TENDER NO KP1/9AA-2/PT/15/NW/13-14

FOR SUPPLY, INSTALLATION AND COMMISSIONING OF SWITCHED REACTIVE POWER COMPENSATORS ON SELECTED 11KV FEEDERS IN NAIROBI.

TECHNICAL SPECIFICATIONS AND DRAWINGS

NOVEMBER, 2014

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

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SECTION I:
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. General technical specifications
3. Guaranteed technical particulars
4. Project specific design data
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 equipment
- Layout proposals for each equipment
- 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:
  - Manuals for preventive maintenance indicating periodic inspections, cleaning, lubrication and other routine maintenance.
  - 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 a**t 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 two -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.

SECTION II

PROJECT SPECIFIC DATA

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Efficiency Improvement Unit (EIU), both of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for **Pole Mounted Auto Switched Capacitor Banks** for use in 11kV distribution feeders. It is intended for use by KPLC in purchasing of the Capacitor Banks.

1. SCOPE

1.1. This specification covers the design, manufacture, delivery, transportation, and commissioning of 3 phase pole mounted auto switched capacitor banks rated voltage 12 kV line-to-line at a frequency of 50 Hz; mounted outdoors in overhead lines as distribution shunt capacitor banks.

1.2. The capacitors banks shall be complete with HV fuse cut-outs, control power/measurement voltage transformer, surge arrestors, vacuum switches, capacitor units, current sensor, capacitor bank controller, interconnection cables and hot dipped galvanised steelwork all rated at 12 kV suitable to be installed outdoors as specified.

1.3. The capacitor bank controller shall provide the specified control and protection requirements and also facilitate a connection to a communication modem to be installed by KPLC.

1.4. The capacitor bank shall be factory assembled, and shall be as complete as possible to reduce the work required at site during installation.

1.5. The capacitor banks and related accessories shall be designed as compactly as possible in order to reduce space and weight requirements.

1.6. The specification also covers inspection and test of the capacitor bank as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

1.7. The specification stipulates the minimum requirements for Pole Mounted Automatic Switched Capacitor Banks acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good engineering practice, adherence to the specification, applicable standards and applicable regulations as well as ensuring good workmanship in the manufacture of the equipment for The Kenya Power & Lighting Company.

The specification does not purport to include all the necessary provisions of a contract.

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 60871:	Shunt capacitors for a.c power systems having a rated voltage above 1000V –Part 1: General – Performance, testing and rating –Safety requirements – Guide for installation and operation; Part 2: Endurance testing -- Part 3: Protection of shunt capacitors and shunt capacitor banks Part 4: Internal fuses
IEC 60137	Insulated bushings for alternating voltage above 1000V
IEC 60867	Insulating liquids-specification for unused liquids based on Synthetic aromatic hydrocarbons
IEC 60282:	High Voltage Fuses - Part 2: Expulsion fuses
IEC 60099:	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems - Part 5: Selection and application recommendations
IEC 60273:	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC 60271:	High voltage switchgear and control gear--Part-1: Common specifications
IEC 60076:	Power transformers –Part 1: General - Part 2: Temperature rise - Part 6: Reactors
IEC 61869:	Instrument transformers: Part-1: General requirements P art-3 Additional requirements for inductive voltage transformers
IEC 60529:	Degrees of protection provided by enclosures (IP Code)
ASTM A123:	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ANSI C 37.66:	Requirements for capacitor switches for alternating current Systems
ANSI C29.9:	Wet Process Porcelain Insulators (Apparatus, Post Type)
BS 4:	Structural steel sections.

3. TERMS AND DEFINITIONS

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

4. REQUIREMENTS

4.1. SERVICE CONDITIONS

4.1.1 Operating Conditions

S. No.	Particulars	Specified value
1	Nominal system voltage	11kV
2	Highest system voltage	12kV
3	Frequency	50Hz ±3%
4	Number of Phases	3
6	Fault level (minimum)	12.5 kA for 3 sec.
7	Auxiliary AC supply	bidder to specify
9	Maximum duration of earth fault	≤ 3 seconds
13	Power frequency withstand voltage, wet, kVrms	28
14	Lightning impulse withstand voltage, kVpk	75
15	Pollution level III , 31mm/kV as per IEC 60507	Heavy

4.1.2 The capacitor banks shall be designed for temperature class D (min -5 / max. 55° C) As per IEC 60871-1 for outdoor installation.

4.1.3 The radio influence voltage when measured in accordance with the foregoing at a frequency of 1 MHz shall not exceed 250 µV.

4.1.4 The line impedance values shall be as per the table below;

Description	R(1)	X(1)	C(1)	R(0)	X(0)	C(0)
	Ohm/km	Ohm/km	uF/km	Ohm/km	Ohm/km	uF/km
11kV Hor - 75mm^2 ACSR	0.4427	0.333921	0.011117358	0.590031	1.886324	0.004135
11kV_Hor - 150mm^2_ACSR	0.2237	0.304939	0.012061872	0.371031	1.857342	0.004259

4.1.5 Climatic Conditions

Sr. No.	Particulars	Specified value
1.	Maximum ambient air temperature	40^{0}C
2.	Minimum ambient air temperature	- 1^{0}C
3.	Average daily maximum ambient temperature	30^{0}C
4.	Maximum altitude above mean sea level (meters)	2200 m
5.	Seismic level (Horizontal acceleration)	0.3g
6.	Relative humidity (% age)	>95%
7.	Average number of rainy days/year	120
8.	Average annual rainfall	900mm
10.	Wind pressure on project areas of conductors and	383-430 N/mm^2

	cylindrical objects	
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	

4.2. GENERAL REQUIREMENTS

A complete automatic switched pole mounted capacitor bank shall incorporate the following individual equipment and accessories as per Fig. 1 & 2 of Annex B:

(i) Three single phase capacitor units producing 300VAr (or 600VAr as per requirement) at 11 kV including protective terminal caps,

(ii) Three single pole (or one 3 phase) vacuum (or SF_6) switches including protective terminal caps,

(iii)Three surge arresters including NEMA type mounting bracket assembly,

(iv) Capacitor bank controller,

(v) Line current sensor,

(vi) Frame and pole mounting hot dipped galvanized steel hardware

(vii) Control power / measurement voltage (VT),

(viii) Fuse cut-outs,

(ix) Interconnecting insulated copper cables, jumpers and lugs as required

(x) Earthing cables, connectors, cleats, protective guard, bonding accessories, earth rods conforming to KPLC current standards and practices,

(xi) Junction boxes,

(xii) Current limiting/damping reactors as shall be determined based on the line impedances.

4.3. CAPACITOR UNIT

4.3.1. Construction and processing – external

4.3.1.1. The capacitor unit in this specification shall be classified as in the temperature category of -5^{0}C / D in accordance with IEC 60871-1 requirements.

4.3.1.2. The container of capacitor unit shall be of stainless steel, 304 high grade, equivalent to grade “A2” steel in accordance with ISO 3506 or CRCA steel painted with suitable anti rust primer and two finishing coats of paint as per manufacturer’s standard practice. The container shall be made considering expansion due to all ambient and loading conditions expected during the life of the unit

4.3.1.3. To enable the potential of the metal container of the capacitor to be fixed, and to be able to carry the fault current in the event of a breakdown to the container, the container shall have provision for connection by means of a grade “A2” steel bolt of thread size at least M10 or equivalent.

4.3.1.4. Capacitor bushings shall be light grey (RAL 7035), electrical grade II bushing type, wet processed hard-paste porcelain or reinforced high temperature vulcanized (HTV) silicone rubber based on dimethyl silohexane of same colour.

4.3.1.5. The bushing shall be welded to the top of the case with a weldable flange to provide a strong, hermetically sealed system, with a minimum of 400 mm creepage for 95 kV-BIL

4.3.1.6. Each capacitors unit shall be mounted so that it can easily be removed from the racks and replaced without removing other units or de-assembling any portion of the rack.

4.3.1.7. The mounting brackets shall be stainless steel, with 304 high-grade, with about 397mm spacing between mounting slots and shall include an unpainted portion on the bottom mounting surface for proper grounding of capacitors to pole top equipment racks.

4.3.1.8. The bushing terminal(s) and ground lug shall be stainless steel,304 high-grade, and shall be equipped with a clamp-type terminal connector to accommodate copper or aluminum conductors of $6mm^2$ - solid to $50mm^2$ - stranded conductors. Otherwise connections shall be made using appropriate compression type cable lugs.

4.3.1.9. The bushing stud shall be preferably solid round bar. If hollow round bar then the nuts shall be plated soft brass to strip, if excess torque is applied, before damage to the bushing stud.

4.3.1.10. The rating nameplate shall be anodized aluminum and shall be located on the narrow side of the capacitor can.

4.3.2. Construction and processing - Internal

4.3.2.1. Capacitor units shall be of the "all-film" design using two (2) or three (3) layers of hazy impregnated polypropylene film as the solid dielectric material. This dielectric material shall be suitable to operate the capacitors on continuous load under the specified ambient conditions.

4.3.2.2. The units shall be of internally fused design; manufactured with elements in parallel. When an element fails (welds together), the fuse of the faulty elements shall blow, disconnecting the faulty element from the other parallel elements hence

the lost capacitance is small and the increase in voltage across the healthy parallel units is also small.

4.3.2.3. Internal fuses shall limit possible failure to a single capacitor element only. The design of internally fused capacitor units shall be such that it shall permit up to 40% element failure in series group without passing more than 10% over voltage on other healthy units.

4.3.2.4. Connection to capacitor elements shall be done in such a manner to ensure soundness.

4.3.2.5. Each capacitor shall be provided with a discharge resistor assembly. The guaranteed minimum values of losses of the capacitor units shall include losses due to discharge resistors which shall be mounted inside each unit to discharge each unit from peak voltage to maximum 75volts or less within 10 minutes after the capacitor is disconnected from rated voltage.

