1. GENERAL
   * + 1. **SUMMARY**
          1. Section Includes

This section covers the supply, installation, testing and commissioning and put in operation all mechanical control panels (MCCs) as indicated on drawings and according to the approved elected mechanical equipment complete with regard to power supply and control requirements. Mechanical and electrical Contractors must ensure full coordination between each other’s for proper implementation of MCC panels.

* + - * 1. Related Sections and Documents

Drawings and general provisions of the Contract, including General and Supplementary Conditions.

* + - 1. **REFERENCES**
         1. IEC Standard 61439 (Part-1 & 2) or BS EN.61439-1 - Factory built assemblies low voltage switchgear and control gear.
         2. IEC Standard 60529 - Degrees of protection of enclosures.
         3. BS159 - Busbars and busbar connections.
         4. IEE - Regulations
         5. IEC 60947-1 : LV Switchgear & Control Gear- General rules
         6. IEC 60947-2 : Low voltage switchgear and Control Gear
         7. IEC 60947-3 : Switches, Disconnectors, Switch‑ disconnectors & Fuse combination unit
         8. IEC 60947-4 (1 to 3 parts) : Contactors and motor starters
         9. IEC 60947-5 (1 to 9 parts) : Control Circuit Devices and Switching Elements
         10. BS 7626 : Current transformers
         11. IEC 60898: Circuit breakers for over current protection for household and  
             similar installation.
         12. BS 159 : Busbars and busbar connections
         13. BS 5685 / IEC 60051 : Electric Meters
         14. Local Electrical Power Company/ Utility.
         15. Notes mentioned on the Tender drawings
         16. Local Codes, Standards and Regulations.
      2. **SUBMITTALS**
         1. Submit manufacturer's catalogs and data including schematic drawings, dimensioned layout of equipment and accessories, technical specifications, installation instruction and general recommendations. Include data substantiating that the proposed units comply with the project requirements.
         2. Submit a dimensioned outline drawing of each MCC showing all leading dimensions and the estimated weight of the equipment.
         3. Submit manufacturer's fabrication, builders work and installation drawings showing all significant details of each MCC including the following:

All components.

Fuse, circuit-breaker and switch ratings.

Current and voltage transformer ratios, class, terminal markings and output.

Instruments, including scale details.

Relay types and characteristics.

Indicating lamps, including color.

Position of switches, and details of function.

All internal connections, with terminal markings.

Arrangement of terminal blocks.

Wire numbers.

Size, type and color of secondary wiring.

Principal physical dimensions, including clearances required for removing covers, opening doors, operating handles, withdrawing equipment, etc.

Position of all panel face equipment.

Identification of all equipment, and appropriate label inscriptions.

Foundation details, including weights and fixing points.

Cable entry details including gland and gland plate provisions.

* + - * 1. Submit list of tools, test equipment, spare parts and ancillary equipment.
        2. Provide samples of all proposed panels, devices, fittings and related accessories together with the above submittal for approval of the Engineer. It's the contractor's responsibility to get the samples approvals without any extra time extension.
        3. Submit the factory test reports verifying that MCCs have successfully passed all routine tests. Type tests results shall be submitted, when required by the Engineer.
        4. Method Statement of system installation, connection, setting, testing, operation and commissioning.
      1. **CLOSEOUT SUBMITTALS**
         1. Project Record Documents: Record actual locations, configurations, and ratings of motor control centers and major components.
         2. Operation and Maintenance Data: Submit replacement parts list for controllers.
      2. **QUALIFICATIONS**
         1. Firms regularly engaged in manufacture of the MCCs of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.
         2. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
      3. **QUALITY ASSURANCE**
         1. The MCC panels shall comply with the requirements of BS, IEC
         2. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.
      4. **DELIVERY, STORAGE, AND HANDLING**
         1. Handle MCCs carefully to prevent breakage, denting or scoring the finish. Store equipment at indoor location and protect from weather. When outdoor storage is necessary, elevate well above ground and enclose with durable, waterproof wrapping.
         2. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
         3. Handle in accordance with IEC standards. Lift only with lugs provided. Handle carefully to avoid damage to motor control center components, enclosure, and finish.
      5. **ENVIRONMENTAL REQUIREMENTS**
         1. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.
      6. **FIELD MEASUREMENTS**
         1. Verify field measurements prior to fabrication.
      7. **OPERATION AND MAINTENANCE DATA**
         1. A. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
      8. **SPARE PARTS**
         1. Supply as maintenance stock, additional devices of all types and ratings, amounting to one unit for every 10 installed units, but not less than two units of each type and rating.
         2. Incase three or less numbers of any device of certain rating/ size are installed, a minimum of one for each three numbers additional devices of same rating/ size shall be provided as spare.
      9. **MAINTENANCE SERVICE**
         1. Maintenance Contract: Obtain an undertaking by the equipment manufacturer and his authorized local representative to provide an annual maintenance contract, available after substantial completion of the work, covering routine service and emergency service by trained employees, and to ensure supply of necessary standard spare parts.
         2. Initial Maintenance Service: Beginning at Substantial Completion, provide (12) months full maintenance service by skilled, competent employees of the Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Use parts and supplies as used in the manufacture and installation of original equipment.

