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1 Subject of specification

This specification used in conjunction with other technical specifications of LOTOS Group S.A., establishes minimal requirements regarding designing and execution of main Low Voltage Switchgears (with rated voltage up to 1kV).

Due to designation there are following types of main Low Voltage Switchgears:

- Main power distribution switchgears – RNN
- Main motor control switchgears – TS, MCC

Merging of above types in one switchgear needs LOTOS S.A. approval for each case.

Requirements for other Low Voltage Switchgears: Lighting Switchgears (ROE), Heat Tracing Switchgears (RPHT), Auxiliary AC Switchgears (RPZ) and Auxiliary DC Switchgears (RPS) are described in 4170 – "Low Voltage Auxiliary Switchgears" standard.

2 Scope of validity

This specification shall be used when preparing both quotations and Purchase Orders concerning planned LOTOS Group S.A. new investments and modernizations.

It shall also be a base for preparation of other detailed specifications and quotations relevant for package units or other equipment deliveries.

The Contractor is independently responsible for selection of equipment and materials to be purchased on the basis of technical design particularly in relation to instruments and equipment made in explosion – proof execution.

2.1 Deviations

Any deviations from this specification and relevant specifications, standards and documents, including the bidder's proposals indicating a more economic and/or technically better design or solution, shall be submitted in writing for checking and approval by LOTOS Group S.A. No deviation or modification shall be permitted unless confirmed in writing by LOTOS Group S.A.

The supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS SA or non-compliance with the referred documents / standards and obtain a written explanation from Grupa Lotos SA.

2.2 Exclusions

The scope of this specification does not include requirements concerning low voltage switchgear room. Such requirements are covered in civil specification – standard N° 5200 „Buildings"

3 Hierarchy of Documents

In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

- The current Polish legislation
- Terms of purchase order/contract and other requirements agreed in writing with GL SA
- Data Sheets approved by GL SA

- This Specification
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

CONTRACTOR: GL SA., LOTOS Group Inc., / BUYER

SUPPLIER: BIDDER/ SUPPLIER/CONTRACTOR

4.1 Designations

GL SA – LOTOS Group Inc.

LV – low voltage

AC -- alternate current

DC – direct current

NO – normally open

NC – normally closed

SZR – Auto Transfer Switching system

PPZ – Scheduled Supply Switching-over

DOL – Direct online Motor Start-up

CSNiM – Central Monitoring and Supervision System

KiA – Control and Automatics (Instrument)

EMC – Electromagnetic Compatibility

Shall – Indicate a mandatory requirement

5 Description

5.1 Ambient conditions

- Atmosphere — marine, aggressive industrial, chemical and dusty
- Ambient temperature (max/min) — +36°C/-25 °C
- Relative humidity (max/min) — 90%/70%
- Elevation above sea level — 1m
- Wind speed — 26 m/s
- Work conditions — refinery, sea coast

5.2 Electrical network parameters

- Medium voltage — 15kV (LOTOS Railway, North Marine and 6000V, Przejazdowo Water Supply Point), 3-phase,

	IT (isolated network)
	10.5kV (GPZ3), 3-phase, IT (isolated network)
	6kV (GPZ1, GPZ2), 3-phase, IT (isolated network)
▪ Frequency	50Hz with +4%/-6% allowable tolerance
▪ Low voltage	400V, TN-C/S with +/-10% allowable tolerance
▪ Low voltage (lighting, heating)	230V, TN-S
▪ Low voltage (emergency lighting)	110V DC
▪ Alternate current control voltage	230V, 1-phase
▪ Direct current control voltage	24V DC, 110V DC or 220V DC

5.3 Basic design requirements

5.3.1 Documentation

The bidder (supplier) shall submit to GLSA for approval the following documents:

- list of documents
- operating manuals
- dimensional drawings
- data sheets filled by supplier
- diagrams of the switchgear
- drawings for outfit of cubicles (equipment arrangement),
- layout drawings for control/signalling devices and connection terminals
- assembly diagrams
- list of equipment
- spare parts list
- test schedule
- certificates
- EMC declarations
- declaration of conformity
- mounting and maintenance instructions
- others, required by legislation

5.3.2 General requirements

Reliability, smooth operation, safety and easy handling are required for all equipment applied. Typical equipment should be used. Application of prototype equipment, not registered and not admitted for production is forbidden.

Spare parts should be attainable through 10 years minimum.

Rated data for equipment shall correspond to continuous operation rated data of the equipment, at specified (previously given) working conditions.