4.3.2.6. The capacitors shall be able to carry continuously 1.3 times the rated current, 1.1 times the maximum system voltage and shall provide continuously 1.3 times the rated output. All the above requirements shall be fulfilled under maximum ambient temperature.

4.3.2.7. The impregnant shall be of a hydrocarbon type fluid characterized by high electrical strength and adequate physical and chemical properties and shall be non-PCB and low toxicity. The impregnant shall be a class III B (OSHA classification) combustible fluid.

4.3.2.8. Each capacitor shall have two bushings manufactured to ANSI C29.9or IEC 60137; dependent on the mounting arrangement with a creepage distance of minimum 400mm.

4.3.2.9. The arrangement of the capacitor unit fixing and the bushings shall be identical in order to easily exchange and replace any capacitor unit of the total capacitor bank. The terminals for bushings and fixing elements shall be ISO standard (metric).

4.4. CAPACITOR BANK

4.4.1. General

4.4.1.1. The capacitor units shall be designed as per IEC 60871-1, but subject to requirements of this specification.

4.4.1.2. Three capacitor units shall be combined to form capacitor banks in an ungrounded star (wye) arrangement. The capacitor units shall be arranged as an assembly on suitably designed rack and constructional members of hot dipped galvanized steel.

4.4.1.3. The capacitor banks shall include all necessary connections, insulators and other fittings.

4.4.1.4. The capacitor bank rack shall be designed to carry all required capacitors units, vacuum switches, control power/voltage measurement transformer, surge arrestors and accessories, and the conductors comprising the incoming and outgoing circuits under the loadings and factors of safety specified and to give the minimum phase and earth clearances.

4.4.1.5. The safe removal and safe replacement of capacitor units shall not require the dismantling of any structural member, support, including insulators or the main connections from the HV fuse cut-outs

4.4.1.6. Where necessary, approved means by KPLC shall be provided upon the capacitor equipment for the fixing and bonding of external connections to secure efficient earthing.

4.4.1.7. Steelwork and all items of the auto-switched capacitor bank shall be bonded as necessary with copper straps of adequate cross-sectional area. In case of outdoor open rack installation, tinned copper straps shall be used.

4.4.1.8. Approved facilities shall be provided to temporarily earth the connections and apparatus during maintenance.

4.4.2. Electrical Requirements

4.4.2.1. Capacitor units shall be capable of continuous operation and meet permissible overload conditions as listed in the latest revision of IEC 60871-1.

4.4.2.2. Capacitors units shall have a voltage rating no less than the maximum system phase voltage.

4.4.2.3. Capacitor units shall be capable of continuous operation over an ambient range of -5^0C to $+45^0$C provided that the following limitations are not exceeded:

a) 130% of nameplate kVAr
b) 110% of rated voltage rms, including harmonics
c) 130% of rated current rms, including fundamental and harmonic currents

4.4.2.4. Capacitor units shall be capable of meeting the permissible overload operating conditions as specified in IEC 60871-1.

4.4.3. Rack assemblies for pole mounting

4.4.3.1. Racks and pole mount frames shall be constructed with MIG welded mild steel angular section and channel section of minimum thickness 6mm. On completion of all required welding and drilling the completed racks shall be grit blasted in accordance with Swedish Standards SA2.5 and hot dipped galvanized in accordance with ASTM A123 with a minimum average zinc coating of 85µm.Compliance with these requirements shall be verified by routine tests that measure coating thickness.

4.4.3.2. The capacitor bank rack shall include appropriately positioned lifting eyes such that rack assemblies can be evenly lifted in place.

4.4.3.3. 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.

4.4.3.4. Capacitors shall be mounted in racks capable of holding three (3) units with spacing of 225 mm between unit centerlines.

4.4.3.5. All high voltage connections shall be made using 25mm^2 copper wires (either stranded or solid), with 5 kV cable insulation.

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

4.4.4. Capacitor Protection

4.4.4.1. The capacitor banks/units protection shall meet all the requirements of IEC 60871-3 and that of this specification. They shall be provided completely with internal and external protection which is considered as part of the capacitor equipment.

4.4.4.2. Nevertheless, the general stipulations of this specification shall be applicable.

4.4.4.3. 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.

4.4.4.4. 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.

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

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

NOTE: *The supplier must include in his bid the following for tender evaluation:*

a) Calculations of constraints subjected to the capacitor unit,

b) The fuse's time-current coordination curve.

c) Recommendations for fusing to provide a satisfactory probability against case rupture.

d) Case rupture curves for the manufactured capacitors

4.4.4.7. Over-voltage protection

The supplier shall propose and provide suitable surge arrestor type and connection arrangement in order to limit any - transferred internal and external over-voltages on the capacitor banks.

The capacitor bank controller shall include settable over voltage protection for sustained over voltage conditions.

4.4.4.8. Loss of Capacitance

Facilities shall be provided to allow for safe, simple and quick identification of defective capacitor units. Portable test equipment or other means shall be supplied being able to detect defective units.

NOTE – *The manufacturer shall provide curves or tables showing the capacitor losses (or tan δ) under steady-state condition at rated output as a function of ambient temperature within the temperature category*

Table 1: Summary of technical characteristics of capacitor Units and capacitor banks

Particulars	**Units**	**Required**
Capacitor banks		
Power	KVar	300 & 600
Rated voltage	kV	11
Highest voltage	kV	12
Insulation level	kV BIL	38/95
Frequency	Hz	50
Arrangement	Ungrounded single star	
Number of capacitors	no	3
Control voltage	Vac	Supplier to specify
Temperature class	D	
Temperature range	^{0}C	-5/ (+45)
Frame	Hot dipped galvanized steel	
Capacitor units	**Units**	**Requirements**
Type		All film
Rated current unit capacitor	A	specify
Rated voltage unit capacitor	kV	specify
Nominal capacitance and maximum permitted tolerance for each unit capacitor	μF/%	specify
Insulation level of each capacitor bank		specify
Insulation levels Impulse withstand voltage	kVp	95
Power frequency with stand voltage	kVrms	38
Maximum ambient temperature	°C	45
Total loses including discharge resistors	W/KVar	< 0.2
Discharge time	< 75 V within 10 min	
Continuous over voltage	1.1 xVn (rated voltage) for 12 hrs. daily	
Continuous over current	1.3 x In (rated current)	
Capacitance tolerance	–5 % to +15 % for capacitor units	
Connections	1 - phase	
Dielectric material	Bidder to specify	
Container	Stainless steel, 304 high grade	
Bushings	Grey porcelain (RAL 7035)	
Creepage distance (outdoor enclosed installation)	mm	400

4.5. CAPACITOR SWITCH

4.5.1. Design and construction

4.5.1.1. Each pole mounted capacitor bank shall be controlled by a suitable vacuum (or SF_6) switches for switching in and out the respective capacitors, as determined and initiated by the capacitor bank controller.

4.5.1.2. Vacuum (or SF_6) switches shall be of similar electrical ratings produced and tested in compliance with the latest revision of ANSI C37.66 standards or equivalent IEC standard

4.5.1.3. Vacuum (or SF_6) switches shall include a manual operating lever. Vacuum (or SF_6) witches shall include a multi-pin receptacle for control wiring connections to a rack-mounted junction box assembly.

4.5.1.4. The control voltage of the switch shall be specified by the bidder.

4.5.1.5. Switched banks shall include a weather tight junction box / cable assembly mounted on the rack side near the pole.

4.5.1.6. Each junction box assembly shall include 2.5mm^2 control cables rated for 600 volts with a minimum of three conductors color coded in accordance with IEC norms. These cables shall include multi-pin plugs to mate with switch receptacles and shall terminate in a terminal block mounted within the junction box.

4.5.1.7. Terminal blocks shall be appropriately marked to indicate purpose i.e. supply, earth, close, open, etc.

4.5.1.8. Junction box covers shall be gasketed and fixed by corrosion resistant screws.

4.5.1.9. The tenderer shall provide details of the proposed vacuum/SF_6 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.

Table 2: Technical details of a vacuum (or SF_6) switch

S. No.	Characteristics	Units	Requirements
A	**Vacuum /SF_6 Switch**		
1	Rated voltage	kV	11
2	Highest rated voltage	kV	12
3	Rated impulse withstand voltage	kV	38 kVrms AC / 95 kVp
4	Continuous current rating	A	200 A capacitive
5	Symmetrical current rating	A	6,000
6	Asymmetrical current rating	A	9,000
9	Electrical endurance	Operations	10,000
10	Mechanical endurance	Operations	25,000
12	Installation	Outdoor	
13	Mounting	Pole mounted	
14	Power Interface	To be specified	
15	Indication	Switch CLOSE/OPEN	

4.6. SURGE DIVERTER

4.6.1. General design and construction

4.6.1.1. The surge arrester shall be a special type arrester, designed and constructed in accordance with IEC 60099-4, and the requirements of this specification. The surge arrestors and connection arrangement shall be suitable to limit any possible capacitor bank generated over-voltages and protect the capacitor bank equipment from both internally generated over-voltages and over-voltages from the distribution system.

4.6.1.2. The surge arresters shall have non-linear metal-oxide resistors with highly non-linear voltage-current characteristics, connected in series, but having no integrated series or parallel spark gaps

4.6.1.3. The metal-oxide used shall be of quality to ensure thermal stability under service duty of the surge arrester and shall be single column; self-supported and be installed between phase and earth.

4.6.1.4. The guaranteed protection characteristics of the surge arrester based on IEC 60099-4 & 5 selection formulas and shall be required to comply during tests, with all the withstand capabilities stated in Table 3.

