

PETRONAS TECHNICAL STANDARDS

MANUAL

Low-Voltage Switchgear And Controlgear Assemblies (Amendments/Supplements to IEC 439-1)

PTS 33.67.01.31

FEBRUARY 2011



PTS Circular 2011 – 1



PTS No:	33.67.01.31
PTS Title:	Low-Voltage Switchgear And Controlgear Assemblies (Amendments/Supplements to IEC 439-1)

This revision of PTS **33.67.01.31– Low-Voltage Switchgear And Controlgear Assemblies (Amendments/Supplements to IEC 439-1) (February 2011)** has been reviewed and updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font (if any).

The previous version of this PTS **33.67.01.31– Low-Voltage Switchgear And Controlgear Assemblies (Amendments/Supplements to IEC 439-1) (February 2010)** will be removed from PTS binder / e-repository from herein onwards.

Document Approval

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Revision History

Rev No.	Reviewed by	Approved by	Date

PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPUs in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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PART 1 INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for low voltage switchgear and controlgear assemblies.

Part 2 of this PTS amends and supplements IEC 60439-1 (1999 + A1: 2004), referring to the same clause numbers. The additional requirements specified in this PTS are required in order to:

- a. Make selections from the options given in IEC 60439-1,
- b. Specify additional and more stringent requirements, as necessary, to operate and maintain the gear in continuously operating plants,
- c. Specify supplementary provisions required to make the gear suitable for operation in the overall process control design.

Integrated Motor Control Systems (IMCS) when specified shall comply with Appendix 1.

The requirements specified apply to type-tested assemblies (TTA). For assemblies used as sub-distribution systems, with incoming feeders protected by short-circuit current limiting devices of a nominal current of maximum 400 A, less rigorous requirements can be accepted. This is indicated in ***bold italic text*** under the specific headings, and with reference to this clause for the above definition.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS group and to Contractors nominated by them.

This PTS is intended for use in oil refineries, gas plants, chemical plants, exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this PTS as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Integrated A system comprising control modules, central unit(s), a serial bus

Motor Control System (IMCS)	connecting the control modules to the central unit and a communication facility enabling connection of the central unit to a distributed control system (DCS) and/or a Supervisory Control and Data Acquisition System (SCADA).
Panel	A constructional unit of a (multi-) cubicle type assembly between two successive vertical delineations.
Requisition	is one of the following: PTS 33.67.01.93 (requisition for LV switchboard). PTS 33.67.01.94 (requisition for lighting distribution board). NOTE: PTS 33.67.01.80. (schedule for LV switchboard) is normally attached to the requisition.
Restarting relay (RR)	A relay which initiates the re-closure of a motor circuit under predetermined conditions, after a voltage depression or interruption.
Section	A constructional unit consisting of a number of panels connected to a continuous busbar system.
Sectionaliser unit	A mechanical switching device to connect the busbar of two sections.
Skeleton Compartment	A spare compartment for later completion but so equipped that completion can take place safely without the need to de-energise the switchboard or any other panel.
Time delayed restarting relay (TMR)	A time delayed relay which initiates a delayed re-closure of a motor circuit controlled by the process control system, under predetermined conditions, after a voltage depression or interruption.

1.4 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

- IEC numbers have been updated by adding prefix 6X;
- Reference made to newly developed IECs, and withdrawn IECs have been deleted;
- EMC requirements in latest version of IEC 60439-1 implemented;
- Appendix 1 on IMCS modified in order to:
 - make it a specification describing the functional requirements;
 - include the possibility to select specific features and extend the IMCS as required;
 - bring it more in line with the commercially available systems.
- A sheet has been added to the requisition specifying the features of the IMCS.

1.5 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced clause number is shown in brackets. Other documents referenced by this PTS are listed in (Part 3).

PART 2 AMENDMENTS/SUPPLEMENTS TO IEC 60439-1

In this part, clauses of IEC 60439-1 are amended or supplemented, or new clauses are added. Clauses of IEC 60439-1 that are not mentioned shall remain applicable as written.

3. CLASSIFICATION OF ASSEMBLIES

Add to this clause:

Although this standard is mainly concerned with fully withdrawable gear of (multi-) cubicle type assemblies for indoor installation, it shall also apply to fixed and semi-withdrawable cubicle type assemblies and combinations thereof, and to multi-box type assemblies and assemblies located outdoors.

