Please raise M.A.S. for meter change in the Billing System.

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED **Appendix 6.3**

AMR METER COMMISSIONING FORM

REGION: **DATE:**

<table>
<tr><td rowspan="11"></td><td rowspan="11"></td><td rowspan="11"></td><td>M/N:</td><td rowspan="2"></td><td colspan="4"></td><td>S/N:</td></tr>
<tr><td>Size:</td><td colspan="4">Modem Status(dB)</td><td>Make:</td></tr>
<tr><td>Rdgs: Imp kWh:</td><td>IP Address</td><td colspan="4"></td><td>Type:</td></tr>
<tr><td></td><td colspan="4">Load Comparison (A)</td><td>Size:</td></tr>
<tr><td>Exp kWh:</td><td>GPS Coordinat</td><td colspan="2">Amp Stick</td><td colspan="2">Meter</td><td>CT:</td></tr>
<tr><td>MD1:</td><td rowspan="4"></td><td>R</td><td></td><td>R</td><td></td><td>VT:</td></tr>
<tr><td>M.A.S No</td><td>New Meter / Type:</td><td rowspan="2">Y</td><td rowspan="2"></td><td rowspan="2">Y</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td rowspan="3"></td><td>M/N:</td></tr>
<tr><td>Size:</td><td>B</td><td></td><td>B</td><td></td><td>REMARKS</td></tr>
<tr><td>Rdgs: Imp kWh:</td><td>Tariff:</td><td>Configuration:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exp kWh:</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="4">Voltage Measurements (V)</td><td></td></tr>
<tr><td>MD1:</td><td>R</td><td>Y</td><td>B</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">Seals found:</td><td colspan="5"></td><td rowspan="3"></td></tr>
<tr><td colspan="6">Seals(on Completion)</td></tr>
<tr><td colspan="6">PERSONNEL INVOLVED IN THE JOB</td></tr>
<tr><td></td><td colspan="2">NAME</td><td>COY No.</td><td>TITLE</td><td colspan="2">SIGNATURE</td><td>REGION / DEPARTMENT</td></tr>
<tr><td>1</td><td colspan="2"></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>2</td><td colspan="2"></td><td></td><td></td><td colspan="2"></td><td></td></tr>
</table>

Customer Representative Name ……Signature……

CHECKED By: ……..

Appendix 6.4

Power Supply Service
Contract Agreement

This agreement made this _____ day, the ___ date of _____month of year 20 __ between Tanzania Electric Supply Company Limited, a limited liability company having its registered office at P. O. Box 9024, Dar Es Salaam, (hereinafter referred to as "Utility") and the Customer for LPU by the name of the Company called _____, having its registered office at P. O. Box _____, Region _____, located at _____, (hereinafter referred to as "Customer").

1. This Document constitutes the entire understanding of the Parties and constitutes the entire terms agreed upon between them and supersedes and replaces entirely earlier Power Supply Contract as well as any prior written or by reason of any promise or verbal agreement between the Parties with respect to the supply of electricity.

2. Following are the terms and conditions relevant to the supply of electricity to the Large Power User customer on Low Voltage Service ~~or~~/ Medium Voltage Service or High Voltage Service:-

   Except in cases of Transient over Voltage and frequency phenomena due to electrical causes, the Utility maintains

2.1 The supply consists of a three phase alternating current,

2.2 Nominal supply Voltage is either 0.4 kV (± 5%); 11 kV, or 33 kV with ± 10% at a frequency of 50 Hz with

   ± 2.5%,

2.3 To supply all necessary ancillary services to ensure the reliable and effective supply of Electricity up to the Metering Point,

2.4 The Utility agrees to endeavour to supply Electricity to the customer at the designated site and point of metering up to the Maximum Demand not exceeding [kVA].

2.5 Customer must notify the Utility in writing if he/she wishes to increase demand from the above declared value, and the increase has to be mutually agreed upon in writing.