4.6.2. Housing

4.6.2.1. The housing of the surge arrester shall be made of high quality reinforced high temperature vulcanized (HTV) silicone rubber based on dimethyl silohexane.

4.6.2.2. The reinforced HTV silicone rubber shall have a Shore 'A" hardness of not less than 60 as per ISO 48 and the track resistance of the sheath and shed materials shall meet the requirements of IEC 60587 Method 1 Class 1A4.5 or 1B4.5 or Method 2 Class 2A4.5.

4.6.2.3. The housings shall meet the requirements of IEC standards demonstrating shield resistance of less than 5000Ω and capability of initiating two consecutive fault-current arcs to ground.

4.6.2.4. The surge arrester shall be designed and constructed in a manner so as to prevent explosive shattering relief capability (short circuit) as per Table 3.

4.6.2.5. The entire insulator housing shall have the rated withstand voltage given in Table 3 based on IEC 60099-4 clause 6.1. The creepage distance shall be based on nominal line-to-earth voltage and shall be 400mm minimum.

4.6.2.6. Insulator sheds shall be open type, designed to minimize trapping of contamination. It shall be made of polymer having glazed brown or gray color. The silicon rubber housing shall be made by direct molding method.

4.6.3. Disconnector

4.6.3.1. Disconnector shall be an integral part of the arrester to give a visual indication of a failed arrester by disconnecting it from the system while the line remains in operation after disconnection of the arrester. This shall be an explosive device triggered by the fault current; but shall extinguish the fault current.

4.6.3.2. The disconnected shall be incorporated in the arrester and shall withstand, without operating, long-duration current impulse test and operating duty tests as per IEC 60099-4.

4.6.4. Moisture Sealing

4.6.4.1. 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.

4.6.4.2. The supplier shall describe the moisture sealing system used and shall state his own experience with the design offered. The method of factory testing of the sealing shall be described. It is the discretion of KPLC either to accept or to ask the manufacturer to modify the surge arrester design and construction.

4.6.5. Mounting Arrangement

4.6.5.1. The surge arrester shall be supplied complete with an insulating mounting bracket made of a base polymer or cast resin. The device shall withstand each of the following tests without damage:

a) Environmental tests –
   (i) Temperature cycling tests
   (ii) Salt mist tests in accordance with IEC 60099-4 clause 8.10
b) Bending tests as per IEC 60099-4 clause 8.9

4.6.5.2. The mounting brackets shall be NEMA type mounting brackets to facilitate mounting of arresters on angle or channel iron type cross arms suitable for both horizontal and vertical mounting on a steel cross-arm (U-channel).

4.6.5.3. The brackets shall have fixing accessories and connector suitable for both copper and aluminum conductors of up to 12.5mm diameter.. All parts shall be protected against corrosion.

4.6.6. Corrosion Protection:

All metal parts shall be hot dip galvanized in accordance with the ASTM A123 with exception to stainless steel. In all cases the supplier shall clearly mention the protective measure used when dissimilar metals are in contact.

4.6.7. Terminals:

Terminals shall be clamp or lug type and shall be constructed for both copper and aluminum conductors of up to 12.5mm diameter and a continuous work shall be guaranteed without any deterioration. Full details of the design of terminals shall be submitted at the time of tendering and must receive KPLC approval.

4.6.8. Characteristics

The surge arresters shall be of the following minimum characteristics:

Table 3: Withstand capabilities of surge arrestor housing as per IEC 60099-4& 5

Description	Units	Requirement
Lightning impulse withstand voltage,	kVpk	95
Power frequency withstand voltage for 1 min, wet	kVrms	38
Creepage distance, 31mm/kV, mm		400
Permissible head load static	N	Manufacturer to state
Permissible head load dynamic	N	Manufacturer to state
Short circuit withstand capability (rated short circuit (withstand) current Is)	kA	20
Permissible length of the active part	mm	Manufacturer to state
Housing shield resistance	Ω	<5,000
Number of units		3 for each capacitor bank

NOTE: *The design parameters of the special surge arrester to be stated by the manufacturer shall be accompanied by an analytical evidence to prove how the values have been arrived at in relation to the service conditions stated in clause 4.1, with the bid for tender evaluation.*

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Table 4: Guaranteed protective data for Arrester calculated as per IEC 60099-4 & 5

Description		Requirement
Maximum system voltage, Um, kV		12
Rated voltage, Ur, kV		11
Maximum continuous operating voltage, kVrms	As per IEC 60099-4, Uc	Manufacturer to state
Temporary overvoltage capability (TOV), kVrms	1 s	Manufacturer to state
	10 s	Manufacturer to state
Maximum residual voltage with current wave	5 kA 8/20 µs	Manufacturer to state
	10 kA 8/20 µs	Manufacturer to state
	20 kA 8/20 µs	Manufacturer to state
	40 kA 8/20 µs	Manufacturer to state
	500 A 30/60 µs	Manufacturer to state
	1 kA 30/60 µs	Manufacturer to state
	2 kA 30/60 µs	Manufacturer to state
Lightning impulse protective level, max, kV as per IEC 60099-5		Manufacturer to state
Steep current impulse protective level, max, kV as per IEC 60099-5		Manufacturer to state
Energy discharge capability , kJ/kVr at Ur		Manufacturer to state
Metal oxide (MO) diameter , mm		Manufacturer to state
Height of the MO resistor column, mm		Manufacturer to state
Long duration discharge class (current compliance)	Current, A	Manufacturer to state
	Duration , µs	Manufacturer to state
	Discharge tolerance, %	Manufacturer to state
Accelerated ageing performance	Temperature , ^{0}C	Manufacturer to state
	Time, hrs	Manufacturer to state
	Watt loss	Continuous decreasing
Operating duty characteristics (Discharge current withstand)	Two 4/10µs current wave (Ur) , kA	Manufacturer to state
	Low current at 2000µs, kApk	Manufacturer to state
	Discharge tolerance, %	Manufacturer to state
Partial discharge performance, pC as per IEC 60270.		< 10
Pressure relief withstand capability (Short circuit)	High symmetrical RMS (A), duration (s)	20 kA at 0.2s
	Low symmetrical RMS (A), duration (s)	2 kA at 1s
	Asymmetrical peak (A)	50 kA at 0.2s

4.7. CONTROL POWER/ MEASUREMENT VOLTAGE TRANSFORMER

4.7.1. Design and construction

4.7.1.1. A control power / measurement voltage transformer (VT) shall be supplied to operate the switches and the capacitor bank controller and to measure the HV line to line voltage measurement. The design, manufacture and testing shall conform to IEC 60076/IEC 61869 standard and to be installed on the capacitor bank rack.

4.7.1.2. The VT shall be rated 1kVA minimum rating with LV rating to be specified.

4.7.1.3. The VT shall be suitable to provide the necessary power to operate three vacuum switches at a reduced line voltage of 10kV.The VT shall provide measurement

accuracy with maximum error of ±1% over the range of line to line voltage of±10% of 11kV and at the actual burden of the secondary measurement circuit.

4.7.2. Characteristics

Table 5: Technical characteristics of a control power/measurement transformer

S. No	Characteristics	Units	Ratings
1	Power rating	kVA	specify
2	Insulation levels Impulse withstand voltage	kVp	95
3	Power frequency with stand voltage	kVrms	38
4	Kind of insulation	specify	
5	Rated voltage	kV	12
6	Ratio	kV/kV	11/ specify
7	Temperature rise	As per IEC 60076-2	
8	Accuracy class	Class 1.0 up to 100VA burden	
9	Bushing type	HTV Silicon Rubber/Porcelain	
10	Creepage	mm	400

4.8. CURRENT SENSOR

4.8.1. Design and construction

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

4.8.1.2. A suitable ultraviolet-resistant cable, at least 5 m long and rated 15kV 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.

4.8.1.3. 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.

4.8.1.4. Insulator shall be open profile type with characteristics complying with the guidelines in annex D of IEC 60815.

4.8.1.5. The bushing material shall be either porcelain or HVT silicone rubber. The minimum bushing creepage distance from phase-to-earth (in mm) shall be 400mm.

Table 6: Technical details of a current sensor

S. No.	Characteristics	Units	Ratings
1	Voltage rating	kV	12
2	Insulation levels Impulse withstand voltage	kVp	95
3	Power frequency with stand voltage	kVrms	38
4	Ratio	A/V or A/A	specify
5	Accuracy		± 2%
6	Insulator		specify

7	Creepage distance	mm	400

4.9. FUSE CUT-OUTS

4.9.1. General

4.9.1.1. The expulsion fuse cutouts shall be of Class A as per IEC 60282-2. It shall be suitable for use in outdoor circuits under tropical conditions stipulated in clause 4.1 above. The expulsion fuse shall be complying with the minimum technical requirements stipulated in Table 4.

4.9.1.2. Current-limiting HV HRC fuses to IEC 60549 shall be used with the cutouts. If capacitors are overloaded, or any fault occurs, these shall help prevent the capacitor casing rupturing.

4.9.1.3. As heavy transient currents and high voltages can occur when capacitors are switched in and out, the fuse rating shall be at least twice the value of the capacitor current rating, and the voltage rating of the HV HRC fuse shall be one level higher than the network nominal voltage (e.g. for a 12kV network voltage use a fuse with a 24kV voltage rating). IEC 60549 must be complied with.

4.9.2. Design and construction

4.9.2.1. The expulsion fuse shall be designed with a solid core, bird proof, and one (1) piece porcelain/ HVT silicon rubber insulator and, it shall be robust enough to withstand shocks due to frequent operations. The fuse carrier shall drop-out immediately following the blowing of the fuse.

