



FLOW PETROLEUM PRIVATE LIMITED

PETROLEUM STORAGE DEPOT AT KHUSHAL GARH, KOHAT

SPECIFICATION FOR
LOW VOLTAGE SWITCHGEAR / MCC

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1.0 **INTRODUCTION**

1.1 **Scope**

The specification covers the minimum requirements for the Low Voltage Switchgear / Motor Control Centre (MCC).

1.2 **Definitions**

Following definitions apply throughout this document:

COMPANY / OWNER	Flow Petroleum Private Limited (FPL)
CONSULTANT:	Optimum Engineering Services (OES)
CONTRACTOR:	Means the Construction Company to be engaged by the COMPANY to perform the Procurement, Construction, Commissioning and performance testing of the system.
VENDOR / SUPPLIER:	The organization, firm or agency with whom order for the supply of equipment and or material has been placed.

1.3 **Errors or Omissions**

1.3.1 Review and comment by the CONSULTANT / COMPANY of any CONTRACTOR / SUPPLIER's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the CONTRACTOR / SUPPLIER of its obligations to comply with the requirements of this specification and other related parts of the contract documents.

1.3.2 Any errors or omissions noted by the CONTRACTOR / SUPPLIER in this Specification shall be immediately brought to the attention of the CONSULTANT / COMPANY.

1.4 **Deviations**

All deviations to this specification, other specifications or attachments shall be brought to the knowledge of the CONSULTANT / COMPANY in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of the CONSULTANT prior to execution of the work. Such deviations shall be shown in the documentation prepared by the CONTRACTOR / SUPPLIER.

1.5 **Conflicting Requirements**

In the event of conflict, inconsistency or ambiguity between the contract scope of work, this Specification, National Codes & Standards referenced in this Specification or any other documents, the CONTRACTOR / SUPPLIER shall refer to the CONSULTANT whose decision shall prevail.

2.0 **GENERAL**

The miscellaneous items as described in this specification shall comply with other sections of other specifications as applicable. No specific reference to any manufacturer has been made and the Contractor shall ensure that all the miscellaneous items shall be supplied / fabricated from the reputable manufacturers, who have already supplied/fabricated similar items.

3.0 **CODES AND STANDARDS**

3.1 Applicable Codes and Standards

- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- American National Standards Institute, Inc. (ANSI)
- Underwriters' Laboratories (UL)
- Insulated Cable Engineers association (ICEA)
- International Electrotechnical Commission (IEC)

The equipment shall comply with the latest editions of the International Electrotechnical Commission recommendations, including the following:- IEC 51 Recommendations for direct acting indicating electrical measuring instruments and their accessories.

IEC 59 Standard current ratings.

IEC 144 Degrees of protection of enclosures for low voltage switchgear and control gear.

IEC 157 Low voltage switchgear and control gear.

IEC 158 Low voltage control gear.

IEC 185 Current transformers.

IEC 186 Voltage transformers.

IEC 255 Electrical relays.

IEC 269 Low voltage fuses.

IEC 292 Low voltage motor starters.

IEC 337 Control switches.

IEC 408 Low voltage air break switches, air break disconnectors, air break switch disconnectors and fuse combination units.

3.2 The recommendations listed in 3.1 is supplemented by this specification, which states only requirements in addition to the requirements stated in these recommendations.

3.3 Reference shall also be made to the following documents:

- Single Line Diagram For MDB-001 (220-1-ELE-SLN-001)
- Single Line Diagram For Motor Control Centre (220-1-ELE-SLN-002)

3.4 All electrical equipment within the system shall be to IEC codes and standards and shall carry a label of an IEC approved certifying authority. The labeling shall include the total assembly (when available) in addition to individual components. Documentation of such compliance shall be provided; likewise any item that does not comply with this requirement shall be documented. If any equipment is not available with this labeling, written documentation shall be provided that the equipment conforms to all applicable IEC codes and standards.