3.0 METERING

For the purposes of metering the supply of Electricity, the Utility will install and maintain at the power delivery point an appropriate Metering System. The entire cost for the metering at LV, MV, or HV is borne by the customer as indicated in the price schedule. The metering is owned and maintained by the utility, and is equipped with the following facilities:-

3.1 The meter is an electronic, multi-functional type with accuracy of class 1 or better.

3.2 The meter is able to store historical information with integrated intervals of 20 minutes for kVA registration.

3.3 Utility ensures that:-

3.3.1 Customer may request at any time, at his/her own cost, to have his/her Meter tested. If the Meter is found to be in error outside its precision class, the cost of the testing shall be refunded by the utility.

3.3.2 Unless the period of Meter inaccuracy can be determined so as to be used as a basis for retroactive billing, retroactive billing must be limited to and adjusted for errors found as a result of any meter test and is not limited not to exceed twelve months.

3.3.3 The customer is responsible for all costs related to back-up metering beyond the existing Utility Metering Point for purposes of carrying out energy management practice including peak shaving, PF correction and Load Factor improvement.

3.3.4 For the purposes of carrying out independent metering as described above in 3.3.3, the customer needs to have independent measurement transformers. The use of Utility measuring transformers or provision of dual secondary core on the utility measurement transformers is not allowed.

4.0 OWNERSHIP AND RISK OF ELECTRICITY

Ownership and risk in Electricity passes to the customer at the Metering Point the Customer must:-

4.1 Practice high sense of responsibility related to Revenue Protection.

4.2 Refrain and safe guard against un-ethical practices that could jeopardise proper meter registration and cause high non-technical loss.

4.3 Realize that tampering or jeopardizing meter registration is liable with heavy penalty and consequential disconnection of Electricity supply for an indefinite period.

4.4 Be aware that revenue recovery due to non-technical loss shall be checked and computed for the entire term deemed necessary and based on the highest Load Factor during the term.

4.5 Note that the used metering system comprised of current and potential transformers, both primary as well as secondary sides, shall be used for the purposes of metering by Company only.

4.6 Notify the Utility immediately about any malfunctioning of the metering system if observed from the customer installed “back-up meter.”

4.7 Pay any Invoice within seven (7) days after notification; failure to do so will result in power disconnection with 48 hours notice.

4.8 Remember that any account not settled within thirty (30) days from the date of the invoice will have 2% interest over and above the commercial rate declared by Bank of Tanzania, applied and compounded monthly.

4.9 Realize that failure to pay any invoice will result in the Utility discontinuing the supply of Electricity to the customer in accordance with this Document and the customer may be subjected to disconnection.

4.10 Be aware that the Utility does not guarantee for an un-interruptible quality of Electricity supply to the Metering Point, and shall not bear any liquidated damages.

4.11 Install protective gadgets to safe guard sensitive equipment against injurious under or over Voltage and frequency. Utility does not accept any liquidated damages.

4.12 The customer may, on his/her cost, install any monitoring equipment after the Metering Point to assist in determining engineering functions like kW demand, power factor, and other indicating measurements.

4.13 The execution, delivery, and performance by Utility of services indicated in this Document does not and will not require any further consent or approval as the document has been duly authorised by the Regulator.

4.14 The Utility may discontinue the supply of Electricity to the customer without prior notice. Utility will notify the customer of its reasons for discontinuing the supply of Electricity immediately following the discontinuance.

4.15 The Utility will restore the supply of Electricity to the customer as soon as practicable after the customer has remedied the default and has paid the requisite disconnection and reconnection fee.

5.0 PRICE SCHEDULE

The customer must pay the Utility for Electricity supplied in accordance with this Document at the rates set out in the Pricing Schedule. The schedule is the present declared and enforced Tariff rate for Large Power User of Low Voltage Service T2 or Large Power User of Medium Voltage Service T3. The T2 or T3 tariff rate is liable to changes and the most recent one in use shall be applicable.

