MATERIAL AND EQUIPMENT STANDARD

FOR

SWITCHGEAR

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0. INTRODUCTION

This Standard may not cover every requirement or diversity of conditions at each locality; but this is recognized and the write up is sufficiently, flexible to allow individual companies in oil, gas, and petrochemical industries of Iran to exercise their own judgment in these situations, with due consideration to the existing electrical installations of oil, gas and petrochemical industries in Iran and the pertinent prevailing hazards.

It is necessary to mention also that this standard is written mainly for the purchase of switchgear and controlgear assemblies to be installed in non hazardous atmospheres, and their installation shall be avoided in hazardous locations, however if requirement dictates such application; in addition to requirements of this Standard specification, the assembly shall be designed specially for the petroleum, gas and petrochemical industries, suitable for the climatic conditions specified in this Standard Specification and in compliance with the requirements of standards for electrical apparatus in explosive atmospheres to which reference is made in Appendix G.

This Standard is prepared in two parts:

part I : Deals with the Low Voltage (LV) 400/230 volt, 3 phase, 4 wire, a.c. 50 Hz industrial switchgear and controlgear.

Part II : Deals with the Medium Voltage (MV) 3.3 kV to 66 kV, 3 phase, 3 wire a.c. 50 Hz industrial switchgear.

In order to have precise and clear definitions for Low Voltage (LV), Medium Voltage (MV), and High Voltage (HV) standards; the ISIRI No. 6 (1987) derived from the IEC standard No. 38 (1983) with some changes is quoted below:

A) - LOW VOLTAGE

Low Voltage(LV) is defined as voltages below 1000 volt in a 3 phase 4 wire 50 Hz system.

B) - MEDIUM VOLTAGE

Medium Voltage (MV) is defined as voltages higher than 1000 volt up to and including 66 kV in a 3 phase , 3 wire , 50 Hz system.

C) - HIGH VOLTAGE

High Voltage (HV) is defined as voltages higher than 66 kV in a 3 phase, 3 wire, 50 Hz system.

High voltages are mainly used for power transmission and unlikely to have application for the purpose of switchgear and controlgear standard in this Standard Specification.

PART I

MATERIAL AND EQUIPMENT STANDARD
FOR
LOW VOLTAGE INDUSTRIAL "a.c." SWITCHGEAR AND CONTROLGEAR ASSEMBLY

1. SCOPE

1.1 This Standard Specification covers the minimum technical requirements for design, manufacture, quality control, testing and finishing of low voltage a.c. switchgear and controlgear assemblies indoor or outdoor which shall be installed in oil, gas and petro-chemical industries in Iran under the service conditions stated in Clause 2 of this Standard Specification.

1.2 Only the general requirements of switchgear and controlgear are given in this Standard Specification, the specific requirements of individual assemblies will be given in pertinent data sheets, relevant one line diagrams, and or requisitions.

1.3 This Standard Specification shall be used for the preparation of requisitions and purchase orders and subsequently as a guideline for the manufacturers of the equipment described.

2. REFERENCES

In preparation of this Standard, the following standards and codes have been considered or referred to.

Switchgear and controlgear assembly shall, to the extent specified herein, be designed, constructed, wired and tested in accordance with all applicable sections of these standards that are in effect at the time of publication of this standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor.

ISIRI (INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCHES OF IRAN)

ISIRI 6 "Standard Voltages"
ISIRI 9 "Standard Frequencies"

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 27 "Letter Symbols to be used in Electrical Technology"

IEC 50 "International Electrotechnical Vocabulary"

IEC 51 "Recommendations for Indicating Electrical Measuring Instruments and their Accessories"

IEC 59 "Standard Current Ratings"

IEC 73 "Color of Indicating Light and Push Buttons"

IEC 79 "Electrical Apparatus for Explosive Gas Atmospheres"

IEC 112 "Method for Determining the Comparative and the Proof Tracking Indices of Solid Insulating Material under Moist Condition"

IEC 144 "Degrees of Protection of Enclosures for LV Switchgear and Controlgear"

IEC 157 "Low Voltage Switchgear and Controlgear"

IEC 158 "LV Controlgear for Industrial Use"

IEC 185 "Current Transformers"

IEC 186 "Voltage Transformers"

IEC 211 "Max. Demand Indicators"

IEC 255 "Electrical Relays"

IEC 258 "Direct Acting Electrical Measuring Instruments and Their Accessories"

IEC 269 "LV Fuses with High Breaking Capacity"

IEC 292 "LV Motor Starters"

IEC 337 "Control Switches (LV Switching) Devices for Control and Auxiliary Circuits Including Contactor Relays"

IEC 364 "Electrical Installations of Buildings"

IEC 391 "Marking of Insulated Conductors"

IEC 408 "Low Voltage Air Break Switches, Air Break Disconnectors, Air Break Disconnectors and Fuse Combination Units"

IEC 414 "Safety Requirements for Indicating and Recording Electrical Measuring Instruments and Their Accessories"

IEC 439 "Factory Built Assemblies of LV Switchgear and Controlgear" (see also EN 60 439)

IEC 445 "Identification of Apparatus Terminals and General Rules for a Uniform System of Terminal Marking, using an Alphanumeric Notation"

IEC 446 "Identification of Insulated and Bare Conductors by Color"

IEC 473 "Dimensions for Panel Mounted Indicating and Recording Electrical Measuring Instrument"

IEC 521 "Class 0.5, 1, and 2 Alternating Current Watthour Meters"

IEC 617 "Graphical Symbols for Diagrams"

IEC 664 "Insulation Coordination Within Low Voltage System Including Clearances and Creepage Distances for Equipment"

BSI (BRITISH STANDARDS INSTITUTION)

BS 159 "Busbars and Busbar Connections"

Notes:

1) Where standards other than "IEC" are used manufacturer/supplier shall submit the applied equivalent standards and the pertinent deviations from "IEC" standard specified.

2) The testing and certification by following authorities are acceptable where relevant:

- **Association of Short Circuit Testing Authorities (ASTA).**
- **European Organization for Testing and Certification (under cenelec administration).**
- **Underwriters Laboratories Inc.**
- **Electrical Equipment Certification Services (EECS).**
- **International Commission for Conformity Certification of Electrical Equipment (CEE).**

3. UNITS

International System of Units (SI) in accordance with IPS-E-GN-100 shall be used.

4. SERVICE CONDITIONS

4.1 Environmental Conditions

See Attachment 1.

4.2 Electricity Supply

4.2.1 Power supply in site is 400/230 volt, 3 phase, 4 wire 50 Hz, solidly neutral earthed system.

4.2.2 Fault level: 31 MVA (for industrial purpose).

4.2.3 Voltage variation: 10% (to IEC 38).

4.2.4 Frequency variation: 5% (to IEC 242).

5. BASIC DESIGN CONSTRUCTION AND RATING

5.1 General Arrangement

5.1.1 Switchgear assembly shall be of the sheet metal cubicle, free standing, vertical dead front, floor mounting.

Depending on the location of the switchgear, one of the following minimum degrees of protection of the enclosure against contact with live or moving parts and against ingress of solid foreign bodies and liquids as per IEC Publication 144 shall be selected:

-Indoors in enclosed building	IP 41
-Outdoors protected by canopy	IP 54
-Outdoors unprotected (example remote control units).	IP 65

Notes:

1) The above mentioned degrees of ingress protection shall be applied only when no mention is made of degree of IP in data sheets.

2) When outdoor equipment are requested, the vendor shall submit full detailed drawing of canopy to be provided by purchaser.

5.1.2 Switchgear and controlgear shall be so designed to minimize any risk of short circuit and to ensure personal and operational safety during all operating conditions, inspection, maintenance, the connection of main, control and auxiliary cables and the equipping and commissioning of spare panels while the switchgear is live and in operation.

5.1.3 Switchgear assembly shall comprise incoming, outgoing and bus section circuit together with a single air insulated busbar system as shown in single line diagram in Appendix A and detailed in data sheets Appendix B.

5.1.4 All circuits shall be controlled by the air circuit breakers, but in certain circumstances the use of contactors, air break switches, air break switch disconnectors and fuse combination units for the control of certain minor circuit may be needed as shown in single line diagram and circuit data sheets.

5.1.5 Each switchgear assembly shall contain necessary auxiliary control devices, specified instruments and protection current transformers, voltage transformers, control meters and meter switches where applicable.

5.1.6 A multiple arrangement of circuit breakers shall be acceptable but relay reset button, selector switch or operating device shall not be more than 1750 mm nor less than 150 mm above the floor level.

5.1.7 Sheet steel barriers shall be provided between the breaker compartments in each vertical section, and control and power compartments.

5.1.8 Each circuit shall be housed in a separate cubicle compartment with the circuit breakers mounted on a draw out type chassis. Interlocks shall be provided to ensure that the chassis cannot be withdrawn when the circuit breaker is closed; and the equipment is safe to operate or examine in all conditions of services.

5.1.9 The total enclosure and individual panel cubicles and compartments shall be so designed and constructed to prevent the passage of flame, vapor or gases from one section to another.

5.1.10 Circuit breakers, instruments, busbar; connections and current transformers shall all be housed in compartments.

5.1.11 The switchgear shall be designed to withstand the effects of the internal and external faults.

5.1.12 Cubicles structure shall be rigid to prevent misalignment.

5.1.13 Isolation contacts temporarily exposed when air circuit breakers are withdrawn shall automatically be shielded behind lockable covers.

5.1.14 Access to cubicles, other than withdrawable circuit breaker front panels, shall be by lockable, mild steel doors and at the back via door: and or removable mild steel sheets.

5.1.15 Provision shall be made for all main and auxiliary cable entries.

5.1.16 Provision shall be made for the future extension of the assembly in either ends unless otherwise noted in data sheets.

5.1.17 A ground busbar shall be provided for the entire length of switchgear. It shall be provided with at least two solderless crimp type terminals located at the ends of the earth bars.

The size of earthing terminals shall be compatible with the fault level. But should not be less than 70 mm.

5.1.18 Means shall be provided for lifting the switchgear into position.

5.1.19 Interchangeability

5.1.19.1 Electrically identical components shall be of one type and make.

5.1.19.2 Withdrawable sub-assemblies with identical electrical functions and capacities shall be mechanically interchangeable, but with different electrical functions or capacities shall not be interchangeable.

5.1.20 The following aspects of the assembly shall comply with the requirements of the IEC publication 439.1

5.1.20.1 Mechanical design.

5.1.20.2 Temperature rise.

5.1.20.3 Protection against electric shock.

5.1.20.4 Short circuit protection and short circuit withstand strength.

5.1.20.5 Component installed in assembly.

5.1.20.6 Internal separation of assembly by barrier or partitions.

5.1.20.7 Electrical connections inside the switchgear: bars and insulated conductors.

5.1.20.8 Requirements for electronic equipment supply circuits where applicable (Ref. EN 60 439 Clause 7.9).

5.2 Power Bus

5.2.1 Busbar and main connections shall be of hard drawn high conductivity electrolytic copper sheathed with color coded self extinguishing shrunk on sleeving.

5.2.2 Short time withstand current shall be in accordance with the requirements of Sub-clause 4.3 of IEC publication 439.1 and BS 159.

5.2.3 Normal current rating shall also be in accordance with the requirements of Sub-clause 4.2 of IEC publication 439.1, and BS 159, but shall be derated for site conditions.

5.2.4 The neutral bar shall have half the cross section of the phase bars under normal conditions and shall be provided with neutral link. The neutral bus shall be perfectly insulated from metallic surrounding.

5.2.5 All bolted bus joints shall be silver plated (unless otherwise specified in requisition) and shall be tightened to manufacturers' standard.

5.2.6 Space shall be provided for incoming cables in vicinity of busbars.

5.2.7 The load terminals on breakers located in the bottom of a vertical section shall be arranged to permit easy connections of outgoing cables.

5.2.8 Busbars shall be the same size throughout the length of the switchgear assembly, and shall be fully current rated over the whole length of the switchgear and shall not be rated less than incoming and bus section circuit breakers rating.

Vertical sections of busbars shall be fully rated.

5.2.9 Vertical busbars shall also be provided with sheathing or shrunk on sleeving. The insulation shall be color coded.

5.2.10 Arc propagation barriers shall be provided to prevent arcs (occurring in incoming bus duct) from flashing through or around the main incoming unit to the main busbars.

5.2.11 The switchgear assembly shall be so designed and constructed as to prevent arcs occurring in one main busbar from flashing through or around bus tie units to the other parts of main busbars.

5.2.12 Protective covers shall be provided for all live parts of the bus when the breaker is removed.

5.2.13 Bus connections to the circuit breakers shall match the breaker rating.

5.2.14 The busbars shall be mechanically braced to withstand short circuit current.

5.2.15 Provision shall be made in design for expansion and contraction of busbar under specified requirements.

5.2.16 Busbars and busbars connection shall be supported and proportioned as to be capable of safely withstanding stresses to which they may be subjected including those due to short circuit and climatic conditions.

5.2.17 Bus trunking

5.2.17.1 Where bus trunking is required for either incoming or outgoing connection, the switchgear shall be provided with the vendors standard flanged entry terminal box suitable for connection in the vertical direction, with the bus trunking approaching from the above unless otherwise agreed.

5.2.17.2 Flexible connections to prevent strain on the switchgear shall be supplied by vendor as part of the order.

5.2.17.3 Bus trunking shall have as a minimum the degree of ingress protection as stated in Sub-clause 5.1.1 of this Standard, in addition a tight fitting barrier made of flame resistant, non-conducting material shall be provided in the bus trunking.

5.2.17.4 Bus trunking shall be provided with anti-condensation heater and thermostat according to requirements of Sub-clause 4.3.15 of this Standard Specification.

5.2.17.5 Bus trunking design shall take care for expansion and contraction of equipment.

5.2.17.6 Current rating and short time rating of bus trunking shall not be less than that of busbar.

Note:

Switchgear manufacturer is responsible for provision of bus trunking and relevant coordination.

5.3 Circuit Breakers

5.3.1 General

5.3.1.1 Circuit breaker shall comply with the requirements of IEC Publication 157.1, and shall be of dead front single air break, triple pole, horizontal draw out isolation type, fully interlocked with positive on/off indication and shall be complete with slide rails and automatically operated lockable shutters over isolating contacts.

5.3.1.2 The draw out mechanism shall hold the breaker rigidly in the connected and test positions. It shall be possible when the breaker is open, to test and then close the door.

5.3.1.3 Interlocks shall be provided to prevent connecting the breaker to, or removing it from the bus tabs, unless the breaker is open tripped.

All spare contacts on interlock block, position switches and auxiliary relays shall be wired to accessible terminal blocks.

5.3.1.4 Main contacts shall comprise, single break per phase, butt type fixed and moving contacts, designed so that short circuit forces, increase the contact pressure.

Main contacts shall be silver plated or silver nickel tipped.

Fixed and moving arcing contacts shall be silver tungsten tipped.

5.3.1.5 Arc chutes shall consist of removable molded asbestos cement boxes fitted with steel splitter plates in such a way that arcs being completely contained under all operating conditions, and all arc products being deionized.

5.3.1.6 Manually operated circuit breakers shall be equipped with the stored energy operation type mechanism and an externally visible main contacts position indicator.

5.3.1.7 Circuit breakers operating mechanism shall be of the trip free type such that the circuit breaker is free to open inrespective of whether the closing power is applied or not.

5.3.2 Circuit breakers rating

5.3.2.1 Circuit breakers in accordance with the data sheet shall have normal current rating selected from the following ratings: 630, 800, 1250, 1600, 2000, 2500, 3150 and 4000 amps.

The above mentioned fig. shall be derated for 50 C.

5.3.2.2 Short circuit breaking and making rating current shall not be less than 50 kA and 105 kA respectively.

5.3.3 Circuit breaker operation

5.3.3.1 Circuit breaker closing

Normally circuit breaker closing shall be by spring assisted closing mechanism, and designed so that the speed of closure is independent of the operator, but if remote operation is required the mode of operation shall be one of the following:

a) d.c. solenoid closing type, with anti-pumping device mechanism, energized from a battery.
b) Spring assisted motor recharger mechanism energized from a battery or voltage transformer.

5.3.3.2 Circuit breaker tripping

Tripping shall normally be effected by means of a d.c. shunt trip coil in conjunction with current transformer operated relays.

5.3.3.3 Indicating lights

Each circuit breaker shall have normally 110 volt d.c. indicating lights in compliance with IEC 73 to show the position of the main contacts of the circuit breaker.

Normally the following shall be provided:

Color	Indicating
red	circuit breaker closed
green	circuit breaker open
white	trip circuit healthy
amber	auto trip operated

5.3.3.4 Auxiliary contacts

Sufficient contacts shall be included for visual and audible alarm circuits. In addition, two normally closed and two normally open auxiliary contacts to be provided as spare.

5.3.3.5 Control supplies

Vendor shall give full details for closing and tripping requirement of the offered circuit breakers for consideration of purchaser; however the close and trip circuits for each breaker shall be separately fused.

Fuse blocks shall be dead front, pull out type, which provides the control power disconnecting means.

5.3.4 Circuit breaker anti-pumping device

5.3.4.1 Anti-pumping devices shall be provided on all circuit breakers, and where specified on requisition.

5.3.4.2 Anti-pumping devices shall prevent damage to the closing circuit and mechanism, after a close open operation, as long as the device initiating closing is maintained in the position for closing.

5.3.5 Instruments and control transformers

5.3.5.1 Current transformers (CTs)

a) Current transformers shall be of the straight through, ring type in accordance with circuits requirements and in compliance with the IEC Publication No. 185.

The current transformers shall be mounted on the fixed portion of the equipment in the main copper connections between circuit breakers and main cable terminations.

b) Each "CT" shall have a short circuiting device. Shorting type terminal blocks shall be located remote from power compartment in a visible and accessible location.

c) Current ratio and polarity marking of all "CTs" shall be easily identified after their primary connections have been made.

d) Accuracy class of CT shall be 1 on 3 for measurement and "5P" or "10P" for protection as specified in requisition .

e) Saturation factor "n" shall be equal or less than 5 for measuring CT, and equal or more than 10 for protective CT.

5.3.5.2 Voltage transformers (VTs)

a) When VTs are called for measuring instruments or electrical protective devices, they should comply with the requirements of IEC standard No. 186.

b) Each potential transformer shall be protected by disconnect type current limiting primary fuses, and shall be designed to withstand the basic impulse level of the switchgear.

c) The secondary winding of transformers shall be earthed at one end.

d) Voltage transformers shall be air insulated and of accuracy class: 1 or 3 for measuring (as specified in requisition), and "3P" for protection.

e) Voltage ratio required is given in data sheets.

5.3.6 Electrical measuring, indicating and recording instruments

5.3.6.1 General requirements

a) The number and type of instruments for individual circuits shall be in accordance with the requirements stated in data sheets for each circuit.

b) Instruments shall be of the flush mounted, industrial grade, enclosed in dust and damp proof casing, non projecting dial with non glare, non reflecting window, similar throughout in type and size, and in compliance with the requirements of pertinent parts of IEC publications 51 and 473 from requirements and dimensions point of view.

c) Special precautions shall be taken that the operation of sensitive instruments shall not be influenced or hampered by vibration or shocks e.g. by opening or closing of doors and switching devices.

Note:

Electronic or digital instruments may also be considered if full information is given by manufacturer.

5.3.6.2 Indicating instruments

a) Indicating instruments shall be in accordance with IEC publication No. 51 the accuracy shall be class "2.5".

b) Ammeters in motor starting circuits shall have a compressed overload end scale of at least "6" times the full load motor current. Indications shall be in actual values.

c) Indicating instruments shall be the square pattern type. Preferred dimensions are 96 × 96 mm.

5.3.6.3 Integrating instruments

a) Watthour meters

Watthour meters shall be in accordance with the requirements of IEC publication 521. The accuracy shall be class "2" except for supply of third parties which shall be class "1".

Notes:

1) Reference shall be made to data sheet for applicable class of watthour meters.

2) Watthour meters shall have cyclometric registers and normally be of two element type.