- 3.5 Supplier shall be knowledgeable of the requirements of the above listed codes and standards. Any changes or alterations to the equipment to meet the above listed codes and standards shall be at the expense of Supplier.
- 3.6 In the event of conflict between the technical requirements, codes and standards, the most stringent shall govern.

4.0 **SERVICE CONDITIONS**

- 4.1 The equipment shall in all respects, be suitable for operation in service conditions typical of gas production facilities.
- 4.2 The equipment shall be suitable for indoor installation with normal ambient temperature of 50°C. However, the equipment should be rated for 50°C.

5.0 **ELECTRICAL SYSTEM**

- 5.1 The equipment shall be supplied in accordance with the single line diagram(s) and/or data sheet(s) referenced in the material requisition.
- 5.2 All equipment shall be rated for continuous operation unless otherwise specified. The rating (voltage, current, frequency, fault current, etc.) shall be as stated on the single line diagram/data sheets. Short time current rating shall be certified by a recognized testing authority.
- 5.3 Switchgear shall be suitable for operation, without deleterious effect, with variations of +10% voltage and +5% frequency.
- 5.4 Transient voltage depressions down to 80 percent of rated voltage shall not affect the performance of the equipment.

6.0 **STRUCTURAL & MECHANICAL REQUIREMENTS**

- 6.1 The equipment rated for operation at 400/230V AC, 50 Hz shall be of multicubicle, and factory built assembly type complying with BS 5486 / IEC 439 form 4 or equal.
- 6.2 The equipment shall be metal clad, free standing, floor mounting, flush fronted and arranged to form a single structure with a common busbar assembly to which additional sections may be readily added.
- 6.3 The minimum IEC protection coding for the enclosure shall be IP 54 to BS 5420 / IEC 144 or equal and shall be vermin proof.
- 6.4 The equipment shall be of angle iron frame work fabricated, welded and grinded, and covered with 3.2 mm thick sheet steel. The sheets shall be cleaned to bear shining, derusted degreased provided with two base coats of anti-rust paint, finished inside and outside with powder coated paints.
- 6.5 The equipment shall be complete with eyebolts/lifting angles etc. to facilities installation. The Supplier shall supply appropriate base frames to provide a substantial foundation for the equipment installation together with the necessary holding down bolts, nuts and washers etc.

- 6.6 The structure, including doors and panels, shall be capable of withstanding the internal pressures created by faults within the structure (equal to the maximum fault current rating) without danger to the operating personal.
- 6.7 Back to back arrangement is permitted for the motor control centers.
- 6.8 Structures shall be self ventilating.
- 6.9 Interlocks, busbars shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation, and to prevent access to live parts.
- 6.10 Isolation between compartment/cubicle, bus and cable spaces shall provide the following:
 - 6.10.1 Permit cables to be pulled safely into the equipment and extended to the compartments/cubicles, with the equipment energized. It is preferred that no uninsulated live parts be located in the cable pulling spaces. It is acceptable guarded cable terminals are located there, provided temporary insulation can be installed during cable pulling.
 - 6.10.2 Arc propagation barrier between compartments.
 - 6.10.3 Permit personnel to work safely within an empty compartment/cubicle, or one from which the device assembly has been removed, with the busbar energized.
- 6.11 Similar parts and components shall be interchangeable wherever practical.
- 6.12 Incoming and bus-section units shall be housed in separate cubicles (tier formation shall not be used).
- 6.13 Outgoing feeder circuit breakers may be arranged in tier formation, limited to a maximum of 2 feet high.
- 6.14 Each motor starter, feeder switch and fuse unit, etc. shall be housed in a separate compartment within the equipment.
- 6.15 The equipment shall be designed to permit rearrangement of compartment sizes after installation at site.
- 6.16 Self tapping screws shall not be used in the main construction of the equipment. Where removable cover plates are fitted, the anchor nuts or similar shall be fitted to the underside of the plate. Threaded holes are acceptable provided at least four threads are engaged.
- 6.17 Isolating mechanisms and unit withdrawal facilities shall be suitable for operation by a single operator.
- 6.18 All equipment shall be treated for operation in tropical conditions.
- 6.19 There shall be no exposed bare copper. All copper must either be covered with insulation or tinned.
- 6.20 All materials used shall be of the "self extinguishing" type.
- 6.21 Cable entry inside the equipment shall be from bottom only.
- 6.22 Bus-Duct would be installed on the top of the equipment.