Assemblies intended to be installed in hazardous areas (IEC 60079-10) shall meet the additional requirements specified by the Principal

4. ELECTRICAL CHARACTERISTICS OF ASSEMBLIES

Add to this clause:

During normal system operation and under steady-state conditions, the supply voltage shall not deviate from the rated voltage by more than 5 % and the system frequency shall not deviate from the rated frequency by more than 2 %.

Transient voltage deviations during e.g. motor or group motor starting/reacceleration shall be such as to maintain a minimum of 90 % and shall be not more than 110 % of rated voltage on switchgear busbars.

Switchgear to be installed on mobile and fixed offshore installations shall be suitable for continuous operation from a supply which is subject to voltage waveform distortions caused by thyristor controlled loads. In the quotation stage, the Principal shall advise the percentage Total Harmonic Distortion that has to be taken into account.

Deviation from the supply characteristics, if any, shall be stated on the requisition.

4.1 RATED VOLTAGES

Add to this clause:

The assembly shall be suitable to form part of a system with coordinated insulation values in accordance with IEC 60664-1, overvoltage category IV, and shall be type tested accordingly.

The overvoltage category of assemblies with a rated voltage in excess of 600 V shall be as a minimum category III.

4.2 RATED CURRENT

Add to this clause:

Unless otherwise specified in the requisition, the assembly shall be arranged for a TN-S power system, i.e. with separate neutral and protective busbars throughout the system.

The main busbars shall be rated for the nominal current over the entire length of the assembly and shall not be rated lower than the incoming and sectionaliser units.

4.7 RATED DIVERSITY FACTOR

Add to this clause:

For temperature rise tests or temperature rise calculations, a diversity factor of 1.0 shall be applied for each switchboard panel containing only one functional unit. If a panel contains two or more functional units, the rated diversity factor applied shall be not less than 0.9 when considering the circuit loads as known at the time of final inspection at the Manufacturer's works. Spare circuits and skeleton compartments shall be considered as being loaded to 90 % of their rated current.

Where IMCS is specified, the equipment shall be included in the temperature test.

This supplement does not apply to assemblies used as sub-distribution systems as defined in (Part 1; 1.1), to which the original clause of IEC 60439-1 shall apply.

5 INFORMATION TO BE GIVEN REGARDING THE ASSEMBLY

5.1 NAMEPLATES

Add to this clause:

Nameplates including circuit labels, instruction and warning plates and caution notes shall be made of durable, corrosion resistant material.

Add new clause:

5.1.1 General equipment nameplate

The following information shall be given on the general equipment nameplate, which shall be mounted on the front of the assembly, e.g. on the sectionaliser or incoming feeder:

- a. Manufacturer's name or trademark;
- b. Type designation;
- c. Purchase order number;
- d. Year of manufacture;
- e. Rated voltage;
- f. Rated frequency;
- g. Rated current of busbar system;
- h. Rated voltage of auxiliary circuits (if applicable);
- i. Rated peak and short time withstand current and withstand time;
- j. Degree of IP protection;
- k. Form of internal separation
- l. Pollution degree
- m. Hazardous area rating (where applicable)

The above information together with the other information of IEC 60439-1 clause 5.1 shall be given in the relevant documents of the Manufacturer.

Where applicable, other markings shall be provided on the assembly (e.g. CE, IECEx)

Add new clause:

5.1.2 Circuit labels

Each circuit of the assembly shall be provided with the following circuit identification labels:

- a. Circuit identification tag number in accordance with standard drawing S 67.021. The circuit labels shall be installed on the front of the fixed and the removable part of a withdrawable or removable unit and repeated at the main and auxiliary cable terminations which are not clearly identifiable from the physical layout, e.g. cable compartments at the rear or bottom of the assembly.

- b. Identification number of connected equipment or circuit destination as specified in PTS 33.67.01.80.

Add new clause:

5.1.3 Synoptic diagram

Assemblies shall be provided with a durable one-line synoptic diagram, indicating the busbar circuit and the specific function of the different compartments.

Synoptic diagrams are not required if the busbar system and the branch circuits can be viewed via transparent covers.

Add new clause:

5.1.4 Instruction plates

If the operating sequence or procedure of certain equipment items in the assembly is not evident, e.g. mechanical interlocking features, instruction plates shall be provided fixed near the point of operation. The instruction shall be given as far as possible in a pictorial manner.

