SECTION: 2.15

MOTOR AND ELECTRICAL INSTALLATION

1.0 Scope of work

1.1 The scope of work covers, selection, supply, installation, testing and commissioning all electrical items of work comprising:

i) Drive motors & starters
ii) Cable laying
& iii) Protective Earthing (PE)

2.0 Ratings

2.1 All motor, switchgear, cable and PE ratings shall comply with the data sheets and the specification. Where higher ratings are required to match equipment offered, the tenderer may provide accordingly and bring out the fact specifically.

2.2 Ratings shall be at the ambient conditions specified. Motors shall comply with IS: 325 or equivalent BSS revised upto date. All motors shall be statically and dynamically balanced and shall be selected for low noise levels. Ratings shall be suitable for the complete operating range of the equipment concerned and should not cause overloading

2.3 Switchgear and starters shall be rated for the equipment and system fault levels. Protective Earthing shall be consistent with the over current tripping devices.

3.0 Squirrel Cage Induction Motors

3.1 Stator cores shall be made up of low loss high permeability sheet steel laminations. Stator windings shall be made of electrolytic copper with class B/E insulation and inserted as formed coils baked in position. Rotors shall be of die cast aluminium or copper cage construction.

3.2 Roller bearings at the drive and ball bearings at the free end shall be provided.

3.3 Motor windings shall be air cooled by means of shaft-mounted fan, designed for quiet operation. Enclosures shall be as shown on the data sheets or as required.

3.4 Motors, especially for air handling unit and fan drives shall be selected for low sound power level. Efficiency shall be standard (IS – 8789-1996) or High efficiency (IS 12615 – 2004) as stated in the data sheets.

4.0 Starters

4.1 The starter selections shown in the relevant data sheets shall be used as a general guide. Where the load torque demands higher starting torque, motor and starter shall be accordingly selected.

4.2 Direct to line or Star Delta or autotransformer starters shall be air insulated totally enclosed metal clad. Star Delta starters shall be automatic change over type.

4.3 All starters shall have:

i) Adjustable thermal over load trips on all phases.
ii) Single phase preventing device
iii) Under voltage protection (80%)
iv) Latch-on contacts with trip mechanism to indicate fault tripping

4.4 Solid state soft starters, wherever specified, shall be of tested and approved makes.

5.0 Variable Frequency Drives

5.1 Standards

5.1.1 Equipment must comply with recognized, international standards, and the manufacture must be carried out in accordance with ISO 9001 and BS 5750, parts 1 and 2. The VFD must comply with EMC and RFI requirements according to EN 55011 (VDE 0875), and the supplier must be willing to issue a certificate of such compliance.

5.2 Mechanical Protection

5.2.1 The VFD must have a separate metal enclosure which will meet the requirements of IP54 unless specified otherwise in the schedule of work to ensure that an extra enclosure is not necessary and have integrated fans as required. The supplier must provide information on heat dissipation.

5.3 **Operating parameters**

5.3.1 The VFD must be able to operate under the following conditions:

a) Rated input voltage 400V +/- 10%, 3 phase, 50 Hz +/- 2 Hz
b) Ambient temperature as specified.

The VFD must be suitable for manual as well as remote control.

5.4 **Technical features**

5.4.1 The VFD must be able to supply the motor with a sine shaped supply and fully circular magnetic flux to obtain full motor torque at rated frequency, without the motor becoming warmer than in normal mains operations.

5.4.2 The VFD must be able to vary the output frequency from 0 to 100 Hz and output voltage from 10% to full mains voltage even at -10% of full mains voltage. The VFD must regulate the output to continuously adapt as the case may be to the current load on the pump or the fan so as to minimize energy consumption.

5.4.3 The VFD must be able to work as a Stand-Alone unit, where all safety requirements have been fulfilled, or as part of a larger BMS system (Building Management System), where the control is centralised and operated via serial communication using the integrated RS 485 ports.

5.4.4 The control panel must be detachable and be able to function in a central control panel, if used.

5.4.5 The VFD must be able to regulate all types of motors without load reduction and without the motor temperature becoming higher than under normal mains operation.

5.4.6 The VFD must be able to control motors of different sizes connected in parallel, and it must be possible to stop a machine during operation without the risk of tripping. The VFD must be able to run without the motor being connected, for the purpose of servicing. Servicing must not require access from the back of the VFD.

5.4.6.1 The following features should be incorporated in the VFD.

a. Alphanumeric display (alphanumeric code)
b. Light diodes indicating “ON.” and “ALARM”
c. Choice of 12 different displays, eg. of output current, voltage, frequency, speed, output, torque, motor temp., energy kwh.

5.5 **Design features of the VFD**

5.5.1 The VFD must be able to avoid at least 4 bypass frequencies with adjustable bandwidth to avoid mechanical resonance.

5.5.2 The VFD must have filters in the intermediate circuit to ensure that the 5th harmonic transmitted to the mains supply is limited to approx. 30%.

5.5.3 The current limiting function must be quick enough for the VFD to resist short-term earthing and short circuiting on the output terminals without any damage to the components.

5.5.4 The VFD must have integrated protection against the mains transients in accordance with VDE 0160, single phasing, in the mains or motor, or short-circuiting of motor phases. If the speed reference is lost, it must be a programming option to either maintain the motor speed or regulate to stop.