4.9.2.2. Expulsion fuses within the same voltage class shall be so designed that fuse carrier together with mounting assembly shall be dimensionally compatible to facilitate the interchange of fuse carriers of the cutouts of corresponding rating.

4.9.2.3. The cutouts shall be able to mount on a single channel iron cross arm at an angle of 15 to 20 degrees to the vertical .The whole unit shall be complete with long mounting bracket, bolts, nuts and washers.

4.9.2.4. Fuse carrier shall be made of high strength fiberglass filament wound tube or suitable insulating material and it shall be protected from weather and environment by a ultraviolet resistant coating. Inside liner of the fuse tube shall be constructed of a synthetic arc quenching material.

4.9.2.5. Copper arc shortening rod shall be attached to the cap of the fuse tube to obtain higher interrupting rating. A removable button head type fuse link having M6x1 thread shall be able to fix to the arc shortening tube.

4.9.2.6. The installation and removal of the fuse carrier shall be facilitated by inserting the operating rod into a lifting eye at the hinge end (lower) of the fuse carrier when it is in the dropped out position. An operating lever eye shall be provided at the top of

the carrier to facilitate a downward pull by the operating rod to release the latch incorporated in the stationary upper contact

4.9.2.7. All castings such as upper and lower moving and fixed contacts, clamp type terminals, toggle mechanism shall be of phosphor bronze, silicon bronze, aluminum bronze or silver-plated brass.

4.9.2.8. All iron and steel parts such as mounting and support brackets, bolts and nuts, washers etc. shall be galvanized after processes such as sawing, shearing, drilling, punching, filling, bending and machining are completed. Galvanizing shall be the hot-dip process to comply with the standard ASTM A123.

4.9.3. Stationary and Movable Contact

4.9.3.1. The stationary and movable contact surfaces shall be silver plated to minimize the contact resistance.

4.9.3.2. The upper stationary contact assembly shall be provided with a safety latch to prevent the fuse carrier from dropping due to vibration and The upper contacts shall be protected from any airborne contaminants

4.9.3.3. A back up spring made out of stainless steel or phosphor bronze shall be provided to ensure constant pressure between the upper stationary contact and the upper movable contact of the fuse carrier.

4.9.3.4. The lower stationary contact support and the fuse carrier shall be machined at the swiveling or axle point to enable the fuse carrier with the fuse link to be correctly guided into the latching position by an operating rod. The hinge at the stationary contact shall be so designed to prevent the dropping off of the fuse carrier in the drop-out position, due to shock and vibration.

4.9.3.5. A suitable guiding arrangement shall be provided in the upper contact to ensure easy engagement of the fuse carrier.

4.9.3.6. The asymmetrical breaking current ratings shall be permanently marked on the upper metal part.

4.9.4. Terminals

4.9.4.1. The upper and lower terminals shall be of Bi-metallic type, suitable to accommodate copper/aluminum conductors of sizes from 5mm to 14mm diameter.

4.9.4.2. The upper terminal shall be positioned to receive the conductor from either side or upward direction while the lower terminal shall be able to receive the conductor from either side or downward direction.

4.9.4.3. The maximum temperature rise for contacts (movable and stationary) shall not be more than 40º.C and, for terminals the temperature rise shall not be more than 30º C.

Table 7: Technical characteristics of a fuse cutout

S. No	Particulars	Units	Ratings
1	Rated voltage	kV	11
2	Highest Voltage	kV	12
3	Rated continuous current	A	200
4	Insulation level		
	1. Dry impulse withstand (1.2/50μs) voltage (positive and negative polarity) (peak)		
	(i) Across the isolating distance of the fuse base	kVpeak	95
	(ii) To earth and between poles	kVpeak	85
	Wet 1 minute power frequency withstand voltage (rms)		
	(i) Across isolating distance of the fuse base	kVrms	45
	(ii) To earth and between poles	kVrms	38
5	Total creepage distance	mm	400
6	Mounting angle	degrees	15 - 20
7	Interrupting rating		
	(i) Symmetrical interrupting rating (minimum) rms	kA	8
	(ii) Asymmetrical interrupting rating (minimum) rms	kA	9.6
	(iii) X/R ratio		4.0

4.10. INRUSH CURRENT REACTOR

4.10.1. General

4.10.1.1. The inrush current reactors shall be single-phase, dry type, mounted on suitably rated support insulator; manufactured and tested as per the latest version of IEC 60076-6.They shall be designed for the full system lightning impulse-withstand level with the temperature rise limits as specified in IEC 60076-2.

4.10.1.2. The inrush current reactors shall be required in order to limit the high inrush current occurring when switching two or more parallel capacitor banks. The reactors shall be sized to eliminate unwanted tripping of the earth-fault protections.

4.10.1.3. The maximum permissible (overload) current of the inrush current reactor shall be equal to the corresponding value of the capacitor bank as called for in the relevant standards for power (shunt) capacitors.

4.10.1.4. The reactors shall also be dimensioned so that the harmonics created during switching-in of the bank does not disturb other equipment inside or around the substation. Verification of this shall be done by site measurements during commissioning tests.

4.10.1.5. The transient current that flows on energizing shall not exceed the rated making current of the vacuum switch controlling the capacitor bank

4.10.1.6. The current calculation which flows upon energizing shall be declared

4.10.2. Ratings

4.10.2.1. The rated continuous current rating of the inrush current reactor shall be selected at least equal to the maximum permissible current of the associated capacitor

NOTE - *The maximum permissible current according to IEC 60871-1 for power capacitor is a current with the rms value equal to 1.3 times the value obtained at rated sinusoidal voltage across the capacitor.*

4.10.2.2. The rated inrush current shall be selected to cover all recognized cases of switching the capacitor. The relevant inrush resonant frequency shall be specified in the inquiry. The manufacturer shall on request supply information about the expected Q-factor of the inrush current reactor at this frequency. The reactor shall be capable of withstanding the dynamic effects of this rated inrush current. :

NOTES

1. *The thermal effect of the inrush current is normally without significance.*
2. *If the reactor is required to withstand overcurrent in excess of the rated inrush current, for example, due to capacitor faults the magnitude and duration of such overcurrent shall be specified.*

4.10.2.3. The insulation level shall correspond to the highest voltage for equipment Um of the system in which the reactor is to be installed.

4.11. CAPACITOR BANK CONTROLLER

4.11.1. General requirements

4.11.1.1. The Capacitor Bank Controller (CBC) shall be designed to control utility distribution capacitor banks by a vacuum switch. The controller shall have the ability to operate independently using site measurement values or remotely by wireless communications.

4.11.1.2. If communication is lost, the CBC shall have the capability to provide a backup failsafe operational mode using the site measurement values.

4.11.2. Control cabinet

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

4.11.2.2. 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.

4.11.2.3. 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 male part of the connector shall be mounted on the capacitor bank controller and the female part shall be mounted on the cable.

4.11.2.4. 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.

4.11.2.5. 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.

4.11.2.6. 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.

4.11.2.7. 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.

4.11.2.8. 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.

4.11.2.9. 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.

4.11.3. Electronic control equipment

4.11.3.1. The controller shall be microprocessor based and shall not suffer any damage if one or more phases of the system are open upstream or downstream.

4.11.3.2. Electronic modules shall perform continuous diagnostic monitoring and shall contain hardware and software watchdog checking.

4.11.3.3. Electronic modules shall be suitably protected against voltage surges. Details of the onboard surge protection shall be provided in the tender documentation.

4.11.3.4. The upper limit of the date window shall extend until at least 2075.

4.11.4. Configuration port

4.11.4.1. To facilitate remote configuration via standard Data Communication Equipment (DCE), the configuration port shall be a standard EIA-232 or Ethernet port. The configuration port shall be configured as Data Terminal Equipment (DTE). For local configuration USB port shall be provided on the front panel of the controller.

4.11.4.2. The capacitor controller will therefore connect to a modem using a modem cable (straight through), and to a PC using USB port

4.11.4.3. The configuration port shall as a minimum be capable of asynchronous communication with hardware handshaking.

4.11.4.4. The configuration port shall be capable of operating at the following data communication speeds as a minimum requirement: 1 200, 2 400, 4 800, 9 600 and 19 200 bits per second.

4.11.5. Configuration software and firmware

4.11.5.1. The capacitor control shall be fully configurable from a PC, utilizing the controller's configuration software.

4.11.5.2. The configuration software shall be compatible with at least one Microsoft Windows Operating System less than 2 years old and another that is between 2 and 5 years old at time of tender. Software is regarded as an integral part of the capacitor control and shall therefore be included as part of the package at no additional cost.

4.11.5.3. It shall be possible to perform future firmware upgrades via the configuration port. Firmware upgrades involving EPROM replacement is not acceptable.

4.11.5.4. Software and firmware updates shall be made available to KPLC at no additional cost for a minimum of 5 years after the delivery of the unit.

4.11.5.5. Software and firmware updates shall be fully backward compatible with all units less than 15 years old.

4.11.6. Control features

The following control features shall be provided:

a) **Voltage control**:
The voltage control function shall be provided with a settable range.

b) **VAr control**:
The VAr control function shall be provided with a settable range between 1 to 1600 kVAr in 1 kVAr increments.

c) Time control:
The time control function shall be provided with a settable range of 24 hour with 1 minute increments.

4.11.7. Control requirements

4.11.7.1. The capacitor controller shall be equipped with a battery backed up real time clock (RTC) with leap year support. It shall be possible to set the clock via the configuration software to within 1s of the PC's clock.

a) The accuracy of the clock shall be better than 12 (twelve) parts per million across the whole operating temperature range.

b) The resolution of the clock shall be 1 second or better i.e. CCYY/MM/DD hh:mm:ss.
c) The RTC battery shall provide at least 50 days of total standby time. The battery should not need replacing more often than every ten years.