Perform maintenance, including emergency callback service, during normal working hours.

Include 24-hour-per-day, 7-day-per-week emergency callback service. a. Response Time: 2 hours or less.

* + - 1. **WARRANTY**
         1. Submit written guarantee signed by the manufacturer and the contractor for the period of (1) year from the date of substantial completion. The guarantee shall cover the repair and replacement of defective materials and workmanship as directed by the engineer except where any specific warranty from a supplier or manufacturer extends for a longer time.
      2. **TRAINING** 
         1. Vendor shall provide operation, maintenance and administration training for the proposed system to Two Engineers. Training shall be sufficient enough to enable the engineers to carry out day-to-day operation, maintenance and operation of the system without or with minimal assistance from the vendor’s technical staff.

1. PRODUCTS
   * + 1. **GENERAL**
          1. The design construction material and finishes of all control panels and component parts shall be suitable for the location, climatic and operating conditions indicated in the specification and drawings.
          2. All power supplies to mechanical equipment shall be routed via an MCC unless otherwise as shown on drawings.
          3. Each MCC Panel, unless otherwise requested in section 25 50 00, shall be totally controlled by a local BMS outstation. The outstation shall be located outside the MCC Panel in a separate enclosure. Control signal interface connections between the outstation and the MCC Panels shall be brought out of the panel and terminated within an interface terminal box. All control signal wiring for sensors, actuators, heater batteries and packaged equipment shall be direct between the outstation and the devices.
          4. Inverter speed control devices shall be mounted internally in the MCC panels enclosure.
          5. User interfaces at the MCC panels shall be restricted to the following;

Hand / off / auto selector for each fan and pump.

Manual controls for speed controllers.

Run and trip/fault lights for each fan and pump.

Main isolator.

Power healthy light.

Switchable ammeter showing total MCC PANEL current.

