SECTION 263513

CAPACITOR BANK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes automatic power factor correction equipment, with harmonic filters, rated 600 V and less.

B. Fully dimensional drawings to scale and in A3 sized sheets, g1v1ng constructional details and material specifications of all parts and components including all schematic diagrams for a 450, 350 KVAR rated Low Voltage Capacitor Bank comprising of dry type capacitor units having an ambient temperature category of -5/D and rated voltage of 525 volts and copper wire wound series reactors with a detuning frequency below the third harmonic level and from contactor or thyristor switched type for step controls. The normal rating of the capacitor banks shall be the maximum continuous rating at an ambient temperature of 52°C (Fifty-two degrees centigrade) as frequently encountered in Kuwait during the peak summer days.

C. Complete type test reports and certificates for the above type and rating of Low Voltage Capacitor Bank designed and constructed as per the technical specifications and requirements of the Ministry of Electricity & Water (MEW), Kuwait, or for Capacitor Banks of similar rating, design and construction from an Internationally Recognized Independent Test Laboratory (ASTA, KEMA or CESI). The test reports and certificates older than five (5) years are not accepted

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: Include the following:
   1. Lists of spare parts and replacement components recommended for storage at Project site.
   2. Detailed instructions covering operation under both normal and abnormal conditions.

D. Country of origin of the products

E. Design calculations as and where applicable

1.3 Applicable Standards**:**

A. Unless specified otherwise the capacitor banks shall conform in design, material, construction and performance to the latest editions of the IEC standards, their corresponding British/European (BS EN) standards and in particular to the following publications:

IEC 60831-1 & 2	:	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V
IEC 61921	:	Power capacitors - Low voltage power factor correction banks.
IEC 60076-6	:	Power transformers - Part 6: Reactors
IEC 60747-6	:	Semiconductor devices. Discrete devices Part 6: Thyristors.
IEC 60085-1	:	Electrical insulation - Thermal evaluation and Designation
IEC 60664	:	Insulation coordination for equipment within low- voltage systems
IEC 60439-1	:	Low-Voltage Switchgear and Control gear Assemblies - Part 1: Type Tested and Partially Type-Tested Assemblies.
IEC 60947-1	:	Low-voltage Switchgear and Control gear - Part 1: General Rules
IEC 60947-2	:	Low-voltage Switchgear and Control gear - Part 2: Circuit breakers Circuit-Breakers.
IEC 60947-4-1	:	Low-voltage Switchgear and Control gear - Part 4- 1: Contactors and Motor-starters.
IEC 60529	:	Degree of protection provided enclosures (IP code)
IEEE 519-199	:	IEEE Recommended Practices and Requirements For Harmonic Control in Electric Power Systems.

In addition to the above listed standards, the regulations for electrical installations issued by the Ministry of Electricity & Water, Kuwait, shall also be adhered to.

1.4 QUALITY ASSURANCE

A. Manufacturer's profile including copy of the audited balance sheet including summary of actual assets and liabilities for a minimum three (3) financial years attested by the concerned authorities in the manufacturer's own country and in Kuwait

B. Copy of certificate of registration with the Ministry of Commerce showing local agent's name against the manufacturer of the product.

1.05 GUARANTEES

A. The supplier / manufacturer / installer of the capacitor banks shall submit the following guarantees:

i) Guarantee that all the capacitor banks and all parts and components thereof like, capacitor units, series reactors, thyristor switched contactors, electro-magnetic contactors, power factor controllers, power quality meters, current transformers, MCCBs, MCBs, etc., whether installed indoor or outdoor, will give continuous trouble free service at Kuwait's extreme ambient temperature (520C) and weather conditions (100% RH), and any capacitor bank and/or any parts/components thereof that will fail, malfunction or burn out within a period of three (3) years will be replaced and reinstalled free of charge.