Nominal working conditions of equipment shall fulfil requirement for at least nominal voltage and nominal current ranges, for all applications and with voltage tolerance ±10%.

The supplier shall deliver thermal balance emitted by equipment, on assumption that all equipment is working at full load.

The switchgear must fulfil requirements of EMC directive, which means that it shall properly operate in defined electromagnetic environment, while not introducing additional electromagnetic interferences.

5.3.3 Technical requirements

The typical switchgear shall be fabricated as indoor use, free-standing, single-system, two-section, in metal enclosure.

The supplier should deliver a typical switchgear, fabricated according to applicable standards and regulations, and having certificate of official certification.

Equipment and instruments dedicated for operation inside a building located outside of explosion hazard areas should be used.

Cubicles of the switchgear shall be adapted to assembling on a frame installed in electric station building, in switchgear room. The frame shall be included in the switchgear scope of supply.

The switchgear shall be:

- entirely prepared for connection to Central Monitoring and Supervision System
- equipped in dedicated, computerised control, protections and signalling system (using of computer system and its type needs GL SA. approval for each case).

5.4 Design requirements

5.4.1 Electrical parameters

Insulation rated voltage	Ui = 1000V
Operating rated voltage	Ue= 690V
Rated short circuit current	min. 60kA. 1sec.
Auxiliary voltage	24V DC (protection, control and signalling circuits in outgoing feeders), 110V DC (SZR, incomers and tie breakers control circuits), 230V AC (power supply for motor contactors in motor cubicles)
Supply system	TN-C/S - main power distribution switchgears – RNN TN-S – main motor control switchgears – TS, MCC
Outgoing cubicles	TN-S (Circuit breakers, fuse switch disconnectors in 4-pole version in case of using neutral pole, - if not - 3-pole version)

Auxiliary voltage must be finally agreed with GL.

5.4.2 Operating conditions

The switchgear shall be installed in electrical station building, in the room intended for LV switchgear location. Temperature in switchgear room should not exceed +5ºC ÷ +40ºC range.

5.4.3 Enclosure

The switchgear shall be fabricated as indoor, free-standing, in metal housing. Required protection class IP30.

Metal enclosure of the switchgear shall be equipped in at least two connection points to earthing system.

Design of all switchgear units must preclude penetration of rodents, birds etc. to their interior. Enclosure door must be equipped with gaskets against rodents / insects.

5.4.4 Basic design requirements

Construction of each cubicle shall be adapted to possible extension of the switchgear by adding new cubicles. Solutions of cubicles shall permit adding of new ones later on, without need for any cutting, welding or structure changing.

Each cubicle shall have metallic external guards, excluding floor which constitutes integral part of the enclosure, as well as door locked with standard key lock. The cubicles shall be fully separated one from another. Electric arc protection barriers shall be applied between cubicles.

Functional compartments in a cubicle shall be separated one from another with internal partition walls.

Cubicles of the switchgear shall be composed of the following functional compartments:

- busbar compartment (main and distribution busbars)
- equipment compartment
- cable compartment
- control compartment (for feeding cubicles)

Opening of both busbar compartment and cable compartment shall be possible only with use of adequate tools.

Compartments of the switchgear cubicles shall be easily accessible from front side, and easy exchangeable. Compartment door shall be fastened to cubicle structure by means of regulated hinges.

Opening angle of door shall not exceed 120°. Opening of door shall not cause damage or actuation of equipment mounted on them.

Modules should be separated one from another with horizontal particle plates made of metal or proper type of material.

All partition walls shall minimize spreading of electric short circuits effects, formed inside the switchgear, outside of the place of their arising.

Structure of switchgear cubicle shall be made of galvanized elements. The other components should be made of sheet steel plate coated with epoxy resins. Painting method will be determined during detailed planning stage.

Depending on switchgear designation the individual cubicles should be made as:

- stationary incoming and tie feeders, circuit breakers in withdrawable version – for RNN, TS and MCC
- outgoing feeders as withdrawable cubicles – for TS, MCC,
- stationary outgoing feeders with removable breakers or stationary fuse disconnectors – for RNN type

Earthing PE busbar, with cross-section fulfilling requirements of valid regulations, should be laid inside panels.

Main busbars shall be divided into sections, corresponding to transport division length. In place of the switchgear installation, individual sections of busbars shall be joined with copper band or by bolting, according to supplier standard. Joining of busbars shall proceed without need for their relocation.

