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شرکت ملی گاز ایران

مدیریت پژوهش و فنآوری

امورتدوین استانداردها

IGS

مشخصات فنی خرید

تابلو های برق فشار ضعیف

Low Voltage Switch Gears

دفترمدیرعامل

شرکت ملی گازایران

تاریخ : ۱۴۰۳/۰۳/۳۰

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ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می‌رساند در جلسه ۲۰۵۹ مورخ ۱۴۰۳/۰۳/۰۶ هیات مدیره، نامه شماره ۳۲۰۳۷ مورخ ۱۴۰۳/۰۲/۳۱ مدیر پژوهش و فناوری درمورد تصویب نهایی مقررات فنی شرکت ملی گاز ایران به شرح زیر مطرح و مورد تصویب قرار گرفت.

۱-مشخصات فنی خرید "تابلوهای برق فشار ضعیف"

IGS-M-EL-011(1)

سیدمحمد پیشوایی
دبیر هیات مدیره

رونوشت : مدیرعامل محترم شرکت ملی گاز ایران و رئیس هیات مدیره
اعضای محترم هیات مدیره
مشاور و رئیس دفتر محترم مدیرعامل
رئیس محترم امور حقوقی
رئیس محترم حسابرسی داخلی
رئیس محترم امور مجامع

Foreword

This standard specification is intended to be mainly used by N.I.G.C. and contractors, and has been prepared base on interpretation of recognized standards and technical documents, as well as knowledge, backgrounds and experiences in gas industries at national and international levels.

Iranian Gas Specification (IGS) are prepared, reviewed and amended by technical standard committees within NIGC standardization division of research and technology management and submitted to "the standards council of NIGC" for approval.

IGSs are subjected to revision, amendment or withdrawal, if required, and thus the latest edition of IGS shall be checked / inquired by NIGC'S users.

This standard must not be modified or altered by NIGC employees or its contractors. Any deviation or conflicts between this specification and other applicable standards, codes, procedure or well-known manufacturer's specifications must be resolved in writing by the user or its representative through Manager, Engineering Department or standardization division of NIGC.

The technical standard committee welcomes comments and feedbacks from concerned or interested corporate and individuals about this standard, and may revise this document accordingly based on the received feedbacks.

General Definitions

Throughout this standard the following definitions, where applicable, should be followed:

1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.

2- "COMPANY": refers to National Iranian Gas Company (NIGC).

3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to IGS specification whether as the prime producer or manufacturer or a trading firm.

4- "SHALL ": is used where a provision is mandatory.

5- "SHOULD": is used where a provision is advised only.

6- "MAY": is used where a provision is completely discretionary.

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Guidance for Use of This Specification:

The amendments/ supplements IPS-M-EL-143(3)[1] low voltage switchgear and control gear given in this specification are directly equivalent sections or clauses in IPS-M-EL-143(3) all other Paragraphs which are not amended by this supplementary shall remain valid as Written. The following annotations, as specified hereunder, have been used at the Beginning of each paragraph to indicate the type of change made to that paragraph of IPS-M-EL-143(3).

Sub. (Substitution) "The paragraph in IPS-M-EL-143(3) low voltage switchgear and controlgear shall be deleted and replaced by the new paragraph in this supplementary"

Del. (Deletion) "The paragraph in IPS-M-EL-143(3) low voltage switchgear and controlgear shall be deleted without any replacement"

Add. (Addition) "The new paragraph with the new number shall be added to the relevant section of IPS-M-EL-143(3) low voltage switchgear and controlgear"

Mod. (Modification) "Part of the clause or paragraph in IPS-M-EL-143(3) low voltage switchgear and controlgear shall be modified and/or the new description and/or statement shall be added to that clause or paragraph as given in this supplementary".

[1] Third edition April 2019

1. Scope (Sub.)

This document applies to all projects in NIGC and covers the minimum requirements of low voltage AC switchgear and controlgear assemblies herein after referred to this specification as “low voltage switchgear” or “switchgear.

3.10 Cubicle-Type Assembly (add)

enclosed assembly of the floor-standing type, which may comprise several sections, subsections or compartments.

3.11 Multi-Cubicle-Type Assembly (add)

combination of a number of mechanically joined cubicle-type assemblies

3.12 Desk-Type Assembly (add)

enclosed assembly with a horizontal or inclined control panel, or a combination of both, that incorporates control, measuring, and signaling apparatus, etc.

3.13 Box-Type Assembly (add)

enclosed assembly intended to be mounted on a vertical plane.

3.14 Multi-Box-Type Assembly (add)

combination of box-type assemblies mechanically joined together, with or without a common supporting frame, the electrical connections passing between two adjacent boxes through openings in the adjoining faces.

3.15 Wall-Mounted Surface Type Assembly (add)

assembly for installation on the surface of a wall

3.16 Wall-Mounted Recessed Type Assembly (add)

assembly for installation into a wall recess, where the enclosure does not support the portion of wall above

3.17 Floor-Standing Type Assembly (add)

assembly for installation on the floor

7.2.11 (mod)

A separate earth busbar made of hard drawn copper, rated for the maximum available earth fault current for one second(minimum acceptable cross section is 35 mm^2), shall run the entire length of the switchgear. Sufficient connection points with adequate terminating facilities shall be provided for terminating the cables screen and/or armors. The earth busbar shall be equipped with suitable connectors or bolts to be connected to earth copper conductors at each end.

The size of earth copper conductors shall be considered according to IPS-E-EL-100 and switchgear earthing system shall be according to IGS-E-EL- 030.

7.2.12 Main Circuits(add)

The phase, neutral and earth busbars shall be of hard or medium hard drawn, high conductivity copper.

The phase and neutral busbars shall be located in the top compartments of the switchboard or alternatively in the rear of the switchgear. In the latter case the design shall be such that access is provided to the busbar joints via a firmly secured cover that is at least IP 4X and has captive bolts/nuts.

The busbar system shall be accessible for construction and maintenance duties.

The neutral bar shall be insulated from earth and shall be extended to all compartments reached by the phase busbars.

The earth bar shall be located in the top or bottom compartments over the whole length of the switchboard and in all cable riser compartments (top to bottom) and shall be easily accessible. Sufficient connection points with adequate terminating facilities shall be provided for terminating the cable earth leads and the external earth connections. For the termination of external earth connections, the earth bar shall be provided with an M10 bolt near the bottom of each outgoing cable compartment and at the incoming panels.

In the busbar compartment the phase busbars shall be fully insulated. The insulation shall be type tested for withstanding at least an AC test voltage of 2 kV for a period of 60 s applied between the bar and an aluminium foil wrapped closely around the insulation over a length of at least one metre.

The distribution busbars (droppers, phase and neutral) shall have full segregation by insulated material. The insulation of the busbar joints and busbar to dropper joints shall be of equal quality to that of the main bars and shall be removable and easily replaceable for inspection. The comparative tracking index (CTI as defined in IEC 60112) of the insulating material used for the supports and insulation of the busbar and dropper systems shall be at least 300. The CTI for the insulation materials used for the components protected by the short-circuit protective devices in the outgoing functional units shall be at least 175.

The neutral busbar may be un-insulated in the busbar compartment but shall be insulated in all other compartments with the same insulation level as the phase conductors.

7.5 Arc protection (add)

Arc detection and mitigation devices shall be considered in cubicle type assembly Switchgear with short circuit level of 50KA and higher in accordance to IEC 60947-9-2.

7.6 Labels (add)

7.6.1 Cubicles, compartments, withdrawable units, circuit breakers and components shall be identified by labels with circuit numbers. Cubicle label designations (at front and rear of panel, on the fixed and removable parts, at the main and auxiliaries' cables terminations) shall be in accordance with the switchgear assembly single line diagram and associated data sheets.

7.6.2 Mimic one-line diagram shall be provided on request, indicating the busbars, incomers, bus-ties and main feeders.

Nameplates shall bear all identification in accordance with the reference standards. Language used for labelling shall be stated in the data sheet.

