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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 medium voltage capacitors' bank of rated voltage 6 kV, and low voltage capacitors' bank of rated voltage 0.4 kV.

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 deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and / or technically superior solutions must be submitted in writing for review and approval by Grupa LOTOS SA. Non-approved exceptions are not acceptable by Grupa Lotos 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

Scope of this specification does not include requirements concerning low voltage switchgear and medium voltage switchgear. Such requirements are covered in electrical branch specifications:

standard Nº 4150 „Medium voltage switchgears"

standard Nº 4140 „Low voltage switchgears"

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 S.A.
- Data Sheets approved by GL S.A.
- This Specification
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

GL S.A. – LOTOS Group S.A.

SN – medium voltage

DC – direct current

IT – electrical network with isolated neutral point

SZR – Auto Transfer Switching system

PPZ – Scheduled Supply Switching-over

DOL – Direct online Motor Start-up

CSNiM – Central Monitoring and Supervision System

KiA – Control Systems and Instrumentation

EMC – Electromagnetic Compatibility

PURCHASER: LOTOS Group S.A.

DESIGN OFFICE: Bidder / Contractor of documentation

SUPPLIER: Bidder / Supplier of equipment/ Contractor of works

Shall – Indicate a mandatory requirement.

5 Description

5.1 Ambient conditions

- Atmosphere: marine, aggressive industrial, chemical and dusty
- Ambient temperature (max/min): +36ºC/-25 ºC
- 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 110V DC. 220V DC (for GPZ1,S7 and S9)

5.3 GL S.A. basic design requirements

5.3.1 Documentation

The bidder (supplier) shall submit to GL S.A. the following documents:

- list of documents
- dimensional drawings
- data sheets filled by supplier
- basic diagram of capacitors' bank
- technical and operating documentation
- spare parts' list
- certificates
- EMC declarations
- declaration of conformity

5.3.2 General requirements

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

Spare parts shall be attainable for 10 years minimum.

Bank of capacitors or active filter shall be designed, manufactured and installed according to this specification.

Design solutions of capacitors' bank, recommended by supplier, shall fulfil requirements of valid standards and regulations, and shall be adjusted with GL SA.

The supplier shall indicate the scope, in which the requirements included in this specification are causing changes in relation to typical solutions. The supplier is obliged to indicate all such differences.

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

5.4 Medium voltage bank of capacitors

5.4.1 Design requirements

5.4.1.1 Conditions of electric supply

The switchgear, to which bank of capacitors shall be connected, has the following rated data:

Operating voltage 10kV or 6kV, 3 phase IT(insulated)

Rated voltage of the switchgear 12kV 3phase IT (insulated)

Rated short-circuit current	min. 31,5kA. 1 sec. (for10kV and 6 kV requires final agreement with GL SA)
Direct current control voltage	110V DC

5.4.1.2 Basic requirements

Power compensation should be provided using a capacitor bank with automatic control

for m.v. motors equal or bigger than 1,5MW with low power factor less than 0,75;

The battery shall be installed to operate in reactive power compensation system for the whole of the switchboard section (current measurement of reactive power shall be determined on the power supply section).

On the each switchboard section, shall be considered bank of capacitor with an adequate number to compensate the reactive power to the required level, minimum cos fi = 0,95.

Reactive power compensation in the basic layout of the battery shall be selected automatically. In addition, it shall be possibility to manually switch off or switch on capacitor banks units. Bank of capacitors shall be adapted to work in networks where are higher harmonics occur.

The remaining requirements are included in data sheet provided by GL SA.

5.4.1.3 Rated parameters

Rated parameters for bank of capacitors shall correspond to reactive power demand of the switchgear section, for which the bank is being selected. The supplier shall make all calculations necessary for selection of the bank, on the grounds of provided by GL S.A. rated data of electric motors.

5.4.1.4 Constructional requirements

The bank shall have metallic, free-standing enclosure, adapted for operation in closed room, outside of hazard explosion area.

The cabinets shall have hinged door at front, while hinged door or removable covers at back.

Structure of the cabinets shall be made of galvanized elements. The remaining elements shall be made of steel sheets coated with epoxide resins, subsequently painted.