6.0 CUSTOMER'S WARRANTIES

The customer agrees and warrants to the Utility that the execution and performance of its obligations under this Power Supply Service Contract Agreement Document will not breach or result in the breach of any of the above statutory, contractual, or other obligation owed by it.

6.1 Having examined the general information and conditions as stated above for LPU power supply, we the undersigned, offer to abide with all conditions of this contract and in conformity with the said document.

LPU Customer	**Utility**
Customer Name:	Tanzania Electric Supply Co Ltd.
Company' Name:	Location: Umeme Park, Ubungo,
Location:	Dar Es Salaam,
P. O. Box:	P. O. Box: 9024
Region:	Region:
TANZANIA	TANZANIA
Attention:	Attention:
Phone:	Phone:
E – Mail:	E – Mail:
Facsimile:	Facsimile:
Signed for and on behalf of LPU by duly authorized representative.	Signed for and on behalf of Tanesco by duly authorized representative.

_____	**Tanzania Electric Supply Co. Ltd**
(LPU Company's Name)	_____
_____	**SIGNATURE**
SIGNATURE	_____

REQUEST FOR METER VERIFICATION TEST

Appendix 7.1-1

From	To
Regional Manager, P.O. Box: Region: Tanzania	Senior Manager (S & M), P.O. Box: Head Office, Dar Es Salaam, Tanzania

Ref/Meter Test A:

Date:

REQUEST FOR METER VERIFICATION TEST

The following meters are suspected to operate incorrectly beyond the normal meter error (± 2%) as per inspection report received from Senior Revenue Accountant /Billing Accountant/District Manager /Chief Internal auditor/ Regional Security officer /Meter Workshop Engineer of ...../...../20....., and we do hereby request Company Meter Workshop office to conduct thorough tests and re-calibrations of the same.

The meter numbers, consumers' names and account numbers are as follows:-

S/No.	Consumer Name	Meter Number	Account Number	GPS coordinates
1				
2				
3				
4				
5				
6				

Submitted for your further advice

REGIONAL MANAGER

c.c. Senior Zonal Manager

Appendix 7.1 -2

From

Senior Manager (S & M),

P.O. Box:

Head Office, Dar es Salaam

Tanzania

To

Regional Manager,

P.O. Box:

Region:

Tanzania

Ref/Meter Test B:

Date:

REQUEST FOR METER VERIFICATION TEST

Refer to your request for meter testing, letter Ref _____dated _____We would like to confirm that the meters suspected to be operating incorrectly beyond the normal meter error have been tested and re-calibrated accordingly at our meter workshop on date _____

Below are the final test results:

S/No.	Customer name	Meter Number	GPS Coordinates	% Error before Calibration	% Error after Calibration
1					
2					
3					
4					
5					

Submitted for information and further action

SENIOR MANAGER SALES AND MARKETING

Appendix 7.1 -3

To

Consumer Name & Address:
P.O. Box:
Region:
Tanzania

Ref/Meter Test 1

Date:

Dear Sir(s)/ Madame(s)

METER VERIFICATION TEST

PREMISES:

A/C No: Meter No:

Following the Company's suspicion that the meter at your premises is not recording accurately, we installed a test meter at your premises on date…….....

During inspection it was found that you have malpracticed with metering system by:…….

After testing the energy meter, it was found to have an error of ----------% slow.

The accuracy is not within the Company's tolerance limits of ± 2 %. Therefore, adjustment will be made to your electricity account/bills according to your previous consumption records and your test fee is refundable also inspection report shall be sent to you.

Yours faithfully,

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: MANAGING DIRECTOR

Appendix 7.1-4

To

Consumer Name & Address:
P.O. Box:
Region:
Tanzania

Ref/Meter Test 2

Date:

Dear Sir(s)/ Madame(s)

METER VERIFICATION TEST

PREMISES:

A/C No: Meter No:

Following your request for meter test that the meter at your premises is not recording accurately, we installed a test meter at your premises. After testing the energy meter, it was found that the Meter is -------%

The accuracy is within the Company's tolerance limits of ± 2 %. Therefore, no adjustment will be made to your electricity account/bills and your test fee shall not be refunded.