7.7 Circuit Breaker Padlock(add)

7.7.1 Incoming circuit for distribution boards Unless otherwise specified, a padlockable switching device shall be used.

7.7.2 Outgoing circuit breakers of distribution boards shall be fitted with padlocking device. Unless otherwise specified, circuit-breakers for distribution feeders shall be operated manually. If a tripping coil is required, it shall be of energized to trip type unless otherwise stated. Socket outlets circuits shall be fitted with a 30-mA earth leakage device

8.1.2 (mod)

In cubicle type assembly switchgear Circuit-breakers used as incomers and bus tie breaker shall be four poles with drawable air circuit breakers. Molded case circuit breakers (MCCB) should be used for such purpose with maximum rating/setting of 400 A.

8.1.8 (mod)

The short circuit capacity of circuit-breakers shall be appropriate to the specified system short circuit and power factor. The breaking and making short circuit capacities of circuit breakers as defined in IEC 60947-2 shall not be less than 50 kA and 105 kA rms symmetrical respectively.
For box type assembly and wall mounted assembly switchgear The minimum Ics shall be 10 kA unless otherwise agreed by the Principal.
Circuit breakers in a change-over supply duty should be withdrawable but shall at least have isolating facilities for maintenance and testing purposes.
If the circuit breakers require a separate DC supply for tripping and/or closing, then the Principal shall be consulted as to supplies available, if this information is not stated on the requisition sheet.

8. 4 Fuses (add)

8.4.1 High breaking capacity (HBC) type general purpose fuse links, utilisation category gG in accordance with IEC 60269-1 shall be used. The breaking capacity shall be equal to the short circuit rating of the busbar system with a minimum of 80 kA. The requisition shall indicate what type of fuse system in accordance with IEC 60269-2-1.

Material and equipment standard for low voltage switchgear and controlgear – Technical Specifications

Third edition

April 2019

Foreword

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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Contents

Introduction

This standard has been developed in "specialized reference committees"[1] and with the consensus of a wide range of professionals, representatives of organizations, companies, management, institutions and research-laboratory centers, manufacturers, associations, etc.

Petroleum Standards developed by the Ministry of Petroleum are reviewed systematically by specialized reference committees every five years and, are performed with regard to their applicability and effectiveness, approve, revoke or revise them in accordance with current Ministry of Petroleum regulations. Obviously, in accordance with clause 4 of the Procedure, the periodical review can be done early, if necessary. In case of conflict between Farsi (Persian) and English languages, English language shall govern.

Note 1 - The standard specification for switchgear, IPS-M-EL-140(0) is withdrawn in June 2004 , and replaced by the following two standard specifications which are issued as revision(1).

IPS-M-EL-143(1) Low voltage switchgear and control gear

IPS-M-EL-144(1) Medium and high voltage switchgear and control gear

By the way, standard specification low voltage motor starters IPS-M-EL-142(0) and standard specification low voltage motor control center IPS-M-EL-165(0) are withdrawn.

Note 2 - This bilingual standard is a revised version of the IPS-M-EL-143(2) standard specification by the relevant technical committee on 2019, which is issued as revision (3). Revision (2) of the mentioned standard specification is withdrawn.

Iranian Petroleum Standards (IPS)

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1 - Standardized specialized reference committees are qualified committees responsible for determination and reviewing standards for the petroleum industry (governmental, private and cooperative sectors).

Material and equipment standard for low voltage switchgear and controlgear - Technical specifications

Warning - Safety requirements are mandatory in all parts of this standard. Not all safety and hygiene items are listed in this standard. In the event of such occurrence, the user is responsible for maintaining the proper health and safety conditions and enforcing it.

1 Scope

1.1 This standard specification covers the minimum requirements for design, manufacture, tests, inspection and quality control of low voltage AC switchgear and controlgear assemblies herein after referred to this specification as “low voltage switchgear” or “switchgear”.

1.2 The low voltage switchgear will be installed in oil, gas and petrochemical industries in Iran under the environmental and service conditions specified herein.

1.3 The general requirements are given in this specification; the specific requirements of individual cases will be given in request for quotation and / or purchase order.

1.4 This standard specification will be supplemented by a single line diagram and other attachments when necessary.

Note - In case of conflict between Farsi (persian) and English languages, English language shall govern.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Usage of these references for utilizing this standard are mandatory.

2-1 ANSI C37.2 (IEEE C37.2) IEEE Standard electrical power system device function numbers, acronyms, and contact designations

2-2 API RP 505, Recommended practice for classification of locations for electrical installations at petroleum facilities classified as class 1, zone 0, zone 1 and zone 2

2-3 IEC 60038, IEC Standard Voltages

2-4 IEC 60051-1, Direct acting indicating analogue electrical measuring instruments and their accessories - Part 1: Definitions and general requirements common to all parts

2-5 IEC 60073, Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators

2-6 IEC 60079-1, Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures ‘d’

2-7 IEC 60079-10-1, Explosive atmospheres - Part 10-1: Classification of areas - Explosive

gas atmospheres

2-8 IEC 60079-10-2, Explosive atmospheres – Part 10-2: Classification of areas – Explosive dust atmospheres

2-9 IEC 60269-1+AMD1+AMD2, Low-voltage fuses - Part 1: General requirements

2-10 IEC 60269-2+AMD1, Low-voltage fuses - Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) - Examples of standardized systems of fuses A to K

2-11 IEC 60269-3+AMD1+AMD2, Low-voltage fuses - Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications) - Examples of standardized systems of fuses A to F

2-12 IEC 60269-4+AMD1+AMD2, Low-voltage fuses - Part 4: Supplementary requirements forfuse-links for the protection of semiconductor devices

2-13 IEC 60445+COR1, Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors

2-14 IEC 60529+AMD2+COR1, Degrees of protection provided by enclosures (IP Code)

2-15 IEC 60688+COR1, Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals

2-16 IEC 60947 (All parts), Low-voltage switchgear and controlgear

2-17 IEC 61869-1, Instrument transformers - Part 1: General requirements

2-18 IEC 61869-2, Instrument transformers - Part 2: Additional requirements for current transformers

2-19 IEC 61869-3, Instrument transformers - Part 3: Additional requirements for inductive voltage transformers

2-20 IEC 61869-5, Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers

2-21 IEC 61439-1, Low-voltage switchgear and controlgear assemblies - Part 1: General rules

2-22 IEC 61439-6, Low-voltage switchgear and controlgear assemblies - Part 6: Busbar trunking systems (busways)

2-23 IEC 62052-11+AMD1, Electricity metering equipment (a.c.) - General requirements, tests and test conditions - Part 11: Metering equipment

2-24 IEC 62053-11+AMD1, Electricity metering equipment (a.c.) - Particular requirements - Part 11: Electromechanical meters for active energy (classes 0.5, 1and 2)

2-25 IEC 62262, Degrees of protection provided by enclosures for electrical equipment

against external mechanical impacts (IK code)

2-26 IPS-E-EL-100, Engineering and equipment standard for electrical system design(industrial and non-industrial

2-27 IPS-E-GN-100, Engineering standard for units

2-28 IPS-M-EL-161, Material and equipment standard for general electrical items

Note 1- Where standards other than IEC are specified (such as ANSI C37.2), it is understood that the equivalent IEC standard is acceptable.

Note 2- Any deviation from this specification and the above mentioned references shall be clearly mentioned in the vendor's proposal.

3 Terms and definitions

This standard uses the terms and definitions set forth in IEC 60050-151 and IEC 60050-441 standards.

3.1

company

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

3.2

purchaser

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document

3.3

vendor and supplier

Refers to firm or person who will supply and/or fabricate the equipment or material.

3.4

contractor

Refers to the persons, firm or company whose tender has been accepted by the company.

3.5

inspector

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

3.6

shall

Is used where a provision is mandatory.

3.7

should

Is used where a provision is advisory only.

3.8

will

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

3.9

may

Is used where a provision is completely discretionary.

4 Service conditions

4.1 The low voltage switchgear specified herein will generally be installed indoor in substation rooms, which will be ventilated and/or air conditioned.

4.2 As far as the area classification is concerned the substation rooms and other indoor locations where the low voltage switchgear will be installed are considered safe area. This standard specification specifies the equipment suitable for safe area indoor installation.