The enclosures shall be connected with common system of bus-bars. Fastening of the bus-bars shall ensure withstanding without damage of dynamic stresses and thermal effects, resulting from maximum short-circuit currents, specified in data sheets. Earthing bus-bar shall be installed on the whole length of capacitors' bank assembly.

The enclosure shall be furnished with barriers preventing migration of gases between compartments, or between compartments and bus-bars. Barriers preventing moving of electric arc, shall separate compartments of power circuits from compartments of control and measuring instruments, in order to confine place of electric disturbances or damages.

The barriers shall also be installed between fuses, single-pole switch disconnectors, and knives of three-pole power switch disconnectors.

Cable and bus terminals shall be located in rear part of circuit breaker compartments. Cable and bus terminals shall be arranged in such a manner, that laying and connecting of cables or bus-bar bridges would be facilitated.

All assemblies of banks shall be designed in such a way, that penetration of rodents, insects, etc. to inside of them would be prevented. Door of enclosures shall be equipped with gaskets against rodents / insects.

5.4.1.5 Technical requirements

The bank of capacitors shall be equipped with protection against electric arc and filters or reactors. Technical solutions for the capacitor bank must be agreed with GL S.A. in writing.

The individual units of the batteries must be made in the double star system with the differential protection at a connection point between star points, as a protection against internal short circuit of the individual units.

The bank of capacitors shall be equipped with power factor regulator, which shall be installed on the front door feeding bank of capacitors cubicles of 6 kV switchgear .

For each regulating bank of capacitors modules interlock shall be provided for:

preventing execution of disconnecting elements operation when the contactor is closed, even then, when contactor coil has been switched off

- preventing to opening switch in connection part of capacitor banks when the contactor of any part is switch on or when switch in supply buy of capacitor bank is switch on
- preventing to opening of the contactor compartment door, if switch in connection part of capacitor bank is switch on. preventing to opening the compartment door with contactor before time 600s required to discharge capacitors banks after switching off in connection part

Circuit breakers mounted in the capacitor banks feeder buy shall have:

- possibility of closing the padlock in test position
- possibility of manual switching on and off, with mechanical indicator of position

5.4.1.6 Auxiliary equipment

Relays

Capacitor banks at feeder part shall be protected by:

- short-circuit protection
- overload protection with time/current characteristic of protection releases or time delay depends on selectivity of protection
- protection against earth faults shall be comply to work with system with non-earthed star point. Digital protecting units shall be located in MV supply bay .
- zero differential protection of the double star points, shall be performed separately for each of the battery segments
- undervoltage protection
- overvoltage protection
- protection before switching on undischarged capacitor banks

Digital protection terminals must be used, located in the individual battery units and the m.v. switchgear's feeders, accordingly.

As an individual short-circuit protection of the battery units , contactor and fuses located directly in the battery cabinets shall be used.

Additionally protection provided by manufacturer for the type of battery shall be used.

Current transformers

Rated data of current transformers installed inside modules of capacitor banks shall be selected accordingly:

- thermal and magnetic loads resulting from breaking currents or disturbance from other protective devices, connected with those measuring transformers.
- rated primary current, at open secondary winding, for 1 minute.

Rated data of measuring transformers, such as current, load, class (accuracy) shall be matched to their functions, loads and predestination.

Voltage transformers and their fuses shall be mounted to ensure easy access for replacement of the fuse (after switching off capacitor from exploitation)

5.5 Low voltage bank of capacitors

5.5.1 Design requirements

5.5.1.1 Electric supply conditions

The switchgear, to which the bank of capacitors shall be connected, has the following rated data:

Insulation rated voltage	Ui = 1000V
Operating rated voltage	Ue= 690V
Rated short circuit current	min. 60kA. 1 sec.
Auxiliary voltage	24V DC, 110V DC or 230V AC
Supply system	TN-C/S
Outgoing feeders	TN-S (Circuit breakers, fuse switch disconnectors in 4-pole version)

The auxiliary voltage shall be finally agreed with GL SA.

5.5.1.2 Basic requirements

Power compensation of low voltage 0.4 kV consumers shall proceed with use capacitors banks with automatic control. Banks of capacitors shall be connected to adequate sections of main low voltage switchgear. Compensation shall lead to reaching of power factor cos φ = 0.98 as minimum. Regulation of reactive power compensation shall proceed automatically. Bank of capacitors shall be adapted to work in networks where higher harmonics occur. The other requirements are included in data sheet provided by GL SA.