Easy access to equipment mounted inside the switchgear cubicles shall be provided. All indicators shall be visible.

All cubicles of the switchgear shall have sufficient ventilation provided, by means of air grates. It is necessary to ensure adequate carrying away of heat generated by equipment mounted inside the cubicle. The switchgear shall be built in such a way, that at maximum ambient temperature rise additional mechanical ventilation would not be required.

Each outgoing cubicle shall have reserve outgoing feeders, at least 20% for each section, according to schematic diagram of the switchgear, approved by GL SA..

For switchgear designs, where such solution is possible, pockets for drawings/documentation shall be fitted on cubicle door.

For transportable equipment, which weight exceeds normal transport possibilities, conveying device should be foreseen.

Together with the switchgear, the following drawings shall be delivered:

- general arrangement of cubicles
- front view
- outfit of cubicles (arrangement of equipment)
- arrangement of control and signalling instruments
- one line diagram
- expanded assembly diagrams of whole switchgear
- assembly diagrams.

All equipment shall be unequivocally marked, according to control diagrams and one-line switchgear diagrams.

The supplier shall provide detailed data concerning assembly of the switchgear, along with data regarding installation of mounting frame, included in scope of switchgear delivery.

On switchgear front shall be drawn switchgear one-line diagram with description of power sources on main incomer cubicles, incomer feeder diagrams, tie diagrams, and main and distribution busbars.

5.4.5 Automatics of the switchgear

Due to required reliability of power supply for main motor control switchgears TS, MCC automatics for section incomers and tie should be realised by microprocessor device e.g. AZRS-3, dedicated to Auto Transfer Switching System – SZR, including incoming and bus-tie feeder, along with Scheduled Supply Switching-over – PPZ. SZR system task is to minimize effects of partial switchgear supply failure and independent additional power supply sources control.

PPZ system shall enable uninterrupted switching over of incoming feeders.

For RNN types of switchgear is required that incomer and tie breakers shall have possibility of planned closing of parallel all three (two incomers and tie) breakers. In this type of switchgears should not be implemented SZR/PPZ system.

5.4.6 Busbar system

Low voltage switchgear should be equipped with:

- five-busbar system of main busbars (L1, L2, L3 busbars should mounted in upper or rear part of the switchgear cubicles. Earthing and neutral busbars should be laid horizontally, along lower part of cubicles).
- framing system of auxiliary circuits.

Main busbars shall be separated from framing auxiliary circuits.

The busbars should be such selected thermally and dynamically, so as to withstand maximum short circuit current on incoming feeder side.

Busbar cross-sections must be such selected, that their load capacity is greater, or at least equal to 120% of nominal current of incoming feeder. Required rated withstand shall be approved by GL SA. for each case.

Allowable temperature rise of busbars should amount to 40ºC for maximum load conditions and natural ventilation

While making selection of number and location of buses fastening, as well as method of their coupling, it is necessary to take into account the following requirements:

- dynamical forces present in failure conditions
- resonance phenomenon
- insulating gaps

Size of the buses shall be constant along whole switchgear. The buses shall be marked with L1, L2, L3 labels from left to right side, and from top to bottom.

Layout of busbar system, i.e. the buses, connections of individual bus sections and fixed contacts for withdrawable buses elements, shall be made of electrolytic copper. Connections between fixed contacts and cable terminals, such as in case of measuring current transformers, shall be made with copper buses.

Flexible connections shall be used in case of necessity for compensation of expansion, spreading and short-circuits or vibration transfer on connections or busbar system prevention, which can be harmful to the system.

Earthing bus should be installed on the whole length of switchgear unit.

The following elements shall be connected to PE earthing bus:

- metal parts of housings
- cable screens or metal shields (if required)
- secondary windings of current transformers.

Earthing bus shall be connected in two places to external earthing system. Adequate terminals should be provided in switchgear for this purpose.