4.3 In case where the low voltage switchgear will be installed outdoor, which will be indicated in data sheet Annex A. This standard specification shall be supplemented with additional requirements and/or modifications stipulated in Annex B "Additional requirements for outdoor low voltage switchgear and control gear".

4.4 Unless otherwise stated in data sheet, The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.
The lower limit of the ambient air temperature is –5 °C.
Ambient air temperature is that existing in the vicinity of the equipment if supplied without enclosure, or in the vicinity of the enclosure if supplied with an enclosure.

4.5 Unless otherwise indicated in data sheet, the altitude of the site of installation does not exceed 2000 meter.

Note- For equipment to be used at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and the cooling effect of the air. Electrical equipment intended to operate under these conditions shall be designed or used in accordance with an agreement between manufacturer and user.

4.6 The relative humidity of the air does not exceed 50 % at a maximum temperature of +40 °C.

4.7 The atmosphere in which the equipment is to be installed may have a relative humidity greater than the values specified herein or contain an abnormal amount of dust, acids, corrosive gases, etc.

If the conditions for operation in service and the application differ from those given in this standard, the user shall state the deviations from the standard conditions and consult the manufacturer on the suitability of the equipment for use under such conditions.

4.8 A special agreement shall be made between user and manufacturer if the conditions during transport and storage, e.g. temperature and humidity, differ from those defined in 4.1 to 4.7, except that, unless otherwise specified, The following temperature range applies during transport and storage: between –25 °C and +55 °C and, for short periods not exceeding 24 h, up to +70 °C.

4.9 Unless otherwise specified in the datasheet, the assembly and the components installed therein shall be suitable for use in a pollution degree 3 environment according to IEC 60947-1. However, the air will be laden with dust, salt and/or sulphur as encountered in the petroleum industries.

The equipment subjected to these extreme conditions without being operated shall not be damaged and shall operate normally under the specified conditions.

4.10 The equipment shall be suitable for operation, without deleterious effect, with variations of voltage and frequency tolerances as follows:

- AC Voltage supply: ± 10%
- Frequency: ± 5%
- DC Voltage supply: +10 / -15%.

4.11 Impact strength shall be at minimum IK 08 as defined in the IEC 62262.

5 Units

This standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified. If it is necessary to express values in another unit, at first, it must be stated to the SI equivalent and then inserted in front of the desired unit in parentheses.

6 Application

6.1 The voltage levels adapted in the oil, gas and petrochemical industries of Iran are based on the IEC 60038.

6.2 The low voltage system is generally 230/400 volt with solidly earthed neutral.

6.3 The low voltage switchgear will be fed from low voltage generator/s or transformer/s with a voltage of 230/400 volt.

6.4 The low voltage switchgear is equipment, which includes switching devices with associated control, measuring, protective and regulating devices and intended in principle for the control of electrical energy consuming equipment, with voltage rating of 400 volt three phase and 230 volt single phase.

6.5 The low voltage switchgear includes motor starters and/or motor control center/s (MCC), incomer circuit breaker/s, bus tie circuit breaker/s, outgoing feeder breakers and/or switch fuses and auxiliary components as specified in this specification and/or indicated in the single line diagram/s.

6.6 The incomer circuit breakers, if more than one, shall be closed at normal operation. The tie breaker/s can be closed at normal operation, or can be open which shall close automatically when one of the incomer breakers opens. The mode of operation of the tie breaker/s will be decided by company representative and shall be indicated in the single line diagram/s and/or data sheet. The protection scheme and intertripping of incomers and tie breakers with upstream breakers shall be included accordingly.

6.7 Single line diagram/s is/are mentioned in this specification show/s only the major components of the low voltage switchgear. Control circuit schematic diagrams, wiring diagrams, schedule sheets and interconnection diagrams will be attached when necessary.

7 General requirments

7.1 Enclosure

7.1.1 The switchgear assemblies shall be multi cubicle type as specified and shown in IEC 61439-1 and shall be suitable for indoor installation.

7.1.2 The enclosure shall be metal enclosed compartmented type, self supporting, free standing, floor mounted and shall be constructed with steel structure/s and minimum thickness of 2 mm. Thickness of other parts of enclosure shall be in accordance with type test certificate. Components shall be accessible from the front of the switchgear.

7.1.3 All equipment shall be installed inside the enclosure, suitably subdivided into separate compartments. The internal separation by partitions or barriers (metallic or non-metallic) shall conform to Form 3b/4b or Form 4a (as stated by owner) as defined in IEC 61439-2.

7.1.4 According to IEC 61439-2, Form 3b and 4a are as follows:

– From 3b: Separation of busbars from all functional units. Separation of all functional units from one another.

Separation of terminals for external conductors and external conductors from the functional units, but not from the terminals of other functional units.

– From 4a: Separation of busbars from all functional units. Separation of all functional units from one another.

Separation of terminals for external conductors associated with a functional unit from the terminals of any other functional unit and the busbars. Seperation of the external conductors from the busbars. Separation of the external conductors associated with a functional unit from other functional units and their terminals. External conductors need not be separated from each other.

Terminals in same compartment as associated functional unit.

7.1.5 Unless otherwise specified in data sheet, the indoor enclosure shall at least provide a degree of protection of IP 41 according to IEC 60529 without using the floor of the switch room as part of the enclosure. The partitions or barriers between functional units shall at least provide a degree of protection of IP 2X. (The IP rating for outdoor enclosure is indicated in Annex B).

7.1.6 The height and the depth of the enclosure shall be as per manufacturer standard and shall be indicated in data sheet and maximum height of enclosure shall be 220cm. Switches, buttons and operating handles and indicating instruments shall be installed at a height of not more than 180cm.

7.1.7 The enclosure together with bus bars and wirings shall be extendable at both ends without the need to cut or drill any part of the enclosure.

7.1.8 Empty enclosures (space) at least one on each section of the switchgear shall be foreseen within the enclosure for future use. Such compartments shall be arranged so that they can be equipped with minimum de-energisation of the relevant section of the switchgear.

The empty cubicle shall include connection to busbar and corresponding support, fixed parts of the equipment.

The number of empty enclosures (space) shall be 10% of each size of outgoing units of which at least three units are installed. This is in excess of spare units. Fully equipped spare units shall be provided on the basis of 20%, as indicated in single line diagram/s, with minimum of one unit for each different starter/feeder size (except incomer and bus-tie).

7.1.9 The switchgear enclosure shall be natural cooling. The design of the vertical structures and the placement of starters and feeders shall be such as to avoid heat build-up in the top of the cubicles.

7.1.10 The enclosure, for outdoor and indoor installation, intended for use in locations with high humidity and temperatures varying within wide limits, shall be provided with suitable arrangements (ventilation and/or internal heating, drain holes, etc.) to prevent harmful condensation within the enclosure. However, the specified degree of protection shall at the same time be maintained. Where such heaters are specified in data sheet Annex A, they shall conform to article 9.6 of this specification.

7.1.11 The enclosure shall be properly degreased, phophasized, cleaned and painted from inside and outside. The painting shall be done by means of electrostatic powder coating based on epoxy and polyester resins. The thickness of paint coating shall be 60 to 80 microns and shall be cured in accordance with powder manufacturer specification. The color of the enclosure will be decided by company representative. Manufacturer's standard painting system, if different from above shall be agreed by company representative.

7.1.12 All incoming and outgoing cables will enter the switchgear from trenches or floor cut-outs. If bus ducts are specified for incomers, they enter the switchgear from above. In case incomers are specified to be via bus ducts, the switchgear supplier shall provide flanged entry to the switchgear with insulated copper bars extending to the flange point.

7.1.13 Provisions shall be included inside the enclosure to support the cables. Cable supports shall be foreseen at least 40 cm above the bottom of the switchgear. Suitable size cable entries shall be foreseen in the bottom plate of the enclosure for the cables to pass through. Such entries will be sealed after complete installation of cables. Cable glands will be used for incoming and outgoing cables (cable glands will be supplied by others). Where single core cables are to be used the bottom plate shall be non-magnetic.