4.11.7.2. Non-volatile memory storage shall be sized to store the following minimum data:

a) An event record containing:
(i) The last 20 occurrences of changes to the capacitor bank operating parameters; and
(ii) At least the last five capacitor bank operation events. The actual number available shall be stated in the tender documentation,

b) Operation counters
(i) All events shall be time and date stamped with a resolution of at least 1s relative to the onboard real time clock and shall be recorded sequentially and chronologically.
(ii) The naming of the events in the event recorder shall be consistent with those used on the operator panel.
(iii) The event recorder shall operate on the FIFO principle.
(iv) A pointer shall be provided to indicate up to where the data was last read. This will enable regular uploading of the data without re-loading of previously read data. Registers shall not clear automatically after uploading of data. The option to clear the register after uploading shall be provided to the user.

4.11.7.3. The option to download all available information in the databases in one dump shall be provided. A total dump shall be done in less than 5 min at a 9600 baud rate. The option to also download user selectable segments of the database will be preferred.

4.11.7.4. Preference will be given to units that do not require specialized test equipment; it should thus be possible to test the full functionality of the unit with a universal test set.

4.11.7.5. If specialized test equipment is required the cost of these units shall be provided in the tender documentation. The detailed drawing of the control cable pin-outs shall be provided.

4.11.7.6. Terminals shall be provided for the connection of an external voltmeter to measure the capacitor bank input voltage.

4.11.7.7. Adequate fuse protection shall be provided to protect the control from the external power supply.

4.11.7.8. The capacitor control will be powered from an auxiliary transformer that complies with the requirements specified in clause 4.7 of this specification. The controller shall therefore be compatible with the specified VT secondary voltage.

4.11.8. Measurement functions.

The measurement functions that are provided with the capacitor controller shall be clearly defined in the tender documentation. They shall include:

a) VAR
b) Voltage
c) Current
d) Time
e) Thresholds from the analog inputs
f) Remote
g) Backup communication lost

4.11.9. Local control and indication

4.11.9.1. All local controls and indications shall be accessible in adverse weather conditions. Switches used for local control shall offer the type of control described in Table 8, i.e. secure control.

4.11.9.2. Electronic keypad controls shall offer 'quick key' (maximum of one keystroke) access to the controls in Table 8, if not implemented with switches. The following set of switches shall be provided:

a) A controller power switch with two positions, ON and OFF for powering up and down of the controller.
b) An operation control switch with two positions, Auto and Manual for the selection of either automatic or manual operation of the capacitor bank.
c) A service control switches with two positions, IN and OUT for switching the capacitor bank in or out of service.

Table 8 −Minimum specification of local controls and indications

Item	**Features**	**Remarks**
Local control (See note 1)	Capacitor bank operation: **Auto/Manual**	Secure control
	Capacitor bank service: **OPEN/CLOSE**	Secure control
Local state indication (See note 1)	Capacitor bank operation: **Auto/Manual**	
	Capacitor bank: **OPEN/CLOSE**	
	Power supply fail	
	Operation counter	

NOTES:

1. *The local control and indication features on the control panel shall be labelled as presented in '**Features**' column.*
2. *The type of switch used for local control shall not allow for a conflict to exist between the switch position and the function status.*

4.11.9.3. A facility for setting all the control features, operating parameters and communication (modem) parameters shall be locally fixed in the control cabinet. Password protection against unauthorized changes shall be provided.

4.11.9.4. It shall be possible to manually reset these counters under password control.

4.11.10. Tele-control requirements

4.11.10.1. Capacitor controllers are required to provide full functionality of the configuration software via a GSM modem.

4.11.10.2. The modem shall be fitted by KPLC and will be in accordance with the relevant standards. The modem will be connected to the configuration port, as specified in clause 4.11.4.

4.11.10.3. The capacitor controller shall be capable of providing power for the modem. The power requirements for the modem are:

a) Input Voltage – to be specified
b) Input current – to be specified

4.11.10.4. To enable remote communication via GPRS, the software shall support DNP3.0, TCP/IP and UDP/IP protocols for the advanced use of RTUs, SCADA master stations and IEDs.

4.11.10.5. For full flexibility, this shall include polled and unsolicited responses, support up to class 3 polling, and DNP3.0 time synchronization. Using analog output points, the auto switch mode programmable parameters shall also be remotely configured.

4.11.10.6. For transmitting remote data, the controller shall support EIA-232or Ethernet (TCP or UDP) communication ports allowing a wide range of modem / radio devices to be used, while also accepting to retrofit with existing communications infrastructure.

4.11.10.7. In case there is a problem with the communication system (i.e. master station is down, communication power failure), the PFC shall be equipped with a configurable time-out period which returns the unit to local automatic mode until the communication link has been restored.

4.11.10.8. The controller shall also allow for remote monitoring and recording while the unit is in local automatic control mode.

4.12. AUXILLIARY ACCESSORIES

4.12.1. The supplier shall provide:

a) A complete listing of all accessories mounted on the rack including descriptions / ratings for but not limited to:

- Vacuum switches, SF_6
- Control power/ voltage measurement transformer,

- Surge arresters
- (other special materials)

b) List of accessories to be shipped separately (for mounting by customer) including but not limited to:

- Controls
- (other special materials)

4.12.2. Outline drawing of pole top equipment showing all capacitor units and accessories with the related wiring and including schematic view of junction box terminal shall be submitted by the tenderer in the bidding document for evaluation. .

4.12.3. Listing of all exceptions or deviations from this pole top capacitor equipment specifications shall be submitted by the tenderer in the bidding document for evaluation.

5. TESTS AND INSPECTION

5.1. General

5.1.1. The Auto Switched Capacitor Bank shall be inspected and tested in accordance with the requirements of IEC 60871, IEC 60137, IEC 60867, IEC 60282, IEC 60099, IEC 61869, IEC 60529, ANSI C 37.66, ANSI C 29.9, ASTM A123 standards. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works.

5.1.2. The capacitors bank assembly shall be of design and construction which have been validated by the type tests specified in the applicable standards. Additional tests may be required to verify adequate over- voltage endurance and life for which the manufacturer may supply a certified test report.

5.1.3. Copies of previous Type Tests Reports issued by a third party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the tender for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third party testing laboratory used shall also be submitted with the tender (all in English Language)

5.1.4. Routine tests on the capacitor banks assembly shall be carried out by the manufacturer as per the latest edition of relevant IEC standards and as mentioned in this specification. The complete routine test report shall be submitted to KPLC for approval two (2) weeks before inspection.

5.1.5. Also two (2) sets of inspection packages (which shall include approved set of drawings, test procedures, copies of relevant standards, day wise test programme etc.) shall be submitted at least two (2) weeks before each inspection.

5.1.6. All capacitor banks complete will all accessories shall be offered for factory acceptance tests and inspection in the presence of KPLC engineers.

5.1.7. During inspection by KPLC engineers, at the manufacturer's works, the quantities of equipment etc., which will be ready and offered for inspection and tests, shall be considered already tested. The remaining components shall be subject to future tests whenever they will be ready.

5.1.8. On receipt of the goods KPLC may perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC any equipment or component parts which upon examination, test or use fail to meet any of the requirements in the specification

5.2. Factory acceptance tests on fully assembled pole mounted capacitor banks

5.2.1. The Auto Switched Capacitor Bank shall be inspected and tested in accordance with the requirements of IEC standards. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works. The factory acceptance tests to be witnessed by KPLC engineers at the factory before shipment shall be in accordance with IEC standard and this specification and shall include the following:

a) Repeat of routine tests on representative sample.
b) Power frequency withstand test
c) Lightning impulse withstand test
   The lightning impulse withstand test shall be carried on a sample of completely assembled capacitor bank to verify the design and clearance requirements. The test shall be carried on each phase independently by opening the star point connections and shorting the capacitor terminals of the phase under test while the other phases are connected to ground.
d) Functional Tests
   Complete verification of control scheme on an assembled capacitor bank shall be carried out to demonstrate the operation and functioning of vacuum switches and capacitor bank controller.
e) Measurement of VT and current sensor characteristics
   This shall include polarity check and verification of winding ratios by primary injection.
f) Visual and dimensional check
   The capacitor bank assembly shall be verified as per the approved drawings to ensure that the bank complies with all the requirements of design and minimum clearances.
g) Creepage measurement
h) Galvanization thickness
   Inspection for appearance and the presence of defects after galvanizing and verification of galvanizing thickness and adhesion shall be carried out on randomly selected samples.
i) Capacitance measurement of units

5.2.2. Copies of manufacturer's Routine and Type Tests Reports for capacitor units, vacuum switches, current sensors, capacitor bank controller and surge arrestors issued by a third party testing laboratory shall be made available for the purpose of technical evaluation/comparison at the time of inspection.

5.3. Tests on capacitor units

5.3.1. Type Tests

Type tests on the capacitor units shall be performed by the manufacturer on a sufficient number of capacitors to demonstrate that the design meets the applicable IEC standards. Capacitors shall first meet routine tests before being subjected to type tests. Type tests shall include:

a) Thermal stability test
b) Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
c) AC voltage test between terminals and container
d) Lightning impulse voltage test between terminals and container
e) Short-circuit discharge test
f) Disconnecting test on internal fuses

5.3.2. Routine tests

Routine tests on the capacitor units shall be witnessed by KPCL at capacitor unit manufacturer's factory. Each capacitor shall be subjected to the routine tests as specified in the applicable IEC standards

Routine tests shall include:

a) Capacitance measurement
b) Measurement of the tangent of the loss angle (tan δ) of the capacitor
c) Voltage test between terminals
d) AC voltage test between terminals and container
e) Test of internal discharge device
f) Sealing test
g) Discharge test on internal fuses

5.4. Tests for the Accessories

All routine tests shall be carried out by the component manufacturer in accordance with the applicable IEC standards. The manufacturer routine test reports shall be made available at the time of factory acceptance test for evaluation and comparison.