5.5.5 The VFD must be able to give off a warning or stop the motor if the motor is overheated. This function must form an integral part of the VFD. Consequently, a thermistor in the motor must not be required.

5.5.6 The output circuit is to ensure the possibility of unlimited switching between VFD and motor regardless of load and speed, without any damage to the VFD, and without extra equipment being required.

5.5.7 The VFD must have an override function which in the case of overloads during operation and starting reduces the motor current to prevent damage.

5.5.8 The VFD must have a power factor of 1 on the supply side (AC) at all loads and speeds; extra AC coils for stable operation must not be required.

5.6 **Protection features**

5.6.1 The following protection shall be provided:

a) Inverter trip at 75 C on the heat sink.
b) Protection against under voltage
c) Protection against overvoltage
d) A lock to prevent unintended programming of the VFD.

5.7 **Product Support**

5.7.1 The supplier must be able to provide technical documentation, covering both catalogues and statements of dimensions and weight.

5.7.2 The local dealer must be able to provide full technical and maintenance assistance with full complements of spares.

6.0 **Motor Installation**

6.1 Motors and driven equipment shall be mounts on a common base and coupled through flexible couplings or multiple V-belt drive. Coupling and belt drives shall be provided with suitable safety guard.

6.2 Final wiring connections to motors shall be flexible.

6.3 Where motors are installed away from the starter.

7.0 **Motor Control Centres & Power Panels**

7.1 All motor control centres and power panels shall be cubicle type fabricated from a combination of 14 & 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and modular construction suitable for 3 phase 415V 4 wire 50 Hz system. All boards shall be accessible from the front for the maintenance of switch fuses, bus bars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meters etc. All sheet shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with two coats of synthetic enamel of approved colour applied over one coat of red oxide primer. Engraved plastic labels shall be provided indicating the feeder details, and capacity and danger signs.

7.2 The boards shall accommodate air-insulated bus bars, air circuit breakers, switch fuse units with HRS fuses, starters, necessary meters, relays contactors etc. As required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.

7.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an interlocked door with facility for pad-locking. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 2147/1962. Feeder connections shall be made out of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required. Internal wiring, bus bar markings etc. Shall conform to IS: 375/1963. Internal wiring shall have terminal ferrules. Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75m from floor level. Cable glands need not form part of the switch board as the cost of glands will form part of the cable termination.

7.4 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy as specified and shown on drawings and rated for a temperature rise of 30 ^{o}C over the ambient temperature specified, based on insulated conductor rating (IS:8084-1976). Neutral bars may be of one half the size of the phase bars. The main horizontal bus bars shall be of uniform cross section and rated in accord with the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to-bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hygroscopic insulated blocks to withstand thermal and dynamic overloads during system short circuits. An earth bus of size 50% of the phase bar subject to a minimum of 15 x 3 Cu or 25 x 3 Al. shall be provided. Individual switch components shall be connected with the earth bus through copper or aluminium or galvanised steel strip size as shown. All wire connections to bars shall be through lugs, bolts and nuts and spring washers.

7.5 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.

7.6 Panels shall be installed on a base channel frame and on a concrete pad to be provided by others. All panels shall be meggar-tested and shall not be commissioned till the valves are more than 2.5 megohms phase to phase and 1.5 megohm phase to neutral. All meters on the panel shall be calibrated before commissioning.

7.7 The general arrangement and fabrications drawings shall be got approved before taking up for fabrication.

8.0 **Cabling**

8.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards. All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm centres

8.2 Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

8.3 Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be fixed directly to walls or ceiling and supported at not more than 500 mm. Where number of cables are run, necessary perforated cable trays shall be provided wherever shown. Perforated cable trays shall be mild steel or Aluminium as specified in the schedule of work. Perforated trays shall not be directly suspended but supported on mild steel frame work as shown on drgs. or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic identification tags shall be provided at every 20m. Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

8.4 In the case of cables burried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid in an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement titles. Width of excavated trenches shall be as required. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cables markers at every 30 meters and at all loop points.

8.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

8.6 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

1) Continuity on all phases

2) Insulation Resistance
   (a) between conductors
   (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

9.0 **Equipment earthing**

9.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

Size of phase conductor	*Copper*	*Aluminium*	*Galvanised steel*
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs.	>
Minimum (base)	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

The earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

9.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metalic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

9.3 Armoured cables shall be earthed by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. DB's a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

9.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

10.0 Electrical Installation

10.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

10.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

11.0 Mode of measurement

11.1 Each electric panel or motor control centre shall be separately quoted and paid for. The cost of panel shall include earthing as specified and include for mounting of starters wherever required and shown or as shown in the schedule of work.

11.2 Cables will be measured on the basis of a common rate per unit length and shall include the following items.

Laid in doors	i) cables and clamps ii) cable markers
Laid out doors	i) cables and protective bricks & tiles

11.3 Cable trays/racks/ladders shall be measured per unit length and width as specified in the schedule of work.

11.4 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

i) Cable glands, lugs, bolts, nuts
ii) All jointing materials
iii) Installations, testing and commissioning
iv) Earthing the glands

11.5 For cables burried under ground excavation shall be paid for additionally for the following per unit volume:

i) Excavation and back filling
ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost.

11.6 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

a) Motors - earthing forming part of the cabling/wiring for the motors.

b) Isolating switches and starters should form part of mounting frame, switch starter etc.