7.1.14 Cables armor and lead cover will be removed inside the enclosure, and will be earthed by a suitable size flexible earthing wire soldered and clamped to the cable armor and connected to the switchgear earthing busbar.

7.1.15 Lifting lugs shall be provided on enclosure/s for ease of handling.

7.1.16 Specification of foundation bolts and installation instructions shall be provided by the vendor.

7.2 Busbars

7.2.1 Busbars shall be manufactured from hard drawn, high conductivity copper and shall comply with IEC 61439-1.

7.2.2 Busbars shall be designed for the full rated current at the maximum ambient temperature specified without exceeding their temperature rise limits. Design of the busbars shall be such that future extension of the switchgear to either side will be possible.

7.2.3 Power and neutral busbars shall be fully insulated with flame retardant non-hygroscopic insulation material and shall be color coded. Suitable insulation shall be provided for the bolted joints. The insulation of busbar joints and connections shall be removable for inspection purposes. Busbar joints and connections shall be corrosion protected and secured to prevent loosening. In cases where requested by the purchaser and indicated in data sheet the busbar joints shall be silver plated.

7.2.4 Unless otherwise indicated in data sheet the color or the color coding of the busbars insulation shall be red, yellow and blue for phase busbars and black for neutral busbar, from top to bottom and from left to right when facing the front of the switchgear.

7.2.5 The main horizontal busbars shall be of the same cross sectional area throughout the length of the switchgear. The cross section and the continuous ampere rating of the main horizontal busbars shall be indicated in data sheet/s.

7.2.6 The vertical busbars shall be of the same cross sectional area throughout their length and their current rating shall be equal to the sum of the maximum full load ratings of the outgoing units connected to that busbar considering the future units which could be installed in empty compartments.

7.2.7 The horizontal and vertical busbars shall be capable of withstanding, without damage, the magnetic forces and the thermal effects created by the maximum specified short circuit current for at least one second. The busbars short circuit withstands current shall be indicated in data sheet and shall not be less than 50 kA rms symmetrical.

7.2.8 Main horizontal busbars shall be in separate compartment. The vertical busbars shall also be in separate compartment and can be installed behind functional units of each vertical section. The vertical busbars shall be arranged such that accidental finger contact with live parts shall be impossible when the breaker/s or starter modules are withdrawn.

7.2.9 Where bus section (tie) breaker/s are specified, they shall be so arranged that one complete section of busbars and associated connections can be made dead and safe to work on, while the adjoining section of busbars is still alive.

7.2.10 The neutral busbar shall extend the entire length of the switchgear and shall be insulated from the earth potential. The neutral bus shall extend into each incomer compartment. Means of disconnection (e.g. a bolted link) shall be provided to isolate the neutral bus from the neutral source for testing purposes. The current rating of the neutral busbar shall be at least 50% of the phase busbars.

7.2.11 A separate earth busbar, rated for the maximum available earth fault current for one second, shall run the entire length of the switchgear. Sufficient connection points with adequate terminating facilities shall be provided for terminating the cables screen and/or armors. The earth busbar shall be equipped with suitable connectors or bolts to be connected to earth copper conductors at each end.

The size of earth copper conductors shall be considered accrding to IPS-E-EL-100.

7.3 Wiring, terminals and markings

7.3.1 All internal wiring shall be continuous from terminal to terminal with no splicing.

7.3.2 Wiring shall be stranded copper conductor with flame retardant PVC insulation. Minimum conductor sizes shall be 2.5 mm^2 for protection (CT/PT), and 1.5 mm^2 for control and signal wiring.

7.3.3 In case of direct connection between main busbar and first protection device, the minimum cross-section size of conductor, shall be at least 4 mm^2 and the conductor shall be fixed correctly. This connection in busbar side shall be ring type cable lug.

7.3.4 Where wiring is run through a metal sheet or barrier, bushing or other mechanical protection shall be provided.

7.3.5 All internal power wiring shall be suitable for the largest continuous current rating of the functional unit in maximum ambient temperature and the short circuit current as limited by fuses or circuit breakers.

7.3.6 The sizes of earth wires shall be according to the recommendations of IEC 61439-1.

7.3.7 Where applicable, flexible wires shall be used for connection of door mounted equipment to the cubicle mounted equipment. Such wiring shall be wrapped with flexible PVC coil or installed in flexible conduit and shall be firmly clamped at both ends to prevent movement at terminations.

7.3.8 Covers and/or doors with electrical apparatus attached to them shall be connected to the switchgear frame via bonding conductors.

7.3.9 All wiring shall be numbered on each end with permanently embossed wire markers of the heat shrinkable type or slip-on ferrules. Wire numbers shall match the manufacturer's interconnection drawings.

7.3.10 All wires shall have cable lugs and shall be terminated in clamp type terminals such that direct contacts between screw, bolt or nut and cable lugs are avoided. For current transformers secondary wiring circuit, "ring type cable lugs" shall be used.

7.3.11 The terminals shall be identified by suitable permanent numbers in accordance with the relevant wiring diagrams. Terminal marking shall comply with IEC 60445.

7.3.12 Not more than two wires shall be connected to any one terminal. Links shall be provided where more connections are required at one point.

7.3.13 Wiring in various circuit breakers, starter and feeder cubicles performing the same common function shall bear the same wire and terminal numbers.

7.3.14 The control terminal blocks shall include minimum 10 % spare terminals.

7.3.15 Nameplates shall comply with IEC 61439-1 and information on the nameplates shall be approved by company representative. Nameplates shall be made of durable corrosion resistant material.

The nameplates shall at least contain the following information: manufacturer's name and trade mark, type designation and serial number, date of manufacturing, applicable rated values and number of relevant standard.

7.3.16 Labels on withdrawable units shall be duplicated on the withdrawable part and the fixed part.

7.3.17 When operation of certain items of the switchgear needs sequential actions such as the release of interlocking features, instruction plates shall be provided near the point of operation.

7.4 Safety considerations and interlocks

7.4.1 The low voltage switchgear and controlgear shall offer a maximum degree of safety under all normal operating and fault conditions. It must be impossible to unwillingly, without the use of tools, touch live parts of the switchgear or to perform operations that may lead to arcing faults.

7.4.2 Circuit breakers and feeder units shall be provided with required safety interlocks in accordance with the functions of such equipment in the overall electrical system and shall conform to the requirements of IEC 61439. Interlocks shall be mechanical in nature.

7.4.3 Motor starter units shall be equipped with necessary interlocks such that it will not be possible to open the doors or covers of starter compartments when the isolating switch is in the ON position. The isolating device shall only be operable when the door or cover is fully closed and/or the withdrawable unit is in the fully inserted position.

7.4.4 The reversing and two speed motor starters shall be equipped with suitable mechanical interlocks, in addition to the electrical interlocks in the control circuits.

7.4.5 All interlocks that prevent potentially dangerous mal operations must be constructed such that they can not be easily defeated. If any mechanical interlock is capable of being defeated without the use of tools, provision shall be made for padlocking. The requirements for interlocks and/or padlocking shall be approved by company representative.

7.4.6 When a withdrawable unit has been removed from the switchgear assembly, the live parts inside the fixed compartments shall be protected against touch.

7.4.7 Arc-barriers shall be arranged such that the propagation of a possible arc is hindered from one vertical section of the switchgear to another vertical section and also from one compartment to another compartment of each vertical section.

7.4.8 Temperature rise of current-carrying parts shall be limited to the values stipulated in IEC 60947 and derated in accordance with environmental conditions specified in data sheet.

7.4.9 The complete switchgear assembly shall be capable to withstand the thermal and dynamic stresses resulting from short circuit currents. The supplier shall state the short circuit withstand current of the assembly namely busbars, breakers, starters etc. at quotation stage.

7.4.10 All the metallic non-current carrying parts of the switchgear including the main structure shall be bonded together and connected to the earth busbar. Doors shall be bonded to the main structure by means of flexible copper connections.

8 Major components

8.1 Incoming air circuit breakers

8.1.1 In the low voltage switchgear, air circuit breakers shall be used for incomer/s to the switchgear and also for bus coupler/s.