5.4.6.1 Auxiliary circuits

Voltage for auxiliary circuits:

- 230V AC to supply main contactors in motor and space heaters outgoing feeders
- 110V DC to supply SZR/PPZ automation device, incomer and tie breaker control and for selected signalization circuits

- 24V DC to supply protection, control and signalization circuits in motor outgoing cubicles

The following 24V DC power supply systems for auxiliary circuits are preferred:

- In case of lack substation 110V DC or 220V DC power supply system is required that 24V DC auxiliary systems will be supplied from redundant 230V AC/24V DC modular power supply unit. Power supply unit shall work in automatic mode, supplying common for section I and II 24V DC auxiliary circuits using two impulse converters working parallel, and in case of lack of main power supply using mounted inside batteries. In case of malfunction of one converters the second one should cover in 100% current consumption for whole switchgear. Power supply unit should be equipped in voltage regulated charger with temperature compensation. Power supply unit should be equipped in acoustic and optic LED signalization. Basic signals about power supply unit condition e.g. external alarm should be connected to substation common signalization system as a dry contact.
- In case when substation DC power supply system (110V DC or 220V DC battery) is available it is preferred supplying 24V DC auxiliary circuits from redundant 110V/24V DC or 220/24V DC converters. Converters, supplied from DC switchgear, should work parallel for common 24V DC switchgear auxiliary circuits. It is required that one converter shall be able to cover 100% of whole switchgear current consumption. Converters shall be equipped in permanent voltage control. Internal alarm from converters should be connected to substation common signalization system as a dry contact.

In each case selected 24V DC or 110V DC power supply system for auxiliary circuits shall be agreed with GL SA.

5.4.7 Cable compartment

Cable compartment shall be made in such a way, that supply and control cables would be easily connected to adequate terminals of each outgoing feeder.

Earthing terminals, intended for earthing of cable screens or armour, shall be made in cable compartment.

All elements that can be live, shall be guarded. Cable compartment shall be adapted for safe routing and connecting of cables without additional safety measures use, in case when the switchgear is live.

All cable glands and other insulation materials necessary for making of connections constitute part of the switchgear, and shall correspond to the number and type of cables used. The cables shall enter from switchgear bottom side through cable entrances fitted with rubber bushings or cable glands.

There shall be foreseen additional cable entrances for future cable enter and connection to spare feeders Spare cable entrances should be cover by rubber stop-plugs

Adequate structures for fastening of cables shall be made in cable compartment to allow cable mounting by special cable holders. It is not allowed to fix cables to construction by cable binders. It is required that cables shall be also fixed (to cable structures by special cable holders) in cable cellar. Fixing cables in switchgear cable compartment only is prohibited because it allows for free hanging down of cables in cable cellar.

5.4.8 Equipment compartment

Cubicles with withdrawable, movable or fixed modules shall be such dimensioned, that connection of those modules to common busbar system would be possible (height, width, main busbars, etc., shall fit each other).

All precautions, making accidentally access to the switchgear compartments interior impossible, shall be applied. All permanent, insulated contacts shall be guarded.

Dismountable handles, for carrying purposes, should be mounted on upper or lower part of panel. Upper frame shall be strong enough, to withstand all stresses occurring during transport.

Main current circuits of control instruments, relays, fuses, overcurrent breaker switches, shall be isolated from auxiliary circuits.

Earthing terminal should be made in each feeder cubicle and in each busbar compartment. Earthing terminals shall be easily accessible.

5.4.9 Wiring

Main current circuits:
Copper conductor in PVC jacket – cross area 2.5 mm^2 as minimum

Control circuits:
Copper conductor in PVC jacket – cross area 1.5 mm^2 as minimum. For prefabricated circuits, application of conductor of 0.75 mm^2 cross section is allowed.

Wiring shall be performed carefully, according to valid regulations, norms and long-term workmanship practice and in such a way, that finding and rectifying of possible defects would be easy.

Not more than two wires can be connected to single terminal, only single wire to single modular terminal.

The conductors can be of cable type, single- or multi-wire. Multi-wire conductors should be used for flexible connections of equipment mounted on cubicle door. Such conductors shall be protected against mechanical damages by means of flexible protective tubes.

Each conductor end shall be equipped with connector, enabling connecting it to terminal strip, and with terminal enabling connecting it to specific equipment. For multi-wire conductors sleeve-type cable terminals should be used.

For single-wire conductors, yellow and green colours are not allowed, in order to avoid mistakes with yellow- green PE conductor.

All conductors shall be marked next to connection place by means of markers using two side address method. It is prohibited to mark conductors by potential method. Terminals of equipment and instruments shall also be marked, which would enable to avoid improper connections with terminals strips.

Insulation of conductors shall be fire resistant, of fire resistance in excess of 15 sec.

In places, where fire resistant conductors will not be applied, adequate barriers, preventing spreading of fire between compartments of the switchgear, should be used.

Conductors to heaters of motors' windings, as well as to other equipment that can heat up to high temperature, shall be adequately thermally resistant.

Conductors to telemetry instruments shall be screened. The screen shall be earthed on single end.