The supplier/manufacturer/installer shall further guarantee fully satisfactory operation and running of the entire equipment, whether installed indoor or outdoor, for a period of three (3) years from the date of commissioning.

ii) Guarantee that the various fixing screws for different components are from high quality stainless steel, which will not corrode during the life time of the and in twenty-five (25) years as a minimum. In case any of the fixing screw will undergo problem of corrosion or any other form of deterioration, the same will be replaced and fixed free of charge throughout the lifetime of the capacitor bank units.

iii) Guarantee that if the painting of the capacitor bank enclosures is damaged or deteriorated within a period of 5 (five) years, all capacitor bank enclosures will be repainted free of charge.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

i. Automatic Power Factor Correction Units with Harmonic Filters:
1. ICAR - Italy.
2. Ducati Energia, Itay
3. Schneider.
4. Eton.USA

2.02 DETAILS OF EQUIPMENT AND MATERIALS

A POWER FACTOR CORRECTION CAPACITOR BANKS:

1. **Type:**

The power factor correction capacitor banks shall be three phase, of modular design, shall be switched ON/OFF automatically in steps through the use of Electromagnetic Contactors designed for capacitor switching or shall be Thyristor controlled depending on the type of electrical loads and shall incorporate series reactors for harmonic current suppression and to prevent resonance.

2. **Normal Rating:**

The normal rating of the capacitor banks shall be the maximum continuous rating under the worst temperature conditions encountered in Kuwait (at 52°C, see climatic conditions).

B CAPACITOR UNITS:

The capacitor units shall be dry, self-healing type with individual discharge resistors, shall be protected against internal faults, over pressure, etc. and shall fully comply with and tested to the requirements of the International Electro-technical Commission Publication No. IEC 60831, Part-1 and Part-2.

a) The capacitor units will be installed in an electrical distribution system having system voltage of 415 volts (System highest voltage 457 volts) as stipulated under Clause NO.2 of this tender specification and shall be rated at 480yvolts due to the voltage rise caused by connecting the detuned series reactors.

b) The ambient temperature category of the capacitor units shall be -SID as per the IEC Publication No. 60831, Part-1, but as mentioned under C1.2, the normal rating of the capacitor banks shall be the maximum

continuous rating under the worst temperature conditions encountered in Kuwait (i.e., at 52 Deg C)

c) The capacitors shall be completely leakage proof and of dry type construction without any filling of jelly, wax, etc. They shall be of the self-healing type utilizing low-Ioss metalized polypropylene film dielectrics.

d) The capacitor element casings shall be of non-metallic design from high temperature withstanding material and shall not require an earth connection.

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

f) A suitable device shall be provided to automatically disconnect the capacitor unit form supply if excessive pressure is generated inside the unit.

g) The capacitors shall have permanently connected built-in discharge resistors to ensure safe discharge of the capacitors to less than 50 volts in 1 minute after switch off.

h) The total losses including discharge resistors to be less than 0.5 Walt/KVAR

i) The capacitors shall be rated for a minimum of 130% continuous current overload and 110% continuous voltage overload based on the Rated Voltage of the capacitors.

j) Suitable rating plates from non-corrosive material shall be provided on each capacitor unit giving fully detailed information as follows:

Capacitor Unit Rating Plate:

Manufacturer

Serial number and manufacturing year

Rated total output in kilovars (KVAR)

Rated voltage in volts (V)

Rated frequency in hertz (Hz)

Temperature category and temperature range

Discharge device

Reference of self-healing design

Connection symbol

Internal fuses

Indication for the overpressure

Insulation level in kilovats (KV)

C. SERIES REACTORS TO PREVENT AMPLIFICATION OF SYSTEM HARMONICS:

The three phase series reactors to be connected in series with each capacitor unit for harmonic current suppression and to prevent resonance shall be iron cored type with copper windings. The reactor shall comply with the IEC Publication No. 60076-6.

The current ratings of the reactors shall be. increased suitably to take into account the effect of harmonics in the networks which could be generated by variable speed drives, dimmers, elevators, UPS system, fax machines, computers, fluorescent and other discharge lamps, etc. The offered reactors shall be tested by harmonic current generating test equipment with magnitudes corresponding to the maximum harmonic current magnitudes measured in any distribution system. All necessary test reports for such tests and measurements shall be submitted to the Purchaser for scrutiny and record purposes.

The reactor insulation shall be Class "H" rated at 180°C to IEC 60085-1. The maximum temperature of the reactor at maximum continuous RMS amperage shall be no higher than 145°C with a 45°C ambient. The maximum continuous RMS amperage of the reactor shall be sized to match the maximum continuous RMS amperage of the capacitors. The minimum reactor Q factor shall be 25.

The reactors shall be equipped with snap action thermostats to trip at 145°C and shall be wired to the associated step switching module which will switch off and lock out the associated step for the overheated reactor. The automatic power factor controller shall indicate which step has the overheated reactor .

