



TENDER NO KP1/9AA-2/PT/16/13-14

**FOR THE DESIGN, MANUFACTURE, SUPPLY, CONSTRUCTION INSTALLATION,
TESTING AND COMMISSIONING OF SWITCHED POLE MOUNTED REACTIVE
POWER COMPENSATORS FOR NAIROBI REGION
TECHNICAL SPECIFICATIONS AND DRAWINGS**

MAY, 2014

**ALL TENDERERS ARE ADVISED TO READ CAREFULLY THIS TENDER DOCUMENT
IN ITS ENTIRETY BEFORE MAKING ANY BID**

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SECTION 1: ELECTRICAL WORK AND EQUIPMENT

GENERAL SPECIFICATIONS

1. General

The scope of work, data sheets, special and general specifications constitute the complete technical specifications and must be read as a whole.

If more than one contractor contributes to the completion of the plant each contractor is obliged to cooperate, adapt solutions and exchange information so that the plant forms functional and optimized entirety.

2. Document Priority

If in conflict, the ranking of documents in the technical specifications, in decreasing priority, is as follows:

1. Scope of Works
2. Particular technical specifications
3. Project Specific Design Data
4. General technical specifications
5. General specifications
6. Standards

In the event of any difference between the Drawings and the Specifications, the latter shall prevail. In the event of any difference between scaled dimensions and figures on the drawings, the figures shall prevail.

If the Bidder is of the opinion that there is conflict or disagreement between the particulars of the documents, standards etc., this must be clearly stated in the Bid, failing which, the materials and equipment offered shall be deemed to comply in every respect with the current Specification both in manufacture and in performance, and compliance thereof shall be insisted upon without additional cost to the Employer.

3. Completeness of Contract

- 1.3.1 All apparatus, accessories or fittings which may not have been specifically mentioned, but which are usual or necessary in the respective equipment for the completeness of the finished work in an operable status, shall be deemed to be included in the Contract and shall be provided by the Contractor without any extra charge. All equipment shall be complete in all details, whether or not such details are mentioned in the Specifications. This includes fixation details and connection clamps and/or terminals.

- 1.3.2 All materials and skilled labour, whether of temporary or permanent nature, required by the Contractor for the design, manufacture, erection and testing at site of the equipment shall be supplied and paid for by the Contractor. All computer equipment shall be delivered with all software and licenses necessary to achieve the specified functionality as well as the software necessary for programming, testing, service and maintenance through the lifetime of the equipment.
- 1.3.3 Any reference in the quantity and price schedules, the delivery period schedule or in the various clauses and schedules of the text of either the Specification or the Bid, to any equipment shall imply equipment that is complete with all accessories, apparatus and fittings as outlined in sub clause 1.3.1 and 1.3.2 above.

The Bidder shall be responsible for ensuring that the equipment supplied is fit for the purpose intended. Available information on the characteristics of the system, to which the works will be connected and associated, will be supplied on request to the Bidder who shall be responsible for obtaining and determining all applicable knowledge relevant to the works.

4. Space Requirement

The Bidder shall check the dimensions of rooms and outdoor plots where electrical equipment is proposed to be erected. The rooms and plots must accommodate the equipment as well as having workspace for operators and maintenance personnel.

The Bidder shall in his bid present arrangement drawings showing how he intends to adapt the equipment to the space available. If the space is not sufficient the Bidder shall indicate necessary enlargements; failing to do so the Bidder must bear the cost of later modifications of the facilities.

5. Documentation and Drawings

5.1 General

Contractor's obligations with regard to preparation and submission of drawings, calculations, samples, patterns, models, etc. are stated in the Conditions of Contract.

The Contractor shall prepare and submit to the Project Manager for approval dimensioned general and detailed design drawings and other pertinent information of all the Plant and equipment specified in the Bid Documents. Unless otherwise agreed the information shall be exchanged on paper.

Approval of drawings shall not relieve the Contractor of his obligations to supply the Plant in accordance with the Specifications. The Contractor is responsible for any errors that may appear in the approved documents. He shall as soon as an error has been detected, deliver the corrected documents to the Project Manager for re-approval.

If the plant is to be connected to existing equipment the connection shall be documented in a coherent and overlapping way at least containing terminal identification in old

equipment. Schematic diagrams shall contain complete loops within new and old equipment.

All text on documents provided by the Contractor shall be in the English language in addition, if necessary, to that of the country of origin. All drawings shall be dimensioned in millimeter.

The Contractor shall, during the total project time, maintain a List of Documentation to be updated by him whenever needed. The List of Documentation shall include the date of original issue of each document submitted as well as the dates of every revision. The List of Documentation shall also include a time schedule for the submittal of the documentation.

Symbols used for electrical equipment shall be in accordance with IEC 60617. The Contractor shall establish a coherent system for physical and functional reference designation in accordance with IEC61346. A similar systematic scheme shall be defined for cable numeration. These schemes shall be used throughout on the drawings and documentation and the designation shall be labeled on the components and cables.

In addition to what is stated in Conditions of Contract, the following shall apply:

- The sizes of all documents and drawings shall conform to the ISO standard, i.e.:

A1	594mm x 841mm	A2	420mm x 594mm
A3	297mm x 420mm	A4	210mm x 297mm
- Sizes larger than A1 shall be avoided. The schematic diagrams and, apparatus and cable lists shall be of size of A4 except for one original and possible transparency copies of schematic diagrams that shall be in A3. Scales to be used on the drawings shall be 1:10, 1:20, 1:40, 1:50 and multiples of this series.
- All drawings made special for this project including civil works drawings, mechanical drawings, layout drawings and circuit diagrams shall be compiled on a computer aided drawing system and as part of the as built documentation be handed over on a CD with a format readable in AutoCAD version 14 or another format to be agreed upon in addition to the paper copies.
- All drawings shall be bound in hard covers.

5.2 Bid Drawings

The Employer's drawings attached to the Bid Documents are of informative character. These drawings are intended to illustrate the basic requirements to be satisfied. It is the responsibility of the Contractor to prepare a detailed layout showing the manner in which the various items of equipment offered can be accommodated to best advantage within the available area.

The Contractor is at liberty to offer arrangements based on significantly different principles where it is considered that these offer economic or technical advantages. **It is emphasized, however, that the main Bid should comply with the principles shown in the enclosed drawings, other arrangements being submitted solely as alternatives to the main offer.**

Significant changes in the layouts caused by the Employer may warrant price adjustments. However, no adjustments will be applied for minor changes due to incorporation of the Contractor's equipment.

The Bidder shall in his Bid enclose overall drawings showing dimensions, main working principles, and internal components and fixing methods to a detail level allowing the Employer to evaluate the functionality and completeness of the plant and equipment.

The following specific drawings shall be enclosed with the Bid:

- Single Line Diagram for each plant
- Layout proposals for each plant
- Proposal for arrangement of the apparatus and machinery
- Topological drawings of the Control System

5.3 Progress Plans

The Progress Plans shall at least contain the following milestones:

- Essential information delivered from Employer
- Documentation for approval from Contractor to Employer
- Release of factory documentation
- Factory Tests
- Shipment
- Site ready for erection
- Start erection
- Ready for pre-commissioning
- Ready for commissioning
- Test run
- Taking over
- Submittal of final documentation

5.4 Exchange of Interface Information

The Contractors shall in due time supply interface information to other sub-contractors where needed. The Contractor is in particular required to check that all foundations and fixations of his equipment are sufficiently dimensioned to meet the forces acting upon it. If the Contractor feels that he lacks such information from other contractors he is obliged to request such from the Project Manager. The Contractor cannot claim liability exemption for his own contractual responsibilities because of actions performed or omitted by other sub-contractors.

5.6 Final Documentation

The Contractor shall supply final **“as built” documentation** taking into account all changes done under erection and commissioning (within 6 months of completion of the work and within the reliability period).

The Contractor shall also deliver manuals for operation and maintenance (within the period stated above). These shall at least contain the following information:

- Detailed description of the equipment, the individual components, relevant clearances, tolerances, allowable temperatures, settings etc.
- Descriptions of main principles including flow diagrams, single line diagrams, circuit diagram, connection diagram, cable schedules, software documentation etc.
- Operational instruction. These shall illustrate the operational sequences in a clear and concise way.
- Test and adjustment procedures containing instruction for test and adjustment of the equipment under operation, after inspection and maintenance
- Test reports
- Spare part lists
- Maintenance instructions split into:
 - o Manuals for preventive maintenance indicating periodic inspections, cleaning, lubrication and other routine maintenance.
 - o Repair manuals describing fault location, dismantling, re-assembly etc.

The documentation shall leave the operators and maintenance personnel in position to operate the plant in a safe and optimal way and to perform repairs usual to be done by such personnel. The Project Manager shall approve the manuals before final submission.

6. Contractor's Quality Assurance Procedures

The Contractor shall have established a quality assurance system based on ISO 9001 also covering sub-contractors. The Bidder shall include in the Bid a documentation of the system with a list of current procedures, an organization-chart of the quality organization and the name of the quality manager. He shall also submit a list of quality revisions performed in the last twelve months with a list of closed and unclosed findings as well as planned revisions during the coming twelve months as well as a list of findings. The documentation shall give special emphases on how subcontracts are included in the quality assurance system. The Employer shall be entitled to perform quality revision at the Contractor or any subcontractor with two weeks' notice.