The following colours of insulation shall be used:

AC current circuits:	black for phase, ends and terminals (L1, L2, L3)
AC neutral conductor:	light-blue
AC control circuits:	black, with numbering of ends
DC circuits:	grey, with numbering of ends

PE protective bus: yellow / green

Marking scheme of conductors should be agreed with GL SA.

Terminals shall be marked in accordance to 6120 "Process identification system" standard, section "Electric equipment identification system" and agreed with GL SA.

All internal circuit conductors in each cubicle and all conductors coming from external circuits shall be marked by address method. Other marking method for internal wiring is not allowed.

It is required that all conductors shall be in one piece – making connections on one conductor by any kind of junction elements is prohibited.

5.4.10 Terminals

All incoming and outgoing feeders shall be equipped with separate terminals.

The terminals with short circuiting switches should be used for main circuits, so that disconnection of one cable shall not result in disconnection of others.

All terminals shall be selected for cables of cross-sections listed on technical documentation

All terminal strips and all terminals shall be marked in accordance with technical documentation.

Connecting terminals shall be grouped in the following way:

- Separately for measuring transformers
- Separately for DC current circuits
- Separately for control and signallig circuits

Individual groups of terminals shall be separated one from another by means of insulating partitions.

Only single conductor can be led into single terminal. Interconnections shall be executed by means of bridges.

Measuring terminals and short circuiting terminals should be made for voltage and current transformers.

Control circuits connected to SIL system shall have separate connection terminals strips.

10% as a minimum of reserve terminals should be foreseen for each terminal strip.

All terminals and terminal strips shall be of the same type. Wherever bolting of conductor can cause its damage, latch type terminals should be used.

Terminal strips shall be made for all internal and external control, measuring, protection and supply circuits.

Terminal strips shall be arranged in cable compartment in such manner, that enough space would be provided, necessary for execution of connections, conductors and cables change-over and tags placement.

5.5 Incoming feeder and bus-tie feeder

Low voltage switchgear can be fed from power transformers or from diesel generator (emergency feeding) or from main switchgear (e.g. from switchgear TS or MCC type).

Incoming feeders and bus-tie feeder shall be provided with automatic circuit breaker, stationary type with electric drive.

Rated parameters of circuit breakers shall be matched to maximum power demand of feeding transformers (their rated data), or to rated parameters of diesel generator.

Automatic circuit breakers shall be selected for short circuit parameters determined in clause 4.4.1 of this specification.

Short circuit and overcurrent protective instruments should be intergated with breakers and perform selectivity of actuation:

- with protective instruments in medium voltage switchgear (power transformers)
- with protective instruments of power transformers
- with protective instruments of diesel generator.

5.6 Reactive power compensation

Each section of LV switchgear fed from power transformer, may be provided with banks of capacitors in free-standing version. The necessity of installing of capacitor banks shall be agreed with GL SA.

Bank of capacitors is not required for section fed from diesel generator.

Requirements for bank of capacitors are included in specification N° 4150 "Reactive power compensation".

5.7 Outgoing feeders

All outgoing feeders in contactor switchgear (TS, MCC type) shall be of withdrawable type.

5.7.1 Motor feeders

5.7.1.1 General requirements

Motor control system shall provide:

- flying start with possibility of switch off this function
- automatic restart after voltage failure with restart time delay setting or restart switch off

The motor feeders shall be located directly in main switchgear, in planned manner.

- Two drives making the same function in parallel (motor "A" and "B") cannot be fed from the same section.
- Arrangement of motor feeders shall be characterized with the following order:

Process drives	Feeding from section
MP1A	1
MP1B	2
MP2A	2
MP2B	1
etc.	etc.

* Assuming, that the drives making the same process function are doubled, i.e. A and B.

In motor feeder field, control circuits and anti-condensing heater supply, fed with 230V 50Hz voltage, should be foreseen.

All signals sent to DCS in central control room, shall be sent by interposing auxiliary relays, separately grouped for each motor.

In order to ensure work safety, possibility of switching the motor on directly from switchgear, with use of pushbuttons or auxiliary switches, should be precluded.

Switching on and off of power breaker-switch directly from the switchgear, should be enabled exclusively in „TEST" position.

Possibility of motor feeder cassette locking in „OFF" position shall be provided, for safe execution of works on the drive.

Soft-start systems shall be applied if necessity arises. In this case feeders for those soft starts shall be equipped in fuse disconnectors only.

