




**SPECIFICATION FOR
LOW VOLTAGE
AUTOMATIC POWER
FACTOR CORRECTION
EQUIPMENT
(L-S2)**


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1.0 GENERAL

1.1 SCOPE

- 1.1.1 This section of the Specification describes and specifies requirements for the supply, delivery, installation, testing, commissioning, and handing over in approved working order and maintenance during the Defects Liability Period of the whole low voltage automatic power factor correction equipment in accordance with the Conditions of Contracts, Bill of Quantities, Drawings Specification, etc.
- 1.1.2 All standards shall conform to the latest Malaysia Standards (MS), International Electrotechnical Commission (IEC), MS IEC, British Standard Institution (BS) the latest relevant standards. The standards and/or relevant standards as listed in Section 12.0.

1.2 TECHNICAL PARTICULARS


- 1.2.1 Tenderers shall submit at the time of tendering all catalogues, detailed technical particulars and guarantees in respect of the equipment offered, which shall be binding. No departure from these technical particulars and guarantees shall be permitted except with the written approval of the Superintendent Officer (S.O) and/or S.O's Representative.

1.3 GUARANTEES

- 1.3.1 The tenderers shall guarantee all equipment to be supplied under this contract against faulty design, materials and workmanship at the manufacturer's works within the Defect Liability Period (DLP).

1.4 ELECTRICAL SYSTEM

- 1.4.1 All equipment shall be rated for operation on a 230/400V within the tolerance defined in MS IEC 60038, +10% to -6% as of the rated voltage. The Low Voltage (LV) System shall be 3 phase, 4 wire, 50 Hz system with solidly earthed neutral.

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2.0 SYSTEM DESCRIPTION

2.1 COMPONENTS AND MATERIALS

2.1.1 The system generally consists of the following components:

2.1.1.1 Power Factor Correction Boards


2.1.1.2 Switchgears

2.1.1.3 Protection Relays

2.1.1.4 Power Factor Controller

2.1.1.5 Series Reactors


2.1.1.6 Shunt Power Capacitors

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3.0 POWER FACTOR CORRECTION BOARDS


3.1 ENCLOSURES

- 3.1.1 The Power Factor Correction Boards (PFCB) shall be suitable for operation on a 230/400V, 3 phase, 4 wire, 50Hz system with solidly earthed neutral. The PFCB shall be capable of withstanding the fault condition of not less than 50kA at 400V, 1 second or as specified in the drawings and/or Bill of Quantities (BQ).
- 3.1.2 The PFCB shall not form part of but shall be independent and match the height and depth of the switchboard it is connected to. The PFCB shall be self-contained, floor mounted, flush fronted cubicle, electrogalvanised type suitable for front and rear access or as specified in the drawings and/or BQ.
- 3.1.3 The framework of the PFCB shall be fabricated from electrogalvanised sheet steel sections of thickness not less than 2.5 mm. All panels, covers and doors shall be fabricated from electrogalvanised sheet steel of thickness not less than 2.0 mm and constructed to provide a clear and flush appearance. The panels, covers and front doors shall be secured to the enclosure by means of chromed type of cylindrical knurled head screws complete with retaining clips. The insert nuts shall be fixed at the framework to suit with cylindrical knurled head screws. Welded cross struts shall not be used at cylindrical knurled head screws.
- 3.1.4 The PFCB shall be of Form 2b and comply with MS IEC 61439-2. The busbars shall be separated from the switchgears and the incoming and outgoing terminals. The form of separation shall be achieved by metallic or non-metallic rigid barriers or partitions. The PFCB degree of protection (IP code) shall be IP41 in accordance with MS IEC 60529.
- 3.1.5 The PFCB shall provide adequate dimensions for efficient natural heat dissipation of the capacitors and reactors at ambient operating temperature. The capacitors shall be separated at not less than 30 mm apart. All louvres shall be provided with filters. The forced ventilation fans shall be installed complete with automatic shutter. The capacity cubic feet per minute (CFM) required for ventilation fans shall be calculated by PFCB manufacturer and appear in the shop drawing. The ventilation fans complete with control switch and indicating lamp shall operate automatically with thermostats control at pre-set temperature.
- 3.1.6 The capacitor and reactor shall be installed either in the same or separate compartment. The reactor shall be located at the upper part if both capacitors and reactors installed in the same compartment.
- 3.1.7 The interior and exterior PFCB shall be finished with epoxy dry-powder and oven baked semi-gloss beige colour. The PFCB shall be bolted to mild steel channel base. The channel shall be anti-rusted and painted with a primer.