7. Guarantees and Particulars

The Works shall comply with the **Technical Guarantee Data** stated in the Bid. The Contractor shall be responsible for any discrepancies, errors and omissions in the particulars and guarantees.

8. Manufacturing and Shipment

8.1 Places of Manufacture and Sub-Contractors

All equipment offered should be the product of recognized and experienced manufacturers and shall be of basic design and size similar to such that has been in successful continuous operation for at least three years preferably under similar climatic conditions. Proven plant

reliability and high availability are of prime importance and the attention of the Bidder is drawn to these particular requirements.

The manufacturer's identity and places of manufacture, testing and inspection before shipment for the various portions of the Contract Works shall be specified in the Technical Schedules and shall not be departed from without the agreement of the Project Manager.

As soon as practicable after entering into the Contract, the Contractor shall, having obtained the Project Manager's consent in accordance with the Conditions of Contract, enter into the Sub-contracts he considers necessary for the satisfactory completion of the Contract Works.

All Sub-contractors and Sub-suppliers of components and materials shall be subject to the approval of the Project Manager. Information shall be given on each Sub-order sufficient to identify the material or equipment to which the sub-order relates, **stating that the material is subject to inspection by the Project Manager before dispatch.**

If the Employer at any stage in the design and production period finds out that the sub-contractors do not fulfill the requirements in the specifications and it is obvious that the required quality cannot be achieved by corrective measure he can request the subcontract to be suspended and the works to be produced elsewhere without extra cost for the Employer.

8.2 Inspection and Testing

The Contractor shall submit for approval a program of quality control and inspection procedures to assure that the product during manufacture and on completion comply with the specified requirements. The program shall relate the quality control and inspection activities to the production cycle. The Contractor shall provide details of quality control and inspection procedures used. The Contractor shall retain responsibility for quality control and inspection activities made by his sub-contractors and shall indicate on the program, which items are to be sub-contracted and how they are to be inspected and tested both **at subcontractor's works and by Contractor's acceptance control.**

All materials used in the Contract Works are subject to inspection by the Project Manager and it is the Contractor's responsibility to advise the Project Manager when equipment and materials are available for inspection, **at least one month in advance.** Factory tests on equipment shall be made according to the applicable IEC Standards, or as specifically specified or **according to standards approved by the Project Manager.** Routine tests shall be made on each unit of all equipment.

Type tests shall be made on one unit of each type of different equipment. Instead of carrying out the type tests the Contractor may submit suitable certificates of tests made on equipment of the same type; however, the Purchaser reserves the right of accepting these certificates or to reject them partially or totally.

On complex systems the Bidder shall propose factory acceptance tests (FAT) to be performed.

The Project Manager shall be at liberty to demand any additional testing at the manufacturer's works, at site or elsewhere in order to verify that the equipment complies with the conditions of the Specifications.

A test program shall be submitted to the Project Manager for approval at least one month ahead of the commencement of testing. The program shall include tests to be performed at sub contractor's works.

Measuring apparatus shall be approved by the Project Manager and if required shall be calibrated at the **expense of the Contractor** at an approved laboratory.

8.3 Packing, Transportation and Storage

The Supplier shall provide such packing of the Goods as is required to prevent their damage or deterioration during transit and temporary storage up to their final destination as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling and exposure to extreme temperatures, salt and precipitation. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the Goods' final destination and the absence of heavy handling facilities at all points in transit. Indoor electrical equipment must be enclosed in welded polythene envelopes inside packing cases and the envelopes shall be evacuated or have a desiccant inside.

The following information must be clearly stenciled or printed on each packing case, crate, cask, drum, bundle or loose piece, care being taken that the number and other particulars on each package agree with those entered in the packing list accompanying the Invoice:

- Employer's Identity
- Supplier's Identity
- Destination
- Contract No.
- Package No.
- Item Code
- Weight, dimensions
- Sub-Project (Plant Identity).

The marking shall be durable. The marking shall be upon the body of the package. Marking upon a batten fastened on the case, etc. shall not be used.

In the case of bags, bundles and loose pieces, the shapes of which do not permit the marks to be put on the actual package, each bag, bundle or loose piece shall have two metal labels each with two holes, securely fastened by independent wires. Each label shall be die-stamped with the above particulars.

Goods belonging to different plants shall not be mixed, but kept in separate packing cases, bundles or similar.

The Contractor shall be responsible for all transportation; from works to port of shipment and onwards to port of unloading, as well as all handling and transport to sites and handling on site.

9. Erection, Installation and Commissioning

9.1 Storage at Site

The Contractor shall be responsible for proper storage of equipment when delivered at the different sites until taking over. Care shall be taken to assure adequate storage to avoid damage to equipment due to rain or strong sunshine. The responsibility also covers security measures against theft and vandalism.

9.2 Work on Live Lines

If work is to be done on lines in operation the following factors are of paramount importance:

- (i) Minimization of outage time
- (ii) Adaptation to operational constraints.

All work must be planned with this in mind. The Contractor must obey to all instructions and safety rules given by the Government and the Employer and must strictly follow all instructions from the Employer's supervisory personnel. The Contractor shall appoint his Project Manager/Technician who will be authorized to receive work permits at the work sites as required by safety rules. All outages shall be discussed with the Employer and the Project Manager at **least two weeks before the outage is required**. The Contractor will normally only be allowed to have only one high voltage circuit out of operation at a time. No work must start before Employer's site manager has authorized the work, established the required earthing and marked the safe area. All switching on live parts shall be done by the Employer. In the rare cases where more than one circuit have to be taken out of operation the Contractor must be prepared to do the work during nights or at off-peak time. The Contractor and his personnel must respect the physical constraints as well as constraints for scheduling set by these circumstances. However, the Employer will co-operate in making the work conditions and the scheduling as efficient as possible for the Contractor and keep a responsible person with switching authority at site during all working hours (including night time).

If physical constraints make it necessary to replace cabinets needed for operation, the Contractor must as far as possible erect and connect the new cabinets temporarily adjacent to the one in operation. A quick disconnection and removal of the old cabinets can then be performed and the new cabinets pulled in with most of its cables already fitted. Location of new cabinets shall be approved by the Project Manager and a proposal for such shall be given by the Contractor one month prior to erection.

9.3 Erection, Testing at Site, Commissioning

The Contractor shall carry out erection, testing at site and commissioning of the Plants specified in the Specifications. All work, methods of work and workmanship, whether fully specified herein or not, shall be of the highest order in all respect; the generally accepted requirements and commonly recognized good practice for first-class work of the nature are to be adhered to.

The Contractor shall provide all staff, such as engineers, supervisory staff, skilled and unskilled labor necessary to carry out and complete the Contract Works on schedule as specified. Information regarding site staff shall be shown in the relevant Schedule.

The Contractor shall provide all vehicles, erection, tools and equipment necessary to carry out the Contract Works, including personnel transport. At the completion of the Contract, the Employer reserves the right, at his discretion, to take over vehicles, any tools, special tools, test equipment and other construction equipment used by the Contractor in connection with the Contract, at depreciated prices to be mutually agreed upon at that time.

Testing at site shall be carried out by experienced test engineers. Functional tests shall be inherent in all test procedures. The Contractor shall record the test results in an approved form in such a manner that the test reports can be used as the basis for future maintenance tests. **Test methods and equipment shall be noted on the test sheets.**

A complete test report in 4 sets shall be handed over to the Project Manager not later than one month after the Plant being commissioned. The test engineers shall at site keep a complete record of correction made during testing and one set of corrected drawings shall be kept at site after commissioning and one set handed over to the Project Manager.

Commissioning shall be carried out by the Contractor in the presence of the Employer's engineers and the Project Manager. The Contractor shall prior to commissioning **draw up a detailed commissioning schedule for approval** showing the sequence to follow step by step in all connections, including control of phase sequence and other pertinent factors. Switching of energized components will be performed by the Employer.

9.4 Accommodation of Contractor's Personnel

The Contractor shall make his own full provision for temporary accommodation of own and sub-contractor's employees to suit their requirements.

9.5 Health, environment and safety

The Contractor shall follow all local rules and regulations related to workers' safety and health as well as regarding protection of the environment.

The Contractor is responsible for employing a health worker to inform the workforce and affected villages about the increased health risks, especially HIV/AIDS.

The Contractor is also responsible for equipping all his workers with necessary safety equipment as helmets, eye protection glasses and safety belts and enforces the use of such.

No toxic material (such as Halon, PCB and Asbestos) shall be utilized neither during construction nor under operation and maintenance.

The Contractor shall at all times during the course of work prevent accumulation of debris caused by the work. He shall also remove all debris and temporary structures when finishing the work. The Contractor shall also be responsible for removal of old equipment and cables. All surplus material should be disposed in an environmental satisfying way. Particular attention should be given to safe disposal of environmentally hazardous substances such as battery acid, transformer oil and capacitors. Workable equipment shall be handed over to the Employer.

10. Time of Delivery and Completion

The Implementation Schedule shown in the Bid Documents shows the completion of the project of which the equipment forms an integral part. The equipment must thus be delivered and erected in accordance with this schedule.