Control of motor feeder should be executed on the basis of control diagram, approved by GL SA.

5.7.1.2 "Intelligent" switchgears

In case of so-called "intelligent" switchgears, motor feeders shall be provided with microprocessor protections, featuring the following functions: Manufacurer, type and planned to use protection functions should be agreed with GL SA during design phase prior to purchase.

Motor outgoing feeders shall be provided with:

- Power fuse (fuse switch disconnector) for short-circuit protection
- Power contactor (230V AC controlled)
- Network electronic protection module
- Auxiliary circuits (protection, control and signalling – with signalization on front panel of withrawable module)

5.7.1.3 Classic type switchgears

In case of classic type switchgears, for the sake of feeding asymmetry protection, the following solutions should be applied:

- Power fuse (fuse switch disconnector) for short circuit protection)
- Power contactor (230V AC controlled)
- Independent electronic protection module
- Auxiliary circuits
- Signalization circuits with signalization on front panel of withrawable module)

5.7.2 Non-motor outgoing feeders

Non-motor outgoing feeders shall be provided with:

- for 3-phase circuits – fuse switch disconnectors, 4 –pole, coupled (3 fuses in phases + short-circuiting switch for N). Caution: it is necessary to check on design stage, if fuses selected in phase conductors ensure effectiveness of N cable conductor protection (considering long-term load) with one of phase fuses blown out, and two-phase operation with N conductor connected.
- for 1-phase circuits - 2-pole overcurrent circuit breakers (with protection only in phase pole, the second one being disconnected jointly with phase pole).

5.8 Switchgear (switching instruments)

5.8.1 Circuit breakers

It is required that each three-phase outgoing feeder should be equipped with fuse switch disconnector in four-pole version, providing feed disconnection possibility, and performing function of short-circuit protection and contactor in main circuit as switching element.

It is prohibited to use disconnector/breraker as switching on/off element for motor type consumer. Breakers with integrated short-circuit and overcurrent protection shall be used for incomer and tie, and for outgoing feeders for capacitor banks.

Each single-phase outgoing feeder should be protected with two-pole miniature circuit breaker, providing feed disconnection possibility, and performing function of overcurrent protection.

Each circuit breaker shall be adapted to work in "OFF-ON-OFF" cycle, starting from "ON" position. Each circuit breaker shall be provided with indicator of mechanical spring engagement and disengagement, as well as indicator of mechanical switching on and off. Circuit breakers with electric drive shall be equipped with adequate short circuit trips, rise type.

After emergency switch off, actuated by short circuit protections, switching on the circuit breaker again can take place only after intentional, manual resetting of the circuit breaker protection.

5.8.2 Contactors

Rated parameters of contactors shall be selected for appropriate rated values of motors being fed, with consideration given to their start-up conditions.

In order to increase operating ability of motors in the moment of voltage drop, the contactors shall be provided with special coil for 75% of rated voltage.

Each contactor shall be equipped with auxiliary NO and NC contacts, for connection of interlocks, signalling, etc.

It is required that main power contactors shall be supplied from own withrawable cubicle 230V AC circuit in both "RUN" and "TEST" positions.

5.8.3 Control and signalling instruments

Control, protection and signalling instruments shall be unequivocally marked, according to technical documentation

For incoming and outgoing feeders control valotage is similar with auxiliary voltage (refer to p. 4.4.1), with exeption of main power contactors, which shall be controlled by 230V AC..

Pilot lamps

LED or neon type pilot lamps should be used. All installed lamps shall be of uniform type, with glass fittings.

Signalling circuits shall have their own protections.

Colours of lamps should be selected according to valid regulations and norms.

Danger shall be signalled with use of red colour.

Each lamp shall also properly functioning in "TEST" position.

Control and signalling

Control circuits shall be protected with two-pole miniature circuit breakers. Characteristics of these circuit breakers shall be such selected, that selectivity of protections is ensured.

Miniature circuit breakers shall be manually switched on and off, and they shall be equipped with auxiliary contacts, enabling monitoring of these circuit-breakers.

Control and signalling system shall be fed with the following voltages:

- internal circuits of control and signalling – with auxiliary voltage (refer to p. 4.4.1)
- main outgoing feeder power contactor shall be controlled on 230V AC voltage
- external circuits of control and signalling (connections to control columns of motors and DCS) – with 24 V DC voltage.

Auxiliary relays

Auxiliary relays should be used in order to:

- multiply of auxiliary contacts
- obtain time delays in control
- monitor of voltage condition in control circuits
- separate signals transmitted to DCS.