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3.2 BUSBARS

- 3.2.1 Busbars shall conform to BS EN 13601 and shall be tinned hard drawn high conductivity copper with an adequate uniform rectangular cross section to carry continuously their rated current without overheating. They shall be rigidly mounted on non-hygroscopic insulators e.g. glass fibre reinforced polyester to withstand any mechanical stresses to which they may be subjected under maximum fault condition.
- 3.2.2 Busbar sizes shall not be less than that specified in the Drawings. However, if the busbar sizes are not specified, then the busbar rating shall be based on a current density of not more than 1.5A/sq.mm. In any case, the main busbars rating shall not be less than or equal to the current rating of the incoming switchgear (I_n).
- 3.2.3 The main busbars shall be run for the full length of the incoming section of PFCB. Neutral busbar shall be of full size and full length as the phase busbars. Connections shall be made up with bronze or other copper alloy bolts and nuts utilising tension washers on both outer faces. Where multiple parallel busbars are used, they shall be separated by tinned copper spacers at spacing equal to the busbar thickness.
- 3.2.4 The dimensions of tinned copper PFCB earthing bar shall comply with Table 14A in Section 14.0 Specification for Low Voltage Internal Electrical Installation (L-S1). The PFCB earthing bar shall be run along the floor mounted PFCB for its entire length and shall be painted at appropriate points with green colour.

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4.0 SWITCHGEARS

4.0.1 All switchgears shall have voltage and frequency rating suitable for the power system to which they are connected to. The current rating shall not be less than that specified in the Drawings and/or BQ.

4.1 MOULDED CASE CIRCUIT BREAKERS

4.1.1 Moulded case circuit breakers (MCCB) shall have the number of poles as specified in the Drawings and/or BQ. They shall comply with IEC 60947-1 and IEC 60947-2 or MS IEC 60947-1 and MS IEC 60947-2. They shall be fully tropicalised and suitable to be used up to an ambient operating temperature of 40°C, enclosed in glass-reinforced polyester moulded case and suitable for use on 230/400V, 50Hz a.c. supply system.

4.1.2 They shall be of the quick-make, quick-break type having manually operable toggle type handle. Permanent position indicators shall be provided to show status of the breaker. When tripping occurs, the handle shall be in the 'trip' position midway between the 'OFF' and 'ON' or 'O' and 'I' position to provide positive indication of automatic interruption. The operating mechanism shall be non-tamperable. The MCCB shall have trip-free feature to prevent the breaker from being closed against fault conditions. Multipole MCCB shall have common-trip operating mechanism for simultaneous operation of all poles.

4.1.3 The tripping units shall be either one of the following types:

4.1.3.1 Thermal-magnetic type with bimetallic elements for inverse time-delay overload protection and magnetic elements for short circuit protection ; or


4.1.3.2 Solid state trip unit with adjustable overload protection and electronic trip unit short circuit protection with or without adjustable time-delay.

4.1.4 An arc extinguisher shall be incorporated to confine, divide and extinguish the arc drawn between the breaker contacts each time a breaker interrupts current. The contacts shall be of non-welding type.

4.1.5 The minimum rated ultimate short circuit breaking capacity (Icu) of the incoming and outgoing MCCB shall be 50kA at 400V or specified in the drawings and/or BQ.