5.3.6.4 Maximum demand indicators

Maximum demand indicators shall be in accordance with the requirements of IEC publication No. 211.

5.3.6.5 Recording instruments

a) Recording instruments shall comply with the requirements of IEC Publications No. 258 and 414 .
b) Accuracy shall be class "2.5".

Note:

Where frequency meters, phase meters and synchroscopes are stated in data sheets, they shall comply with the requirements of parts 4 and 5 of IEC Publication No. 51.

5.3.7 Protective devices

5.3.7.1 Fuses

The application of fuses requires a correct correlation with other protective devices in the assembly.

Industrial cartridge fuses, in accordance with IEC 269, shall be used for control, measuring and auxiliary circuits. Alternatively, miniature circuit breakers may be used for this purpose, provided that a satisfactory selective overall protection coordination can be reached.

Each individual branch (take off point) from an auxiliary bus wiring system shall be provided with a selectively graded protective device.

Short circuit protection fuse for motors shall be current limiting and high breaking capacity type.

5.3.7.2 General requirements for relays

a) The selection of relays shall be in compliance with the requirements of each circuit and in accordance to pertinent section of IEC 255.

b) The number and type of protective relays are stated in data sheets.

c) Subject to approval of purchaser, static type relays may be used provided that their effectiveness and reliability are guaranteed.

d) Relays shall be dust proof, flush mounted and of the removable type provided with calibrating resetting and testing facilities. Current carrying terminals of the relays shall be automatically short circuited when the relays are withdrawn.

e) Protective relays shall have hand reset facilities and relay operated signals such as flags or other means of indication used on static type relays like Light Emitting Diodes (L.E.D.).

f) Relays with combined functions shall have separate indication for each function.

g) Indicators (flags or Light Emitting Diodes) shall be visible from the front of the switchgear without the need of opening the relay case or equipment door.

h) Special precaution shall be taken to ensure that relays will not operate accidentally owing to vibrations or shocks, e.g. by opening or closing of doors and switching the devices.

i) Elements with multiple functions such as trip and alarm duties shall have separate operating contacts for each function which shall be wired out to separate terminals.

Tripping circuits shall always be separated from the other circuits.

j) Relays shall be capable of withstanding the output current of associated current transformers for at least the specified short circuit withstand time of the assembly.

k) The relay test provision shall consist of built in test plugs or switches or separately mounted test terminal blocks.

l) The test provisions shall permit the shorting of any current transformer circuits and for selective disconnection of the relays from current transformers, potential transformers, auxiliary power and circuits controlled by relays.

m) Contacts rating and performance shall be in accordance with IEC 255-0-20.

n) "d.c." relays shall maintain their accuracy over the full range of voltage variation as specified in the requisition.

o) Relay function, or function number shall be given on relays.

p) Relays of different input voltages shall be of different color and preferably not interchangeable, where requirements dictates so.

5.3.7.3 Overcurrent relay (OCR)

Overcurrent relays shall be of the inverse definite minimum time (standard inverse, very inverse or extremely inverse) type with or without high set instantaneous operation and with the following ranges of settings (unless otherwise stated in requisition):

- Current : 50% to 200% of rated nominal current in step of 25% adjustable.
- Time : Multiplier time characteristics from 0.05 to 1.00 second.

5.3.7.4 Earth fault relays

Earth fault protection for consumers e.g. motors, heaters etc. shall operate instantaneously. In other cases a range of setting possibilities shall be provided for both current and time.

5.3.7.5 Motor thermal overload and single phase prevention shall be considered for all three poles with hand reset and provision for ambient temperature compensation.

Note:

When selecting an appropriate protective relay for motor starting units, consisting of high rupturing capacity, short circuit current limiting fuses and contactor, the fuse characteristics shall be taken into account.

5.3.7.6 Under voltage relay (UVR)

Each section of an assembly containing motor starting units equipped with circuit breakers or latched contactors shall be provided with an instantaneous acting under voltage relay. The UVR shall be of the automatic reset type, but equipped with a relay operated signal that is maintained until hand reset.

The drop out value shall be adjustable between 50% and 65%. The pick up value shall be at least 85% of the system voltage.

The number of operating contacts shall be:

- 3 sets, normally open and;
- 1 set, normally closed.

This UVR shall operate in combination with a time delayed tripping relay per motor starting unit, having a time delay adjustable between 0.2 and 5 s.

5.3.7.7 Restarting relays for contactors

Unless otherwise requested in data sheets each motor contactor compartment shall be equipped and wired with a universal standard relay base for future insertion of an automatic restarting relay. (RR) or a time delay module (TDM) when need arises. (RR) or (TDM) relay base shall be provided with proper tight cover or dummy relay.

Note:

Characteristic of restarting relays shall be decided on individual contactor requirement.

5.3.8 Internal and auxiliary wiring

5.3.8.1 Wiring shall be carried out in copper conductor cables and or flexible cables having fire and moisture resisting insulation of not less than 2.5 sq. mm. conductor cross section and of 1000 volt insulation grade.

5.3.8.2 Wiring to equipment mounted on doors, shall be carried out in flexible cables which shall be so arranged that it is not possible for the flexible cables to be trapped in the doors, or mechanically strained.

5.3.8.3 Wiring shall be neatly arranged and so located as to prevent damage. Cable looms shall not normally contain more than "25" wires. Sufficient length shall be provided on all wiring to prevent undue tension on terminals or connections.

5.3.8.4 Wiring shall not be included in busbar compartment or sections of switchgear carrying conductors at a higher potential.

5.3.8.5 Connection between different sections of the switchgear shall be deemed as internal wiring.

5.3.8.6 Where live conductors pass through any section or compartment of the switchgear they shall be adequately insulated, mechanically protected and shall be provided with warning and danger signs, to indicate the danger.

5.3.8.7 Wiring run on cleats shall be in harness formation and shall be colored and ferruled for identification. To IEC Publication No. 391.

5.3.8.8 Cables between two connecting devices shall have no intermediate splices or soldered joints.

5.3.8.9 Connection shall be made on fixed terminals.

5.3.8.10 Insulated conductors shall not rest against bare live parts at different potential or sharp edges, and shall be adequately supported.

5.3.8.11 Color coding of secondary wiring shall be in accordance with IEC Publication No. 466. Earth wires shall be green/yellow stripped.

Notes:

1) For remote control indication and alarm annunciation devices, provision shall be made from spare contacts to the terminal blocks compartment with pertinent marking and warning signs (for purchaser's use).

2) Where remote control indication and alarm annunciator panel is part of purchase order it shall comply with the requirements of IEC 466 and Clause 4.9 of this Standard Specification.

5.3.9 Incoming and outgoing cable connections

5.3.9.1 Provision such as cable glands, cable plates, cable lugs, cable supports, cable clamps and cable cleats shall be for incoming and outgoing cables including protection, control and alarm cables.

5.3.9.2 Glands and plates shall be so located to allow easy termination of cables.

5.3.9.3 Particular attention shall be given to the space and bending radii required for aluminum and large size core of copper cables.

5.3.9.4 Where compound filled cable dividing box are requested in requisition they shall have large filling holes and suitable expansion space.

5.3.9.5 Cable entries shall be from below and shall be suitable for multicore pvc/pvc, pvc/swa, pvc/lc swa cables detailed in circuits data sheets.

5.3.9.6 Cables and wires shall be positively fixed in such a manner that the removal or addition of cables could be carried out easily.

5.3.9.7 Cables earthing shall be carried out at the cable glands and positively fixed to earth busbars.

5.3.9.8 Non corrosive and non ferrous stud bolts with washers, nuts and locknuts shall be provided for external power cables including neutral conductor connection sized to suit the cable core sizes.

5.3.10 Cables and cores termination

5.3.10.1 Terminals shall be so designed that they clamp the conductors between metal surfaces with sufficient contact pressure and without significant damage to the individual conductors.

5.3.10.2 Control cable terminal blocks shall be of approved screwed type and easily accessible either from lower front or back of panels provided with a durable marking arrangement which is easily legible.

5.3.10.3 All terminals shall be numbered and where a cable terminates at a terminal which bears a number different from the cable, then the cable shall be provided with double numbering to indicate both the terminal number and the cable number.

5.3.10.4 All terminal blocks shall be so constructed as to prevent accidental contact between circuits and between circuits and earth.

5.3.10.5 Circuits and terminals operating at different voltages and/or performing different functions shall be segregated.

5.3.10.6 Terminal blocks shall be arranged and positioned to afford easy access for carrying out external cabling, testing, inspection and maintenance.

5.3.10.7 Not more than two wires shall be connected to any one terminal. Where more connections are required to a common point, link shall be taken to adjacent terminals.

5.3.10.8 Each individual terminal shall be easily replaceable.

5.3.11 Interlocks

5.3.11.1 All withdrawable units shall be provided with a complete set of interlocks to prevent incorrect operation.

5.3.11.2 All Interlocks shall be mechanical in nature.

5.3.11.3 Interlocks shall be provided to prevent the following operations and any other operations which could cause danger or damage:

a) The withdrawable unit being closed unless it is correctly located in the service, isolated or earthed positions or unless it is withdrawn from the fixed part of the switchgear.

b) The withdrawable unit being withdrawn from or inserted into the feeder spouts or isolating device when it is in the closed position.

c) The withdrawable unit being moved to any position other than that selected by means of the mechanical selector.

d) The withdrawable unit being withdrawn or inserted into the fixed unit housing unless it is in the correct position for withdrawal or insertion.

e) The withdrawable unit being closed in the service position unless all auxiliary circuits between fixed and movable parts have been completed.

5.3.11.4 The correct operation of the withdrawable unit shall be selected by means of an operating selector device, lever or handle.

5.3.11.5 The selector device shall be labeled to indicate the method of operation.

5.3.11.6 Where mechanical interlocks are required between two or more switching devices, the materials and devices shall be to the purchaser's approval.

5.3.11.7 Necessary electrical Interlocks shall also be provided in addition to mechanical Interlocks where specified in requisition.

5.3.11.8 Where fuses and switches of switchfuses are mounted in separate enclosures the doors of such enclosures shall be interlocked such that the fuse compartment doors cannot be opened unless the switch is open and the switch cannot be closed unless the fuse compartment door is closed.

Note:

For the purpose of the testing the operation of a circuit breaker, switch or contactor in the earthed position shall be possible only by local facilities while the remote control circuit is inoperative.

5.3.12 Mechanical indication and trip

5.3.12.1 All circuit breakers shall be provided with mechanically operated on and off indicators which shall be positively driven in both directions, and shall be visible from the front of the equipment (when in their operating position of the devices). Test position shall also have indication.

5.3.12.2 All circuit breakers shall be provided with a hand operated mechanical trip device which shall be protected against inadvertent tripping.

5.3.13 Safety and reliability

5.3.13.1 Switchgear and controlgear shall be designed to minimize any risk of short circuit and to ensure personal and operational safety during all operating conditions, inspection, maintenance, the connection of mains, control and auxiliary cables, and the equipping and commissioning of spare panels while the switchgear is live and in operation, with due consideration to the following points:

a) Automatically operated safety shutters shall be provided to cover all busbar spouts, sockets and all live connections when withdrawable units are withdrawn and isolators and switches are opened, to allow safe access for maintenance and inspection with all other units operating.

b) Under no circumstances the safety requirements and proper functioning for the use intended shall be less than those described in IEC publication No. 364.5.53, and 364.5.537 in conjunction with selection and erection of switchgear, controlgear, and devices for isolating and switching purposes.

5.3.14 Earthing and bonding

5.3.14.1 The chassis frameworks and the fixed parts of the metal enclosure of the circuit breakers shall be interconnected electrically and connected to a terminal which enables them to be earthed.

5.3.14.2 The earth terminal shall be readily accessible and so placed that the earth connection of the circuit breaker is maintained when the cover or any other movable part is removed.

5.3.14.3 Under no circumstances shall a removable metal part of the enclosure be insulated from the part carrying the earth terminal when the removable part is in the place.

5.3.14.4 The earth terminal shall be protected against corrosion.

5.3.14.5 The earth terminal shall be permanently and indelibly marked with the sign ⏚ for earthing.

5.3.14.6 The main earth bar shall be so positioned and fixed to receive bonding straps from the incoming and outgoing cables.

5.3.14.7 All doors shall be bonded to the switchgear body by means of flexible copper bonds which shall be so arranged that it is not possible for bonds to be trapped in the doors.

Particular attention shall be given to the size and method of earthing and bonding of withdrawable items of equipment.

5.3.14.8 The circuit breaker frames shall be earthed in service by means of moving and fixed contacts making direct connection with the switchgear earthing main bar; which shall comprise a 50 mm by 6.25 mm copper bar extended the entire length of the switchboard bolted at intervals and provided with two crimp type earthing terminals at two ends, convenient to take 70 mm^2 cables of site earthing.

5.3.14.9 One complete earthing device shall be provided with a suitable box or container with locking facilities.

5.3.14.10 Operating handles shall be fully insulated from the circuit, and if, of a metal, shall be effectively bonded to the equipment.

5.3.15 Anti condensation heaters

5.3.15.1 Anti condensation heaters shall be provided within the switchgear, if considered necessary by the vendor or as specified in the requisition.

When anti condensation heaters are used , they shall be supplied from 230 volt single phase 50 hz a.c. supply.

5.3.15.2 All heaters and thermostats shall be internally wired. The wiring shall be brought out to a common terminal block approximately located midway along the length of the switchgear.

5.3.15.3 A heater master switch controlling all heaters, shall also be provided on the switchboard.

5.3.15.4 Heater circuits shall be provided with fuse or earth leakage protection as specified in requisition.

5.4 Contactors

5.4.1 Contactors shall comply with the requirements of IEC Publication 158.1. For characteristic of contactors such as: type of contactor, rated values control circuits, auxiliary circuits and degree of ingress protection, reference shall be made to individual circuit requirements in data sheets, however consideration shall be given to the following features:

5.4.1.1 Contactors shall be capable of making on the let through current of the fuse and capable of carrying the let through current of the fuse for the total break time for any current throughout the current/total break time characteristic of the fuse that is fitted into the fuse base, holder or carrier.

5.4.1.2 The fuse, overload and contactor rating combination shall be such that the contactor shall not be called by the overload or earth leakage relays to open currents in excess of the contactor breaking capacity.

5.4.1.3 All contactors shall have the class of intermittent duty as specified in the data sheet and as necessary to perform their functions which shall not be less than 30 on load operations per hour.

5.4.1.4 The class of intermittent duty of contactors provided shall be based on the actual starting currents, run up times and running current specified in the data sheets.

5.4.1.5 All contactors shall have making and breaking capacities, in addition to those required for the fault conditions and suitable for the actual starting currents and starting power factors specified in data sheets and as necessary to perform their functions which shall not be less than the following:

a) Normal Operation

(I) Make
6 × Rated Current
Voltage Before Make 100%
Power Factors 0.35

(II) Break
Rated Current
Recovery voltage 17%
Power Factor 0.35

b) Abnormal Operation

(I) Make
10 × Rated Current up to and including 100 A
Minimum of 1000 A for rating above 100 A
Voltage before make 110%

(II) Break
8 × Rated Current up to and including 100 A
Minimum of 800 A for rating above 100 A
Recovery Voltage 110%
Power Factor 0.35

5.4.1.6 All contactors shall have a mechanical endurance rating suitable to perform their function which shall not be less than 250,000 no load operations.

5.4.1.7 All contactors shall be capable of the number of on load operations to perform their function which shall not be less than 12,500 on load operations.

5.4.1.8 All contactor duty ratings shall be suitable for the motor starting times specified in the requisition but the duty ratings shall be based on not less than the following motor starting times:

a) For Pumps - 5 secs.
b) For Fans - 8 secs.
c) For Compressors - 10 secs.

5.4.1.9 The supply side and the load side of contactors shall be capable of being made onto the let through current of the fuses for the total break time for any current throughout the current/total break time characteristic of the fuse that is fitted into the fuse base, holder or carrier.

5.4.1.10 The supply side and the load side of contactors shall also be capable of carrying the normal operating duty cycle currents of the contactors.

5.4.1.11 All contactors shall be suitable for remaining in the on load closed position for long period of time.

5.4.1.12 Isolators associated and interlocked with contactors shall be of the off load, full load or stalled current type as specified in the requisition and shall be capable of carrying the current for the duty cycle of the contactors.

5.4.1.13 Time delay relays shall be provided for contactors when specified in data sheets, to delay tripping by under voltage and preventing unnecessary outage, following transient supply interruptions.

Time delay relays shall be adjustable in the range of 0-4 seconds and the contactors shall reclose immediately on restoration of supply.

5.4.1.14 Time delay relays shall be provided when called for in requisition to reclose contactors after predetermined delay, following tripping due to power interruptions:

a) Relays shall be adjustable in the range "0-20" seconds or as otherwise specified in data sheets.
b) Particular attention shall be given to the arrangement and position of the calibration device to prevent accidental disturbance.

5.4.2 Contactor coils and control supplies

5.4.2.1 Contactor coils shall be suitable for the voltage specified in the data sheets and shall normally be derived from the phase and neutral in four wire systems provided with single pole fusing and between phases in three wire systems provided with two pole fusing.

5.4.2.2 Where the voltage of the contactor coils is specified other than the phase to neutral or the phase to phase voltage, the contactor coil shall be supplied from individual transformers mounted in the contactor compartments, unless specified otherwise in the data sheets.

The supply to individual transformers shall be derived from the contactor circuit with which they are associated.

5.4.2.3 Where d.c. operated latched contactors are specified in the requisition and which require a main external d.c. supply the battery /rectifier will be provided by the purchaser unless specified otherwise in the requisition.

5.4.2.4 The d.c. supply required for the operation of the protection will be associated with the total protection of the switchgear and controlgear.

5.4.2.5 All contactors shall close satisfactorily with any voltage between 85% and 110% of rated voltage and the drop out voltage shall not be higher than 75% nor lower than 10% of the rated voltage unless otherwise specified in the requisition.

5.4.2.6 The trip coil of latched contactors shall operate correctly at 75% of rated voltage unless otherwise specified in the requisition.

5.5 Air Break Switches, Disconnectors and Fuse Combination Units

5.5.1 When air break switches, air break disconnectors, air break switch disconnectors and fuse combination units are requested in data sheets, they shall comply with the requirements of IEC Publication No. 408.

5.5.2 Where fuses and switches of fuse combination units are mounted in separate enclosures, they shall be interlocked such that fuse compartment door cannot be opened unless the switch is open, and the switch cannot be closed unless the fuse compartment door is closed.

5.5.3 Fuses shall be of the high breaking capacity type to IEC Publication No. 269.

5.5.4 Fuse sizes protecting circuits which supply motors shall be kept to a minimum compatible with the starting time and current of pertinent motors.

5.5.5 Fuse carriers shall be such that when they are withdrawn, the operator is protected from accidental contact with any live metal of the fuse link, and fuse contacts.

5.5.6 Incoming isolators together with their supply side and load side connections shall be capable of carrying the peak asymmetrical fault current and the short time rated fault current for the short time period without damage or danger; they shall also be capable of carrying their rated current continuously.

5.5.7 Isolators connected in the supply side of fuses, together with their supply side and load side connections, shall be rated for main incoming isolators.

5.5.8 Isolators connected in the load side of fuses, together with their supply side and load side connections, shall be capable of carrying the peak asymmetrical let through current of the fuses and shall be capable of carrying the let through current of the fuses for the total break time for any current through out the current/total break time characteristic of the fuse that is fitted into the fuse base, holder or carrier.

5.6 Extensions

The switchgear including the framework busbars, bus wiring, earth bar, etc., shall be suitable in all respects for extension at both ends, so that only the minimum of work will be required to make such extension.

5.7 Separate Panels

5.7.1 Every effort shall be made to house and accommodate on or within the switchgear assembly all required equipment, but where this is not possible and/or when specified in the data sheets separate panel(s) shall be provided.

5.7.2 The separate panels shall comply with the requirement of this Specification.

5.7.3 Separate panel shall be compatible with the main panel from design and structure point of view.

5.7.4 Cable entries shall be from the base unless specified otherwise in data sheets and a suitable gland plate complete with glands shall be fitted to accommodate all cables.