Add new clause:

5.1.5 Warning plates, caution notices

In locations where dangerous situations may inadvertently be created, 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 an assembly.

5.3 INSTRUCTIONS FOR INSTALLATION, OPERATION AND MAINTENANCE

Add to this clause:

The Manufacturer shall supply at least the following drawings/documents in the quantities and at the times stated in form PTS 40.10.01.93, attached to the requisition:

- a. Final single-line diagram *,
- b. Schematic diagrams of all different types of circuits,
- c. Documentation as specified in Appendix 1 (in case of IMCS only),
- d. Final assembly arrangement drawing showing main circuits, main dimensions, panel layout, floor plan and shipping sections *,
- e. Minimum clearances around the assemblies for ventilation and safety during operation and maintenance *,
- f. Total mass of the assembly and of the individual shipping sections *,
- g. Transport, installation, commissioning, operation and maintenance instructions, limited and specific to the assembly and its components,
- h. Instructions of measures to be taken, if any, with regard to EMC associated with the installation, operation and maintenance of the assembly,
- i. List of recommended spare parts and SPIR forms (see PTS 70.10.90.11),
- j. List of applicable type test certificates,
- k. Test report of the final routine testing.

NOTE*: Items marked * may be combined, provided all information indicated above is included.

All documents shall show the relevant order number, item and Manufacturer's references, and shall be formatted and distributed as specified in the purchasing documents. Documents shall also be provided on a PC readable device (e.g. CD-ROM) in a format to be agreed by the Principal.

Assemblies supplied in transport units shall have these units clearly marked to facilitate assembly at site.

Erection instructions and any special tools required for erection and maintenance shall form an integral part of the order and shall be packed with the equipment.

The Manufacturer shall provide with the quotation preliminary arrangement drawings and details of component ratings, e.g. by filling in the appropriate sections of schedule for LV switchboard, and all other information as specified further on in this PTS.

The language used shall be as specified in the requisition.

6. SERVICE CONDITIONS

6.1 NORMAL SERVICE CONDITIONS

Add to this clause:

The actual service conditions shall be specified in the requisition if they are more onerous than those stated in IEC 60439-1.

The requisition shall specify the location (land or offshore installation) where the assembly will be installed. It also specifies whether the assembly will be installed indoors or outdoors.

6.1.2.3 Pollution degree

Add to this clause:

Unless otherwise specified in the requisition, the assembly and the components installed therein shall be suitable for use in a pollution degree 3 environment as a minimum. However, the air will be laden with dust, salt and/or sulphur as encountered in the petrochemical industries or in oil/gas fields.

6.2 SPECIAL SERVICE CONDITIONS

Add to this clause:

Any special service condition that the switchgear may be required to withstand in its operational location shall be specified on the requisition.

Equipment installed on mobile and fixed offshore installations shall be unaffected by vibration and shock. The equipment for these applications shall be tested according to IEC 61892-3:1999, Table 9, Item 9.

Unless otherwise specified, the switchboard shall be suitable for installation in a non-hazardous area as defined in IEC 60079-10.

6.3 CONDITIONS DURING TRANSPORT, STORAGE AND ERECTION

Add to this clause:

The requisition shall specify any special conditions that may arise, e.g. shock and vibration and/or extreme temperatures.

7. DESIGN AND CONSTRUCTION

7.1 MECHANICAL DESIGN

7.1.1 General

Add to this clause:

The assemblies shall be designed for continuous operation at full load for at least 90,000 h without maintenance which would require the main busbars and the distribution busbars (dropper system) to be de-energised. When operating under the specified service conditions, the main and distribution busbars including their connections shall not require maintenance during the lifetime of the assembly.

NOTE: 1) De-energising of the main busbar and distribution busbars after 90,000 h may be required, e.g. to inspect and clean the compartments.
2) Operation of switching devices may be required within the period of 90,000 h as mentioned above. For non-essential switchgear this may lead to de-energising of the busbar. Assemblies in vital and essential service will normally have dual feeders and bussection switches to cater for continuous operation, even when one of these switches is operated.

The assemblies shall have a design lifetime of at least 25 years, under the service conditions specified and maintained according to the Manufacturer's recommendation. Where IMCS is specified, the lifetime of this system shall be aligned with the lifetime of the assembly (see also Appendix 1).