The guaranteed completion and delivery times shall be stated in the Bid and the guarantee therein signed by the Bidder. In addition the Bidder shall submit an erection program and estimate the necessary man-weeks for erection, alternatively erection supervision, testing and commissioning.

11. On the Job Training

The Employer shall be allowed to take part in erection, pre-commissioning and commissioning thus taking part in a transfer of knowledge scheme. Before the erection starts, the Contractor shall arrange a one-day course in understanding of the Contractors documentation and reference system.

The contractor shall also demonstrate to the operators all the operations of the substation before the tests run of the station.

12. Tools

The Supplier shall supply in lockable boxes, for the Employer's use, any special tools that may be required for assembly, dismantling adjustments and maintenance of the equipment. The tools shall be unused and in new condition at the time of handover. Suitable special spanners shall be **provided for bolts and nuts, which are not properly accessible by means of an ordinary spanner.**

13. Spare Parts

Spare parts supplied under the contract shall be packed and preserved for long time storage.

PROJECT SPECIFIC DATA

1. Definitions

Whenever the following terms or words are found in the specifications and/or other documents, they shall have the following meaning:

1.1 "Medium Voltage Equipment" (MV):

Equipment provided for a maximum operating voltage higher than 1000 V and up to 52.5 kV.

"Low Voltage Equipment" (LV):

Equipment provided for operation at 1000 V or below. (For transformers the term Low Voltage Winding is used for the side with lowest rated voltage regardless value)

AC means Alternating Current, DC means Direct Current, where protection degree IP xx is mentioned it shall generally be according to IEC 60529 "Degree of Protection Provided by Enclosure".

2. Design Data, Medium and low Voltage

2.1 The rating and design criteria for MV plant and equipment shall be as follows:

Table 1.1: Design Data Medium Voltage

Item	Parameters		SYSTEM VOLTAGE
	Equipment rated voltage		12kV
1	System		50 Hz, 3 phase
2	Neutral point earthing		Solid earthed
3	Nominal voltage of networks		11kV
4	Highest system voltage as defined by IEC-60871		12KV
5	Power Ratings		300kVAr
			600KVA
6	External Insulation	1.2/50us dry	95kV peak
		50Hz wet(60s)	38kV peak
7	Bushings		Porcelain to IEC standards
8	Creepage distance (minimum)		300mm
9	Discharge resistors		Built-in
10	Safety requirements		Discharge devices- Maximum discharged to 75kV:10min as per IEC 60871
11			Container Connections-Bolt connections at least M10 as per IEC 60871
12	Losses		≤0.15W/kVAR including resistors
13	Overload		Maximum permissible (long duration voltages and switching over voltages) and maximum permissible current as per IEC 60871
14	Surge Arrestors		At least class 2, nominal discharge current of 10kA pk (8/20uS) and to IEC 60099-4.

2.2 Design Data, Low Voltage Equipment

Low voltage installation shall be in accordance with EMC directives. The rating and design criteria for low voltage equipment shall be as follows:

Table 1.2: Design Data, Low Voltage Equipment

AC Voltage	
Nominal system voltage	415/240 V -15%, +10% (+ or – 6%), TN - CS
System frequency	50 Hz (+ or – 2%)
DC System	110 V, & (48V for communication)
Power frequency Test Voltage 1 min	2.5 kV
Thermal rating of conductors	120 % of load
Max short-circuit Current	31.5 kA (3 sec)

AC LV equipment can, after the Project Manager's approval, be rated for lower short-circuit current if calculation demonstrates that lower values are applicable at the place of installation. DC equipment shall be adapted to the actual values at sites as shown in calculations.

2.3 Phase Relationship

The phase relations and designations shall be in accordance with the existing system of the Employer. The phase sequences will be made known to the Contractor at a later date, but not later than 1 month from date of commencement. The standard phase colours are Red, Yellow, and Blue (RYB).

2.4 Colour Coding

All wires must have ferrules at all terminations to distinguish each signal. In addition the wires shall have the following colours:

Circuit	Colour of Wire
Voltage transformers	<i>Red, Yellow, Blue, black</i>
Current transformers	<i>Black</i>
A.C. Circuit	<i>red ,yellow, blue, black</i>
D.C. Circuit	<i>grey</i>
Grounding circuit	<i>Green with yellow stripe</i>

(Following coloured ferrules shall be provided on each wire in order to identify phase and polarity).

	Phase and Polarity	Colour of ferrules
A.C.	First phase	Red
	Second phase	Yellow
	Third phase	Blue
	Neutral	Black
	Grounded	Green with yellow stripe

Auxiliary DC Supply

Positive
Negative

Red
Black

Ferruling system should be submitted to the Employer for approval before commencement of works.

2.5 Environment

Unless otherwise specifically stated in Particular Technical Specifications or Scope of Works, any equipment, component and assembly shall be designed for the following service conditions:

Table 1.3: Service Conditions

Sr. No.	Particulars	Specified value
1.	Max. ambient air temperature	40°C
2.	Min. ambient air temperature	- 1°C
3.	Average Daily Max. Ambient temperature	30°C
4.	Max. altitude above mean sea level (Meters)	2200 m
5.	Seismic level (Horizontal acceleration)	0.3g
6.	Relative Humidity (% age)	>95%
7.	Avg. No. of Rainy days/year	120
8.	Avg. annual rainfall	900mm
10.	Wind pressure on project areas of conductors & cylindrical objects	383-430 N/mm ²
11.	Maximum wind pressure on steel members of 1.5 times projected area	820 N/mm ²
12.	Isokeraunic level (days/year)	180 days/year
13.	Moderately hot and humid tropical climate conducive to rust and fungus growth	

Wherever any of these maximum or 24 hour average temperatures exceed the normal service condition temperatures of the IEC Recommendations for the relevant equipment, or of such other standard which is approved to be applied, the permissible temperature rises of the IEC Recommendations or the standard shall be reduced by the same amount as the difference between the above figures and the normal service condition temperatures. The Contractor shall guarantee these reduced temperature rises.

All air cooled equipment shall be cooled with convection (i.e. without fans) provided other cooling methods are not explicitly allowed for in the specifications.

2.6 Noise

The equipment shall as far as possible not generate undue vibrations or bothersome noise. Provided nothing else is specified the following requirements shall not be exceeded:

- Machine hall, workshop etc. (one meter from the machine) - max 85 dB(A)
- Office, control room, day room etc. -max 55 dB(A)
- Emergency diesel generator (7 meter from engine room) -max 85 dB(A)

2.7 Operation and Control

The operations, control procedures, monitoring and protective devices for the plants are described in Particular Technical Specifications.

The Contractor shall take all measures and furnish all requirements necessary for affecting the intended method of operation and control.

2.8 Interface between Contractors and towards Employer

For substations to be extended, all connections shall be made and all equipment and drawings be provided by the Contractor to ensure proper operation of the complete plants.

The Contractor shall pay special attention to the Power Transformers. All necessary equipment and connections required to form a complete working plant and not mentioned under the Power transformer shall be included in the switchgear contract whether or not specifically mentioned in these Particular Technical Specifications.

The Contractor shall supply and execute all cable connections between the control room and the transformer marshalling boxes and cabinets as well as supply all AC power for motors and DC voltage for control, indication and alarm purpose. The Contractor shall also provide all necessary connections to the control system from other sources like voltage and current transformer terminals, etc.

All the control cables laid in panels and trenches shall be armored cables that will allow the glanding of the cables at the panels.

PARTICULAR TECHNICAL SPECIFICATIONS

FOREWORD

The specifications in this document have been prepared and it lay down requirements for the following equipment.

- Capacitors(12KV)
- Surge arrester (12kV)
- Voltage transformer (12KV)
- Isolators (12kV)
- Current Transformers (15VA minimum)
- Vacuum switch(12kV)

The above equipments are intended for use in the pole mounted reactive power compensation project for the following feeders:

Table1.4 Proposed Reactive Power Compensation

Feeder Name	Nominal Voltage level(kV)	Switched (KVAR)
General Motors	11	900
Dam	11	900
South B	11	900
Industrial	11	900
Westlands	11	900
Kahawa	11	600
Sukari	11	600
Buru Buru	11	1200
Harambee	11	900
1 st Avenue	11	1200

The specifications stipulate the minimum requirements for equipment acceptable for use in the company and it shall be the responsibility of the contractor/manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the equipment for the KPLC.

Compliance by the supplier with the provisions of the specification does not relieve him of his responsibility to furnish equipment and accessories of suitable and safe design to meet the specified service conditions, and requirements of the international standards. The manufacturer shall submit information, which confirms satisfactory service experience with products which fall within the scope of this specification.

For each item, full technical details and design drawings shall be submitted to KPLC for approval before manufacture.

Prior to the manufacture of the items on order, KPLC reserves the right to inspect the manufacturing facility and the quality management system at no extra cost. It is the responsibility of the supplier to confirm if this right is to be exercised. Such visit/inspection shall in no way prejudice the purchaser's rights and privileges.