5.7.5 Terminals shall be mounted as close as practicable to gland plate to prevent excessive length of cables within the enclosure.

5.7.6 The direct termination of incoming cables to individual components shall be avoided.

5.8 Spare Panels

5.8.1 Where spare panels or compartments are specified in the data sheets, they shall be equipped as required in circuit details.

5.8.2 Where spare panels or compartments occur due to the layout or arrangement of the switchgear, or where no specific requirements are detailed in the data sheet for the required spare panels or compartment; such panels or compartments shall be provided with blank doors and the minimum of equipment and devices to ensure safety.

5.8.3 Spare panels and circuits shall be provided with all components enabling future completion without shutting down the existing equipment.

5.9 Control, Indication and Annunciation Panel

A separate control panel complete with annunciator panel and with the following requirements may be provided for LV switchgear assembly as specified in data sheet.

5.9.1 The control panel shall include an open/close control switch for each circuit breaker and motor starter together, with synoptic diagrams and associated indication lamps as follows:

Red - Closed
Green - Open
White - Trip circuit healthy
Amber - Auto trip operated

5.9.2 The control panel shall include control switches for circuit breakers and local/remote/off selector switch for each motor starter in compliance with IEC 337.1.

5.9.2.1 In the local position the starter shall be controlled from this control panel (for testing of the operation of motor starter only in isolated position).

5.9.2.2 In the remote position, the starter shall be controlled from a control station adjacent to the associated motor only.

5.9.2.3 Tripping shall be possible from both locations described above, and also from the associated motor starter panel regardless of the position of the selector switch.

5.9.3 The control panel shall include all wiring terminals, fuses, compression type cable glands, etc., to requirements of Clause 5.3.8 of this Standard Specification.

5.9.3.1 The main circuit designation labels shall correspond with the relevant labels of switchgear assembly.

5.9.3.2 Marking and warning signs shall be provided for purpose of identification and prevention of mal operation.

5.9.4 The control panel shall be of sheet steel fabrication, dust and damp protected to IP 51 of IEC Publication No. 144 suitable for bottom entry cable. The panel shall be free floor standing.

5.9.5 The annunciator panel shall monitor status of alarm and trip device of all functional units.

5.9.6 The annunciator shall include at least "4" number of spare elements fully wired for purchaser's use.

5.9.7 Annunciator panel shall have a back lighted front, with visible and legible lettering, complete with:

5.9.7.1 Audible alarm consisting of continuously rated variable tone horn.

5.9.7.2 Acknowledgment push buttons.

5.9.7.3 Horn release push button.

5.9.7.4 Lamp set push button.

5.10 Electrical Rated Characteristics of Circuits

5.10.1 System voltage, system frequency and rated normal current of each circuit shall be as stated in data sheets.

5.10.2 The following rated characteristics shall comply with the requirements of Clause 4 of IEC publication "439.1":

5.10.2.1 Rated short time withstand current of each circuit.

5.10.2.2 Rated peak withstand current of each circuit.

5.10.2.3 Prospective short circuit current of each circuit.

5.10.2.4 Rated conditional short circuit current of each circuit.

5.10.2.5 Rated fused short circuit current of each circuit.

5.10.2.6 Rated diversity factor.

5.11 Information to be Given on the LV Switchgear Assembly

5.11.1 Information on the outside

5.11.1.1 Each switchgear assembly shall be provided with one or more general nameplates located in a place such that they are visible and legible when the switchgear is installed.

The information given on these general nameplates shall be as follows but not be limited to:

a) Purchaser's name and order No.
b) The year of manufacture.
c) The manufacturer name or trade mark.
d) Type designation or serial number, making it possible to obtain relevant information from the manufacturer.
e) Type of current and frequency.
f) Rated operational voltage.
g) Rated insulation voltage.
h) Rated voltage of auxiliary circuits.
i) Limits of operation.
j) Rated current of each circuit.
k) Short circuit strength.
l) Degree of protection.
m) Measures for protection of persons (EN 60439.1 Clause 7.4).
n) Service conditions for indoor use outdoor use or special use.
o) Type of system earthing for which the assembly is designed.
p) Dimensions: height, width (length) and depth.
q) Weight.

Note:

The nameplates of each functional units shall be legible during normal service, the removable part if any shall have a separate nameplate with data relating to the functional units, they belong to, but this nameplate needs only be legible when the removable part is in the removed position.

5.11.1.2 Identifying circuit label(s)

a) Further to the general nameplates, each circuit of the switchgear assembly shall be provided with identifying circuit labels, fitted on the fixed portion.

The information to be given on these circuits labels shall be compatible with the nomenclature given in guidance for designation of circuits of switchgear (see Appendix C).

b) Circuit labels shall be repeated in the following cases:

- On the frame of a withdrawable unit unless they are all identical.
- When circuits have main and auxiliary cable connections that are not clearly identifiable from the physical layout e.g. cable compartments at the rear of switchboard.

5.11.1.3 Synoptic diagram

Switchboard shall be provided with a durable one line synoptic diagram clearly indicating the specific function of the different compartments when this would not be clear from the general layout.

5.11.1.4 Instruction plates

When the methods or sequences of operation of certain equipment or component(s) in the switchgear assembly is not evident (e.g. mechanical interlocking features) instruction plates shall be provided fixed near the point of operation. Instruction plates should be pictorial.

5.11.1.5 Warning plates, caution notice(s)

When required e.g. in a location where a dangerous situation may be created inadvertently, warning plate(s) shall be installed identifying the danger point(s). This may be either in a compartment or on the outside of switchgear:

a) When operation of a relay trips more than one circuit breakers.
b) When drawout of a potential transformer supplying motor under voltage relays causes motor tripping.

5.11.2 Information to be given on the equipment and components mounted inside the switchgear

5.11.2.1 General

All equipment and components such as switching devices, protection relays, instruments, instrument transformers, terminals, fuses, and fuse holders, shall be marked with their ratings and all other essential data as required following pertinent recommendation of IEC publications referred to in Clause 2 of this Standard.

5.11.2.2 Marking

It shall be possible to identify all equipment inside the switchgear including their circuits.

Identification of equipment in the switchboard shall be identical with that in the schematic and wiring diagrams supplied with the switchgear.

5.12 Nameplates and Labels

5.12.1 General requirements

The nameplates, labels and their fixing materials shall be proven, durable under the service conditions specified for the switchgear assembly.

They shall be corrosion and moisture resistant, and provided with indelible inscription in the language specified in Attachment 8. Stainless nameplates, and traffolite labels are acceptable.

Note:

For material layout and lettering of labels see Attachment 13.

5.12.2 Fixing

Nameplates and labels shall be fixed to the switchgear assembly and its components (functional units) by means of proven durable non corrosive self threading screws.

Holes for fixing shall not influence in any way the degree of ingress protection of enclosure.

5.12.3 Color

5.12.3.1 Circuit designation or nomenclature to be engraved into the white layer of traffolite to give black lettering on a white background.

5.12.3.2 Instruction plates shall be yellow with black inscription.

5.12.3.3 Warning or caution plates shall be red with white inscription.

5.13 Provision for Handling, Erection, Special Tools and Devices

5.13.1 In case of multicubicle and multisection assembly, lifting eye bolts or angles shall be furnished for crane hook up of slings during installation.

5.13.2 Each shipping section shall also be furnished with removable steel channel base plates which will permit using rollers without damaging the frame steel of the equipment.

5.13.3 Where the design of the switchgear is such that special steel runners are required in front of the switchgear for the alignment of the switching trucks, then such steel runners shall be provided by the manufacturer for inclusion in the purchaser's civil work and design.

5.13.4 Where withdrawable switching equipment are not mounted on their own movable trucks, and are too large or heavy to be handled by one man, then the manufacturer shall provide one handling truck for each assembly.

5.13.5 The following accessories and device shall be furnished on each assembly or group of assemblies in the same switch room:

5.13.5.1 Handle for moving the breaker into the connected, test, or disconnected position.

5.13.5.2 Breaker maintenance closing device.

5.13.5.3 Device for manually charging the stored energy operating mechanism on electrically operated breakers.

5.13.5.4 Other accessories required for installation, operation and maintenance of functional units.

5.13.5.5 Any special device like phasing out equipment.

6. INSPECTION, QUALITY CONTROL AND QUALITY RECORDS

See Attachment 2.

7. TESTS AND CERTIFICATION

7.1 General Requirements for Tests

See Attachment 3.

7.2 Specific Requirements for Tests

The tests shall consist of but shall not necessarily be limited to the followings:

7.2.1 Circuit breaker tests

7.2.1.1 Type tests

The manufacturer shall provide documentary evidence that type tests have been carried out in accordance with the requirements of Clause 8.2 of IEC Publication 157.1 and shall also provide A.S.T.A or equivalent short circuit testing authority certificate(s) on demand.

7.2.1.2 Routine tests

Shall be carried out in accordance with the requirements of Clause 8.3 of IEC Publication No. 157.1.

7.2.2 Contactor tests

7.2.2.1 Type tests

Submission of documentary evidence in accordance with the requirements of Clauses 8.1.1 and 8.1.2 of IEC Publication No. 158.1.

7.2.2.2 Routine tests

Shall be carried out in accordance with the requirements of Clause 8.3 of IEC Publication 158.1.

7.2.3 Switchgear assembly tests

7.2.3.1 Type tests

Submission of documentary evidence to requirements of Clause 8.2 of IEC Publication 439.1.

7.2.3.2 Routine tests

To requirements of Clause 8.3 of IEC 439.1. In addition the following checks, verifications or tests shall be made wherever pertinent, to ensure that the operational, functional and safety requirements are met:

a) The effectiveness and reliability of safety shutters, partitions and shrouds.

b) The degree of protection of enclosure.

c) The degree of ingress protection within the compartment from safety point of view.

d) The effectiveness of reliability of operating mechanism of :

- Key locks interlocks and transfer switches.

e) The insulation resistance of busbar system.

f) Creepage distance and clearances.

g) The proper mounting of control devices, and other components.

h) The internal wiring and cabling for proper marking, tightness and provision of contacts for remote controls.

i) The suitability of clamping, earthing termination, and marking arrangement for incoming, outgoing and auxiliary cables.

j) The functioning of protective relays and auxiliary devices.

k) Simulation of remote controls operation.

l) The control of anti condensation heaters.

m) The soundness of indicating, integrating recording and other type of meters specified.

n) The correctness of circuit designation labels.

o) The completeness of data on the name plates.

p) The presence of danger and warning signs in visible places.

q) The earthing system and its availability throughout the switchgear assembly.

r) The interchangeability of electrically identical components, such as withdrawable circuit breakers, motor starters etc. Special attention shall be paid to any auxiliary contacts to ensure compatibility.

s) The non interchangeability of mechanically similar but electrically different components.

t) Verification of compliance of main and auxiliary circuits with the approved schematic circuit diagrams.

u) When solid state relays or other electronic devices are fitted the manufacturer shall introduce evidence that solid state relays or the electronic devices have been quality assessed in compliance with the IEC Publication No. 255.10.

v) The switchgear and controlgear assembly shall be finally checked to ascertain that they are not damaged.

Note:

Complete record of the above mentioned verifications, tests and checks shall be accompanied with the certificates to which reference is made in Appendix No. 6 of this Specification.

8. FINISH

8.1 The equipment shall be cleaned, primed with two layers of antirust undercoat and one final layer of durable paint suitable for environmental conditions given in Attachment 1.

8.2 The color of final layer shall be:

a) Light gray color No. 631 to BS 381C or:
b) As specified in requisition.

8.3 All unpainted surface (internal and external) shall have a coat of moisture and fungus resistance varnish.

8.4 All parts that are required to be left bright shall be treated and or coated to prevent corrosion.

8.5 The manufacturer shall supply and deliver with the switchgear assembly a minimum of two half liters aerosol spray cans for the field touch up after installation. This paint shall match with the color used for the assembly.

9. INFORMATION FOR MANUFACTURER/SUPPLIER

9.1 Provisional Single Line Diagram

9.2 Circuit Data

- Duty and current rating as required in Iran.
- M.V.A rating if different from Clause 4.2.
- Busbar details.
- Circuit designation.
- Voltage transformers ratio.
- Current transformers ratio.
- Indicating lights requirements.

9.3 Cable Data

- Main cable.
- Auxiliary cable.

9.4 Control Supply

- Closing supply voltage.
- Tripping supply voltage.

9.5 Equipment Heating Supply Voltage

9.6 Degree of Ingress Protection (IP)

9.7 Explosion Protection

- To IEC 79 where applicable for remote control stations if installed in hazardous areas.

Notes:

1) For typical provisional single line diagram see Appendix A.

2) For circuit data and circuit designation see Appendices A and B.

10. DOCUMENTATION/LITERATURE TO BE SUBMITTED BY MANUFACTURER/SUPPLIER

10.1 At Quotation Stage

- Report of experience background major clients and annual sale for the similar equipment.

- Reference list showing the successful operation of equipment for at least two years and the locations of equipment offered in major oil industries.

- Typical type test certificate of similar equipment.

- Declaration of confirmation with the set standards and or clear indication of deviations from the standards and the specification.

- Drawings and documents for electrical equipment:

  i) Dimensioned outlines and foundation details including weights, and cable entries (size and clearance).
  ii) Details of cross sectional arrangements.
  iii) Mounting details relevant catalogues.

- Electrical schematic diagram.
- Electrical reference documents

  i) General description.
  ii) Equipment specification.
  iii) Performance data.
  iv) Cable data as requested in Appendix D.
  v) d.c. power supply demand as requested in Appendix E.

- Spare parts and special tools requirements.

  i) List of recommended commissioning spare with price.
  ii) List of recommended spare for three years of operation.
  iii) List of special tools, testing devices and instruments.

- Guarantee and warranty policies.
- Complaint and compensation policies.

Note:

The quotation will be considered as incomplete and rejected if the above mentioned information are not included.

10.2 At Ordering Stage

- Preliminary single line diagram for approval, and the final single line diagram .

- Final general arrangement drawings, showing synoptic diagrams, floor plan, elevation and end views of assembly.

- Mass and dimensions of the assembly and of individual shipping sections.

- Drawing, diagrams and curves

  i) Schematic diagrams of all circuits.
  ii) Wiring diagrams.
  iii) Interconnecting diagrams.

iv) Relay coordination curves.
v) Switching sequence schedule.
vi) Alarm and tripping scheme.
vii) Neutral earthing where applicable.
viii) Final electrical reference documents, including:

- General description.
- Equipment specification.
- Performance data.
- Drawings/parts and material lists.

ix) Where electronic circuits are involved full circuit diagram showing test points, voltage, wave form and calibration instruction.

- Instruction manuals for:

i) Transport and storage.
ii) Installation.
iii) Commissioning.
iv) Operation.
v) Inspection/test.
vi) Maintenance.
vii) Illustrated spare parts lists including special tools.

- Certificates

i) List of applicable type test certificates.
ii) Final test certificates.
iii) A.S.T.A certificate when required.
iv) Certificate of quality assurance.

Notes:

1) The above mentioned documents shall include identifications of all proprietary items including order number and purchaser's name.

2) For schedule of drawings/documents, manuals and certificates required see Appendix F of this Standard Specification.

3) For instructions of purchaser about drawings, see Attachment 12.

11. PACKING

For general requirements, see Attachment 4.

12. SHIPMENT

For general requirements, see Attachment 5.

13. GUARANTEE

See Attachment 6.

14. SPARE PARTS

See Attachment 7.

15. LANGUAGE

See Attachment 8.

16. COORDINATION, RESPONSIBILITY WITH OTHERS

See Attachment 9.

PART II

MATERIAL, AND EQUIPMENT STANDARD
FOR
MEDIUM VOLTAGE
INDUSTRIAL a.c. SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

1. SCOPE

1.1 This Standard Specification covers the minimum technical requirements for design, manufacture, quality control, testing, and finishing of medium voltage a.c. switchgear and controlgear assemblies (indoor and outdoor) above 1000 volt to and including 66 kV rated voltage, at a frequency of 50 Hz, which shall be installed in oil, gas and petrochemical industries in Iran under the service conditions stated in Clause 4 of this Standard Specification.

1.2 Only the general requirements of switchgear and controlgear are given in this Standard Specification;the specific requirements of individual assemblies will be given in pertinent data sheets, relevant single line diagrams and or requisitions.

1.3 This Standard Specification shall be used for the preparation of requisitions and purchase orders and subsequently as general requirements of the equipment to be supplied by the manufacturer.

1.4 Where cross references are made on this Standard Specification, the number of section or subsection referred to is shown in brackets.

2. REFERENCES

In preparation of this Standard, the following standards and codes have been considered or referred to:

Switchgear and controlgear assembly shall, to the extent specified herein, be designed, constructed, wired and tested in accordance with all applicable sections of these standards that are in effect at the time of publication of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor.

ISIRI (INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCHES OF IRAN)

ISIRI 6 "Standard Voltages" * (IEC 38)
ISIRI 9 "Standard Frequencies" * (IEC 242)

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 27 "Letter Symbols to be used in Electrical Technology"

IEC 50 "International Electrotechnical Vocabulary"

IEC 51 "Recommendations for Indicating Electrical Measuring Instruments and their Accessories"

IEC 56 "High Voltage Alternating Current Circuit Breakers"

IEC 59 "Standard Current Ratings"

IEC 60 "HV Test Techniques"

IEC 71 "Insulation Coordination"

IEC 73 "Color of Indicating Light and Push Buttons"

IEC 79 "Electrical Apparatus for Explosive Gas Atmospheres"

IEC 129 "Alternating Current Disconnectors (Isolators) and Earthing Switches"

IEC 144 "Degrees of Protection of Enclosures for LV Switchgear and Controlgear"

IEC 185 "Current Transformers"

IEC 186 "Voltage Transformers"

IEC 211 "Max. Demand Indicators"

IEC 255 "Electrical Relays"

IEC 258 "Direct Acting Electrical Measuring Instruments and Their Accessories"

IEC 265 "High Voltage Switches"

IEC 269 "LV Fuses with High Breaking Capacity"

IEC 282 "High Voltage Fuses"

IEC 296 "Mineral Insulation Oil"

IEC 337 "Control Switches (LV Switching) Devices for Control and Auxiliary Circuits Including Contactor Relays"

IEC 376 "Specification and Acceptance of New Sulfur Hexafluoride"

IEC 391 "Marking of Insulated Conductors"

IEC 414 "Safety Requirements for Indicating and Recording Electrical Measuring Instruments and Their Accessories"

IEC 420 "High Voltage Alternating Current Fuse Switch Combinations and Fuse Circuit Breaker Combinations"

IEC 445 "Identification of Apparatus Terminals and General Rules for a Uniform System of Terminal Marking, using an Alphanumeric Notation"

IEC 446 "Identification of Insulated and Bare Conductors by Color"

IEC 466 "High Voltage Insulation Enclosed Switchgear and Controlgear"

IEC 470 "High Voltage Alternating Current Contactors" *

IEC 473 "Dimensions for Panel Mounted Indicating and Recording Electrical Measuring Instruments"

IEC 518 "Dimensional Standardization of Terminals for HV Switchgear and Controlgear" *

IEC 521 "Class 0.5, 1, and 2 Alternating Current Watthour Meters"

IEC 529 "Classification of Degrees of Protection Provided by Enclosures"

IEC 617 "Graphical Symbols for Diagrams"

IEC 632.1 "High Voltage Direct Online Motor Starter" *

IEC 694 "Common Clauses for High Voltage Switchgear and Controlgear Standards"

BSI (BRITISH STANDARDS INSTITUTION)

BS 159 "Busbars and Busbar Connections"

Notes:

*** 1) By definitions in ISIRI Standard No. 6 the voltages above 1000 volt to 66 kV inclusive are called medium voltage.**

2) Where standards other than "IEC" are used, manufacturer/supplier shall submit the applied equivalent standards and pertinent deviations.

3) The testing and certification by following authorities are acceptable where relevant:

- Association of Shortcircuit Testing Authorities (ASTA).

- European Organization for Testing and Certification (under CENCENELEC administration).