All structural work shall be adequately protected against corrosion. Frame and partitions may be of galvanised steel without a further paint coating. Those parts/covers requiring painting shall be properly pre-treated before the final coat(s) of oil resistant finishing paint is (are) applied. The Manufacturer's standard colour is acceptable. If a Manufacturer does not have a standard colour, light grey is preferred for the external surface.

Assemblies shall comprise one or more sections of busbars to which incoming and outgoing units are connected. Busbar sections shall be linked through sectionaliser units.

In addition to the outgoing units specified in the requisition or schedule, spare skeleton compartments shall be included in each switchboard. The number of skeleton compartments shall be 10 % of each size of outgoing units of which at least three units are installed. They shall be allocated to the switchboard sections in accordance with the actual load distribution and the maximum load that can be accommodated shall be taken into account. A skeleton compartment shall be equipped so that completion at its maximum capacity can take place safely without the need to de-energise the switchboard or any other panel.

7.1.3 Terminals for external conductors

Add to this clause:

In view of the substantial cable derating that is normally applied, adequate terminals and cable termination space shall be provided for the main cabling. Details on size and type of cable and its conductors shall be given in the Schedule for LV Switchboard.

For main incoming and outgoing power circuit cabling, terminals allowing the conductors to be connected without the use of cable lugs of any type should be used. Adequate bracing and support for the cables shall be provided to avoid unrestrained movement under short circuit conditions.

Individual terminals shall be provided for each conductor of external auxiliary cables. These terminals shall be of the non-loosening wedge type or cage type construction, obviating the use of cable lugs. They shall be constructed in such a way that direct contact between screw, bolt or nut and conductor is avoided.

NOTE: For the termination of internal control wiring, push-on connections with insulation support of the compression type may be used.

Terminals shall be identified in accordance with the related wiring diagrams. The layout shall be consistent and logical. Unless otherwise specified, terminal arrangements for the control of motors shall be in accordance with drawing S 67.004.

As a standard, assemblies shall have facilities for the entry of cables from below. If top entry is required this shall be stated on the requisition. Cable entries, support facilities for cable clamping, and earthing facilities shall be provided suitable for the type, size and number of cables as specified.

Vertical cable compartments, where provided, shall provide sufficient space to satisfy the bending radii of the specified cables.

NOTE: For main assemblies cable compartments of form 3b, an effective width of 300 mm is generally sufficient. For cable compartments of form 4 switchgear, 250 mm is generally sufficient.

Cable glands or metal gland plates should only be included if specified in the requisition.

Gland plates and glands for single core cables shall be of non-magnetic material. In the case of single core cables with armour and/or lead sheathing, the requirement for special glands which allow for insulation between the armour/lead sheath and gland plate shall be specified in the requisition.

7.2 ENCLOSURE AND DEGREE OF PROTECTION

Add to this clause:

Switchgear assemblies shall be completely enclosed, self-supporting and suitable for floor or wall mounting, in multi-cubicle or multi-box type structures. The floor shall not be considered as being part of the enclosure.

Details of specific installation requirements for e.g. offshore facilities shall be specified by the Principal.

Cover bolts or nuts shall be retained in place when undone (captive bolts and nuts).

The degree of protection as defined in IEC 60529 for any assembly shall be:

- For indoor use (in enclosed buildings) IP 41
- For outdoor use (protected by e.g. rain canopy) IP 55

NOTE: Outdoor switchgear shall be provided with a rain/sun canopy.

The requirement for anti-condensation heating shall be specified in the requisition.

NOTE: Space heaters shall be included in the quotation as an option, if they are not specified in the requisition but the Manufacturer recommends their installation.

If anti-condensation heating is required inside the assembly, it shall be supplied from a separate source connected between system phase and neutral. The heating system of each section shall be separately protected and switched for isolation purposes by means of a miniature circuit breaker in combination with an earth leakage protecting device of 30 mA sensitivity. When the heating system is live, this shall be indicated by means of a prominently situated red LED. The heating system shall be designed in such a way that the heat is adequately distributed over all functional units.

7.3 TEMPERATURE RISE

Add to this clause:

The temperature rise limits as given in Table 2 shall not be exceeded when the assembly is fully loaded in accordance with the diversity factors as given in clause 4.7 of IEC 60439-1 as amended/supplemented by this PTS.

The temperature rise limits for assemblies operating in mean ambient air temperatures higher than 35 °C shall be agreed with the Principal at the quotation stage.

NOTE: Particular attention shall be paid to electronic components, e.g. IMCS if installed.