

<b>16</b>	<b>POWER FACTOR CORRECTION CAPACITORS .....</b>	<b>2</b>
<b>16.1</b>	<b>GENERAL.....</b>	<b>2</b>
16.1.1	General.....	2
16.1.2	Description.....	2
16.1.3	References .....	2
16.1.4	Submissions .....	2
16.1.5	Delivery, Storage and Handling .....	3
16.1.6	Co-ordination .....	3
<b>16.2</b>	<b>PRODUCTS .....</b>	<b>3</b>
16.2.1	General.....	3
16.2.2	Capacitors .....	3
16.2.3	Control and Protection .....	4
<b>16.3</b>	<b>INSTALLATION .....</b>	<b>5</b>
16.3.1	Installation .....	5
<b>16.4</b>	<b>TESTS.....</b>	<b>5</b>
16.4.1	Factory and Field Tests .....	5

## 16 POWER FACTOR CORRECTION CAPACITORS

### 16.1 GENERAL

#### 16.1.1 General

- 1 This specification section covers the supply and installation of power factor correction equipment operating on electrical power systems up to 600 V ac 50 Hz.
- 2 The work of this part is integral with the whole of the Project Documentation and is not intended to be interpreted outside that context.
- 3 Co-ordinate the work with all other services affecting the work of this Section.
- 4 Related Parts and Sections are as follows:

This Section

Part 1..... General Provision for Electrical Installation  
Part 2..... HV & MV Factory Built Assemblies (FBA's)  
Part 3..... Protective Devices  
Part 6..... Cables and Small Wiring  
Part 15..... Electric Motors

#### 16.1.2 Description

- 1 Provide all labour, materials, equipment, services and accessories necessary to furnish and install the work of this Part, complete and functional, as indicated in the Project Documentation and as specified herein.

#### 16.1.3 References

- 1 The following standards are referred to in this Part:  
BS 88.....Cartridge fuses for voltage up to 1000 V ac  
BS 1650.....Capacitors for connection to power frequency systems  
BS 6231.....Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring  
IEEE 519 .....IEEE Standard for Harmonic Control in Electric Power Systems  
EN 60909 .....Short-circuit currents in three-phase a.c. systems; (IEC 60909 Short-circuit currents in three-phase a.c. systems)  
EN 60947 .....Low-voltage switchgear and controlgear; (IEC 60947 Low-voltage switchgear and controlgear)  
Engineering Recommendation G5/4: Planning levels for Harmonic Voltage Distortion and The Connection of Non-Linear Equipment to Transmission Systems and Networks in the UK
- 2 Reference standards as detailed under Part 1 and this Part Clause 17.1.4.

#### 16.1.4 Submissions

- 1 Reference Part 1

#### 16.1.5 Delivery, Storage and Handling

- 1 Deliver, store and handle materials and products in a manner to prevent damage.
- 2 Reference Part 1

#### 16.1.6 Co-ordination

- 1 The work of this Section shall be completely co-ordinated with the work of other services.

### 16.2 PRODUCTS

#### 16.2.1 General

- 1 Power factor improvement equipment shall be provided in LV (415 V) Main Distribution Board. Correction shall be automatic and be capable of correcting the power factor to within range 0.9 lagging to unity as required by the design. The power factor setting shall be adjustable.
- 2 Individual power factor capacitors shall be provided for the larger motorised drives, as indicated on the single line diagrams.
- 3 All capacitors must be arranged so that they are connected in minimum 4 stages and subject to the Engineer's approval. These stages shall be sized to prevent system over-voltage during light loads conditions.

#### 16.2.2 Capacitors

- 1 Capacitors shall comply with BS 1650 and shall be of a dry metalised film construction, containing no liquid and must have low losses (typically 0.5 Watts/kVA).
- 2 Each capacitor shall be housed in a sealed container and be fitted with a fail-safe, pressure sensitive disconnect device.
- 3 Each capacitor shall be equipped with suitable discharge resistors to reduce the voltage to less than 50V in one minute, or less, after supply disconnection.
- 4 The capacitors shall be housed in a metal enclosure, forming part of the Main Distribution Board. The enclosure size should allow enough space and cabling etc., for at least one additional capacitor unit to be fitted at a later date.
- 5 Provision shall be made to ensure that a connection point is available for a series connected, de-tuning reactor in case of problems with harmonics.
- 6 The equipment must comply with BS 800 with respect to electrical interference.
- 7 The capacitors shall be protected by a fused switch-disconnector or circuit breaker on the LV motor control centre.
- 8 The capacitor manufacturer must recommend the maximum fuse or circuit breaker that will ensure the protection of each capacitor bank.
- 9 All power and control cables used within the capacitor bank enclosure must be in accordance with BS 6231 Type BK.
- 10 Detuned reactor/harmonic filters

- (a) anti-resonance reactor detuned or filters deemed necessary to reduce the harmonic content.
- (b) total Harmonic Distortion (THD) of voltage at point of common couplings shall adhere to IEEE Harmonic Standard 519-1992 and ER G5/4 (Engineering Recommendation G5/4).

### 16.2.3 Control and Protection

#### 1 Power Factor Regulator

- (a) The minimum number of capacitor switching steps shall be four (4) as far as practically possible for smaller rating capacitor banks and between 6 to 12 steps for others. The capacitors' KVAR shall be so chosen to provide maximum programming flexibility such as switching sequence 1:2:2:2, 1:1:1:1 etc. in order to maintain the power factor within the set limits for most of the operating time.
- (b) an alphanumeric LCD, micro-processor based automatic power factor correction regulator shall be provided to control steps and display measurement of the following:-
  - (i) power factor
  - (ii) no. of steps connected
  - (iii) step connection and disconnection time
  - (iv) actual current
  - (v) reactive current
  - (vi) active power
  - (vii) reactive power
  - (viii) THD voltage
  - (ix) alarm conditions as listed below
- (c) the regulator shall have built-in alarm relay for remote indication and following alarm conditions locally:-
  - (i) low power factor
  - (ii) abnormal power factor
  - (iii) leading power factor
  - (iv) overcurrent
  - (v) overtemperature
  - (vi) overvoltage
  - (vii) THD high
  - (viii) capacitor overload etc.
- (d) the regulator shall provide facility to manually energize/denergise capacitor steps for the purpose of testing and verification of required/set power factor.
- (e) switching contactors shall have a minimum duty category AC4 to EN 60947 and a minimum current rating of 1.3 x the current consumed by the capacitor bank (see BS 1650).

- (f) Each capacitor “stage” connection shall be indicated on the panel door by an indicating lamp.

### 16.3 INSTALLATION

#### 16.3.1 Installation

- 1 Documentation shall be provided detailing:
  - (a) Type test certificate
  - (b) Routine test certificate
  - (c) Maintenance requirements
  - (d) Fault diagnosis
  - (e) Parts list with part numbers and recommended spares
  - (f) Commissioning instructions

### 16.4 TESTS

#### 16.4.1 Factory and Field Tests

- 1 The PFCC assembly shall be tested at the factory and at site during commissioning. The results so obtained shall be verified with the actual requirements and QGEWC (KAHRAMAA) regulations. Modifications if any shall be carried-out at no extra cost to the Owner.

END OF PART