- Underwriters Laboratories INC.

- Electrical Equipment Certification Services (EECS).

3. UNITS

International System of Units (SI) in accordance with IPS-E-GN-100 shall be used.

4. SERVICE CONDITIONS

4.1 Environmental Conditions

See Attachment 1.

4.2 MV Electric Supply

4.2.1 Power system.

.... * .... kV, 3 phase, 3 wire, 50 Hz with .... * .... neutral earthing.

4.2.2 Fault level .... * .... M.V.A.

4.2.3 Voltage variation ±10 % (to IEC 38).

4.2.4 Frequency variation ±5 % (to IEC 242).

Note:

For unspecified criteria marked thus (*) see relevant data sheets and single line diagrams.

4.3 Area Classification of Location of Installation for Equipment

4.3.1 The MV switchgear and controlgear assembly(s) will be installed indoor or outdoor in safe area according to degree of IP given in data sheets.

4.3.2 If the associated remote control stations are to be located in the hazardous areas, they shall comply with the requirements of standards of electrical apparatus for potentially explosive atmospheres and shall have test certificates from authorities to which reference are made in Appendix G of this Standard Specification.

4.4 Local LV Supply

See Appendix B.

5. BASIC DESIGN, CONSTRUCTION AND RATING

5.1 General Requirements

5.1.1 Switchgear and controlgear shall be of the metal clad withdrawable type, have either a single or a double busbar system and consist of a number of separate panels assembled into one or more sections. Sections shall be electrically interconnected by a bus-section switch.

5.1.2 Double busbar system shall have facilities for being electrically coupled per section by a bus coupler switch.

5.1.3 Facilities for extension of assembly shall be provided at both ends.

5.1.4 Depending on the requirements, the assembly may include the following types of functional units.

- Incoming : From generators.
- Incoming : Feeders.

- Outgoing : Distribution feeder.
- Outgoing : Transformer feeder.
- Outgoing : Motor starter.
- Outgoing : Single capacitor bank.

- Coupling : Bus-section switch.
- Coupling : Bus coupler switch.

5.1.5 Depending on number of incoming circuits bus sections shall be provided.

5.1.6 Incoming units shall preferably be located in the center of the electrical load.

5.1.7 If more than one incoming unit e.g. generator units are to be located in one section these units shall be evenly divided in the section concerned.

5.1.8 Voltage transformers, current transformers, measuring, protection etc. shall be provided in accordance to requirements of data sheets.

5.1.9 The layout of operational front and the location of the components of the assembly shall be arranged in a logical and systematic sequence and standardized throughout.

5.1.10 No operational equipment, metering apparatus or control devices shall be located on the switchgear assembly at levels below 200 mm and above 1750 mm.

5.1.11 Alphanumeric system notation in accordance with IEC Publication No. 445 shall be used for identification and marking of phases conductors and terminals.

5.1.12 The MV switchgear and controlgear assembly and its components shall basically comply with requirements of the IEC 298, IEC 56 and with the relevant IEC recommendations mentioned there in, in conjunction with the pertinent data sheet given in Appendix B of this Standard Specification.

5.1.13 Switchgear and controlgear shall be designed to minimize any risk of short circuit, and to ensure personal and operational safety during all operational conditions, inspection and maintenance, the connection of main, control and auxiliary cables, and equipping and commissioning of spare panels whilst, the switchgear is live and in operation.

Even under extreme conditions of major short circuits or mal operations there shall be no danger to persons in the vicinity of the assembly.

5.1.14 Selection of feeder switching device shall be made from the following type of circuit breakers in accordance with Sub-clause 3.102 of IEC Publication 56:

a) Vacuum.
b) Minimum.
c) Sulfur hexafluoride (SF6) gas.

5.1.15 Subject to approval of purchaser bulk oil circuit breakers may be selected in accordance with above mentioned Sub-clause of IEC Publication.

5.1.16 Circuit breaker using "SF6" gas as insulating switching medium, shall be provided with pressure indicating devices with contacts wired to an alarm and trip circuit.

5.1.17 Each circuit breaker shall be provided with a padlock facility for locking in the open and isolated position.

5.2 Interchangeability

5.2.1 Electrically identical components shall be of one type and make.

5.2.2 Withdrawable sub assemblies with identical electrical functions and capacities shall be mechanically interchangeable, but with different electrical functions or capacities shall not be interchangeable.

5.3 Busbar System

5.3.1 General requirements

5.3.1.1 Busbar shall be located in a separate compartment. Busbar system shall be air insulated with the individual solidly insulated busbars and connections. Provision shall be made at the bolted connections to enable accessibility for maintenance and extensions when appropriate.

5.3.1.2 The busbar insulation system shall be continued as far as practicable in bus compartment.

5.3.1.3 Shrunk on sleeving or epoxy resin to be used for insulation of busbars.

5.3.1.4 Sheathing or shrunk on sleeving shall be preferably color coded.

5.3.1.5 Busbars shall be made of plain hard drawn, high conductivity electrolytic copper.

5.3.1.6 Busbars and connections shall be fully rated, braced and supported to withstand the dynamic, thermal and dielectric stresses over the full length of the switchboard.

Normal current rating of busbars and connections shall be in compliance with the requirements of BS 159 (No IEC Publication is equivalent).

5.3.1.7 Busbar short time rating shall be to requirements of Sub clause 4.6 of IEC Publication 694 and rated duration of short circuit shall comply with the requirements of Sub clause 4.7 of IEC Publication 694, in conjunction with the data sheets.

5.3.1.8 Bolted connections shall be made with high tensile strength bolts effectively secured against loosening.

5.3.1.9 The busbar shall include all necessary supports, expansion joints, bolts and nuts for complete installations.

5.3.1.10 Busbars and busbar connections shall be supported and proportioned as to be capable of safely withstanding stresses to which they may be subjected including those due to short circuit and climatic conditions.

5.3.1.11 Switchgear assembly shall be so designed and constructed as to prevent arcs occurring in one main busbar, from flashing through or around bus tie units to the other parts of main busbars.

5.3.1.12 Arc propagation barriers shall be provided to prevent arcs (occurring in incoming bus ducts) from flashing through or around the main incoming unit to the main busbar.

5.3.2 Double busbar system

5.3.2.1 When double busbar system is required and shown in single line diagram, each system shall be located in a separate busbar compartment.

Facilities for extension, shall be so arranged that busbar systems can be extended safely on both end with only one of the busbar systems deenergized at a time.

5.3.3 Busbar selectors in double busbar systems

5.3.3.1 When disconnectors (isolators) are applied for busbars selection, they shall be of the make before break type and shall be interlocked with the bus coupler switch of their particular section.

5.3.3.2 Disconnectors shall comply with the requirements of IEC Publication No. 129. i.e.: Alternating current disconnectors (isolators) and earthing switches.

Notes:

1) Where double busbar system is requested all the requirements stated under Sub clause (4.3.1) of this Standard Specification shall be met.

2) Busbar selection arrangement shall be subject to purchaser's approval.

5.3.4 Bus trunking

5.3.4.1 When bus trunking is required for either incoming or outgoing connection, the switchgear shall be provided with the supplier's standard flanged entry terminal box, suitable for connection in the vertical direction with the bus trunking approaching from the above, unless otherwise agreed by purchaser.

5.3.4.2 Flexible connections to prevent strain on the switchgear shall be supplied by vendor as part of the purchase order.

5.3.4.3 Bus trunking shall have as a minimum the degree of ingress protection as stated in Clause 5.4 of this Standard, in addition a tight fitting barrier made of flame resistant non conducting material shall be provided in the bus trunking.

5.3.4.4 Bus trunking shall be provided with anti condensation heater and thermostat according to requirements of sub Clause 5.5 of this standard specification.

5.3.4.5 Bus trunking design shall take care for expansion and contraction of equipment.

5.3.4.6 Current rating and short time rating of bus trunking shall not be less than that of busbar.

5.3.4.7 The busbar trunking shall include all necessary support, flanges expansion joints and terminations compatible with the power transformer and switchgear assembly. Connectors, bolts etc. for a complete installation.

5.3.4.8 If switch manufacturer does not manufacture bus trunking, the coordination responsibility for both side of bus trunking rests on him.

Notes:

1) Where busbar trunking is required, the general requirements for busbar stated in Sub clause 4.3.1 of this Standard Specification shall be met.

2) Switchgear manufacturer is responsible for provision of bus trunking and relevant coordination.

5.4 Enclosure

5.4.1 Minimum degree of protection shall be "IP 41" to "IEC 529", for indoor installations and to "IP 65" of the same standard for outdoor installations, unless otherwise specified in data sheet.

5.4.2 The floor foundation of the switch house shall not be considered as part of enclosure.

Between compartment a degree of protection IP 4X shall be achieved.

5.4.3 LV compartments shall be easily accessible and when opened shall offer a degree of protection of at least IP 20 towards any live parts.

Notes:

1) The above mentioned degree of ingress protection shall be applied only when no mention is made of degree "IP" in data sheets.

2) When outdoor equipment are requested the vendor shall submit full detailed drawing of canopy to be provided by purchaser for a degree of ingress protection of IPW 54 to facilitate also maintenance and inspection under adverse weather conditions in winter or summer.

5.4.4 Enclosure shall comply with IEC 298 Appendix AA with regard to their mechanical strength in the event of an internal arc.

Notes:

1) The test performance shall be in conformity with Table AAII of IEC Publication No. 298.

2) The maximum allowable arc duration shall be stated by the manufacturer.

3) Type test reports shall be available in the quotation stage.

5.5 Anti Condensation Heaters

5.5.1 Effective measures shall be taken to prevent the formation of condensation inside the enclosure during installation and under either operating or non operating situations with due consideration to environmental conditions.

5.5.2 The anti condensation heating system shall be electrical and to be supplied from a separate source connected between system phase and neutral (i.e. 230 volt 50 Hz) and controlled by thermostat.

Heater circuits mounted in the separate sections of the switchgear shall be separately protected and switched for insulation purposes.

The protection shall include fuse or earth leakage protection as specified in requisition suitably protected terminals (at least to IP 20).

The wiring of heaters and thermostat shall be brought out to a common terminal block, approximately located midway along the length of the switchgear.

5.6 Requirements for Functional Units

5.6.1 General

5.6.1.1 The requirements for duty cycle and performance characteristics of the switching devices shall be selected in accordance with the relevant IEC publication which follows for individual functions.

5.6.1.2 The functional units shall be suitable for duty period of 27000 hours, operating within their rated duties and under the specified conditions without requiring major repairs or replacements and with minimum attendance.

5.6.1.3 Withdrawable sub assemblies shall be mechanically forced to make and break the electrical contact with the busbars of the cable connection side.

5.6.2 Mechanical/electrical contact position indication

5.6.2.1 All MV switching devices shall be provided with a clearly visible contact position indicator operated mechanically by the operating mechanism.

5.6.2.2 If direct mechanical indication can not be provided in a satisfactory way a clear red indicator light for on and a clear green indicator light for off position shall be installed.

5.6.2.3 The indicator lights shall be of the long life, low power consumption type like neon or Light Emitted Diode (L.E.D).

5.6.2.4 In case of a stored energy closing mechanism, an additional marking shall be provided indicating charged or discharged conditions.

5.6.3 Auxiliary contacts

5.6.3.1 In order to provide facility for connections to remote control, alarm and indicating devices, each MV functional unit shall be provided with spare potential free auxiliary contacts directly operated by the operating mechanism.

5.6.3.2 The additional auxiliary contacts shall at least consist of:

a) 2 sets of double gap make contact elements each with two terminals.
b) 2 sets of double gap break contact elements each with two terminals.

5.6.3.3 These contacts shall be completely wired up to the terminal blocks in the LV control terminal compartment.

5.6.3.4 The characteristics of all control devices and switching elements shall at least comply with IEC Publication 337.1 and 337.2

5.6.3.5 The rated current and the utilization category shall be according to requirements in data sheets.

5.6.4 Switch operation counter

5.6.4.1 All functional units shall have counters and they shall be mechanically operated and located at an accessible and visible location.

5.6.5 Emergency tripping device

5.6.5.1 Each MV latched switching device shall be provided with a mechanical manually operated tripping device.

5.6.5.2 Each MV nonlatched switching device shall have a local manually operated emergency tripping device of the "stay put" type.

5.6.5.3 The emergency tripping device shall be protected against inadvertent tripping actions.

5.6.6 Spare panel(s)

5.6.6.1 Each MV switchgear assembly shall have at least one spare panel of each outgoing type in each section.

5.6.6.2 Spare panels and circuits shall be provided with all components enabling future completion without shutting down the existing equipment.

5.6.7 Separate panels

5.6.7.1 Every effort shall be made to house and accommodate on or within the equipment all those devices associated with the equipment; but where this is not possible and/or when specified in the requisition , separate panels shall be provided.

5.6.7.2 These separate panels shall comply with the requirements of this Specification, from design, construction, rating and specified standards points of view.

5.6.7.3 Separate panels shall normally be free standing, suitable for floor fixing.

5.6.7.4 The separate panels shall be manufactured in sheet steel of not less than 2 mm (14 SWG), shall be internally braced to give a rigid construction and shall be complete with front access hinged doors complete with locks.

5.6.7.5 Cable entries shall be from the base unless specified otherwise and a suitable gland plate complete with glands shall be fitted to accommodate all cables.

5.6.7.6 Terminals shall be located as close as practicably possible to the gland plate to prevent excessive lengths of cable within the enclosure.

5.6.7.7 The direct termination of incoming cables to individual components should be avoided.

5.6.8 Control indication and annunciation panel

A separate control-panel complete with annunciator panel and with the following requirement may be provided for MV switchgear assembly on request.

5.6.8.1 The control-panel shall include an open/close control switch for each circuit breaker and motor starter together, with synoptic diagrams and associated indication lamps as follows:

Red - closed
Green - open
White - trip circuit healthy
Amber - auto trip operated

5.6.8.2 The control-panel shall include control switch for circuit breaker and local/remote/off selector switch for each motor starter in compliance with IEC 337.1.

a) In the local position the starter shall be controlled from this control panel (for testing of the operation of motor starter only in isolated position).

b) In the remote position, the starter shall be controlled from a control station adjacent to the associated motor only.

c) Tripping shall be possible from both locations described above, and also from the associated motor starter panel, regardless of the position of the selector switch.

5.6.8.3 The control-panel shall include all wiring terminal, fuses compression type cable glands , etc. to requirements, of Clause 5.16 of this Standard Specification:

a) The main circuit designation labels shall correspond with the relevant labels of switchgear assembly.
b) Marking and warning signs shall be provided for purpose of identification of mal operations.

5.6.8.4 The control-panel shall be of sheet steel fabrication, dust and damp protected to IP 51 of IEC Publication No. 144 suitable for bottom entry cable. The panel shall be free floor standing.

5.6.8.5 The annunciator panel shall monitor status of alarm and trip devices of all functional units.

5.6.8.6 The annunciator shall include at least "4" number of spare elements fully wired for purchaser's use.

5.6.8.7 Annunciator panel shall have a back lighted front, with visible and legible lettering, complete with:

a) Audible alarm consisting of continuously rated variable tone horn.
b) Acknowledgment push buttons.
c) Horn release push button.
d) Lamp set push button.

5.7 Incoming Functional Unit Requirements

Protective, control and measuring system requirements shall be stated on the data sheets.

5.7.1 Generator feeder switching device

5.7.1.1 The generator feeder circuit breakers shall have the following characteristics:

a) System voltage, system frequency and rated normal current as stated on the data sheets.

b) Insulation level shall be in accordance with requirement of Sub clause 4.2 of IEC Publication No. 694.

c) Rated short time withstand current in accordance with Sub-clause 4.5 of IEC 694.

d) Duration of short circuit as stated in data sheets.

e) Operating sequence shall be "0-3 min.- co.- 3 min.- co." in accordance to definition in Sub clause 441-16-03 of IEC 50.

f) Mechanical operating tests shall be in accordance to requirements of Clause 6.102 of IEC Publication 298.

g) Small inductive breaking current capacity shall be given by manufacturer for critical minimum breaking current condition. The circuit breakers shall satisfy the testing requirements in accordance with Sub clause of "6.107" of IEC Publication No. 56.

5.7.1.2 Isolating facilities shall comply with the requirements of IEC Publication 129.

5.7.1.3 Operating mechanism depending on circuit requirements shall comply with requirement of Sub clause 3.104 of IEC Publication No. 56 and may be one of the following :

a) Dependent power operation.
b) Stored energy operation.

5.7.1.4 Each generator feeder switching devices shall have a local closing facility on the assembly only when:

a) Associated local synchronizing facilities are provided.
b) No synchronizing is necessary (single source of supply).

5.7.2 Incoming feeder switching device

5.7.2.1 Where protected circuits or synchronizing facilities required selection of circuit breaker is limited to a circuit breaker identical with (4.1.14) with local closing, and synchronizing facility if necessary.

5.7.2.2 For unprotected circuits or where no synchronizing is required a fault make and load break switching device in compliance to IEC Publication 265 may be considered (only when rated voltages are above 1 kV and less than 52 kV).

5.7.2.3 Each selected device shall be provided with padlock facility for locking in the open and isolated positions.

5.7.2.4 The switching device shall have the following electrical characteristics:

a) System voltage, system frequency and rated normal current as stated in data sheets.
b) Rated insulation level to Sub clause 4.2 of IEC Publication No. 694 (for voltages less than 52 kV).
c) Operation category "A" (in conjunction with accessibility) to requirements of IEC 298.
d) Mechanical operation tests shall be in accordance to requirements of Clause 6.102 of IEC Publication 298.
e) Mechanical endurance 10 000 operating cycles.

5.7.2.5 Isolating facilities shall comply with the requirements of IEC Publication 129.

5.7.2.6 Operating mechanism depending on the circuit requirements may be selected from one of the following:

a) Dependent power operation.

Note:

Closing mechanism for depending manual operation are not allowed according to Sub clause 5.5 of IEC Publication 265.1 in which reference is made to IEC 694.

b) Stored energy closing.

5.8 Requirements for Coupling Functional Unit

Protective control and measuring system requirements are stated in data sheet.

5.8.1 Bus section switching device

Similar to (5.1.14).

5.8.2 Busbar coupler switching device

Similar to (5.1.14).

5.9 Requirements for Outgoing Functional Units

Protective control and measuring system requirements are stated in data sheets.

5.9.1 Distribution feeder switching device

The type shall be a circuit breaker identical with (5.7.1) and with a local closing facility. However if auto reclosing is required a circuit breaker with agreed operating sequence shall be selected.

5.9.2 Transformer feeder switching device

The following switching devices are acceptable.

5.9.2.1 Fused contactor combination

Similar to (5.9.3.2) which follows, but with latched mechanism:

Fuse links, however shall have time current characteristics for transformers.

5.9.2.2 Circuit breakers

Identical to (5.1.14) but with a local closing facility.

Note:

Selection of a circuit breaker shall be subject to approval of purchaser.

5.9.3 Motor starting switching device

5.9.3.1 Selection

In principle fuses shall be used for short circuit protection of electric motors.

The selection for direct on line motor starting units shall be made in accordance with the following order of preference:

a) Fuse-vacuum contactor combination (5.9.3.2) to requirements of IEC Publication 470.
b) Circuit breakers (5.7.1) to requirements of IEC Publication 56.

5.9.3.2 Fuse contactor combination

MV contactors shall comply with the requirements of IEC 470 and fuses with IEC 282-1.

Notes:

1) Requirements of IEC 470 applies only to contactors the main contacts of which exceeds 1000 volt "a.c." but does not exceed 12 000 volt a.c. for non exposed installations.

2) Contactors forming part of a controlgear assembly shall also meet the requirements of IEC publication No. 298 in matters not covered in IEC 470.

3) Contactor forming part of a direct on line full voltage "a.c." starter or reversing starter shall comply with requirements of IEC Publication 632.1 (max. voltage 12 000 volt).