- 6.23 All exterior hardware (handles, hinges, nuts, bolts etc.) shall be of stainless steel unless otherwise specified. Ventilation openings shall be filtered or screened to prevent the entrance of dust/rodents etc.

7.0 **CIRCUIT BREAKERS**

- 7.1 Circuit breakers shall be withdrawable and of the type specified on respective drawings.
- 7.2 Circuit breaker duty, rating and number of poles shall be as stated on the single line diagram.
- 7.3 Circuit breakers of similar rating shall be interchangeable.
- 7.4 Circuit breakers shall be supplied with manual operating devices.
- 7.5 Tripping, closing, control and indication supplies shall be as shown on the single line diagram.
- 7.6 Circuit breaker operating mechanisms shall be as stated on the switchgear single line diagram/ interlocking block diagrams.
- 7.7 Test facilities shall be provided to permit operation of the circuit breaker whilst in the test/isolated position.
- 7.8 Circuit breakers shall be fully type tested and carry certification from a recognized testing authority.
- 7.9 Circuit breakers shall be provided with trip circuit supervision to monitor trip circuit continuity and trip circuit supply. Alarm and indication facilities shall be provided.
- 7.10 Circuit breakers shall be provided with four normally open and four normally closed spare auxiliary contacts wired out to terminals.
- 7.11 Circuit breakers shall be mechanically interlocked to prevent:
- The breaker being inserted into the service position unless it is open.
 - The breaker being withdrawn from the service position unless it is open.
 - The breaker being closed unless it is fully in the service or withdrawn/test position.
 - Remote operation whilst in the withdrawn/test position.
 - The breaker being inserted into the service position while shutters are padlocked.

8.0 **MOTOR STARTERS**

- 8.1 All motor starters above 15 KW shall be protected with Earth Fault Relay (EFR), whether or not explicitly shown on the drawing.
- 8.2 All motor starters equal to or below 15 KW shall be protected with Earth Leakage Circuit Breaker, whether or not explicitly shown on the drawing.
- 8.3 Motor starters shall be of the withdrawable type, with starter components mounted on a withdrawable chassis.

- 8.4 Motor starters shall include, but not be limited to, the following (see single line diagrams and schematics referenced in the material requisition for details):
- Isolator – fault make and capable of breaking motor locked rotor current, mechanically interlocked with door/withdrawable mechanism, padlockable in the 'off' positions and fitted with additional auxiliary contacts (for isolating internal/external controls, etc.) as specified.
 - Fuses – main fuses shall be the H.B.C. type and have motor protection duty characteristic. Parallel arrangement of fuses to achieve the required rating is not acceptable. Control, indication and instrument circuit fuses shall be the H.B.C. cartridge type.
 - Contactor – suitable for uninterrupted duty, intermittent duty class 1 and utilization category AC3 or AC4 (IEC). Contactor and protective device shall be coordinated to ensure that contactor fault rating is not exceeded.
 - Protective devices – affording overload and single phasing protection. Instantaneous earth fault relays shall be provided for motors rated at 15KW and above. The protective device shall be provided with manual reset.
 - Selector switches-spring loaded type, switch position clearly and indelibly marked and circuits properly interlocked to avoid any maloperation.
 - Stay put stop facility with pad lockable in the 'Stop' position.
 - Overload reset push-button mounted on front of the starter.
 - Ammeters and current transformers where applicable. Provision shall be made for remote ammeter indication. All ammeters shall have an adjustable red pointer.
- 8.5 Test facilities shall be provided to permit operation of the motor starter without energizing the power circuit.
- 8.6 Space shall be provided in each starter compartment for a future auxiliary (Pilot) relay.