8.1.2 Circuit-breakers used as incomers and bus tie breaker shall be four poles with drawable air circuit breakers. Molded case circuit breakers (MCCB) shall not be used for such purpose.

8.1.3 In some cases that the panel feeds only from one transformer or the circuit does not have any single phase load, three poles circuit breaker may be used for incomers.

8.1.4 Air circuit breakers shall conform to IEC 60947-2 in terms of rating, testing and performance, and shall be suitable for uninterrupted duty (utilization category B).

8.1.5 Both the short-circuit making capacity as well as the short-circuit breaking capacity of circuit breakers must be larger than or equal to the prospective short-circuit current at the place of installation. The rated ultimate short circuit breaking capacity (Icu) and rated service short circuit breaking capacity (Ics) in incoming air circuit breaker shall be equal.

8.1.6 The performance of circuit breakers as specified in IEC 60947-2 shall be verified when installed within the assembly for the exact configuration supplied.

8.1.7 Rated currents of circuit breakers shall be selected conforming to IEC recommendations taking into account possible deratings as per site condition specified in data sheet. Incomer circuit breakers shall be sized to feed all the loads indicated in the single line diagram including the spare units and the space units (empty compartments) which would be installed infuture.

8.1.8 The short circuit capacity of circuit-breakers shall be appropriate to the specified system short circuit and power factor. The breaking and making short circuit capacities of circuit breakers as defined in IEC 60947-2 shall not be less than 50 kA and 105 kA rms symmetrical respectively.

8.1.9 Circuit breakers shall be capable of interrupting the specified short circuit current without the aid of replaceable current limiters or fuses.

8.1.10 The operating mechanism of air circuit breakers shall be stored energy spring operated type. The charging of the spring shall be by electric motor and also by manual means. The charged spring mechanism shall be capable of three circuit breaker operation viz: open, close, open.

8.1.11 Each circuit breaker shall be equipped with anti-pumping devices to prevent pumping actions of the operating mechanism.

8.1.12 Unless otherwise indicated in data sheet the voltage of the spring charging motor as well as the circuit breaker close and trip voltage shall be 110V dc with individual protection. The 110V dc will be supplied from the substations of dc power supply system. The 230V ac can be utilized for the spring charging motor if approved by company representative.

8.1.13 Tripping of circuit breakers shall be by means of manual mechanical tripping device and dc shunt trip coil. Electrical and manual closing release shall be provided. Circuit breakers shall be suitable for remote control. The purchaser shall indicate the choice of local or remote control of circuit breakers in data sheet/s.

8.1.14 The local manual trip facility shall be fitted with a guard to preclude inadvertent operation.

8.1.15 Facilities shall be provided for testing the circuit breaker closing and tripping mechanisms when the breaker is in TEST position.

8.1.16 There shall be three distinct positions for circuit breakers. The draw-out mechanism shall hold the circuit breaker rigidly in the three positions of CONNECTED, TEST and DISCONNECTED (Rack Out). The breaker disconnect device shall be mechanically interlocked by the breaker trip-shaft to prevent withdrawal or insertion of the breaker from / into the cubicle with the breaker in the ON position.

8.1.17 If moving of the circuit breaker from or into the operating position requires undue effort by the operator, mechanical aids such as handle shall be provided as indicated in article 9.7. The circuit breaker shall be lockable in the TEST and DISCONNECTED positions.

8.1.18 Circuit breakers shall be equipped with shutters to cover the bus side and cable side disconnect contacts automatically, upon withdrawal of circuit breaker. Shutters shall be opened by the circuit breaker as it moves toward connected position, Shutters shall be colored red for busbar side and yellow for cable side.

8.1.19 Circuit breaker control connections (secondary disconnects) shall be via fixed, self-aligning disconnects, or via flexible cord type plug connection. Either system shall allow test-operation of the circuit breaker in the test position.

8.1.20 In addition to auxiliary contacts required for circuit breaker operation, at least 2 N/O and at least 2 N/C similar contacts shall be provided, and wired to the terminal strip. If additional auxiliary contacts are required, it will be indicated in data sheet.

8.1.21 All auxiliary wiring to and from the circuit breaker shall be terminated on an easily accessible terminal strip within the breaker compartment with label numbering. Each terminal and each wire shall be clearly identified by the same symbols or numbers used in the circuit diagrams. For similar type of feeders, the numbering procedure shall be identical.

8.1.22 Circuit breakers of identical rating and control voltage shall be completely interchangeable. It shall not be possible to interchange breakers of different ratings.

8.1.23 Circuit breakers shall have mechanical indicators to show open/close contact positions and spring charging status. The panel shall also be fitted with red and green indicating lights as per IEC 60073 recommendations to show whether the breaker is in close or open position. In addition a yellow indicating light shall be provided to show trip on fault condition.

8.1.24 Each circuit breaker shall be provided with a trip circuit supervision system complete with a white indicating lamp to indicate that the trip circuit and trip circuit supply are healthy.

8.1.25 The "indicating lamp test" provisions shall be provided for the feeders.

8.1.26 The incomer circuit breaker/s shall be equipped with the required indicating instruments and external type protective relays as shown in single line diagram/s and/or data sheet. Company representative shall approve built-in type protective relays. At least the followings shall be provided for each incomer circuit breaker. The relays function numbers are according to ANSI standard C37.2 (IEEE C37.2)

- Time and instantaneous over current relay. (50/51)
- Time and instantaneous over current ground relay (50N/51N)
- Under voltage and phase sequence voltage protection (27/47)
- Ammeter with selector switch (or three Ammeters one for each phase)
- Voltmeter with phase selector switch

The other protective relays shall be provided according to single line diagram/s.

8.1.27 The bus tie circuit breaker/s shall be equipped with protective relays and electrical interlocks as shown in single line diagram/s.

8.1.28 For Manual/Automatic Transfer System (ATS) refer to IPS-E-EL-100, if indicated in the single line diagram/s and/or data sheet/s.

8.2 Motor controllers

8.2.1 In the low voltage switchgear motor starters feeder, shall be withdrawable and installed in individual compartments. The number and motor rating will be indicated in the single line diagram/s and/or data sheet.

8.2.2 Unless otherwise indicated in single line diagram/s the motor starters for single speed, two speed and reversing motors shall be direct-on-line and shall be in accordance with the requirements of IEC 60947-4.

8.2.3 Motor starters installed in low voltage switchgear are intended to control 3 phase 400 volt electrical loads and/or motors up to 150kW rating. (The voltage of 150kW motors can be 400 volt or 6kv depending upon the availability of such voltages).

8.2.4 Motor starters at least shall consist of the following components as per IPS-E-EL-100:

– HRC fuses with isolator, or molded case circuit breaker (MCCB, without overload protection), or motor protection circuit breaker (MPCB, without overload protection) with approval of company representative

– Contactor

– Essential protective relays

– Other optional protection relays, control devices and indicating instruments shown on the single line diagram/s and/or specified in this specification.

8.2.5 Both the short-circuit making capacity as well as the short-circuit breaking capacity of molded case circuit breakers must be larger than or equal to the prospective short-circuit current at the place of installation. The rated ultimate short circuit breaking capacity (Icu) and rated service short circuit breaking capacity (Ics) in molded case circuit breaker shall be equal.

8.2.6 All motor starter feeders shall meet the requirements of IEC 60947-4-1. These feeders shall be type "2" co-ordination and the manufacturer shall supply required documents to company representative.

8.2.7 Switch-fuse combination units shall comply with IEC 60947-3 suitable for uninterrupted duty, utilization category AC–23. Isolators shall be operable from the front of the switchgear without opening a cover. The HRC fuse links shall be in accordance with IEC 60269-1.

8.2.8 Contactors shall be three pole magnetically operated air-break type rated for utilization category AC-3 according to IEC 60947-4. For induction motors in inching or reversing services contactors with utilization category AC-4 shall be used.

8.2.9 In addition to the load contacts and the auxiliary contacts required to operate the starter, at least one N/O and one N/C auxiliary contacts shall be provided for each contactor and shall be wired to the terminal block of the compartment.