5.9.3.3 The device shall have the following characteristics:

a) System voltage, system frequency and motor current as stated on the requisition.

b) Insulation level to be in accordance with IEC 470.

c) Intermittent duty requirements Class 0.1 unless otherwise stated in data sheet.

d) Utilization category, "AC-3" unless otherwise stated in data sheet.

e) Electrical endurance, conditions for category "AC-3" according to Table 1 of IEC 632.1, unless otherwise stated in data sheet.

f) A minimum mechanical endurance corresponding to 8000 hours of operation at the highest corresponding frequency of operating cycles in compliance Sub-clause 8.2.7 of IEC Publication 632.

g) Windings of control electromagnets, duty class in accordance with endurance requirements of the contactor.

h) Operating mechanisms; trip free.
Effective precautions shall be taken to prevent "pumping actions" of the mechanisms, e.g. by antipumping devices.

j) Fuse links, high rupturing capacity, short circuit, current limiting with positive acting striker. Fuses shall have time current characteristics designed for direct on line starting of motors and shall comply with the requirements of IEC 282.1

k) Isolating facilities. See (5.11).

l) Overvoltage surge diverters, if required in view of switching overvoltages.

m) The fuse contactor combination shall be considered as one unit and tested as such.

n) Depending on the characteristics of the fuse and contactor, and on the surge impedance of the circuit connected, high transient voltage can be produced under operating conditions. These voltages can cause insulation damage to the system. The manufacturer shall take the necessary precautions to keep these voltages within the acceptable values applicable and shall state on his quotation the estimated peak values of the transient recovery voltages (TRV) and power frequency recovery voltages under the worst conditions.

o) Correct correlation shall be established between the fuse characteristics and other protective devices, in order to ensure that overload and fault currents in a particular circuit are safely interrupted by the appropriate components of the fuse contactor combination, without interference with other circuits and without the risk of welding of the contactor contacts or other damage to the contactor itself.

p) The maximum delay in the protection coordination shall be the protective relay operating time plus the contactor's own breaking timing relay.

The maximum tolerance time of the fuse curve shall coincide with the contactor maximum breaking capacity line at or below the maximum time delay mentioned above.

q) The manufacturer shall also include in the quotation the proper coordination curves of all protective devices relevant to the switching capacity of the contactor.

r) For motor starting units with capacitors connected in parallel with the motor terminals, the manufacturer shall confirm that the fuse contactor combination has adequate capacity and performance ability for the rated duties as specified.

Unless otherwise specified on the requisition, each motor starting unit shall be equipped and fully wired with a standard socket base for the possible use of a restarting relay (RR) or a time delaying restarting relay (TMR).

5.9.4 Single capacitor bank switching device

5.9.4.1 The switching device shall be capable of switching single capacitor banks, and may be selected from the following types:

a) Fuse switch combination, of which the switching devices shall be in accordance with (5.7.2.) and with IEC 420.

b) Fuse contactor combination, of which the latched contactor shall be in accordance with (5.9.3.2).

5.9.4.2 The fuse links shall be of high rupturing capacity, short circuit current limiting, with suitable time current characteristics for capacitor banks.

5.9.4.3 Operating mechanisms shall be suitable for independent manual operation or dependent power operation depending on kVA (r) demand requirements. Capacitor switching devices controlled by a kVA (r) demand relay shall have an operating mechanism designed for instantaneous operation and fitted with an antipumping device.

5.9.4.4 The fuse device combination shall be considered as one unit, and be tested as such.

5.10 Closing and Tripping

5.10.1 Supply voltages

5.10.1.1 Voltages for tripping shall be 110 or 220 volt d.c. with a preference for 110 volt d.c. or as specified in data sheet.

5.10.1.2 Voltage supply limits shall be in accordance with the Sub clause 4.8 of IEC Publication No. 56.

5.10.2 Supply units for closing and tripping

5.10.2.1 Closing

a) An assembly consisting of one section only shall be provided with one dedicated closing supply unit if electrical closing is utilized for switchgear other than contactors. For control supply for contactors, see (5.10.2.4).

Similarly, multisection assemblies shall have two units and a clearly labeled manual switching arrangement to enable:

Complete isolation of each unit from the closing bus wiring.

The whole closing bus wiring system to be fed from either unit (with the other unit being out of service).

A normal configuration such that each unit supplies approximately one half of the switchgear.

b) Each supply unit shall be capable of closing or charging at least two switching devices simultaneously and all others in succession per assembly.

However, if the supply unit serves also motor starter units, each supply unit shall be rated for simultaneous closing of at least 30% of all motor starter units in the assembly with a minimum of two units.

c) If d.c. is supplied via a rectifier, the output ripple shall not cause interference with the other equipment of the assembly.

5.10.2.2 Tripping

a) An assembly consisting of one section only shall be provided with one dedicated tripping supply unit if electrical tripping is used.

Similarly, multisection assemblies shall have two units and a clearly labeled manual switching arrangement to enable:

- Complete isolation of each unit from the tripping bus wiring.
- The whole tripping wiring system to be fed from either unit (with the other unit being out of service).
- A normal configuration such that each unit supplies approximately one half of the switchboard.

Note:

To cater for the supply of electronic relays no momentary loss of voltage on the bus wires is permitted.

b) Each supply unit shall be capable of supplying the whole of the assembly load (e.g. electronic relays) for 24 h and then tripping all connected switching devices of the complete assembly twice in succession. Only circuits directly associated with the tripping and protection functions shall be connected to this supply source.

c) A healthy trip indicator shall be provided on all units with electrical tripping. Any loss of trip supply shall operate an alarm relay on the assembly. This relay shall have one set of change over contacts which shall be wired out to a suitable terminal block for connection to an outgoing cable to a remote alarm location.

5.10.2.3 Closing and tripping for intake station and power plant station assemblies:

For these assemblies, only d.c. battery backed supply shall be provided.

The supply for closing and tripping may be taken from the same source if this is of ample capacity and the system is provided with a selective d.c. distribution switchgear.

5.10.2.4 Control supply for contactors

a) Closing/holding supply for contactors should preferably be taken from their individual voltage transformer. The voltage level shall be stated on the requisition.

b) Closing supply for latched contactors may also be taken from their individual voltage transformer; however, the tripping supply shall be taken from the tripping supply unit of the section concerned.

5.10.3 Remote control

A positive closing and tripping action shall be possible under all conditions, when using up to 500 m of the type of control cable as specified on the data sheet. For distances in excess of this length, both length and type of control cables shall be specified on the data sheet. The method of control shall be subject to agreement by the purchaser.

5.10.3.1 Remote control units and safety switches

Standard remote control units and safety switches for installation near motor or electrical apparatus to be controlled, are shown in provisional single line diagram and are stated in the data sheets.

5.10.4 Pneumatic operation

5.10.4.1 When pneumatic system is requested for closing and tripping the air supply system shall consist of two compressors with two air vessels. The capacity of each compressor shall be capable of coping with the requirements of the whole assembly.

5.10.4.2 Single compressor installations may be used only subject to purchasers approval and are to consist of one compressor, one air vessel and one compressed air bottle.

5.10.4.3 The system shall perform the same duty cycle as indicated for an electrically operated system, i.e.:

a) Simultaneous closing of at least 30% of all motor starting units in the assembly, with a minimum of two switching devices.

b) Simultaneous tripping of all connected switching devices in the assembly , twice in succession.

5.11 Isolating Facilities

5.11.1 Isolation of the main circuits

Disconnectors (isolators) shall be in accordance with IEC 298 and in compliance with IEC 129.

Note:

A removable part of an assembly incorporating a switching device or a withdrawable type switching device may be considered to satisfy the requirements, provided that interlocking features are installed (5.11.2).

5.11.2 Interlocks

5.11.2.1 Interlocks shall be in accordance with the requirements of Sub clause 5.105 of IEC 298.

But for testing purposes in addition, the operation of a circuit breaker, switch or contactor in the earthed position shall be possible only by local facilities while the remote control circuit is inoperative.

5.11.2.2 All interlocks shall be mechanical in nature.

5.11.2.3 Interlock shall be provided to prevent the following operations and any other operations which could cause danger or damage.

a) The circuit breaker being closed unless it is correctly located in the service, isolated or earthed positions or unless the circuit breaker is withdrawn from the fixed part of the switchgear.

b) The circuit breaker being withdrawn from or inserted into the feeder spouts or isolating device when it is in the closed position.

c) The circuit breaker being moved to any position other than that selected by means of the mechanical selector.

d) The circuit breaker truck or other movable part being withdrawn or inserted into the fixed unit housing unless the circuit breaker is in the correct position for withdrawal or insertion.

e) The circuit breaker being closed in the service position unless all auxiliary circuits between fixed and movable parts have been completed.

f) Where separate earthing switches are approved by the purchaser they shall be interlocked to prevent their being closed on to energized equipment.

5.11.2.4 The correct operation of the circuit breaker shall be selected by means of an operating selector device lever or handle.

5.11.2.5 The selector device shall be labeled to indicate the method of operation.

5.11.2.6 Where mechanical interlocks are required between two or more circuit breakers, the methods and devices shall be to the purchaser's approval.

5.11.2.7 All necessary electrical interlocks detailed in the requisition.

5.11.2.8 Circuit breaker operating mechanisms shall be of the trip free type such that the circuit breaker is free to open irrespective of whether the closing power is applied or not.

5.11.3 Partitions and safety shutters shall be in accordance with Sub clause of 5.103 of IEC Publication No. 298 and shall meet also the following requirements:

5.11.3.1 The degree of protection "IP 41" shall be maintained through all operating conditions.

5.11.3.2 Shutters shall be closed and opened automatically by the mechanical drive of the removable part when the latter is being racked out or racked into the service position.

5.11.3.3 Each set of shutters shall be individually operated and shall be capable of being padlocked in the closed position.

5.11.3.4 To facilitate testing, a manually operated device shall be installed to permit the opening and fixing, but not the padlocking, of each set of shutters in the open position. The device shall be designed in such a way that it will be overridden by the moving part of the switching device, restoring the automatic features of the shutters.

5.11.4 Isolating contacts of secondary circuits

5.11.4.1 Auxiliary and control circuit connections on withdrawable switching devices shall be made either with self aligning plug and socket contacts or with multi conductor cable with plug and socket arrangement.

5.11.4.2 The voltage carrying part of the switching device shall be of the male type.

Connections shall be maintained or restored by special facilities, when the withdrawable part of the switching device is in the test position (5.11.2).

5.12 Voltage Transformers

Voltage transformers shall be in accordance with IEC Publication 186.

5.12.1 Rating and type

5.12.1.1 The rated primary voltage depends on system data as stated on the data sheets.

5.12.1.2 The secondary voltage of measuring and protection transformers shall be 110 V.

5.12.1.3 The rated output capacity of the transformers shall be matched to cover the burden required by the equipment connected, and should be selected from the range of standard values.

5.12.2 Class of accuracy

5.12.2.1 Generally, measuring voltage transformers should be class 3, except those for measuring the supply of third parties, which shall be Class 1. If Class 1 is applicable this shall be stated on the requisition.

5.12.2.2 Voltage transformers for use with generator AVR's shall be accuracy Class 0.5.

5.12.2.3 Protective voltage transformers shall be of Class 3 P.

5.12.3 Winding connections of voltage transformers

5.12.3.1 Single phase

The MV windings shall be connected between phases. LV windings shall be earthed at one side. The termination shall be provided with an earthing link.

5.12.3.2 Three phase

Depends on the system arrangement preferred connections are:

a) MV windings, star connected, star point isolated.
b) LV windings, star connected, star point earthed.

5.12.4 Protection of MV voltage transformers

5.12.4.1 At MV side : High rupturing capacity, short circuit current limiting fuses shall be installed in accordance with IEC 282-1, see (4.17.1.1).

Fuses shall be readily accessible and suitable arrangements shall be made to enable safe removal and replacement of fuses whilst the busbar systems remain live.

5.12.4.2 At LV side : industrial cartridge fuses are preferred (4.17.1.1). The connection between transformer and fuse base shall be as short as possible.

5.12.4.3 All protective fuses shall be capable of handling the in rush current for all service conditions, without abnormal aging or deterioration.

5.12.4.4 Voltage transformers for automatic voltage regulators shall not have fuses but shall be connected within the protection zone of the differential protection of the generator.

5.12.4.5 The successive protection control, metering and auxiliary circuits shall be selectively coordinated.

5.12.5 Location

Depending on requirements, the following general rules should be used as a guide for establishing the correct location of voltage transformers in an assembly:

5.12.5.1 For voltage detection, indication, etc., a measuring transformer shall be connected to the busbar of each section.

In addition, however, measuring voltage transformers for incoming units, e.g. generator and main intake feeders, shall be connected on the supply side.

5.12.5.2 For the control supply of the switching devices of a section, preference is given to a voltage transformer connected to the busbar side of the section concerned.

Alternative supply sources are acceptable for intake and power plant stations and large load consumers, e.g. electric motor driven compressors for pneumatic control.

5.12.5.3 Special arrangements shall be subject to the purchaser's approval.

5.13 Current Transformers

Current transformers shall be in accordance with IEC 185.

5.13.1 Rating and type

5.13.1.1 Rated output capacity of the transformers shall be matched to cover the burden required by the equipment connected, and preferably be selected from the range of the standard values.

5.13.1.2 Rated primary current should be selected from the range of standard values.

5.13.1.3 Rated secondary current shall be either 1 A or 5 A. For remote metering 1 A only is acceptable.

Other means of remote indication may be considered and quoted for, e.g. transducer system, but shall be subject to approval by the purchaser.

5.13.2 Class of accuracy

5.13.2.1 Generally, measuring current transformers shall be Class 3, except those for measuring the supply of third parties, which shall be Class 1. If Class 1 is applicable this will be stated on the requisition.

The saturation factor "n" shall be ≤ 5 in order to prevent damage of instruments at maximum fault current.

5.13.2.2 Protective current transformers are to be Class 5 P. However, Class 10 P is acceptable for the protection of electric motors, capacitor banks, etc.

The saturation factor shall be 10 in order to ensure the proper working of the protective devices and shall be indicated as follows: Class 5 P 10 or 10 P 10.

5.13.3 Terminals and connections, see also (5.16)

Secondary terminals of current transformers shall be wired up to a terminal block with short circuiting links, located at an accessible place. One side of the secondary winding of each current transformer shall be connected at this terminal block to the earth bar.

5.14 Cable and Core Terminations

5.14.1 General

5.14.1.1 Each functional unit of the assembly shall be provided with appropriate facilities of adequate size and thermal rating for terminating and sealing the MV main cables and the LV control and auxiliary cables.

5.14.1.2 Cable type, size and number of cores will be stated on the data sheets. Cable lugs of the compression type, shall be included in the supply of the assembly.

5.14.1.3 Termination compartments for MV and LV connections shall be effectively segregated; see also IEC Publication 694.

5.14.1.4 The terminals shall be so arranged that bringing in and connecting all cables can be done safely, and without interference with live assembly busbars and adjacent live functional units.

5.14.1.5 Inside the compartments separate terminals or bolts with nuts of adequate dimensions, one for each cable, shall be fitted for cable screen and/or armoring earthing purposes.

5.14.1.6 Efficient means to prevent strain on the actual conductors and soldered cones shall be provided.

5.14.1.7 All main cable termination facilities shall be suitable for d.c. pressure testing of the cable without disconnection.

5.14.2 MV cables, three core type

Cable end boxes or sleeves, if required, shall be of the split type and shall provide adequate space for accommodating stress relief cones if required.

5.14.3 MV cables, single core type

Cable glands, etc., including the mounting plate for single core cables shall be of nonmagnetic material. The glands shall be insulated from the framework or the mounting plate.

5.14.4 LV cables, multicore type

5.14.4.1 Termination compartments for auxiliary and control cables shall have adequate dimensions, with ample accommodation for the required number of terminals. Two or more conductor terminations on one terminal are not acceptable.

5.14.4.2 Metal cable glands suitable for the cables specified shall be included in the supply of the assembly .

5.14.4.3 There shall be adequate marshaling space between the cable glands and the terminal blocks.

5.14.5 Termination and support accessories for cables

The switch gear shall be complete with cable supports, cleats, cable dividing boxes, etc. for the complete termination of all incoming and outgoing cables and cores of the sizes and types as specified in the requisition and shall include power cables and protection control alarm cables.

Notes:

1) Where compound filled cable dividing boxes are provided they shall have large filling holes and suitable expansion space.

2) Glands and plates shall be so located to allow easy termination of cables.

3) Particular attention shall be given to the space and bending radii for aluminum and large core copper cables.

5.15 Earthing

Earthing shall be in accordance with IEC 694; color coding of protective conductors in accordance with IEC 446.

5.15.1 Main earth bar

The main earth bar shall consist of hard drawn high conductivity copper.

For direct connection to the station earthing grid, earthing bolts (M 12) with nuts and spring washers shall be provided at both ends of the main earth bar.

5.15.2 Earthing connections

Branch connections from the main earth bar to components shall consist of copper strips or of green/yellow striped PVC sheathed stranded copper conductors. Termination lugs shall be of the compression type.

5.15.3 Earthing devices

5.15.3.1 Three phase earthing facilities for the MV cable connections and for the busbar system of each section shall be provided.

For this purpose integrally mounted three phase earthing switching devices shall be provided for each MV switching device. These devices shall be capable of making and carrying the prospective short circuit current at the point of earthing.

The earthing devices shall be suitable for local, manual operation only.

Subject to approval by the purchaser, portable earthing devices may be acceptable. A minimum of two of each type is required.

Depending on the design, padlock facilities for locking in the open and closed position shall be provided.

When an earthing device has been applied in a compartment, it shall not be possible to insert a withdrawable switching device into the service position of the compartment concerned.

5.15.3.2 Generally, circuits shall not be earthed automatically, i.e. when withdrawing the switching device the earthing device has to be inserted deliberately.

5.15.3.3 However, outgoing circuits for motor starting may be earthed automatically when the switching device is being whitdrawn.

5.15.3.4 Clear instructions, preferably pictorial, shall be submitted showing the proper methods of how and where to fit the earthing devices.

5.16 Secondary Wiring and Terminals

5.16.1 For secondary wiring, PVC- or XLPE- insulated, fire and moisture resistant interconnection wire shall be used. The size type of the wires to be selected shall be based on mechanical strength, and especially for current circuits, on the prospective current levels.

5.16.2 The minimum allowable cross sectional area of the wires shall be 2.5 mm^2. Wires shall always be standard and of 1000 volt grade.

5.16.3 Color coding of secondary wiring shall be in accordance with IEC 446. Earthing wires shall be green/yellow striped. Wiring between two terminals shall be continuous; joints or interconnections are not allowed.

5.16.4 For the manufacturer's internal panel wiring, other than bus wires, no more than 2 wires shall be connected under one terminal connection. Bus wires shall have only one wire connected to each terminal.

5.16.5 As a minimum requirement, use shall be made of rail mounted terminals of high grade melamine.

Partitions shall be fitted between terminals for different voltages.

5.16.6 Wiring ends of stranded conductors which have to be connected into bus type contacts of terminals, shall be provided with compression type pre-insulated wire pins with insulation support. In general, when lugs, wire pins, etc., are used, they shall be of the compression type.

Note:

For the termination of secondary wiring on components, compression type pre-insulated push on connectors with insulation support may also be used.

5.16.7 All wires shall be identified at both ends by means of ferrules of insulating material, or by plastic code markers. Marking shall be in accordance with the related manufacturer's drawings. For marking of conductors, reference is made to IEC 391.

5.16.8 To accommodate and support the secondary wiring: covered plastic channels,insulated tubes or plastic strips shall be used.

Secondary wiring shall never be mounted direct to metal. The filling factor for channels shall not exceed 70% . Where supporting of a wire is not feasible, the wire or part of it shall be as short as possible.

5.16.9 Wiring to equipment mounted on doors etc. shall be carried out in flexible cables which shall be so arranged that it is not possible for the flexible cables to be trapped in the doors or mechanically strained.

5.16.10 Terminal blocks shall be so constructed, to prevent accidental contact between circuits and earth.

5.16.11 Wiring shall be neatly arranged and so located as to prevent damage. Cable looms shall not normally contain more than 25 wires. Sufficient length shall be provided on all wiring to prevent undue tension on terminals or connections.