9.0 **OTHER FEEDERS**

- 9.1 These shall comprise one or more of the following components as specified on the single line diagrams and schematic diagrams:-
- Isolator – fault make, load break, mechanically interlocked with door/withdrawal mechanism, padlockable in the 'off' position and fitted with additional auxiliary contacts (for isolating internal/external controls, etc.) as specified.
 - Fuses – main control, indication, etc. fuses shall be the HBC type.
 - Contactor – duty, class and utilization category as specified on schematic diagrams/data sheets. The contactor and protective device shall be coordinated to ensure that contactor fault rating is not exceeded.
 - Protective device – as specified on the single line diagrams/data sheets. All protective devices shall be provided with manual reset.
 - Other items as specified on the single line diagrams, schematic diagrams and data sheets.
 - Feeders shall be the withdrawable type.
 - Feeders supplying power above 15 KW shall be protected with Earth Fault Relay (EFR), whether or not explicitly shown on the drawings.
 - Feeders supplying power equal to or below 15 KW shall be protected with Earth Leakage Circuit Breaker, whether or not explicitly shown on the drawings.

10.0 **BUSBARS**

- 10.1 Busbars and connections shall be manufactured from hard drawn copper of 99.9 percent purity.
- 10.2 Busbars shall be insulated with a flame retardant material which will not give off any toxic fumes in high temperature conditions. The oxygen index of the insulation material shall be in excess of 25%.
- 10.3 Busbars shall be of the same cross sectional area throughout the length of the equipment.
- 10.4 Phase and neutral busbars shall be run in a separate compartment not requiring access for any other purpose.
- 10.5 The phase sequence shall be specified in alphabetical order, each phase reaching its maximum in time sequence in this order. Busbars shall be marked as follows, as seen from the front or operating side of a switchboard.
- R S T
 - Front Centre Back
 - Top Centre Bottom
 - Left Centre Right
- Cable terminals and apparatus which are to be connected directly or indirectly to supply conductors shall be marked U, V, W. The earth shall be marked with an E.
- 10.6 Busbars, at bus section switches, shall be arranged to permit safe work on one bus section whilst the other remains energized.
- 10.7 An earthing busbar shall be provided along the full length of the equipment structure with provision for earth cable connections at each end.
- 10.8 Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current and carry certification from a recognized testing authority.
- 10.9 Busbars and other primary connection joints are to be shrouded by means of clip on shrouds or alternatively to be encapsulated.

11.0 **EARTHING**

- 11.1 All metallic non-current carrying parts of the equipment shall be bonded together and connected to the earth busbar.
- 11.2 All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.
- 11.3 Withdrawable parts shall be effectively earthed until they are completely withdrawn, with all power and control connections disconnected.
- 11.4 The cable gland plates shall be bonded to the earthing busbar.

12.0 **INTERNAL WIRING**

- 12.1 Internal wiring shall be PVC insulated 600/1000V grade, stranded copper conductors, minimum size 2.5 sq.mm. For miniaturized relays or intrinsic safe relays, 600/1000 V grade, 1.5 sq.mm cable will be acceptable.
- 12.2 Internal wiring within the switchgear shall be securely held in position (either loomed or run in conduit / trunking). If wiring corridors, conduits and flexible conduits are used, they shall be adequately sized to accommodate future additions (6 conductors minimum) by others.
- 12.3 Bus wires for closing, tripping, control, indication, heaters, etc. shall be run within the equipment.
- 12.4 Wiring identification shall be by non-delible numbered and / or lettered ferrules / slip-on labels of insulating material and located adjacent to the terminals.
- 12.5 Wiring connections to door mounted equipment shall be loomed, wrapped in flexible PVC conduit and be firmly clamped at both ends to prevent movement at terminations.
- 12.6 All wiring for external connections shall be brought out to individual terminals on a readily assessable terminal block. Sufficient spare ways shall be allowed for future usage.
- 12.7 Wires shall be terminated using compression type lugs or crimp sleeves.
- 12.8 Plug and socket connections shall be of robust construction and include a location pin or similar device to prevent the interconnection being made incorrectly.