4.1.6 The rated service short circuit breaking capacity (Ics) shall be 100% of Icu at 400V for incoming MCCB. For all outgoing MCCBs, the Ics shall be 50% of Icu.

4.1.7 The minimum continuous current ratings for the outgoing MCCBs shall be of 155% of the rated capacitor currents.

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4.2 SWITCHING CONTACTORS

- 4.2.1 The switching contactors shall comply with IEC 60947-1 and IEC 60947-4-1 or MS IEC 60947-1 and MS IEC 60947-4-1. They shall be fully tropicalised, suitable to be used up to an ambient operating temperature of 40°C and suitable for use on 230/400V, 50Hz a.c. supply system.
- 4.2.2 The switching contactors shall be of utilization category AC-6b rated for switching low inductance capacitors.
- 4.2.3 The operating coil shall be 230V, 50Hz a.c. type and shall operate satisfactorily when the voltage at the coil terminals is between 85% and 110% of the nominal voltage. The electromagnetic coil shall be of laminated type.
- 4.2.4 The rated power of the switching contactor shall not be less than or equal to the rated power (kVAR) of capacitor.

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5.0 PROTECTION RELAYS

5.0.1 All protection relays shall be rated at 230/400V, 50Hz system and operating voltage shall be in a range from 60V to 280V. The protection relays shall comply with relevant parts of IEC 60255 and shall also comply with relevant parts of IEC 61000 on electromagnetic compatibility. The protection relays shall be fully tropicalised and suitable to be used up to an ambient operating temperature of 50°C and relative humidity of 95%. The protection relays shall be of robust panel flush mounting type.

5.1 OVERCURRENT RELAYS

5.1.1 The protection relays shall provide inverse time lag characteristics in the overcurrent range and with time delay in the short circuit range as specified in the Drawings and/or BQ.

5.1.2 Overcurrent protection shall be provided by externally connected protection current transformers.


5.1.3 Microprocessor based combined overcurrent relays shall be of Inverse Definite Minimum Time (IDMT) type.

5.1.4 The microprocessor-based protection relays shall be of combined three phase overcurrent and earth fault protection with definite time and inverse time characteristics. Time/current characteristic of IDMT overcurrent and earth fault relays shall be of standard inverse curve (3/10).

5.1.5 The microprocessor-based protection relays shall give numerical digital readout of set values, actual measured values and recorded values. The relays shall include a serial communication port or universal serial bus for external connection to facilitate external reading, setting and recording of relay data and parameters by a personal computer (PC).

5.1.6 The microprocessor-based protection relays shall be incorporated with built-in self-supervision system with auto-diagnosis. The self-supervision system shall continuously monitor the relay microprocessor programs. If a permanent fault is detected, an alarm indication shall be given. A 230V/5A alarm contact for connection to external alarm shall be provided.

5.1.7 If current and voltage measurements are specified, the microprocessor-based protection relays shall make available these measurements for local display. The measurements shall include phase currents, phase-to-phase voltages and phase-to neutral voltages.


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5.2 EARTH FAULT RELAYS

The protection relays shall provide inverse time lag characteristics in the overcurrent range and with time delay in the short circuit range as specified in the Drawings and/or BQ.


5.3 COMBINED OVERCURRENT AND EARTH FAULT RELAYS

- 5.3.1 The protection relays shall provide inverse time lag characteristics in the overcurrent range and with time delay in the short circuit range as specified in the Drawings and/or BQ.
- 5.3.2 Overcurrent and earth fault protection shall be provided by externally connected protection current transformers.
- 5.3.3 Microprocessor based combined overcurrent and earth fault relay shall be of Inverse Definite Minimum Time (IDMT) type.
- 5.3.4 The microprocessor-based protection relays shall be of combined three phase overcurrent and earth fault protection with definite time and inverse time characteristics. Time/current characteristic of IDMT overcurrent and earth fault relays shall be of standard inverse curve (3/10).
- 5.3.5 The microprocessor-based protection relays shall give numerical digital readout of set values, actual measured values and recorded values. The relays shall include a serial communication port or universal serial bus for external connection to facilitate external reading, setting and recording of relay data and parameters by a personal computer (PC).
- 5.3.6 The microprocessor-based protection relays shall be incorporated with built-in self-supervision system with auto-diagnosis. The self-supervision system shall continuously monitor the relay microprocessor programs. If a permanent fault is detected, an alarm indication shall be given. A 230V/5A alarm contact for connection to external alarm shall be provided.
- 5.3.7 If current and voltage measurements are specified, the microprocessor-based protection relays shall make available these measurements for local display. The measurements shall include phase currents, phase-to-phase voltages and phase-to neutral voltages.