5.16.12 Terminal blocks shall be so arranged and positioned to afford easy access for carrying out external cabling, testing, inspection and maintenance.

5.16.13 Unless requirements dictates, wiring shall not be installed in busbar compartments or sections of the switchgear carrying conductors at voltages higher than LV.

5.16.14 Connection between different sections or compartments of the switchgear shall be designed and installed as internal wiring.

Where live conductors pass through any section or compartment of the switchgear, they shall be properly insulated and protected, and shall be provided with warning signs to indicate this fact.

5.16.15 Not more than two wires shall be connected to any one terminal, where more connection are required to a common point,links shall be taken to adjacent terminals.

5.16.16 Internal wiring passing through sections shall be protected against mechanical damage.

Notes:

1) For remote control, indication, and alarm annunciation devices provision shall be made for wiring from spare potential free contacts to the terminal blocks with pertinent marking and warning signs, (for purchaser's use).

2) Where remote control,indication and alarm annunciator panel is part of purchase order it shall comply with the requirements of IEC Publication No. 466, and Clause 5.6.8 of this Standard Specification.

5.17 Protective Devices

5.17.1 Fuses

The application of fuses require a correct correlation with other protective devices in the assembly.

5.17.1.1 MV circuits

High rupturing capacity, short circuit current limiting fuses shall be in accordance with IEC 282-1. Application of two or more parallel fuses per phase shall be subject to approval by the purchaser.

5.17.1.2 LV circuits

a) Industrial cartridge fuses, in accordance with IEC 269, shall be used for control, measuring and auxiliary circuits. Alternatively, miniature circuit breakers may be used for this purpose, provided that a satisfactory selective overall protection coordination can be reached.

b) Each individual branch (take off point) from an auxiliary bus wiring system shall be provided with a selectively graded protective device.

5.17.2 Relays

5.17.2.1 General requirements

a) The selection of relays shall be in compliance with the requirement of each circuit and in accordance to pertinent section of IEC 255.

b) The number and type of protective relays are stated in data sheets.

c) Subject to approval of purchaser static type relays may be used provided that their effectiveness and reliability are guaranteed.

d) Relays shall be dust proof flush mounted and of the removable type, provided with calibrating, resetting and testing facilities. Current carrying terminals of the relays shall be automatically short circuited when the relays are withdrawn.

e) Protective relays shall have hand reset facilities and relay operated signals such as flags or other means of indication used on static type relays like Light Emitting Diodes (LED).

f) Relays with combined functions shall have separate indication for each function.

g) Indicators (flags or light emitting diodes) shall be visible from the front of the switchgear without the need of opening the relay case or equipment door.

h) Special precautions shall be taken to ensure that relays will not operate accidentally owing to vibrations or shocks e.g. by opening or closing of doors and switching the devices.

i) Elements with multiple functions such as trip and alarm duties shall have separate operating contacts for each function which shall be wired out to separate terminals. Tripping circuits shall always be separated from the other circuits.

j) Relays shall be capable of withstanding the output current of associated current transformers for at least the specified short circuit withstand time of the assembly.

k) The relay test provision shall consist of built in test plugs or switches or separately mounted test terminal blocks.

l) The test provisions shall permit the shorting of any current transformer circuit and for selective disconnection of the relays from current transformers, potential transformers, auxiliary power and circuits controlled by relays.

m) The relay test provisions shall be arranged so that relay cover or compartment door can not be closed while the relay connections are in the test position.

n) Contacts rating and performance shall be in accordance with IEC 255.

o) d.c. relays shall maintain their accuracy over the full range of voltage variation as specified in the requisition.

p) Relay function, or function device number shall be given on relays.

q) Relays of different input voltages shall be of different color and preferably not interchangeable where requirements dictates so.

5.17.2.2 Over current relay (OCR)

Overcurrent relays shall be of the inverse definite minimum time (standard inverse , very inverse or extremely inverse) type with or without high set instantaneous operation and with the following ranges of settings (unless otherwise stated in requisition):

- Current : 50% to 200% of rated nominal current in steps of 25% adjustable.
- Time : Multiplier time characteristics from 0.05 to 1.00.

5.17.2.3 Earth fault relays

Earth fault protection for consumers e.g. motors, heaters etc. shall operate instantaneously.

In other case a range of setting possibilities shall be provided for both current and time.

5.17.2.4 Motor over load and single phase prevention

Note:

When selecting an appropriate protective relay for motor starting units, consisting of high rupturing capacity, short circuit current limiting fuses and contactor (5.9.3.1), the fuse contactor characteristics shall be taken into account.

5.17.2.5 Under voltage relay (UVR)

Each section of an assembly containing motor starting units equipped with circuit breakers or latched contactors shall be provided with an instantaneous acting undervoltage relay. The UVR shall be of the automatic reset type, but equipped with a relay operated signal that is maintained until hand reset.

The drop out value shall be adjustable between 50% and 65%.The pick up value shall be at least 85% of the system voltage.

The number of operation contacts shall be:

- 3 sets, normally open and;
- 1 set, normally closed.

This UVR shall operate in combination with a time delayed tripping relay per motor starting unit, having a time delay adjustable between 0.2 and 5 s.

5.17.2.6 Restarting relays for contactors

Unless otherwise requested in data sheets each motor contactor compartment shall be equipped and wired with a universal standard relay base for future insertion of an automatic restarting relay (RR) or a time delay module when need arises.

(RR) or (TDM) relay base shall be provided with proper tight cover or dummy relay.

Note:

Characteristics of restarting relays shall be decided on individual contactor requirements.

5.18 Electrical Measuring, Indicating and Recording Instruments

5.18.1 General requirements

5.18.1.1 The number and type of instruments for individual circuits, shall be in accordance with the requirements stated in data sheet for each circuit.

5.18.1.2 Instruments shall be of flush mounted, industrial grade, enclosed in dust and damp proof casing, non projecting dial, with non glare non reflecting window similar throughout.

In type and size, and in compliance with the requirements of pertinent parts of IEC Publications 51 and 473 from requirements and dimensions point of view.

5.18.1.3 Special precautions shall be taken that the operation of sensitive instruments shall not be influenced or hampered by vibration or shocks e.g. by opening or closing of doors and switching devices.

5.18.1.4 Electronic or digital instruments may also be considered.

5.18.2 Indicating instruments

5.18.2.1 Indicating instruments shall be in accordance with IEC Publication No. 51. The accuracy shall be Class 2.5.

5.18.2.2 Ammeters in motor starting circuit, shall have a compressed overload end scale of at least "6" times the full load motor current. Indications shall be in actual values.

5.18.2.3 Indicating instruments shall be of the square pattern type. Preferred dimensions are 96 × 96 mm.

5.18.3 Integrating instruments

5.18.3.1 Watthour meters

Watthour meters shall be in accordance with IEC 521. The accuracy shall be class "2" except for supply of third parties which shall be Class "1".

Note:

Reference shall be made to data sheets for applicable class of watthour meters.

5.18.3.2 Watthour meters shall have cyclometric registers and normally be of two element type.

5.18.4 Maximum demand indicators

Maximum demand indicators shall be in accordance with the requirements of IEC Publication No. 211.

5.18.5 Recording instruments

5.18.5.1 Recording instruments shall comply with the requirements of IEC Publications 258 and 414.

5.18.5.2 Accuracy shall be Class "2.5".

Note:

Where frequency meters, phase meters and synchroscopes are stated in data sheets, they shall comply with the requirements of Parts 4 and 5 of IEC Publication No. 51.

5.19 Electrical Requirements

5.19.1 Rating

Rating of switchgear and controlgear shall be selected on a basis of voltage, frequency, current carrying and short-circuit capacities of the busbar system(s), incorporated switching devices and other components with their interconnections, in accordance with the appropriate IEC publications.

For standard currents reference shall be made to IEC 59 respectively unless otherwise stated in data sheets.

5.19.1.1 Requisition data

The following information will be stated on the data sheets:

- system voltage to ISIRI No. 6 (IEC 38).
- system frequency to ISIRI No. 9 (IEC 242).
- rated normal current.
- short time withstand current, duration 1 or 3 s.
- peak withstand current, including the motor contribution.

5.19.1.2 Rated values for functional units

The rated values for circuit breakers shall preferably be based on the coordination tables, listed in Section 4 of IEC Publication No. 56.

5.19.2 Insulation levels

The rated insulation level of the enclosed switchgear and controlgear shall be selected from IEC publication No. 298 for one of the neutral earthing system stated below in conjunction with the data sheets.

5.19.2.1 Isolated

5.19.2.2 Solidly earthed

5.19.2.3 Earthed through low resistance

5.19.2.4 Earthed through high resistance

5.19.3 Insulation coordination

Insulation coordination shall be in accordance with the requirements of Parts 1, 2 and 3 of IEC Publication No. 71.

5.19.4 Insulation oil

Where mineral insulation oil is used for bulk oil or minimum oil circuit breakers it shall comply with the requirements of IEC Publication No. 296.

5.19.5 Sulfur hexafluoride (SF6)

When "SF6" functional units are requested in data sheets, the properties and methods of test of sulfur hexafluoride shall comply with the requirements of IEC Publication No. 376 and supplements.

5.20 Information to be Given on the "MV" Switchgear Assembly

5.20.1 Information on the outside

5.20.1.1 Each switchgear assembly shall be provided with one or more general nameplates located in a place such that they are visible when the switchgear is installed. The information given on these general nameplates shall be as follows but not to be limited to:

a) Purchaser's name and order number.
b) The year of manufacture.
c) The manufacturer's name or trade mark.
d) Type designation or serial number marking if possible to obtain relevant information from the manufacturer.
e) Rated insulation voltage.
f) Rated frequency.
g) Rated voltage of auxiliary circuits.
h) Limits of operation.
i) Rated current of circuits.
j) Rated operational voltage.
k) Maximum peak and thermal short circuit ratings with withstand time in seconds.
l) Degree of protection.
m) Type of system earthing for which the switchgear is designed.
n) Number of the relevant standard.

o) Dimensions: height, width (length) and depth.
p) Weight.

Note:

The nameplates of each functional units shall be legible during normal service. The removable parts if any shall have a separate nameplate with data relating to the functional units they belong to, but this nameplate needs only be legible when the removable part is in the removed position.

5.20.1.2 Identifying circuit label(s)

a) Further to the general nameplates each circuit of the switchgear shall be provided with identifying circuit label(s) fitted on the fixed portion. The information to be given on these circuit labels shall be compatible with the nomenclature given in guidance for designation of circuits. (see Appendix No. 3).

b) Circuit labels shall be repeated in the following cases:

- On the frame of a withdrawable or removable unit unless they are all identical.
- When circuits have main and auxiliary cable connections that are not clearly identifiable from the physical layout e.g. cable compartments at the rear of the switchgear assembly.

5.20.1.3 Synoptic diagram

Switchgear shall be provided with a durable one line synoptic diagram, clearly indicating the specific function of the different compartments when this would not be clear from the general lay out.

5.20.1.4 Instruction plates

When the method or sequence of operation of certain equipment or component(s) in the switchgear is not evident, (e.g. mechanical interlocking features), instruction plates shall be provided fixed near the point of operation. Instruction plates should be pictorial.

5.20.1.5 Warning plates, caution notices

When required, e.g. in a location where a dangerous situation may be created inadvertently, warning plate(s) or caution notice(s) shall be installed, identifying the danger point(s). This may be either in a compartment or on the outside of a switchgear e.g.:

a) When operation of a relay trips more than one circuit breaker.
b) When drawout of potential transformers supplying motor undervoltage relays, causes motor tripping.

5.20.2 Information to be given on the equipment and components mounted inside the switchgear assembly.

5.20.2.1 General

All equipment and components, such as switching devices, protection relays, instruments, instrument transformers, terminals, fuses and fuse holders, shall be marked with their ratings and all other essential data as required, following pertinent recommendations of IEC Publication referred to in Clause 3 of this Standard Specification.

5.20.2.2 Markings

It shall be possible to identify all equipment inside the switchgear including their circuits. Identification of equipment in the switchgear shall be identical with that in the schematic and wiring diagrams supplied with the switchgear.

5.21 Nameplates and Labels

5.21.1 General requirements

The nameplates, labels and their fixing materials shall be proven durable under the service conditions specified for the switchgear, they shall be corrosion and moisture resistant and provided with indelible inscriptions in the language specified in Attachment 8 stainless nameplates and traffolite labels are acceptable.

Note:

For layout and lettering of traffolite labels see Attachment 13.

5.21.2 Fixing

Nameplates and labels shall be fixed to the switchgear assembly and its components (functional units) by means of proven durable non corrosive self threading screws.

Holes for fixing shall not influence in any way the degree of ingress protection of enclosure.

5.21.3 Color

5.21.3.1 Circuit designation or nomenclature to be engraved into the white layer of traffolite to give black lettering on a white background.

5.21.3.2 Instruction plates shall be yellow with black inscription.

5.21.3.3 Warning or caution plates shall be red with white inscription.

5.22 Tools and Testing Equipment

5.22.1 Special tools and equipment required for erection, commissioning, maintenance and testing shall form part of order and shall be shipped together with the assembly.

5.22.2 Voltage detection and phasing out equipment shall be offered as a separate item in quotation.

5.22.3 A suitable wall mounting cabinet shall be provided for all such portable tools and equipment forming part of the order.

5.22.4 testing equipment for motor starting units shall be provided with local on control facility. This shall however be possible and accessible only in the isolated or withdrawn position of motor starter.

5.23 Provision for Handling and Erection Facilities

5.23.1 General

5.23.1.1 Assemblies shipped in transport units shall have these units clearly marked to facilitate assembly and erection at site.

5.23.1.2 Each transport unit shall be provided with hoisting facilities, bolts, foundation clamps and small materials required for erection on site shall be packed inside the transport unit.

5.23.1.3 Trunk runners

Where the design of the switchgear is such that special steel runners are required in front of switchgear for the correct alignment of the circuit breaker trucks, then such steel runners shall be provided by the vendor for the inclusion in the purchasers civil work and design.

5.23.2 Handling trucks

Where circuit breakers are not mounted on their own movable trucks and are too large or heavy to be handled by one man, then the vendor shall provide one handling truck for each switchgear and controlgear assembly.

6. INSPECTION, QUALITY CONTROL AND QUALITY RECORDS

See Attachment 2.

7. TESTS AND CERTIFICATIONS

7.1 General Requirements for Tests

See Attachment 3.

7.2 Specific Requirements for Tests

The tests shall consist of but shall not necessarily be limited to the following:

7.2.1 Circuit breaker tests

7.2.1.1 Type tests

The supplier shall provide documentary evidence that type tests have been carried out in accordance with the requirements of Clause 6 of IEC Publication No. 56 for the following criteria:

a) Dielectric tests.
b) Radio interference voltage tests.
c) Temperature rise tests.
d) Measurement of the resistance of the main circuits.
e) Short time withstand current and peak withstand current tests.
f) Mechanical and environmental tests.
g) Miscellaneous provisions for making and breaking tests.
h) Test circuits for short circuit making and breaking tests.
i) Short circuits test quantities.
j) Short circuit test procedures.
k) Basic short circuit test duties.
l) Critical current tests.
m) Single phase short circuit tests.
n) Short line fault tests.
o) Out of phase making and breaking tests.
p) Capacitive current switching tests.
q) magnetizing and small inductive tests.

7.2.1.2 Routine tests

Routine tests shall be carried out in accordance with the requirements of Clause 7 of IEC Publication 56 and as described below:

a) Power frequency voltage withstand tests on the main circuit.
b) Voltage withstand tests on control and auxiliary circuits.
c) Measurement of the resistance of main circuit.
d) Mechanical operating tests.
e) Design and visual checks.

7.2.2 Contactor tests

7.2.2.1 Type tests

Shall comprise verification of the following to requirement of Clause 8.1.1 of IEC Publication No. 470:

a) Temperature rise limits.
b) Dielectric properties.
c) Rated making and breaking capacities.
d) Operating limits.
e) Mechanical endurance.
f) Ability to withstand overload currents.

7.2.2.2 Routine tests shall comprise the following in compliance with the requirements of Clause 8.1.2 of IEC Publication 470:

a) Operation tests.
b) Dielectric tests.

7.2.3 Switchgear and controlgear assembly tests

7.2.3.1 Type tests

Submission of documentary evidence by supplier, in accordance with the requirements of Clause 6 of IEC Publication 298 which covers:

a) Sub clauses of (a to g) of Clause 6.2.1.1 of this Standard.
b) Mechanical operation tests.
c) Verification of the degree of ingress protection.
d) Measurement of leakage currents.
e) Weather proofing test.
f) Arcing due to internal faults (see Clause 6.106 of IEC Publication No. 298).

7.2.3.2 Routine tests

In addition to tests mentioned under Sub clauses (a to e) of Clause 6.2.1.2 of this Standard, the following checks, verifications and or tests, shall also be made to ensure that operational and functional requirements are met.

a) The effectiveness and reliability of safety shutters, partitions and shrouds.

b) The degree of ingress protection of the enclosure

c) The degree of protection within the compartments from safety point of view.

d) The effectiveness or reliability of operating mechanism of:

- key locks.
- interlocks.
- transfer switches.
- isolators.
- earthing switches.

e) Insulation resistance of busbars.

f) Creepage distances and clearances.

g) The proper mounting of control devices and other components.

h) The internal wiring and cabling for proper marking and provision of contacts for remote controls and alarms.

i) The suitability of clamping, earthing, termination and marking arrangement for incoming,outgoing and auxiliary cables including stress relief kits (where applicable).

j) Simulation of remote controls operation.

k) The control of anti condensation heaters.

l) Verification of compliance of measuring, integrating and recording meters with the requirements of pertinent parts of IEC Publication No. 51.

m) The correctness of circuit designation labels.

n) The completeness of data on the nameplate(s).

o) The presence of danger and wiring signs where required.

p) The earthing system and its availability throughout.

q) The interchangeability of electrically identical components such as withdrawable circuit breakers, motor contactors, etc. special attention shall be paid to any auxiliary contacts to ensure compatibility.

r) The non interchangeability of mechanically similar but electrically different components.

s) Verification of compliance of main and auxiliary circuits with the approved schematic circuit diagrams.

t) When solid state relay or other electronic devices are fitted, the manufacturer shall introduce evidence that solid state relays or the electronic devices have been quality assessed in compliance with the IEC Publication No. 255.10:

u) Partial discharge tests for all insulation encapsulated parts, or component used at voltage levels above 10 kV e.g. voltage transformers.

v) Mechanical operation tests actuated by a temporary supply of the required auxiliary voltages on at least one of each basic functional unit type concerned e.g. incoming feeder, outgoing transformers feeder panel, and motor feeder etc.

w) These tests shall include the functioning of each of the operating devices, interlocks and all the protective relays to be operated at least once by means of actual or remote contacts arrangements.

x) The switchgear and controlgear shall be finally checked to ascertain that they are not damaged.

Note:

Complete records of above mentioned verifications, tests and checks shall be accompanied with the certificates to which reference is made in Appendix F.

8. FINISH

8.1 All Metal Structures and Metal Sheets shall be Properly Protected Against Corrosion

The equipment shall be cleaned primed with two layers of antirust undercoat and one final layer of durable paint suitable for environmental conditions given in Attachment 1.

8.2 The Color of Final Layer

Shall be:

a) As manufacturer's standard, or,
b) According to IPS-E-TP-100 "Paints"

8.3 All Unpainted Surface (Internal and External) shall have a coat of Moisture and Fungus Resistance Varnish

8.4 All Parts that are Required to be Left Bright shall be Treated and or Coated to Prevent Corrosion

8.5 The Supplier shall Supply and Deliver with the Switchboard a Minimum of Two Half Liters Aerosol Spray Cans, for the Field Touch Up after Installation. This Paint Shall Match with the Color Used for the Assembly

9. INFORMATION FOR MANUFACTURER/SUPPLIER

9.1 Provisional Single Line Diagrams

(Typical diagrams are shown in Appendices A.2 and A.3).