8.2.10 Control scheme of motor starters shall be as per the requirements, shown in control circuit schematic diagrams.

8.2.11 The rated voltage of control circuit shall be single phase 230 volt ac supplied by isolated control transformer in each individual cells or in each motor starter unit as specified by company representative. The control circuit shall be protected by a suitably rated fuse. In case where the purchaser specifies other control voltages in the data sheet or in the single line diagram/s, necessary auxiliaries shall be provided for such purpose.

8.2.12 Where the capacitive current of control cables are larger than the current related to holding power (sealing power) of the contactor coil, the manufacturer shall comply the requirements for using a larger contactor with bigger holding power. Other solutions with approval by company representative are acceptable. Company will submit control cable schedule.

8.2.13 Motor starters shall include a change over Test/Normal selector switch for testing the operation of starters when isolated from the main circuit. In test position, the control circuit which is isolated from the main circuit shall be connected to a male plug located within each starter unit. In this position the starter can be tested when control voltage is supplied to such male plug.

8.2.14 Unless otherwise indicated on drawings, one 230V test voltage supply unit (supplied from isolated transformer) equipped with isolating device and appropriate fuse rated to supply the control circuit of the largest starter unit shall be provided on each busbar section. The test voltage supply unit shall be accommodated in a dedicated compartment and shall be connected to two pole sockets (at least two numbers) mounted on the compartment door.

8.2.15 Flexible cords with matching plugs and socket shall be supplied by manufacturer for connecting test voltage to the male plugs in each starter unit as specified in paragraph 8.2.13. The flexible cords shall have sufficient length to connect the test voltage to all starter units on each section of the switchgear for testing purposes.

8.2.16 Motor starters shall be equipped with start/stop local control stations according to the requirements of article 9.1 of this specification.

8.2.17 Stay-put type stop/reset push-button accessible from outside of the starter compartment shall be provided on the front of all motor starters. Unless otherwise indicated in single line diagram/s no start push button is required on the starter compartment. (Except for testing as per paragraph 8.2.13.)

8.2.18 Each starter module shall be equipped with the following indicating lights installed on the door of the starter compartment.

-Red to show the ON status,

-Green to show OFF status,

-Yellow to show FAULT status.

8.2.19 For motor starters up to 30kW, thermal overload relays with direct heating element or electronical shall be provided. In addition to such overload protection, suitable single phasing protection shall also be included so that the contactor shall trip whenever a single phasing condition develops. The thermal or electronical overload relays shall be three-phase, ambient temperature compensated and adjustable type. Uniform trip- characteristics shall be obtained between 0^{o}C and 50^{o}C. Adjustment range of thermal relays shall be calibrated directly in ampere. Reset shall be via a door-mounted push-button.

8.2.20 For motor starters 30kW and above current transformer operated overload relays shall be used. For such motors instantaneous earth fault protection relay supplied from a core balance current transformer shall also be provided. Earth fault relays shall be adjustable to trip the contactors about 10% of the full load motor current. In addition to overload and earth fault protection relays, single phasing protection relay shall also be included.

8.2.21 Motor starters shall also include other protective or control relays stipulated by the process requirement and indicated in the single line diagram/s.

8.2.22 Relays shall be according to article 9.3 of this specification. Microprocessor type motor protection relays are acceptable.

8.2.23 All motor starters of 4 kW and above shall be provided with one ammeter installed on the starter front panel. This ammeter shall be fed from a current transformer installed on the middle phase. Such starters shall also be fitted with a 1 Ampere secondary current transformer for remote indication of motor current. The ammeter fed from this current transformer will be installed in the relevant local motor control station.

8.2.24 For motors less than 4 kW no ammeter is required on the starter panel, however, ammeter shall be provided on the local control stations when such motors are not visible from starting position.

8.2.25 Starter modules of identical rating and control scheme shall be fully interchangeable. Units which are mechanically identical but electrically different shall not be interchangeable e.g. it shall not be possible to install a motor starter unit into a space for a feeder unit of the same size.

8.2.26 Fully equipped spare motor starters shall be provided as specified in paragraph 7.1.8.

8.3 Other outgoing feeders (rather than motor type)

8.3.1 The low voltage switchgear may include outgoing feeder switch fuses or air circuit breakers. The type and sizes of feeder switch fuses or feeder breakers will be indicated in the single line diagram/s and/or data sheet.

8.3.2 Outgoing Feeder circuit breakers rated up to 400 Ampere can be molded case circuit breaker (MCCB) type, when approved by company representative. For ratings above 400 Ampere, the air circuit breaker type shall be used.

8.3.3 Outgoing Feeder circuit breakers or switch fuses shall be installed in individual compartments.

8.3.4 The circuit breakers and switch fuses shall be in accordance with the requirements of IEC 60947-2 and IEC 60947-3.

8.3.5 Outgoing feeders with rating of 100 Ampere and above shall be provided with one ammeter with selector switch or three ammeters (one for each phase).

8.3.6 Each terminal and each wire shall be clearly identified by the same symbols or numbers used in the circuit diagrams. For similar type of outgoing feeders, the numbering procedure shall be identical.

8.3.7 Both the short-circuit making capacity as well as the short-circuit breaking capacity of circuit breakers must be larger than or equal to the prospective short-circuit current at the place of installation. The rated ultimate short circuit breaking capacity (Icu) and rated service short circuit breaking capacity (Ics) in outgoing air circuit breaker shall be equal.

9 Auxiliary components

9.1 Local motor control stations

9.1.1 Local motor control stations will be located near the motors which they control. If motor control stations are to be supplied together with the switchgear, it shall be indicated in data sheet. The mentioned requirements shall be according to IPS-M-EL-161.

9.1.2 Unless otherwise stated in control philosophy, the local motor control station shall at least include start-stop pushbuttons together with suitable ammeter as required. The ammeter can be located on the associated control station. It shall be possible to lock the control station in stop position.

9.1.3 Separate current transformers shall be mounted in the motor starter compartments to be connected to ammeters at motor control stations in accordance with the requirement of article 9.4.

9.1.4 Terminals shall be provided in the starter compartments to be connected to the ammeter and push buttons installed on the local motor control stations.

9.1.5 Local motor control stations shall be suitable for outdoor installation in classified areas and shall be according to the relevant IPS standard.

9.1.6 Unless otherwise stated in control philosephy, "Local-Off-Remote" or "Manual-Off-Auto" tri-state selector switches shall be provided on Local Control Stations, when indicated on the single line diagram/s. The "Off position" in tri-state selector switches may be defined as "no-state" and shall not cause to stop the motor.

9.2 Instruments

9.2.1 Indicating and measuring instruments shall be provided as shown on single line diagrams and/or data sheet.

9.2.2 All instruments shall be manufactured in accordance with the requirements of IEC 60051.

9.2.3 Where indicated in the single line diagram/s and or data sheet, 4-20mA output transducer/s complying with IEC 60688 shall be provided for selected analogue signals to be transmitted to a remote supervisory system such as distributed control system (DCS).

9.2.4 Measuring instruments shall be flush mounting type and shall have an enclosure with at least a degree of protection of IP41 and IP55 for indoor and outdoor applications, repectively.

9.2.5 Measuring instruments shall be operative by the passage of fault currents in the primary of current transformers or voltage variations on the system within the specified system characteristics.

9.2.6 Analog ammeters, voltmeters and watt-hour meters shall be of the accuracy class 1.5 or better. The accuracy class of the above digital devices shall be class 1.0 or better.

9.2.7 Ammeters for motor duty shall be analog-type and suitable to withstand the motor starting currents and shall have a compressed overload scale of at least 6 times the full load motor current. Scales for such ammeters shall be selected at least 120% of nominal load current appears in meter. Full load motor current shall be indicated by a red line on the ammeter scale.

9.2.8 All analog meters installed on the switchgear shall be of the square pattern type 72 mm × 72 mm. 96 mm × 96 mm meters are acceptable, but 72 mm × 72 mm is preferred. Scales shall be in actual values.