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5.4 EARTH LEAKAGE RELAYS

- 5.4.1 Earth leakage relay (ELR) shall comply to relevant parts of IEC 60255 and shall also comply with relevant parts of IEC 61000 on electromagnetic compatibility.
- 5.4.2 ELR shall be of the type suitable for use on a 230/400V, 50Hz system and up to ambient operating temperature of 40°C. ELR shall be provided with test button for simulation of a fault, earth leakage indicator or digital display, a reset button, protection against nuisance tripping due to transient voltage and d.c. sensitive. ELR shall be of adjustable current sensitivity and adjustable time delay type.
- 5.4.3 The selectivity range for current sensitivity shall be 0.03A to 10A and the time delay selectivity range of 0 second to 1 second. ELR shall be incorporated with matching balanced core current transformer and shunt trip coil for the circuit breaker to which it controls the tripping shall also be provided.

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6.0 POWER FACTOR CONTROLLER

6.1 TYPE

- 6.1.1 The power factor controller ("controller") shall be micro-processor based, solid state in construction, compact, easy to install and use. The controller shall automatically step-in or step-out various capacitors to correct the power factor to the required pre-set level.
- 6.1.2 The controller shall comply with IEC 60831-1, IEC 60255-27 and relevant parts of IEC 61000 on electromagnetic compatibility.
- 6.1.3 The controller shall be insensitive to harmonics and screened from stray electric and magnetic interference and shall be housed in case suitable for panel mounting. The ambient operating temperature shall be up to 55°C.
- 6.1.4 The controller shall be of 6 or 12 steps type as specified in the Drawing and/or BQ. No-voltage trip and zero current trip shall be provided. For a voltage loss of longer than 15 milliseconds or current loss of longer than 3 seconds, all capacitor stages connected shall be switched off until discharged. After voltage or current is restored, the controller switches is required to step-in.

6.2 SWITCHING SEQUENCE

- 6.2.1 The controller shall incorporate minimum following automatic switching sequence modes which are cyclic switching sequence and multi-step switching sequence allowing minimum following combinations of switching programme of capacitor stages:
- (a) 1:1:1:1:1:1 ...
 - (b) 1:1:2:2:2:2 ...
 - (c) 1:1:2:2:4:4 ...
 - (d) 1:2:2:2:2:2 ...
 - (e) 1:2:4:4:4:4 ...
 - (f) 1:2:4:8:8:8 ...
- 6.2.2 The first three control output may be allowed to be set as fixed steps which are not included in the normal control cycle but are switched on immediately after the controller is switched on and always remain switched on.

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6.3 SETTING AND DISPLAY

6.3.1 The following settings and displays shall be incorporated:

- (a) Continuous digital actual power factor display (0.00 inductive - 1.00 - 0.00 capacitive);
- (b) Capacitor step indication;
- (c) C/K (inductive/capacitive) setting and display;
- (d) Target power factor setting and display (0.80 inductive - 1.00 - 0.80 capacitive);
- (e) Operation delay setting and display (5 second to 300 second);
- (f) Apparent Power (VA) display, Active Power (W) display and Reactive Power (VAR) display;
- (g) Flashing display when alarm is activated;
- (h) Harmonics content display.