13.0 **CABLE TERMINATIONS**

13.1 **Cable Terminations**

- Cable terminating facilities and terminals shall be suitable for the specified cable type, gland and conductor size.
- The Supplier shall provide cable terminating facilities with un-drilled gland plate of sufficient dimensions to terminate the specified cables. Cable entry shall be from the bottom of the equipment.
- Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers etc. and provide for easy access for terminating cables. There shall be a minimum space of 50mm allowed for the termination of cable conductors.
- Cable supports shall be provided (where practicable) by the Supplier to avoid under strain on the cable termination.
- Termination of single core cables shall be through an insulating or non magnetic gland plate.
- All terminal blocks shall be shrouded or provided with transparent covers. Clamp type terminals shall be provided; the pinch screw type is not acceptable.
- The number of conductor connected to each terminal shall not exceed two.

- All terminal blocks shall be mounted in a single deck arrangement. The double deck arrangement is not acceptable.
- Spare terminal blocks (approve. 10%) shall be provided with each group of terminals.
- All group or individual terminals and wires shall be segregated and clearly marked and labeled with non-perishable and easily changeable markers or labels. The labels shall be positively fixed as to prevent the loss of labels.
- All terminal blocks shall be numbered with fixed or slip-on type markers.
- All interconnecting cables will have positively fixed, non-destructible slipon cable labels at both ends.
- All labelling and marking shall be in correct technical English which shall have been approved by the Contractor.

14.0 **MOTOR STARTERS – CONTROL CIRCUIT SUPPLIES**

The control circuit supply for each starter shall be derived from fully rated 400 / 230 volt transformers one connected to each busbar. Changeover facilities are to be provided to feed all starters from one transformer should the other transformer fail or be out of service.

15.0 **INSTRUMENT TRANSFORMERS**

- 15.1 Voltage and current transformers of appropriate ratio, output, class and accuracy for protection and metering shall be provided.
- 15.2 The Supplier shall provide details of ratio, output, class and accuracy for all instrument transformers in his supply.
- 15.3 The secondary windings of instrument transformers shall be earthed at one point through a removable link, with provision for attaching test links.
- 15.4 Current transformers shall be rated to withstand the thermal and magnetic stresses resulting from through fault current which, in the case of circuit breaker feeders, shall be equal to the switchgear fault rating.
- 15.5 Where current balance protection is specified the supplier shall provide calculations together with current transformer magnetization curves to prove the through fault stability of the protection up to the switchgear fault rating.
- 15.6 Bridging terminals for current transformers shall be provided at the outgoing terminals where external connections are required.
- 15.7 Voltage transformers primary and secondary windings shall be protected by fuses/MCB.
- 15.8 Instrument transformer nameplates shall be fixed in a position so that details can easily be read when the transformers are fitted in the cubicle.