9.3 Protective relays

9.3.1 The protection function codes shown on single line diagram/s will be according to the latest edition of ANSI standard C37.2. (IEEE C37.2) and IPS-E-EL-100.

9.3.2 All protective relays with the same function shall be similar type and interchangeable. Prefferably the relays to be such that, the removal of each relay automatically short circuits the relevant current transformer.

9.3.3 All protective relays shall have provision for testing and microprocessor type relays shall be configurable. Each protection function shall be activated individually. Activating and de-activating each protective function does not disturb other function operation in any way.

9.3.4 Each incomer and bus-tie shall be equipped with microprocessor type protection relays. Protection scheme shall be based on failsafe scheme and watchdog (self-monitoring) contacts must be provided in these relays to indicate the health of the device. This device shall have hardwired contacts for sending alaram signals.

9.3.5 Relays shall be equipped with clear trip indication, visible to the operator.

9.3.6 Relays shall be manually resetable.

9.3.7 An external electromechanical lockout relay (86) shall be installed on all feeders equipped with ACB, to prohibit automatic restart after a failure (except thermal overload 49). It can be reset only manually.

9.3.8 In all feeders equipped with ACB, the secondary terminals of each current and voltage transformers shall be connected to accessible test block**.**

9.3.9 If programmable digital protective relays are employed, the relevant softwares together with instruction manuals and trouble shooting guidelines shall be included.

9.4 Current transformers

9.4.1 Current transformers shall be in accordance with IEC 61869-2.

9.4.2 The rated secondary current shall be 1 or 5 Ampere for protective relays and 5 Ampere for measuring devices mounted in switchgears. For remote mounted instruments, rated secondary current shall be 1 Ampere, either directly or via intermediate current transformers.

9.4.3 The switchgear manufacturer shall be responsible for assessing and selecting the output rating of the current transformers. If there is any discrepancy from single line diagram of company representative, the manufacturer shall present sizing calculations of the output rating of the current transformers for confirmation of client.

9.4.4 Current transformers for measuring purposes shall be of the accuracy class 1 or better . Current transformers for remote ammeters shall be of the accuracy class 3 or better.

9.4.5 Current transformers for protection purposes shall be of the accuracy class 5P. The accuracy class of current transformers used for motor protection relays shall be as specified by the relay manufacturer. In such case class 10P will be acceptable. The accuracy class of differential protection (ANSI code 87) current transformers shall be class X as defined in IEC 61869-2.

9.4.6 The secondary of the current transformers shall be earthed on one side. Where current transformers are connected in Y, the Y point shall be earthed. The wiring of the secondary circuits shall be at least cross section of 2.5 mm^2.

9.4.7 Secondary terminals of current transformers shall be wired up to terminal block with short-circuiting link, located at an accessible place.

9.4.8 Current transformers for circuit breakers shall be installed in the stationary part of the relevant cubicle. Current transformers for motor starters shall be installed in the withdrawable part of the cubicle.

9.4.9 Current transformers shall be capable of carrying, the specified fault current of the switchgear, without injurious heating or mechanical damage.

9.4.10 Current transformers shall have appropriate VA rating and security factor. The security factor shall not be less than 5.

9.4.11 The markings on the current transformer shall be in accordance with the requirements of IEC 61869-2.

9.5 Voltage transformers

9.5.1 When voltage transformers are indicated in single line diagram, they shall be in accordance with IEC 61869-3, with secondary voltage as specified by the manufacturer of protective and/or measuring instruments.

9.5.2 Voltage transformers shall be protected by disconnect type current limiting fuses on primary side and fuses or miniature circuit breakers (MCB) on secondary side.

9.5.3 The secondary winding of voltage transformers shall be earthed at one end, through a removable link.

9.5.4 Voltage transformers shall be air insulated with accuracy class 1 for measuring and 3P for protection.

9.6 Anti-Condensation heaters

9.6.1 Anti-condensation heaters shall be rated for continuous service and shall operate on single phase voltage of 230Volt, 50Hz.

9.6.2 The numbers and sizes of the heaters, if not shown on drawings, shall be selected by the switchgear supplier. In such case the use of one heater in each cubicle is recommended.

9.6.3 The heaters shall be fed from dedicated power supply. This power supply system may be energized from a dedicated heater panel, independent lighting panel, or electrical distribution panel. The panels feeding the heaters in one section of the switchgear shall be fed from the opposite section of the bus bar.

9.6.4 Heater/s in each cubicle shall be protected by a miniature circuit breaker and an earth leakage protection device or residual circuit breaker of 30 mA sensitivity

9.6.5 In each cubicle a thermostat/hygrostat shall be provided for the operation of heater/s. An indicating light (preferably blue) shall be provided on the enclosure to indicate that the relevant space heater/s is in operation.

9.6.6 Heater/s terminals shall have safety cover .

9.7 Accessories

9.7.1 Accessories required for proper and safe operation of the switchgear shall be supplied. At least the following accessories shall be furnished for each assembly or group of assemblies in the same switch room.

a) Device for manually charging the stored energy operating mechanism of circuit breakers.

b) Handle for moving circuit breakers into positions.

c) Lifting trolley or similar device to remove circuit breakers or large starter modules from the cubicles.

d) Adapter cables and/or flexible cords for testing the withdrawable starter modules in withdrawn (out) positions.

e) Test cabinet for testing circuit breakers, if required (optional).

f) Special tools for erection and maintenance.

10 Tests and inspection

10.1 The equipment under this specification shall be factory tested. Three certified copies of test reports and certificates shall be submitted to the purchaser.

10.2 Fully type tests and routine tests shall be carried out on the low voltage switchgear and its componenets according to requirements of the recommendations of IEC series 60947, and 61439 and the relevant IEC publications referred to therein and related certificates shall be presented. Sample tests according to mentioned standards shall be accomplished by company representative request.

10.3 Purchaser will require the presence of his nominated representative to witness the tests based on IEC requirements as per agreed Quality Control Plan (QCP) and Inspection Test Plan (ITP). The supplier shall inform the date of such tests at least four weeks in advance.

10.4 The purchaser's inspectors shall be granted the right for inspection at any stage of manufacture and testing.

10.5 Prior to shipment of the switchgear an insulation resistance test shall be performed between each phase and neutral against earth, with the remaining phases and neutral connected to earth. The insulation resistance measured shall not be less than 5 mega-ohms. Also visual inspection and spot checks shall be carried out to verify at least the following:

a) The degree of protection of the enclosure;

b) The degree of protection within the compartments;

c) The effectiveness and reliability of safety shutters, partitions and shrouds;

d) The effectiveness and reliability of operating mechanisms, locks and interlock systems;

e) The insulation of the busbar system;

f) The creepage distances and clearances;

g) The proper mounting of components;

h) The internal wiring and cabling system;

i) The correct wiring of main and auxiliary circuits

j) The suitability of clamping, earthing and terminating arrangements;

k) The correct labeling of functional units;

l) The completeness of the data on the nameplates;

m) The availability of the earthing system throughout the switchgear;

n) The interchangeability of electrically identical components;

o) The non-interchangeability of mechanically identical but electrically different withdrawable units.

11 Spare parts

11.1 Together with the supply of all equipment under this specification, a complete set of spare parts for commissioning shall be supplied for each switchgear. The supplied spare parts shall comply with the same specifications as the original parts and shall be fully interchangeable with the original parts without any modification.

11.2 The vendor shall also supply a list of recommended spare parts for two years of operation.

12 Documentation

12.1 The vendor shall supply the necessary information with the quotation to enable evaluation of the submitted proposal. General documents /drawings are not acceptable unless they are revised to show the equipment proposed. The documents to be supplied with the quotation shall at least include the following:

a) Completed enquiry data sheet/s.

b) Summary of exceptions/deviations to this standard specification.

c) Brochures and catalogues containing description of typical switchgear and technical data on major and auxiliary components such as circuit breakers, contactors, relays, meters etc**.**

d) List of accessories included in the bid.

e) Preliminary dimensional drawings.

f) Approximate shipping weights and sizes.