6.4 ALARM INDICATOR

6.4.1 The minimum following alarms indicator shall be incorporated:

6.4.1.1 Power factor alarm:


If the threshold values set for 'switch-on' and 'switch-off' are exceeded and no further change can take place in the output steps, the alarm shall be triggered.

6.4.1.2 Harmonic alarm:

When the harmonics threshold values are exceeded, the alarm shall be triggered; and


6.4.1.3 Over-current alarm:

If the capacitor current exceeded the rated current set, the alarm shall be triggered.

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6.5 MODE OF OPERATION

- 6.5.1 When the controller is in manual operation mode, the capacitor steps can be switched in step by step and switched out in reverse step by step manually. The step that is being switched on shall be displayed.
- 6.5.2 With the controller in OFF mode, all equipment shall be switched off and deenergised. In the automatic mode, the controller shall switch in or switch out the required capacitors without undue switching on and switching off at any step to reach the nominal target power factor.
- 6.5.3 In any event the zero-voltage release function shall take precedent at all modes of operation to prevent capacitive current surge.

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7.0 SERIES REACTORS

- 7.1 Where series reactors ("reactor") are specified in the Drawings and/or BQ, they shall be dry type copper windings, minimum voltage rated at 400V, 50Hz and class H insulation connected in series with the capacitors suitable to operate in ambient operating temperature up to 40°C.
- 7.2 The reactor shall comply with IEC 60076-6.
- 7.3 The rated filtering factor of the reactor shall be 7%.
- 7.4 The reactor shall be securely fastened in the PFCB. Rubber pad shall be used to reduce noise.

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8.0 SHUNT POWER CAPACITORS

8.1 TYPE

- 8.1.1 The shunt power capacitor ("capacitor") shall be of dry type and self-healing. The dielectric medium shall be metallised polypropylene film or foil. The elements shall be insulated with fire-proof material. The capacitor shall be environmental-friendly.
- 8.1.2 The capacitor shall comply with IEC 60831-1 and IEC 60831-2.

8.2 LOSSES

- 8.2.1 The losses of the capacitor shall be not more than 0.5 watt per kVAR at the specified ambient operating temperature measured at the connecting terminals.

8.3 INTERNAL PROTECTION

- 8.3.1 The capacitor shall be provided with overload disconnecter which will interrupt the internal connection and disconnect the capacitor from the circuit in the event of pressure built-up within the capacitor.

8.4 DISCHARGE DEVICE


- 8.4.1 Each capacitor shall be provided with suitable internal discharge device which will reduce the voltage from an initial peak voltage of $\sqrt{2}$ times the rated voltage to 75V or less within a maximum time of 3 minutes after they are disconnected from the source of supply. No isolating device, fuse or otherwise shall be placed between the capacitor and the discharge device.

8.5 AMBIENT TEMPERATURE

- 8.5.1 The capacitor shall be minimum Category C rated and suitable for operation under tropical ambient conditions with the highest mean temperature of 40°C over a 24-hour period of continuous operation.

8.6 VOLTAGE RATING AND MAXIMUM PERMISSIBLE CURRENT

- 8.6.1 Capacitor voltage shall be rated at 525V, 50Hz.
- 8.6.2 The capacitor shall be suitable for continuous operation at an r.m.s. line current of 1.3 times the rated current that occurs at the rated sinusoidal voltage and rated frequency of the supply source. The maximum current of capacitor shall be not more than 143% of the rated current.

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8.7 HOUSING

- 8.7.1 The capacitor shall be housed in container fabricated from heavy metal sheet steel coated with non-corrosive polyurethane resin enamel or in extrusion-processed aluminium container.