16.0 **METERING, PROTECTION, CONTROL & INDICATION**

- 16.1 Metering, protection and control shall be provided in the equipment.
- 16.2 All meters shall be of the industrial type, enclosed in dust and damp-proof casings, square dial, similar throughout in size and type and of suitable standard size.
- 16.3 Incoming supply metering shall include but not limited to:
- Voltmeter and selector switch
 - Ammeter and selector switch
 - Kilowatt meter
 - Kilowatt hour counter to Pakistan Fiscal Standards.
- 16.4 Meters and relays shall be flush mounting and fitted on the front of the equipment.
- 16.5 Meters and relays shall be capable of withstanding without damage the secondary currents associated with the switchgear rated fault current flowing in the primary of current transformers, in the case of circuit breaker feeders, and the maximum available through fault current in the case of fused feeders.
- 16.6 External zero adjustment shall be possible on all indicating instruments to facilitate adjustment without dismantling the instrument.
- 16.7 Voltmeters shall be scaled according to voltage and shall be connected to the system through HRC cartridge fuses or MCB's.
- 16.8 Ammeters shall be fed from appropriate C.T.'s (Secondary having 5A rating at least).
- 16.9 Ammeters for motor starters shall have compressed scale for starting currents, so scaled that the motor full load is shown within 1/2 & 3/4 of full scale deflection. Other ammeters shall have linear scales.
- 16.10 All indicating instruments shall be of class 1.5% accuracy.
- 16.11 All current transformers shall be class 1.5% accuracy, suitably rated for protection and indicating instruments.
- 16.12 An electrical system protection scheme shall be incorporated into the design of the equipment to ensure reliable and safe operation of the distribution network and to minimize damage to electrical equipment resulting from electrical faults. An electrical fault on one part of the network shall be automatically isolated with minimum of disturbance to the remainder of the system.
- 16.13 The equipment shall be incorporated with the following protection device/relays as a minimum for the protection and control of gas engine generator sets, motors, feeders etc.:

Protection Device/Relays Device Function No.

- Checking or interlocking relay(s) 3
- Stopping device 5
- Under voltage relay(s) 27

- Directional power relay(s) 32
- Negative sequence or reverse phase or phase balance current relay(s) 46
- Instantaneous over current relay(s) 50
- Time-delay over current relay(s) 51
- Overvoltage relay(s) 59
- AC directional over current relay(s) 67
- Permissive control device 69
- Operating mechanism(s) 84
- Lock out relay(s) 86
- Differential protective relay(s) 87
- Tripping or trip free relay(s) 94
- Machine or transformer thermal relay(s) 49
- Incomplete sequence relay(s) 48

(From ANSI / IEEE C37.2-1979, IEEE Standard Electrical Power System Device Function Numbers.)

16.14 Open, Closed and Trip circuit healthy indicating lamps for the circuit breakers shall be provided.

16.15 Indication on motor starters shall include but not limited to:

- Running Lamp
- Stop Lamp
- Trip Lamp
- Ammeter
- Power 'ON'

16.16 Indication of feeder units shall include but not limited to:

- Contractor 'Closed' lamp (where applicable)
- 'Earth Fault Trip' Lamp (where applicable)
- Ammeter

16.17 Indication lamps (green-open, red-closed) and mechanical position indicators shall be provided for each circuit breaker.

16.18 When the circuit breakers or motor starters are in the test, withdrawn or earth position, operation shall only be possible from the switchgear.

16.19 Static type relays shall be supplied. Operation indication and test facilities shall be included.

17.0 **ANTI-CONDENSATION HEATERS**

17.1 The enclosure shall be equipped with anti-condensation heaters of sufficient capacity to prevent the formation of condensation within the enclosure under the service conditions.

17.2 Each heater shall be supplied from single phase supply and terminated in a weatherproof terminal box fitted with an un-drilled gland plate and warning label.

17.3 On / off switches and thermostats shall also be provided.

18.0 **LABELS**

18.1 Cubicles, compartments and components shall be identified by labels.

18.2 A main label shall be affixed in a prominent position on each switchgear giving the following information:

- Manufactures name and type.
- Switchboard designation.
- System voltage, phase and frequency.
- Rated operational voltages.
- Rated fault making and breaking current.
- Busbar rating
- Year of manufacture.
- The number of the governing I.E.C. Recommendation.

18.3 Each outgoing unit circuit shall be fitted with internal and external labels giving the following information:

- Current and kilowatt rating
- Service description and equipment tag number.