Yours faithfully,

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: MANAGING DIRECTOR

Appendix 7.1-5

To

Consumer Name & Address:
P.O. Box:
Region:
Tanzania

Ref/Meter Test 3

Date:

Dear Sir(s)/ Madame(s)

METER VERIFICATION TEST

PREMISES:

A/C No: Meter No:

Following your request for meter test that the meter at your premises is not recording accurately, we installed a test meter at your premises. After testing the energy meter it was found to have an error

of ___ % fast.

The accuracy is not within the Company's tolerance limits of ± 2 %. Therefore, adjustment will be made to your electricity account/bills according to your previous consumption records and your test fee is refundable also inspection report shall be sent to you.

Yours faithfully,

TANZANIA ELECTRIC SUPPLY COMPANY LIMITED

for: MANAGING DIRECTOR

Appendix 8.1-1

TARIFF 1 METER AUDIT SHEET

CLIENT
PHYSICAL AREA
TRANSFORMER NAME FEEDER:
GPS COORDINATES S: E:
REGION
ACCOUNT NO./CUST. REF
OUTSTANDING BALANCE
DATE

TOTAL INSTALLED LOAD		kVA	SINGLE PHASE:	THREE PHASE:
METER-MAKE				
METER-TYPE		Serial No.		
METER SIZE		A		
CONVENSIONAL METER		CIU No:		
KEYPAD METER				
E-CARD METER		GSM=	dB.	

Meter - Present Reading		Meter - prev. read.(H1)	No.days After H1	Consumption/day
Meter rgs/Cum. Import kWh =		Import kWh=		
Total unit/Cum. Export kWh =		Export kWh=		

VALUES OBSERVED

	Currents Observed		*FOR AMR 250A*	Voltage Measured	
Phases	Line/Primary Amps	Meter Display	CT Progra:		
Red			CT Observ:	Vr - Vy=	Vr - N=
Yellow			CT Ratio:	Vy - Vb=	Vy - N=
Blue			VT Ratio:	Vb - Vr=	Vb - N=

Is Meter time and actual time are the same? Yes: No: Ahead: Behind:	Instantaneous load			Values for calculation		Load Calculated		
	Inst. kW	Inst.kVA	Power Factor	Amps	Volts	Minimum P .F used	Total kVA	Total kW
						0.9		

Phase rotation		Clockwise direct.		Anti-clockwise direction
Test set results	kW		%	ACTUAL LOAD FOUND

TOKENS DOWNLOADED

1	
2	

ITEM	@Watt	Total
GRAND TOTAL (Watt)		

RECORD CONDITION OF INSTALLATION FOUND:

Meter box used?		Yes		No
Meter box locked and sealed?		Yes		No
Meter Location is Outside?		Yes		No
Position of Cut-outs (Fuses) is after Meter?		Yes		No
Physical appear. of Meter cover damaged?		Yes		No
Possibility of Removable Meter Bypass?		Yes		No
Sunrays affect meter display?		Yes		No
General Safety of Installation		Yes		No
Meter Tampered?		Yes		No

Physical appear. of Seals tampered at;	Meter box?		MeterTerm.Cover?		Meter Housing?	
	Yes.	No.	Yes.	No.	Yes.	No.
Seal No's						

Meter change required? Yes: ___ No: ___ Meter box to be replaced? Yes:____ No:_____

Cable Replacement Needed? Yes:_____ No:_____ Size of Cable Needed (mm^2) :_____ Length of Cable Needed (Meters):_____

Seal no's(on completion) at:	Meter box door		Meter Terminal Cover		Meter cover or Meter Housing	

REMARKS: SMSM/MLPU/PERP/2012Q00271

PARTICIPANTS ON THE EXERCISE
For TANESCO SIGNATURE
For Customer SIGNATURE
Customer's phone/E-mail:

Please look overleaf for Auditors comments if any!