Upon completion of the manufacturing process, KPLC reserves the right to send two Engineers to inspect the items on order at the place of manufacture where inspection and acceptance tests shall be carried out in their presence. Tests shall be done in accordance with the test standard specified and the Technical Specification for each item. It is the responsibility of the supplier to confirm if this right is to be exercised.

Test Reports shall be completed for each item and made available to KPLC **for approval before packaging and shipment of the materials.** No material or equipment shall be shipped /delivered without written approval from KPLC.

PARTICULAR EQUIPMENT SPECIFICATION

A. CAPACITORS

- 1. SCOPE**
- 2. REFERENCES**
- 3. TERMS AND DEFINITIONS**
- 4. REQUIREMENTS**
- 5. TESTS AND INSPECTION**
- 6. MARKING**
- 7. ADDITIONAL REQUIREMENTS**
- 8. DOCUMENTATION**

ANNEX A: SPECIFIC VAR REQUIREMENTS AND TECHNICAL DATA

1. SCOPE

This specification covers the electrical characteristics and mechanical features of three-phase, 50 Hertz, self-contained, metal enclosed multi-step capacitor bank, to be installed pole mounted. The application of the units is for voltage improvement.

This specification describes the minimum requirements for the design, manufacture, factory testing, marking, packing, shipping, transportation to site, installation, site testing and commissioning of 12kV capacitor banks to be installed pole mounted on the following feeders: General motors, Dam, South 'B', Industrial, Westlands, Kahawa, Sukari, Buru Buru, Harambee and 1st Avenue.

2. REFERENCES

The capacitor banks, the entire package, design and installation shall comply with the following standards.

- IEC 60871: 1&2 Shunt capacitors for a.c. power systems having a rated voltage above 1000V
- IEC 60871-4 Shunt capacitors for a.c. power systems having a rated voltage above 1000V-Internal fuses
- IEC 60137 Bushings for Alternating Voltage above 1000V
- IEC 60867 Insulating liquids-specification for unused liquids based on Synthetic aromatic hydrocarbons
- ANSI C 37.66 Requirements for capacitor switches for alternating current systems
- IEC 60044-1: Standard Specification for Instrument Transformers: Current Transformers
- IEC 60289: Standard Specification for Reactors
- ANSI/IEEE C37.99: Guide for Protection of Shunt Capacitor Bank.
- NEMA 107-1993: Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.
- BS 4: Structural steel sections
- ASTM B308/B308M-10: Standard specification for Aluminium Alloy 6061-T6 – Standard Structural Profiles
- IEC 60870-5-101: Transmission Protocols, companion standards especially for basic tele-control tasks
- IEC 61850: Standard Specification for Power Utility Automation
- IEC 60529: Degrees of protection provided by enclosures (IP Code) ISO 1000: The International systems Units (SI) and its Application
- ISO 1111: ISO Metric Hexagon Commercial Bolts and Screws
- ISO 1112: ISO Metric Hexagon Nut, Including Thin Nuts, Slotted Nut and Castle Nuts
- IEE: Recommendations for the Electrical and Electronic Equipment of Mobile and fixed offshore installations
- BS 142: Electrical protection relays
- BS 381 C: Colour Standards for General Purpose

3. TERMS AND DEFINITIONS

The definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1 SERVICE CONDITIONS

4.1.1 The capacitor banks shall be suitable for continuous operation outdoors in tropical areas at altitudes of up to 2200m above sea level, humidity of up to 90%, average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C, and annual mean isokeraunic level of up to 180 thunderstorm days.

4.1.2 The capacitors shall be suitable for installation as a bank on a three phase 11kV pole mounted, frequency 50Hz. The highest system voltage is 12 kV.

The neutral of the 11 kV systems is earthed at the power transformer.

4.2 GENERAL REQUIREMENTS

4.2.1 Design and Construction Requirements

The capacitor banks shall be connected/ installed pole mounted as specified.

The equipment shall be suitable for use in tropical climatic conditions and shall be capable of operating at its full ratings in service conditions as specified in clause 4.1.

The capacitor banks shall be factory pre-assembled as far as possible to minimize work required at site.

The 12kV capacitor banks offered shall be complete in all aspects necessary for their effective and trouble free operation when connected to the system.

The capacitor bank shall not require periodic inspection. Maintenance such as replacement of failed capacitor units shall be done as required, but major maintenance intervals should not be less than 15 years.

The capacitor Bank control system complete with alarms and indications shall be provided.

4.2.2 Capacitor Banks

4.2.2.1 General

The equipment shall be factory assembled and tested prior to shipment and shall comprise:

Incoming Section with provisions for:

- Incoming line lugs

- Disconnect switch
- Surge arrestors
- Voltage transformers
- Current transformers

Capacitor Section with provisions for:

- Vacuum Switches – 3 phase vacuum switches per switched stage
- Series detuning reactors

Control Section:

- Capacitor Control Relay/Controller
- Relays

The 12kV Capacitor banks shall be pole mounted and shall include, but not limited to:

- Capacitor units (capacitor elements in series connection)
- Capacitor elements internal fuse.
- Capacitor elements internal discharge resistors
- Surge arrestors
- Current Transformers
- Protection equipment
- Inter-locking
- Cable termination compartments
- Terminal connectors and
- Other hardware and accessories required for complete functional installation.

The capacitor bank shall comprise of nominal MVAR values per feeder as follows:

Table 1.5: Nominal VAR Rating per substation

Feeder Name	Nominal Voltage level(kV)	Switched (KVAR)	Comment
General Motors	11	900	CAPACITOR
Dam	11	900	CAPACITOR
South B	11	900	CAPACITOR
Industrial	11	900	CAPACITOR
Westlands	11	900	CAPACITOR

Kahawa	11	600	CAPACITOR
Sukari	11	600	CAPACITOR
Buru Buru	11	1200	CAPACITOR
Harambee	11	900	CAPACITOR
1 st Avenue	11	1200	CAPACITOR

The banks will operate with automatically / manually **switched steps** not exceeding 3MVar each for all feeders.

The capacitor bank shall comprise the following:

4.2.2.1.1 Enclosure

a. General

The arrangement of the enclosure and its equipment shall be such as to provide easy access for replacement of the equipment units and safety of operating staff shall be ensured.

b. Rack Assemblies for Pole Mounting

Racks and pole mount frames shall be constructed with light-weight ASTM B308/B308M-10, 6061-T6 structural aluminum and shall include the following design features:

Assemblies shall be free-standing such that the bottom surfaces of capacitor cans mounted in racks do not touch the ground during shipping & storage.

Four equally spaced lifting eyes shall be provided such that rack assemblies can be evenly lifted in place.

Pole mount frames shall be designed with 18 inch pole-bolt spacing for mounting on round wooden or concrete poles and shall not require pole (sway) braces or pole bands for standard mounting conditions.

Standard pole mount racks shall be designed and pre-drilled for future additions of accessories including single/double-pole switches, junction box assemblies, control power transformers and lightning arresters etc.

An oxide inhibitor shall be applied between the capacitor mounting rack and related pole mount frame and shall also be applied between the rack (or frame) and related ground terminal assembly.

Capacitors shall be mounted in racks capable of holding three, six, nine or twelve units with 8 inch spacing between unit centerlines with a minimum of:

- 9 inch spacing for 95 kV-BIL and;

- 14.5" spacing for 125 / 150 kV-BIL - between unit centerlines in adjacent phases.

All high voltage connections shall be made using #4AWG (25mm²) copper wire (either stranded or solid), including 5 kV cable insulation.

Wiring between capacitor terminals and the rack (for grounded wye applications) is to consist of bare #4 AWG (25mm²) solid copper wire.

Wild-life protectors (bird caps) shall be used over all bushing terminals.

Disconnect Switch: This shall include a suitably rated, load break disconnect switch for isolation/ servicing of the capacitor bank. Disconnect switch shall utilize direct drive handle. Chain drive will not be acceptable.

Voltage Transformer: three, single phase 11000/√3:110/√3 Volt, voltage transformer shall be provided for 110 V ac control and voltage for the power factor controller. The VT will have two outputs.

c. **Capacitor Section**

Capacitor Units:

General

The capacitor units shall consist of:

- Capacitor elements
- Internal fuses
- Discharge resistor
- Stainless steel container with two bushings

A common and interchangeable design of capacitor unit shall be used for all banks. The bidder shall provide supportive calculations to confirm that the internal ambient temperature will not exceed the maximum operating temperature of the capacitor unit.

Each capacitor unit shall be designed to meet the following minimum requirements:

- i) Built in resistor permanently connected across the capacitor elements to discharge the unit voltage after disconnecting to a value of 75V within 10 minutes.
- ii) Suitable for continuous operation at voltage between terminals of 1.10 times at the rated voltage, excluding transients.
- iii) Suitable for continuous operation at current of 1.30 times the current which occurs at rated sinusoidal voltage and rated frequency excluding transients.
- iv) Identical and of the same capacity(similarly rated cans)

The output computed from the measured capacitance, at 25°C, rated voltage and frequency shall not be less than rated kVAr and not more than 110 % of this value for each capacitor unit. The capacitor unit having output kVAr beyond these limits shall not be accepted.

The entire capacitor unit shall not have to be changed due to single capacitor element failure. It shall be able to continue in operation.