5.4.1. Auxiliary Voltage Transformers

Routine tests shall be carried out in accordance with IEC 60076-1/ IEC 61869-3

5.4.2. Vacuum Switch

Routine tests shall be carried out in accordance with ANSI C37.66.

5.4.3. Current Sensors

Routine tests shall be carried out in accordance with applicable standards.

5.4.4. Fuse cutout and fuse link

Routine tests shall be carried out in accordance with IEC 60282-2 / IEC 60549

5.4.5. Inrush current reactor

Routine tests shall be carried out in accordance with IEC 60076-6.

5.4.6. Capacitor bank controller

Routine tests shall be carried out in accordance with IEC 60529 and other applicable standards

5.5. Site Tests

5.5.1. After the plant and ancillary equipment has been erected and connected on site, the supplier shall, under the supervision of the manufacturer, carry out tests to the satisfaction of KPLC. Details of site tests shall be agreed with KPLC, but shall include:

a) System measurements of harmonics to ensure that the addition of the bank has not affected the system.
b) Visual checks of all equipment (for damage, leaks etc.).
c) Continuity of Cable Connections and Phasing tests
d) Insulation between Phases, Insulation to Earth tests
e) Testing of Line Current sensor on the Capacitor Bank

5.5.2. Control and Protection

The bidder/supplier shall be responsible for carrying out required tests to prove the correct operation of the following equipment under the manufacturer's supervision.

a) Capacitor vacuum, SF_6 switch
b) Overvoltage Protection
c) Under-voltage Protection

5.5.3. Mechanical Inspection

All capacitor bank controllers shall be examined to ensure that they are in proper working condition and correctly adjusted, correctly labeled and that the relay case, cover, and gasket are in good order and properly fitting.

5.5.4. Operations

Tests are to be carried out to prove the correctness of all polarities, the operating levels of capacitor bank controller and the correct functioning of control schemes, selection and control switching, indicating and alarms.

5.5.5. Wiring

5.5.5.1. Any wiring, if carried out at site shall be checked to the appropriate circuit wiring diagram.

5.5.5.2. Where it is found necessary during pre-commissioning work, to effect site modifications to the secondary wiring, site copies of the appropriate schematic and wiring diagrams shall be suitably marked as agreed with KPLC before the circuit is commissioned.

5.5.5.3. Loop resistance measurements are to be made on all current transformer circuits.

5.5.6. Secondary Injection

Secondary injection test shall be carried out on all capacitor bank controllers and meters using voltage and current of sinusoidal waveform at rated power frequency.

5.5.7. Operation of Capacitor bank controller

Functional testing of the numerical capacitor bank controller shall be carried out.

6. PACKING AND MARKING

6.1. Packing

6.1.1. All capacitor banks and accessories shall be supplied separately packaged in wooden boxes/crates suitable for seaworthy packing, transportation by rail/road storage etc.

6.1.2. These boxes/crates shall allow for access (by the KPLC acceptance personnel) so that the capacitor banks and accessories may be easily removed for inspection and then be easily repacked and sealed for holding in store.

6.1.3. The packing may be in accordance with the manufacturer's standard practice unless otherwise specified. The supplier shall however, ensure that the packing is such that the equipment reaches the destination locations without damages after transport by rail, road or sea. The packing shall stand unloading and inter stores transfer with reasonable care.

6.2. Marking

6.2.1. The marking shall be indelible, permanent and easily legible.

6.2.2. The nameplates shall be anodized aluminum for all the component parts and shall be located on the narrow side of every equipment and shall contain the following information in English language:

a) Name of manufacturer
b) Unique serial number
c) Catalog number
d) Year of manufacture
e) Rated capacitance for capacitor banks.

f) Rated rms voltage
g) Number of poles
h) Rated frequency
i) Rated BIL
j) Amount of fluid, indicate flammable or not flammable.
k) Statement that the capacitor contains an internal discharge device
l) In addition, the capacitor shall be identified as containing NO PCB's by means of a colored label.
m) Standards of manufacture (IEC 60871 etc.)
n) Words "**PROPERTY OF KPLC".**

6.2.3. Instructions for storage, handling and installation shall be provided, all in English language.

7. DOCUMENTATION

7.1. The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation.

7.2. The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

a) Guaranteed Technical Particulars,
b) Design drawings and construction details of the capacitor banks assembly,
c) Quality Assurance Plan (QAP) that will be used to ensure that the capacitor banks assembly design, material, workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations.
d) Test Program to be used after manufacture,
e) Marking details and method to be used in marking the capacitor bank assembly,
f) Manufacturer's undertaking to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the fuse links for KPLC,
g) Packaging details of all the components.
h) Each proposal shall include the following documentation for evaluation purposes:
   - Description of capacitor units
   - Number of series sections
   - Voltage per section
   - Average dielectric stress in volts per mil including both film & fluid thicknesses
   - Film thickness
   - Number of sheets of film
   - Outline drawings of capacitor units.
i) Material Safety Data Sheet and quantity of insulating fluid per unit.

j) Manufacturer's failure data on previous three years' shipments for year of manufacture and following year.
k) Certification of ability to pass capacitor design tests including over-voltage endurance as well as long-term life.

7.3. Drawings

7.3.1. The bidder shall furnish one set of following drawings along with their bid to check the stability of their equipment: -

- Outline general arrangement drawing of capacitor bank with detailed dimension of Capacitor Bank/Unit and structure with complete bill of materials.
- Electrical layout drawing of Capacitor Bank showing spacing of each equipment.
- Outline arrangement drawing of Capacitor Unit with detail dimensions.
- Outline general arrangement drawing of 12kV Power/measurement Transformer, Surge Arresters, Vacuum Switches, and Current Sensors etc.
- Terminal connector drawings for Capacitor Bank, Control Unit, Vacuum Switches etc.

7.3.2. The successful bidder shall, within four weeks of placement of order, submit five sets of final versions of all the above said drawings for KPLC's approval. KPLC shall communicate the comments/approval on drawings to the supplier within a period of four (4) weeks.

7.3.3. The supplier shall, if necessary, modify the drawings and re-submit five (5) copies of the modified drawings for KPLC's approval, within one (1) week from the date of purchaser's comments.

7.3.4. After receipt of KPLC's approval the supplier shall, within two (2) weeks submit five (5) prints along with reproducible of the approved drawings and descriptive literatures on capacitor and all allied equipment covered by the specification for KPLC's use.

7.3.5. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without written approval of the KPLC.

7.3.6. Approval of drawings by KPLC shall not relieve the supplier of any of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest version of applicable standard of engineering, design and workmanship and latest revision of relevant standards at the time of supply. KPLC shall have the power to reject any work or material which in his judgment is not in accordance there-with.

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ANNEX A: Guaranteed Technical Particulars

(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, four customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)

Sr. No	Particulars	KPLC requirements	Tenderer
1.0	**General**		
	Name of manufacturer (OEM)	Specify	
	Country of Origin	Specify	
	Delivery from (location)	Specify	
	Type & Designation	Specify	
	Type tested at:		
	Name of laboratory	Specify	
	Address of laboratory	Specify	
	Installation (indoor or outdoor)	Specify	
	Standards applicable	Specify	
	No. of phases	Specify	
	Single or Three Phase design	Specify	
	Configuration	Ungrounded star (wye) arrangement	
1.1	**Scope**		
	1. Capacitor bank units	No.	
	2. Vacuum switches	No.	
	3. Fuse cut-outs	No.	
	4. Control power/measurement voltage transformer	No.	
	5. Surge arresters	No.	
	6. Current sensors	No.	
	7. Capacitor bank controller	No.	
	8. Junction box and interconnection cables	No.	
	9. Hot dip galvanized steel work	No.	
	10. Inrush current reactors	No.	
1.2	**Service conditions**		
1.3	Climatic conditions		
	Maximum ambient air temperature	45^0C	
	Minimum ambient air temperature	- 1^0C	
	Average daily maximum ambient temperature	30^0C	
	Maximum altitude above mean sea level (meters)	2200 m	
	Seismic level (Horizontal acceleration)	0.3g	
	Relative humidity (% age)	>95%	
	Average number of rainy days/year	120	
	Average annual rainfall	900mm	
	Wind pressure on project areas of conductors and cylindrical objects	383-430 N/mm^2	
	Maximum wind pressure on steel members of 1.5	820 N/mm^2	

	times projected area			
	Isokeraunic level (days/year)		180 days/year	
	Moderately hot and humid tropical climate conducive to rust and fungus growth			
1.4	**Operating conditions**			
	Nominal system voltage		11kV	
	Highest system voltage		12kV	
	Frequency		50Hz ±3%	
	Number of Phases		3	
	Fault level (minimum)		12.5 kA for 3 sec.	
	Auxiliary AC supply		Bidder to specify	
	Maximum duration of earth fault		≤ 3 secs	
	Power frequency withstand voltage, wet, kVrms		28	
	Lightning impulse withstand voltage, kVpk		75	
	Pollution level III , 31mm/kV as per IEC 60507		Heavy	
	The capacitor banks shall be designed for temperature class D (min -5 / max. 45° C) as per IEC 60871-1 for outdoor installation.			
1.5	**Capacitor Units**			
	Type		All film	
	Rated current unit capacitor, A		specify	
	Rated voltage unit capacitor, kV		12/√3	
	Nominal capacitance and maximum permitted tolerance for each unit capacitor, μF/%		specify	
	Insulation level of each capacitor bank		specify	
	Insulation levels Impulse withstand voltage , kVp		95	
	Power frequency with stand voltage , kVrms		38	
	Maximum ambient temperature, °C		45	
	Total loses including discharge resistors, W/KVar		< 0.2	
	Discharge time		< 75 V within 10 min	
	Continuous over voltage		1.1 x Vn (rated voltage) for 12 hrs. daily	
	Continuous over current		1.3 x In (rated current)	
	Capacitance tolerance		–5 % to +15 % for capacitor units	
	Connections		1 - phase	
	Dielectric material		Polypropylene	
	Container		Stainless steel, 304 high grade, grade “A2” steel or Anti-rust painted CRCA	
	Earth terminals		At least M10 grade “A2” steel bolts	
	Bushings	Material	Wet processed hard paste porcelain or HTV silicon rubber	
		Terminals	Clamp type solid or hollow round bar	
		Creepage	400 mm	
		Colour	Grey porcelain (RAL 7035)	
	Mounting brackets	Material	Stainless steel, 304 high grade	
		Spacing between mounting slots	397 mm	