8.8 TEST RESULTS

- 8.8.1 Test results for routine test report shall be provided for the capacitors. The routine tests according to IEC 60831-1 shall include:


(a) Capacitance measurement and output calculation	Capacitance tolerances; (i) -5% to +10% for capacitor and banks up to 100 kVAR (ii) -5% to +5% for capacitor and banks above 100 kVAR
(b) Measurement of the tangent of the loss angle ($\tan \delta$) of the capacitor	Measurement at a; (i) Voltage between 0.9 and 1.1 times the rated voltage; and (ii) Frequency between 0.8 and 1.2 times the rated frequency
(c) Voltage test between terminals	2.15 times capacitor rated voltage for a minimum 2 seconds
(d) Voltage test between terminals and container	(i) (2 x capacitor rated voltage +2kV) or 3kV, whichever is the higher for 10 seconds; or (ii) 20% higher of capacitor rated voltage from (d)(i) for a minimum 2 seconds
(e) Test of the internal discharge device	Manufacturer requirements/procedures
(f) Sealing test	Manufacturer requirements/procedures

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9.0 TESTING AND COMMISSIONING


9.1 TEST AND CALIBRATION OF MEASURING AND TEST INSTRUMENTS

- 9.1.1 The test instruments shall be designed, manufactured, tested and shipped in accordance with IEC 61010-1 and IEC 61557-1. All measuring and test instruments used for testing of the PFCB installations, calibration and test for the protection relays shall be regularly tested and calibrated by the manufacturers or accredited calibration laboratories for their functionality and accuracy. The measurement accuracy of reading shall be +10% for analog and digital instruments. Test and Calibration Reports or Certificates for the measuring and test instruments issued by the calibration laboratory shall be valid for 2 years from the date of issuance.
- 9.1.2 The instruments and their Test and Calibration Reports or Certificates shall be submitted to S.O and/or S.O.'s Representative for verification two (2) weeks before testing of the PFCB installations being carried out. No test on the electrical installations shall be carried out without prior approval of the S.O and/or S.O.'s Representative. Notwithstanding the validity of the aforesaid Reports or Certificates the measuring and test instruments shall be re-calibrated if required by the S.O and/or S.O.'s Representative after any mechanical or electrical mishandling. Fee required for the testing and calibrating of the measuring and test instruments is deemed to be included in the Contract.

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9.2 TEST AND TEST CERTIFICATES

- 9.2.1 After the installation work has been completed and before Certificate of Practical Completion is issued, the electrical installations (covered under this part of the Contract) shall be tested as prescribed in Electricity Regulations 1994 and IEC 60364-6 and any other tests deem necessary by the S.O and/or S.O.'s Representative. In the event the installation fails to pass any of these tests, the Electrical Contractor shall take such measures as are necessary to remedy the defects and the installation shall not be considered as completed until all such tests have been passed.
- 9.2.2 The tests to be carried out by the Electrical Contractor shall consist of the following tests as a minimum requirement:
- 9.2.2.1 Configuration of power factor controller.
- 9.2.2.2 Functional and operational tests.
- 9.2.3 All protection relays and device shall be checked, tested and calibrated by an Electrical Services Engineer registered with Suruhanjaya Tenaga.
- 9.2.4 The Electrical Contractor shall arrange with the Electrical Services Engineer to conduct and carry out the stability and functionality test, check and calibration of the protection relays and device. Fee required for the test, check and calibration as described above is deemed to be included in the Contract.
- 9.2.5 The S.O and/or S.O.'s Representative reserves the right to be present at all tests and the Electrical contractor shall give at least one (1) week notice in writing to the S.O and/or S.O.'s Representative for this purpose. In any case, no test shall be carried out without prior approval of the S.O and/or S.O.'s Representative. Copies of all test certificates together with As-Installed Drawings properly bound and titled shall be submitted to the S.O and/or S.O.'s Representative within one (1) week after the completion of the testing.
- 9.2.6 Supervision and Completion Certificate and Test Certificate including copies of all the test results and drawings as prescribed in Electricity Regulations 1994 shall be submitted to the S.O and/or S.O.'s Representative within two (2) weeks after the completion of the testing. The Certificates shall be properly bound in hard cover and titled.