9.2 Circuit Details

(Typical circuit data sheets are given in Appendix B.2).

9.2.1 Duty and current rating as required in Iran.

9.2.2 M.V.A. rating.

9.2.3 Busbar details.

9.2.4 Circuit designation (see Appendix C).

9.2.5 Voltage transformer: Ratio and volt amper rating.

9.2.6 Current transformers ratio and loading for protection and metering.

9.2.7 Indicating lights requirements.

9.3 Cable Data

9.3.1 Main cable

9.3.2 Auxiliary cable

9.4 MV System Neutral Earthing

9.5 Type of Circuit Breaker Required (Vacuum, Gas, Oil or Air)

9.6 Control Supply

9.6.1 Closing supply voltage

9.6.2 Tripping supply voltage

9.7 Equipment Heating Supply Voltage

9.8 Degree of Ingress Protection

9.9 Explosion Protection to IEC Publication No. 79 Where Applicable

(For example remote control stations in hazardous area).
See Appendix G of this Specification for relevant standards.

9.10 Any Other Optional Features

(Dictated by individual cases.)

9.11 Details of Low Voltage Power Supply at Site such as Voltage, Frequency, Number of Phases, Number of Wires, Fault Level and Method of Neutral Earthing

10. DOCUMENTATION/LITERATURE TO BE SUBMITTED BY MANUFACTURER/ SUPPLIER

10.1 At Quotation Stage

- Report of experience background, major clients and annual sale for the similar equipment.

- Reference list showing the successful operation of similar equipment for at least two years, and the locations of equipment offered in major oil industries.

- Typical type test certificate of similar equipment.

- Declaration of confirmation with the set standards, and or clear indication of deviations from the standards and specification.

- Drawings and Documents for Electrical Equipment:

i) Dimensioned outlines and foundation details including: weight and cable entries (size and clearances).
ii) Details of cross sectional arrangements.
iii) Mounting.

- Electrical Schematic Diagrams.
- Electrical Reference Documents:

i) General description.
ii) Equipment specification.
iii) Performance data.
iv) Cable data as requested in Appendix D of this Standard Specification.
v) d.c. power supply demand as requested in Appendix E.

- Spare Parts and Special Tools Requirements

i) List of recommended commissioning spare parts with the price.
ii) List of recommended spare parts for three years of operation.
iii) List of special tools testing devices, and instruments.

- Guarantee and warranty policies.
- Complaint and compensation policies.

Note:

The quotation will be considered as incomplete and rejected if the above mentioned information are not included.

10.2 At Ordering Stage

- Final single line diagrams.

- Final general arrangement drawings, showing synoptic diagrams, floor plan elevation and end view of switch-gear assembly.

- Clear indication of the shipping sections.
Mass and dimensions (height, depth and width or length).

- Drawing diagrams and curves.

i) Schematic diagram of all circuits.
ii) Wiring diagrams.
iii) Interconnecting diagrams.
iv) Relay coordination curves.
v) Switching sequence schedule.
vi) Alarm and tripping scheme.
vii) Neutral earthing system.

- Final electrical reference documents, including:

i) General description.
ii) Equipment specification.
iii) Performance data.
iv) Drawings/parts and material list.

- Where electronic circuits are involved full circuit diagram showing test points, voltages wave forms, and calibration instruction

- Instruction manuals for:

i) Transport and storage.
ii) Installation.
iii) Commissioning.
iv) Operation.
v) Inspection/test.
vi) Maintenance.
vii) Illustrated spare parts lists including special tools.

- Certifications

i) List of applicable type test certificates.
ii) Final test certificates.
iii) A.S.T.A. certificate when required.
iv) Certificate of quality assurance.

Notes:

1) The above mentioned documents shall include identifications of all proprietary items including order number and purchaser's name.

2) For schedule of drawings, documents, manuals and certificates required see Appendix F of this Standard Specification.

3) For instructions of purchaser about drawings see Attachment 12.

11. PACKING

For general requirements for packing: see Attachment 4.

12. SHIPMENT

For general requirements for shipment: see Attachment 5.

13. GUARANTEE

See Attachment 6.

14. SPARE PARTS

See Attachment 7.

15. LANGUAGE

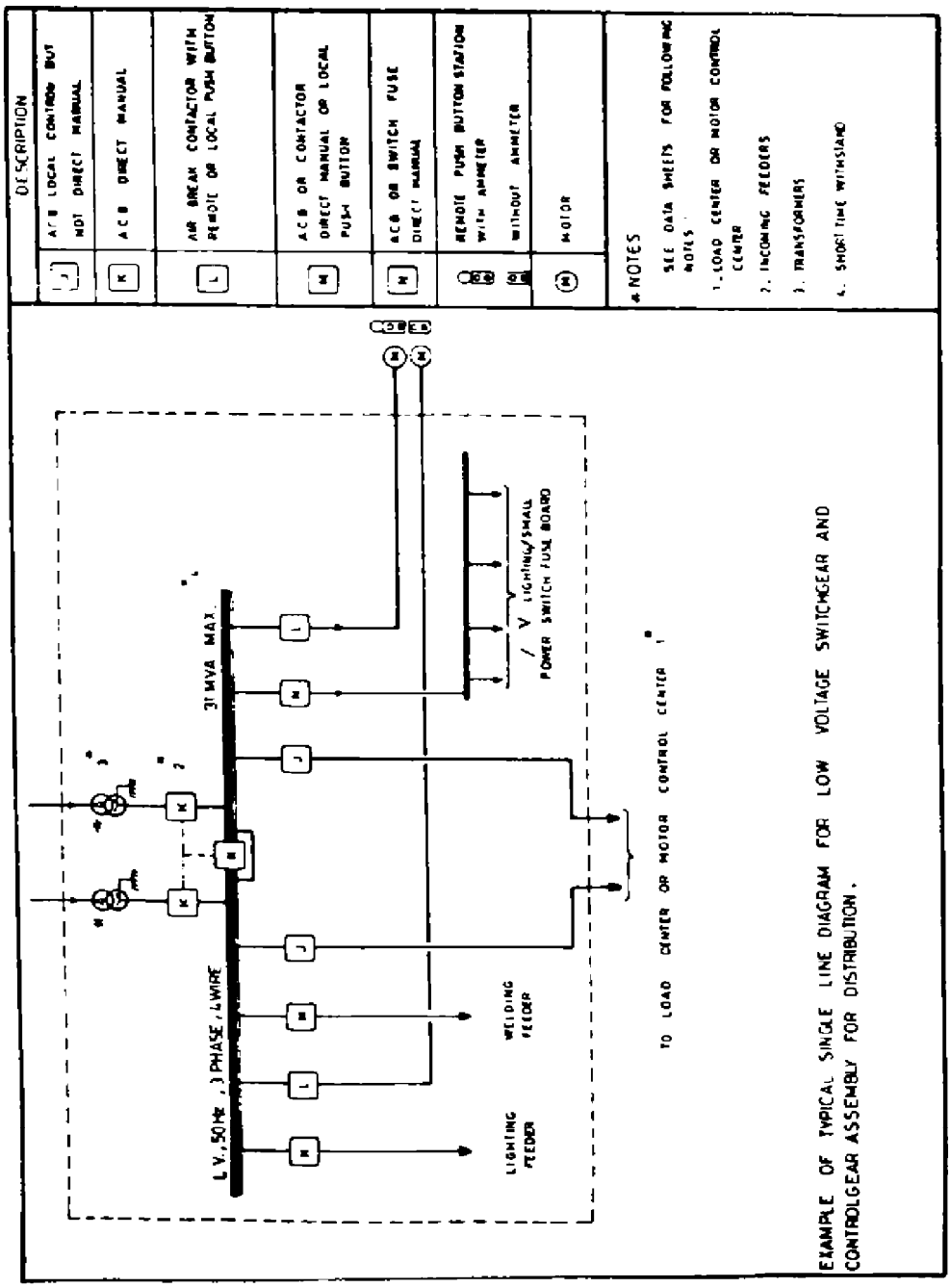
See Attachment 8.

16. COORDINATION RESPONSIBILITY WITH OTHERS

See Attachment 9.

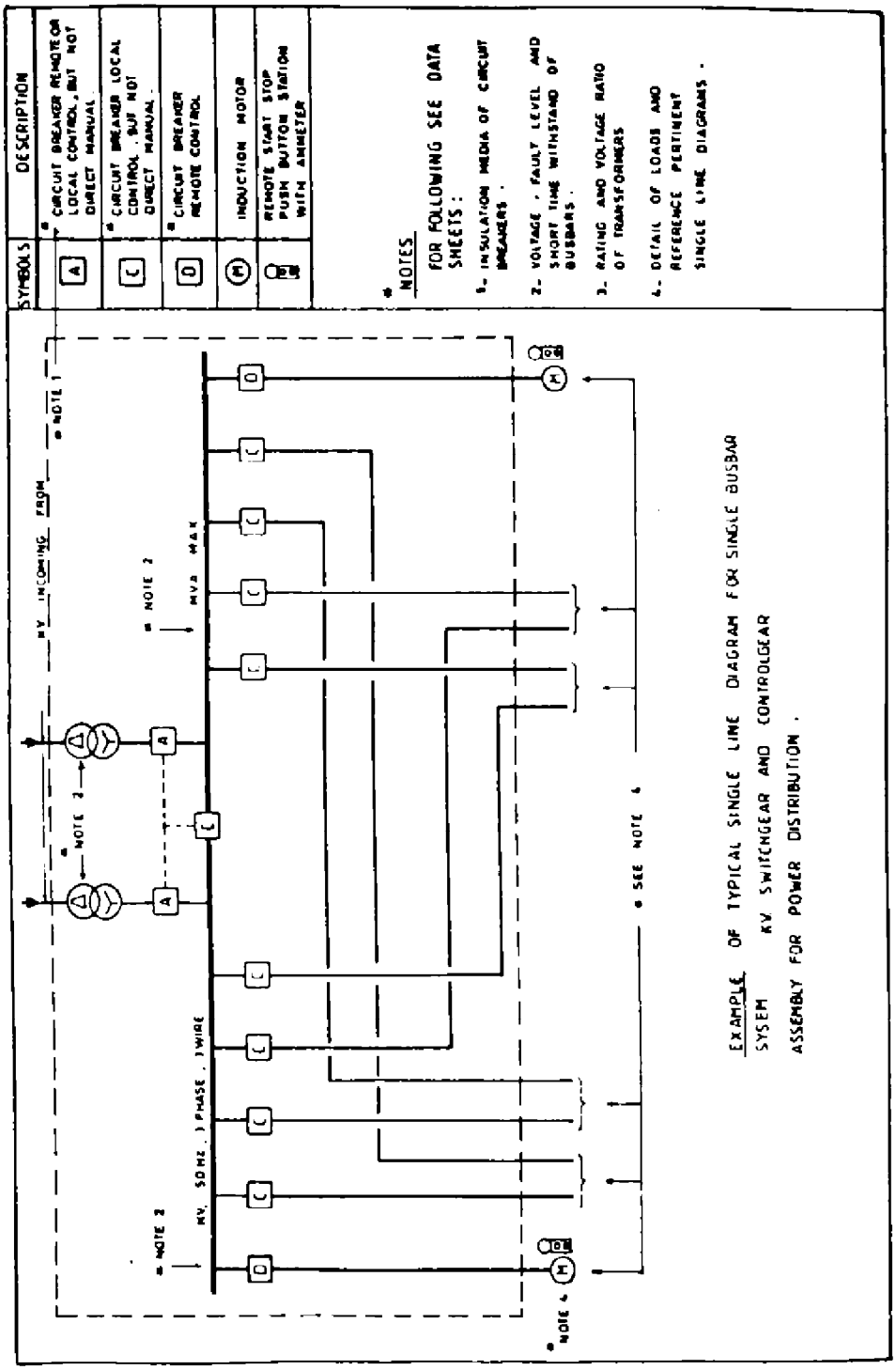
APPENDICES

APPENDIX A.1
EXAMPLE OF TYPICAL SINGLE LINE DIAGRAM FOR LV SWITCHGEAR AND CONTROLGEAR ASSEMBLY FOR DISTRIBUTION



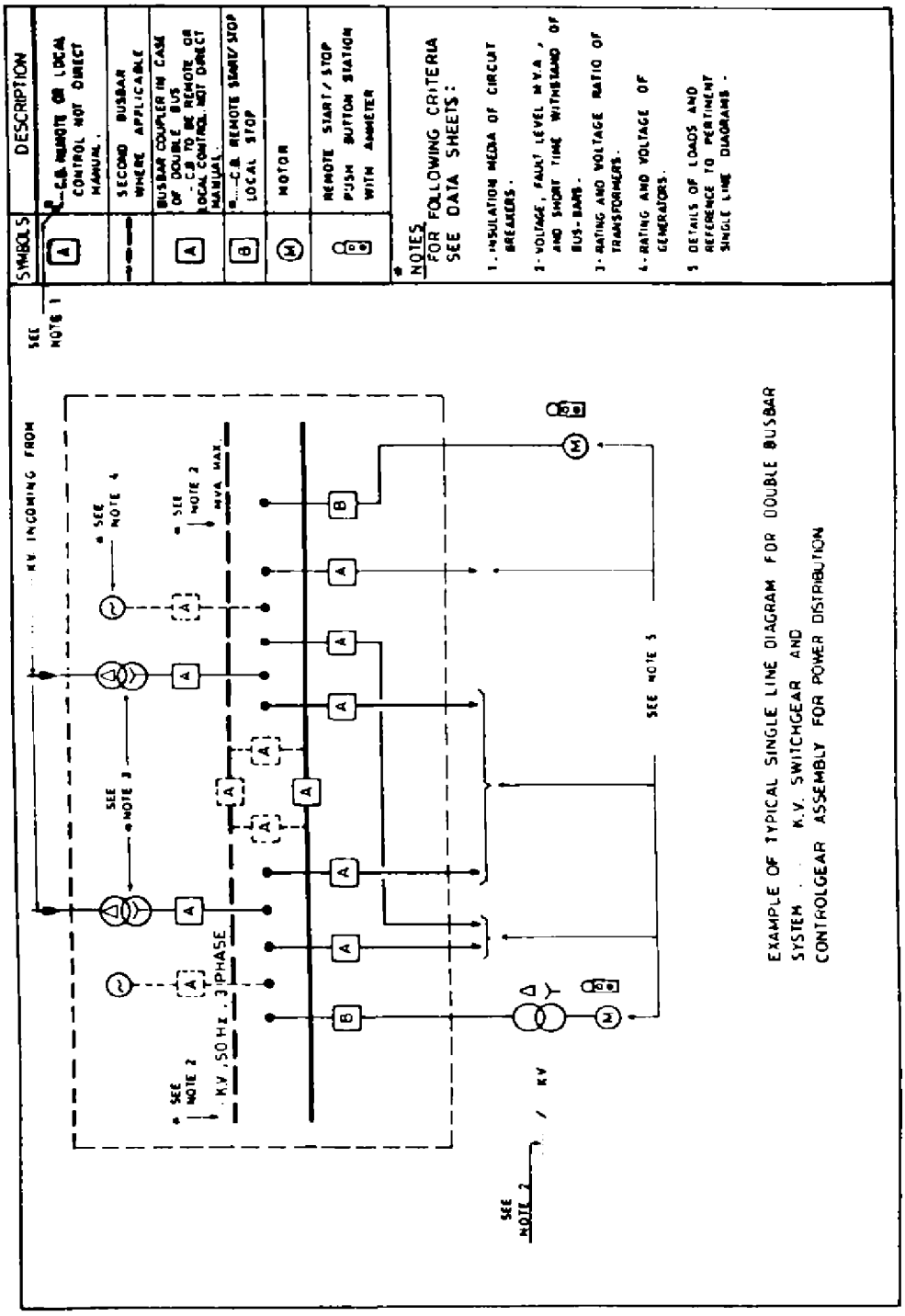
APPENDIX A.2

EXAMPLE OF TYPICAL SINGLE LINE DIAGRAM FOR SINGLE BUSBAR SYSTEM ....kV. SWITCHGEAR AND CONTROLGEAR ASSEMBLY FOR POWER DISTRIBUTION



APPENDIX A.3

EXAMPLE OF TYPICAL SINGLE LINE DIAGRAM FOR DOUBLE BUSBAR SYSTEM ....kV. SWITCHGEAR AND CONTROLGEAR ASSEMBLY FOR POWER DISTRIBUTION



APPENDIX B.1
TYPICAL LV SWITCHGEAR AND CONTROLGEAR DATA SHEET

PROJECT NAME: .....

AREA CLASSIFICATION: (safe) .....

BUSBAR: Voltage ..... Phase ..... Wire .....
Site rating .....AMP .....
Fault rating ..... MVA .....
Short time withstand ..... Second(s) .....

Circuit No. .....
Circuit Title .....
Standard Specification No. .....

CIRCUIT LOAD: ..... kVA/kW (site rating) .....

Circuit full load current ..... AMPS (site rating) .....
Circuit power factor ..... leading
lagging

Motor starting current ..... AMPS .....

CLASS OF INTERMITTENT DUTY OF CONTACTOR: .....(where applicable)
Utilization category of contactor:..... "

PROTECTIVE RELAYS:

.....
.....
.....

CURRENT TRANSFORMERS:
For metering .....
.....
For protection .....
.....

VOLTAGE TRANSFORMER:

Voltage ratio .....
Volt amperes .....

MEASURING AND INDICATING INSTRUMENTS:

.....
.....
.....
.....
.....

(to be continued)

APPENDIX B.1 (continued)

PROTECTION AND CONTROL SUPPLY VOLTAGES:

Closing ..... volt "d.c."
Tripping ..... volt "d.c."
Indicating lights ..... volt "d.c."

(see Appendix E for coordination with manufacturer)

ANTI CONDENSATION HEATER SUPPLY VOLTAGE: .....

Supply circuit protected by:
a) Fuses .....
b) Earth leakage device .....

INGRESS PROTECTION (IP) .....

EXPLOSION PROTECTION: .....

For remote control station in hazardous area (where applicable)

CABLE DATA:

Main cable .....

AUXILIARY CABLES FOR:

Closing of circuit breakers .....
Tripping of circuit .....
Indication lamps .....
Alarms to annunciator (where applicable) .....

(see Appendix D for coordination with the manufacturer)

APPENDIX B.2
TYPICAL MV SWITCHGEAR AND CONTROLGEAR DATA SHEET

PROJECT NAME: .....

AREA CLASSIFICATION: (safe) .....

BUSBAR: Voltage ..... Phase ..... Wire .....
Site rating .....AMP .....
Fault rating ..... MVA .....
Short time withstand ..... Second(s) .....

Circuit No. .....
Circuit Title .....
Standard Specification No. .....

CIRCUIT LOAD: ..... kVA/kW (site rating) .....

Circuit full load current ..... AMPS (site rating) .....
Circuit power factor ..... leading
lagging

Motor starting current ..... AMPS .....

CLASS OF INTERMITTENT DUTY OF CONTACTOR: .....(where applicable)
Utilization category of contactor:..... "

PROTECTIVE RELAYS:

.....
.....
.....

CURRENT TRANSFORMERS:
For metering .....
.....
For protection .....
.....

VOLTAGE TRANSFORMER:

Voltage ratio .....
Volt amperes .....

MEASURING AND INDICATING INSTRUMENTS:

.....
.....
.....
.....
.....

(to be continued)

APPENDIX B.2 (continued)

PROTECTION AND CONTROL SUPPLY VOLTAGES:

Closing ..... volt "d.c."
Tripping ..... volt "d.c."
Indicating lights ..... volt "d.c."

(see Appendix E for coordination with manufacturer)

ANTI CONDENSATION HEATER SUPPLY VOLTAGE: .....

Supply circuit protected by:
a) Fuses .....
b) Earth leakage device .....

INGRESS PROTECTION (IP) .....

EXPLOSION PROTECTION: .....

For remote control station in hazardous area (where applicable)

CABLE DATA:

Main cable .....

AUXILIARY CABLES FOR:

Closing of circuit breakers .....
Tripping of circuit .....
Indication lamps .....
Alarms to annunciator (where applicable) .....