5.9 Measuring instruments

5.9.1 Current transformers

Current transformers, of 5 or 1A secondary current at rated primary current should be used in case of necessity.

Secondary windings shall be appropriately connected to terminals, and unequivocally marked.

Measuring transformers shall be selected according to requirements of measuring instruments applied.

Dynamical and thermal resistance of current transformers shall correspond to short circuit parameters of individual system elements.

The current transformers shall operate uninterruptedly at load equal to 120% of rated current.

- Measuring current transformers shall be of class 0.5 (for ammeters and settlement system)
- Measuring current transformers shall be of class 1 (for measuring instruments, excluding ammeters)
- Current transformers for protecting devices shall be of class 3.

Each motor outgoing feeder for motor of rated power **>15kW** shall be provided with current transformer and ammeter located on motor local control station.

5.9.2 Instruments

The instruments supplied directly with 400V voltage and maximum current load of contacts 10A should be used, excluding measuring transformers (unless otherwise settled).

230V, 1 ampere secondary circuits should be equipped with shunts of 100mV measured value. If instruments' overload is possible, then saturated transformers should be used.

Glass shields of instruments shall feature anti-reflexive and non-glossy design.

Indicating instruments shall be calibrated and provided with movable coil for alternate current circuits. They shall also withstand 20% constant overload without being damaged.

AC indicating instruments shall be equipped in removable contacts. DC indicating instruments shall have removable coil. They shall withstand 20% constant overload without being damaged.

The following dimensions of instruments are allowable:

96x96mm/90° , 72x72mm/90° , 48x48mm/90°

The instruments shall have:

- circular scales, beyond 90°, concentrated in higher ranges
- black frames
- white scales' background with black letters

Required accuracy of the instruments: 1,5%.

It is allowed to use digital instruments after agreement with GL SA.

5.9.3 Arrangement of circuits

Control, protection, monitoring and signalling circuits, present in the switchgear, shall be executed according to closed circuit principle, i.e. each feeder control circuits are independent from other feeders control circuits.

Above-mentioned circuits should be single-phase fed.

All control circuits shall be:

- divided to high degree
- controlled by voltage control relays or by miniature circuit breakers equipped with auxiliary contacts. Voltage failure shall be signalled by adequate lamp.

Number of voltage control relays, auxiliary contacts and pilot lamps shall correspond to needs, and should ensure proper monitoring of control circuits.

For further details – refer to control diagrams (provided by GL SA.).

5.10 Connections to DCS

Scope of connections to DCS system shall be every time agreed with GL SA. in written form. Each time project for connections with DCS shall be compared with Control System project for this scope.

5.11 Links to CSNiM

1Scope of connections between Low Voltage switchgears and monitoring and supervision system shall be agreed with GL SA. in written form each time.

5.12 Marking

The main and auxiliary buses, as well as cable terminals, must be marked.

Removable nameplates shall be placed on the front of cubicle. If rear access to switchgear equipment is foreseen, then necessary nameplates should be places on switchgear back as well.

All inscriptions shall be legible and made in Polish language.

In case of withdrawable units, the nameplates shall be placed both on fixed parts and on movable parts.

Each device shall be described with use of permanent nameplates, according to technical documentation.

Reserve cassettes shall be labelled, along with specification of their maximum rated current or maximum rated power.

All cables and conductors shall be labelled according to assembly diagram.

Contents of the nameplates should be agreed with GL SA.

5.13 Painting

Factory painting standards for determined, harsh ambient conditions, should be employed.

Minimum thickness of paint layer should be greater than 60 micrometers.

Final RAL colour should be adjusted with GL SA.

5.14 Scope of delivery

The delivery shall include the following items:

- Completed LV switchgear built in accordance to this specification and relevant documents.
- Documentation of the Supplier which include calculations, diagrams, installation requirements, confirmations for tests and trials, adequate certificates.
- Fine accessories, fuse-links, connectors, nuts, auxiliary materials, etc.
- Spare parts necessary for starting-up and commissioning.
- Spare parts for 2-year operation period.
- Adequate packaging and transport to installation site.
- Supervision on erection, tests, start-up and commissioning.

5.14.1 Reserve outgoing feeders

Quantity of spare outgoing feeders should be agreed with GL SA. In case ol lack of such agreement it is required that Supplier should provide minimum 20% of reserve outgoing feeders.

It is required for outgoing feeders to contain each type of withdrawable module type, occurring in the switchgear.