Phase healthy lamp

Transformers

Lamp test facility

* + - 1. **PANEL CONSTRUCTION**
         1. Motor control centers shall be free standing standard extendible cubicle, multi-tier, low voltage, flush fronted, in line assemblies designed for front access only. Panels shall be rigidly constructed from folded mild steel sheet of minimum thickness 2.0mm according to BS 2989 to the approval of the Engineer.
         2. The panels shall be constructed in compliance with FORM-2 to BS 5486: Part 1:1990, EN 60439-IEC 439-1. Unless otherwise specifically mentioned.
         3. MCC panel, incoming and outgoing breakers, busbars, components and accessories shall be rated to 35KA.
         4. Finished panels shall be without sharp edges and all exposed screws, bolts and similar fastenings shall have smooth surfaces and protectively plated.
         5. Panels secured to a finished floor shall be provided with a metal plinth. A metal plinth is not required if panels are mounted on a raised builders work base. In all cases, panels shall be provided with fixing holes and, in the case of large or heavy panels, detachable lifting eyes shall be provided.
         6. Panels shall be supplied painted internally with a semi-gloss stoved enamel to a RAL color as indicated or approved by the Engineer. All surfaces shall be properly prepared before final finishing.
         7. All doors shall be fitted with concealed hinges together with gaskets to provide dust and weather protecting to min. IP54 unless otherwise specifically mentioned. The panels shall be fully vermin proof, meet the requirements of BS 4941 and be fitted with anti-condensation heaters. Panels shall be provided with hinged and lockable access doors or covers at the front of the panel and/or at the back of the panel as required to facilitate maintenance. All access doors or covers shall incorporate sealing gaskets. Two keys shall be provided which shall be common to all locks on all panels.
         8. All access doors and covers shall be so arranged that access to panels cannot be made until an isolating device interlocked with each door or cover is opened and all equipment accessible through that door or cover is isolated. A purpose made device shall also be provided to enable a competent examiner to override the interlock when the door or cover has opened.
         9. Internal power wiring shall be identified by color code in accordance with BS 6346. Control circuit and other wiring shall be coded for identification right up to the point of each cable termination using attached ferrules or other approved permanent means. Secure fixing of all cable ends shall be ensured by the use of purpose made clamps, pinch-type terminals, crimped cable tags or other approved termination devices.
         10. Grouped terminal blocks of adequate size and capacity shall be provided for all cables leading to equipment outside the panel. Removable covers shall be provided for the entry of incoming cables, conduits, trunking, etc. with means of effective earthing to the panel. Provisions shall be made for the earthing of all non-current carrying components of the panels. All necessary bonding shall be provided together with an earthing terminal of adequate size.
         11. MCB’s / MCCB’s shall be grouped so as to be readily accessible without danger. MCB’s shall be DIN rail mounted.
         12. MCB’s / MCCB’s, terminal blocks and all other items of equipment within panels shall have their functions identified by means of clearly inscribed labels attached to them, or adjacent to them. All items on the outside of panels shall be identified by means of attached white laminated plastics labels engraved in black.
         13. The internal and external layout of a panel shall be agreed with the Engineer before manufacture. A neat and orderly arrangement is required. Equipment shall not be fixed to any cover, which is removable for maintenance access purposes. Items of equipment fixed to a door shall be kept to a minimum and in any case shall not include heavy components or sensitive instruments.
         14. All live terminals and components within any panel shall be shielded in such a manner as to prevent inadvertent contact with them. All live terminals and components mounted on panel doors shall be shrouded such that contact can only be made after removal of the shroud.
         15. All panels shall be provided with engraved labels identifying the panels, the indicators and the switches. The labels shall be engraved with white writing and black onto a composite plastic ‘Traffolyte’ material. The labels shall be screwed and adhered to the panel. The language of the labels shall be Arabic and English.
         16. Control panels shall be manufactured, equipped wired and tested before delivery to site. Unless otherwise agreed by the Engineer, a functional test simulating operation of the complete panel shall be performed and witnessed by the Engineer or his nominated representative before delivery to site. The contractor shall arrange for site commissioning of the panel to the satisfaction of the Engineer.
         17. The panels shall be fitted with air insulated busbars run in separate enclosures. Busbars shall run the full length of the panels. Busbars and connections shall conform to BS 159.