Isolation of one capacitor unit in a group should not cause voltage unbalance of more than 110% rated voltage on the remaining capacitors in the group. During the design stage contractor shall submit the detailed calculation for selection of the capacitor unit rating and total number of units to be used for each stage of the capacitor bank for the approval of KPLC.

The capacitor units shall have a record of production and field experience of not less than three years. Reference lists of supply and failure rate of capacitor of the same design and material shall be submitted with the bid.

Capacitor Element

The dielectric material of a capacitor element shall consist of an aluminum film material suitable to operate the capacitors at continuous load under the specified ambient conditions. The capacitor shall be completely leakage proof.

The impregnant shall be according to IEC 60871 of a hydrocarbon type fluid characterized by high insulation strength and adequate physical and chemical properties and shall be non-PCB (Poly-Chlorinated-Biphenyl), but rapidly biologically degradable, non-poisonous, of trouble-free disposal and have a flash point >150°C.

The edges of the electrode foils shall be folded to enable high electrical stress.

Capacitor Element Fuses

Each capacitor (element) shall have an internal fuse combined with a secondary solid foil electrode to ensure safe disconnection from the circuit at the end of its normal working life.

Fuses shall only rupture in case the related unit is subject to failure and shall be capable of breaking the current following a failure of the capacitor unit without hazard from the fuse or the capacitor. The ruptured fuse of each capacitor (element) shall withstand indefinitely the voltage imposed across it under all operating conditions.

The remaining capacitor elements shall be able to operate within the capacitor unit without undue disturbance for a present number of unit capacitors. If one internal capacitor (element) fuse get burnt, this shall not affect the total power and capacitance of the concerned capacitor unit by more than 2.5 %.

During the design stage contractor shall submit the detailed calculation for number of internal fuse element failure to be considered for safe operation and the setting to be

adopted for unbalance protection relay alarm and tripping a overvoltage protection relay alarm and tripping.

Capacitor (Element) Container

The capacitor elements shall be enclosed in stainless steel housing with all joints welded and tested for liquid tightness.

Standard corrosion protection of the manufacturer may be acceptable subject to approval of KPLC based upon the submission of the complete factory painting procedure.

Capacitor unit bushings

Each capacitor unit shall have two outdoor terminal bushings which shall be hermetically soldered to the case. Terminal bushings shall be of silicon rubber compound (Composite) with a creepage distance as specified in the Data Sheets. Connections between the bushings and elements and the bushings and container shall not rely on soldered joints for mechanical support. Sealing gaskets shall not be accepted.

Connections

The connection between individual capacitor units in the same block shall be such that a failed capacitor unit can be easily replaced. All interconnections between various components shall be preferably carried out with tinned copper bus bar only to avoid fatigue associated with magnetic forces during bank energization.

- **Vacuum Switch:**

Each stage shall be controlled by a suitable vacuum switch for switching in and out the respective capacitor stage, according to the capacitive demand required by the system operating conditions.

Vacuum switches shall be of similar electrical ratings produced and tested in compliance with the latest revision of ANSI C37.66 standards.

Switches shall include a manual operating lever. Motor operated switches shall include a 5-pin receptacle for control wiring connections to a rack-mounted junction box assembly.

Control voltage shall be 110/240 VAC at 50 Hz. One switch shall be provided per phase complete with factory assembly and wiring - switches locations are to be specified in the proposal.

Switched banks with motor operated switches shall include a weather tight aluminum junction box / cable assembly mounted on the rack side near the pole.

Each junction box assembly shall include: #14 AWG (2.5mm²) control cables rated for 600 volts with a minimum of three conductors color coded "white"

(common), “red” (closing) & “black” (tripping). These cables shall include 5-pin plugs to mate with switch receptacles and shall terminate in a 6-position terminal block mounted within the junction box.

Terminal blocks shall be marked: “L” (for Line), “G” (for Ground), “C” (for closing), “T” (for Trip) & “5”, “6” (for last two positions).

Junction box covers shall slide into position and shall not require screws for attachment. A captive chain shall be attached between the cover and box.

The tenderer shall provide details of the proposed vacuum switch in his tender, together with evidence that they are suitable for switching duties and that the switch and associated power equipment will not be subject to damaging over-voltages when switching.

Each switched stage shall be switched via a capacitor rated switching device with current and voltage ratings appropriate for the system design.

The vacuum switches will have been tested for capacitor switching and meet the following criteria:

Solenoid operated, rated for 50,000 operations (open & close), do not utilize oil or gas insulation and utilize porcelain housing.

c. Control Section

- **Current Sensor**

The current sensor (CS) shall be of line post insulator type for VAR control and shall also be supplied with switched capacitor type and its cost shall be included in the respective bid price.

A suitable ultraviolet-resistant cable, at least 5 m long, shall be provided for the connection between the CS and the junction box. If longer cables are required, the length will be specified in the tender documentation.

It shall be possible to disconnect the cable from the CS, at the controller, while the network is under load, without the risk of damage to personnel, the CS, and /or any other equipment that may come into contact with the bare wires.

Insulator profile characteristics shall comply with the guidelines in annex D of IEC 60044-1.

The minimum bushing creepage distance from phase-to-earth (in mm) shall be 744 mm.

The bushing material shall be either porcelain or silicone rubber.

- **Control cabinet**

The control cabinet shall be suitable for mounting on a single wood pole. The necessary mounting bolts, nuts, etc. shall be supplied with the cabinet. The cabinet shall be easily removable for workshop repair purposes.

A suitable ultraviolet-resistant cable, at least 3 m long, shall be provided for connecting the capacitor bank to the control cabinet. If longer cables are required, the length will be specified in the tender documentation.

It shall be possible to disconnect the cable at the capacitor controller while the capacitor bank is connected to the energized power system, without causing a dangerous condition to field staff, damage or mal-operation. Care shall be taken to ensure that the current sensor is not open-circuited. A robust, multi-pin, weatherproof connector shall be fitted. The female part of the connector shall be mounted on the capacitor bank and the male part shall be mounted on the cable.

Cabinets shall be adequately sealed and dust protected and shall be internally treated to prevent moisture condensation. The degree of protection shall be IP 55 or better in accordance with IEC 60529.

The supplier shall ensure that the equipment housed in the control cabinet can withstand the heating effect of direct solar radiation without causing failure and/normal-operation. Details shall be provided in the tender documentation.

The cabinet shall be provided with an external M12 earthing stud with a nut and a serrated washer. A suitable arrangement shall be provided to ensure that earth continuity is maintained between the cabinet and the door.

The door of the cabinet shall be fitted with a robust fastening arrangement that is capable of being secured by a padlock that has a shackle of 8 mm diameter. Pewter or other brittle metal type handles will not be acceptable.

Provision shall be made in the cabinet for mounting of a cell phone modem. The maximum modem dimensions are 150mm long, 80mm wide and 50mm thick. (The modem will be supplied and installed by KPLC).

The cabinet shall make provision for bottom entry for the lead for the modem's aerial. A 10 mm diameter hole blanked off with blanking plugs shall be provided.

Means shall be provided to secure the blanking plug to the inside of the cabinet to ensure that the plug is not lost during transport.

d. Capacitor Protection

The capacitor banks/units shall be provided completely with its internal and external protection which is considered as part of the capacitor equipment.

Fuses shall be provided internally for protection of individual capacitor units. The fuses shall not deteriorate when the capacitor is subjected to discharge testing or the currents associated with service operations of the capacitor equipment.

Fuses shall only rupture in case the related unit is subject to failure and shall be capable of breaking the current following a failure of the capacitor unit without hazard from the fuse or the capacitor.

The ruptured fuse of each element shall withstand indefinitely the voltage imposed across it under all operating conditions.

The remaining capacitor units shall be able to operate within the capacitor bank without undue disturbance for a present number of unit capacitor failures.

5. TESTING AND INSPECTION

5.1 Testing and inspection for capacitor bank

Type tests

Certified type test certificates and reports from an ISO/IEC 17025 accredited laboratory shall be submitted with this tender.

The design tests shall conform to IEC and must include at least the following tests:

- a) Complete assembled capacitor banks according to IEC 62271-200 and IEC 60694 recommendations. In all cases the design of the completed equipment shall be verified by Temperature Rise Tests, LI Withstand Test and Ingress Protection Test.
- b) Capacitor Units
The capacitor units shall be subjected to the following type tests as per IEC 60871:
 - i. Thermal stability test
 - ii. Capacitor loss angle
 - iii. A.C. voltage test between terminals and container
 - iv. Lightning impulse voltage test between terminals and container
 - v. Short circuit discharge test
 - Vi. Disconnecting test on internal fuses
- c) Capacitor Contactors
 - i. Insulation (dielectric) test
 - ii. Short time current test
 - iii. Rated making current test
 - iv. Operating duty test
 - v. Temperature rise test
 - vi. Radio influence voltage test
 - vii. Mechanical life test
 - viii. Control wiring test.

Fuses shall be tested according to IEC 60549 / 60282 recommendations.

Routine tests

Routine tests shall be performed according to the relevant IEC Standards and shall be witnessed by KPLC representatives unless otherwise waived in writing:

Site tests

Not less than one month prior to the commencement of site testing, the Bidder/Contractor shall submit to KPLC the Site Test and commissioning procedure (SAT).