5.5.1.3 Rated parameters

Rated parameters for bank of capacitors shall correspond to rated output of power transformers feeding low voltage switchgear, as well as to reactive power demand of the switchgear, for which the bank is being selected. The supplier shall make all calculations necessary for selection of the bank, on the basis of rated data of the transformers and power balance of low voltage switchgear, provided by GL SA.

5.5.1.4 Constructional requirements

The bank shall have metallic, free-standing enclosure, adapted for operation in closed room, outside of hazard explosion area.

The cabinets shall have hinged door at front, while hinged door or removable covers at back.

The enclosures shall be connected with common system of bus-bars. Fastening of the bus-bars shall ensure withstanding without damage of dynamic stresses and thermal effects, resulting from maximum short-circuit currents, specified in data sheets. Earthing bus shall be installed on the whole length of capacitors' bank assembly.

Cable and bus terminals shall be located in rear part of cabinets. Cable and bus terminals shall be arranged in such a manner, so that laying and connecting of cables or bus-bar bridges would be facilitated.

All assemblies of banks shall be designed in such a way, that penetration of rodents, insects, etc. to inside of them would be prevented. Door of enclosures shall be equipped with gaskets against rodents / insects.

5.5.1.5 Technical requirements

In case of exceeding allowable emission of interferences specified in PN-EN 50160 standard, being sent to network by power engineering equipment, it is necessary to install reactors on the bank, suppressing higher harmonics.

The capacitor banks shall be equipped with power factor regulator, which shall be installed in on the front door of capacitor bank.

5.6 Power Quality Filters

5.6.1 Design requirements

5.6.1.1 Electrical conditions

Switchgear where the power quality filter will be use shall have following parameters:

- rated insulation voltage level Ui = 1000V
- rated operating voltage Ue = 690V
- nominal short-circuit min. 60kA. 1s.
- auxiliary voltage 110V auxiliary DC
- power System for TN-C-S
- output feeders TN-S (switches, Fuse switch-disconnectors version 4-pole)
- auxiliary voltage level shall be agreed with GL SA.

5.6.1.2 Basic requirements

For the compensation of reactive power of low voltage circuits follow-up capacitor banks shall be used.
Power quality filters shall be connected to the relevant section of the main low-voltage distribution switchgear.
Reactive power compensation shall lead to the achievement of the power factor cos fi = 0,98 minimum.
Power quality filters shall compensate for reactive power.
Reactive power compensation shall take place automatically.
Power quality filters shall be adaptable to work in networks where high harmonic are accrues
Other requirements are included in the data sheet provided by the GL SA.

5.6.1.3 Nominal data

Nominal data of Power Quality Filter shall comply with reactive power consumption by switchgear.
Manufacturer shall prepared all calculations required to power quality filter selection, Calculation shall be ma made on the basis of the power balance of switchgear, delivered by the GL SA.

The manufacturer shall perform all the necessary quality parameters measurements of electricity with a view to the selection of active filter and its parameterization.

5.6.1.4 Construction requirements

Power quality filter shall have a metal housing, free-standing, adapted to work in an enclosed, outside of the Ex Zone. Power quality filter cabinets shall have a hinged door from the side, from which the support or maintenance of the device will be provided.
The Cabinet shall have at the back and sides of the hinged door or demountable covers. Cable terminals and busbars shall be located at the rear part of cabinet.
Cable terminals and busbars shall be located to have easy access to cable connection or busbars.
All Power Quality Filters are to be so designed to prevent the penetration to the center of the rodents, insects, etc. Enclosures are to be fitted with door gaskets rodents/insects.

5.7 Control and signalling

Contactors shall be controlled through electronic regulator of power factor.

The banks of capacitors shall be such equipped, that leading out of the following signals to central control room would be possible:

- the capacitor bank is switch on (potential-free contact 1C)
- the bank is emergency switched off (potential-free contact 1C)

From the Power Quality filter below listed signals shall be transmitted to central control room:

- the power quality filter is switch on (potential-free contact 1C)
- the power quality filter is emergency switch off (potential-free contact 1C)

5.8 Degree of protection

Degree of protection for capacitor banks and power quality filter shall conform to PN-EN 60529 standard, but not less than IP 41.