         18. Moulded case circuit breakers and miniature circuit breakers shall be used throughout for current protection and isolation of individual circuits. These shall be adequately rated for their duty and the prospective fault rating at their point of installation.
         19. Control circuits shall be divided in small logical groups or sections, each being supplied through a miniature circuit breaker so that only one small group or section is affected if a circuit fault occurs.
         20. The panels shall be made up in standard width sections with an incoming section housing the incoming main supply cable terminations, main incoming and outgoing breakers, voltmeter, overloads, contactors, indicating lamps, selector switches, relays, current transformers, digital/electronic multi metering unit...etc.
         21. A suitable control and instrument section shall be provided to accommodate relays, instruments, pressure gauges, temperature indicators, recorders and free issue equipment as specified in the mechanical specifications.
         22. External fixing screws, door and switch handles, handle lock barrels, push-button and indicating lamp bezels shall be chromium plated steel.
         23. Access doors shall be efficiently earthed to the fixed enclosure by braided copper straps and have an additional restraint to prevent damage to the hinged and painted surfaces.
         24. Moulded case circuit breakers, isolators and overload relay resets shall be arranged for through the door operation.
         25. Suitable kicking space shall be provided at the base of every control board.
         26. Panels shall not be bolted direct to concrete floors but to steel channels inset into the floor screed. The channels shall be supplied and fixed by the Contractor.
         27. Provision shall be made for conduits, cables, instrument piping, etc., to enter at the top or bottom of the respective panels as specified. Suitable approved cable cleats shall be provided to ensure that the weight of incoming cables is not carried by the cable glands.
         28. Removable eye bolts or lifting lugs to facilitate unloading and erection shall be provided together with blanking set screws.
         29. Ventilation ducts shall be provided in control panels for resistance or other cooling.
      2. **INSTRUMENTS AND INDICATION**
         1. All indication lamps, instruments and controls shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and facilitate maintenance. Externally visible equipment shall be flush mounted and fixed securely to the faces of control panels. Internal equipment shall be fixed to purpose-made rails or mounting bars. All fixings shall incorporate shake-proof washers or other vibration resisting fastenings.
         2. An ammeter with phase selector switch shall be supplied with each MCC PANEL. The ammeter shall have a scale not less than 70mm in length and shall indicate maximum operating current at not less than 75% of total scale length.
         3. The colors and color significance of indicator lights shall be in accordance with BS 4099. Where extra low voltage filament lamps are installed, they shall be fed from a double wound transformer complying with BS 3535 or similar standard. Permanent legible information shall be provided adjacent to each indicator light to readily identify its function. For plant where there could be a requirement to indicate more than one danger or alarm condition individual indicator lights shall be provided at positions where stated, each suitably identified.
         4. Indicator lights shall be capable of functioning with selector switches in any position i.e., 'ON', ‘HAND’ or ‘AUTOMATIC'.
      3. **STARTERS AND CONTROL GEAR**
         1. Starters shall comply with BS 587 or BS4941 or similar standard as applicable. The 'rated duty' shall be 'intermittent' and the intermittent duty class of the standard shall be appropriate to their operating conditions.
         2. One types of starters must be provided to all mechanical equipment/motors as listed under section 26 29 16 - Enclosed Starters and Contactors and MCC panel schedules:
         3. For starters incorporating reduced voltage starting the changeover in voltage shall be automatic.
         4. Starters shall be provided on each phase with combined thermal overload devices and single phasing protection, with adjustable time lag, and an under-voltage release. Contactor operating coils DC or rectified AC operation. Where a contractor is arranged for remote operation the coil circuit shall be protected by MCB.
         5. Where duplicate plant is provided the starters for each plant shall be housed in a separate compartment of the panel. Where more than one refrigeration compressor is provided the compressor motor starters shall be housed in separate cubicles. Each stand-by (installed spare) electric motor shall be provided with its own control gear and starting equipment and be connected to a separate final sub-circuit.
         6. Power supplies for equipment controlled by direct link between the outstation and the device shall be protected by MCB or MCCB as appropriate.
      4. **COMPONENT** 
         1. Each motor control center shall include: -