18.4 Equipment designation & labels shall have black characters on a white background and be made of a non-corrodible material. Warning labels shall be the same except black characters on a yellow background.

18.5 Labels shall be affixed by means of stainless steel screws.

18.6 A Purchase Order No. label shall be affixed externally.

19.0 **FINISH**

The color and finish shall be in accordance with the recommendation of the Contractor.

20.0 **SPECIAL TOOLS**

A complete set of any special tools required for operation, maintenance and testing shall be provided. The Supplier shall provide a list of special tools, individually priced, with his quotation.

21.0 **INSPECTION & TESTING**

21.1 All equipment shall be subject to inspection by the Contractor or his nominated representative, during the course of manufacture, fabrication, assembly and testing. Inspection shall include verification of the equipment, dimensions, functional test and examination of the documentation.

- 21.2 The Supplier shall provide test certificates for each type and rating of switchgear for type and routine tests carried out on the switchgear. Tests shall be those listed in the relevant standards (refer to para. 3.0).
- 21.3 The Contractor reserves the right to witness the following tests:
- 21.3.1 Routine tests on all switchgear / components, including power frequency voltage withstand tests, as specified in the relevant standards (refer to Para. 3.0), and:
- Operational (electrical and mechanical) tests on all components.
 - Primary and secondary injection tests to prove correct operation of relays.
- 21.3.2 Type tests where specified.
- 21.4 The Supplier shall give three weeks notice of test prior to commencement. All relevant certified documentation shall be sent to the Contractor at least 20 days prior to the test. The test will be witnessed only if the documentation is complete and acceptable to Contractor. No testing shall commence without written approval of Contractor.
- 21.5 The extent of the Contractor participation in inspection and testing will be identified prior to the placement of an order. The Supplier shall submit an inspection and testing procedure for review and approval by Contractor prior to start assembling. The inspection and testing procedure shall as a minimum cover:
- Assembling sequence, including inspection and testing.
 - Proposed check of system architecture against approved for construction documents.
 - Proposed physical inspection of equipment.
 - Proposed functional test.
 - Proposed check of documentation.
- 21.6 The Supplier shall submit for Contractor's review and approval a complete plan for the factory and site acceptance testing. This plan must be complete and provide sufficient detail to indicate the exact nature of each test, time required, expected results and systematic procedure. The plan shall be submitted at least six weeks in advance to the FAT. The objective of the FAT is to verify that the purchased systems, as configured for delivery to site, meets or exceeds the specified designed functional requirements. The FAT shall be a 100% complete system functional test and shall be witnessed by the EPC Contractor and by Company.
- 21.7 Expenses including airfare, boarding & lodging shall be borne by the Supplier for the agreed number of Contractor and / Company representatives.

22.0 **DRAWINGS AND DATA**

- 22.1 Drawings and data shall be provided. This data shall include all the protection and overload relay performance curves.
- 22.2 The Supplier shall comply with the following requirements for Installations, Operating and Maintenance Manuals.

- 22.2.1 The front cover, spine and inside page shall state the purchase order number and seller's reference number.
- 22.2.2 The inside front page shall carry an index listing the contents of each section of the manual.
- 22.2.3 Individual sections shall be complete and shall refer to equipment actually supplied.
- 22.2.4 Published data shall be included, including published data for bought-in items.
- 22.2.5 Full details of any special equipment shall be clearly set out in separate sections.
- 22.2.6 Details of all protective devices shall be fully documented.
- 22.2.7 A punch list of "do's" and "don'ts" shall be included.
- 22.2.8 Full details for installation and setting up shall be included.
- 22.2.9 Recommended test data shall be stated, covering initial and also regular testing, i.e. values for high voltage, A.C. or D.C. etc. shall be given.
- 22.2.10 Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated.
- 22.2.11 Important items shall be cross referenced to other parts of the manual as necessary.