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10.0 SERVICE AND MAINTENANCE

- 10.1 During the Defects Liability Period, the Electrical Contractor shall be responsible for the service and maintenance work for the complete installation. All works shall be carried out by competent person. All labour, material, tools and parts necessary to rectify the defect due to manufacturing/installation faults shall be supplied/executed at the Electrical Contractor's cost.
- 10.2 The service and maintenance to be performed and defects to be rectified and making good shall include but not limited to the following:
- 10.2.1 Replace or make good all controllers, control gears, capacitors, reactors, MCCB, protection relays, contactors, etc.
- 10.2.2 Replace and make good all loose and burnt cables and termination, all mechanical support linkage, earth electrode inspection chambers and covers, conduits, trunkings, etc.
- 10.2.3 Making good any damage to roads, buildings, drains, cables, pipes, concrete areas, paved areas, etc. which had not been properly made good arising out of the work.
- 10.2.4 All other works as deemed necessary by the S.O and/or S.O.'s Representative.
- 10.3 All works shall be carried out as soon as the Contractor is being informed by the S.O / S.O's Representative or the occupant, and shall be completed within a reasonable time except under emergency situation.
- 10.4 If the Electrical Contractor fails to comply with the above requirements, the S.O and/or S.O.'s Representative reserves the right to engage another party to carry out the work, in which case, the Electrical Contractor shall be responsible for all the expenses incurred.

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11.0 SHOP DRAWINGS AND AS BUILT DOCUMENTS

11.1 SHOP DRAWINGS

11.1.1 Two (2) sets of prints of shop drawings for construction and/or installation of the PFCB showing the dimensional general arrangement and layout of the equipment and the schematic line diagram shall be submitted to the S.O and/or S.O.'s Representative for approval. The Electrical Contractor shall prepare and submit shop drawings for the whole work or parts of the work at least minimum two (2) weeks before the work begins. If the shop drawings submitted are not acceptable by the S.O and/or S.O.'s Representative, the Electrical Contractor shall amend and re-submit the shop drawings within two (2) weeks from the date of return of the shop drawings. No work including fabrication of the PFCB shall be carried out without the shop drawings being approved by the S.O and/or S.O.'s Representative.

11.1.2 The cost of all these shop drawings is deemed to be included in the Contract.

11.2 AS BUILT DOCUMENTS

11.2.1 As built document shall consist of but not limited to the as installed drawings, manuals, certificates, catalogues, inventories and parts lists.

11.2.2 The as installed drawings shall comprise of:


11.2.2.1 Schematic Wiring Diagram and Electrical Layout Plans;

11.2.2.2 Control Circuits drawings

11.2.3 These drawings shall be labelled at the lower right hand corner with the Electrical Contractor's name and address, date of commissioning, scale, drawing number (the drawing number to be obtained from the S.O and/or S.O's Representative), title and following particulars:-

**JABATAN KERJA RAYA
CAWANGAN KEJURUTERAAN ELEKTRIK
CONTRACT NO.:**

11.2.4 If the drawings submitted are not according to the actual installation at site and/or not acceptable to the S.O and/or S.O's Representative, the Electrical Contractor shall amend and re-submit the drawings within two (2) weeks from the date of return of the drawings to the satisfaction of the S.O and/or S.O's Representative.

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11.2.5 Manual and documents for the installation shall be provided. It shall comprise of:-

- 11.2.5.1 Installation manual;
- 11.2.5.2 Operation manual;
- 11.2.5.3 Service and maintenance manual;
- 11.2.5.4 Inventories and parts list;
- 11.2.5.5 Product data and catalogue;
- 11.2.5.6 Product test certificates; and
- 11.2.5.7 Installation test results.

11.2.6 Each of the as built documents shall be bound together with the electrical as built documents with hard cover and submitted in minimum four (4) sets upon issuance of Certificate of Practical Completion of the project.


11.2.7 In addition, one (1) set of the as installed drawing shall be submitted in the form of tracing/original document, and four (4) sets in Physical Digital Storage.