Equipment Starters

Isolating switches & circuit breakers

Interposing relays

Digital multi metering unit

Kilowatt hour meters

Digital Hour & Day Clocks

Digital hours run meters

Bus bars

Terminals

Interconnecting power & control wiring & cabling

Auxiliary contacts

Transformers

* + - * 1. Protections for earth leakage, phase failure, phase reversal, under and over voltages and excess current
        2. Push buttons and indicating lamps, selector switches.
        3. The above shall be flush mounting & shall not be mounted at a height greater than 1800mm or less than 450mm from finished floor level. Where push buttons, lamps, meters and switches are mounted on access doors, their terminals shall be screened to prevent accidental contact.
        4. Excess current protection and isolation of each motor circuit shall be made using a moulded case circuit breaker.
        5. Excess current protection of control circuits or sections of control circuits shall be made using miniature circuit breakers.
        6. Cubicle isolators or moulded case circuit breakers shall be capable of breaking the installed motor current & shall be mechanically interlocked with the cubicle door. The contacts and live terminals shall be shielded. The isolator or moulded case circuit breaker shall be rated for the full load motor current, taking into account any de-rating factors which may apply.
        7. Each control circuit shall be powered by a separate supply protected by a miniature circuit breaker.
        8. Where a control panel is interconnected with another control panel or item of electrical equipment, interposing relays shall be provided in each control panel or item of equipment to provide complete isolation between the two sources of electrical supply. These relays shall be mounted in an enclosure, which must be removed to gain access to them.
        9. The control panel or item of equipment's main supply isolator shall also be equipped with a sufficient number of auxiliary contacts to isolate all interconnecting wiring. When this is not possible, a multi-pole isolating switch shall be provided adjacent to the relays.
        10. A warning notice shall be installed on the relay unit engraved "DANGER. SEVERAL ELECTRICAL SUPPLIES PRESENT DO NOT INTERCONNECT".
        11. Test facilities shall be provided at the starter cubicle such that the control voltage is maintained but the mains supply to the motor is isolated. There shall be a mechanical interlock to prevent the mains voltage being applied whilst the starter cubicle is in the "Test' position.
        12. Starters and contactors shall be compatible with the motors and motor duties as supplied by the manufacturers of the Mechanical Equipment
        13. Individual drive reference labels are to be provided on the front door of each starter/ feeder. All controls shall be clearly labeled. Labels shall be engraved on white/black/white Traffolyte.
        14. All cabling, circuit breakers, moulded case circuit breakers, miniature circuit breakers and all marking and labeling shall be as described in the General Requirements unless otherwise described elsewhere in this Specification.
        15. Unless otherwise described, metering solid state equipment and precautions concerning access to dangerous voltage shall be as described in the General Requirements. Timers shall be as described in the Particular Requirements and shall be variable solid state. All equipment shall be suitable for the required application and supply voltage.
        16. Contactors shall comply with BS 5424: Part 1 and be mounted in an enclosure complying with BS 5490 classification IP 32 for use indoors and IP 54 with corrosion-resistant finish for use outdoors. Contactors shall be utilization category AC3 of Table 2, BS 5424, unless otherwise described elsewhere in this Specification.
        17. Contactors shall be duty rated as specified or where not so described then the appropriate rating shall be determined from the duty or function of the equipment and to the approval of the Consultant.
        18. Where contactors are used in conjunction with earth fault relays, the contactor shall be rated to break the full earth fault current or other measures shall be taken to ensure that the fault current is safely interrupted.
        19. MCCs shall be provided with earth leakage protection devices as shown in MCC panel schedules.
        20. Hours run meters shall have flush mounting non-resettable cyclometer type dials with 6 digits. The first digit shall register in 0.1 hour increments. The plastic surround shall be black of the same pattern as ammeters and voltmeters.
        21. Ammeters shall be industrial pattern accuracy with 100 mm dials and the scale shall be marked with a red line to indicate the FLC of the motor to which it is connected.
      1. **PUSH BUTTONS AND SWITCHES**
         1. Push buttons and indicating lamps shall be of matching design arranged for single hole fixing and of small body size to allow close grouping.
         2. Terminals shall be of the screw clamp type having minimum screw size of 4 mm.