5.14.2 Tools and spare parts

The Bidder shall deliver:

- tools
- spare parts

necessary for start-up and exploatation of the switchgear.

Furthermore, the Bidder shall submit list of spare parts for 2-year operation. This list, and price list of specified spare parts, shall be submitted to GL SA. prior to receiving order on the switchgear delivery.

The Bidder should deliver 0,5l of paint used for the switchgear painting.

5.15 Quality control

The quality control shall be carried out according to requirements of valid standards and regulations. The manufacturer procedures should be applied as a minimum.

5.15.1 Inspection

Inspection of the switchgear shall be carried out in presence of Buyer, or representatives assigned by him.

The Buyer acceptance does not release the supplier from liability for keeping to purchase terms, delivery of required documents and fulfilling of all requirements of this specification.

5.15.2 Factory tests

The supplier shall carry out all required tests according to factory procedures, this specification, relevant data sheets and adequate domestic and international regulations.

Filled certificate of completed tests shall be issued after their positive completion.

The supplier shall submit to GL SA. for revision schedule of factory tests and activities, resulting from procedures regarding these tests, minimum 8 weeks in advance of their beginning date.

The supplier is responsible for delivery of copies for current operating conditions of tests, confirmed with certificate of completed tests.

All measuring equipment and instruments shall have up-to-date certificates, issued by independent firms.

Below listed tests and trials shall be carried out for each cubicle by Supplier, and confirmed with a certificate for following scope:

- Standard tests according to PN-EN 60439. All circuit breakers and all cassettes in outgoing cubicles shall be inspected visually and functionally, with consideration given to overloads.
- Tests of dielectric strength, described in detail in PN-EN 60439 standard
- Insulation resistance measurement by means of insulation resistance of 1000V
- Graduation and polarity check for all current and voltage transformers at original, unequivocal representation
- Original, unequivocal representation for protecting relays, and for ±10% of random chosen thermal relays.
- Checking of releasing and engaging of contactor contacts.

- Detailed simulation test for selectivity of protections

The supplier shall specify number and type of tests, which have to be carried out for working switchgear.

5.15.3 Acceptance

Acceptance of the switchgear by Buyer can be proceed after:

- Carrying out of all tests by supplier, with test results being satisfactory for Buyer
- Approving by Buyer of all documents listed in purchase documentation.

5.16 Guarantee requirements

Main requirements regarding the guarantee are contained in purchase documentation. The guarantee shall include all equipment and instruments installed in cubicles of the switchgear, until end of their operation period.

5.17 Deliveries

The switchgear shall be delivered to GL SA. according to requirements contained in purchase documentation.

All devices shall be protected for period of transport. Particular attention should be paid on protections of measuring instruments and protecting devices.

The equipment shall be protected against moisture penetration and improper handling during transportation and storage. The supplier shall analyse necessity for anti-condensation heaters installation. .

6 Relevant documents

- Other Technical Specifications, shown on delivered List of Technical Specifications for GL SA.
- Specification N° 4150 „Reactive power compensation”

7 Codes and standards

Low voltage switchgear shall be fabricated according to below listed Polish Standards PN-EN, PN-IEC and European equivalents of IEC/CENELEC standards.

PN-IEC 60050-151	International electrotechnical vocabulary. Part 151: Electrical and magnetic devices.
PN-EN 60073	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators.
PN-IEC 60050-441	International electrotechnical vocabulary. Part 441: Switchgear, controlgear and fuses
PN-EN 60439	Low-voltage switchgear and controlgear assemblies. (all parts)
PN-EN 60669	Switches for household and similar fixed electrical installations (all parts)

PN-EN 60243-1	Methods of test for electric strength of solid insulating materials. Part 1. Tests at power frequencies
PN-EN 60947 (all parts)	Low- voltage switchgear and controlgear
PN-EN 61095	Electromechanical contactors for household and similar purposes.
PN-EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals and of terminations of certain designated conductors, as well as general principles of alphanumerical system.
PN-EN 60529	Degree of protection provided by enclosures (IP code)

Low voltage switchgears built according to other norms and standards shall be submitted to GL for approval.

8 Record of changes

No.	Date	Description	Introduced by
0		This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 424 with the same title.	J. Bućko
1	30-11-2013 (rev.1)	Review, update, standardize and changes to the Standard within scope of order No. OK/990/2012	Editorial board coordinated by T.Wróbel
-	31-08-2015	Page layout corrections, no content changes.	T. Wróbel