	Films in elements	Type	All-film	
		Thickness, mm		
		Number of elements connected in series and/or parallel per unit capacitor	2 or 3 layers	
		Number of unit capacitor connected per bank	specify	
	Impregnating medium	Type	Hydrocarbon type fluid	
		Specification Reference	Class III B (OSHA classification)	
		Total losses per kVar	specify	
		Chemical property	Non PCB	
		Physical property	Low toxicity combustible fluid	
	Number of terminals of each unit capacitor		2	
	Creepage distance (outdoor open installation)		31 mm/kV	
	Type of fuse (internal)		Internally fused with many elements	
	Total weight of complete unit capacitor including all fitting and impregnating medium, Kg		specify	
	Overall dimensions of unit			
	a) Height, mm		specify	
	b) Depth. mm		specify	
	c) Width, mm		specify	
1.6	**Capacitor Bank**			
	Type		Auto-switched pole mounted capacitor bank	
	Power, KVar		300 & 600	
	Voltage , kV		11	
	Highest voltage, kV		12	
	Insulation level , kVpk BIL		Up to 38/95	
	Frequency, Hz		50	
	Arrangement		Ungrounded star (wye) arrangement	
	Number of capacitors		3	
	Control voltage, Vac		Bidder to specify	
	Temperature range, ^{0}C		-5 to +45	
	Frame		Galvanized steel	
	Pole bracket lifting eyes and bird guards		Y/N	
	Provision for replacement units with ease		Y/N	
	Steelwork and capacitor bank bonding		Y/N	
	Control Options		Switched	
	Standards		IEC standards - specify	
	Mounting - hardwares included		State	
1.7	Rack Assemblies	Type	Single pole mounted	
		Material	MIG welded mild steel angular and channel sections	
		Size, mm	6	
		Thickness of zinc coating, µm , min	85	
		Number of lifting eyes	4	
		Pre-drilled for all the	Y/N	

		components		
		Unit centrelines, mm	225	
	Connection cables	Cables, mm^2	25	
		Insulation level, kV	5	
1.8	**Capacitor bank protection**			
	Standard reference		IEC 60871-3	
	Type		Internal and external	
	Internal protection		Specify	
	External protection		Specify	
	Overvoltage protection		Specify	
	Loss of capacitance		Specify	
	Loss curves		Provide	
1.9	**Capacitor Switch**			
	Type designation		Specify	
	Type		Vacuum / SF_6	
	Manufacturer		specify	
	Standards		IEEE C37.66	
	Rated voltage, kV		11	
	Rated Impulse Withstand Voltage , kV		38 kVrms AC / 95 kVp	
	Continuous current rating , A		200 A capacitive	
	Symmetrical fault current rating , A		6000	
	Asymmetrical fault current rating , A		9000	
	Electrical endurance - Operations		10000	
	Mechanical endurance - Operations		25,000	
	Controller type		Specify	
	Installation		Outdoor	
	Mounting		Pole mounted	
	Power Interface		Bidder to specify	
	Indication		CLOSE/OPEN	
	Weight, Kg		specify	
	Dimensions, mm		specify	
2.0	**Fuse Cut-out**			
	Type designation		Specify	
	Type		Drop-type	
	Manufacturer		specify	
	Standards		IEC 60282-2	
	Rated voltage, kV		11	
	Highest Voltage, kV		12	
	Rated continuous current, A		200	
	Dry impulse withstand (1.2/50μs) voltage (positive and negative polarity) (peak)			
	(i)	Across the isolating distance of the fuse base, kVpeak	95	
	(ii)	To earth and between poles, kVpeak	85	
	Wet 1 minute power frequency withstand voltage (rms)			
	(i)	Across isolating distance of the fuse base, kVrms	45	
	(ii)	To earth and between poles, kVrms	38	
	Total creepage distance, mm		400	
	Mounting angle, degrees		15 - 20	

	Interrupting rating		
	(i) Symmetrical interrupting rating (minimum) rms, kA	8	
	(ii) Asymmetrical interrupting rating (minimum) rms, kA	9.6	
	X/R ratio	4.0	
2.1	**Inrush current reactors**		
	Supplier / manufacturer	specify	
	Place of manufacture	specify	
	Place of testing	specify	
	Standard	IEC 60076-6	
	Rated voltage, kV	11	
	Highest voltage, kV	12	
	Rating of series reactors	0.2% of capacitor bank rating to be connected on neutral end	
	Insulation levels Impulse withstand voltage , kVp	95	
	Power frequency with stand voltage , kVrms	38	
	Short-time withstand capacity and duration	16 times of 130% rated current of capacitor bank for 3 s	
	Kind of insulation	Specify	
	Linear characteristic, pu.	Up to 1.5	
	Inductance value, µH	specify	
	Tolerance, +%	specify	
	Rated continuous current, A	specify	
	Rated inrush current, A	specify	
	Rated short circuit current	As per IEC 60076-6	
	Q-factor	specify	
	Temperature rise as per IEC 60076-2	specify	
	Rated short circuit current	As per IEC 60076-6	
	Conductor material	specify	
	Continuous rating	130% of rated current of capacitor bank.	
	Weight, Kg	specify	
	Dimensions, mm	specify	
2.2	**Control power / measurement voltage transformer**		
	Supplier / manufacturer	specify	
	Place of manufacture	specify	
	Place of testing	specify	
	Standard	IEC 61869	
	Power rating (KVA)	Specify	
	Insulation levels Impulse withstand voltage , kVp	95	
	Power frequency with stand voltage , kVrms	38	
	Kind of insulation	specify	
	Rated voltage, kV	11	
	Ratio, kV/kV	specify	
	Burden, VA	1000 minimum	
	Accuracy class	Class 1.0 up to 100VA burden	
2.3	**Current Sensor (Var only)**		
	Ratio, A:V	600A:10V ± 2%	

	Insulator		specify	
	Creepage distance, mm/kV		400	
2.4	**Surge Arrestors**			
	Supplier / manufacturer		specify	
	Place of manufacture		specify	
	Place of testing		specify	
	Standard		IEC 60099-4	
	Type		Gapless Arresters	
	Material		Silicon rubber	
	Maximum system voltage, Um, kV		12	
	Rated voltage, Ur, kV		11	
	Maximum continuous operating voltage, kVrms as per IEC 60099-4, Uc		Manufacturer to state	
	Temporary overvoltage capability (TOV), kVrms	1 s	Manufacturer to state	
		10 s	Manufacturer to state	
	Maximum residual voltage with current wave	5 kA 8/20 µs	Manufacturer to state	
		10 kA 8/20 µs	Manufacturer to state	
		20 kA 8/20 µs	Manufacturer to state	
		40 kA 8/20 µs	Manufacturer to state	
		500 A 30/60 µs	Manufacturer to state	
		1 kA 30/60 µs	Manufacturer to state	
		2 kA 30/60 µs	Manufacturer to state	
	Lightning impulse protective level, max, kV as per IEC 60099-5		Manufacturer to state	
	Steep current impulse protective level, max, kV as per IEC 60099-5		Manufacturer to state	
	Energy discharge capability , kJ/kVr at Ur		Manufacturer to state	
	Metal oxide (MO) diameter , mm		Manufacturer to state	
	Height of the MO resistor column, mm		Manufacturer to state	
	Long duration discharge class (current compliance)	Current, A	Manufacturer to state	
		Duration , µs	Manufacturer to state	
		Discharge tolerance, %	Manufacturer to state	
	Accelerated ageing performance	Temperature , ^{0}C	Manufacturer to state	
		Time, hrs	Manufacturer to state	
		Watt loss	Continuous decreasing	
	Operating duty characteristics (Discharge current withstand)	Two 4/10µs current wave (Ur) , kA	Manufacturer to state	
		Low current at 2000µs, kApk	Manufacturer to state	
		Discharge tolerance, %	Manufacturer to state	
	Partial discharge performance, pC as per IEC 60270.		< 10	
	Pressure relief withstand capability (Short circuit)	High symmetrical RMS (A), duration (s)	20 kA at 0.2s	
		Low symmetrical RMS (A), duration (s)	2 kA at 1s	
		Asymmetrical peak (A)	50 kA at 0.2s	
	Surge Arrester Housing			
	Lightning impulse withstand voltage, , kVpk		95	
	Power frequency withstand voltage for 1 min,		38	