LARGE POWER USERS AUDIT SHEET

TANESCO – Test Certificate

Electricity Meter Audit

CLIENT _____

TRADE _____

PHYSICAL AREA _____ FEEDER: _____

GPS COORDINATES S: _____ E: _____

REGION _____

ACCOUNT NO./CUST. REF _____

DATE

INSTALLED CAPACITY		kVA	TARIFF	**T2:**	**T3:**
METER-MAKE					
METER-TYPE			Serial No.		
WIRING SYSTEM					
3 PHASE 3 WIRE					
3 PHASE 4 WIRE					
CB Size		A			

Meter - Present Reading			**Meter - prev. read.(H1)**		No.days After H1	Consumption/day
Cum. Import kWh =	CT Ratio Prog. =		Import kWh=			
Cum. Export kWh =	VT Ratio Prog. =		Export kWh=			
Max Demand =	Date:	Time:	Max Demand=		Date:	Time:
Meter Downloaded	Billing?	Yes: No:	Profile?	Yes: No:	GSM=	dB.

Meter time and actual time are the same? Yes: No: Ahead: Behind:	**Instantaneous load**			**Values for calculation**		**Load Calculated**	
	Inst. kW	Inst.kVA	Power Factor	Av. Amps	AV. Volts	Total kVA	Total kW

CT/VT Verification						Min. Power factor used is 0.9	
Phases	**Currents Observed**		**CT Ratio test**			**Voltage Measured**	
	Line/Prim.	**Meter Displ.**	**Line/Prim.A**	**Sec.A**	**CT Ratio calc**		
Red						Vr - Vy=	Vr - N=
Yellow						Vy - Vb=	Vy - N=
Blue						Vb - Vr=	Vb - N=

Phase rotation		Clock		Anti-clock	Notes:
CT Polarity correct		Yes		No	
Record CT positioning		Correct		Incorrect	
Test set results	kW		%		
	kVA		%		

Data for Actual CT/VT Installed			
	CT Ratio=	VT ratio=	CT/VT exposed? Yes: No:
	Class=	Class=	CT/VT Sealed? Yes: No:
	Burden=	Burden=	Seal No's

RECORD CONDITION OF INSTALLATION FOUND: Notes:

Metering unit	Unprotected?	Sealed?	Locked?	Locked and Sealed?		Padlock prov. avail	Seal No:
	Yes: No:	Yes: No:	Yes: No:	Yes:	No:	Yes: No:	
For Tariff 3, is meter box used?		Yes		No			
For Tariff 2, is Lv cabined used?		Yes		No			
Amr Lv cabinet or meter box?		Yes		No			

Meter box/Lv cabinet locked?		Yes		No			
Meter box/Lv cabinet sealed?		Yes		No			
Are Seals tampered at;	Meter box or Meter cabinet?		Meter Terminal Cover?		Meter cover or Meter Housing?		TTB?
	Yes.	No.	Yes.	No.	Yes.	No.	Yes. No.
Seal No's							
Sunrays affects meter display?		Yes		No			
Meter box/cab.Vermon Proof?		Yes		No			
Rusted?		Yes		No			
Wiring correct?		Yes		No			
Wiring to standard?		Yes		No			
General Safety of Installation		Accept		Not			
Metering System Tampered?		Yes		No			
Meter status downloaded?		Yes		No			
Meter-change required?		Yes		No			
Meterbox/cabinet to be replaced?		Yes		No			
Seal no's(on completion) at:	Meter box or Lv cabinet door		Meter Terminal Cover		Meter cover or Meter Housing		TTB

REMARKS:

PARTICIPANTS ON THE EXERCISE

For TANESCO _____ SIGNATURE _____

For Customer _____ SIGNATURE

Customer's phone/E-mail: ***Please look overleaf for Auditors comments***