         3. Start and stop push buttons shall be of the shrouded type. Emergency stop push buttons shall be of the mushroom push type with stop/lock action. All push buttons for use outdoors shall be protected to IP 65.
         4. Indicating lamps shall be of the step down transformer push to test type having 10 volt secondary and 12 volt bulbs to give long bulb life. They shall be arranged so that the bulb may be replaced from the front and shall have shallow bezels, which incorporate plastic lenses of the specified colour.
         5. When key switches are specified to match the push buttons and indicating lamps, duplicate keys shall be provided.
         6. Engraved legend plates shall be fitted with all push buttons, indicating lamps and switches. The minimum character height shall be 3 mm. They shall be made from anodized aluminum with black enameled lettering or white/ black/white Traffolyte.
         7. Selector switches shall be positive action rotary cam switches, which shall incorporate double break contacts. They shall be of modular construction and suitable for extension to twelve cells. It shall be possible to arrange the switches for four, six or eight positions and operation shall be in either direction.
         8. Selector switch contacts shall be double break and of hard silver alloy. They shall have a minimum continuous current rating of 10 amps and be of high breaking capacity.
         9. Connections shall be by large terminals with clamp screws of minimum size 5 mm.
         10. Operating knobs shall be of the type, which positively indicates the position of the switch. The switch positions shall be clearly marked.
         11. Where required for remote automatic operation the 'Local/Off/Remote' control switch shall be arranged such that in the 'local position the respective drive shall be controlled from the cubicle.
         12. A suitable selector switch or flush mounting board shall be provided to enable the motor drive duties to be interchanged where specified for Duty/Standby operation.
         13. Drive shafts and operating knobs shall not be of round section.
      2. **TERMINALS**
         1. Terminals for incoming and outgoing control wiring shall be of 'Klippon' manufacture with screw type pressure connectors and of minimum size SAK 4. When more than one connector is required for each termination jumper bars shall be used.
         2. Terminals for incoming and outgoing power connections shall be of the bolted type using brass nuts with additional locknuts and shall be provided with cable lugs or clamp washers as required.
         3. Partitions shall be provided between phase terminals and protection covers shall be fitted over incoming connections.
         4. Each terminal shall be clearly and indelibly marked with the terminal designation and shall conform to the 'As Fitted' drawings.
         5. All incoming and outgoing terminals shall be horizontal rows at least 200 mm from the cubicle base/top dependent on the cable entry.
         6. Provision shall be made for the support of cables between the gland plate and control panel terminals.
      3. **WIRING**
         1. Panels wiring shall be carried out in 600 volt grade PVC insulated cables having multi-strand copper conductors of not less than 1.0 mm2 cross section terminated by crimp type lugs, tags or pins.
         2. Panels wiring shall be run in neat looms and shall be installed vertically and horizontally and not diagonally across any framing.
         3. Where practicable cable looms shall be installed in PVC trunking.
         4. Wiring shall be provided with colour coded Critchley Z type marking ferrules at every connection & termination point. The markings shall conform with the 'As Fitted' drawings.
      4. **TRANSFORMERS**
         1. The primary input shall be 230/400V 50Hz controlled from a way of the distribution board.
         2. The secondary outputs shall be 110 volt & 24 volt protected by two fuses in each circuit & shall be centre point earthed. Terminals for both input & output cabling shall be provided.
         3. The transformer shall be located within its own compartment of the control board.
         4. The control circuit of the motor starters, remote and local control circuits etc. shall be supplied at 230 volts from a continuously rated, wound transformer with metallic earthed screen between the primary and secondary windings.
         5. A separate control circuit cubicle shall be provided within the control board housing the transformer and associated control gear.
         6. The transformer shall comply with BS 3535 and be capable of controlling the whole of the board, and rated to 125% of the initial load as a minimum requirement.
         7. A removable earth link shall connect the earth side of the transformer to the earth side of the control circuit.
         8. The earth side of the control circuit shall be wired with PVC insulated cable with all earth connections brought back to the control circuit earth terminal.
      5. **STARTER EQUIPMENT**
         1. Each starter shall comply with BS 4941 having Type C co-ordination and be complete with the following:

One (1) set of busbars and/or dropper bars of similar ratings to the incoming protection.

One (1) molded case circuit breaker of suitable rating interlocked with the door for isolation and excess current protection.

One (1) set of contactors with auxiliary contacts, timing devices, interlocks etc. suitable for a minimum of 15 starts per hour.

One (1) overload and single phase protection device as specified.

One (1) spare contact set of one normally open and one normally closed contact to be provided per starter.

One (1) test switch to allow operation of contactors, relays etc., without energizing the main circuits.

One (1) thermal overload device to protect the rotor /stator winding, where applicable.

One (1) indicator light to show motor has tripped for any reason.

One (1) indicator light to show motor running.

One (1) indicator light to show test facility has been selected.

One (1) set of 'START'/ 'STOP' - push buttons.

One (1) HAND/OFF + AUTO/OFF selector switch.

One (1) LOCAL/REMOTE selector switch where specified.

One (1) 230V anti-condensation heater with thermostat, hand control switch, & also auxiliary contacts to isolate the panel heater & corresponding motor heater when running.

One (1) set of terminals.

One (1) set of starting equipment as specified.

One (1) suitable engraved duty label.

One (1) KWH meter where specified.

One (1) thermostat relay where specified

1. EXECUTION
   * + 1. **LOCATION**
          1. Panels shall be provided in the approximate positions shown on the drawings. Final position to be agreed by the Engineer. Care shall be taken to ensure that all panel access doors can open fully and that a minimum space of 1100mm is kept clear in front of each panel.
       2. **INSTALLATION** 
          1. All electrical/mechanical equipment materials shall be installed securely in place. Equipment shall be mounted parallel and perpendicular to the walls, floors, and ceilings.
          2. All anchors and fasteners shall be types designed for the intended purpose and shall be capable of adequately, safely, and permanently securing the material in place. Generally, screws shall be used on wood surfaces, masonry anchors in concrete or brick, toggle bolts on hollow walls, machine screws, bolts, or welded studs on steel. Nails shall be used only for temporary attachment or support.
          3. Omissions or conflicts on Drawings or between Drawings and Specifications shall be brought to the attention of the Engineer for clarification before proceeding with the Work.
          4. The Contractor shall make all necessary provisions throughout the Site to receive the Work as construction progresses and shall provide adequate backing, supports, inserts, and anchor bolts for the hanging and support of all electromechanichal equipment, conduit, switches,wiring, …etc and shall provide and install sleeves through walls, floors, or foundations where electrical lines are required to penetrate.
          5. Floor standing equipment shall be leveled with shims as required to maintain horizontal surfaces within 1/32-inch per horizontal foot; after leveling, equipment shall be anchored, then grouted so that no space is existing between concrete and equipment support beams.
          6. Install motor control centres in accordance with manufacturer's instructions.
          7. Tighten accessible bus connections and mechanical fasteners after placing motor control centre.
          8. Install fuses in fusible switches.
          9. Select and install heater elements in motor starters controlled by ‘Off/Auto’ switches and humidistat to match specified humidity range.
          10. Provide engraved plastic nameplates under the provisions of Section 26 05 53.
          11. Motor Data: Provide neatly typed label inside each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
       3. **FIELD QUALITY CONTROL**
          1. Comply with Section 26 01 26.
          2. Prior to energization of MCCs, following tests shall be carried out:

Testing of all accessible bolted connections to manufacturer’s torque specifications.

Testing of insulation resistance.

Testing of electrical continuity / short circuits of the circuits.

Current injection testing of all circuit breakers and protective devices.

Ratio tests of all current transformers.

* + - * 1. Subsequent to wire and cable hook-ups, energize the MCCs and demonstrate functioning in accordance with the requirements. Check whether all outgoings are connected as per load schedules. Record changes in the schedule for final as-built, if acceptable to the Engineer.
        2. Verify that all starters, controls … etc are as per mechanical requirements.
      1. **IDENTIFICATION**
         1. Complete identification as detailed in Section 26 05 53.
      2. **EXECUTION OF TESTS ON SITE**
         1. Conduct tests in accordance with the requirements of BS.EN-60439-1, Local Electrical Power Company and IEE Regulations.

Insulation resistance tests.

Circuit continuity tests.

Check of proper working of locks.

Check proper working of controls, start-up and stop of circuit breaking appliances.

Phase rotation tests.

Check of protection relays and protection circuits by injection of current or voltage into the transformer primary or secondary.

Test of operation of signaling.

Test of operation of any automation.

Test of direction of rotation of all motors.

Test all starters for performance of functions as required by the contract.

* + - 1. **FACTORY TESTING**
         1. All factory tests shall be performed at manufacturing locations in the presence of minimum three persons one each from client, project/ construction manager and consultant. Contractor shall make provision for all the expenses of business class air travels, insurance, five-star hotel accommodation, local travel etc. to witness these tests.

END OF SECTION