(see Appendix D for coordination with the manufacturer)

*** SYSTEM NEUTRAL EARTHING:**

1) Solidly neutral earthing
2) Low resistance earthing
3) High resistance earthing
4) Isolated neutral
5) .....

*** TYPE OF CIRCUIT BREAKER REQUIRED:**

1) Air
2) Vacuum
3) Minimum oil
4) Sulphur hexafluoride (SF6)
5) Others .....

(to be continued)

APPENDIX B.2 (continued)

DETAILS OF LOW VOLTAGE (LV) POWER SUPPLY AT SITE:

Voltage ..... volt ±10% frequency ..... Hz 5%
No. of phases ..... No. of wires ..... fault MVA .....
Method of neutral earthing .....

*** To select relevant requirement, and delete others.**

APPENDIX C
GUIDANCE FOR DESIGNATION OF CIRCUITS OF SWITCHGEAR ASSEMBLY

(To be engraved on pertinent labels)

CIRCUIT No.	DESCRIPTION OF EQUIPMENT	REFERENCE TO DATA SHEET

APPENDIX D
CABLE DATA

Manufacturer of switchgear and controlgear shall give type size, core number and external diameter of cables for following functions:

1) 110 volt "d.c." closing .....

2) 110 volt "d.c." tripping .....

3) 110 volt "d.c." indicating lights .....

4) 220 volt "a.c." anti condensation heaters .....

5) Interlock between bus section and incoming feeders .....

6) Intertripping with other circuit breakers .....

7) Alarm and annunciation system .....

8) Motor starter closing supply .....
(where applicable)

APPENDIX E
"d.c." POWER SUPPLY

The following data shall be filled by manufacturer/supplier:

1) Inrush current for closing solenoid including duration, and relevant fuse rating .....

2) Maximum "d.c." voltage for closing solenoid and tripping coils .....

3) Minimum "d.c." voltage for closing solenoid and tripping coils .....

4) Power demand for closing solenoid and duration .....

5) Power demand for tripping coil and duration .....

6) Power demand for indication lights .....

7) Ampere hours capacity of 110 volt batteries for commissioning of switchgear assembly .....

8) Data for battery charger to satisfy the demand for closing, tripping and indication under worse condition .....

Also "a.c." power demand for each anti condensation heater and total number of them for the subject switchgear and controlgear assembly .....

APPENDIX F

LIST OF DRAWINGS, DOCUMENTS, MANUALS AND CERTIFICATES TO BE SUBMITTED BY MANUFACTURER/SUPPLIER IN NUMBERS AND THE TIMES INDICATED BELOW:

	DESCRIPTION	REQUIRED WITH QUATATION	CERTIFIED INFORM. REQ. WITH ORDER			NUMBER OF WEEKS BEFORE DELIVERY
			N0. OF COPIES		NUMBER OF WEEKS AFTER ORDER	
			REPRO-DICIBLES	PRINTED MATTER		
A	**DRAWING AND OTHER DOCUMENTS:**					
	a) ELECTRICAL EQUIPMENT:					
	1. DIMENSIONED OUTLINES AND FOUNDATION DETAILS					
	INCLUDING: CABLE ENTRIES AND CLEARANCES					
	2. DETAILS AND CROSS-SECTIONAL ARRANGEMENT					
	3. MOUNTING DETAILS					
	4. PERFORMANCE DATA (TYPICAL)					
	5. PARTS / MATERIAL LIST					
	6. RELEVANT CATALOGUES					
	7. NAME PLATES					
	8. LIST OF FINAL LABELS					
	b) TERMINATION:					
	1. CONNECTION DIAGRAM					
	2. TERMINAL BOX ARRANGEMENT					
	3. CONNECTION AND TERMINAL DESIGNATION					
	c) ELECTRICAL REFERENCE DOCUMENTS:					
	1. GENERAL DESCRIPTION					
	2. EQUIPMENT SPECIFICATION					
	3. PERFORMANCE DATA (ACTUAL)					
	4. DRAWINGS / PARTS / MATERIALS LIST					
B	**INSTRUCTION MANUALS :** (FOR ALL REQUIRED ITEMS)					
	1. INSTALLATION, COMMISSIONING AND INSPECTION					
	2. OPERATION AND MAINTENANCE					
C	**SPARE PARTS REQUIREMENTS:**					
	1. ILLUSTRATED SPARE PARTS					
	2. RECOMMENDED COMMISSIONING SPARE LIST					
	3. RECOMMENDED SPARES FOR THREE YEARS OPARATION					
D	**CERTIFICATION:**					
	1. PERFORMANCE TEST, MATERIALS CERTIFICATES AND					
	CURVES					

APPENDIX G
STANDARDS FOR ELECTRICAL APPARATUS FOR POTENTIALLY EXPLOSIVE ATMOSPHERES

DESCRIPTION OF STANDARDS	BSI No.	IEC AND EN No.
General requirements	BS 5501 PT. 1 (1977)	# IEC 79-0 PT. 0 (1983) ≡ EN 50014
Oil immersion "o"	BS 5501 PT. 2 (1977)	# IEC 79-6 PT. 6 (1968) ≡ EN 50015
Pressurized apparatus "p"	BS 5501 PT. 3 (1977)	# IEC 79-2 PT. 2 (1983) ≡ EN 50016
Powder filling "q"	BS 5501 PT. 4 (1977)	# IEC 79-5 PT. 5 (1967) ≡ EN 50017
Flameproof enclosure "d"	BS 5501 PT. 5 (1977)	# IEC 79-1 PT. 1 (1971) AMD 1 (1979) IEC 79-1A (1975) ≡ EN 50018
Increased safety "e"	BS 5501 PT. 6 (1977)	# IEC 79-7 PT. 7 (1969)
Intrinsic safety "i" (ia. ib)	BS 5501 PT. 7 (1977)	# IEC 79-2 PT. 11 (1984)
Encapsulation "m"	BS 5501 PT. 8 (1988)	≡ EN 50028

Note:

The symbols under description of standard refer to BSI. they shall be preceded by "Ex for IEC., and "EEx for EN Standards.

(to be continued)

APPENDIX G (continued)

CERTIFICATION AUTHORITIES:

British Approval Services for Electrical Equipment in Flammable Atmospheres. (BASEEFA)

Association of Short Circuit Testing Authorities (ASTA)

Underwriters Laboratories (UL)

European Authority for Harmonized Standard Certification under *EEC *(now EOTC)

Physicalisch Technische Bundesanstait (PTB)

LEGENDS

≡ stands for identical

= " " technically identical

" " related

*** Notes:**

1) EEC Stands for European Economic Community.

2) EOTC Stands for European Organization for Testing and Certification.

ATTACHMENTS

ATTACHMENT 1
ENVIRONMENTAL CONDITIONS

1.1 Site elevation : ---------- meters above sea level.

1.2 Maximum ambient air temperature : ---------- degree centigrade. Bare metal directly exposed to the sun can at times reach a surface temperature of ---------- degree centigrade.

1.3 Minimum air temperature : ---------- degree centigrade.

1.4 Relative humidity : ---------- percent.

1.5 Atmosphere : saliferrous, dusty corrosive and subject to dust storms with concentration of 70-1412 mg/cubic meter, H_2S may be present unless otherwise specified.

1.6 Lightning storm isoceraunic level : ---------- storm days/year.

1.7 Maximum intensity of earthquake ---------- richters.

Note:

Blanks to be filled by client.

ATTACHMENT 2
INSPECTION, QUALITY CONTROL AND QUALITY RECORDS

2.1 Inspection, Quality Control

2.1.1 The purchaser's inspector, or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment, to carry out necessary inspection at any stage of work.

2.1.2 Inspection may include the visit to quality control laboratories, work shops, testing bay etc.

2.1.3 The supplier shall make available technical data, test pieces and samples that the purchaser's representative may require for verification in conjunction with pertinent equipment.

If required the supplier shall forward the same to any person or location that the purchaser's representative may direct.

2.2 Quality Records

2.2.1 The supplier shall maintain appropriate inspection and test records to substantiate conformance with specified requirements.

2.2.2 Quality record shall be legible and relevant to the product involved.

2.2.3 Quality records that substantiate conformance with the specified requirements, shall be retained by manufacturer and made available on request by purchaser.

2.2.4 The supplier shall establish and maintain procedure for identification collection, indexing, filing, storage, maintenance and disposition of quality records.

2.2.5 Supplier shall submit to purchaser: reports, test schedules, and test certificates (in ----- copies) on completion of tests.

Note:

Blanks to be filled by client.

ATTACHMENT 3
TESTS AND CERTIFICATION

3.1 General Requirements

3.1.1 Test procedure as proposed by the supplier shall be agreed upon, and approved by the purchaser before any test is carried out.

3.1.2 Purchaser may require witnessed tests to be carried out in the presence of his nominated representative who should be informed at least ----- weeks in advance of the date of the tests and confirmed ----- weeks before the tests.

3.1.3 Test certificates and test reports shall refer to the serial No. of the equipment tested and must bear the purchaser's name, order No. and manufacturer's name and seal.

The certificates shall be approved by the purchaser before shipment instruction are given.

3.1.4 Approval by the purchaser's inspector or representative shall not relieve the vendor of his commitments under the terms of this specification or any associated order.

3.1.5 The equipment may be rejected if measurement and inspection reveal any discrepancies between quoted figures resulting in purchase order and those measured actually.

3.1.6 Any charges incurred by the tests quoted under heading of specific requirements for tests to be quoted as a separate item and are not to be included in the cost of the equipment.

Note:

Blanks to be filled by client.

ATTACHMENT 4
PACKING

4.1 Equipment must be carefully packed to provide necessary protection during transit to destination and shall be in accordance with any special provision contained in the order.

4.2 Special attention must be given to protection against corrosion during transit, and silica gel or similar dehydrating compound shall be enclosed.

4.3 The method of cleaning preserving and the details of packing including moisture elimination, cushioning, blocking and crating shall be such as that protect the product against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open air storage generally as client general conditions of purchase see Attachment 10.

4.4 All bright and machined parts must be given the protection against corrosion.

4.5 Ancillary items forming an integral part of the equipment should be packed preferably in a separate container if the equipment is normally cased or crated.

Alternatively the ancillary items should be fixed securely to the equipment and adequate precautions taken to ensure that the item do not come loose in transit or be otherwise damaged.

4.6 The supplier shall provide methods of handling to prevent damage and or deterioration during transit.

4.7 Where deemed necessary each shipping section shall be furnished with removable steel angles.

4.8 The requirements of above items shall not relieve the supplier of any of his responsibilities and his obligations for delivery of equipment in a sound undamaged and operable conditions at site.

4.9 Identification for Shipment

The marking and labels of products should be legible, durable and in accordance to specification.

Identification should remain intact from the time of initial dispatch at work to the final destination.

Marking shall be adequate for identifying a particular equipment in the event that a recall or inspection becomes necessary.

ATTACHMENT 5
SHIPMENT

5.1 Motor remote control stations package shall be provided with a permanently attached readily visible identification tag(s) bearing the equipment number of the remote control station to which it belongs.

5.2 The greatest care must be taken to ensure that shipping and associated documents with exact description for custom release are accompanied with the shipment.

ATTACHMENT 6
GUARANTEE

6.1 Clearance of Defects

The supplier shall guarantee his equipment during commissioning and for one year operation starting from the completion of seven days continuous service test in site at full load against the following defects:

- All operational defects.
- All material defects.
- All constructional and design defects.

6.2 Replacement of Defective Parts

All defective parts shall be replaced by the supplier in the shortest possible time free of charge including dismantling reassembling at site and all transportation cost. The above mentioned period shall not however be longer than 18 months from the date of dispatch from the manufacturer's works.

6.3 Supply of Spare Parts

Further more the supplier shall guarantee the provision of spare parts to the purchaser for a minimum period of ----- years from the date of dispatch.

6.4 After Sale Technical Services

6.4.1 Commissioning

6.4.1.1 The supplier shall quote if required for the services of competent engineer(s) and or technician(s) to assist in installation commissioning and testing of the equipment at site on a per diem basis.

6.4.1.2 The quoted rates shall be irrespective of duration and frequency and the supplier shall guarantee the services of the engineer(s) and technician(s) on the specified date within a minimum of ----- weeks advance notice by the purchaser.

6.4.2 Training

6.4.2.1 The purchaser may require the supplier to arrange for training of his personnel in the manufacturing plant and or in site for the operation and maintenance of the equipment offered.

6.4.2.2 The supplier shall quote (if required) for the cost of any of above mentioned services on a per person per diem basis. The program for the training shall be prepared by mutual agreement. An advance notice of----------weeks minimum, is required by purchaser for the commencement of training program.

Note:

Blanks to be filled by client.

ATTACHMENT 7
SPARE PARTS

7.1 All spare parts shall comply with the same standards, specification and tests of the original equipment and shall be fully interchangeable with the original parts without any modification at site.

7.2 They shall be correctly marked in accordance with client reference and manufacturer part numbers, giving also the purchaser's order number.

7.3 Spare parts shall be preserved to prevent deterioration during shipment and storage in humid tropical climate.

7.4 List of recommended spare parts and interchangeability with spare parts of similar equipment shall be submitted by supplier.

ATTACHMENT 8
LANGUAGE

8.1 All correspondence, drawings, documents, certificates, including testing, operation and maintenance manuals and spare part lists etc. shall be in English.

8.2 Offers in other languages will not be considered.

ATTACHMENT 9
COORDINATION RESPONSIBILITY WITH OTHERS

9.1 In case the equipment ordered should be mounted on, aligned, connected, adjusted, or tested with the equipment of other manufacturer(s) the supplier shall contact directly the said manufacturer(s) and supply and obtain all dimensional and technical informations and arrange for any interconnecting equipment and combined test that may be required.

9.2 The supplier shall be responsible for correct and timely communication with the said manufacturer(s) and for any delay and/or cost claims arising from such communications.

9.3 Copies of all correspondence should be sent to purchaser.

9.4 The name and address of the manufacturer(s) will be given as soon as their orders have been confirmed.

ATTACHMENT 10
GENERAL CONDITIONS OF PURCHASE

This document will be submitted by purchaser at the time of ordering.

ATTACHMENT 11
SAMPLES OF PURCHASER'S DRAWING TITLE BLOCK

TYPICAL DRAWING TITLE BLOCK

DRAWING NO.	DESCRIPTION

REFERENCE DRAWINGS

D					
C					
B					
A					
REV	DATE	DESCRIPTION	REF	CHK	APP

THE NAME
OF
RELEVANT COMPANY

DRAWING TITLE :

DRN. BY	SCALE	MICRO FILM CODE	PROJECT NO.	CHK. BY	APP. BY

JOB NO.	AREA CODE	DWG. NO.	SHEET	REV.

Note:

Appropriate Nomenclature and Registered mark shall be used for quotation and order.

ATTACHMENT 12
INSTRUCTIONS OF PURCHASER ABOUT PERTINENT DRAWINGS

12.1 Purchaser's drawing title block, "the sample of which is given in Attachment 11 shall be shown in the right lower corner of the drawings.

12.2 Drawings are to be protected and packed. Negatives must be dispatched in a strong card board cylinder.

12.3 Drawings must be rolled and not folded.

12.4 All drawings, documents and literatures shall be forwarded under cover of a fully detailed letter to purchaser whose addresses given in Attachment 14.

Note:

Blank to be filled by client.

ATTACHMENT 13
MATERIAL, LAYOUT AND LETTERING OF LABELS

Label material to be "Traffolite" 5 mm. Thick having two outer layers. Letter to be engraved into the white layer to give black lettering on a white background.

LETTER TYPE

TYPE	HEIGHT	WIDTH mm	STROKE	CASE		LETTERS / 25 mm	SAMPLE
A	5	WIDE	LIGHT	UPPER	CASE	7½ ± 1.2mm. TOL	ABCDEFGHIJKLM
B	5	WIDE	HEAVY	"	"	7½ ± 1.2mm. TOL	
C	5	NARROW	LIGHT	"	"	11 ± 2.5mm. TOL	
D	5	NARROW	HEAVY	"	"	11 ± 2.5mm. TOL	
E	3	WIDE	LIGHT	"	"	10 ± 1.2mm. TOL	
F	3	WIDE	HEAVY	"	"	10 ± 1.2mm. TOL	
G	3	NARROW	LIGHT	"	"	15 ± 1.2mm. TOL	
H	10	WIDE	HEAVY	"	"	3½	
J	12	WIDE	HEAVY	"	"	2½	

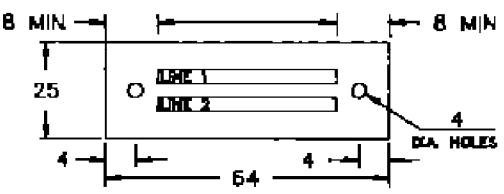
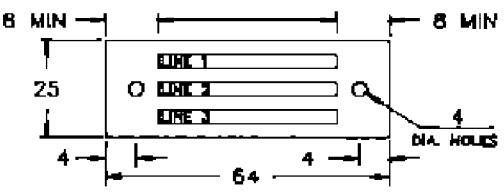
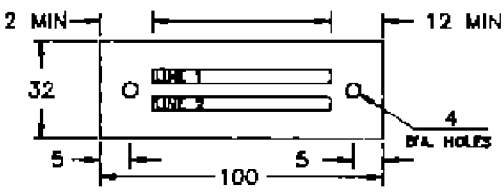
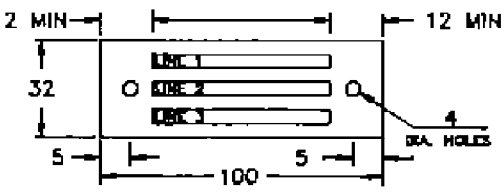
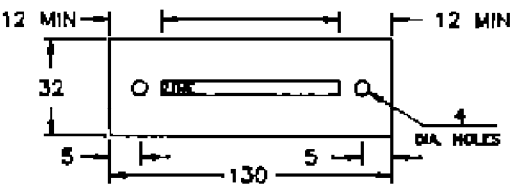
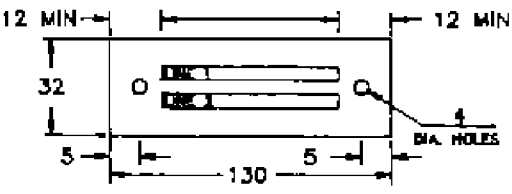
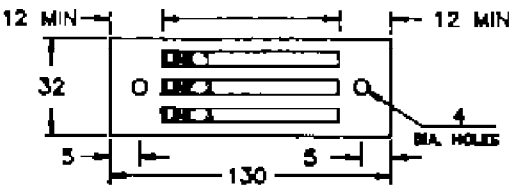
Note:

Height is in millimeters.

(to be continued)

ATTACHMENT 13 (continued)

LAYOUTS

LAYOUT 1		LETTERS MAX / LINE	
LETTER TYPE	G	28	
	E & F	19	
LAYOUT 2		LETTERS MAX / LINE	
LETTER TYPE	G	28	
	E & F	19	
LAYOUT 3		LETTERS MAX / LINE	
LETTER TYPE	A & B	22	
	C & D	23	
	E & F	30	
	G	45	
LAYOUT 4		LETTERS MAX / LINE	
LETTER TYPE	A & B	22	
	C & D	23	
	E & F	30	
	G	45	
LAYOUT 5		LETTERS MAX / LINE	
LETTER TYPE	H	15	
	J	10	
LAYOUT 6		LETTERS MAX / LINE	
LETTER TYPE	A & B	28	
	C & D	40	
	E & F	40	
	G	58	
LAYOUT 7		LETTERS MAX / LINE	
LETTER TYPE	A & B	28	
	C & D	40	
	E & F	40	
	G	58	

Note:

All dimensions are given in mm.
min. = minimum

ATTACHMENT 14
FULL ADDRESS OF PURCHASER

FULL ADDRESS OF PURCHASER:

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.....
.....
.....

P.O.BOX ..... No. ..... **CODE No. .....**

TELEPHONE No. .....

TELEX No. .....

FACSIMILE No. .....

Note:

Blank to be filled by client.