12.2 The documents which shall be supplied together with the equipment shall at least include the following:

a) Generated drawings and schematics shall be delivered in native type and hardcopy.

b) Updated and completed enquiry data sheet/s.

c) Final single line diagram/s.

d) Schematic control circuit diagrams of each kind of circuit breaker and starter module.

e) General arrangement drawings showing main dimensions, panels' layout, floor panel and shipping sections.

f) Drawing/s showing the location of field wiring terminal strips and power cable connections.

g) Information concerning interlock sequences and all logic diagrams if applicable.

h) List of major and auxiliary components, showing complete reordering information for all replaceable parts.

i) Recommended spare parts list for two years of operation.

j) Test reports and performance curves of the final routine tests.

k) Painting specification and test result/s.

l) Applicable test certificates as stated in IEC61439-2 and Annex D of IEC 61439-1

m) Installation, operation and maintenance instruction/s.

n) Fault finding and trouble shooting manual/s.

o) Protective relay/s types, curves and setting ranges.

p) Cut-off current characteristics of fuses.

q) Total weight of the assembly and weight of the individual shipping sections.

r) List of accessories and/or any special tools required for erection, operation and maintenance.

13 Shipment

13.1 The supplier of the equipment under this specification is the sole responsible for packaging and preparation for shipment.

13.2 The packaging and preparation for shipment shall be adequate to avoid mechanical damage during transport, handling and stacking.

13.3 Each shipping section shall be provided with permanently attached identification tag containing necessary information together with the switchgear identification number indicated in data sheet Annex A.

13.4 Shipping documents with exact description of equipment for custom release shall be supplied, with the equipment.

14 Guarantee

14.1 The supplier of the equipment under this specification shall guarantee the equipment and shall replace any damaged equipment/parts resulting from poor workmanship and / or faulty design.

14.2 The supplier shall replace any equipment failed under the following condition:

- Failure under startup and commissioning tests performed according to IEC recommendations.

- Failure under normal usage for a period of 12 months, not exceeding 18 months from the delivery date to company.

Annex A

(Normative)

Low voltage switchgear and controlgear data sheet

The vendor shall complete and submit this data sheet with its proposal.
Items marked with asterisk will be specified by purchaser.

No.	Subject	
1.	Name of project or plant	*
2.	Switchgear identification No	*
3.	Single line diagram number	*
4.	Site elevation above sea level (m)	*
5.	Maximum indoor temperature	*
6.	Minimum indoor temperature	*
7.	24 hr. average indoor temperature	*
8.	Maximum outdoor ambient temperature	*
9.	Minimum outdoor ambient temperature	*
10.	Relative humidity	*
11.	Pollution Degree	*
12.	Installation (indoor/ outdoor)	*
13.	Area classification zones,(in case of outdoor installation)	*
14.	Nominal system voltage, 3phase and neutral	*
15.	System voltage variation	*
16.	Nominal frequency and frequency variation	*
17.	Neutral earthing system (solidly earthed)	*
18.	Incomers to the switchgear by duct or cable	*
19.	Enclosure degree of protection (IP code)	*
20.	External Mechanical Impact (IK code)	*
21.	Ics, Icu, Icw, Icm	
22.	Form of internal separation of the enclosure	
23.	Degree of protection of separation partitions or barriers (IP code)	
24.	Plate thickness of the enclosure	
25.	Color of the enclosure	
26.	Power busbars cross section	
27.	Busbars rated current	
28.	Busbars short circuit withstand current rms symmetrical	
29.	Busbars short circuit withstand time	
30.	Busbars insulation	
31.	Busbars colors, phases and neutral	
32.	Busbars joints silver plated or not	*
33.	Total length of the switchgear	
34.	Height of the switchgear	
35.	Depth of the switchgear	

No.	Subject	
36.	Shipping weight of the switchgear/individual shipping sections	
37.	Numbers of incomer circuit breaker/s	
38.	Numbers of bus tie circuit breaker/s	
39.	Tie breaker/s mode of operation OPEN/CLOSE	*
40.	Numbers of poles and current rating of incomer and tie breakers	
41.	Circuit breakers interrupting medium (if different than air)	
42.	Circuit breakers closing mechanism (direct manual/motor driven)	
43.	Circuit breakers breaking capacity rms symmetrical at 1sec and 3sec.	
44.	Circuit breakers breaking capacity (kA) rms asymmetrical	
45.	Circuit breakers making capacity (kA) asymmetrical	
46.	Opening time of circuit breakers	
47.	Closing time of circuit breakers	
48.	The voltage of the spring charging motor of circuit breakers	
49.	Circuit breakers closing and tripping voltage	
50.	Control of circuit breakers (local/remote)	
51.	Circuit breakers protective relays	Attach list or diagram/s
52.	Circuit breakers indicating instruments	Attach list or diagram/s
53.	Watt-hour meter for incomers (supplied or not)	*
54.	Additional auxiliary contacts for circuit breakers (paragraph 6.1.19)	
55.	Numbers and sizes of outgoing feeders	Attach list or diagram/s
56.	Type of outgoing feeders (ACB/MCCB/switch fuse)	
57.	Numbers and motor rating	Attach list or diagram/s
58.	Motor starters isolating means (fused isolator/MCCB)	
59.	Motor starters control voltage	
60.	Motor starters protection relays	Attach list or diagram/s
61.	Motor starters indicating instruments	Attach list or diagram/s
62.	Motor control stations (to be included or not)	*
63.	CT type and ratio for protection and indication metering	
64.	CT type and ratio for remote ammeter (on control station)	
65.	Numbers and wattage of anti-condensation heaters (if any)	
66.	4-20 mA output transducers 4-20 mA	
67.	Manufacturer of circuit breakers	
68.	Manufacturer of contactors	
69.	Manufacturer of switch fuses and MCCB's	
70.	Manufacturer of protective relays	
71.	Manufacturer of indicating instruments	
72.	Type test certificates for complete switchgear and components.	To be attached
73.	Accessories	Attach list
74.	Deviation from this specification if any	Attach list

Annex B

(Normative)

Additional requirements for outdoor low voltage switchgear

This standard mainly specifies switchgears for indoor installation. Where this standard specification is used for the manufacture of outdoor equipment the following clauses shall also be taken into consideration.

B.1 Service Condition

- The outdoor ambient air temperatures are indicated in data sheet Annex A. The outdoor type low voltage switchgear shall be suitable for operation at the specified ambient conditions.

- Outdoor type switchgear shall be installed in safe area according to the recommendations of IEC 60079-10 and API RP 505.

- This standard specification does not cover the switchgears suitable for installation in hazardous areas (zone 1 and zone 2).

– Equipment intended to be used in ambient air temperature above +40°C (e.g. in forges, boiler rooms, tropical atmosphere) or below –5°C (e.g. –25 °C, as required by IEC 61439 series for outdoor installed low voltage switchgear and controlgear assemblies) should be designed or used according to the relevant product standard, where applicable, or according to agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

- Ambient air temperature(s) for certain types of equipment, e.g. circuit-breakers or overload relays for starters, is indicated in the relevant product standard.

B.2 General requirements

B.2.1 Enclosure

- The enclosure of the outdoor type switchgear shall provide a degree of protection of IP55W according to IEC 60529 or the switchgear shall be housed in a non walk-in cabinet or cubicle with a degree of protection of IP55W. Each section of the enclosure shall be equipped with a hinged front door with provision for padlocking.

- Each section of outdoor type enclosure shall include anti-condensation heater conforming to article 9.6 of this standard specification.

- Within each section of outdoor type enclosure one lamp receptacle with on/off switch for interior illumination and one 230 Volt receptacle with integral ground fault protection for electric tools shall be provided.

- Outdoor type switchgear shall always be provided with suitable rain and sun canopy.

B.2.2 Busbars

- The busbars for outdoor type switchgear shall be silver coated and shall conform to article 7.2 of this standard specification.

B.3 Major components

B.3.1 Circuit breaker

- Air circuit breakers in outdoor switchgear shall be stored energy spring operated type and shall be equipped with manual charging mechanism. Manual operating mechanism for closing and tripping of such circuit breakers shall also be provided.