The tests shall be carried out as per approved SAT document. No testing shall commence until the test procedures are agreed. All results shall be submitted on the approved form.

Testing shall be carried out during normal working hours as far as practicable. Tests, which involve existing apparatus and outages, may be carried out outside normal working hours. The Bidder/Contractor shall give sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing program.

The Bidder/Contractor shall advise KPLC in writing at the time of commencement of site erection of the site supplies, which will be required for the operation of the test equipment.

The Bidder/Contractor shall provide the requisite experienced test personnel and all relevant test equipment, unless otherwise agreed by KPLC or stated in the Schedules.

On completion of any group of tests the Bidder/Contractor shall submit two clean copies of the test results recorded on the approved form. KPLC shall countersign the test sheets found to be satisfactory and retain one copy.

The Bidder/Contractor shall subsequently provide to KPLC six bound copies of all site test sheets as final records. The test sheets shall be grouped by substation subdivided by plant type and further on a circuit-by-circuit basis.

So that the records may be used for maintenance tests the final records shall be provided as soon as possible after completion of testing.

No tests as agreed under the program of tests shall be waived except upon the instruction of KPLC in writing.

All tests shall be carried out in the presence of KPLC unless otherwise agreed. The Bidder/Contractor shall carry out all the necessary tests for the capacitor bank units, cables and other associated equipment and submit a report that they are ready for commissioning.

Tests on the capacitor bank units will be carried out by the Bidder/Contractor under the supervision of the manufacturer and energized by the Engineer from KPLC, after witnessing necessary commissioning tests carried out by the Bidder/Contractor.

Any defects noticed during commissioning due to poor workmanship, wrong phasing or any other reason shall be made good by the Bidder/Contractor immediately.

Any defects noticed due to poor workmanship in the guarantee period must be rectified by the Bidder/Contractor to the satisfaction of KPLC.

Tests on Capacitor Bank Units and Auxiliary Equipment

General Checks

A general check of all the main switchgear, labeling and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, painted surfaces, cables, wiring, plates and all other auxiliary and ancillary items. Checks shall be made for any leaks, and that insulators are clean and free from external damage. A check shall be made that loose items which are to be taken over by KPLC, e.g. tools, spares, are in order and are correctly stored for taking over.

Shutters, interlocking, earthing procedures and the interchangeability of components shall be checked.

Isolator/Switches

Isolator / switches (panel side mounted) shall be subject to operational tests to confirm contact pressures, contact resistance and the ease of operation.

The test to confirm the opening and closing sequences and Checks on earth mat, indicators and manual locking devices shall be performed. Checks shall be made of the local and remote indications and operation of auxiliary contacts.

Continuity of Cable Connections and Phasing

Continuity of cable connections and phasing sequence to be checked

Insulation between Phases, Insulation to Earth

Insulation resistance between phases and to earth shall be measured.

Testing of Current and Voltage Transformers on the Capacitor Bank

The Bidder/Contractor shall be responsible for performing all required tests on the current and voltage transformers installed in the capacitor bank unit.

6. MARKING

Markings on the unit and the bank shall be in accordance with IEC 60871-1. The markings shall be permanent.

7. ADDITIONAL REQUIREMENTS

- One remote current transformer (15VA minimum) for the VAr controller to be provided for each bank.
- Equipment shall be neatly constructed and finished.
- Bank shall be supplied with appropriate cautionary nameplates.
- Any miscellaneous components not specifically named, but required for proper operation, shall be included.
- Capacitor bank manufacturer to have over 20 years of experience as a supplier to major utilities and industrial partners. References shall be provided with proposal.

8. DOCUMENTATION

The following information for the capacitor banks shall be submitted for evaluation and approval:

- i. Outline drawings complete with elevations, sections, base plan, anchoring information and weight.
- ii. Bill of quantities
- iii. Control schematic diagram
- iv. Three line diagram
- v. Design drawings for approval

TECHNICAL DATA OF EQUIPMENT:

Table 1.6: Technical data

Nominal Voltage	11kV
Highest System Voltage	12kV
Frequency	50Hz
Impulse withstand voltage	External (between terminal & tank): Internal:
Power frequency withstand voltage (r.m.s)	External (between terminal & tank):
Creepage Distance of bushings (minimum)	300mm

ANNEX A: Technical Particulars (to be filled and signed by the Bidder/Contractor for all clauses and submitted together with catalogues, brochures, drawings, guaranteed technical particulars signed by the manufacturer and certified true copies of test reports for tender evaluation)

GUARANTEED TECHNICAL PARTICULARS

Table 1.7: Guaranteed Technical Particulars-shunt capacitors

Description	Unit	Requirement	Bidder
Manufacturer -	-		
Type	-		
Nominal system voltage	kV	11	
Rated voltage of Capacitor bank	kV (rms)	12	
Voltage variation (steady state)	%	+/- 5	
Voltage variation (transient)	%	+/- 10	
Number of phases /wires		3 phase 3 wires	
Nominal reactive power output	MVar		
Rated reactive power output of capacitor bank	MVar		
Short circuit power of 12kV System	kA		

Circuit breaker classification according to IEC 62271-100	Class		
Type of connection for capacitor bank	Star/double star		
Dielectric losses (excluding losses of discharge resistances & other losses)	kW		
Dielectric loss angle			
Temperature rise (Max)	°C		
Thermal/overload capability curve			
Min. time between disconnection & reclosure	s		
Arrangement of capacitor units to form 3 phase capacitor bank stage	Star/double star		
Rated voltage of capacitor unit	kV		
Rated reactive power output of capacitor unit	MVar		
Rated current of capacitor bank	A		
Dielectric	-	ALL FILM	
Impregnating medium		Non PCB	
Number of layers	-		
Thickness of each layer	µm		
Capacitor element voltage	V		
Number of elements in capacitor unit			
Total losses of capacitor bank at rated voltage - Initially - After 500 operating hours	kW kW		
Internal fuses	yes/no	yes	
Internal discharge resistor	yes/no	yes	
Allowable residual voltage for the capacitor unit	V	75 V	
Discharge time from rated voltage to 75V	min	Max 10 min	
Details of impregnant			
Dielectric strength of impregnant			
Type and rating of internal fuse			
Dielectric losses of capacitor unit			
Dielectric loss angle of capacitor unit			
Capacitor unit container material	-	Stainless steel	
Painting thickness	µm	80	
Dimensions of enclosure			
Capacitor bank length x width x height	mm		
Capacitor unit length x width x height	mm		
Capacitor bank weight	kg		
Capacitor unit weight	kg		
Mechanical degree of protection		IP 43	
Rated lightning impulse withstand voltage	kV(peak)	200	
Rated power frequency withstand voltage,(1 min)	kV (rms)	95	
Creepage distance of bushings and support insulators, based on maximum phase-to-earth voltage	mm/kV	31	

Table 1.9: Tests

Description	Unit	Requirement	Bidder
Routine test according to specification		on each unit	
Full wave lightning impulse tests (on all terminals) Test voltage • Polarity	kV	on each unit 200 Positive	
Separate source overvoltage withstand tests	kV		
Heat run test (at 1.1 times rated current)		on one unit	
All other applicable tests according to these specifications		on each unit	
Overall dimensions • Diameter • Length	mm mm		
Minimum clearances to metallic parts • Radially • Axially	mm mm		
Total weight • Erected as for service • Ready for shipment	kg kg		
Arrangement drawing showing all fitting and mounting details	Dwg-No		
Arrangement drawing for shipping	Dwg-No		

B. 12kV SURGE ARRESTERS

CONTENTS

1. SCOPE
2. REFERENCES
3. TERMS AND DEFINITIONS
4. REQUIREMENTS
5. TESTS AND INSPECTION
6. MARKING, LABELING AND PACKING

ANNEX A: Technical Particulars (to be filled and signed by the Manufacturer *for all clauses* and submitted together with catalogues, brochures, drawings, guaranteed technical particulars and certified true copies of test reports *for tender evaluation*)

1. SCOPE

- 1.1 This specification is for metal-oxide surge arresters without gaps for a.c. system operated at 12kV 50Hz.
- 1.2 The specification covers 10kA distribution class surge arresters for use along 11kV power lines and substations.

2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

ISO 1461: Metallic Coatings – Hot dip galvanized coatings on fabricated ferrous products – Requirements.

KS IEC 60099-4: Metal-oxide surge arresters without gaps for a.c. systems

IEC 60099-4: Metal-oxide surge arresters without gaps for a.c. systems

IEEE Std C62.22: Guide for the application of metal-oxide surge arresters for alternating current systems.

3. TERMS AND DEFINITIONS

Terms and definitions given in IEC 60099-4 shall apply.

4. REQUIREMENTS

4.1 Service Conditions and System Data

The surge arresters shall be suitable for continuous operation outdoors in tropical areas at altitudes of up to 2200m above sea level, humidity of up to 90%, average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C, heavy saline conditions along the coast and annual mean isokeraunic level of up to 180 thunderstorm days.