The capacitors and the reactors combination shall be tuned below the lowest harmonic present in a particular distribution system.

With the capacitors and suitable series reactors connected it must be proved through submission of relevant calculations that the total harmonic voltage distortion is within the limits as specified in IEEE Std 519-1992, standards on IEEE recommended practices and requirements for Harmonic Control in Electric Power System.

f) If the total harmonic distortion limits are exceeded even with the use of the detuned harmonic suppression capacitor banks, then suitably rated active harmonic filters shall be proposed in conjunction with the detuned capacitor banks to limit the total harmonic distortion below the specified limits in IEEE 519.

D. CIRCUIT BREAKERS:

The capacitor bank shall have a suitably rated circuit breaker at the incomer. The circuit breaker shall be a three pole 'MCCB' and shall fully comply with the requirements of the IEC 60947-1 & 2. They shall be rated for a minimum insulation voltage of 660 V and designed for 52 degrees C ambient temperature. The current rating shall be at least 1.5 times the full load current of the capacitor bank and have a mechanical endurance of a minimum 1000 operations. It shall have a rotary front operating door mounted handle and should be interlocked with the door to ensure that the capacitor bank is de-energised when door is open.

Each stage of the capacitor bank shall also have a suitably rated circuit breaker. The circuit breaker shall be adjusted to trip if the RMS current of the stage exceeds 130%.

E. ACTIVE HARMONIC FILTERS FOR HARMONIC CURRENT FILTERATION :

The active harmonic filters shall work on the principle of measurement of harmonic currents and generate actively a harmonic spectrum in opposite phrase to the measured distorting harmonic current thereby canceling the original harmonics.
The rating of the active harmonic filters shall be so selected that the total harmonic voltage distortion at the point of common coupling is brought down to below the total harmonic voltage distortion limits specified in IEEE 519, as extracted below.

Table 10-3- Current Distortion Limits for General Distribution Systems (120V through 69 000 V)
Maximum Harmonic Current Distortion in Percent of IL

Individual Harmonic Order (Odd Harmonics)						
Isc / IL	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0

20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a dc offset, e.g. half-wave converters, are not allowed

* All power generation equipment is limited to these values of current distortion, Regardless of actual Isc / IL.

Where
Isc = maximum short-circuit current at PCC
IL = maximum demand load current (fundamental frequency component) at PCC

b) Should there be a large component of single phase non linear loads present in a distribution system (offices, shopping malls, etc.) then measurements/calculations must be carried out to ascertain the magnitude of the third harmonic current and provisions shall be made for a suitably rated 3 Phase, 4 wire active harmonic filters.

c) Should there be a large component of three phase non linear loads present in a distribution system (Industrial loads with VFD's etc) then measurements/calculations must be carried out to ascertain the magnitude of the third harmonic current and provisions shall be made for a suitably rated, 3 Phase, 3 wire active harmonic filters.

d) The active harmonic filters shall be of parallel configuration.

e) The active harmonic filters shall monitor all three phases of the low voltage line current in real time by means of a Digital Signal Processor (DSP).

f) The output of the DSP unit in combination with a micro-controller based system shall generate a pulse width modulated (PWM) signal to control power modules based on IGBT (Insulated Gate Bipolar Transistor) technology which act as a current source.

g) The PWM signal shall be of fixed switching frequency.

h) The system shall be operated under closed loop control and shall have a maximum response time of not more than 40 milliseconds. The control system shall be such that the Active Filter cannot be overloaded.

Simultaneous filtering shall be provided for all harmonics up to the 50th one.

The filtering efficiency shall be typically of better than 97%

k) The operating power factor of the active harmonic filters shall be programmable over the range 0.7 capacitive. Both fixed and dynamic reactive power compensation shall be available for selection by the programmer.

l) The active harmonic filters shall be protected against over current, short-circuit, thermal overload and IG8T bridge abnormal operation.

m) The design of the active harmonic filters shall be such that the current rating of the filter system can be increased by the addition of extra power modules.

n) Optional graphic monitoring of the wave shape shall be provided.

Optional on-line harmonic analysis shall be provided.

p) After the installation of the active harmonic filters, harmonic measurements shall be carried out to prove that the total harmonic distortion is within IEEE 519 limits.

H. AUTOMATIC POWER FACTOR CONTROLLER:

The automatic power factor controller shall be microprocessor based VAR Sensing type and shall comply with IEC 61326. The controller shall be able to sense the reactive current requirement and switch on / off to the required stage of the capacitor bank.