	wet, kVrms		
	Creepage distance, 31mm/kV, mm	400	
	Permissible head load static, N	Manufacturer to state	
	Permissible head load dynamic, N	Manufacturer to state	
	Short circuit withstand capability (rated short circuit (withstand) current Is), kA	20	
	Permissible length of the active part, mm	Manufacturer to state	
	Housing shield resistance, Ω	<5,000	
	Number of units	3 for each capacitor bank	
2.5	**Reactive Power Controller**		
	Type	Numerical	
	Manufacturer	specify	
	Description No.	specify	
	Standards	IEC 60870-5-1 & IEC61850	
	Rated Current, A	Specify	
	Rated frequency, Hz	50	
	Supply voltage, V AC	Specify	
	Scan Rate, kHz	specify	
	Regulation steps	min 3	
	Setting Range, cos phi	specify	
	Memory Capacity, kB RAM	specify	
	Over Compensation Monitoring	yes	
	Manual Mode	yes	
	Self-Monitoring	yes	
	External Interface	EIA-232 or Ethernet for remote USB for local	
	Control	Automatic & manual Schedule, Volt, Temp, Var Overrides	
	Switch on/off delays	Programmable	
	Other features	-Single or seasonal schedule -Anti-hunting -Maximum daily operations -LCD display	
	Data logging	Should be included	
	Padlockable enclosure	Polycarbonate/Stainless steel, 316 marine grade,	
	IP Rating	IP55	
	Mounting	Pole bracket or meter socket	
2.6	List of type test certificates and type test reports submitted (indicate test report numbers) with the tender for evaluation	Provide	
2.7	List of tests to be witnessed by KPLC Engineers at the factory	Provide	
2.8	List of Site Acceptance Tests to be performed at installation and commissioning	Provide	
2.9	Marking (parameters to be indicated and method of marking of all the equipment)	Provide	

	Method to be used for packing	Provide	
	Installation and technical manuals	Provide	
3.0	List of catalogues, brochures, drawings, technical data and customer sales records submitted to support the offer	Provide	
3.1	Statement of compliance and/or deviations from Tender Specification	Provide	

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

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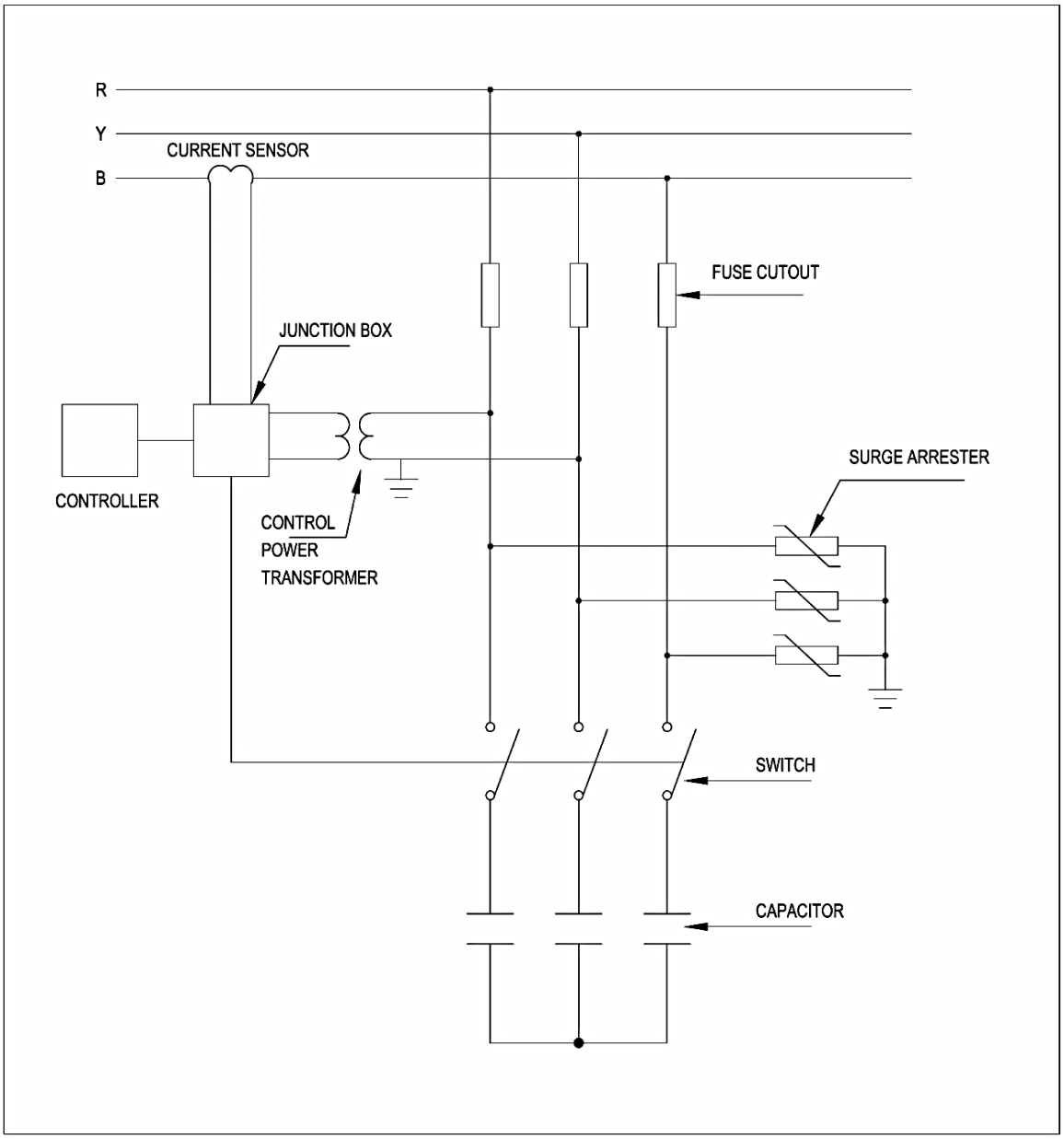
Manufacturer's Name, Signature, Stamp and Date

ANNEX B: DRAWINGS



Figue1: Pole mounted auto switched capacitor bank circuit diagram– without reactor

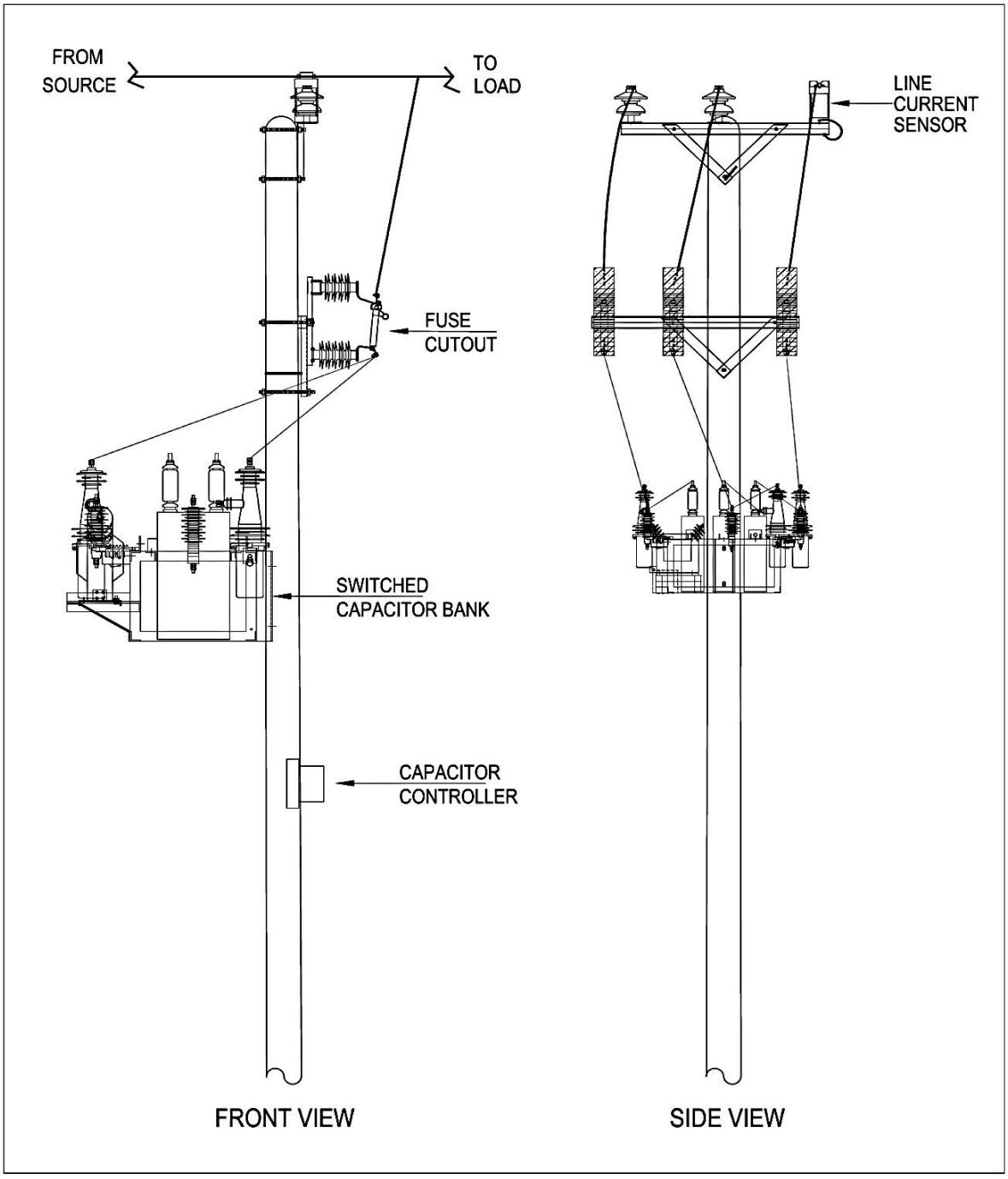


Figure2: Pole- mounted three - phase capacitor bank– without reactor