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ARAB ENGINEERING BUREAUS

4 LOW VOLTAGE MOTOR STARTERS (<1000V)

4.1 GENERAL

4.1.1 Scope

1 This Part includes the supply and installation of motor starters and associated equipment.

4.1.2 References

1 The following standards or updated/revised/superseded versions shall be followed

EN 60073Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators.

EN 60439, IEC 439 Low-voltage switchgear and controlgear assemblies

EN 60947-4Low-voltage switchgear and controlgear - Part 4-2: Contactors and motor-starters

EN 60947-1, IEC 947 Low-voltage switchgear and controlgear

4.2 PRODUCTS

4.2.1 Starters

1 Motor starters shall be rated to carry the full load current of its rated duty at its most severe load conditions. All starters shall be capable of at least 20 starts per hour at 100 % full load torque unless otherwise specified.

2 In accordance with the current QGEWC regulations, motors up to and including 11 kW shall be started direct on line. Motors above 11 kW shall incorporate assisted starting.

3 Motor starters shall be housed in a separate cubicle compartment of the relevant motor control centre and each starter cubicle shall contain the following components, or as otherwise indicated on the Project Drawings or Project Documentation.

- (a) 1 no. triple pole ACB or MCCB or fuse switch, as indicated on the Project Documents, externally operated and interlocked with the cubicle door. There shall be provision for padlocking in the OFF position.
- (b) 1 no. starter, comprising one of the following types, as indicated on the Project Drawings:
 - (i) direct on line
 - (ii) star/delta
 - (iii) close transition star/delta
 - (iv) reduced voltage "soft start"
 - (v) VFD control as per part 5
- (c) 1 no. motor protection relay, as specified in Part 3
- (d) 1 no. set of auxiliary relays and timers required to provide the necessary indication and control sequence
- (e) 1 no. set of main motor terminals and auxiliary terminals for remote controls and indications.
- (f) 1 no. set of terminals for remote lock-off stop push buttons
- (g) 1 no. control circuit transformer, where applicable
- (h) 1 no. anti-condensation heater

- (i) 1 no. set of power factor correction capacitors with separate fuses for all drives above 11 kW, to give a power factor of not less than 0.85.
 - (j) Thermistor relays where applicable
 - (k) Bearing Vibration/temperature relays where applicable.
 - (l) Pump protection relays for submersible pumps > 2.2kW (moisture within the oil chamber, moisture within the cable connection box, mechanical seal failure, temperature rise of the hydraulic driven end bearing, loss of oil from the oil chamber/if available).
- 4 The components of the starter shall be type tested and ASTA certified to achieve Type 2 co-ordination in accordance with IEC 947.
- 5 The following equipment shall be mounted on the door of the starter cubicle, or as otherwise indicated in the Project Drawings or Project Documentation.
- (a) 1 no. Ammeter with selector switch for Motors with P<10 KW, and 3 no. A meters for motors with P>10 KW, 96 X 96, with 240° scale fitted with suppressed 6xFLC scale to read motor running and starting current, with an adjustable red pointer to indicate full load current. The scale range shall be such that normal full load current gives approximately 60% full scale deflection.
 - (b) 3 no. pilot lamps to indicate "SUPPLY ON" () and 1 no lamp to indicate "MOTOR RUNNING" (Green) and "MOTOR STOP (White)"
 - (c) 1 no. pilot lamp to indicate "MOTOR FAILED" (Amber)
 - (d) "X" no pilot alarm indication lamps (a separate lamp for each motor fault conditions)
 - (e) 1 no. "Hand/OFF/AUTO" three positions Selector switch and all status shall be indicated in PLC/ SCADA/HMI.
 - (f) 1 set "Start/Stop" push button.
 - (g) 1 no. externally operated overload reset push button.
 - (h) 1 no. motor heater and cubicle heater humidistat controlled "OFF/AUTO" control switch,.
 - (i) 1 no. electronic hour counter reading to 99999 hours with analogue display, memory and battery backup with reset button
 - (j) lamp test push button
 - (k) 1 duty label
 - (l) All motors shall have local emergency stop push buttons on MCC and near the motor. For small motors, 2.2KW & lower, local isolator shall be enough. For submersible pumps emergency stop shall be near the junction box on wet well floor.
- 6 All starters shall contain a totally enclosed dust proof timer, or the operation will be controlled by a timer in the automatic section, which shall prevent pump(s) starting after a power failure until after a pre-set time has elapsed. The timer(s) or contacts shall be adjustable in the range 50 to 200 percent of the anticipated maximum delay which shall be taken as twice the total time required for all pumps to start and run steadily having been started consecutively. The timer(s) or contacts shall be set to give individual sequential start after a power failure with no drive starting until its predecessor has reached full steady running.

4.2.2 DOL Starters

- 1 DOL starters shall consist of a TP contactor for switching direct on line in accordance with EN 60947-4-1 and fitted with auxiliary contacts.

- 2 Contactors shall be selected for category AC-3 duty.