The automatic power factor controller shall maintain a targeted power factor within 0.95 lagging and unity.

The controller shall be programmed to have different switching sequences. In general, for 500 KVAR Capacitor Banks the sequence shall be 1:1:2:2:2:2 (i.e.

50/50/100/100/100/100 KVAR), for 40 KVAR Banks, 1:1:2 (i.e. 10/10/20 KVAR) and similar.

c) The controller shall sense current from a single phase and voltage from two phases to compute the average 3-phase power factor and accordingly compensate by switching in necessary capacitor stages.

d) The controller shall be suitable for 1A or SA current input.

The voltage on the capacitor terminals may be particularly high at times of light load conditions. In such cases, some or all of the capacitors shall be switched out of circuit in order to prevent overstressing of the capacitors and undue voltage increase in the distribution system.

f) The controller shall be easily programmable from front panel itself.

g) The controller shall be able to recognize the connection of CT and Voltage and be able to automatically adjust itself to the phase angle difference.

h) The voltage input to the controller should be through a VT and protected by a fuse.

There should be a time delay of 120 seconds for switching on a capacitor bank into circuit, from its last disconnection from the circuit.

j) The controller shall have LED / LCD display. Parameter in display should be cyclic with suitable time delay. Necessary membrane key pad for manual scrolling of display parameter shall be provided. The display unit shall be easily visible without opening the doors of the capacitor bank enclosure.

The automatic power factor controllers shall allow the following settings and readings.

Discharge time
Disconnection pause of relay stages
Power Station service
Choke degree
Voltage transformer ratio
Harmonic table
Switching frequency of transistor stages
Averaging time for reactive power
Averaging time of the mean value cos (phi)
Fan control
Over temperature disconnection
Indication in manual mode
Password
Contrast

Reset of programming
Connection configuration
Software release
RS485 Interface

The automatic power factor controllers shall initiate alarms and warnings in the following events.
Insufficient capacitor output and / or low power factor
Abnormal power factor
Over compensation
Over current
Under voltage
Over voltage
Over temperature
Total voltage harmonic distortion limits exceeded

The automatic power factor controllers shall instantaneously switch off the thyristor in the following contingencies occurring in any of the Phases.

Voltage above 457V

Voltage below 290V

Load current imbalance +/- 50 %

Instances of spike current

Notes :

(a) In case of (i), (ii) and (iii) above, normal automatic functioning of the capacitor bank will resume after the excessive voltage has dropped to below 457V in the case of (i), the low voltage has risen above 290V in case of (ii) and the imbalance in load currents reached to below 50% in the case of (iii) and the specified values in all these cases are maintained for two minutes.

(b) In case of (iv) above, the Contactor / thyristor will not switch ON again till the fault condition is attended to.

I. POWER QUALITY METERING AND REMOTE MONITORING:

The Power Quality (PQ) Meter shall be a Digital Signal Processor (DSP) based micro controller operating as an intelligent unit to monitor and measure all the electrical parameters of the system as well as that of the capacitor control panel. The controller shall sense and monitor 3 Phase Currents, Neutral Current, 3 Phase Voltages, 3 Phase Power Factors, 3 Phase KW, KVA, KVAR, KW-HR, KVA-HR,KVAR-HR, Capacitance of all 3 phases, Capacitance of each capacitor and % THO, and shall switch in necessary rating of capacitors to maintain the minimum power factor specified.

1) Compliance to Standards:
   a) The power quality meters shall comply with one or more of the following safety/construction standards:

      i) IEC 61010-1 (EN 61010-1): Safety requirements for electrical equipment for measurement, control and laboratory use.

   b) The power quality meters shall comply to the following electromagnetic immunity standards:

      i) IEEE C.37-90.1: IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI). All inputs tested, except for the. network communications port.

   c) The power quality meter shall have a 3rd party certification proving compliance to one or more of the following electromagnetic emission standards:

      FCC Part 15 Subpart B, Class A: Class A Digital Device, Radiated Emissions.
      ICES-003, Industry Canada, Interference Causing Equipment Standard (ICES) Class A

Current / Voltage Inputs :

a) The current input for power quality meter as well as APF controller shall be taken from the same current transformer on the LV board.

b) The power quality meter shall have no less then 4 voltage inputs and 5 current inputs.

c) In its standard configuration, the meter shall be able to accept 600VAC LL / 347VAC
LN without using potential transformers.

d) It shall be able to withstand 1500 VAC RMS continuously without damaging the device.

e) It shall have adequate nominal and overcorrect current ratings.