5.9 Battery limits of design and deliveries

5.9.1 Designing

The supplier is fully responsible for:

- selection of all parts of capacitor banks or selection all parts of power quality filters (including current transformers selection)
- power and control cable selection
- provide information about cable glands requirements
- provide information and requirements for main protection of Power Quality Filter
- capacitors to select all the elements of the active filter (including the electrodes current transformers) the correct selection of power cables and transmission control requirements for the transfer of the main security requirements cable screw-in filter Cabinet active

5.9.2 The completeness of the supplies and services

The supplier is fully responsible for:

- Delivery of factory assembled Capacitor banks including filters(high harmonics reactor) full wiring or delivery package Unit including Power Quality Filter with current transformers and wiring.
- Cable glands for delivered equipment including feeder cables

Furthermore, the supplier shall deliver instruments for detection and removal of defects.

5.10 Marking

All equipment and instruments shall be labelled according to numbers specified on drawings enclosed to factory documentation of capacitors' bank or Power Quality Filter.

5.11 Painting

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

5.12 Quality control

The quality control shall be carried out according to requirements of valid ISO 9001 standards and regulations. The manufacturer procedures shall be applied as a minimum.

5.12.1 Inspection

Inspection of capacitors' bank or Power Quality Filter 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 all requirements of this specification.

5.12.2 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 S.A. for revision schedule of factory tests and activities, resulting from procedures regarding these tests, 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.

5.12.3 Acceptance

Acceptance of the capacitors' bank by Buyer can 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.

5.12.4 Tests on installation site

It is necessary to perform tests on installation site of the capacitors' bank, according to technical and operation documentation of the supplier.

5.13 Guarantee requirements

Main requirements regarding the guarantee are contained in purchase documentation. The guarantee shall ensure maintaining of specified output parameters of the capacitor bank or power quality filter, until its lifetime expiration.

5.14 Deliveries

The bank of capacitors shall be delivered to GL S.A. according to requirements contained in purchase documentation.

All equipment shall be protected for time of transport. Particular attention shall be paid on protections of measuring instruments and protecting devices. Cable entrances shall be protected with airtight plugs of IP protection degree corresponding to rated protection degree of the capacitor banks.

The equipment shall be protected against moisture penetration and improper handling during transportation and storage.

Not connected terminals of cables and conductors shall be protected by means of thermo-shrinkable tips, in order to protect them against leakage current caused by moisture.

6 Relevant documents

- Other Technical Specifications, shown on delivered List of Technical Specifications for GL S.A.

7 Codes and standards

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

PN-EN 50178	Electronic equipment for use in power installations
PN-EN 55016-2-1	Requirements for measuring apparatus and methods of measurement of radio disturbance and immunity research on disorders - Part 2-1: Methods of measurement of disturbances and immunity test - Measurement of conducted disturbances
PN-EN 61800-3	Electrical power drive systems with adjustable speed - Part 3: EMC requirements and specific test methods
PN-EN 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Test of resistance to electrostatic discharge
PN-EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Test of resistance to a series of electrical fast transients
EN 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test

PN-EN 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6 : Testing and measurement techniques - Immunity to conducted disturbances , induced by radio-frequency fields
EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2 : Generic standards - Immunity for industrial environments
PN-EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4 : Generic standards - Emission standard for industrial environments
PN-EN 60143-2	Power capacitors for reactive power compensation serial . Part 2 : Protective equipment for series capacitor banks
PN-EN 61921	Power capacitors . Battery low voltage capacitors for power factor correction
PN-EN 61642	Industrial ac networks affected by harmonics . The use of filters and capacitors for parallel reactive power compensation
PN-EN 50160	Voltage characteristics of electricity supplied by public distribution networks.
PN-EN 60038	CENELEC standard voltages
PN-EN 60445	Basic and safety principles for man- machine interface, marking and identification . Identification of the terminal equipment and cable terminations
PN-EN 60529	Degrees of protection provided by enclosures (IP Code)

Equipment for reactive power compensation made by other norms and standards must be submitted to GL SA for approval.

8 Record of changes

No.	Date	Description	Introduced by
		This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 422 with the same title.	J. Bućko

2	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
3	20-05-2014 (rew. 2)	The requirements to use banks capacitors in the double star system.	J. Bućko T. Wróbel