- 4.1.1 The surge arrestor shall be connected between phase and earth to an overhead system that is generally not effectively earthed and with the following system characteristics:

Table 1.25: surge arresters

System highest voltage and frequency	12kV, 50Hz
Maximum duration of earth fault	3 sec
Power frequency withstand voltage, wet (kV)	95
Lightning impulse withstand voltage (kVp)	200

- 4.1.2 The type of equipment to be protected includes capacitors (directly connected to a line or via cable), equipment in substations and cables.

4.2 Design and Construction

- 4.2.1 The surge arrester shall be designed and constructed in accordance with IEC 60099-4 and the requirements of this specification. It shall be suitable for over-voltage protection of distribution networks.
- 4.2.2 The metal-oxide used shall be of quality to ensure thermal stability under service duty of the surge arrester.
- 4.2.3 The arrester shall be single column; self-supported and be installed between phase and earth.
- 4.2.4 The housing of the surge arrester shall be made of high quality silicone rubber of the following minimum properties:
- a) hydrophobic
 - b) insensitivity to ultra-violet radiation
 - c) excellent tracking resistance
 - d) excellent mechanical impact, abrasion and shear resistance
 - e) Excellent long-term stability and resistance to ageing under climatic and electrical stresses.
- 4.2.5 The surge arrester shall be sealed (end caps) with a controlled permanent seal to ensure no moisture absorption or deterioration of the metal-oxide element of the surge arrester.
- 4.2.6 The surge arrester shall be designed and constructed in a manner so as to prevent explosive shattering of the housing in the event of the arrester failure.
- 4.2.7 The surge arrester shall be supplied complete fitted with a mechanical fault indicator. Details on the operation shall be submitted with the offer.
- 4.2.8 The surge arrester shall be supplied complete with mounting bracket, fixing accessories and clamp connector suitable for both copper and aluminum conductors of up to 12.5mm diameter. All parts shall be protected against corrosion.

The mounting brackets for distribution class surge arresters shall be suitable for both horizontal and vertical mounting on a steel cross arm (U-channel).

Station class surge arrester, when required, shall be suitable for pedestal mounting with a suitable pitch circle diameter.

- 4.2.9 The steel plates or straps and all ferrous parts shall be hot dip galvanized in accordance to ISO 1461.

4.3 Characteristics

- 4.3.1 The surge arresters shall be of the following minimum characteristics:

Table 2.6: surge arresters' minimum characteristic

Rated Voltage and Frequency	12kV, 50Hz
Nominal discharge current and long duration discharge class	10kA, Class 1
Continuous operating voltage of arrester	30kV
Insulation withstand of arrester housing	200kVp
Creep age distance of arrester housing (minimum)	300mm

4.3.2 The bidder shall submit together with his bid detailed characteristics (including lightning impulse residual voltages at 0.5, 1.0 and 2.0 times the nominal discharge current and steep current impulse residual voltage) for the surge arresters offered.

5. TESTS AND INSPECTION

5.1 Type tests and routine/sample tests shall be done in accordance to IEC 60099-4, ISO 1461 and the requirements of this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified.

5.2 Certified true copies of previous Type Test Certificates and Type Test Reports by the relevant International or National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 accredited laboratory) shall be submitted with the offer for evaluation (all in English Language). A copy of accreditation certificate for the laboratory shall also be submitted. Any translations of certificates and test reports into English language shall be signed and stamped by the Testing Authority.

Copies of type test reports (as per IEC 60099-4) to be submitted shall include the following;

- i. Insulation withstand tests on the arrester housing;
- ii. Residual voltage tests;
- iii. Long duration current impulse withstand test;
- iv. Operating duty tests;
- v. Tests of arrester disconnectors.

5.3 Routine/sample test reports for the surge arresters to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers (2) shall witness tests at the factory before shipment.

Tests to be witnessed by two (2) KPLC Engineers at the factory shall include the following:

- Measurement of reference voltage;
- Residual voltage test;
- Measurement of power frequency voltage on the complete arrester;

- Lightning impulse residual voltage on the complete arrester;
- Partial discharge test.

5.4 On receipt of the surge arresters, KPLC will inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The manufacturer shall replace without charge to KPLC, surge arresters which upon examination, test or use fail to meet any or all of the requirements in the specification.

6. MARKING, LABELLING AND PACKING

6.1 The following information shall be marked indelibly and legibly on a nameplate permanently attached to the surge arrester.

- continuous operating voltage;
- rated voltage;
- rated frequency;
- the manufacturer's name, type and identification of the complete arrester;
- the year of manufacture;
- serial number;
- line discharge class

6.2 The surge arresters shall be packed in wood crates which are reinforced and held closed by external steel wire bindings. Each crate shall be internally braced to permit stacking and the steel wire bindings shall be designed to keep the crate firmly closed and permit easy and rapid opening at time of installation.

The crates shall then be stacked on sturdy wood pallet. The assembly shall be held tightly in place with steel bands and protected against moisture by a complete covering of heat-shrinkable polyethylene film.

The package shall bear the manufacturer's name, type and identification of the complete arrester.

ANNEX A: Technical Particulars *(to be filled and signed by the Manufacturer for all clauses and submitted together with catalogues, brochures, drawings, guaranteed technical particulars and certified true copies of test reports for tender evaluation)*

Table 2.7: Technical particulars

Description	Bidder's offer
	12kV
Manufacturer, Country of origin of surge arresters offered	
Type Reference No./Model No.	
Service Conditions	
Applicable Standard(s)	
Type and design	

Insulator and sealing	
<u>Pressure relief/ disconnecter (and technical details)</u>	
<u>Surge counter (and technical details)</u>	
Fixing accessories and mounting	
Galvanizing	
RATINGS	
System Rated Voltage and Frequency	11kV, 50Hz
Maximum system operating voltage(kV)	12
System BIL	
Nominal discharge current	
Line discharge class	
Continuous operating voltage	
Creepage distance of insulator	
Insulation level of housing	
Lightning impulse residual voltage	
Maximum residual voltage at :	
10 kA 1/2 μ s	
5 kA 8/20 μ s	
10 kA 8/20 μ s	
20 kA 8/20 μ s	
40 kA 8/20 μ s	
500 A 30/60 μ s	
1 kA 30/60 μ s	
2 kA 30/60 μ s	
Temporary overvoltage for 1 s	
Temporary overvoltage for 10 s	
Energy discharge capability - thermal	
Energy discharge capability - impulse	
Cantilever load, dynamic	
List of Type Test Reports submitted (indicate Test Report Numbers, Testing Authority and Contact Addresses)	
List of Tests to be witnessed by KPLC Engineers at the factory	
Marking	
Packing	
Manufacturer's Guarantee and Warranty	
List of catalogues, brochures, drawings, technical data, test reports and customer sales records submitted to support the offer.	
STATEMENT OF COMPLIANCE TO SPECIFICATION	

Manufacturer's Name, Signature, Stamp and Date

Note: This schedule does not in any way substitute for detailed information required elsewhere in the specification.

C. 12 KV VOLTAGE TRANSFORMERS

CONTENTS

- 1. SCOPE**
- 2. REFERENCES**
- 3. DEFINITIONS**
- 4. REQUIREMENTS**
- 5. TESTS AND INSPECTION**
- 6. MARKING**

1. SCOPE

This specification is for voltage transformers for use with electrical measuring instruments and electrical protective devices on system with maximum operating voltage of 12kV, 50Hz.

2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

IEC 60044-2: Instruments Transformers – Part 2: Inductive Voltage Transformers.

IEC 60815: Guide for selection of insulators in respect of polluted conditions

3. DEFINITIONS

For the purpose of this specification the definitions given in the reference standards shall apply.

1. REQUIREMENTS

4.1 Service Conditions

4.1.1 Climatic Conditions

The Voltage Transformers shall be suitable for continuous operation outdoors in tropical areas at altitudes of up to 2200m above sea level, humidity of up to 90%, average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C, Humidity 95%, Design pollution level to be taken as “Very Heavy”(pollution level IV) according to IEC 60815, in direct sunlight and isokeraunic levels of up to 180 thunderstorm days per year.

4.1.3 System Conditions

A Power Voltage Transformer (VT, conforming to IEC 60044-2 standard and to be installed outside capacitor bank), with respective 1kVA rating and preferably dual LV rating of 110V/ 240V (phase-neutral) as an auxiliary source of supply shall be supplied with switched capacitor type and its cost shall be included in the respective bid price.

The voltage transformer will be connected between line and earth of a 3-phase 3-wire system with the neutral point solidly earthed.

The overhead system is of unearthed construction i.e. without aerial earth wire. The system nominal voltage is 11000 Volts with system highest voltage of 12000 Volts and a frequency of 50Hz.

4.2 Design and Construction

The voltage transformer shall be designed and constructed in accordance with IEC 60044-2 and the requirements of this specification.

The voltage transformer shall be outdoor oil type or cast resin. Insulators shall be either porcelain or silicon composite/cast resin types.

The voltage transformer shall be suitable for installation on steel structure.

All external parts of the voltage transformer shall be resistant to atmospheric corrosion.

The voltage transformer shall have primary, secondary and earth terminals.

The primary terminal shall be tin-plated, suitable for both copper and aluminum conductors. The terminal shall have at least four bolts for clamping the conductor.