Measured Values:

a) The power quality meter shall provide at minimum the following voltage, current, power and energy values:

Voltage:

i) Voltage L-L Per-Phase
ii) Voltage L-L 3-Phase Avg
iii) Voltage L-N Per-Phase
iv) Voltage 3-Phase Avg
iv) Voltage % unbalanced

Current:
.i) Current Per-Phase
ii) Current, Neutral (measured)
iii) Current 3-Phase Avg
iv) Current % Unbalanced

Power:

i) Real Power (Per-Phase, 3-Phase Total)
ii) Reactive Power (Per-Phase, 3-Phase Total)
iii) Apparent Power (Per-Phase, 3-Phase Total)
iv) Power Factor - True (Per-Phase, 3- Phase Total)
v) Power Factor - Displacement (Per-Phase, 3-Phase Total)

Energy:

i) Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh)(Signed/Absolute)

ii) Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh)(Signed/Absolute)

iii) Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)

iv) Reactive Energy by Quadrant

b) The power quality meter shall provide a minimum/maximum value for any measured parameter.

c) The power quality meter shall be capable of deriving values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (or equivalent PLC capabilities):

4) Accuracv:

The power quality meters shall meet the following accuracy classes. ANSI C12.20 accuracy class 0.2.

IEC62053-22: Electricity metering equipment (AC) - particular requirements -part 22: static meters for active energy, accuracy class 0.28
IEC62053-23: Electricity metering equipment (AC) - particular requirements -part 23: static meters for reactive energy, accuracy class 1.

5) Display:
   a) The power quality meter shall have a LCD display of reasonably high level pixel value.
   b) It shall support direct display of all parameters on the front panel.
   c) It shall provide a trend display of any parameter internally recorded at regular intervals.
   d) It shall have a user programmable custom display that is capable of displaying up to 20 quantities on a single screen.

6) Logging:

The power quality meter shall have at least 5MB of user programmable onboard data logging. Field Expansion shall be possible.

The PMS will store all critical internal and revenue data upon sudden power loss.

The meter shall have non-volatile memory.

It shall have a time-stamped event log with the following features:

i) Supports at least 500 events.

The number of records in the log is programmable.

Each event is recorded with the date and time of the event, the cause and effect of the event, and the priority of the event.

All events relating to set-point activity, relay operation and self-diagnostics is recorded in the event log.

Time stamps have a resolution of 1 millisecond.

Time stamps can be synchronized to within 100ms between devices on the same serial communications medium.

Minimum event recording response time ½ cycle (8.3ms 60Hz, 10ms 50Hz) for high speed events and 1 second for other events.

The priority of set-point events is programmable.

The power quality meter shall be able to log any parameter in the meter including min/max and waveforms.

7) Alarm

A. System Alarms: Alarm relay and local display indication of the following conditions:
1. Low power factor.
2. Leading power factor.
3. Frequency not detected.
4. Overcurrent.
5. Overvoltage.
6. Overtemperature.
7. Excessive voltage THD.
8. Capacitor overload.
9. Loss of capacitance.

B. Remote Alarm: Provide alarm relay contact for remote indication of the following conditions:
Summary "Trouble" contact to activate if any of the local System Alarms specified are set

J. CAPACITOR BANK ENCLOSURE SYSTEM:

The capacitor bank comprising of capacitor units, power factor controller, series reactors, electro-magnetic and/or thyristor switched contactors, MCCBs, MCBs, etc. shall be housed in a suitable metallic enclosure having a front door with a provision for locking arrangement.

a) The capacitor bank enclosure shall be fabricated from pre hot dip galvanized sheet steel of minimum thickness 3 mm. having a zinc coating thickness of minimum 275 gm / sq.mm (38.5 Microns). The enclosure shall be in one piece without any horizontal joint from outside and a substantial base frame shall be provided at the bottom with all welding from inside only.