11.2.8 The cost of all these prints, manuals, tools etc. is deemed to be included in the Contract.


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12.0 LIST OF STANDARDS

STANDARD	DESCRIPTION
MS IEC 60038	IEC standard voltages
IEC 61439-2	Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies
MS IEC 60529	Degrees of protection provided by enclosures (IP Code)
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
MS IEC 60947-1	Low-voltage switchgear and controlgear - Part 1: General rules
MS IEC 60947-2	Low-voltage switchgear and controlgear - Part 2: Circuit-breakers
MS IEC 60947-4-1	Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
IEC 60255	Measuring relays and protection equipment - Part 1: Common requirements
IEC 60255-27	Measuring relays and protection equipment - Part 27: Product safety requirements
IEC 60831-1	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V - Part 1: General - Performance, testing and rating - Safety requirements - Guide for installation and operation
IEC 60831-2	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V - Part 2: Ageing test, self-healing test and destruction test
IEC 60076-6	Power transformers - Part 6: Reactors

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STANDARD	DESCRIPTION
IEC 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
IEC 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
IEC 61557-1	Electrical safety in low voltage distribution systems up to 1000V AC and 1500V DC - Equipment for testing, measuring or monitoring of protective measures - Part 1: General requirements
IEC 60364-6	Low voltage electrical installations - Part 6: Verification

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13.0 APPENDIX

APPENDIX A

SCHEDULE OF TECHNICAL DATA AND GUARANTEE

(Note: Unless otherwise specified elsewhere, the information indicated in italic are as stated in the Specification)

(A) CAPACITORS


- (1) Make :
- (2) Country of Manufacture :
- (3) Model No. :
- (4) Type (*Dry Type*) :
- (5) Losses (*Not more than 0.5 watts per kvar*) :
- (6) Rated Voltage (*525V, 50Hz*) :
- (7) Ambient Operating Temperature (*40°C*) :
- (8) Maximum Permissible Current (*1.3 times rated current*) :
- (9) Housing :

(B) SERIES REACTORS

- (1) Make :
- (2) Country of Manufacture :
- (3) Model No. :
- (4) Type :
- (5) Winding (*Copper*) :
- (6) Rated Voltage (*min 400V*) :
- (7) Ambient Operating Temperature (*40°C*) :

(C) POWER FACTOR CONTROLLER

- (1) Make :
- (2) Country of Manufacture :
- (3) Model No. :
- (4) Type (*Micro-processor Based*) :
- (5) Number of Steps :
- (6) Rated Voltage :
- (7) Ambient Operating Temperature (*55°C*) :
- (8) Modes of Operation (*Manual/Cyclic/Multi Steps*) :
- (9) Settings and Displays :
- (a) Power Factor Display : Yes / No
- (b) Capacitor Step Indication : Yes / No
- (c) C/K (inductive/capacitive) : Yes / No
- Setting and Display

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- (d) Target Power Factor Setting :..... Yes / No
 (e) Operation Current Setting and Display :..... Yes / No
 (f) Apparent Current Display :..... Yes / No
 (g) Flashing Display When Alarm Activated :..... Yes / No
 (h) Harmonics Content Display :..... Yes / No

- (10) Alarm Indicator
 (a) Power Factor Alarm :..... Yes / No
 (b) Harmonic Alarm :..... Yes / No
 (c) Over-current Alarm :..... Yes / No
 (d) Others..... Yes / No

(D) SWITCHING CONTACTORS

- (1) Make :.....
 (2) Country of Manufacture :.....
 (3) Model No. :.....
 (4) Type :.....
 (5) Utilization Category (*AC-6b*) :.....
 (6) Rated Voltage :.....
 (7) Rated Voltage for Operating Coil (230V) :.....

(E) VENTILATION FANS

- (1) Make :.....
 (2) Country of Manufacture :.....
 (3) Model No. :.....
 (4) Type :.....
 (5) Diameter (*mm*) :.....
 (6) Air Exchange (*CFM*) :.....

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(Cop dan Tandatangan Kontraktor Elektrik)

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(Tarikh)