4.2.3 Star Delta Starters

- 1 Star-delta starters shall be provided with contactors as for DOL starters, arranged in such a manner to ensure the star contactor opens before the delta contactor closes.
- 2 The period of running in star and the transition time shall be controlled by adjustable solid state type timers.
- 3 For closed transition type star-delta starters, further requirements shall be wire wound or pressed sheet resistor banks of sufficient thermal rating to allow three (3) consecutive starts of 30 seconds period followed by a 15 minutes rest and another 30 seconds starting period. They shall also be of sufficient thermal rating to allow 10 starts per hour in line with the pump and starter specification unless otherwise specified. Resistance values shall be chosen to give a high starting current with low transient current. A thermal cut out shall be provided for transient resistance banks. Starter cubicles incorporating resistor banks shall be well ventilated and vermin proof with ventilation louvres.

4.2.4 Reduced Voltage “Soft Starters”

- 1 Solid-state reduced voltage motor starters shall be closed transition, shunt duty type with isolation contactor and bypass contactor. When the motor reaches full speed, the bypass contactor bypasses the soft starter power section. The solid-state power section shall consist of six silicon controlled rectifiers (two per phase connected back to back, in reverse parallel configuration) to provide soft start. The starters shall conform to the latest IEC Standards.
- 2 The starters shall use the current limit method of starting with the current adjustable between 150 percent and 425 percent of full load current of the motor. At turn-on, the control ramps up to the current limit in approximately 1 second and maintains that current until the motor comes up to full speed. If a problem exists and the motor fails to reach rated speed within a predetermined period, the control will shutdown. The starter shall provide a smooth, stepless acceleration and deceleration of the load from start to full speed and from full speed to stop. The starter shall be equipped with metal oxide varistor type surge suppressers across the SCR to protect against voltage transients and resistor/capacitor scrubber networks to protect against false firing of the SCR. Each SCR heat sink shall have a temperature sensor that shall shut the starter down in the event of an over temperature condition. When a starter failure occurs, the actual problem shall be indicated by an LED on the control panel front.
- 3 There shall be a overcurrent protective device, which shall provide over current protection and main disconnect function for the control unit. The position of the operating handle shall indicate “ON” or “OFF” position of the protective device and include provision for padlocking in the “OFF” position. This protective device shall be equipped with a shunt trip and shall trip when there is a SCR or plant power failure. Motor space heaters shall be energised when the motor is not running.
- 4 The reduced voltage starters shall be equipped with micro-processor controlled motor protection relays to control, monitor and protect the motors. The relay shall monitor three phase current and voltage and make trip and alarm decisions based on pre-programmed motor current and voltage conditions. Control functions shall include start detection, starter transition, incomplete sequence and number of starts per hour. The relay shall monitor and display load current of each phase, percent of full load current of each phase and running time. The relay shall protect the motor against time overcurrent, instantaneous overcurrent, underload, phase unbalance, earth fault, phase loss and phase reversal.

- 5 The manufacturer shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable standards. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity and bus bracing. In addition, the unit shall be factory tested in accordance with applicable standards.
- 6 Manufacturer shall be prepared to show proper evidence of having tested for noise immunity on both input and output power connections.
- 7 The softstarter shall be supplied factory configured ready to commission, without requiring any parametering or reconfiguration at site.
- 8 The softstarter shall have the following protective feature as minimum: -
 - (a) over temperature
 - (b) overload
 - (c) jam
 - (d) stall
 - (e) phase Loss
 - (f) phase reversal
 - (g) shorted SCR
- 9 The softstarter shall have the following control feature as minimum: -
 - 10 kick start 0-85% locked rotor torque – 0 to 2 seconds.
 - 11 ramp start 0-85% locked rotor torque – 1 to 60 seconds.
 - 12 current limits start 0-85% locked rotor current – 1 to 60 S
 - 13 soft stop 0 to 60 seconds
- 14 The softstarter shall be provided with high speed fuses as recommended.

4.3 INSTALLATION

- 1 The Contractor shall submit details of proposed equipment and method of installation to the Engineer and QGEWC for approval prior to commencement of installation work.
- 2 Provide all the motor control equipment installations, wiring installations and tests, including connections and interconnections for the electrical controls as indicated, specified and required. Assure proper fits for all equipment and materials in the spaces shown on the Drawings. The starter can be installed in a separate cubicle for MCC or can be an item in the Distribution Board, as per the Project Documentation. The installation procedures as applicable for MCC and DB shall also in general applicable for motor starter items.
- 3 Equipment shall be installed level and securely attached to the cubicle frames. The sections shall be joined together with bolts, nuts and washers to form a complete unit assembly. Floor standing equipment shall be installed on concrete plinths as shown on the Drawings.

4.3.2 Earth Bonding

- 1 Each Medium Voltage/MCC switchgear panel or section shall be individually connected (at both end of the panel earthing bar) to two separate earthing pits trough the main earth bar located in the electrical or cable basement rooms. The earthing cable size shall be provided using a professional international recognized cable size design software subject to the Engineer's approval.

- 2 Medium Voltage /MCC switchgear panel earthing conductor to earthing bar and earthing pit is to be sized for maximum earth fault current for 5 seconds with final conductor temperature not exceeding 160 °C or sized not less than 20 mm² per 100 kVA of transformer rating, and with a minimum of 95 mm².
- 3 Each panel section shall be cross bonded to adjacent panel section earthing terminal.

END OF PART

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