The compartment door(s) shall be fitted by minimum 4 Nos. of 80 mm. long robust weather-proof stainless steel hinges and suitable spring hinges shall be provided to automatically close these doors. A suitable and substantial latching device with handles only shall be provided to keep the doors properly in place when closed. This should not be lockable and substantial pad locking strips from 3mm. thick sheet steel with 14mm. dia. Holes shall be provided and welded all around in an aesthetic manner. The left hand side door shall also be provided with separate latches from inside at the top and bottom for its independent closing. The doors shall be gasketted to provide protection against the ingress of moisture and dust to comply with a degree of protection IP53 in accordance with IEC-60529. On the inside of the door, a pocket of adequate size shall be provided for keeping the drawings, etc.

The equipment mounting panel shall from pre-hot dip galvanized sheet steel of minimum thickness of 3 mm. and shall be drilled and tapped for front mounting of the equipment. It shall be possible to install and remove the panel easily from the front of the capacitor bank enclosure and shall be provided with robust stainless steel handles at the top and bottom or at the sides for handling purposes. All cable connections shall be at the front of the panel only.

The low voltage control compartment shall be complete isolated from the power section and the complete enclosure system shall have provision for adequate air forced cooling}

Each item on the front panel of the capacitor banks shall have a proper label of adequate dimensions. These labels shall be made of suitable and approved engraving material approximately 2 mm. thick having white surface with black engraving. Alternative design of labels can be proposed subject to Purchaser's approval.

All other labels shall be from similar material and engraved in English. Full details and locations of all labels shall be indicated on the drawings and shall be subject to approval of the Purchaser.

All fixing screws for the different components shall be from stainless steel of adequate size.

The capacitor bank enclosure after fabrication shall be applied with a two-component polyamide cured zinc-rich epoxy primer (Hempadure Zinc 15360 or equivalent to a dry film thickness coating of minimum 40 microns and then with a final coat of paint by using electrostatic dry powder epoxy polyester method of painting to a film thickness of 80 microns.

Each capacitor bank enclosure shall be provided with a 200 mm x 150 mm. electrical danger sign of approved type from non-corrosive metal plate, which shall be fixed on the outside of the right hand side door of the capacitor bank enclosure.

Substantial brass or stainless steel diagram and rating plates shall be provided on the capacitor bank unit giving fully detailed information as follows:

Capacitor Bank Rating Plate:

Manufacturer
Serial number and manufacturing year
Rated total output in kilovars (KVAR) / Number of switchable Capacitors with capacity.
Rated voltage in volts (V)
Rated frequency in hertz (Hz)

Suitable for : Rating of Transformer in KVA
Maximum power consumption of APFC panel
Guarantee period
Date of Dispatch

K. INTERNAL WIRING:

All small wiring shall have a cross sectional) area of not less than 2.5 sq. mm. and shall be 600/1000 volts, insulated with type 5 PVC table I Of BS: 6746, stranded copper conductors. All small wiring shall be suitably terminated and fitted with identification ferrules and marked with circuit numbers in accordance with "British Central Electricity Authority Engineering Recommendations" S-12 standard numbers for small wiring or similar approved standard.

The trip circuits shall have an additional ferrule coloured red and marked trip.

All terminal blocks shall be from an approved design and all exposed terminals shall be enclosed by detachable covers. The trip circuit cables shall be colored black and the instrument transformer cables (C.Ts) colored with their respective phase colors. Alternatively, all small wiring can be uniform colour (e.g., grey) but instrument transformer cables shall have additional colored ferrules at both ends of each conductor run (in accordance with their phase colours). The wiring of the auxiliary circuits shall be segregated from the main circuit by heat resistant tubes made of insulating material covered by earthed metallic partitions, Terminal blocks, small wiring terminations, ferrules and wire numbering and colouring shall be subject to the approval of the Purchaser.

L. CONTROL CURRENT TRANSFORMERS:

Three (3) numbers of current transformers for sensing the load current (for computation of KVAR) shall be provided. The CTs shall be mounted on the bus-bars of the LV Boards. The control CTs shall be suitable for continuous operation in ambient temperatures of up to 52 De9. C. The primary current rating shall be suitable for the transformer full load current and secondary rating shall be 5 amp or shall match the automatic power factor controller and/or power quality meter requirements. These should be epoxy molded resin cast CTs with bar primary. The inner diameter should be suitable for connecting it around the bus-bar of the LV Boards. The VA rating of the CTs shall not be less than 5 VA, The CTs shall be of 0.5S class accuracy and shall have the current sensing linearity in the specified accuracy range from 1 % to 120% of its rated current. The terminations for the CTs shall have the provision to short the CTs,

PART 3 - EXECUTION

3.01 - INSTALLATION OF CAPACITOR BANKS

A. The installation of the capacitor bank shall be generally in accordance with manufacturer's recommendations. Clearance shall be provided around the capacitor bank for safety and adequate ventilation. The design of the capacitor banks must be as to facilitate easy alignment and erection on the site.