The secondary terminal shall be brought out to a separate terminal box, complete with protection fuses and links.

4.3 Ratings

The voltage transformer shall be capable of carrying 50% burden above the rated capacity without damage for 30 seconds.

It should have two secondary outputs. Each output should have a burden of a minimum of 50 VA. The ratings of the voltage transformer shall be as indicated herein:-

Rated Primary Voltage (volts)		11000/ $\sqrt{3}$ volts
Rated Secondary Voltage(volts)		110/ $\sqrt{3}$,110/ $\sqrt{3}$
Rated Frequency		50 Hz
Minimum Creepage Distance of Insulator		380mm
Minimum lightning impulse withstand voltage, primary winding		95kV (peak)
Minimum power frequency withstand voltage, primary winding		38kV (r.m.s.)
Minimum power frequency withstand voltage, secondary winding		5kV (r.m.s.)
Maximum temperature rise	Windings	65K
	Oil at top tank	55K
Rated Voltage Factor		1.2 Continuous
		1.5 for 30 sec.
Accuracy class		3P, 0.5

Table 1.28: Voltage Transformer Data

2. TESTS AND INSPECTION

- 5.1 The voltage transformer shall be inspected and tested in accordance with the requirements of this specification and IEC 60044-2.

It shall be the responsibility of the manufacturer to perform or to have performed the tests specified and whatever other tests he normally performs at works.

- 5.2 Certified true copies of previous Type Test Reports from an ISO/IEC 17025 accredited Laboratory recognized by the International Laboratory Accreditation Co-operation (ILAC) shall be submitted with the tender for the purpose of technical evaluation, all in English Language. The Type Test Reports shall be in accordance with IEC 60076.
- 5.3 Test Reports for the Voltage Transformers to be supplied shall be submitted to KPLC for approval before shipment/delivery.

3. MARKING

The voltage transformer shall be fitted with a rating plate indicating the following:

- The manufacturer's name or identification mark.
- The type reference number and serial number.
- The rated primary and secondary voltage.
- The rated frequency.
- The burden and accuracy class.
- The highest system voltage (e.g. 12kV).
- The basic insulation level.
- The rated voltage factor and corresponding rated time.
- The terminals shall be marked clearly and indelibly.
- The marking shall be in accordance with IEC 60044-2.

ANNEX A: Technical Particulars *(to be filled and signed by the Manufacturer for all clauses and submitted together with catalogues, brochures, drawings, guaranteed technical particulars and certified true copies of test reports for tender evaluation)*

Table 2.9: technical Particulars

Outdoor voltage transformer		11kv	
Particulars	unit	Guar. Figure	Tolerance
Voltage Transformers, type	-		
Manufacturer	-		
- Rated voltage	kv		
- Maximum service voltage	kv		
- Rated frequency	Hz		
- One- minute power frequency test voltage:			
- Primary winding	kV rms		
- Secondary winding	kV rms		

- Lightning Impulse withstand	kV peak		
- short time thermal rating			
- 1 sec.	kV rms		
- Short time dynamic rating			
- burden and accuracy class	kA rms		
measurement core 1			
measurement core 2			
- Ratio of each output	-		
Output 1:	-		
Output 2:			

D. ISOLATOR (DISCONNECTOR) -12kV

CONTENTS

- 1. SCOPE**
- 2. REFERENCES**
- 3. TERMS AND DEFINITIONS**
- 4. REQUIREMENTS**
- 5. TESTS**
- 6. NOTICES**

1. SCOPE

1.1 This specification is for the following isolators use for line disconnection, isolation of substation apparatus and sectionalizing purposes.

1.2. This specification covers the following isolators.

- a. 12 kV isolators without earth switch

2. REFERENCES

The following documents were referred to during the preparation of this specification, and may be referred to in case of conflict; the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply

IEC 129: Alternating current disconnectors (isolators) and earthing switches.

BS 729: Hot dip galvanized coating on iron and steel articles.

IEEE C37.66

3. TERMS AND DEFINITIONS

For the purpose of this specification, the definitions in IEC 129 shall apply.

4 REQUIREMENTS

4.1. Service Conditions

The Isolator shall be suitable for continuous outdoor operation in tropical areas with the following atmospheric conditions.

Altitude:- From sea level up to 2200m above mean sea level.

Humidity:- Heavily polluting saline atmosphere in coastal areas and where humidity is in excess of 90% and up country area where air is relatively clean and humidity not below 50%.

Ambient:- temperature of +30 °C average, (+40 °C Max. -1° C Min)

4.2. Construction

4.2.1 The isolator shall be vertical or side opening, single break or double Centre break rotating post type for use on a 11kV, 50 Hz, three phase system.

The isolator shall be complete with supporting base, phase coupling details, operating rod, unions and guides.

The operating mechanism shall be provided with a universal joint to allow for a reasonable degree of out-of alignment of the operating rod.

4.2.2 The supporting under base shall be hot dip galvanized steel as per the requirement of BS 729.

The underbase shall be suitable for mounting on a steel structure.

4.2.3 All the three switches shall be arranged so that the phase units are mounted independently and then finally interconnected with coupling tubes so as to ensure simultaneous operation of all switches by drive rods and operating handle, both manual and motor operation. Motor operating voltage shall be 110volts DC.

4.2.4 The operating mechanism shall be fixed at the base frame, in a weather proof, vermin proof and dust proof housing. The degree of protection shall be class IP 53.

The operating mechanism shall be provided with off/local/remote selector switch. The selection of local operation shall inhibit the operation from any remote source.

4.2.5 Auxiliary switches, five normally open and five normally closed at 110 volts DC. shall be provided for electrical interlocks with a circuit breaker.

4.2.6 Each phase shall be mounted on a spiral type solid cone insulator and shall be fitted with clamp connector for ACSR conductor up to 18.2 mm diameter.

- 4.2.7 The isolator shall be designed such that in fully open position, it shall provide adequate electrical isolation between the contacts on all the three switches.
- 4.2.8 All current carrying parts be made of electrolytic high conductivity material with switch contacts silver plated.
- 4.2.9 The isolator with the earth switch shall consist of a hinged type earth switch fixed at the base frame. The earth switch shall have the same rating as the isolator.
- 4.2.10 The isolator shall be provided with a padlocking facility such that it can be locked in either OPEN or CLOSED position.

4.3. Rating

The ratings of the isolator, including its operating devices and auxiliary equipment shall be as under.

Table1.30 Isolator ratings

Rated voltage(KV),	12
Rated lightening impulse voltage(KV)p,	75
Rated Power frequency withstand voltage,(KV)rms	28
Rated frequency	50 Hz
Rated normal current(A)	200
Rated short time withstand current (kA)for (3seconds for 12kv)	21KA
Minimum creepage distance of Insulators(mm)	300mm

4.4. Instructions and Marking

- Instructions, in English, for the assembly and installation of the complete device shall accompany the equipment during delivery.
- The Isolator (Disconnecter) shall be marked (permanently) in accordance with IEC 129 and IEC 60694. All markings shall be in the English language and figures representing ratings shall be followed by the symbol of the unit in which they are expressed.

5. TESTS AND FACTORY INSPECTION

- The Isolator (Disconnecter) shall be inspected and tested in accordance with the requirement of IEC 129 and IEC 60694 and this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified.
- Copies of previous Type Test Reports certified by the National Testing/ Standards Authority of the country of manufacture or its accredited testing laboratory shall be

submitted with the tender (including certificate of accreditation for laboratory) for the purpose of technical evaluation, all in English.

- c) Prior to the manufacture of Isolators (Disconnectors) on order, the purchaser (KPLC) reserves the right to inspect the manufacturing facility and the quality management system at no extra cost save for the air travel (of two Engineers) to the nearest international airport in the country of manufacture.
- d) Upon completion of manufacturing process, the Isolators (Disconnectors) shall be subject to inspection by two KPLC Engineers at place of manufacture and tests carried out on samples picked at random in their presence. Test reports shall be completed and made available for approval before shipment/delivery of the Isolators (Disconnectors).

The cost of inspection and witnessing of tests (except the cost of air travel to the nearest international airport) shall be borne by the manufacturer.

6. TECHNICAL DOCUMENTATION

The Bidder shall submit a clause by clause statement of compliance with these specifications together with copies of the manufacturer's catalogues, brochures, technical data, drawings, bill of materials and test certificates clearly marked to support each clause, all in English for evaluation.

The manufacturer's type reference/designation of the item offered shall be indicated.

In the case of tender award, technical details and detailed drawings for the Isolator (Disconnecter) to be supplied shall be submitted to the purchaser (KPLC) for approval before manufacture commences. The drawings shall include all the accessories and components to be supplied.

The manufacturer's certified Declaration of Conformity to Reference Standards and detailed list of previous customers (utilities) outside the country of manufacture shall also be submitted.

ANNEX A: Statement of Compliance (to be filled by the Supplier for all clauses and submitted for tender evaluation)

Table 1.31: Isolators Technical Particulars

Clause Number	Bidder's offer	<u>Manufacturer's</u> catalogue, drawing, technical data or tests certificate <u>Reference Page</u> to support the offer.
4.1		
5. d)		

NB: - This schedule does not in any way substitute for detailed information required elsewhere in the specification.