B. Provision of proper earthing of the metallic enclosure of the capacitor bank shall be made. The capacitor banks at the Main LV Distribution Boards and Sub-main Distribution Boards shall be connected to the earth ring bus by 1000 Volts grade cables of adequate cross-sections.

C. The capacitor bank at the service intake of the consumers shall have an earthing system consisting of a set of two (2) Nos. 1.5 metres (to make a 3.0 metres long rod) x 19 mm dia. copper bonded earth rods and connected by 1000 Volts grade insulated cable of 70 sq. mm .. The earth rods are to be installed inside pre-cast hand holes of 30 cm. x 30 cm. clear opening and a depth of 55 cm. provided with a heavy duty concrete cover to enable checking of the connection and measurement of the earth resistance.

3.02 TESTS

A) GENERAL:

The supplier/manufacturer/installer of the capacitor banks shall carry out the tests specified in any applicable International Electro-technical Commission (IEC) and/or British Standard (BS) Specifications, unless otherwise agreed upon and such additional tests as in the opinion of the Purchaser or his representative are necessary to determine that the works comply with the conditions of this specification.

All instrument used for testing purposes, shall be calibrated by an approved authority and calibration certificates shall be submitted along with the inspection reports.

The test results/readings recorded during measurements and other observations noted shall be compiled/tabulated separately for each item of equipment and furnished to the Purchase in a fully professional manner in three (3) complete sets. Electronic copies of the reports shall also be submitted in three (3) complete sets of compact disks (CDs).

B. TYPE TESTS:

The supplier/manufacturer/installer of the capacitor banks shall submit complete type test certificates and reports from an internationally recognized

independent testing laboratory (ASTA, KEMA or CESI) for the capacitor bank units of the specified design. Construction and rating. The certificates and reports shall not be older than five (5) years.

However, if such certificates and reports cannot be produced and/or are not acceptable to the Purchaser for any reason, all the necessary type tests as listed below against each equipment shall be carried out in an internationally recognized independent testing laboratory (ASTA, KEMA or CESI) and test certificates and reports shall be made available to the Purchaser for approval prior to delivery of any of the equipment to the site.

The following type tests shall be carried out as indicated against each equipment:

1. Individual Capacitor Units:
   All type tests shall be carried out in accordance with the International Electro-technical Commission (lEG) Publication No. lEG 60831 as per the relevant clauses mentioned against each test. Every capacitor sample to which it is intended to apply the type test shall first have withstood satisfactorily the application of all the routine tests.

   i) Thermal stability test (CI.13).

   ii) Measurement of the tangent of the loss angle (tan 0) of the capacitor at elevated temperature (CI. 14).

   iii) Voltage test between terminals (CI. 9.2)

   iv) Voltage test between terminals and container (CI. 10.2).

   v) Lightning impulse voltage test between terminals and container (CI. 15).

   vi) Discharge test (CI. 16).

   Ageing test (Cl.17).

   Self-healing test (Cl.18).

   Destruction test (Cl.19).

C. . Complete Capacitor Bank Units:

All type tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 60439 as per the relevant clauses mentioned against each test.

i) Temperature Rise Test (Cl. 8.2.1)

Di-electric Test (Cl. 8.2.2)

Short-circuit withstand strength (Cl. 8.2.3)

Effectiveness of the protective circuit (Cl. 8.2.4.1 & 8.2.4.2)

Clearances and creepage distances (Cl. 8.2.5)

Mechanical operation (Cl. 8.2.6)

Verification of Degree of Protection (Cl. 8.2.7)

Wiring, electrical operation (Cl. 8.3.1)

Electromagnetic compatibility EMC (Cl. 7.10)

3. MCCB's, Series Reactors, Thyristors, Electro-magnetic Contactor, Current Transformers:

Complete type test certificates for all major components, like MCCBs, Series Reactors, Thyristors, Electro-magnetic Contactor, Current Transformers, etc. shall be submitted as per the relevant IEC/BS standards.

D. ROUTINE TESTS:

All routine tests shall be carried out in the presence of and to the satisfaction of the Purchaser or his representative. Routine test results shall be produced and must be available at the time of delivery of the equipment.

The following routine tests shall be carried out as indicated against each equipment:

1. Individual Capacitor Units:

All routine tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 60831 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every capacitor before delivery.

i) Capacitance measurement and output calculation (CI. 7).
ii) Measurement of the tangent of the loss angle (tan 0) of the capacitor (CI. 8).

iii) Voltage test between terminals (CI. 9.1).

iv) Voltage test between terminals and container (CI.10.1).

Test of the internal discharge device (CI. 11).

vi) Sealing test (CI. 12).

2. Complete Capacitor Bank Units:
All routine tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 60439 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every capacitor bank unit before delivery.

i) Inspection, including checking of clearance, dimensions etc. (CI. 8.3.1)
Di-electric Test (Cl. 8.3.2)

A functional test of the complete capacitor bank control, protection and interlocking schemes shall be carried out in the factory. These shall include secondary injection tests on the protection relays.

D. SITE TESTS:

All site tests shall be carried out in the presence of and to the satisfaction of the Purchaser of his representative. The following site tests / inspection shall be carried out prior to energizing the capacitor banks:

1. Mechanical Tests :

Checking of panel conformity to drawing and Engineer's requirements.

Checking of all devices for proper mounting and all conductors and cables for proper routing.

Checking of creepage and clearance distances.

Checking effectiveness of all mechanical devices, e.g. handles, locks, interlocks, operating devices, etc.

Checking of all electrical connections for tightness/surface area contacts.

Checking of Labels, Identifications, Nameplate, .Danger Signs, etc ..

Checking of installation works of capacitor banks and cabling, earthing, etc ..

Checking of capacitor bank enclosure for overall workmanship and smooth finish.

2. Electrical Tests :

   Insulation resistance measurements on the buses, phase to phase and phase to ground, with all breakers in the fully connected position and contacts open. Insulation resistance shall exceed 10 megaohms.

   Control circuit insulation resistance to ground.

   Flash test all main circuit at 2.5 kV for one minute. Leakage current shall be measured and recorded.

   Repeat insulation resistance measurements to verify the same has not been affected by the dielectric test.

   Primary and secondary injection tests of all relays, CT's and indicating and metering instruments.

3. Functional Tests:

   Functional test of all circuit breakers, switches, contactors, relays, etc. and every circuit to verify correct operation.

   Operate the equipment through all design functions, including remote operation, actuation of alarm and indicating devices, mechanical and electrical tripping and closing, and operation of the protective devices.

   Inspect all relays and protective devices, and verify settings in accordance with the manufacturer's instructions.

   Inspect current transformers and relays for correct polarity of connections and the installation of junipers on unused current transformer circuits.

   Simulate the operations and check the logic of interlocks.

   Manually close and trip each breaker checking and adjusting the main contact alignment and wiring action in accordance with the manufacturer's instructions.

   Check the phasing on each side tie breaker, before closing.

   Test protective relay operation for incomer circuit breakers.

   Measurement of the power factor and system harmonics before and after commissioning of the capacitor bank.

   Data communication.

E. - GUARANTEES

The supplier / manufacturer / installer of the capacitor banks shall submit the following guarantees:

Guarantee that all the capacitor banks and all parts and components thereof like, capacitor units, series reactors, thyristor switched contactors, electro-magnetic contactors, power factor controllers, power quality meters, current transformers, MCCBs, MCBs, etc., whether installed indoor or outdoor, will give continuous trouble free service at Kuwait's extreme ambient temperature (520C) and weather conditions (100% RH), and any capacitor bank and/or any parts/components thereof that will fail, malfunction or burn out within a period of three (3) years will be replaced and reinstalled free of charge.

The supplier/manufacturer/installer shall further guarantee fully satisfactory operation and running of the entire equipment, whether installed indoor or outdoor, for a period of three (3) years from the date of commissioning.

ii) Guarantee that the various fixing screws for different components are from high quality stainless steel, which will not corrode during the life time of the and in twenty-five (25) years as a minimum. In case any of the fixing screw will undergo problem of corrosion or any other form of deterioration, the same will be replaced and fixed free of charge throughout the lifetime of the capacitor bank units.

iii) Guarantee that if the painting of the capacitor bank enclosures is damaged or deteriorated within a period of 5 (five) years, all capacitor bank enclosures will be repainted free of charge.

END OF SECTION